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Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee

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ACRONYMS

AWQC	ambient water quality criteria
ARARs	applicable or relevant and appropriate requirements
BCBG	Bear Creek Burial Grounds
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COCs	contaminants of concern
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EMDF	Environmental Management Disposal Facility
EMWMF	Environmental Management Waste Management Facility
ETTP	East Tennessee Technology Park
EPA	U.S. Environmental Protection Agency
FR	Federal Register
HDPE	high-density polyethylene
LWTS	Landfill Wastewater Treatment System
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OF200 MTF	Outfall 200 Mercury Treatment Facility
PWTC	Process Water Treatment Complex
RCRA	Resource Conservation and Recovery Act
TBC	to be considered
TDEC	Tennessee Department of Environment and Conservation
UEFPC	Upper East Fork Poplar Creek
WAC	waste acceptance criteria
Y-12	Y-12 National Security Complex

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EXECUTIVE SUMMARY

The purpose of this focused feasibility study (FFS) is to evaluate alternatives for the management of landfill wastewater generated from the on-site disposal of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) waste from the Oak Ridge Reservation and associated sites. The waste has been disposed at the Environmental Management Waste Management Facility (EMWMF) and will be disposed in the future at the proposed Environmental Management Disposal Facility (EMDF).

Currently, contact water from EMWMF is discharged to Bear Creek if it meets the discharge limits that are based on the fish and aquatic life criterion maximum concentration ambient water quality criteria. If the contact water does not meet the discharge limits, it is conditioned to meet the discharge limits or transferred by tanker truck to the Process Water Treatment Complex (PWTC) at the Oak Ridge National Laboratory for treatment and disposal. Leachate is transferred by tanker truck to PWTC for treatment and disposal

The alternatives evaluated are:

- Alternative 1: No Action
- Alternative 2: Managed Discharge/Treat at EMWMF/proposed EMDF site
- Alternative 3: Treat at the PWTC at the Oak Ridge National Laboratory
- Alternative 4: Treat at Outfall 200 at the Y-12 National Security Complex.

All alternatives, except No Action, meet the threshold criteria of overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements. Alternative 2 can be implemented immediately at EMWMF for existing discharge limits for no additional capital cost. Capital costs are required for construction of a right-sized, adaptable landfill wastewater treatment system that will provide treatment to meet the new discharge limits with the ability to adapt to changing contaminants of concern (COCs). Since neither the PWTC nor the Outfall 200 Mercury Treatment Facility are designed to treat all the key COCs in the landfill wastewater, both alternatives require pretreatment in order to provide long-term effectiveness. In addition, the landfill wastewater has to be transported to both sites. Therefore, the capital cost of these alternatives is greater than Alternative 2. Alternatives 2, 3, and 4 are all easy to implement because the treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easy to construct using standard equipment and techniques.

While this FFS describes the landfill wastewater management evaluation for both EMWMF and the proposed EMDF, implementation will be tailored to the current phase of the CERCLA process for each. EMWMF is currently operating and is nearing capacity, while the proposed EMDF is in the initial stages of the CERCLA planning process.

- Proposed EMDF. The selection and approval of a landfill wastewater management alternative will be included in the proposed plan. The record of decision will document acceptance of the recommendation. Implementation of landfill wastewater management will continue as part of the normal CERCLA process for the proposed EMDF, from design to initiation of operations.
- EMWMF. An Explanation of Significant Differences for the EMWMF record of decision will be prepared to include landfill wastewater management and provided for public review and comment. Following approval, the remedial action work plan, operations plan, and the sampling and analysis plan/quality assurance project plan will be revised for implementation.

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1. INTRODUCTION

1.1 PURPOSE

The purpose of this focused feasibility study is to evaluate alternatives for the management of landfill wastewater generated from the on-site disposal of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) waste from the Oak Ridge Reservation (ORR) and associated sites. This CERCLA waste is currently being disposed at the on-site Environmental Management Waste Management Facility (EMWMF) and will be disposed in the future at the proposed on-site Environmental Management Disposal Facility (EMDF). EMWMF is located in the Bear Creek watershed. The proposed EMDF is planned to be constructed in the same watershed. The alternatives will provide both short-term and long-term solutions for the management of landfill wastewater generated during operation of the disposal facilities and during post-closure. This solution will supersede any previous decisions (*Addendum to Remedial Design Report for Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* [DOE/OR/01-1873&D2/A1/R2]) for landfill wastewater management. During the planning process for the proposed EMDF, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) agreed to evaluate the management of landfill wastewater in a focused feasibility study and then to integrate the evaluation into the decision-making documents for the proposed EMDF and EMWMF.

This is a focused feasibility study because it only addresses the management of landfill wastewater generated from EMWMF and the proposed EMDF. The evaluation from this focused feasibility study will be included in the *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge Tennessee* (DOE/OR/01-2535&D4), currently being prepared for the proposed EMDF, and in other appropriate EMWMF CERCLA decision-making documents (see Sect. 1.10, "Estimated Timeline"). The appropriate CERCLA decision-making documents are described for each alternative (Sect. 3.3, "Description of Alternatives").

Because this focused feasibility study is focused only on landfill wastewater management from engineered facilities, the hydrogeology of the site, soils information, and ecological information is not included in this focused feasibility study. This information is contained in the *Remedial Investigation/Feasibility Study for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* (DOE/OR/02-1637&D2 and DOE/OR/02-1637&D2/A1) and the proposed EMDF remedial investigation/feasibility study (DOE/OR/01-2535&D4).

1.2 ORGANIZATION OF THE STUDY

This focused feasibility study consists of six chapters and supporting appendices.

- Chapter 1, "Introduction," describes the purpose of the study and site conditions.
- Chapter 2, "Remedial Action Objectives," presents the objectives of the study and an introduction to the applicable or relevant and appropriate requirements (ARARs).
- Chapter 3, "Development and Description of Alternatives," summarizes the assemblage of representative process options into alternatives to meet the remedial action objectives and describes each alternative.

- Chapter 4, "Analysis of Alternatives," evaluates the ability of the alternatives and no action to achieve the evaluation criteria and to meet the remedial action objectives, and summarizes the alternative evaluations as compared to no action.
- Chapter 5, "References," provides full citations for documents used in the preparation of this study and cited in the main text.

The appendices provide supporting data and additional information, including:

- Appendix A, "Bear Creek Burial Grounds Evaluation," is an evaluation of Bear Creek Burial Grounds (BCBG) as a scope element.
- Appendix B, "Contact Water and Leachate Flow Rate," describes the development of flow rates.
- Appendix C, "Explanation of How the Key Contaminants of Concern Were Developed," provides an explanation of the key contaminants of concern (COCs).
- Appendix D, "Applicable or Relevant and Appropriate Requirements," is a complete set of proposed ARARs.
- Appendix E, "Mercury Concentration in Environmental Management Disposal Facility Leachate," is a projection of mercury concentration in the proposed EMDF leachate.
- Appendix F, "Leachate and Contact Water Waste Determination," is a discussion of waste determination for leachate and contact water.
- Appendix G, "Zero Discharge," evaluates the feasibility of zero discharge of landfill wastewater.
- Appendix H, "Water Storage Requirements," develops the amount of water storage required.
- Appendix I, "Basis of Cost Estimates," presents the basis of the cost estimates.
- Appendix J, "Screening Water Sampling Results for Evaluating Compliance With ARARs"
- Appendix K, "Development of Discharge Limits for Landfill Wastewater"
- Appendix L, "Proposed Sampling Approach for the Water Management Focused Feasibility Study"

1.3 SITE DESCRIPTION

The approximately 33,000-acre DOE ORR is located within and adjacent to the city limits of Oak Ridge, Tennessee in Roane and Anderson counties (Fig. 1). The ORR is bounded to the east and north by the developed portion of the city of Oak Ridge. The three major industrial, research, and production facilities originally constructed as part of the World War II-era Manhattan Project and currently managed by DOE are the East Tennessee Technology Park (ETTP), the Oak Ridge National Laboratory (ORNL), and the Y-12 National Security Complex (Y-12).

Historic nuclear research and national defense-related operations on the ORR have led to the contamination of soil, surface water, sediment, groundwater, and buildings and have resulted in burial of material at various sites on the ORR. Because of these contaminant releases, ORR was placed on the EPA National Priorities List established under CERCLA (54 *Federal Register* [FR] 48184, November 21, 1989). DOE, TDEC, and EPA signed the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014) that describes how CERCLA remediation activities are performed on the ORR.

The Bear Creek watershed (Fig. 2) contains closed and active waste disposal facilities, including EMWMF and BCBG, and is the proposed location for the proposed EMDF. For the purpose of this

focused feasibility study, the location of the proposed EMDF is assumed to be contiguous to EMWMF. However, the location has not been finalized, and the alternatives evaluated in this focused feasibility study also address alternate locations (see Sect. 2.1). Bear Creek is classified for fish and aquatic life, recreation, livestock watering and wildlife, and irrigation uses (TDEC 0400-04-03). Bear Creek is designated by TDEC as an impacted stream due to nitrates (TDEC 2014a, *Year 2012 303(d) List*), contains cadmium and mercury concentrations that exceed Tennessee ambient water quality criteria (AWQC) in some locations, and is adversely affected by polychlorinated biphenyls and uranium (TDEC 2014b, Janjic, V.). The *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE/OR/01-1750&D4) establishes protectiveness and cleanup levels for the Bear Creek watershed and specifies remedial actions for the S-3 Site, the Oil Landfarm Area (Oil Landfarm Soil Containment Pad, Boneyard/Burnyard, and North Tributary-3), and the Disposal Area Remedial Action Facility.

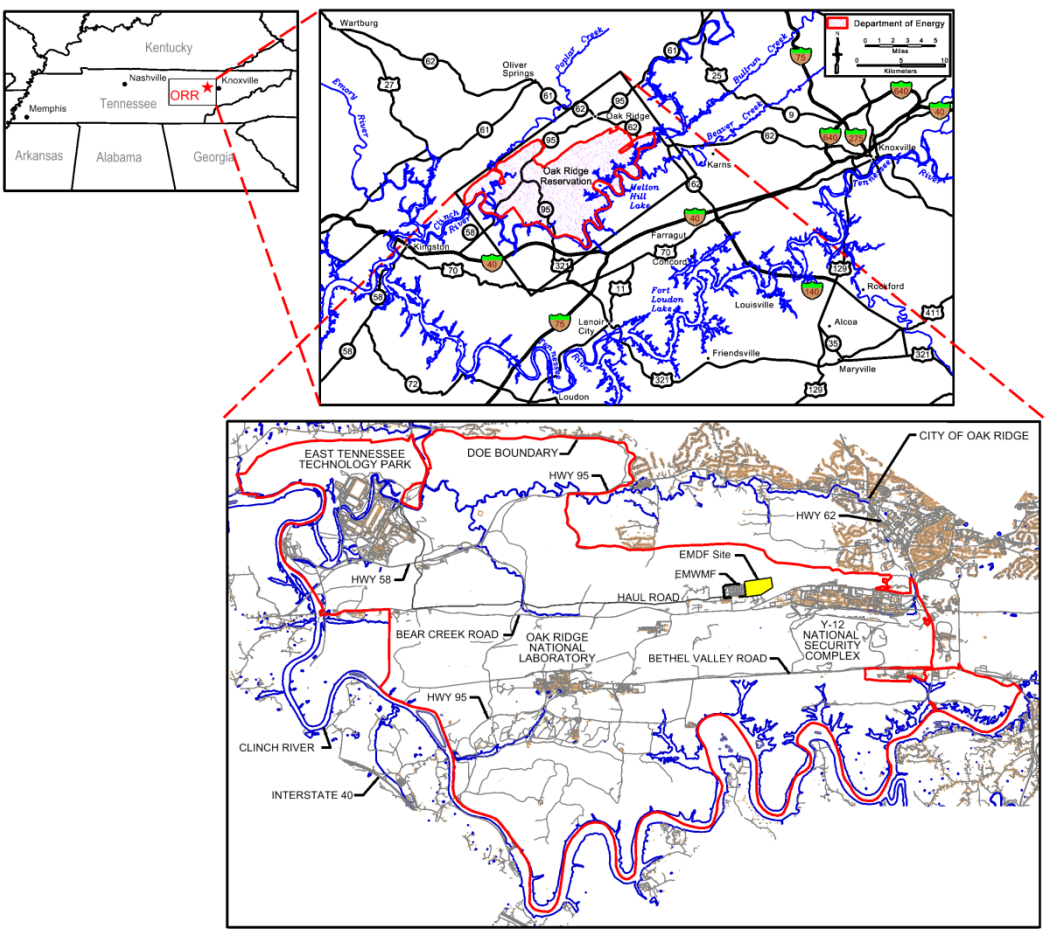

Fig. 1. Oak Ridge Reservation.

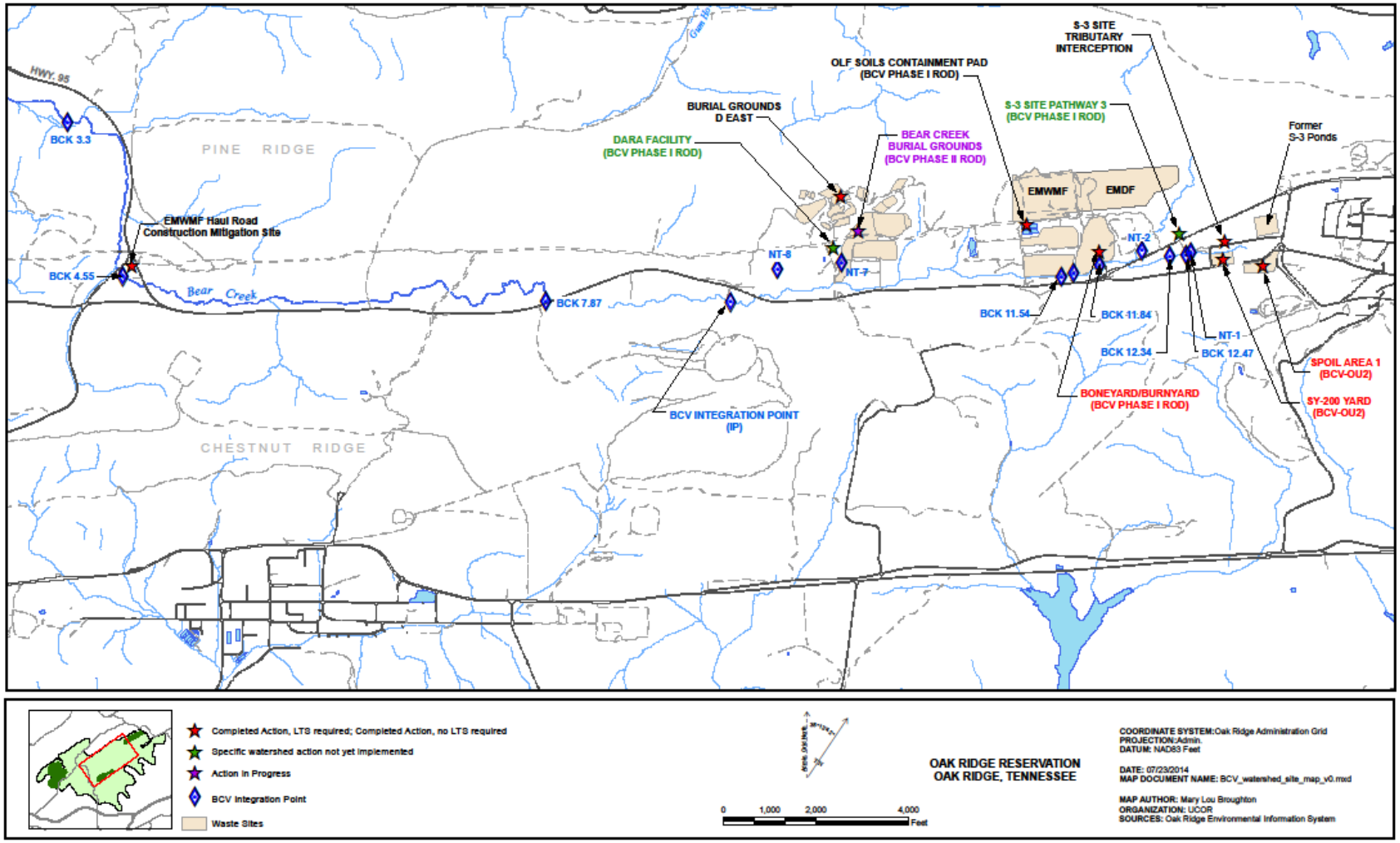

Fig. 2. Bear Creek watershed.

The *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* (DOE/OR/01-1791&D3) presents the selected remedy for the disposal of waste generated from CERCLA cleanup activities performed by DOE on the ORR and associated sites. This remedy is the design, construction, operation, and closure of EMWMF located in the Bear Creek watershed on the ORR. Following approval of the Record of Decision, three Explanations of Significant Difference were prepared to:

- Add classified waste to the description of waste approved for disposal in EMWMF (DOE/OR/01-1905&D2, *Explanation of Significant Difference from the Remedy in the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*)
- Construct a dedicated haul road for the transportation of waste from ETTP to EMWMF (DOE/OR/01-2194&D2, *Explanation of Significant Difference from the Remedy in the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*)
- Construct Cell 6 to expand EMWMF (DOE/OR/01-2426&D2, *Explanation of Significant Difference from the Remedy in the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*)

EMWMF began operations in 2002 and currently is receiving radioactive, hazardous, and mixed wastes from CERCLA actions on ORR and associated sites. EMWMF consists of six disposal cells with a total capacity of 2.2 million cubic yards (Fig. 3). The scope of the cleanup program has increased since the original waste estimates, and another on-site disposal facility, the proposed EMDF, is proposed to provide additional waste disposal capacity. The proposed EMDF is expected to consist of six cells with a total capacity of 2.5 million cubic yards (DOE/OR/01-2535&D4) (Fig. 4).

Fig. 3. Environmental Management Waste Management Facility.

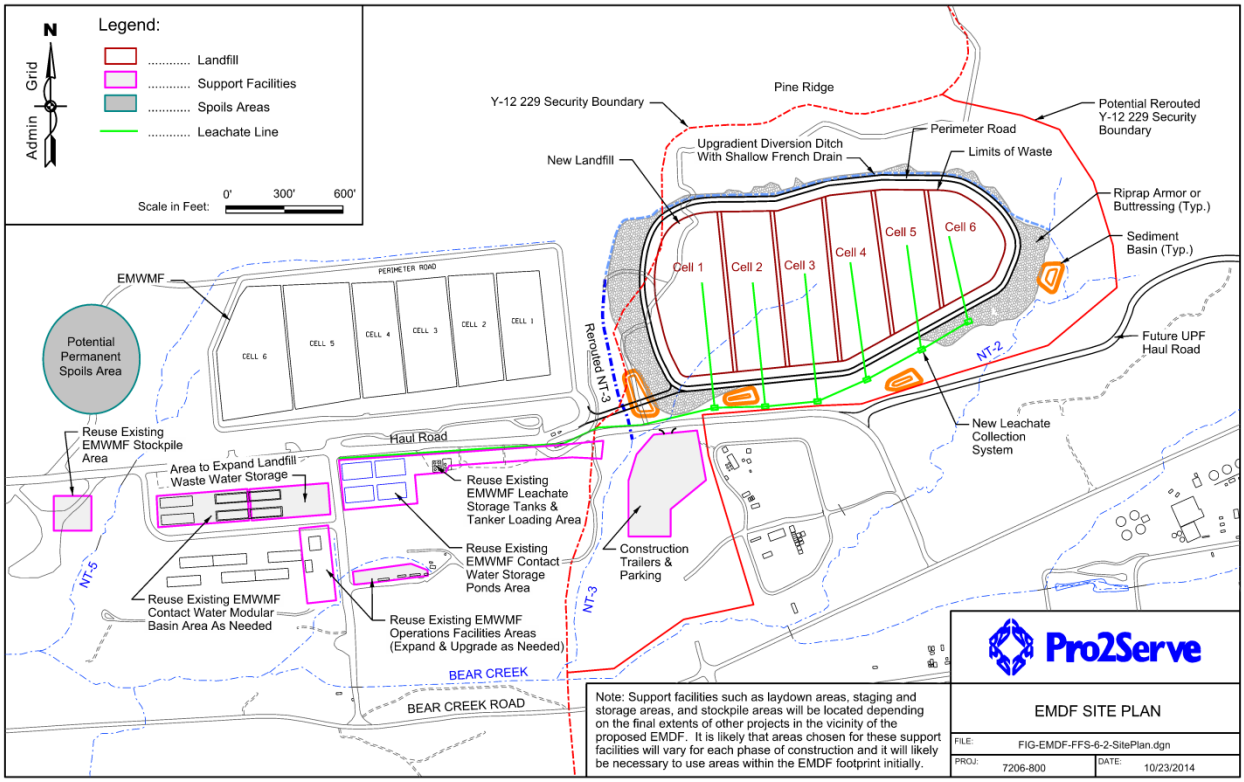

Fig. 4. Proposed Environmental Management Disposal Facility.

1.4 SITE ECOLOGY

Site ecology is described in the *Remedial Investigation/Feasibility Study for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* and the *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge Reservation*. The area surrounding EMWMF and the proposed EMDF has been strongly influenced by anthropogenic structures and industrial activities. Most of the area is covered with grass and engineered structures, such as the EMWMF disposal cells. As a result, this area provides little habitat for terrestrial vertebrates. The likelihood of the existence of federal or state-listed species in this area is low.

Bear Creek and the north tributaries are the dominant aquatic features in the area. Bear Creek has both gaining and losing stretches, with periods of zero flow in the summer months.

1.5 EVALUATION OF THE BEAR CREEK BURIAL GROUNDS FOR INCLUSION IN THE FOCUSED FEASIBILITY STUDY

BCBG was evaluated to determine if it will be feasible to include management of BCBG leachate in the scope of this focused feasibility study. BCBG is a former waste disposal area for radiologically and chemically contaminated waste generated primarily at Y-12. BCBG consists of several waste disposal units designated as BCBG Unit-A, -B, -C, -D, -E, -J, and Walk-in Pits. Each waste disposal unit consists of a series of trenches used for disposal of liquid and solid wastes. The primary wastes disposed in BCBG

were uranium, potentially reactive and explosive waste, organic compounds, polychlorinated biphenyls, acids, metals, and other radionuclides.

Similar to EMWMF and the proposed EMDF, BCBG is also in the Bear Creek watershed and is close to the location of EMWMF and proposed EMDF. Some of the BCBG leachate is collected and adequately processed for release at the Y-12 Groundwater Treatment Facility. However, other sources not currently captured have a negative impact on Bear Creek water quality. Therefore, DOE, EPA, and TDEC agreed to consider the inclusion of BCBG leachate management in this focused feasibility study.

An evaluation of historical information, documented feasibility studies, and remedial effectiveness reports indicate that BCBG leachate is not appropriate for inclusion in this focused feasibility study. Key reasons for this conclusion are:

- The flow rate of contaminated surface water nearest to BCBG seeps is far greater than what is expected for the combined EMWMF and proposed EMDF landfill wastewater volumes.
- The contaminants are not consistent with those at EMWMF and the proposed EMDF.
- No CERCLA remedial decision has been made for the remediation of BCBG.
- The leachate contains Resource Conservation and Recovery Act (RCRA)-listed hazardous waste.
- The larger flow rate and the different contaminants will increase the cost for the EMWMF and proposed EMDF landfill wastewater treatment alternatives. The lack of a BCBG CERCLA decision, high flow rates, and the presence of RCRA-listed hazardous waste introduce too much uncertainty to be addressed in this focused feasibility study.

Appendix A provides further details for evaluating the inclusion of BCBG leachate in the scope of this focused feasibility study.

1.6 EMWMF AND PROPOSED EMDF LANDFILL WASTEWATER MANAGEMENT OPERATIONS

The scope of this focused feasibility study is the management of EMWMF and proposed EMDF landfill wastewater. Landfill wastewater is defined in 40 *CFR* 445.2 as "all wastewater associated with, or produced by, the landfilling activities, including, but not limited to leachate, contaminated storm water, and contact wash water from washing trucks, equipment, and surface areas which have come in direct contact with waste at the facility".

UCOR-4135/R1, *Environmental Management Waste Management Facility (EMWMF) Operation Plan, Oak Ridge, Tennessee,* describes, and Fig. 5 illustrates, how landfill wastewater from EMWMF currently is managed. The landfill wastewater types are:

- Contact water—Contact water is precipitation that falls into an active EMWMF cell, comes in direct contact with waste, is pumped to the contact water tanks from the liner, and does not infiltrate into the leachate collection system. Because contact water contacts the waste, it potentially is contaminated.
- Leachate—Leachate is precipitation that falls into an active cell, infiltrates through the waste, infiltrates through the liner, is collected by the leachate collection system, and is pumped to the leachate storage tanks. Because leachate contacts the waste, it potentially is contaminated. Leachate does not include any liquid wastes, because these are specifically prohibited in accordance with the *Attainment Plan for Risk/Toxicity-Based Waste Acceptance Criteria at the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-1909&D3).

TDEC 0400-11-01 defines leachate as "a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste." RCRA (40 *CFR* 260.10) defines leachate as "any liquid, including any suspended components in the liquid that has percolated through or drained from hazardous waste."

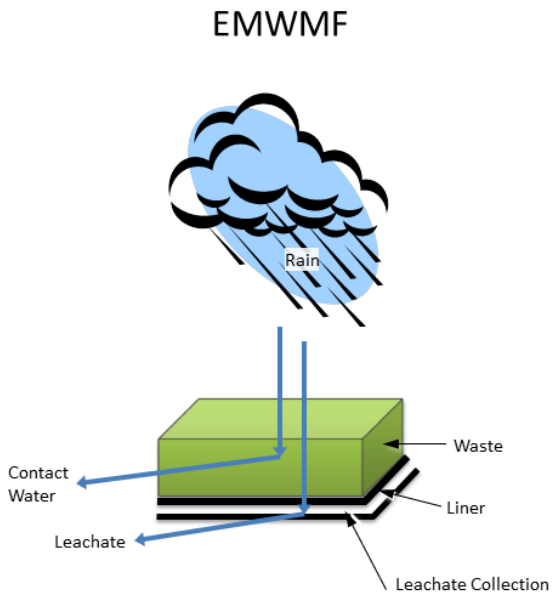

Fig. 5. Landfill wastewater management at EMWMF.

The volume of landfill wastewater is minimized by shedding and diversion of stormwater to the extent possible through landfill design and operating characteristics. Stormwater is precipitation that does not fall into an active cell, does not encounter waste, and does not become contaminated. Therefore, stormwater is not included in this focused feasibility study. Stormwater is addressed in the *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge Reservation*.

Currently, EMWMF contact water is collected in catchments in each disposal cell and pumped to the contact water ponds and contact water tanks. The contact water is sampled and analyzed to determine if the discharge limits contained in the *Addendum to Remedial Design Report for Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* are met. If the discharge limits are met, then the contact water is pumped into the Sediment Basin and discharged to North Tributary-5 of Bear Creek. If the discharge limits are not met, the contact water is treated to meet the discharge limits (currently performed for hexavalent chromium) or transferred by tanker truck to the on-site Process Water Treatment Complex (PWTC) at ORNL for treatment and disposal.

EMWMF leachate is collected by the leachate underdrain, pumped to the leachate storage tanks and loading stations, and transferred by tanker truck to the on-site PWTC for treatment and disposal. The proposed EMDF landfill wastewater will be collected and stored, treated, and/or disposed in accordance with the evaluation of this focused feasibility study. The capacities of the EMWMF contact water catchments, ponds, and tanks and the leachate storage tanks are in Table 1. This capacity is inadequate for operation of the combined EMWMF and proposed EMDF, and an additional 500,000 gal of storage will be needed when the proposed EMDF begins operation.

Table 1. Contact water and leachate storage capacity at EMWMF

Location	Normal maximum capacity (gallons)	Subtotal (gallons)	Remarks
Cell 5 catchment	3,400,000		
Cell 6 catchment	2,400,000		Reserve capacity until Cell 6 opens.
		5,800,000	
CWP #1	482,300		
CWP #2	492,300		
CWP #3	404,600		
CWP #4	425,000		
		1,804,200	
CWT A	235,000		
CWT B	235,000		
CWT C	235,000		
CWP D	235,000		
		940,000	
Leachate Storage Tanks	240,000		Total of 8 leachate storage tanks.
		240,000	
Total		**8,784,200**	

CWP = contact water pond
CWT = contact water tank

The proposed EMDF approach to landfill wastewater collection may differ from EMWMF. A high permeability material in the catchment areas (referred to as "windows") is being considered to allow contact water to percolate quickly into the leachate collection system, thus allowing collection and management as one stream. However, the proposed EMDF approach to landfill wastewater collection will not be finalized until design. The proposed EMDF will utilize the existing EMWMF water storage and transfer systems, along with additional water storage tanks, to the extent practicable.

1.7 EMWMF AND THE PROPOSED EMDF LANDFILL WASTEWATER QUALITY

DOE, EPA, and TDEC agreed to evaluate the management of landfill wastewater from EMWMF and the proposed EMDF in a focused feasibility study and to integrate the evaluation into the CERCLA decision-making documents for the proposed EMDF and, if appropriate, for EMWMF.

COCs for EMWMF were identified initially from the COCs listed for the ORR CERCLA remediation sites that were to send waste to EMWMF for disposal. Contaminants shown through calculations to be a risk were included as COCs to reduce or eliminate their exposure to humans and release to the environment. Waste acceptance criteria (WAC) for EMWMF limit the COCs and/or their concentration that may be placed in EMWMF. Additionally, a list of contaminants known to or that can potentially migrate into the environment was established for surface water and groundwater sampling on the ORR.

The COCs for EMWMF landfill wastewater were developed from the EMWMF WAC list and the list of contaminants for ORR surface water and groundwater monitoring. EMWMF COCs are contained in the *Sampling and Analysis Plan/Quality Assurance Project Plan for Environmental Monitoring at the*

Environmental Management Waste Management Facility (UCOR-4156) and in Appendix C of this focused feasibility study. These COCs apply to both EMWMF and the proposed EMDF for this focused feasibility study.

The concentrations of certain contaminants in landfill wastewater from EMWMF have changed over time, particularly as the origin of the waste received changes. This is particularly noticeable for uranium isotopes and strontium (Sr) as the origin of the waste has changed from Y-12 to ORNL to ETTP. Figure 6 reflects these changes over time, and indicates the potential variability in contaminants as the origin of the waste changes in the future.

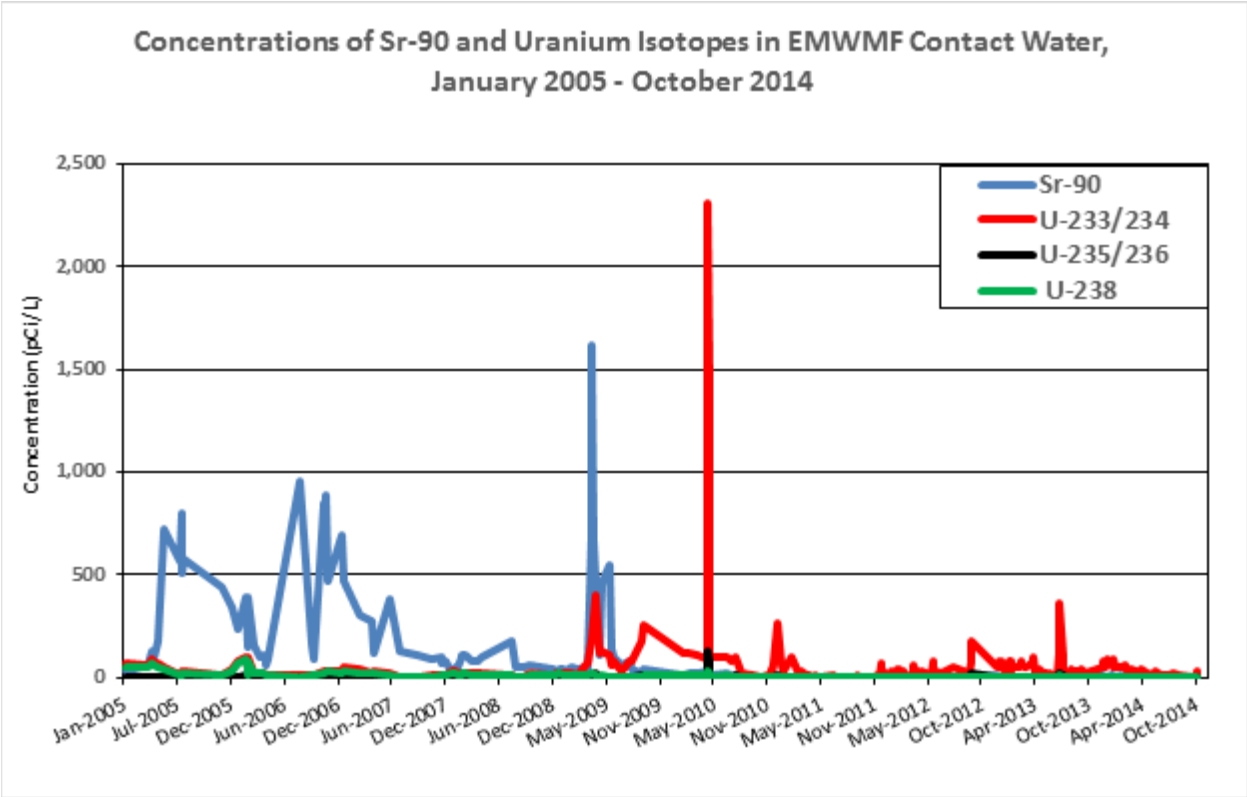

Fig. 6. Concentrations of Sr-90 and uranium isotopes in EMWMF landfill wastewater (Jan. 2005–Oct. 2014).

Because of the different contaminants at ETTP, ORNL, and Y-12, the variability in waste lots and associated waste contaminants over time, the presence of unexpected contaminants, and the mobility of the disposed contaminants, the contaminants in the EMWMF landfill wastewater have varied over time. As shown in Fig. 6 and Appendix C, at times in the past, specific contaminants have appeared for a short time, but are not currently in the landfill wastewater. It is expected that this situation will continue in the future so that both the contaminants and concentrations in the landfill wastewater will vary over time and for varying periods of time (Fig. 7).

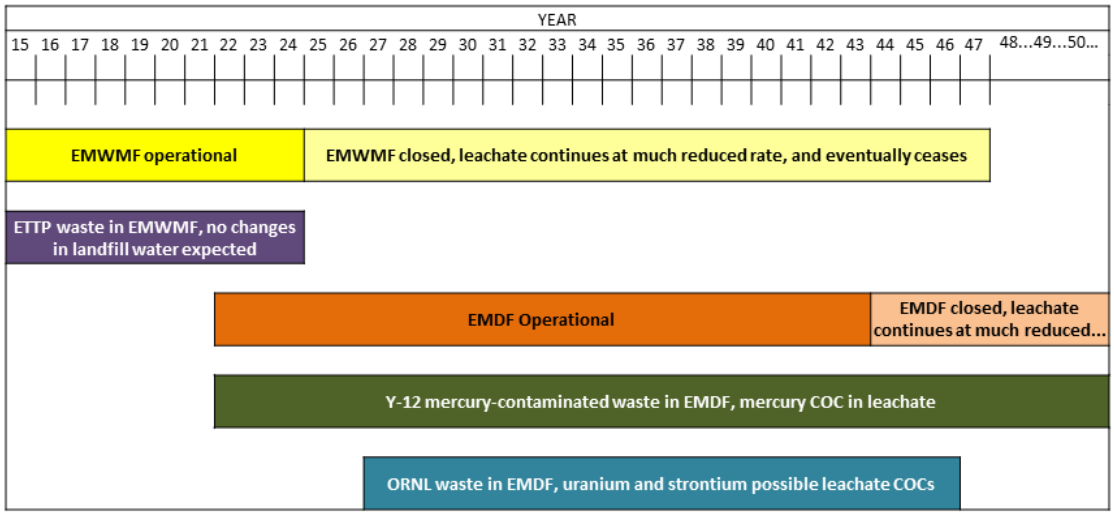

Fig. 7. Contaminants of concern requiring treatment vary over time.

However, to identify the key COCs for this focused feasibility study, all of the COCs were screened against their abundance in EMWMF waste lots, their mobility, stability, and persistence in EMWMF and the surrounding environment, and potential risk concern (Appendix C). Based on this screening, the key COCs were determined upon which this focused feasibility study is based. Table 2 lists the key COCs and their minimum, average, and maximum concentrations in leachate and contact water observed over the past two years at EMWMF. Two years of data were selected to ensure the current contaminants and concentrations are evaluated. EMWMF and the proposed EMDF will periodically evaluate the full suite of contaminants that might be present in the landfill wastewater (see Appendix L). Based on the results, COCs and/or treatment options will be adjusted accordingly. Due to the uncertainty in the contaminants to be treated over time, the ability of the alternatives in this focused feasibility study to adapt quickly and easily to changing treatment requirements will be a key criterion of the evaluation.

The concentration of mercury in the proposed EMDF landfill wastewater does not use the concentration from EMWMF, but uses a concentration derived from the analysis described in Appendix E.

The concentrations in Table 2 are used in this focused feasibility study, and their application to each alternative is discussed in Sect. 3.3. The concentrations of the key COCs in landfill wastewater will change over time due to the wide range of contaminants in debris and soil at ETTP, ORNL, and Y-12. Therefore, the ability to adapt quickly and easily to changes is an important consideration in the evaluation of alternatives.

Based on a combination of process knowledge, historical analytical data, approved EMWMF waste lots and disposal records, and physical characteristics, EMWMF landfill wastewater is shown thus far to be neither listed- nor characteristic-hazardous waste under RCRA. Appendix F provides a detailed determination. Proposed EMDF landfill wastewater is not expected to be RCRA-hazardous due to the expected concentration of mercury (Appendix E). For conservatism, EMWMF and the proposed EMDF are designed to accept RCRA-listed hazardous waste, but EMWMF is not operated and the planned EMDF is not planned to be operated to accept RCRA-listed hazardous waste.

Table 2. Key contaminants of concern

Contaminant type	Contaminant	Units	Average[a]	Maximum
Metal	Arsenic*	ug/L	5	5
Metal	Cadmium**	ug/L	1	1
Metal	Total Chromium**	ug/L	30.39	309
Metal	Chromium, VI*	ug/L	30.88	250
Metal	Copper**	ug/L	5.24	12.8
Metal	Lead**	ug/L	3	3.63
Metal	Mercury (EMWMF lower detection limit)[c*]	ug/L	0.03	0.13
Metal	Mercury (EMDF)[b]	ug/L	1	N/A
Metal	Nickel**	ug/L	11.43	34.2
Metal	Uranium	ug/L	12.94	15
Other	Cyanide	ug/L	5	5
Pesticide	4,4'-DDD	ug/L	0.1	0.1
Pesticide	4,4'-DDE	ug/L	0.1	0.1
Pesticide	4,4'-DDT	ug/L	0.1	0.1
Pesticide	Aldrin	ug/L	0.1	0.1
Pesticide	beta-BHC	ug/L	0.1	0.1
Pesticide	Dieldrin	ug/L	0.54	1
Radiological	Iodine-129	pCi/L	1.5	2.8
Radiological	Strontium-90	pCi/L	6.85	16.1
Radiological	Technetium-99	pCi/L	627.07	3580
Radiological	Tritium	pCi/L	2104	31900
Radiological	Uranium-233/234	pCi/L	66.52	385
Radiological	Uranium-235/236	pCi/L	4.92	25.1
Radiological	Uranium-238	pCi/L	3.15	21.2

[a] Non-detects are replaced by the reporting limit.
[b]Mercury from EMDF landfill wastewater was estimated. See Appendix E.
[c]The detection limit was lowered for appropriate comparison to the ambient water quality criteria.
NA = not applicable
*Criteria for these metals are expressed as dissolved.
**Criteria for these metals are expressed as dissolved and are a function of total hardness.

1.8 FLOW RATES

The quantity of landfill wastewater will vary over the EMWMF and proposed EMDF life cycle, illustrated in Fig. 8. Initially, landfill wastewater will be generated from EMWMF operations, then from the combined operation of EMWMF and the proposed EMDF, then from the proposed EMDF operation, and finally following closure. In order to address this uncertain and varying flow rate, the period of time when EMWMF and the proposed EMDF operations overlap is used in this focused feasibility study because this period represents the maximum estimated flow rates. Therefore, the design flow rate for this focused feasibility study is based on relatively high anticipated flows during years 3 and 4 when EMWMF Cells 5 and 6 and the proposed EMDF Cell 1 are open. Various rainfall events were modeled to predict the flow rate of landfill wastewater, and the predictions were compared to historical data. Table 3 summarizes the flow rates from the model for the peak day, average month, wettest month, and maximum month rainfall events. A detailed description of the flow rate calculations is in Appendix B.

The bounding condition is that both EMWMF and the proposed EMDF are operational. Therefore, for the purposes of this focused feasibility study, the average flow rate is 30 gal per minute (gpm) (average month in Table 3), and the maximum flow rate is 60 gpm (maximum month in Table 3). The landfill wastewater flow rate will vary over the life of the two facilities as rainfall varies, disposal cells are opened and closed, and during post-closure. The flow rate during post-closure will only be leachate and may be less than one gpm. Therefore, the uncertainty of flow rates and the ability to adapt to varying flow rates is considered in the evaluation of alternatives.

Table 3. Landfill wastewater flow rates

Active cell	Active cell area (acres)	Peak day (gal per minute)	Average month (gal per minute)	Wettest month (gal per minute)	Maximum month (gal per minute)
EMWMF Cell 5	6.0	572	10	12	20
EMWMF Cell 6	5.3	501	10	11	20
Proposed EMDF Cell 1	6.2	756	10	12	20
TOTALS	17.5	1839	30	35	60

1.9 ADDITIONAL WATER STORAGE

Additional water storage capacity is required to store the expected landfill wastewater volumes from EMWMF and the proposed EMDF. The current EMWMF storage capacity is adequate to store EMWMF landfill wastewater prior to the proposed EMDF operations.

The water storage capacity was calculated based upon a 100-year, 24-hour design storm that occurs when three cells are open—two EMWMF cells (Cells 5 and 6) and the proposed EMDF Cell 1. The details for the water storage capacity calculations are in Appendix H.

1.10 ESTIMATED TIMELINE

The expected timeline for the operation, closure, and post-closure periods for EMWMF and the proposed EMDF is in Fig. 8. In the first two years, only EMWMF is in operation; in years 3 and 4, both EMWMF and the proposed EMDF are in operation; for the next 23 years, only the proposed EMDF is in operation and EMWMF is closed; finally, both facilities are closed. EMWMF and the proposed EMDF each have a 30-year period of long-term stewardship per the *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA/540/G-89/004) for the purpose of this focused feasibility study. The *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge Reservation* assumes that landfill wastewater only will be generated from the proposed EMDF for ten years following closure, at which time the landfill will be dewatered. However, the 30-year period of long-term stewardship is still used for the purposes of this focused feasibility study.

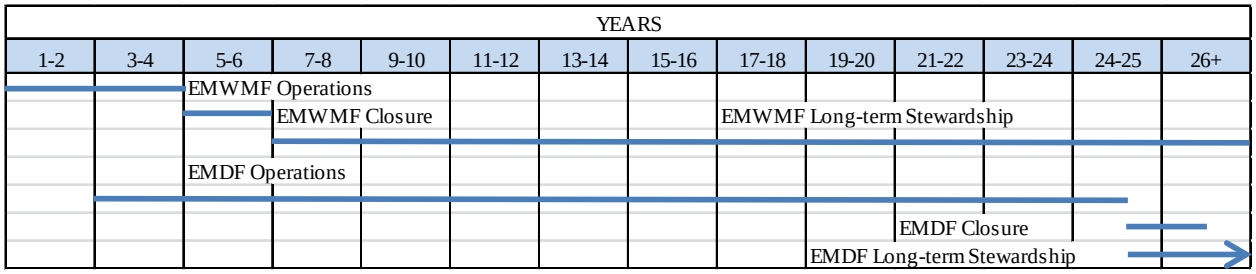

Fig. 8. Timeline.

EMWMF is currently operating and is nearing capacity, while the proposed EMDF is in the initial stages of the CERCLA planning process. Therefore, two different approaches will be taken for implementation of the evaluation in this focused feasibility study:

The proposed EMDF is currently in the Remedial Investigation/Feasibility Study phase of the CERCLA process. Therefore, the selection and approval of a landfill wastewater management alternative will take place as part of the overall CERCLA process. A recommended approach for the proposed EMDF landfill wastewater management will be provided in the Proposed Plan, based upon the evaluation in this focused feasibility study. The Record of Decision will document acceptance of the recommendation. Implementation of the landfill wastewater management approach will continue as part of the normal CERCLA process from design to initiation of operations.

EMWMF has an approved CERCLA Record of Decision (DOE/OR/01-1791&D3) and has been in operation since 2002. Therefore, the CERCLA process for implementation of this focused feasibility study for EMWMF will be as follows:

- Prepare an Explanation of Significant Differences for the EMWMF Record of Decision (DOE/OR/01-1791&D3) based upon the evaluation described in this focused feasibility study.
- Revise the *Remedial Action Work Plan for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* (DOE/OR/01-1874&D4/R1), the Operations Plan (UCOR-4135/R1), and the Sampling and Analysis Plan/Quality Assurance Project Plan (UCOR-4156) to incorporate the changes.
- Implement the recommended alternative

1.11 PROBLEM SUMMARY

As discussed previously, landfill wastewater will be generated as a result of land disposal of CERCLA waste in EMWMF and the proposed EMDF that may contain concentrations of key COCs that exceed discharge limits. The problem encompasses the determination of a safe and environmentally sound approach for management of this landfill wastewater. The approach must be protective of human health and the environment, implementable, adaptable, cost effective, and meet discharge limits.

The options and alternatives identified and evaluated must have a common basis for development and comparison purposes. The following parameters define the basis for the identification, development, and evaluation of the alternatives.

- The average flow rate is 30 gpm, and the maximum flow rate is 60 gpm.

- The design storm is 100 years, 24 hours.
- Alternatives will address all key COCs, but treatment unit operations will be implemented when appropriate. Proposed EMDF landfill wastewater is not expected to be listed or characteristic RCRA hazardous waste.
- The key COCs and their current concentrations are in Table 2. The COCs and their concentrations are expected to change over time, so alternatives must be adaptable to change.

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2. REMEDIAL ACTION OBJECTIVES

2.1 ANTICIPATED FUTURE LAND USE

EMWMF and the proposed EMDF are located in the Bear Creek watershed, entirely within the ORR, where public access is restricted. Because Y-12 is an active production and special nuclear materials management facility, additional security and access limitations apply.

Reasonably anticipated future uses of land are an important consideration in determining remediation levels and extent of remediation. Consistent with EPA guidance in *Land Use in the CERCLA Remedy Selection Process* (EPA 9355.7-04), DOE solicited input on potential future land use from EPA and TDEC, local land-use planning authorities, and the public during the ORR watershed-level remedial investigation and feasibility study development. The ORR Site-Specific Advisory Board (Oak Ridge Reservation End Use Working Group 1998) recommended three zones of end uses—unrestricted, recreational, and DOE-controlled industrial—for the Bear Creek watershed. The selected remedy in the *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plan, Oak Ridge, Tennessee* is consistent with these anticipated future end uses and human exposure restrictions. Figure 9 provides the three end use zones, the EMWMF, and potential sites for the proposed EMDF.

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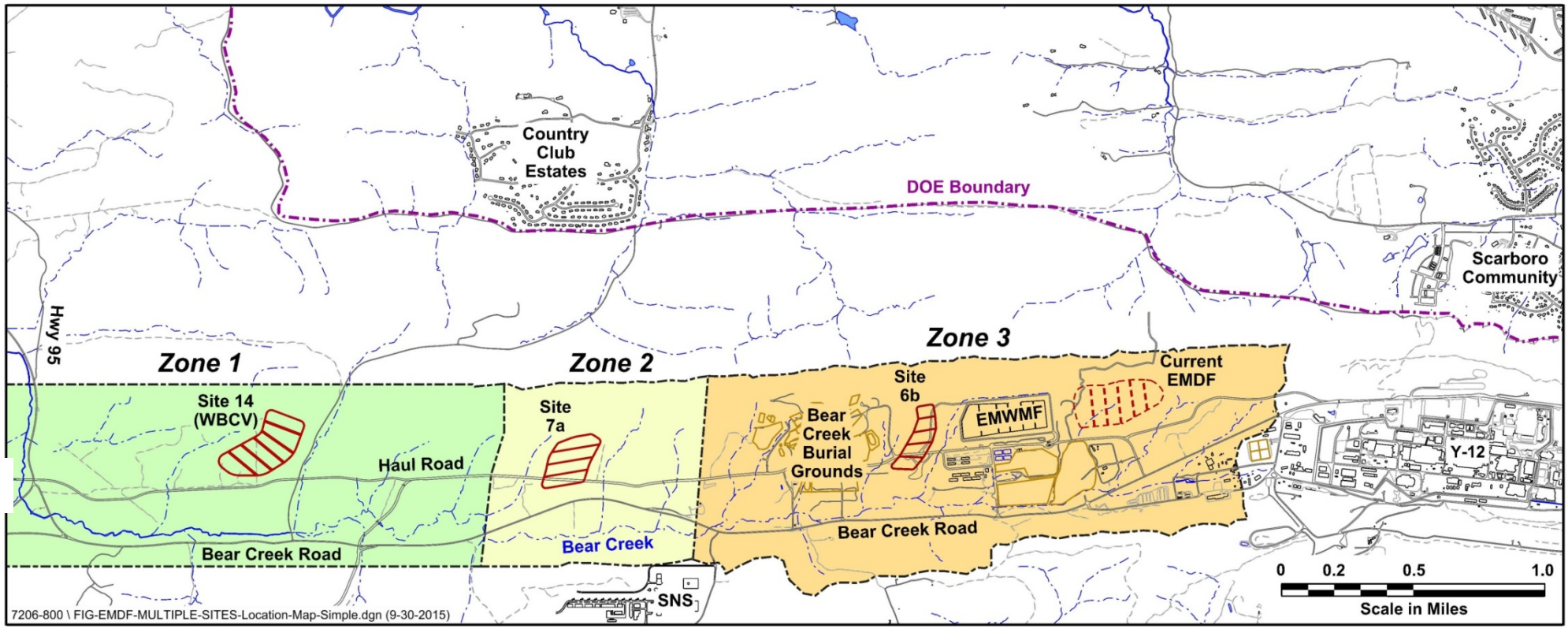

Fig. 9. Bear Creek Valley end uses and potential locations of the proposed EMDF.

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2.2 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are site-specific goals developed from the purpose and scope of remedial actions. CERCLA guidance defines remedial action objectives as "medium-specific or operable unit-specific goals for protecting human health and the environment" (EPA/540/G-89/004). According to the National Oil and Hazardous Substances Pollution Contingency Plan (40*CFR* 300.430[e][2][i]), remedial action objectives should specify the media and contaminants of concern, potential exposure pathways, and remediation goals. Because EMWMF and the proposed EMDF remedial actions provide for the disposition of various waste types derived from a wide range of sources and activities, establishing specific cleanup goals is not appropriate. Instead, these goals will be developed at the project-specific level during future CERCLA remedial decisions.

Since the scope of this focused feasibility study is limited to evaluating alternatives for the management of landfill wastewater, the remedial action objective is to:

- Meet discharge limits for the key COCs to protect surface water for designated uses. This remedial action objective is consistent with the overall remedial action objectives for EMWMF and the proposed EMDF.

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

CERCLA Section 121 and 40 *CFR* 300.430(f)(1)(ii)(B) specify that remedial actions for cleanup of hazardous substances must attain or have waived ARARs under federal or more stringent state environmental laws. Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (40 *CFR* 300.5). Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (40 *CFR* 300.5). Pursuant to EPA guidance, where EPA has delegated to the State of Tennessee the authority to implement a federal program, the Tennessee regulations replace the equivalent federal requirements as the potential ARARs.

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA Section 121(e)]. To ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [55 FR 8756, March 8, 1990]. Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation (e.g., approval of or consultation with administrative bodies, documentation, permit issuance, reporting, record keeping, and enforcement).

The NCP at 40 *CFR* 300.400(e)(1) defines "on-site" as meaning "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action." CERCLA Sect. 104(d)(4) (as discussed further in the preamble to the final NCP, 55 FR 8690) states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having

to obtain a permit (i.e., manage as "on-site" waste). This approach was proposed and agreed to by all signatories to the *Federal Facility Agreement for the Oak Ridge Reservation* for EMWMF, was acknowledged and documented in the *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste*, and was reaffirmed in the *Record of Decision for Soil, Buried Waste, and Subsurface Structures Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*. This agreement serves as the basis for designating waste treatment, storage, and disposal facilities on the ORR as "on-site" facilities not subject to the CERCLA Off-site Rule (40 *CFR* 300.440) when accepting wastes from CERCLA on-site response actions.

ARARs include those federal and state regulations that are designed to protect the environment. ARARs do not include occupational safety regulations. EPA requires compliance with occupational and worker protection standards in Section 300.150 of the NCP, independent of the ARARs process. Therefore, neither the regulations promulgated by the U.S. Occupational Safety and Health Agency nor DOE Orders related to occupational safety are addressed or included as ARARs.

There are three categories of ARARs:

- Location-specific—Location-specific ARARs establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations, e.g., wetlands, floodplains, critical habitats, historic districts, or streams.
- Chemical-specific—Chemical-specific ARARs provide health- or risk-based concentration limits or discharge limitations in various environmental media, i.e., surface water, groundwater, soil, or air, for specific hazardous substances, pollutants, or contaminants.
- Action-specific—Action-specific ARARs include operation, performance, and design requirements or limitations based on waste types, media, and removal activities.

In addition to ARARs, 40 *CFR* 300.400(g)(3) states that federal or state nonpromulgated advisories or guidance may be identified as "to be considered" (TBC) guidance for contaminants, conditions, and/or actions at the site. TBC guidance includes non-promulgated criteria, advisories, guidance, and proposed standards. TBC guidance are not ARARs because they are neither promulgated nor enforceable. TBC guidance may be used to interpret ARARs and to determine remediation goals when ARARs do not exist for particular contaminants or are not sufficiently protective to develop cleanup goals.

The ARARs for this focused feasibility study that may be added to the *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* are in Appendix D. Those ARARs required for the proposed EMDF will be included in the *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, Tennessee* and subsequent CERCLA decision documents.

CERCLA Section 121(d) provides that, under certain circumstances, an ARAR may be waived. The six statutory waivers are:

- Interim measures
- Equivalent standard of performance
- Greater risk to health and the environment
- Technical impracticability
- Inconsistent application of state standard
- Fund-balancing

3. DEVELOPMENT AND DESCRIPTION OF ALTERNATIVES

3.1 PURPOSE

This chapter summarizes the screening of remediation technologies and process options and the development of remedial alternatives for the management of landfill wastewater from EMWMF and the proposed EMDF. In accordance with CERCLA [40 *CFR* 300.430(1)], the goal of this focused feasibility study is to develop and evaluate remedial alternatives that eliminate, reduce, or control risks to human health and the environment. The NCP provides recommendations for developing remedial action alternatives, including:

- Use of treatment to address the principal threats posted by a site, wherever practicable.
- Use of engineering controls (e.g., containment) for waste that poses a relatively low, long-term threat for which treatment is impracticable.
- Implementation of a combination of actions, as appropriate, to achieve protection of human health and the environment. For example, in appropriate site situations, treatment of principal threats is combined with engineering and institutional controls for treatment of residuals and untreated waste.
- Use of institutional controls to supplement engineering controls for short- and long-term management to prevent or limit exposures to hazardous substances.
- Selection of an innovative technology when the technology offers the potential for comparable or better treatment performance or implementability than other technologies, fewer adverse impacts than other technologies, or lower costs than demonstrated technologies for similar levels of performance.
- Restoration of environmental media (e.g., groundwater) to their beneficial uses wherever practicable and within a reasonable time frame given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not practicable, EPA expects remedial action to prevent further migration of the contaminant plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

Because this focused feasibility study focuses on the management of landfill wastewater generated from EMWMF and the proposed EMDF, the range of alternatives is focused on water management actions. Therefore, the range of technology types and process options applicable to this study is limited to those pertinent to the management of landfill wastewater from EMWMF and the proposed EMDF. The primary problem addressed in this study is ensuring that the landfill wastewater discharge meets the discharge limits.

3.2 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Remedial action objectives are met through implementation of general response actions, alone or in combination. General response actions are categories of actions intended to protect human and ecological receptors from exposure to contamination in sources or environmental media, e.g., groundwater and surface water. Technology types are identified for each general response action that are appropriate for the media, contaminants, and location being considered. Next, process options are identified and evaluated to select representative process options for each technology type. Process options are broad categories of technologies that, alone or in combination, are used to satisfy the remedial action objectives. These representative process options are retained for alternative development.

As specified in EPA guidance (EPA/540/G-89/004), two screening steps typically are taken to reduce the number of technology types and process options associated with each general response action. Initially, each process option is screened for technical applicability against the following criteria:

- Applicability to the type and combination of contaminants
- Applicability to the site physical conditions

Process options that are not technically applicable to the site or to the contaminants are eliminated from further consideration. In the second screening step, the retained process options are evaluated more closely against the following criteria to select one or more options to represent each technology type.

- Effectiveness—Effectiveness considers the potential effectiveness of process options in handling the estimated areas or volumes of media and meeting the remediation goals identified in the remedial action objectives; the potential impacts to human health and the environment during the construction and implementation phases; and how proven and reliable the process is with respect to the contaminants and conditions at the site.
- Implementability—Implementability encompasses both the technical and administrative feasibility of implementing a technology process. Technical implementability is an initial screen to eliminate those that are clearly ineffective or unworkable at the site. Administrative implementability considers the ability to obtain necessary permits for off-site actions; the decision-making process; the availability of treatment, storage, and disposal services (including capacity); and the availability of necessary equipment and skilled workers to implement the technology.
- Cost—Cost plays a limited role in the screening of process options. Relative capital, operations, and maintenance (O&M) costs are used rather than detailed estimates. At this stage in the process, the cost analysis is based on engineering judgment, and each process option is evaluated as to whether costs are high, low, or medium relative to other process options.

Because this is a focused feasibility study evaluating how to manage landfill wastewater, the two screening steps were combined, and the range of general response actions, technology types, and process options was limited to those pertinent to the management of landfill wastewater. The general response actions identified for management of EMWMF and the proposed EMDF landfill wastewater are:

- No action
- Monitoring
- Water treatment
- Zero discharge

The no action general response action involves the free release of untreated landfill wastewater to the environment, while other general response actions involve providing health and environmental protection from the potential impacts of contaminated landfill wastewater. Each of the general response actions was evaluated with respect to the evaluation criteria and a determination was made to either retain for further evaluation or reject from further consideration. The results of the evaluation are in Table 4.

Zero discharge was not retained because of the relatively high volume of landfill wastewater generated at EMWMF and the proposed EMDF that makes evaporation impractical. The greater volume is a result of maintaining the large working faces necessary to minimize the amount of clean fill used and provide sufficient space for the concurrent disposal of differing waste streams. Reuse of the generated landfill wastewater for dust control is confined to the working cells only. Use outside of the cells results in the potential to spread contamination. Therefore, reuse requires maintaining two separate systems for dust

control and adds additional cost. Appendix G contains additional discussion of the zero discharge general response action.

In the development and evaluation of the alternatives, an adaptive management approach is used to make a decision based on existing information, monitoring and evaluating data during operation, and modifying the landfill wastewater management system as appropriate over time (Everett and Ebert, *Production and Operations Management: Concepts, Models, and Behavior*; Holling, C. S., *Adaptive Environmental Assessment and Management*; National Research Council 2003, *Environmental Cleanup at Navy Facilities: Adaptive Site Management*; and National Research Council 2004, *Adaptive Management for Water Resources Project Planning*). This approach is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Adaptive management acknowledges uncertainty and makes use of management interventions and follow-up monitoring to promote understanding and improve decision making through an iterative process. In this case, uncertainties associated with future COCs is addressed by allowing for flexibility in construction and operations. Additional processing capability or modified operations will be implemented to address COCs that are not anticipated during initial design.

Table 4. Evaluation of process options

General response action	Technology type	Process option	Description	Technical applicability	Effectiveness	Implementability	Cost	Retained
No action	None	None	No additional action	Not applicable	Not effective	Easy to implement	No incremental cost	Retained as required by the National Contingency Plan
Monitoring	Monitoring	Managed discharge	Discharge if discharge limits met	Not applicable	Not effective; not adaptable	Easy to implement	Low	Not retained; discharge limits not met at all times; not adaptable
Water treatment	Treat in situ	Constructed wetlands	Construct wetlands to treat water	Partly applicable; will convert mercury to methyl mercury	Not certain if discharge limits met; perhaps useful for polishing; not adaptable	Will convert mercury to methyl mercury; will have to be constructed	Low	Not retained; conversion of mercury to methyl mercury; uncertainty in meeting discharge limits; not adaptable

Table 4. Evaluation of process options (cont.)

General response action	Technology type	Process option	Description	Technical applicability	Effectiveness	Implementability	Cost	Retained
Water treatment	Treat at EMWMF/EMDF site	Landfill wastewater treatment system	Construct new landfill wastewater treatment system	Applicable	Effective; proven treatment technology; meets discharge limits; adaptable	Easy to implement; standard treatment processes; cannot be implemented immediately	Medium	Not retained; cannot be implemented immediately; redundant with following process option; meets discharge limits; proven treatment technology; adaptable
	Monitoring/Treat at EMWMF/EMDF site	Managed discharge/landfill wastewater treatment system	Discharge if discharge limits met; construct new landfill wastewater treatment system if required	Applicable	Effective; proven treatment technology; meets discharge limits; adaptable	Easy to implement; standard treatment processes	Medium	Retained; can be implemented immediately; meets discharge limits; proven treatment technology; adaptable
	Treat elsewhere on ORR	ORNL PWTC	Transport to ORNL PWTC for treatment by truck or pipeline	Partly applicable; WAC do not accept mercury; radiological treatment system does not have capacity	Effective	WAC does not allow mercury, so WAC will have to be revised; harder to implement due to trucking or pipeline; may need expansion of storage facilities and future modification of treatment processes for additional COCs; radiological treatment processes limited; past useful life of PWTC; adaptable	Medium	Retained; mercury WAC required; upgrade being planned to extend operating life

Table 4. Evaluation of process options (cont.)

General response action	Technology type	Process option	Description	Technical applicability	Effectiveness	Implementability	Cost	Retained
		Y-12 WETF	Transport to Y-12 WETF for treatment by truck or pipeline	Applicable	Effective	Meets WAC; harder to implement due to trucking or pipeline and work in Y-12; significant treatment plant expansion required; adaptable	Medium	Not retained; trucking/pipeline construction; significant expansion; construction required in Y-12
		Outfall 200 treatment system	Transport to Outfall 200 treatment system by truck or pipeline	Partly applicable; addresses only mercury	Effective for mercury; will require modification for other key COCs	Easy to implement; treatment system proposed but not built; discharges into another watershed; ROD revision; adaptable	Medium	Retained; addresses mercury; adaptable
	Treat off-site	Existing facility	Use an existing offsite treatment facility and transport by truck or pipeline	Applicable	Not effective	No facility available	Not applicable	Not retained; no facility available
		New facility	Construct a new offsite treatment facility and transport by truck or pipeline	Applicable	Effective	Difficult due to new construction and transporting to new facility	High	Not retained; construction of offsite facility; high cost
Zero discharge	Reuse of water	Reuse of water	Reuse landfill wastewater	Applicable	Not effective	Use of contaminated water unacceptable; treatment prior to reuse is not cost effective	High	Not retained; use of contaminated water unacceptable; treatment prior to reuse is not cost effective

Table 4. Evaluation of process options (cont.)

General response action	Technology type	Process option	Description	Technical applicability	Effectiveness	Implementability	Cost	Retained
	Evaporation	Evaporation	Evaporate landfill wastewater	Applicable	Not effective due to inadequate evaporation rate	Easy to implement	Low	Not retained; inadequate evaporation rate

ROD = record of decision
WETF = West End Treatment Facility

The general response actions, technology types, and representative process options retained for alternative development are in Table 5.

Table 5. Retained representative process options

General response action	Technology type	Representative process option (s)
No action	None	No action
Water treatment	Monitoring/Treat at EMWMF/EMDF site	Managed discharge/landfill wastewater treatment system
	Treat elsewhere on ORR	ORNL PWTC
		Outfall 200

The specific treatment unit operations assumed in this focused feasibility study might change during design, but they will be substantively equivalent for the treatment of the key COCs.

3.3 DESCRIPTION OF ALTERNATIVES

3.3.1 Introduction

This section presents the description of the alternatives to manage the landfill wastewater from EMWMF and the proposed EMDF. The general response actions and representative process options selected in the preceding section were used to develop a range of alternatives. The purpose of a range of alternatives is to present the decision makers with technical and economic options for implementation. While the representative process options provide a basis for developing alternatives, the specific process options used to implement the action can change and may not be selected until the design phase. The following four alternatives were assembled from the retained representative process options:

- Alternative 1: No Action. In Alternative 1, EMDF is not built. Current operations continue at EMWMF. Landfill wastewater is discharged to Bear Creek or trucked to PWTC at ORNL.
- Alternative 2: Managed Discharge/Treat. In Alternative 2, landfill wastewater initially is discharged to Bear Creek in accordance with current discharge limits and subsequently is treated at the Landfill Wastewater Treatment System (LWTS) located at the proposed, adjacent EMDF site prior to discharge to Bear Creek in accordance with revised discharge limits.
- Alternative 3: Treat at PWTC. In Alternative 3, landfill wastewater is transported by truck or pipeline to the on-site PWTC at ORNL.
- Alternative 4: Treat at Outfall 200 Mercury Treatment Facility (OF200 MTF). In Alternative 4, the landfill wastewater is transported by truck or pipeline to the planned, on-site OF200 MTF at Y-12.

Following are descriptions of the alternatives in sufficient detail to support their analysis in Chap. 4. Specific treatment unit operations, other than those described here, may be substituted once the alternative is selected and subsequent detailed design is underway.

3.3.2 Alternative 1: No Action

Summary: In Alternative 1, EMDF is not built. At EMWMF, current operations continue. Landfill wastewater is discharged to Bear Creek if it meets the current discharge limits. Landfill wastewater that does not meet the current discharge limits is trucked to PWTC at ORNL. As required by the NCP, the No Action alternative provides a comparative baseline against which other alternatives are evaluated. The No Action alternative does not initiate any new remedial action, normally assumes that present security measures and land use controls to limit access and use are not maintained, and eliminates short- and long-term monitoring. The landfill wastewater will not be expected to meet discharge limits at all times. No implementation is required and there are no additional costs associated with this alternative.

Time frame for implementation: This alternative can be implemented immediately.

3.3.3 Alternative 2: Managed Discharge/Treat

Summary: In Alternative 2, landfill wastewater initially is discharged to Bear Creek in accordance with current discharge limits (Table 6) and subsequently is treated at the LWTS located at the proposed, adjacent EMDF site prior to discharge to Bear Creek in accordance with revised discharge limits (Table 6). If the proposed EMDF is not constructed adjacent to EMWMF, then the landfill wastewater from EMWMF will be transported by either a pipeline or truck to the proposed EMDF site, assumed to be located in West Bear Creek. The LWTS is built in accordance with a compliance schedule negotiated per the *Federal Facility Agreement for the Oak Ridge Reservation*, but for estimating purposes, the assumption is LWTS is built when EMDF is built. Prior to construction and operation of LWTS, landfill wastewater that exceeds current discharge limits is treated, such as done currently for chromium, or will be transported by truck to the on-site PWTC.

Figure 10 illustrates the process flow diagram for this alternative.

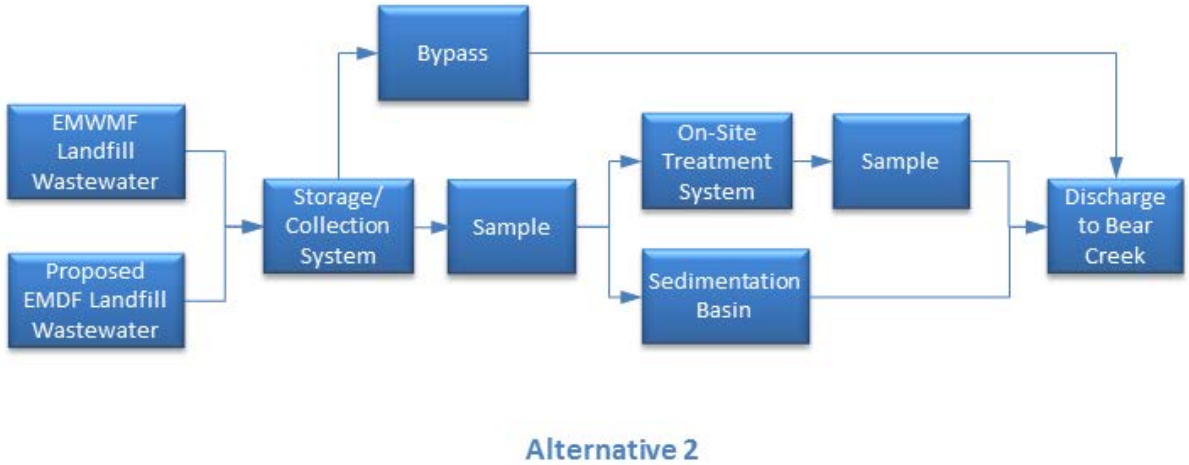

Fig. 10. Alternative 2: process flow diagram.

Details: Landfill wastewater is collected in existing and new ponds and tanks. From these storage facilities, the landfill wastewater passes through a flow proportional sampler that collects representative samples and measures flow rates. The design flow is 60 gpm. If storm flow above the design storm rate occurs that exceeds the storage capacity, the stormwater is released through a bypass pipeline without active management, per Rule 0400-40-05-.07(2)(l), to prevent damage to LWTS and to protect the workers. The existing EMWMF and proposed EMDF site layout with landfill wastewater management features is in Fig. 11.

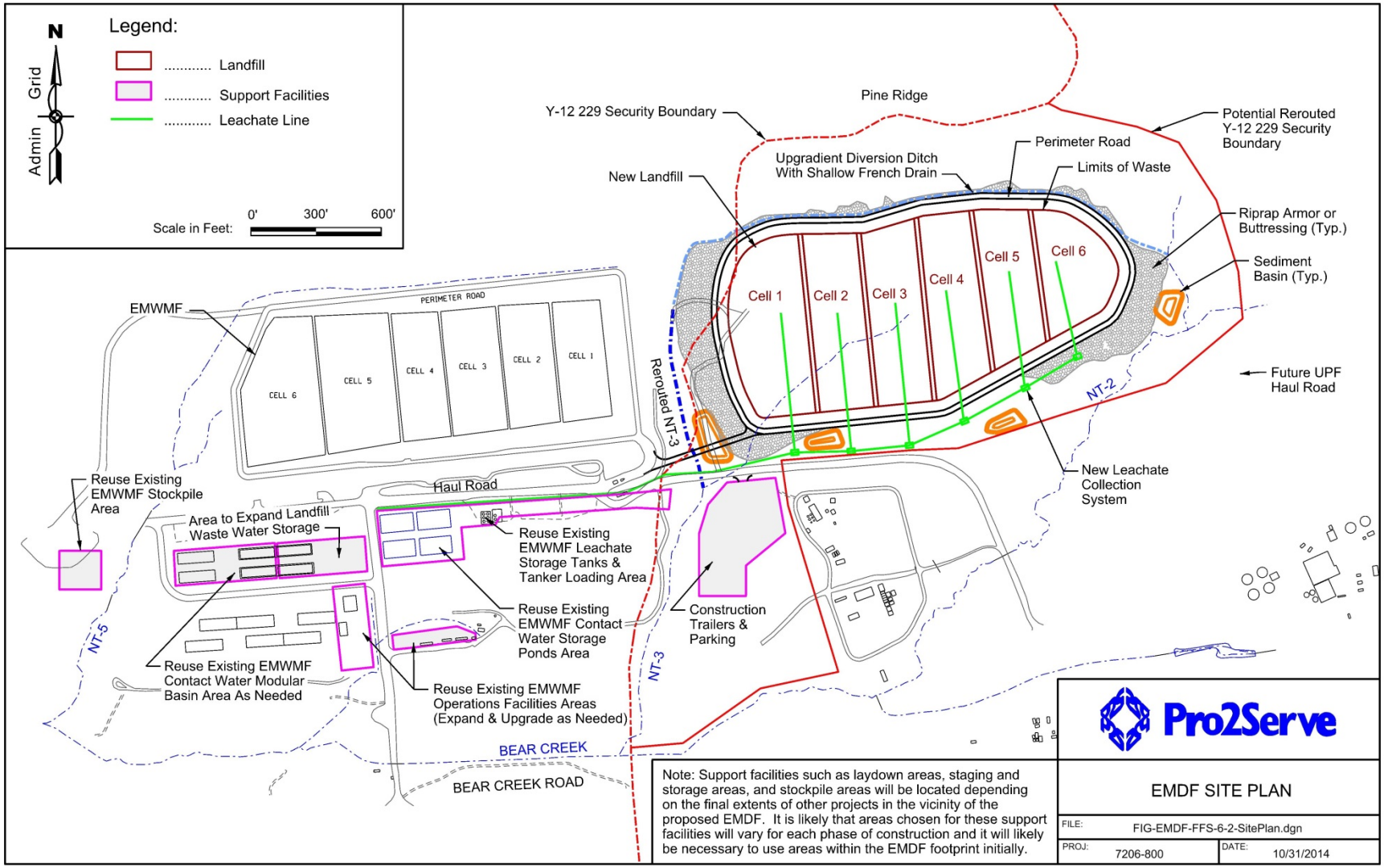

Fig. 11. Alternative 2: site plan.

The proposed EMDF is assumed to be located adjacent to EMWMF. If the proposed EMDF is not constructed adjacent to EMWMF, then the landfill wastewater from EMWMF is transported by either a pipeline or truck to the proposed EMDF site, assumed to be in West Bear Creek (Fig. 9).

Ultimately, the discharge limits (Table 6) for landfill wastewater must be protective of human health and the environment and meet ARARs and are developed as follows:

- Non-radiological key COCs—Discharge limits are based on the lowest AWQC (TDEC 0400-40-03-.03) and the anti-degradation requirements (TDEC 0400-40-03-.06).
- Radionuclides and uranium metal—AWQC are not available for radionuclides and uranium metal, so risk-based discharge limits are calculated using the EPA Radionuclide Preliminary Remediation Goal calculator under a recreational scenario.

Details on development of these discharge limits are in Appendix K.

Landfill wastewater initially is discharged to Bear Creek in accordance with current discharge limits (Table 6) and points of compliance. Subsequently, landfill wastewater is treated at LWTS, located at the proposed, adjacent EMDF site prior to discharge to Bear Creek in accordance with revised discharge limits (Table 6). The point of compliance will be the discharge pipe from LWTS. LWTS is built in accordance with a compliance schedule negotiated per the *Federal Facility Agreement for the Oak Ridge Reservation*.

Prior to construction and operation of LWTS during Managed Discharge, landfill wastewater that exceeds current discharge limits will be treated, such as is done currently for chromium, or will be transported by truck to the on-site PWTC. Construction of LWTS at the proposed EMDF site provides the treatment capability to remove key COCs that exceed the revised discharge limits (Table 6). LWTS occupies an area of approximately 3100 square feet, located south of EMWMF and immediately east of the existing modular collection tanks (Fig. 12). LWTS consists of manufactured units housed in a structure to provide weather protection. Preliminary process equipment is selected based on key COC characteristics (Tables 2 and 6) and best available technology to meet the revised discharge limits. The assumed LWTS process flow diagram is in Fig. 13. A treatability study is included in this alternative to ensure the appropriate process equipment is identified and installed.

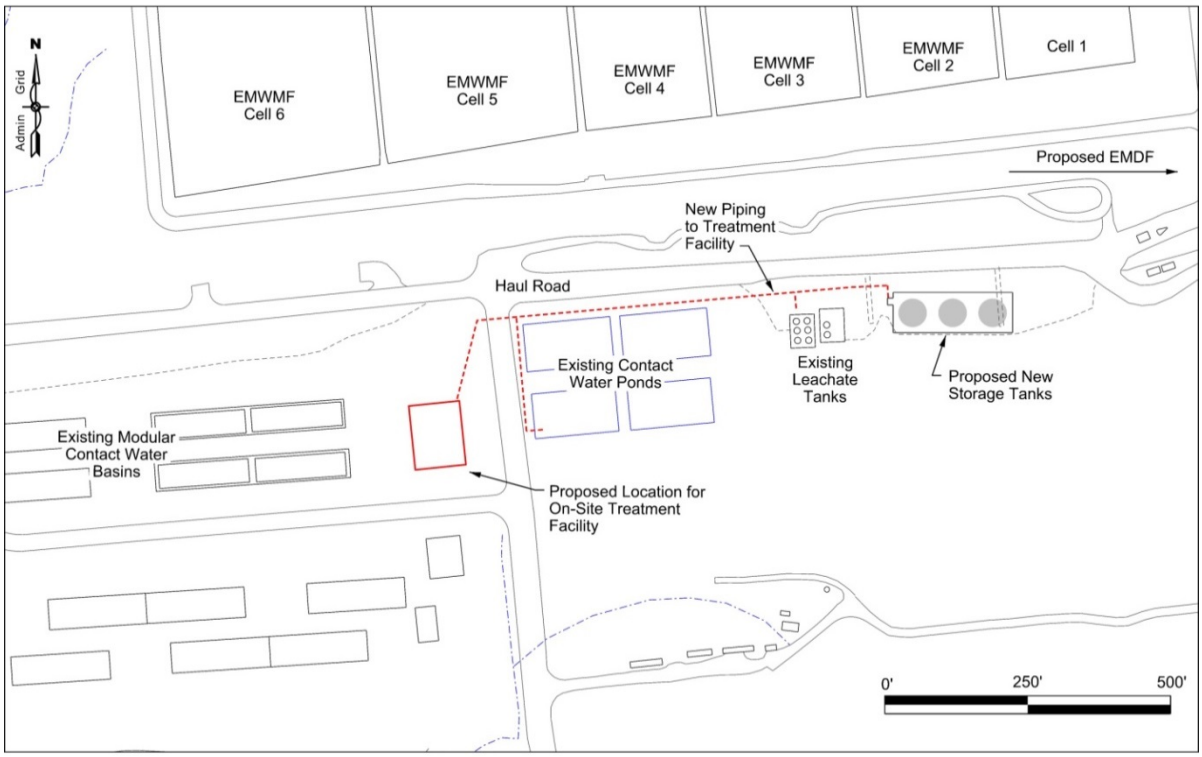

Fig. 12. Alternative 2: location of the landfill wastewater treatment system.

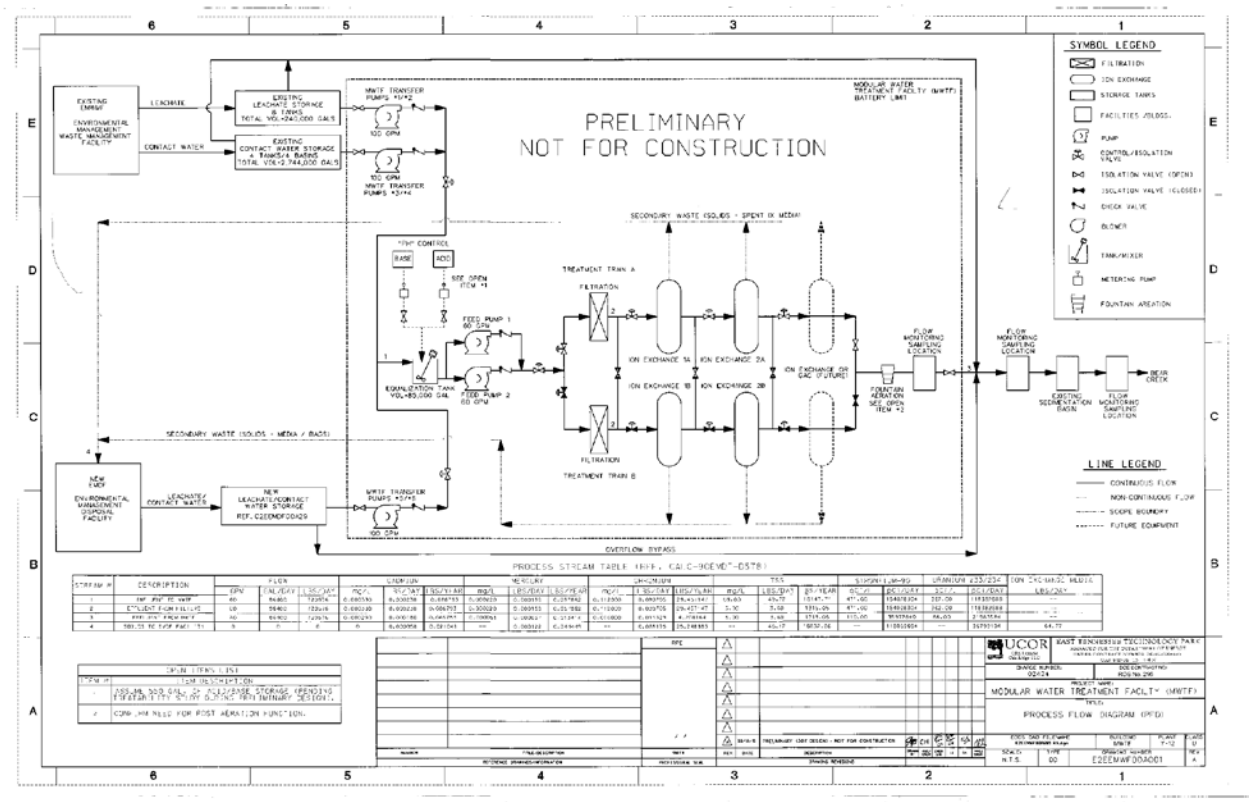

Fig. 13. Alternative 2. Landfill wastewater treatment system process flow diagram.

Managed Discharge is operated on a batch basis. LWTS can be operated on either a batch or continuous basis. Samples will be collected from a continuous, flow proportional sampler prior to release.

Secondary waste may include spent cartridge filters, spent granular carbon, clarifier settled solids (blowdown), carbon column backwash, and liquid from spent carbon dewatering. The spent filters and carbon is dewatered, packaged, and placed in EMWMF or proposed EMDF. The blowdown, backwash return, and dewatering liquid is transferred to the existing contact water ponds where suspended solids will settle until dredging of the basin is necessary to maintain design capacity. The solids from dredging are dewatered, packaged, and placed in EMWMF or the proposed EMDF.

Table 6. Alternative 2 discharge limits

Contaminant Type	Contaminant	Units	Average[a]	Maximum	Discharge Limits - Managed Discharge[b]	Discharge Limits – LWTS[b]
Metal	Arsenic*	ug/L	5	5	340	10
Metal	Cadmium**	ug/L	1	1	2.2	0.27
Metal	Total Chromium**	ug/L	30.39	309	625	81
Metal	Chromium, VI*	ug/L	30.88	250	16	11
Metal	Copper**	ug/L	5.24	12.8	15	9.9
Metal	Lead**	ug/L	3	3.63	73	2.8
Metal	Mercury (EMWMF lower detection limit)[c*]	ug/L	0.03	0.13	1.4	0.051
Metal	Mercury (EMDF)[d]	ug/L	1	NA	NA	0.051
Metal	Nickel**	ug/L	11.43	34.2	515	57
Metal	Uranium	ug/L	12.94	15	NA	24
Other	Cyanide	ug/L	5	5	22	5.2
Pesticide	4,4'-DDD	ug/L	0.1	0.1	NA	0.1
Pesticide	4,4'-DDE	ug/L	0.1	0.1	NA	0.1
Pesticide	4,4'-DDT	ug/L	0.1	0.1	1.1	0.1
Pesticide	Aldrin	ug/L	0.1	0.1	3	0.5
Pesticide	beta-BHC	ug/L	0.1	0.1	NA	0.17
Pesticide	Dieldrin	ug/L	0.54	1	0.24	0.05
Radiological	Iodine-129	pCi/L	1.5	2.8	83	83
Radiological	Strontium-90	pCi/L	6.85	16.1	275	275
Radiological	Technetium-99	pCi/L	627.07	3580	11000	11000
Radiological	Tritium	pCi/L	2104	31900	215000	215000
Radiological	Uranium-233/234	pCi/L	66.52	385	170	170
Radiological	Uranium-235/236	pCi/L	4.92	25.1	180	180
Radiological	Uranium-238	pCi/L	3.15	21.2	188	188

[a]Non-detects are replaced by the reporting limit.
[c]The detection limit was lowered for appropriate comparison to the ambient water quality criteria.
[b]See Appendix K for the development of these discharge limits.
[d]Mercury from EMDF landfill wastewater was estimated. See Appendix E.

NA = not applicable
*Criteria for these metals are expressed as dissolved.
**Criteria for these metals are expressed as dissolved and are a function of total hardness.

The landfill wastewater is also analyzed for the indicator parameters, e.g., nutrients, dissolved solids, total suspended solids, and total organic carbon. Total organic carbon is used as an indicator of organic compounds. An increasing trend triggers additional evaluation of the potential for increased organic compounds in the landfill wastewater. The indicator parameters are not EMWMF or proposed EMDF key COCs, but are used to ensure the landfill wastewater can be discharged without additional impairment of Bear Creek.

Support Activities: No additional support facilities are required to implement Managed Discharge. Managed Discharge of EMWMF landfill wastewater is performed with the existing EMWMF landfill wastewater management staff. No additional resources are needed.

LWTS is constructed near EMWMF in a central location. Site preparation for LWTS requires minor excavation for the weather structure. The footprint includes 750 square feet of free space to add additional process equipment, if needed, per the adaptive management approach. Utility requirements include electrical power for pumping systems, an air compressor, mechanical equipment, lighting, and instrumentation, and process water for fire protection and cleaning.

Support activities include constructing the weather structure and providing connection between the alarm systems and emergency transponders for high-level alarms and similar alerts. Operating LWTS requires trained chemical operators and an operations supervisor to oversee the processing activities. The EMWMF/proposed EMDF operating contractor provides support functions (operations management, engineering, health and safety, environmental management, human resources, payroll, accounting, etc.) Sanitary services and change facilities are available in the existing EMWMF office complex.

Monitoring and Land Use Controls: EMWMF and the proposed EMDF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

For Managed Discharge, landfill wastewater is sampled and the results compared to the current discharge limits (Table 6) prior to batch discharge. LWTS effluent is sampled at the flow proportional sampler at the LWTS discharge pipe and compared to the revised discharge limits (Table 6). The details of current EMWMF monitoring are described in the *Sampling and Analysis Plan/Quality Assurance Project Plan for Environmental Monitoring at the Environmental Management Waste Management Facility*. This document requires revision for this alternative. Appendix L provides details on sampling landfill wastewater to determine compliance with discharge limits. One sample per week is collected for the indicator parameters using the flow proportional sampler.

Monitoring will continue following closure of EMWMF and the proposed EMDF. Landfill wastewater volume is reduced. Following closure and construction of the final covers, LWTS is operated on a batch basis when sufficient landfill wastewater has accumulated to justify operating LWTS. The sampling frequency is reduced to one sample a month. New flow proportional samplers are installed at completion of the final covers to ensure representative samples are collected.

Time frame for implementation: Managed Discharge can be implemented immediately. LWTS is built in accordance with a compliance schedule negotiated per the *Federal Facility Agreement for the Oak Ridge Reservation*. Construction of LWTS is assumed to be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill wastewater over time because of the different contaminants at ETTP, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation

will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods of time. There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells (cells under enhanced operational cover or equivalent). Therefore, LWTS is constructed using a modular design that can be modified, as needed. The adaptive management approach is used with likely additional contaminants identified, and potential additional processing capability is identified in advance of need based on waste and wastewater data. The ability to adapt to changes in key COCs, COC concentrations, and fluctuating flow rate is considered in the subsequent evaluation of this alternative. Although current concentrations of key COCs in Table 2 indicate Managed Discharge will be successful for EMWMF landfill wastewater, there is the potential for increases in the EMWMF key COCs above existing discharge limits that could require extensive trucking to PWTC. Since PWTC is at the end of its design life, the extension of the PWTC life-cycle is necessary for the long-term viability of this alternative.

The indicator parameters also may change based on potential changes in waste characteristics, changes in field measurements, or total organic carbon indicating a change in the landfill wastewater characteristics and/or the results of the biennial sampling results. The nutrient loading, total suspended solids, and/or total dissolved solids sample results may require additional management controls to reduce these to acceptable levels. These management controls, if required, are implemented at the EMWMF/proposed EMDF site and will not require transport for treatment elsewhere on the ORR or additional treatment unit operations.

Documents: To implement this alternative, the EMWMF record of decision and implementing documents, including the sampling and analysis plan (UCOR-4156) and remedial action work plan (DOE/OR/0-1874&D4/R4), will have to be revised. The proposed EMDF remedial investigation/feasibility study, proposed plan, and record of decision will have to be approved. A remedial action work plan/remedial design report will be completed that include the specific design for LWTS, and a remedial action work plan for operations will be completed. A completion report will be required to document the as-built conditions. Operations details will be included in the annual report.

3.3.4 Alternative 3: Treat at Process Waste Treatment Complex

3.3.4.1 Common Components

Summary: In Alternative 3, landfill wastewater is transported by pipeline (Alternative 3a) or truck (Alternative 3b) to the on-site PWTC. Figure 14 illustrates the process flow diagram for this alternative.

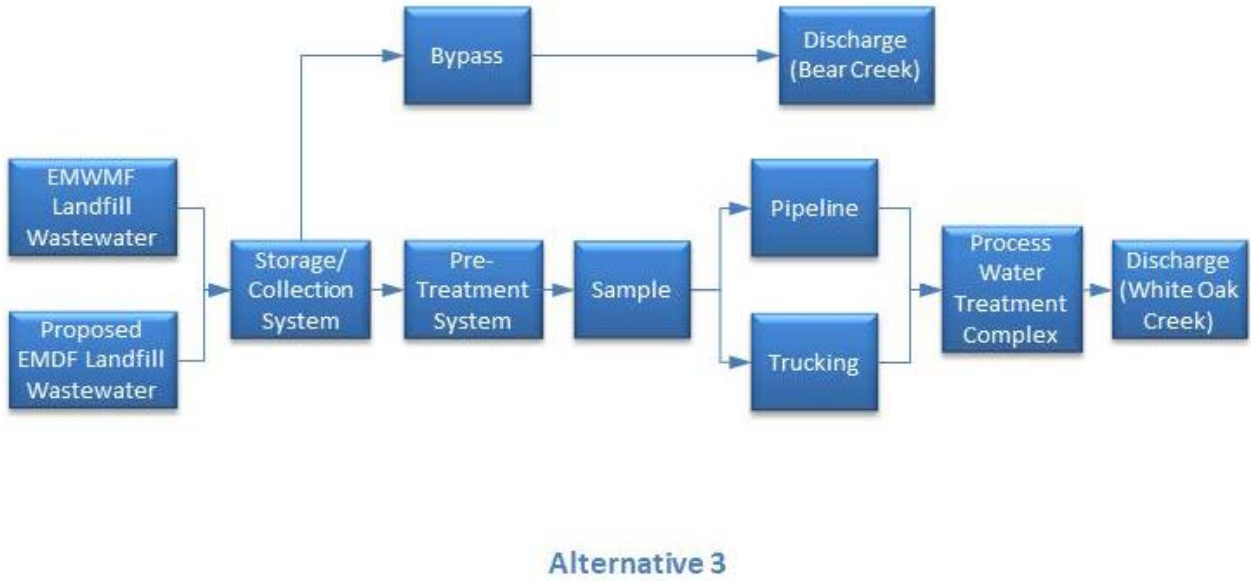

Fig. 14. Alternative 3: process flow diagram.

Background: The entire ORR is on the CERCLA National Priorities List due to legacy contamination. The ORNL PWTC is located on the ORR and is an on-site treatment facility primarily used to treat waters arising from the ORNL facilities and environmental management actions. PWTC treats the existing EMWMF landfill wastewater that does not meet the current EMWMF discharge limits (DOE/OR/01-1873&D2/A1/R2). This landfill wastewater is currently trucked to the ORNL PWTC.

The NCP at 40 *CFR* 300.400(e)(1) defines "on-site" as meaning "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action." CERCLA Sect. 104(d)(4) (as discussed further in the preamble to the final NCP, 55 FR 8690) states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as "on-site" waste).

This approach was proposed and agreed to by all signatories to the *Federal Facility Agreement for the Oak Ridge Reservation* for EMWMF, was acknowledged and documented in the EMWMF Record of Decision (DOE/OR/01-1791&D3), and was reaffirmed in the ETTP Zone 2 Record of Decision (DOE/OR-01-2161&D2). This agreement serves as the basis for designating waste treatment, storage, and disposal facilities on the ORR as "on-site" facilities not subject to the CERCLA Off-Site Rule (40 *CFR* 300.440) when accepting wastes from CERCLA on-site response actions.

Details: Landfill wastewater is collected in storage tanks and then transferred to PWTC. The average flow rate is 30 gpm, an 18 gpm increase over the current yearly average of approximately 12 gpm. The maximum flow rate is 60 gpm. Figure 4 illustrates the existing EMWMF and proposed EMDF site layout with water management features.

PWTC is at its design life, and there are plans to extend the life of PWTC. However, this extension of the design life does not consider EMWMF and proposed EMDF landfill wastewater as an influent, so the ability to treat mercury and radionuclides, and possibly other key COCs, and to manage the increased flow is limited. Therefore, pretreatment of EMWMF and proposed EMDF landfill wastewater and the extension of the design life are required for the long-term viability of this alternative. The pretreatment system is equivalent to the LWTS in Alternative 2 and is located at the proposed EMDF site due to a lack of space at PWTC.

From the water storage locations, the landfill wastewater is pretreated and then pumped through a pipeline or to a truck for transport to the ORNL PWTC. Following pretreatment, the landfill wastewater flows through a flow proportional sampler at which the flow is measured and samples are collected for analysis and verification that the PWTC WAC (Table 7) are met. If storm flow above the design storm rate occurs that exceeds the storage capacity, the stormwater is released through a bypass pipeline without active management, per Rule 0400-40-05-.07(2)(l) to prevent damage to the pretreatment system and to protect the workers. The storage capacity design is based on a 100-year, 24-hour storm. Water storage is constructed or upgraded to be RCRA-compliant.

Based on the design flow of 60 gpm from EMWMF and the proposed EMDF, there is sufficient capacity at PWTC to accommodate the landfill wastewater in the non-radiological treatment system, but not in the radiological treatment system.

Table 7 . Alternative 3: landfill wastewater characteristics and PWTC waste acceptance criteria

Contaminant type	Contaminant	Units	Average[a]	Maximum	PWTC WAC[b] (Bldg. 3544-radiological)	PWTC WAC[b] (Bldg. 3608-non-radiological)
Metal	Arsenic*	ug/L	5	5	4000	4000
Metal	Cadmium**	ug/L	1	1	300	10
Metal	Chromium, III**	ug/L	30.39	309	NA	NA
Metal	Chromium, VI*	ug/L	30.88	250	NA	NA
Metal	Copper**	ug/L	5.24	12.8	2500	100
Metal	Lead**	ug/L	3	3.63	30,000	30,000
Metal	Mercury (EMWMF lower detection limit)[c*]	ug/L	0.03	0.13	0[d]	0[d]
Metal	Mercury (EMDF)[e]	ug/L	1	NA	0[d]	0[d]
Metal	Nickel**	ug/L	11.43	34.2	65,000	11,000
Metal	Uranium	ug/L	12.94	15	NA	NA
Other	Cyanide	ug/L	5	5	200	200
Pesticide	4,4'-DDD	ug/L	0.1	0.1	NA	NA
Pesticide	4,4'-DDE	ug/L	0.1	0.1	NA	NA
Pesticide	4,4'-DDT	ug/L	0.1	0.1	NA	NA
Pesticide	Aldrin	ug/L	0.1	0.1	NA	NA
Pesticide	beta-BHC	ug/L	0.1	0.1	NA	NA
Pesticide	Dieldrin	ug/L	0.54	1	NA	NA
Radiological	Iodine-129[b]	pCi/L	1.5	2.8	NA	NA
Radiological	Strontium-90[b]	pCi/L	6.85	16.1	10,000B q/L	NA
Radiological	Technetium-99[b]	pCi/L	627.07	3580	NA	NA
Radiological	Tritium[b]	pCi/L	2104	31900	NA	NA
Radiological	Uranium-233/234[b]	pCi/L	66.52	385	NA	NA
Radiological	Uranium-235/236[b]	pCi/L	4.92	25.1	NA	NA
Radiological	Uranium-238[d]	pCi/L	3.15	21.2	NA	NA

Table 7. Alternative 3: landfill wastewater characteristics and PWTC waste acceptance criteria (cont.)

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[a]Non-detects are replaced by the reporting limit.
[b]*Waste Acceptance Criteria for Liquid Waste Systems Operated by Liquid and Gaseous Waste Operations at Oak Ridge National Laboratory, WM-LWS-WAC, Rev. 9.*
[c]The detection limit was lowered for appropriate comparison to the ambient water quality criteria.
[d]Waiver to WAC required.
[e]Mercury from EMDF landfill wastewater was estimated. See Appendix E.

NA = not applicable
*Criteria for these metals are expressed as dissolved.
**Criteria for these metals are expressed as dissolved and are a function of total hardness.

The current process flow diagram for PWTC is illustrated in Fig. 15. Following treatment, the treated effluent is discharged into White Oak Creek under a National Pollutant Discharge Elimination System (NPDES) permit.

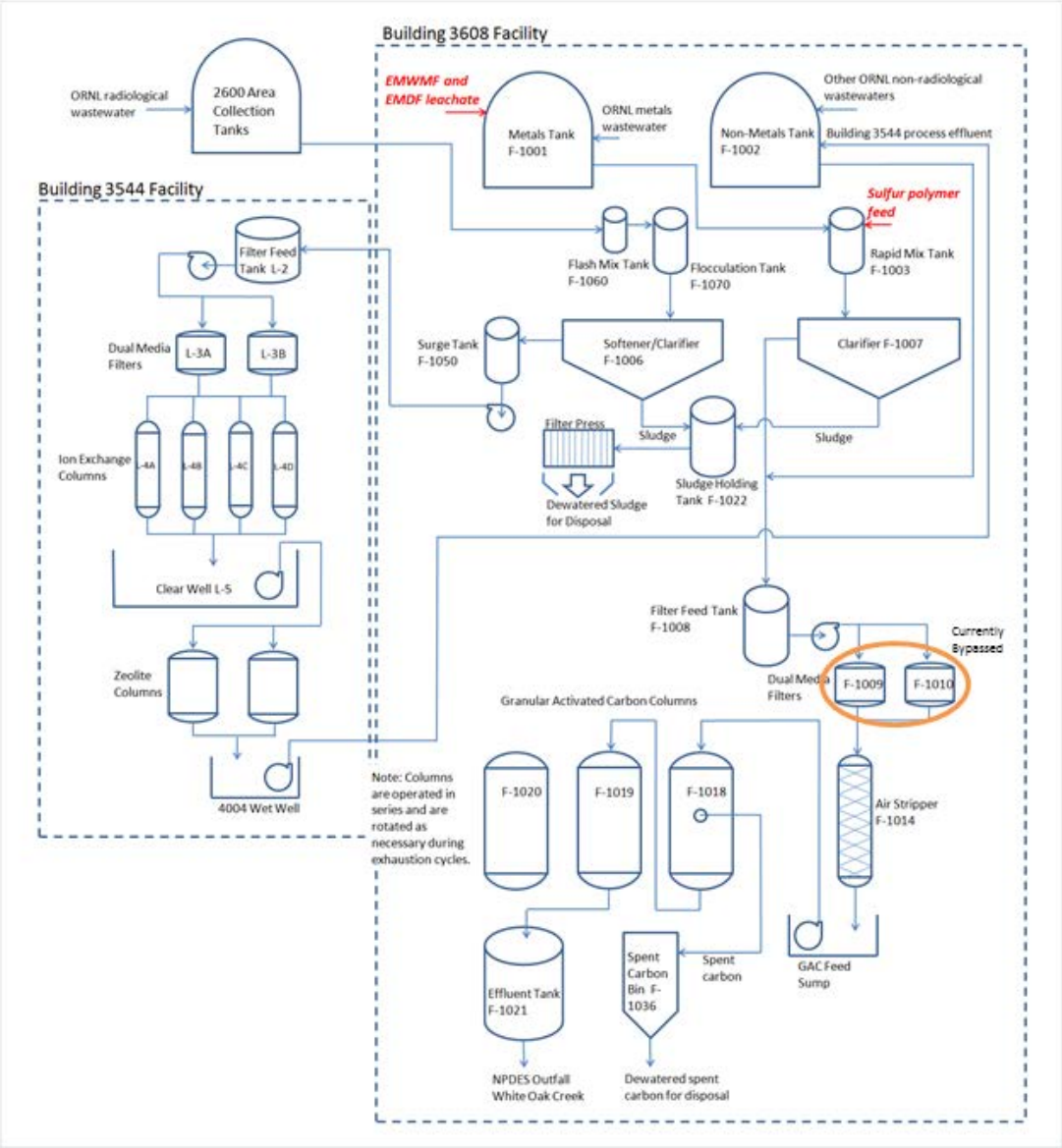

Fig. 15. Alternative 3: PWTC process flow diagram.

Prior to accepting new wastewater for treatment at PWTC, the waste generator must ensure the wastewater meets the WAC (WM-LWS-WAC/R9, *Waste Acceptance Criteria for Liquid Waste Systems Operated by Liquid and Gaseous Waste Operations at Oak Ridge National Laboratory*). In limited situations, wastewaters containing mercury can be accepted at the PWTC, but even then, only with an approved variance request. Therefore, a variance request will have to be issued and approved to allow for the treatment of mercury-containing landfill wastewater. Longer-term treatment of mercury-containing landfill wastewater will require a NPDES permit modification, as will the planned addition of increased, long-term landfill wastewater flow from the EMWMF and proposed EMDF.

Support activities: Landfill wastewater is transferred to PWTC by either pipeline (Alternative 3a) or truck (Alternative 3b). Support activities are needed to construct additional loading and unloading stations, connect to utilities, construct the pretreatment facility, and provide connection between the alarm systems and emergency transponders for high-level alarms and similar alerts. Operation of the PWTC will use the existing trained and qualified chemical operators, but operation of the pretreatment facility located at EMWMF/proposed EMDF site will require additional operators.

Monitoring and land use controls: EMWMF, proposed EMDF, and PWTC are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

One sample is collected using a flow proportional sampler for every 140,000 gal to ensure compliance with PWTC WAC (Table 7). The number of samples is estimated at 72 per year, based on current and projected landfill wastewater generation rates.

Monitoring continues following completion of the EMWMF and proposed EMDF final covers. Landfill wastewater volume is reduced, and the sampling frequency is reduced to one sample a month. New flow proportional samplers are installed at completion of the final covers to ensure representative samples continue to be collected.

Effluent from PWTC is monitored in accordance with the NPDES permit.

Time frame for implementation: The time frame for extending the life of PWTC is uncertain, but must be complete at the start of proposed EMDF operations. Construction of the pretreatment facility also must be complete at the start of proposed EMDF operations. Additionally, the PWTC NPDES permit and WAC need to be renegotiated prior to long-term acceptance of landfill wastewater. Construction of the pipeline, if selected, will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill wastewater over time because of the different contaminants at ETTP, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods.

Since the concentration of mercury in EMDF landfill water is estimated and uncertain, the actual concentration may exceed the ability of the PWTC to reduce it sufficiently to meet the discharge permit limits. If the mercury levels are sustained at high levels, and/or are projected to result in effluent that exceeds the NPDES permit, then this water cannot be treated at the PWTC without pre-treatment. Therefore, extension of PWTC life and construction of the pretreatment facility must be complete prior to receipt of landfill wastewater. Even though planning for the extension of PWTC life has started, it is

uncertain if it will be complete in time for receipt of EMWMF/planned EMDF landfill wastewater. Because of space limitations at PWTC, pretreatment is expected to take place at the EMWMF/proposed EMDF site.

There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells. The combined flow from the proposed EMDF and EMWMF, the ability to adapt to changes in key COCs, COC concentrations, and fluctuating flow rate are considered in the subsequent evaluation of this alternative.

There are no unit operations for uranium removal at PWTC, so landfill wastewater with uranium isotopes cannot be accepted at this time. Pretreatment facilities are needed at the EMWMF/proposed EMDF site if high levels of uranium or other radionuclides in landfill wastewater are encountered in the future.

The PWTC 3608 processing system was constructed in 1989 and shows signs of deterioration from 25 years of operation. Recently, the dual media filters F-1009 and F-1010 have experienced corrosion problems and have been removed from service. The sulfuric acid feed tank was also recently replaced because of corrosion. Routine maintenance and component replacement will continue, as necessary, to continue operations, although an extension of PWTC life is planned.

Documents: To implement this alternative, the proposed EMDF remedial investigation/feasibility study, proposed plan, and record of decision have to be approved. The EMDF remedial action work plan/remedial design report will be completed that include the specific design, and a completion report will be required to document the as-built conditions.

The PWTC NPDES permit and WAC require modification to include EMWMF and the proposed EMDF leachate wastewater.

The EMWMF record of decision and implementing documents, including the Sampling and Analysis Plan/Quality Assurance Project Plan (UCOR-4156) and the remedial action work plan (DOE/OR/01-1874&D4/R4), will have to be revised.

3.3.4.2 Alternative 3a: Pipeline Transport to PWTC

Summary: A pipeline is constructed to transport landfill wastewater from EMWMF/proposed EMDF to PWTC. This pipeline consists of double-walled, welded, high-density polyethylene (HDPE) piping and follows existing disturbed areas, such as Haul Road and the power line easement, where possible.

Details: Approximately 4.8 miles of pressurized pipe is installed between EMWMF/proposed EMDF and PWTC. The pipeline is double-walled 4-in. (SDR 11) HDPE pipe with a single lift station and leak detection sensors in the annular space. The primary pipe is contained within a secondary HDPE pipe with leak detection sensors. The leak detection sensors are electronic low-point leak detection stations set approximately 5000 feet apart that communicate wirelessly to a main receiver. The pipeline lift station receives landfill wastewater from the water storage facilities currently provided at EMWMF and the additional tanks provided for the proposed EMDF.

The pipeline follows the existing Haul Road west from EMWMF, turns south at Reeves Road, and joins the power line easement that crosses over Chestnut Ridge (Fig. 16). The pipeline exits the power line easement alongside Bethel Valley Road, then turns south at First Street, turning east near the 2600 tanks. The pipeline follows First Street within ORNL to avoid the congestion of utilities that typically exists within the ORNL main campus footprint. This route is anticipated to have minimal impact to the

environment or ORNL operations. There are two pipeline crossings for Bear Creek and White Oak Creek. The creek crossings utilize the existing bridges at these locations.

The pump station is located at the beginning of the pipeline near to the existing EMWMF contact water storage areas. The pump station consists of a prefabricated metal structure over a wet well with a primary transfer pump and secondary back-up pump. The pumps are sized based on the design flow rate of 60 gal per minute and the required head to overcome elevation changes to clear Chestnut Ridge and friction losses along the entire length of the pipeline. Power runs from existing infrastructure at the EMWMF/proposed EMDF site, and an emergency generator is provided to maintain operations during prolonged power outages.

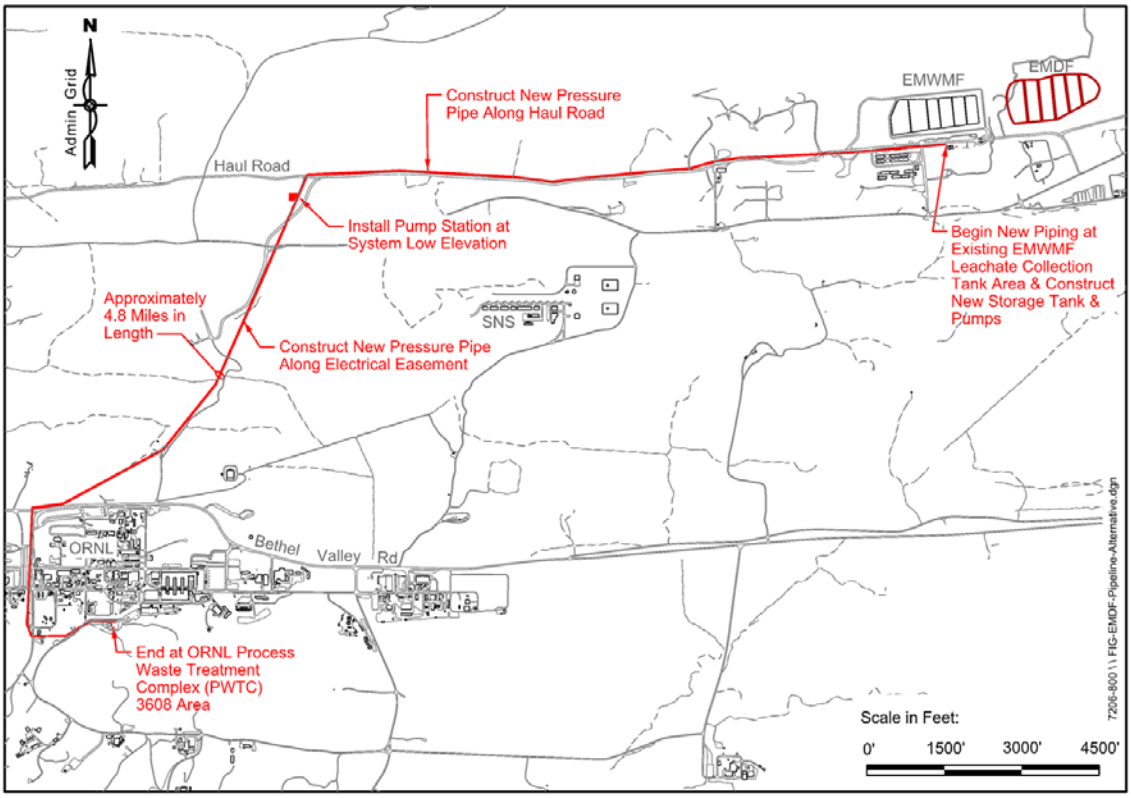

Fig. 16. Alternative 4a: route of pipeline to PWTC.

Support activities: Additional utility support is required at ORNL to ensure utilities and structures are identified, moved, or protected during construction activities. Electrical power is required to the pump stations. Leak detection alarms are required, along with telemetry to alert operators of potential alarms or leaks. Additional storage is required for the landfill wastewater at the EMWMF/proposed EMDF site to retain the design stormwater and to provide a consistent flow of water to the lift station.

Monitoring and land use controls: The ORR remains within the control of DOE indefinitely with existing access restrictions and land use controls. Additional monitoring of the pipeline is performed to verify safe and efficient operating conditions.

Time frame for implementation: Construction of the pipeline is concurrent with the proposed EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The following uncertainties are associated with the pipeline:

- Potential route deviations within ORNL due to structures, utilities, or similar obstructions that cannot be moved or avoided
- Potential route deviations outside of ORNL due to potential ecological impacts
- Construction delays within the ORNL main campus due to conflicts with the existing operations
- Construction delays within the power line easement due to the proximity to electrical lines
- Additional lift stations may be required if the planned lift station cannot be placed at the planned location
- Potential soil contamination along the pipeline route may cause delays and increased cost for disposal

Documents: An environmental survey of the pipeline route is required.

3.3.4.3 Alternative 3b: Truck transport to PWTC

Summary: The landfill wastewater is trucked to PWTC using the existing fleet of government-furnished, 5000-gal capacity tanker trailers and tractors, plus an additional two tankers. The route is the same as the current route taken by EMWMF tanker trucks and is shown in Fig 17.

Details: The trucks typically haul 4500 gal per load. For the higher precipitation season of approximately three months, trucks haul landfill wastewater seven days per week for a regular 10-hour day shift. During the remaining nine months of the year, trucks are expected to haul landfill wastewater four days per week, day shift only, as is the current practice. However, if higher precipitation volumes occur during winter, then the seven-day-per-week schedule may need to be extended for up to six months to empty the storage system.

The two existing EMWMF loading stations are required to process up to 20 shipments per 10-hour shift and a third loading station is required, as a contingency, should additional landfill wastewater require off-site treatment. The existing 4-in. portable pumps are used to transfer the landfill wastewater to the loading station. Connections exist for the portable pump to each tank, and hoses connect the pump discharge to the loading arm pipe at the new loading station.

The new loading station, located centrally to the contact water tanks, includes a pull-through spill containment slab similar to that at the current West Loading Station, but with both long sides curbed. The containment slab is 60-ft long with a sump for collection of rainwater and spill/leaks. The sump has an automatic submersible pump that pumps back to any of the four tanks via a new underground pipe network.

The existing West Loading Station is refurbished to add a loading platform and new articulating loading arm of similar design to the existing East Loading Station. The only change to the East Loading Station is an upgrade to a higher capacity leachate transfer/loading pump.

A second, accessible tanker unloading station or bay is required at PWTC to allow two tankers to be simultaneously unloaded. The unloading station consists of a pull-through concrete containment slab with a sump to collect and transfer rainwater or spills into the treatment system and a gravity discharge pipe header to allow for emptying the tanker into the main collection sump. To create space for the new unloading station, a long retaining wall is demolished, and excavation into a hillside with potentially

contaminated soil is performed. The retaining wall is re-constructed. The excavated soil requires characterization to determine the appropriate disposal pathway, expected to be the ORR landfill.

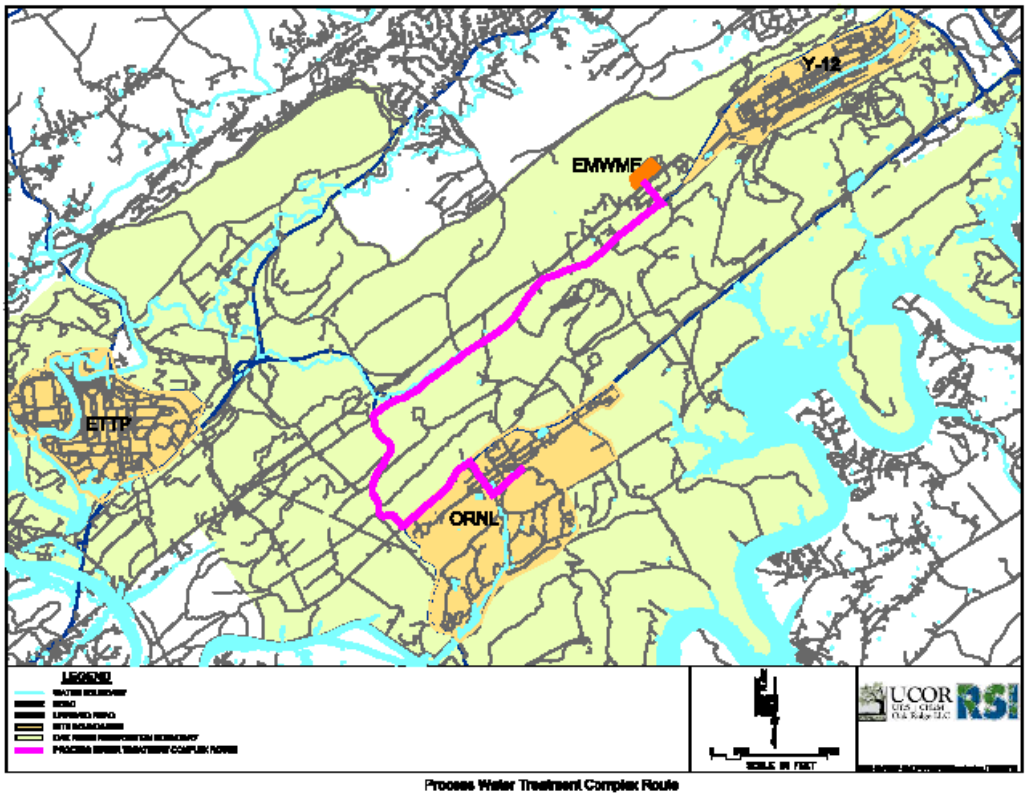

Fig. 17. Alternative 4b: truck route to PWTC.

Support activities: Piping is required to connect the proposed EMDF storage tanks and load-out pump to the new loading station near the existing ModuTanks®[1]. Additional support activities are required to procure two additional tankers, train drivers, and maintain the ORR roadways. Tractors to transport the leachate tankers are leased.

PWTC personnel are required to support a seven-days/week shipping schedule for up to six months per year. In addition, a second tanker unloading station or bay is required at PWTC.

Monitoring and land use controls: ORR remains within the control of DOE indefinitely with existing access restrictions and land use controls. No additional monitoring is required over what is required for Alternative 3.

Time frame for implementation: Construction of the additional support structures is concurrent with the proposed EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: Low levels of contamination are present in the soil that must be removed to undertake the infrastructure modifications at PWTC. While this soil is expected to be suitable for disposition at the

[1] Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

ORR landfill, if higher levels of contamination are found, additional worker protection may be needed. In addition, more stringent packaging and handling may be necessary for waste disposal at an alternate location. The future cost and availability of fuel may be a factor in the execution of this alternative.

The truck route to PWTC (Fig. 17) may be altered due to safety and security issues, as has occurred recently. This change may result in significant inefficiencies and cost increases.

Documents: No additional documentation is required in addition to the Alternative 4 documents.

3.3.5 Alternative 4: Treat at Outfall 200 Mercury Treatment Facility

3.3.5.1 Common Components

Summary: In Alternative 4, the landfill wastewater is transported by truck or pipeline to the planned, on-site OF200 MTF at Y-12. Figure 18 illustrates the process flow diagram for this alternative.

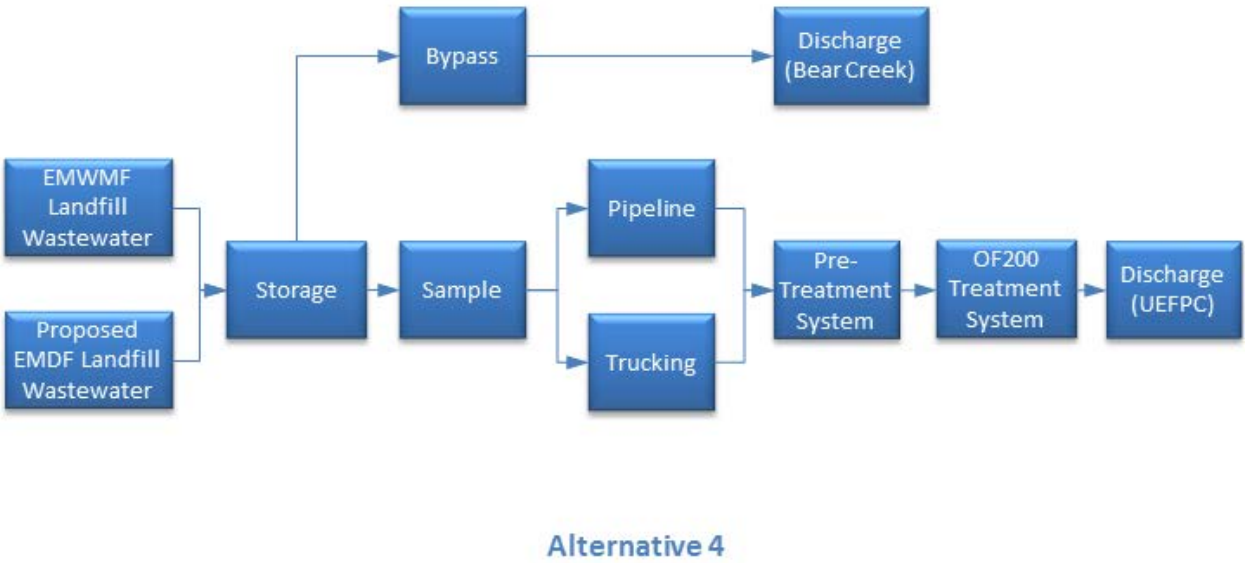

Fig. 18. Alternative 4: process flow diagram.

Background: The proposed OF200 MTF will be an on-site water treatment facility located on the Y-12 footprint of the ORR. OF200 MTF is currently being designed as an on-site water treatment facility to remove mercury from Upper East Fork Poplar Creek (UEFPC) surface water. While not yet in place, this treatment facility is being designed as a CERCLA action to reduce the amount of mercury discharged into UEFPC.

CERCLA remedial actions conducted on-site, as defined by 40 *CFR* 300.5, must comply with the ARARs, but not procedural or administrative requirements. The NCP at 40 *CFR* 300.400(e)(1) defines "on-site" as meaning "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action." CERCLA Sect. 104(d)(4) (as discussed further in the preamble to the final NCP, 55 FR 8690) states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions.

Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as "on-site" waste). This approach was proposed and agreed to by all signatories to the *Federal Facility Agreement for the Oak Ridge Reservation* for EMWMF, was acknowledged and documented in DOE/OR/01-1791&D3, and was reaffirmed in DOE/OR-01-2161&D2. This agreement serves as the basis for designating waste treatment, storage, and disposal facilities on the ORR as "on-site" facilities not subject to the CERCLA Off-Site Rule (40 *CFR* 300.440) when accepting wastes from CERCLA on-site response actions.

Details: The landfill wastewater from EMWMF and the proposed EMDF is pumped to sumps, tanks, and/or basins for storage. The average flow rate is 30 gpm, and the peak flow rate is 60 gpm. From storage, the water is pumped through a pipeline (Alternative 4a) or to a truck (Alternative 4b) for transport to OF200 MTF. The landfill wastewater will flow through a flow proportional sampler at which the flow will be measured, and samples will be collected for analysis. If storm flow above the design storm rate occurs that exceeds the storage capacity, the stormwater is released through a bypass pipeline without active management, per Rule 0400-40-05-.07(2)(l), to prevent damage to LWTS and to protect the workers. Storage capacity design will be based on a 100-year, 24-hour storm. Water storage is constructed or upgraded to be RCRA-compliant.

OF200 MTF is being designed to remove mercury from UEFPC surface water. While the OF200 MTF design may be effective for removal of other COCs in addition to mercury, treatment system performance for other contaminants has not been evaluated to date. Therefore, pretreatment is provided for the other key COCs. The pretreatment system is equivalent to the LWTS in Alternative 2 and is located at the OF200 MTF. The proposed OF200 MTF will be capable of treating 3000 gpm of UEFPC surface water (95_{th} percentile of the projected UEFPC stream flow) with a goal of treating to an effluent concentration < 51 ppt mercury. Storage capacity for the landfill wastewater is provided at the EMWMF/proposed EMDF site until these waters are transferred to the proposed OF200 MTF.

A treatability study is performed as part of this alternative to determine whether contaminants other than mercury, such as cadmium and radionuclides, are removed by the proposed OF200 MTF. The treatability study will evaluate removal of the key COCs requiring treatment. The results of the treatability study will be used to develop the criteria to determine whether landfill wastewater can be accepted at OF200 MTF or require pre-treatment.

The *Proposed Plan for Water Treatment at Outfall 200 Under the Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-2661&D2) describes the water treatment facility planned to reduce the release of mercury from OF200 into UEFPC at Y-12. An amendment to the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-1951&D3) has been prepared and is currently being reviewed by the regulatory agencies.

The OF200 MTF headworks will be constructed near Outfall 200, and the treatment plant will be constructed approximately 3000 feet east (Fig. 19).

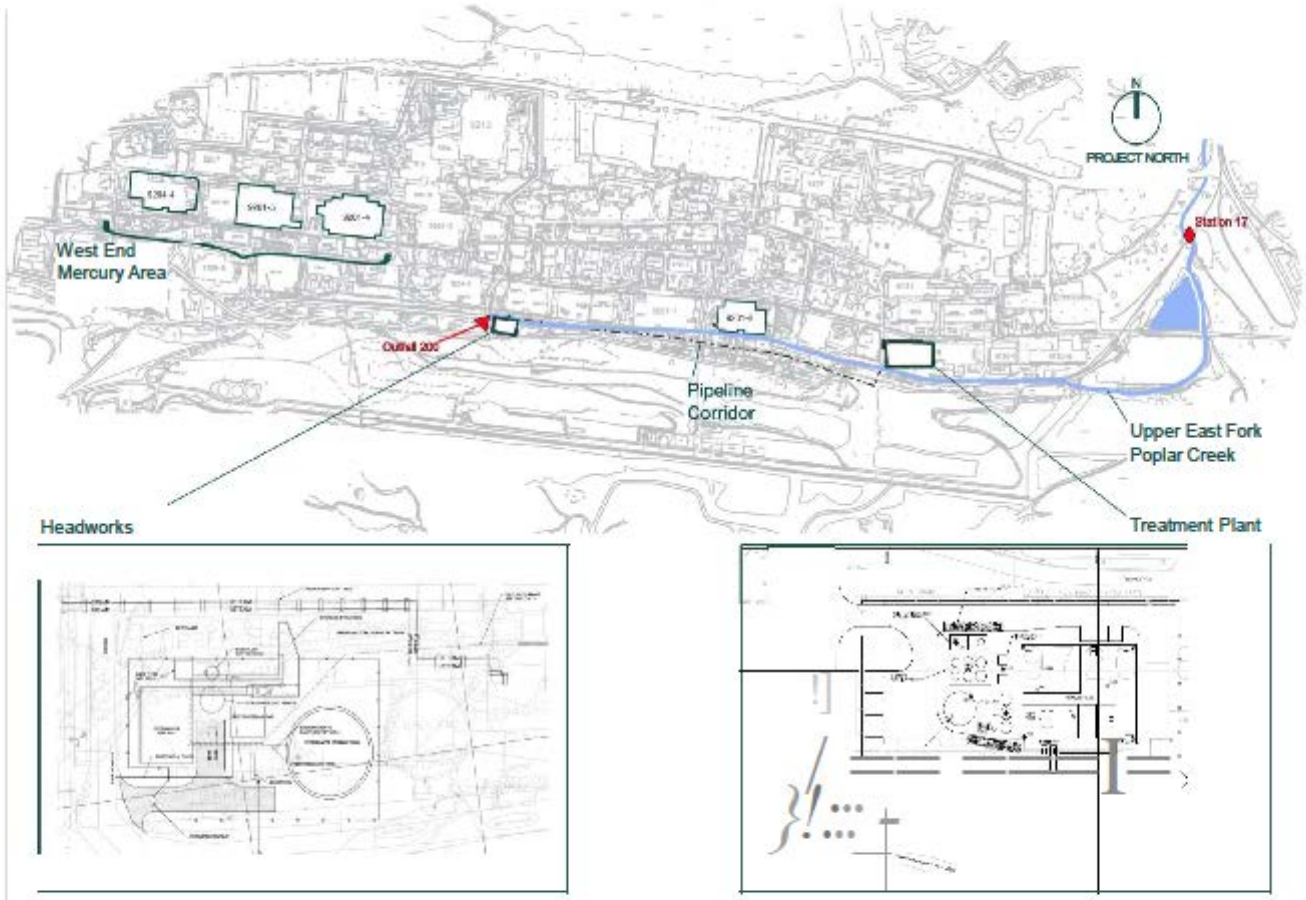

Fig. 19. Proposed location of the Outfall 200 MTF.

As described in the Proposed Plan, water flowing from Outfall 200 will be diverted into the inlet channel of the headworks through an intake structure grit removal and pump station. Water that has completed the grit removal process will be sent to either stormwater storage at the headworks or an equalization tank at the treatment plan. OF200 MTF will include the following sequential unit operations:

- Headworks/intake structure overflow diversion to UEFPC.
- Grit removal and grit classifier for solid waste separation.
- Inclined plate clarifiers for solids removal.
- Multimedia filtration—liquid effluent from the clarifiers will go to multi-media filters for additional solids removal prior to discharge of the treated effluent back to UEFPC.
- Sludge thickening and dewatering—sludge from the clarifiers will go to a sludge thickening tank and then to a filter press for dewatering. The resulting filter cake will be sent for disposal, while the filtrate will be recycled back into the treatment stream.

The OF200 MTF process flow diagram is in Fig. 20.

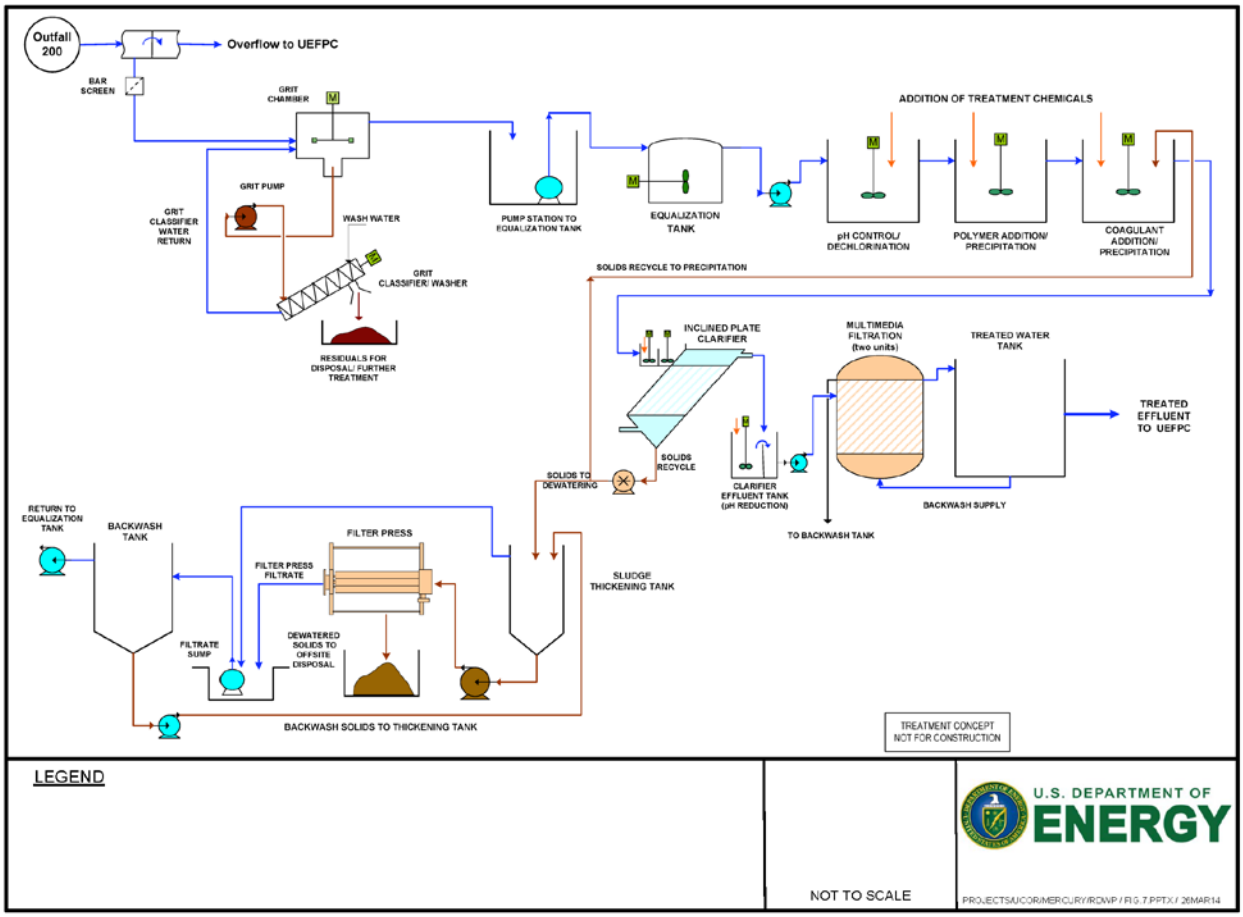

Fig. 20. Proposed Outfall 200 MTF process flow diagram.

OF200 MTF is only planned to accept the influent from UEFPC. If the OF200 MTF alternative is selected, design modifications are required to convey the landfill wastewater to OF200 MTF by either pipeline (Alternative 4a) or trucking (Alternative 4b).

Operation of the OF200 MTF will continue until mercury source areas at the West End Mercury Area have been remediated and mercury levels in discharges from Outfall 200 have declined to levels that no longer require treatment, estimated at 30 years.

Support activities: Landfill wastewater is transferred to OF200 MTF by either pipeline (Alternative 4a) or truck (Alternative 4b). Support activities are needed to construct additional loading and unloading stations, connect to utilities, and provide connection between the alarm systems and emergency transponders for high-level alarms and similar alerts. The additional 60 gpm of wastewater will not be expected to require any additional trained and qualified chemical operators over what is already estimated (DOE/OR/01-2599&D2). Pre-treatment will be needed to enhance the treatment effectiveness and/or minimize impacts to the OF200 facility operations. Pretreatment is expected to increase the operating costs for this facility.

The predominant solid waste streams generated by the proposed OF200 MTF treatment operations are estimated to include grit material from the grit removal system (estimated at 1,300,000 lb/year), filter cake from the filter press (estimated at 440,000 lb/year), and spent media from the multi-media filters (estimated at 44,000 lb/year) (DOE/OR/01-2660&D3, *Focused Feasibility Study for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*). All wastes will be sent for appropriate on-site or off-site disposal as sanitary/industrial waste, RCRA-regulated hazardous waste, low-level radioactive waste, or mixed waste, as suitable (DOE/OR/01-2599&D2, *Remedial Design Work Plan for the Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee*).

Monitoring and land use controls: EMWMF, the proposed EMDF, and OF200 MTF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

Time frame for implementation: The current schedule for the proposed OF200 MTF is for construction to start in 2017, with the treatment system expected to be operational in 2022. This time frame will result in the ability to treat the proposed EMDF landfill wastewater when this begins to be generated in mid- to late-2022. However, OF200 MTF will not be available to treat EMWMF landfill wastewater until 2022.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill wastewater over time because of the different contaminants at ETTP, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods. There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells.

OF200 MTF is being designed to treat mercury in UEFPC surface water. While other waters may be effectively treated and other contaminants potentially may be removed, no evaluation has been conducted to determine if additional contaminant removal will be successful. Therefore, pre-treatment for the key COCs other than mercury are included in this alternative. Treatability studies will be conducted for this alternative to determine effectiveness at removing additional EMWMF/proposed EMDF contaminants.

OF200 MTF is currently in design and planned to be operational in 2022. If landfill wastewater requires treatment during this time frame, an alternative treatment system will be necessary. In addition, delays in completion of OF200 MTF will increase the potential that an alternative treatment system will be required prior to availability of OF200 MTF.

Operation of the OF200 MTF will continue until mercury source areas at the West End Mercury Area have been remediated and mercury levels in discharges from Outfall 200 have declined to levels that no longer require treatment, estimated at 30 years. This duration may be incompatible with the time needed to treat landfill wastewater.

Documents: To implement this alternative, the remedial investigation/feasibility study, proposed plan, and record of decision for the proposed EMDF have to be completed, and the proposed OF200 MTF CERCLA documents must be revised and approved to include the proposed EMDF/EMWMF landfill wastewater as a treatment stream. A remedial action work plan/remedial design report will be completed that include the specific design for conveyance support. A completion report will be required to document the as-built conditions. EMWMF record of decision and implementing documents, including the sampling and analysis plan (UCOR-4156), may have to be revised. The division of scope between EMWMF, the proposed EMDF, and OF200 MTF CERCLA documents will have to be determined.

3.3.5.2 Alternative 4a: Pipeline transport to Outfall 200 MTF

Summary: A pipeline is constructed to transport landfill wastewater from EMWMF/proposed EMDF to OF200 MTF. This pipeline consists of welded HDPE piping and follows existing disturbed areas, such as Haul Road, where possible.

Details: Approximately 4400 feet of pressurized pipe is installed between the EMWMF/proposed EMDF site and OF200 MTF. The pipeline is 4-in. (SDR 11) HDPE pipe with a single lift station and leak detection sensors. This primary pipe is contained within a secondary HDPE pipe with leak detection sensors. The leak detection sensors are electronic low-point leak detection stations set approximately 2000 feet apart that communicate wirelessly to a main receiver.

For ease of installation, the pipeline route follows Haul Road and Bear Creek Road as much as possible (Fig. 21).

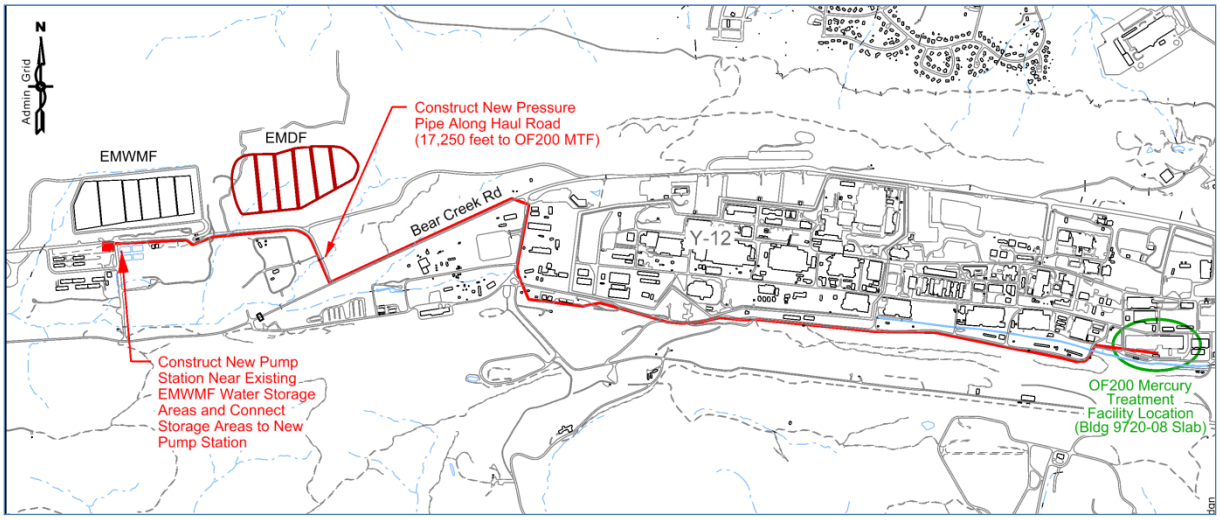

Fig. 21. Alternative 4a: route of pipeline to Outfall 200 MTF.

No additional storage is included in this alternative, but additional storage is required for the proposed EMDF construction.

The pipeline is pressurized with a pump station located near the EMWMF contact water storage tanks and ponds. A pressurized system eliminates the need for large, deep excavations required for a gravity flow system over the varying terrain. Locating the pump station at the beginning of the pipeline near the EMWMF contact water storage areas and making the entire system pressure driven allows for more flexibility when installing the pipe. Minimizing the working footprint along Haul Road lessens the impact to hauling operations, including the Uranium Processing Facility construction traffic.

No bridges are crossed, but North Tributary-2 and North Tributary-3 are crossed. For tributary crossings, the pipeline is buried next to or in the shoulder of Haul Road, while still maintaining the required burial depth when crossing culverts.

Support activities: Additional utility support is required at Y-12 to ensure utilities and structures are identified, moved, or protected during construction activities. Electrical power is required to the pump stations. Leak detection alarms are required, along with telemetry to alert operators of potential leaks. Additional storage is required for the landfill wastewater at the EMWMF/proposed EMDF site to retain the design stormwater and to provide a consistent flow of water for the pipeline.

Monitoring and land use controls: EMWMF, the proposed EMDF, and OF200 MTF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

Additional monitoring of the pipeline is performed to verify operating conditions.

Time frame for implementation: Construction of the pipeline is concurrent with the proposed EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The following uncertainties are associated with the pipeline:

- Potential route deviations within Y-12 because of ecological concerns, structures, utilities, or similar items that cannot be moved or avoided.
- Slower construction rate than planned within Y-12 because of potential conflicts with the existing infrastructure.
- Slower construction rate within Y-12 due to the increased security requirements.
- Additional lift stations may be required if the lift station cannot be placed as planned.

Documents: An environmental survey of the pipeline route is required.

3.3.5.3 Alternative 4b. Truck transport to OF200 MTF

Summary: The landfill wastewater is trucked to OF200 MTF using the existing fleet of government-furnished, 5000-gal capacity tanker trailers and tractors, plus an additional two tankers. The route is along Haul Road to Bear Creek Road (Fig. 22). Similar to Alternative 4a, the tankers discharge to a holding tank.

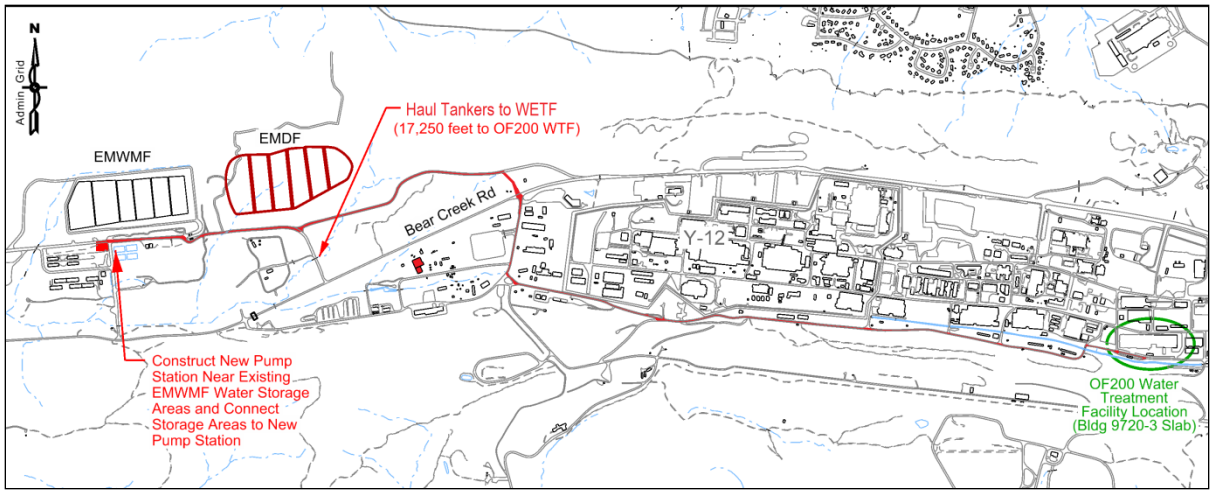

Fig. 22. Alternative 4b: truck route to Outfall 200 MTF.

Details: The existing 5000-gal capacity tanker trucks typically haul 4500 gal per load. For the higher precipitation season of approximately three months, trucks haul landfill wastewater seven days per week during a regular day shift. During the remaining nine months of the year, trucks haul landfill wastewater four days per week, day shift only, as is the current practice.

Two efficient loading stations are required to process up to 20 shipments per 10-hour shift. A new loading station is required at the EMWMF contact water tanks (the four ModuTanks®) to ship the EMWMF contact water. The existing 4-in. Wacker portable pumps are used to transfer the contact water to the loading station. Hook-ups exist for the hose connection of a portable pump to each ModuTank®, and hoses are used to connect the pump discharge to the loading arm pipe at the new station.

The new station includes a pull-through spill containment slab similar to that at the current West Loading Station, but with both long sides curbed. The containment slab will be 60-ft long with a sump for collection of rainwater and spill/leaks. The sump has an automatic submersible pump that pumps back to any of the four ModuTanks® via new 2-in. underground pipe network.

The existing West Loading Station is refurbished to add a SafeRack® loading platform and new articulating loading arm of similar design to the existing East Loading Station. The only change to the East Loading Station is an upgrade to a higher capacity leachate transfer/loading pump.

No new landfill wastewater storage is required at OF200 MTF. Landfill wastewater storage is maintained at the EMWMF/proposed EMDF location due to the proximity to OF200 MTF.

Support activities: Piping is required to connect the proposed EMDF storage tanks and load-out pump to the new loading station. Additional support activities are required to procure an additional tanker, train drivers, and maintain the ORR roadways.

Additional landfill wastewater storage is required at the EMWMF/proposed EMDF location to provide a consistent flow of water for the trucking operation. Operations staff provides sufficient workers to ship from two stations at the same time.

Monitoring and land use controls: EMWMF, the proposed EMDF, and OF200 MTF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. No additional monitoring is required over what is required for Alternative 4.

Time frame for implementation: Construction of the additional support structures is concurrent with the proposed EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The space for additional tanker unloading stations is limited and soil may have low levels of contamination that must be removed prior to construction. The future cost and availability of fuel may be a factor in the execution of this alternative.

The schedule impacts caused by entering and exiting the Y-12 security portal are not determined, but have been significant in the past.

The truck route to OF200 MTF (Fig. 19) may be altered due to safety and security issues. This change may result in significant inefficiencies and cost increases.

Documents: No additional documentation is required in addition to the Alternative 4 documents.

4. ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

This chapter presents the detailed analyses of the alternatives for the management of landfill wastewater generated from EMWMF and the proposed EMDF. The analysis of alternatives provides the basis for subsequently recommending an alternative in the EMDF proposed plan and modifying the EMWMF record of decision. Section 4.2 describes the evaluation criteria, Sect. 4.3 is an in-depth analysis for each alternative that provides the basis of alternative selection, and Sect. 4.4 is a comparative analysis of the alternatives.

4.2 EVALUATION CRITERIA

CERCLA, Section 121, as amended, specifies statutory requirements for remedial actions. These requirements include protection of human health and the environment, compliance with ARARs, a preference for permanent solutions that incorporate treatment as a principal element to the maximum extent practicable, and cost effectiveness. To assess whether alternatives meet these requirements, the following nine criteria (EPA/540/G-89/004**)** are identified in the NCP (40 *CFR* 300.430) that must be evaluated for each alternative [Section 300.430(e)(9)(iii)].

- Threshold Criteria
  - Overall Protection of Human Health and the Environment
  - Compliance with ARARs
- Balancing Criteria
  - Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility, or Volume Through Treatment
  - Short-Term Effectiveness
  - Implementability
  - Cost
- Modifying Criteria
  - State Acceptance
  - Community Acceptance

The first two criteria are the threshold criteria that relate directly to statutory findings that must be documented in the record of decision. The next five criteria, the primary balancing criteria, address the performance of the alternative and verify that the alternative is realistic. The last two modifying criteria are not addressed in the current analyses because they rely on stakeholder participation and feedback on the recommended alternative.

In addition to these evaluation criteria prescribed under CERCLA, DOE policy directs that the substantive elements of analysis required under the National Environmental Policy Act (NEPA) be incorporated into CERCLA decision documents (DOE 1994, *Secretarial Policy Statement on National Environmental Policy Act*). Elements common to both CERCLA and NEPA include protectiveness, compliance with ARARs, long-term effectiveness and permanence, short-term effectiveness, and cost. Additional NEPA values that are not specifically included in the CERCLA criteria include socioeconomic impacts, environmental justice, irreversible and irretrievable commitment of resources, and cumulative impacts.

Additionally, current EPA policy (EPA/542-R-12-002, *Methodology for Understanding and Reducing a Project's Environmental Footprint*) is to incorporate sustainability principles into the remedial decision-making process by considering all environmental effects of remedy implementation and incorporating options to maximize net environmental benefit of cleanup actions. The processes used for remediation also use a lot of water and energy and can create problems with emissions to air and water. To limit such collateral damage from remediation, EPA is adopting and promoting greener remediation practices. The core elements to be considered are energy requirements for treatment technologies, air emissions, water requirements and impacts, land and ecosystem impacts, material consumption and waste generation, and long-term stewardship.

Because both the landfill wastewater flow and potential COCs are expected to be variable over time, the adaptability of each alternative to address these uncertainties is included in the implementability criterion.

Below are summaries of the factors that comprise the nine CERCLA criteria and a brief discussion on the integration of NEPA and green remediation with the CERCLA analysis.

- **Criterion 1: Overall Protection of Human Health and the Environment.** This evaluation criterion assesses whether the alternative achieves and maintains adequate protection of human health and the environment in accordance with the remedial action objectives. Because the scope of this criterion is broad, it also reflects the discussions of the subsequent criteria, including long-term effectiveness and permanence and short-term effectiveness. This criterion evaluates how site risks associated with each exposure pathway will be eliminated, reduced, or mitigated through treatment, engineering controls, or land use controls. This criterion also evaluates impacts to the site environment resulting from the action itself.

- **Criterion 2: Compliance with ARARs.** This evaluation criterion addresses compliance with promulgated federal and state environmental requirements that are legally applicable or relevant and appropriate. If an alternative cannot meet a requirement, a waiver under CERCLA might be appropriate and a basis for justifying the waiver is presented. ARARs consist of two sets of requirements—those that are applicable and those that are relevant and appropriate. If there are no standards that address the proposed action or COCs, nonpromulgated advisories, criteria, or guidance developed by EPA, other federal agencies, or states may be designated as TBC guidance.

  The ARARs for this focused feasibility study that may be added to the *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* are in Appendix D. Those ARARs required for the proposed EMDF will be included in the *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, Tennessee* and subsequent CERCLA decision documents.

- **Criterion 3: Long-Term Effectiveness and Permanence.** This evaluation criterion evaluates the extent to which an alternative achieves an overall reduction in risk to human health and the environment after the remedial action objectives are met. The criterion also considers the degree to which the alternative provides sufficient long-term controls and reliability to prevent exposures that exceed protective levels for human and environmental receptors. The principal factors addressed by this criterion include the magnitude of residual risk, the adequacy and reliability of controls to address such risk, and the uncertainties associated with these factors. This criterion also evaluates the potential long-term environmental effects of the alternative. The evaluation of adequacy and reliability of controls assesses the effectiveness of any treatment, containment, or land use controls that are part of the alternative. Factors considered include performance characteristics, maintenance requirements, and expected durability. Information and data from past performance and similar

technology applications may be appropriately incorporated into the evaluation. Land use controls are considered if they potentially improve the effectiveness of engineering controls.

- **Criterion 4: Reduction of Toxicity, Mobility, or Volume Through Treatment.** This evaluation criterion reflects the statutory preference that remedial alternatives contain a principal component that substantially reduces toxicity, mobility, or volume of hazardous substances through treatment. The evaluation of alternatives against this criterion considers the extent to which alternative technologies can effectively and permanently fix, transform, immobilize, or reduce the volume of contaminants.

- **Criterion 5: Short-Term Effectiveness.** This evaluation criterion addresses the effects on human health and the environment posed by the construction and implementation of the alternative. Both the potential impacts and associated mitigative measures are examined for protectiveness of the community, remediation workers, and environmental receptors during remedial activities. Potential short-term risks to the public include inhalation of contaminants that might be released during construction and implementation of the alternative. Potential short-term risks to workers include direct contact and exposure during construction, waste handling, and transportation; physical injury or death during construction and transportation activities; and airborne contamination during soil removal. Alternative analyses also include a description of mitigative measures, such as engineering and land use controls, expected to minimize potential risks to the public and workers. This criterion also evaluates impacts on environmental media and potentially sensitive resources. Short-term environmental effects and mitigation measures are qualitatively assessed.

- **Criterion 6: Implementability.** This evaluation criterion examines the technical and administrative factors affecting implementation of an alternative and considers the availability of services and materials required during implementation. Technical factors to be assessed include the ease and reliability of construction and operations, the prospects for implementing any needed future actions, and the adequacy of monitoring systems to detect failures. Administrative factors include permitting and coordination requirements between the lead agency (DOE) and regulatory agencies (EPA and TDEC). Service and material considerations include treatment, storage, or disposal capacities; equipment and operator availability; and applicability or development requirements for prospective technologies.

  Technical feasibility considers the performance history of the technologies in direct applications or the expected performance for similar applications. Also addressed are uncertainties associated with construction, operation, and performance monitoring.

  The evaluation of administrative feasibility addresses actions required to coordinate with regulatory agencies in establishing the framework for compliance with substantive technical requirements. The NCP requires that the evaluation of the relative administrative feasibility of each alternative include "…activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions). CERCLA, Sect. 121(e), stipulates that no federal, state, or local permit shall be required for the portion of any removal or remedial action conducted entirely on site." An action must satisfy the substantive requirements of any permits that would otherwise be required. The availability of services and materials is addressed by analyzing the material components of the proposed technologies and then determining the locations and quantities of those materials. Process operations are reviewed to identify any special services, operator skills, or training needed for ready implementation of the process.

  There is uncertainty in the future concentrations of the key COCs in landfill wastewater over time because of the different contaminants at ETTP, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. This situation is expected

to occur in the future with contaminants requiring treatment that will vary over time and for varying periods. There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells (such as under enhanced operational cover). Therefore, a key factor in evaluating the alternatives is the ability to adapt to changes in key COCs, concentrations, and flow rate.

- **Criterion 7: Cost.** A cost estimate is included for each alternative. The estimate is based on feasibility-level scoping and is intended to facilitate evaluation of the alternative. The estimate has an expected accuracy of +50 to -30 percent for the scope of action. All estimates have been escalated using DOE-approved annual rates and a schedule for the various activities based on similar project experience. Typical cost estimating contingencies are not included in the estimate.

  The cost estimate is divided into capital and O&M costs. Capital costs are defined as those expenditures required to initiate and install an alternative. These are short-term costs and exclude costs required to maintain the action throughout the project's lifetime. O&M costs are long-term costs required to maintain the action throughout the project's lifetime. These costs occur after construction and installation are completed.

  Appendix H contains additional information on the cost estimates and the major assumptions used to develop those estimates.

- **Criterion 8: State Acceptance.** State acceptance of alternatives will be evaluated in the proposed plan issued for public comment. Therefore, this criterion is not necessary for this focused feasibility study.

- **Criterion 9: Community Acceptance.** Community acceptance of alternatives will be evaluated when the proposed plan is issued for public comment. Therefore, this criterion is not necessary for this focused feasibility study.

- **NEPA Considerations.** DOE policy (DOE 1994) directs that the substantive elements of analysis required under NEPA be incorporated into CERCLA decision documents. This process provides decision makers with a wider range of environmental and social concerns than those specifically delineated under CERCLA. The CERCLA evaluation criteria are directly applicable to the consideration of environmental and social impacts, as listed below:

  — Compliance with ARARs addresses the NEPA requirement for consideration of applicable laws and guidelines, including cultural and historical resources

  — Long-term effectiveness and permanence addresses the NEPA requirement for consideration of long-term impacts on human health and the environment, including emissions to air and water

  — Short-term effectiveness addresses the NEPA requirement for consideration of short-term impacts on human health and the environment, noise, air, transportation, and short-term emissions to air and water

  — Cost is a consideration under both NEPA and CERCLA

Other NEPA values not normally considered in a CERCLA focused feasibility study include the following:

- Aesthetic effects
- Socioeconomic impacts
- Environmental justice
- Irreversible and irretrievable commitments of resources
- Cumulative impacts

These values are not key differentiators among the alternatives, except for the irreversible and irretrievable commitments of resources.

- **Green remediation considerations.** EPA policy (EPA/542-R-12-002; EPA/542-R-08-002, *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites*) is to incorporate sustainability principles into the remedial decision-making process. The CERCLA evaluation criteria are directly applicable to the following core elements, as listed below:
  - Overall protection of human health and the environment addresses the core element of land and ecosystem impacts.
  - Implementability addresses the core element of long-term stewardship by evaluating the impacts of the alternatives on operations and maintenance. Implementability also addresses the core element of air emissions in the evaluation of the trucking option.
  - Compliance with ARARs addresses the core element of water impacts by evaluating compliance with AWQC.
  - The discussion of process options (Sect. 3.2) already addresses water requirements in terms of reusing water.

The core values not normally considered in a CERCLA feasibility study are the following:

- Energy required
- Material consumption and waste generation

These are similar to the irreversible and irretrievable commitment of resources discussed above with the NEPA values, so another criterion against which each alternative is evaluated is the irreversible and irretrievable commitment of resources.

4.3 INDIVIDUAL ANALYSIS OF ALTERNATIVES

4.3.1 Alternative 1: No Action

Evaluation of the No Action alternative is required under CERCLA [40 *CFR* 300.430(e)(6)] to provide a baseline for comparison with the action alternatives. Under the No Action alternative, the proposed EMDF is not built. Current operations continue at EMWMF. Landfill wastewater is discharged to Bear Creek or trucked to PWTC at ORNL. The landfill wastewater will not be expected to meet the current discharge limits at all times. No implementation is required and there are no additional costs associated with this alternative.

Overall Protection of Human Health and the Environment (Alternative 1)

The No Action alternative will not be protective of human health and the environment, will not meet the remedial action objective to meet current discharge limits for the key COCs to protect surface water for designated uses, and will not be effective. No action will be taken to attain AWQC in surface water, and contaminant releases in excess of current discharge limits are possible.

Compliance with ARARs (Alternative 1)

Compliance with ARARs applies only to actions taken under CERCLA authority. Since the No Action alternative includes no response actions to manage landfill wastewater, there are no ARARs associated with this alternative.

Long-Term Effectiveness and Permanence (1)

The No Action alternative will not be effective in the long-term and is unacceptable since no remedial action will be taken to mitigate contaminant releases from the landfill wastewater. Contaminant releases to surface water and groundwater will continue.

Reduction of Toxicity, Mobility, or Volume through Treatment (Alternative 1)

Implementation of the No Action alternative will not meet the CERCLA preference for treatment to reduce toxicity, mobility, or volume of contaminants.

Short-Term Effectiveness (Alternative 1)

Since the No Action alternative involves no construction, there will be no short-term risks to workers or the community and no short-term environmental impacts.

Implementability (Alternative 1)

No implementation activities will be required for the No Action alternative. Therefore, this alternative is inherently implementable. However, it may be difficult to obtain acceptance from the regulators and the public. Since no action is being taken to manage the discharge of landfill wastewater, the No Action alternative does not address fluctuating flows and varying COCs.

Cost (Alternative 1)

Capital Cost. There is no capital cost for Alternative 1.

O&M Cost. There is no incremental annual O&M cost for Alternative 1.

Present Worth. The present worth of Alternative 1 is zero.

The basis for the cost estimate is in Appendix I.

The No Action alternative can result in fines under the Clean Water Act if AWQC are not maintained.

Irretrievable Commitment of Resources (Alternative 1)

There will be no additional commitment of resources under the No Action alternative. However, the release of contaminants will continue to degrade the water quality of Bear Creek.

4.3.2 Alternative 2: Managed Discharge/Treat

In Alternative 2, landfill wastewater initially is discharged to Bear Creek in accordance with current discharge limits and subsequently is treated at LWTS, located at the proposed, adjacent EMDF site, prior to discharge to Bear Creek in accordance with revised discharge limits. If the proposed EMDF is not

constructed adjacent to EMWMF, LWTS will be constructed at EMDF, and EMWMF landfill wastewater will be transported by truck or pipeline to LWTS.

Overall Protection of Human Health and the Environment (Alternative 2)

Protection of Human Health and the Environment. This alternative will be protective of human health and the environment because landfill wastewater will meet discharge limits prior to discharge. The discharge limits for both managed discharge and treatment were developed considering the anti-degradation requirements (Appendix K). Since discharge limits will be met prior to discharge, Bear Creek will not be further degraded.

Treatment technologies for removal of the key COCs are best available technology, well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill wastewater composition changes and additional contaminants must be addressed, LWTS can be modified easily, due to its modular design, to include the necessary unit operations. Sampling treatment system influent and effluent verifies performance and identifies changes in the characteristics of the landfill wastewater.

The contingent pipeline or trucking to transport landfill wastewater from EMWMF to the proposed EMDF at the West Bear Creek location is protective of human health and the environment. The pipeline is an engineered system with secondary containment, instrumentation, controls, and leak detection capability. The utilization of pipelines is a well-established technology with standards codes and specifications for designing, constructing, and testing a pipeline system. As with any pipeline, there will be inherent minor risk associated with pipeline failure from a manmade event or natural phenomena, e.g., fire, earthquake, freeze damage. Environmental surveys are required prior to construction to evaluate impacts to wetlands and rare and endangered species. Trucking has been practiced for EMWMF landfill wastewater for many years without incident

Effectiveness. This alternative will be effective for the discharge of landfill wastewater because the concentrations of the key COCs will meet discharge limits prior to discharge. The discharge limits for both managed discharge and treatment were developed considering the anti-degradation requirements. Since discharge limits will be met prior to discharge, Bear Creek will not be further degraded. Treatment technologies for removal of key COCs are best available technology, well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill wastewater composition changes and additional contaminants must be addressed, LWTS can be modified easily to include the necessary unit operations.

Impacts to Site Environment. Alternative 2 has minimal impact to the site environment. Managed Discharge will have no impact to the site environment because there will be no new construction. Existing facilities and equipment will be used, and no upgrade will be necessary. Even though LWTS will be constructed at the proposed EMDF, the site previously has been impacted by waste disposal operations, and site preparation will require only minor excavation. If the proposed EMDF is constructed at the West Bear Creek location, then there will be some impact to the site environment by developing an area for waste disposal that has been designated for unrestricted use and the construction of the pipeline.

Compliance with ARARs (Alternative 2)

Compliance with ARARs. Alternative 2 will comply with all chemical-specific, location-specific, and action-specific ARARs. Key COCs concentrations will meet discharge limits prior to discharge. Treatment technologies for removal of the key COCs are best available technology, well demonstrated, reliable, readily available, and easily implemented. Sampling treatment system effluent verifies performance and identifies changes in the characteristics of landfill wastewater. If landfill wastewater

composition changes and additional contaminants must be addressed, LWTS can be modified easily, due to its modular design, to include the necessary unit operations. Anti-degradation will be met because discharge limits were developed considering anti-degradation, the discharge limits will be met prior to discharge, the treatment is best available technology, and periodic toxicity testing will be performed.

ARAR Waivers. No ARAR waivers are required.

Long-Term Effectiveness and Permanence (Alternative 2)

Effectiveness. Alternative 2 will be effective for the long-term. Landfill wastewater will meet discharge limits prior to discharge. LWTS will provide processing equipment with a design life that matches the anticipated landfill operations schedule with continued post-closure operations until landfill wastewater no longer requires treatment or is no longer generated. Since treatment technologies for removal of the key COCs are best available technology, well demonstrated, reliable, effective, readily available, and easily implemented, LWTS can be maintained, and components can be replaced with normal procedures. Sampling LWTS influent and effluent will verify performance and identify changes in the characteristics of the landfill wastewater. If landfill wastewater composition changes, and additional contaminants must be addressed, LWTS can be modified easily, due to its modular design, to include the necessary unit operations.

Permanence. The EMWMF and proposed EMDF sites are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. There is uncertainty associated with the quality of the landfill wastewater in the future, as remediation continues at ORNL and Y-12 with different COCs and as contaminants continue to leach in unpredictable concentrations. Since treatment technologies for removal of the key COCs are best available technology, well demonstrated, reliable, effective, readily available, and easily implemented, LWTS can be maintained, and components can be replaced with normal procedures. Sampling LWTS influent and effluent will verify performance and identify changes in the characteristics of the landfill wastewater. If landfill wastewater composition changes, and additional contaminants must be addressed, LWTS can be modified easily, due to its modular design, to include the necessary unit operations.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 2)

Alternative 2 will meet the CERCLA preference for treatment to reduce toxicity, mobility, or volume of contaminants. LWTS will reduce the concentrations of key COCs to acceptable levels through treatment of landfill wastewater prior to discharge to Bear Creek, if needed.

Short-Term Effectiveness (Alternative 2)

Since Managed Discharge involves no construction, there will be no short-term risk to workers, the community, and the environment. The treatment of landfill wastewater will require construction activities with the associated risk of industrial accidents. DOE safety policies, procedures, and worker training reduce the potential for and mitigate the consequences of such incidents. This alternative will have minimal short-term impacts to the surrounding community and the environment.

The operation of LWTS will have minimal short-term impacts to remediation workers, the surrounding community, and the environment.

Implementability (Alternative 2)

Technical Feasibility. Alternative 2 will be technically feasible and simple to implement. For Managed Discharge, existing facilities and equipment will be used and no upgrade will be necessary. LWTS will be technically easy to implement because the treatment technologies for removal of the key COCs are well demonstrated, reliable, effective, readily available, and easy to construct using standard equipment and techniques. DOE has implemented similar projects at ORNL, Y-12, and ETTP and has access to experienced engineering and project management resources for landfill wastewater treatment projects. LWTS will be designed for ease of expansion if additional COCs are encountered. The time required to respond to additional COCs will be minimized through monitoring of landfill wastewater and through contingency planning that includes evaluation of waste planned for disposal

Administrative Feasibility. Alternative 2 will be administratively easy to implement. The remedial investigation/feasibility study, proposed plan, and record of decision for the proposed EMDF will have to be approved. A remedial action work plan/remedial design report that include the specific LWTS design and a completion document that contains the as-built conditions will be required. The EMWMF record of decision and implementing documents will be revised to include appropriate ARARs for the discharge of landfill wastewater into Bear Creek. All of these documents are conventional CERCLA documents for which DOE has extensive experience. A compliance schedule will be developed in accordance with the *Federal Facility Agreement for the Oak Ridge Reservation*.

Availability of Services and Materials. The services and materials for Alternative 2 are readily available. The treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easy to construct using standard equipment and techniques. DOE has implemented similar projects at ORNL, Y-12, and ETTP and has access to experienced engineering and project management resources for landfill wastewater treatment projects. Construction of LWTS will use conventional construction techniques.

Adaptability. Alternative 2 is adaptable. LWTS will be designed to quickly implement different treatment units, if required by changes in COCs above or below discharge limits or due to long-term changes in flow rates. If higher flow rates are continuous, then the treatment system will be easily expanded. Lower flow rates normally will be treated in batches, requiring no changes to the treatment system. If lower flow rates are continuous, then the treatment system will be easily reduced in size.

Cost (Alternative 2)

Capital Cost. The capital cost is approximately $13 million.

O&M Cost. The annual O&M cost for Alternative 2 is estimated at approximately $1.5 million during operation and closure and approximately $0.3 million during post-closure. Offsetting this annual O&M cost is the current annual cost of approximately $500,000 to transport EMWMF leachate to PWTC for treatment.

Present Worth. The present worth of Alternative 2 is estimated at approximately $51 million.

The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 2)

In Alternative 2, there will be minimal irretrievable commitment of resources. LWTS will be small, so the energy requirements are not excessive. The footprint of LWTS is in an area already dedicated to waste management, so there will be minimal environmental impacts.

4.3.3 Alternative 3: Treat at PWTC

In Alternative 3, the landfill wastewater will be transferred by truck or pipeline to the on-site PWTC at ORNL for treatment prior to discharge into White Oak Creek. Since PWTC is at the end of its design life, an extension of the design life is planned. This extension does not include EMWMF/proposed EMDF landfill wastewater. Also, PWTC currently cannot accept mercury, and the radiological treatment processes are limited. Therefore, the lifetime extension and pretreatment are necessary for the long-term viability of Alternative 3.

Overall Protection of Human Health and the Environment (Alternative 3)

Protection of Human Health and the Environment. Alternative 3 is protective of human health and the environment because the remedial action objective for landfill wastewater from EMWMF and the proposed EMDF will be met by treatment at PWTC prior to discharge to White Oak Creek. The treatment technologies used at PWTC and at the pretreatment facility are effective for the landfill wastewater. Sampling the landfill wastewater prior to shipping to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill wastewater. The need to extend the lifecycle of PWTC and to construct the pretreatment facility will require time to obtain additional funds and to design, construct, and deploy the additional processing equipment. If the landfill wastewater is transported by truck to PWTC, then there will be risk to the drivers and the public associated with the potential for roadway transport incidents.

The pipeline option is protective of human health and the environment because it will transfer landfill wastewater in an engineered system with secondary containment, instrumentation, controls, and leak detection capability. The utilization of pipelines is a well-established technology with standards codes and specifications for designing, constructing, and testing a pipeline system. As with any pipeline, there will be inherent minor risk associated with pipeline failure from a manmade event or natural phenomena, e.g., fire, earthquake, freeze damage. Since the pipeline route will follow the existing Haul Road and power line easement, there will be minimal additional environmental impacts. Environmental surveys will be required prior to construction to evaluate impacts to wetlands and rare and endangered species.

This alternative will reduce the flow of water into Bear Creek that may be detrimental to aquatic life. On rare occasions that storm events necessitate the bypass of untreated landfill wastewater directly into Bear Creek, the overall impact to protection of human health and the environment will be minimal because the flux of contaminants should be small.

Effectiveness. The treatment technologies used at PWTC and the pre-treatment facility will be effective for the landfill wastewater. Sampling the landfill wastewater prior to transferring to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill wastewater. The extension of PWTC design life and pretreatment are necessary for the long-term effectiveness of this alternative. This project will require time to obtain additional funds, design, and deploy the new equipment.

Either transporting the landfill water by truck or transferring by pipeline will be effective for moving landfill wastewater to PWTC for treatment. Both methods have some level of inherent risk associated with potential spills.

Truck transportation of landfill wastewater has been performed successfully for over ten years. However, due to the increased quantity of landfill wastewater to be transported, there is uncertainty in the availability of trucks, the availability of drivers, and the travel time during bad weather. Increased truck transportation will also require additional PWTC support for unloading tankers.

Impacts to Site Environment. Alternative 3 will have minimal impacts to the site environment. Since the pipeline route follows the existing Haul Road and power line easement for most of the route, minimal additional environmental impacts are anticipated. However, an environmental survey will be required prior to construction. This alternative will reduce the flow of water in Bear Creek and may be detrimental to aquatic life. On the rare occasions that untreated landfill water bypasses the treatment system and is discharged directly into Bear Creek, the overall protection of human health and the environment will be minimal. In order to install the additional landfill wastewater offloading stations at PWTC, soil will have to be excavated that has low levels of contamination.

Compliance with ARARs (Alternative 3)

Compliance with ARARs. Alternative 3 will comply with all chemical-specific, location-specific, and action-specific ARARs. Treatment of landfill wastewater at PWTC and the pretreatment facility is compliant with ARARs. The WAC and the NPDES permit will have to be revised. The treatment technologies used at PWTC and the pre-treatment facility are effective for the landfill wastewater. Sampling landfill wastewater prior to transporting it to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill wastewater. The pipeline will be constructed to appropriate engineering standards and will have secondary containment and leak detection capability.

ARAR Waivers. No ARAR waivers are required.

Long-Term Effectiveness and Permanence (Alternative 3)

Effectiveness. Alternative 3 will be effective in the long-term. Treatment of landfill wastewater at PWTC will be effective for long-term operation and compliant performance when the design life is extended and the pretreatment facility is operational. Sampling landfill wastewater prior to transporting it to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill wastewater due to the differing predominant contaminants at ETTP, ORNL, and Y-12. If additional contaminants are introduced into the landfill wastewater, PWTC modifications can be performed, as necessary, to meet processing needs. Significant PWTC modifications can result in impaired treatment effectiveness and performance for the time necessary to provide the required treatment capability. The age of PWTC and the time needed to extend its life may have short-term impacts during future construction, but will still be effective once completed.

Transporting the landfill wastewater by tanker truck to PWTC will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the expected increase and fluctuation in landfill wastewater flow will introduce uncertainty in the availability of trucks and drivers, and increase the potential for transport incidents.

The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill water to the PWTC. Piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and the proposed EMDF.

Permanence. The EMWMF and proposed EMDF sites and ORNL are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. The facilities and equipment at PWTC are aging, show signs of deterioration, and require an extension of design life. Additionally, pretreatment is required for mercury and radionuclides and possibly other COCs. If additional contaminants are introduced into the landfill wastewater, PWTC modifications can be performed, as necessary, to meet processing needs

Transporting the landfill wastewater by tanker truck to PWTC will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the fluctuation in landfill wastewater flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents. The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill wastewater to PWTC. Piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and EMDF.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 3)

Alternative 3 will reduce the concentrations of key COCs to acceptable levels through treatment of landfill wastewater prior to discharge to White Oak Creek.

Short-Term Effectiveness (Alternative 3)

The operation of PWTC will have minimal short-term impacts to remediation workers, the surrounding community, and the environment. The PWTC currently accepts and processes EMWMF leachate effectively and safely. Truck transport is currently used to deliver the leachate to PWTC for treatment and is being performed effectively and safely. Construction of the pipeline will have short-term environmental impacts, but by following the existing duct bank and power line easement, the impacts are minimized. DOE safety policies, procedures, and worker training reduce the potential for and mitigate the consequences of such incidents. Alternative 3 will reduce the flow of water in Bear Creek and may be detrimental to aquatic life. In order to install the additional landfill wastewater offloading stations at PWTC, soil will have to be excavated that has low levels of contamination that will require additional worker protection.

Implementability (Alternative 3)

Technical Feasibility. Alternative 3 will be technically feasible and simple to implement. Upgrades at PWTC to install the additional landfill water offloading stations are easy to construct, and the slightly contaminated soil should be disposed at the ORR landfill. However, implementability during the lifecycle extension and construction of pretreatment will be impaired by the need to obtain additional funds, complete design activities, and perform construction, while maintaining operational capability for continued landfill wastewater processing.

The construction activities required to extend the lifecycle of PWTC and to install pretreatment to accept the landfill wastewater are common, and the additional risk of a construction accident is not significant. Operational risk for landfill wastewater treatment is no greater than what is currently experienced during PWTC ongoing operations.

Construction of the pipeline will use conventional construction techniques. However, there is likely to be interference from existing underground utilities and potentially contaminated soil that will complicate construction of the pipeline. The utilization of trucks has been practiced successfully for over ten years.

However, the expected fluctuation in landfill wastewater flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents.

Administrative Feasibility. Alternative 3 will be administratively easy to implement. The remedial investigation/feasibility study, proposed plan, and record of decision for the proposed EMDF will have to be approved. A remedial action work plan/remedial design report that include the specific pretreatment facility design and a completion document that contains the as-built conditions will be required. The EMWMF record of decision and implementation documents will have to be revised. All of these documents are conventional CERCLA documents for which DOE has extensive experience. The WAC and NPDES permit will have to be revised. If additional contaminants appear in the landfill wastewater in the future, then the WAC will require further revision before the new contaminants can be accepted on a permanent basis.

Availability of Services and Materials. Lifetime extension of PWTC and construction of the pretreatment system to receive the landfill wastewater and construction of the pipeline will use conventional construction techniques. The additional trucks and drivers that will be needed are available, but the varying demand complicates access to them.

Adaptability. The current PWTC is not readily adaptable to changing flow rates and COCs, but PWTC with an extended lifecycle and the pretreatment system should be more adaptable.

Cost (Alternative 3)

- Trucking Option (Alternative 3a):
  - **Capital Cost.** The capital cost of Alternative 3a is estimated at approximately $17 million.
  - **O&M Cost.** The annual O&M cost of Alternative 3a is estimated at approximately $4 million during operation and closure and $0.4 million during post-closure.
  - **Present Worth.** The present worth of Alternative 3a is estimated at approximately $118 million. The basis for the cost estimate is in Appendix I.
- Pipeline Option (Alternative 3b):
  - **Capital Cost.** The capital cost of Alternative 3b is estimated at approximately $20 million.
  - **O&M Cost.** The annual O&M cost of Alternative 3b is estimated at approximately $1.7 million during operations and closure and $0.3 million during post-closure.
  - **Present Worth.** The present worth of Alternative 3b is estimated at approximately $60 million.

The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 3)

In Alternative 3, there will be minimal irretrievable commitment of resources. PWTC is an existing facility, and the additional flow is minimal. Therefore, the incremental energy and chemical requirements for treatment will be minimal, even following the lifetime extension and construction of the pretreatment facility. The route of the pipeline is in an area already used as a haul road and power line easement, so there will be minimal environmental impacts. Transporting landfill wastewater by truck will consume more energy in fuel than the pipeline option.

4.3.4 Alternative 4: Treat at Outfall 200 MTF

In Alternative 4, the landfill wastewater will be transferred by truck or pipeline to the planned, on-site treatment facility at Outfall 200 at Y-12 for treatment prior to discharge into UEFPC. Pretreatment of landfill wastewater is required for key COCs other than mercury.

Overall Protection of Human Health and the Environment (Alternative 4)

Protection of Human Health and the Environment. Alternative 4 will be protective of human health and the environment because the remedial action objective for landfill wastewater from EMWMF and the proposed EMDF will be met by pre-treatment and treatment at OF200 MTF prior to discharge to UEFPC. The treatment technologies planned at OF200 MTF and additional pre-treatment are effective for key COCs. Treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill wastewater composition changes and additional contaminants must be addressed, the pre-treatment system can be modified easily, due to its modular design, to include the necessary unit operations. Sampling the landfill wastewater prior to shipping to OF200 MTF will verify compatibility with OF200 MTF and pretreatment capability and identify changes in the characteristics of the landfill wastewater. If the landfill wastewater becomes contaminated with COCs other than key COCs, the adaptability of OF200 MTF and pre-treatment is adequate. Treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill water composition changes and additional contaminants must be addressed, the pre-treatment system can be modified easily, due to its modular design, to include the necessary unit operations. Until treatability studies are performed, the ability to treat other COCs is not known. The pre-treatment facility will be constructed and operated at the OF200 MTF site. This alternative will reduce the flow of water into Bear Creek that may be detrimental to aquatic life, and at peak, EMDF flow is less than a 5% increase to the average flow rate in East Fork Poplar Creek at OF200.

If the landfill wastewater is transported by truck to OF200 MTF, there will be risk to the drivers and the public associated with the potential for roadway transport incidents. Existing tankers are a proven technology currently used for EMWMF landfill wastewater transport.

The pipeline option is protective of human health and the environment because it will transfer landfill wastewater in an engineered system with secondary containment, instrumentation, controls, and leak detection capability. The utilization of pipelines is a well-established technology with standards, codes, and specifications for designing, constructing, and testing a pipeline system. As with any pipeline, there will be inherent minor risk associated with pipeline failure from a manmade event or natural phenomena, e.g., fire, earthquake, freeze damage. Since the pipeline route will follow the existing Haul Road, there will be minimal additional environmental impacts. Environmental surveys will be required prior to construction to evaluate impacts to wetlands and rare and endangered species.

On the rare occasions that storm events necessitate the bypass of untreated landfill wastewater directly into Bear Creek, the overall impact to protection of human health and the environment will be minimal because Bear Creek will be at high flow conditions.

Effectiveness. OF200 MTF and pre-treatment will be effective for the landfill wastewater key COCs. Treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill water composition changes and additional contaminants must be addressed, the pre-treatment system can be modified easily, due to its modular design, to include the necessary unit operations. Until treatability studies are performed, the ability of OF200 MTF to treat other COCs is not known. Sampling the landfill wastewater prior to transferring to OF200 MTF and pre-treatment will verify compatibility with OF200 MTF and pre-treatment capability and identify changes in

the characteristics of the landfill wastewater. If the landfill wastewater becomes contaminated with other key COCs, the adaptability of OF200 MTF and pre-treatment are adequate.

Either transporting the landfill wastewater by truck or transferring by pipeline will be effective for moving landfill wastewater to OF200 MTF. Both methods have some level of inherent risk associated with potential spills.

The utilization of trucks has been practiced successfully for over ten years. However, due to the increased quantity of landfill wastewater to be transported, there is uncertainty in the availability of trucks, the availability of drivers, and the travel time during bad weather.

Impacts to Site Environment. Alternative 4 will have minimal impacts to the site environment. An environmental survey will be required prior to construction of the pipeline. This alternative will reduce the flow of water in Bear Creek and may be detrimental to aquatic life. On the rare occasions that untreated landfill wastewater bypasses the treatment facility and is discharged directly into Bear Creek, the increased contaminant mass will be minimal.

Compliance with ARARs (Alternative 4)

Compliance with ARARs. Alternative 4 will comply with all chemical-specific, location-specific, and action-specific ARARs. The treatment technologies used at Outfall 200 MTF and pre-treatment are effective for the landfill wastewater key COCs. Until the treatability studies are performed, the ability of OF200 MTF to treat other COCs is not known. Sampling landfill wastewater prior to transporting it to Outfall 200 and pre-treatment will verify compatibility with OF200 MTF and pre-treatment capability and identify changes in the characteristics of the landfill wastewater. The pipeline will be constructed to appropriate engineering standards and will have secondary containment and leak detection capability.

ARAR Waivers. No ARAR waivers are required.

Long-Term Effectiveness and Permanence (Alternative 4)

Effectiveness. Alternative 4 will be effective in the long-term. Treatment of landfill wastewater at OF200 MTF and pre-treatment will be effective for long-term operation and compliant performance. Treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill wastewater composition changes and additional contaminants must be addressed, the pre-treatment system can be modified easily, due to its modular design, to include the necessary unit operations. Sampling landfill wastewater prior to transporting it to Outfall 200 MTF and pre-treatment will verify compatibility with OF200 MTF and pre-treatment capability and identify changes in the characteristics of the landfill wastewater due to the differing predominant contaminants at ETTP, ORNL, and Y-12. If additional contaminants are introduced into the landfill wastewater, OF200 MTF and pre-treatment modifications can be performed, as necessary, to meet processing needs. Significant OF200 MTF and pre-treatment modifications can result in impaired treatment effectiveness and performance for the time necessary to provide the required treatment capability.

Transporting the landfill wastewater by tanker truck to OF200 MTF and pre-treatment will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the expected increase and fluctuation in landfill wastewater flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents.

The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill wastewater to OF200 MTF and pre-treatment. Piping has a long service

life and can be designed and installed to last well beyond the period of performance for EMWMF and the proposed EMDF.

Permanence. The EMWMF and proposed EMDF sites and Y-12 are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. Treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill wastewater composition changes and additional contaminants must be addressed, the pre-treatment system can be modified easily, due to its modular design, to include the necessary unit operations.

Transporting the landfill wastewater by tanker truck to OF200 MTF and pre-treatment will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the fluctuation in landfill wastewater flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents. The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill wastewater to OF200 MTF and pre-treatment. Piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and the proposed EMDF.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 4)

Alternative 4 will reduce the concentrations of key COCs through treatment of landfill wastewater prior to discharge to UEFPC. Until the treatability studies are performed, the ability of OF200 MTF to treat other COCs will not be known.

Short-Term Effectiveness (Alternative 4)

The operation of OF200 MTF and pre-treatment will have minimal short-term impacts to remediation workers, the surrounding community, and the environment. Truck transport is currently used to deliver the leachate to PWTC for treatment and is being performed effectively and safely. Construction of the pipeline and pre-treatment will have short-term environmental impacts. DOE safety policies, procedures, and worker training reduce the potential for and mitigate the consequences of such incidents. Alternative 4 will reduce the flow of water in Bear Creek and may be detrimental to aquatic life, and at peak, EMDF flow is less than a 5% increase to the average East Fork Poplar Creek flow at OF200.

Implementability (Alternative 4)

Technical Feasibility. Alternative 4 will be technically feasible because treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill wastewater composition changes and additional contaminants must be addressed, the pre-treatment system can be modified easily, due to its modular design, to include the necessary unit operations. Upgrades at Outfall 200 MTF to install the additional landfill wastewater offloading stations and pre-treatment processes are easy to construct. Treatability studies are simple to perform, and construction of the pre-treatment facility is technically feasible and simple to implement. If the landfill wastewater becomes contaminated with constituents other than those treated at OF200 MTF and pre-treatment, implementability may be impaired temporarily.

Construction of the pipeline will use conventional construction techniques. However, there is likely to be interference from existing underground utilities and potentially contaminated soil that will complicate construction of the pipeline. The utilization of trucks has been practiced successfully for over ten years. However, the expected fluctuation in landfill wastewater flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents.

Administrative Feasibility. Alternative 4 will be administratively easy to implement. The remedial investigation/feasibility study, proposed plan, and record of decision for the proposed EMDF will have to be approved, and the OF200 MTF CERCLA documents must be revised and approved to include the EMWMF/proposed EMDF landfill wastewater as a treatment stream. A remedial action work plan/remedial design report that includes the specific design and a completion document that contains the as-built conditions will be required. The EMWMF record of decision and implementing documents will require revision. All of these documents are conventional CERCLA documents for which DOE has extensive experience. The separation of scope among EMWMF, the proposed EMDF, and OF200 MTF CERCLA documents will have to be determined.

Availability of Services and Materials. The services and materials for Alternative 4 are readily available. The treatment technologies for removal of key COCs are well demonstrated, reliable, effective, readily available, and easy to construct using standard equipment and techniques. DOE has implemented similar projects at ORNL, Y-12, and ETTP and has access to experienced engineering and project management resources for landfill water treatment projects.

Expansion of the facilities to receive and pre-treat the landfill wastewater and construction of the pipeline will use conventional construction techniques. The additional trucks and drivers that will be needed are available, but the varying demand complicates access to them.

Adaptability. The pre-treatment system will be designed to quickly implement different treatment units, if required by changes in COCs above or below discharge limits or due to long-term changes in flow rates. Flow rates above the design flow rate during storms will bypass the treatment system. If higher flow rates are continuous, then the pre-treatment system will be easily expanded. Lower flow rates normally will be treated in batches, requiring no changes to the pre-treatment system. If lower flow rates are continuous, then the pre-treatment system will be easily reduced in size.

Cost (Alternative 4)

- Trucking Option (Alternative 4a):
  - **Capital Cost.** The capital cost of Alternative 4a is estimated at approximately $17 million.
  - **O&M Cost.** The annual O&M cost of Alternative 4a is estimated at approximately $4 million during the operation and closure and $0.4 million during post-closure.
  - **Present Worth.** The present worth of Alternative 4a is estimated at approximately $118 million.
- Pipeline Option (Alternative 4b):
  - **Capital Cost.** The capital cost of Alternative 4b is estimated at approximately $20 million.
  - **O&M Cost.** The annual O&M cost of Alternative 4b is estimated at approximately $1.6 million during the operations and closure and $0.3 million during post-closure.
  - **Present Worth.** The present worth of Alternative 4b is estimated at approximately $60 million.

The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 4)

In Alternative 4, there will be minimal irretrievable commitment of resources. OF200 MTF is a planned facility for a much larger flow, and the additional flow is minimal. Therefore, the incremental energy and chemical requirements for treatment will be minimal. There will be minimal environmental impacts.

Transporting leachate and contact water by truck will consume more energy in fuel than the pipeline option.

4.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

4.4.1 Introduction

A comparative analysis was performed for the alternatives to develop the basis for selecting a recommended alternative. Both threshold criteria and the primary balancing criteria were considered in the analysis. The following threshold criteria reflect key statutory mandates of CERCLA that must be satisfied by an alternative for it to be eligible for selection.

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

The following primary balancing criteria were used to compare the relative advantages and disadvantages of the alternatives to determine the most appropriate remedy.

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Short-Term Effectiveness
- Implementability
- Adaptability
- Cost

A comparison of these six criteria forms the basis of the comparative analysis. The first three balancing criteria address the statutory preference for treatment as a principal element of the remedy. Together with the last three criteria, these form the basis for determining the general feasibility of each alternative and for determining whether costs are proportional to the overall effectiveness.

The two modifying criteria—state acceptance and community acceptance—will not be evaluated until the public has had the opportunity to comment on the proposed plan. Therefore, these criteria were not formally evaluated in this focused feasibility study.

Finally, irreversible and irretrievable commitment of resources was evaluated.

4.4.2 Threshold Criteria

4.4.2.1 Introduction

The threshold criteria consist of two of the nine criteria that must be satisfied by the selected alternative. These criteria are important because they reflect the key statutory mandates of CERCLA. If an alternative does not satisfy both of these criteria, it is not eligible to be selected as a remedy. CERCLA Sect.121(d) provides that, under certain circumstances, an ARAR may be waived. The following includes a discussion of the degree to which the four alternatives satisfy the two threshold criteria.

4.4.2.2 Overall Protection of Human Health and the Environment

The No Action alternative will not protect human health and the environment because no action will be taken to manage the release of key COCs into Bear Creek in the landfill wastewater.

Alternatives 2 through 4 will protect human health and the environment. Alternatives 2 through 4 will involve treatment of the landfill wastewater and can accommodate changes to COC concentrations in the future. However, Alternatives 3 and 4 require pre-treatment, and Alternative 3 requires the lifecycle extension of PWTC in order for them to be viable alternatives. Alternative 3 WAC does not allow mercury and the lifetime extension does not include the additional EMWMF/proposed EMDF landfill wastewater volumes. Alternative 4 currently does not address any COC, except mercury. Until the treatability studies are completed, the ability of Alternative 4 to treat other COCs will not be known. Alternatives 3 and 4 will require the landfill wastewater to be transported to PWTC and OF200, respectively, by either truck or pipeline. Both of these transportation methods will be effective, but involve risk associated with the potential for transport incident or pipeline failure. In addition, Alternatives 3 and 4 will divert water flow from Bear Creek, which may be detrimental to aquatic life in Bear Creek. The pipeline will be effective and will be protective due to the double containment and leak detection.

4.4.2.3 Compliance with ARARs

Since Alternative 1 is No Action for the management of landfill wastewater, there are no ARARs.

Alternatives 2 through 4 will meet the action-specific, chemical-specific, and location-specific ARARs. Alternative 2, Managed Discharge/Treat, will be compliant with ARARs because it allows only landfill wastewater that meets discharge limits to be released into Bear Creek. In Alternative 3, landfill wastewater is treated at the on-site PWTC, and the discharge will meet the NPDES permit. In Alternative 3, the PWTC WAC do not accept mercury-contaminated landfill wastewater, so pre-treatment will be required. The WAC will have to be revised or a waiver approved to be able to accept the landfill wastewater, and a revision to the NPDES permit may be required. In Alternative 4, the OF200 MTF is designed to treat only mercury, so pre-treatment is required. Alternatives 2 through 4 will accommodate changes to COC concentrations and the need to provide additional treatment processes and continue compliance with ARARs. Alternative 2 will be the easiest to modify to address additional treatment because it will be designed in a modular fashion with expansion in mind. PWTC and OF200 are slightly more difficult.

4.4.2.4 Summary

The No Action alternative will not meet the threshold criteria and cannot be considered for selection. Therefore Alternative 1, No Action will be not be included in the comparative analysis against the balancing criteria in Section 4.4.3.

Alternative 2, Managed Discharge/Treat, will satisfy both criteria because it only allows landfill wastewater that meets the discharge limits to be released to Bear Creek. The treatment system will be the easiest to modify because it is designed in a modular fashion with expansion in mind.

Alternative3, Treatment at PWTC, will satisfy both criteria because with pre-treatment and life-cycle extension it can treat all key COCs.

Alternative 4, Treatment at OF200 MTF, will satisfy both criteria, because with pre-treatment it can treat all key COCs.

Alternatives 2 through 4 can adapt to changing COCs. Therefore, Alternatives 2 through 4 meet the threshold criteria, can be considered for selection, and are included in the comparative analysis against the balancing criteria in Sect. 4.4.3.

4.4.3 Balancing Criteria

4.4.3.1 Long-Term Effectiveness and Permanence

Alternatives 2 through 4 will all be effective in the long-term because treatment systems will be provided that are designed and maintained for long-term operation. Alternative 2 only allows landfill wastewater that meets the discharge limits to be released to Bear Creek and will be the easiest to modify to accommodate changes in the concentrations of COCs in the future because it will be designed in a modular fashion with modification in mind. PWTC in Alternative 3 is an old plant, does not allow mercury, and is limited in accepting radiological contaminants. Therefore, PWTC must have pre-treatment and a life-cycle extension for long-term effectiveness and permanence. OF200 MTF in Alternative 4 is designed only for mercury, so pre-treatment facilities will have to be constructed. Alternatives 2 through 4 are sited at locations fully under the control of the DOE Environmental Management Program, and there are no competing priorities for the utilization of the sites.

4.4.3.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives 2 through 4 will all satisfy this criterion because they include treatment, thus reducing toxicity of the landfill wastewater.

4.4.3.3 Short-Term Effectiveness

Alternatives 2 through 4 will satisfy the short-term effectiveness criterion. Alternative 2, Managed Discharge/Treat, will be immediately effective for landfill wastewater that meets discharge limits and can be discharged without treatment and then later when the LWTS is built. Alternative 4, Treatment at OF200 MTF, will involve construction of treatment and pre-treatment facilities, but will be effective upon treatment system startup. Alternative 3, Treatment at the PWTC, will be effective immediately on a temporary basis for landfill wastewater because it is a current, ongoing process, and permanently when the lifetime extension and pre-treatment are completed.

4.4.3.4 Implementability

Alternatives 2 through 4 will be technically feasible to implement and will be performed using standard construction equipment and techniques. Services and materials required for implementation of all action alternatives will be readily available. Alternative 2, Managed Discharge/Treat, will be the easiest to implement because existing facilities will be used initially, a treatment system will not be required immediately, and piping or trucking is not required. Alternatives 3 and 4 will be more difficult to implement. Alternative 4 will require construction of the OF200 MTF and pre-treatment facilities, as well as trucking or construction of a pipeline to move the landfill wastewater to the site. Alternative 3 will utilize the existing PWTC with life-cycle extension and pre-treatment, but will also require continued trucking or construction of a pipeline to move the landfill wastewater to the site. If additional contaminants appear in the landfill wastewater in the future, Alternative 2 will have the greatest flexibility to implement additional processing capability.

Alternatives 2 through 4 will satisfy the need for administrative implementability. All of the required documents are conventional CERCLA documents with which DOE has extensive experience. All alternatives will require approval of the EMDF proposed plan, record of decision, and implementing documents and revision of the EMWMF record of decision and implementing documents. Alternative 3 will require additional revisions for the facility WAC and NPDES permit. Alternative 4 will require revisions to the UEFPC Record of Decision and OF200 MTF implementing documents.

Alternatives 2 through 4 will be adaptable. Alternative 2 will have the most flexibility to address uncertainties in flow and future COCs through use of a modular approach for treatment to allow treatment units to be added, modified, or removed as the landfill wastewater contaminants change. Alternatives 3 and 4 are less adaptable; however, the pre-treatment facilities will be modular, which will facilitate modifications. Based on future treatability studies, the ability of Alternatives 3 and 4 to treat other COCs may be determined, which will also facilitate modifications.

4.4.3.5 Cost

Cost estimates are used in the CERCLA evaluation process to eliminate alternatives that are significantly more expensive than competing alternatives without offering commensurate increases in performance or overall protection of human health and the environment. The cost estimates are preliminary estimates with an intended accuracy range of +50 to -30 percent. Final costs will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final scope, final schedule, final engineering design, and other variables. Table 8 presents the estimated capital, annual O&M, and total present value costs for each alternative. Alternatives 3 and 4 with trucking will be the most expensive alternatives with present values of approximately $118 million. Alternative 2 will be the least expensive alternative with a present value of approximately $13 million.

4.4.4 Irreversible and Irretrievable Commitment of Resources

None of the action alternatives will have significant irreversible and irretrievable commitment of resources. Alternative 2, Managed Discharge/Treat, will have the least because there will be no treatment system involved initially and no use of trucks or pipelines to transport the landfill wastewater. Alternatives 3 and 4 will be similar because they will require landfill wastewater treatment systems for the entire time and associated energy requirements. The use of trucks or pipelines to transport the landfill wastewater for Alternatives 3 and 4 will increase energy requirements. Alternatives 3 and 4 will remove the landfill wastewater from Bear Creek with possible impacts to aquatic organisms in Bear Creek.

4.4.5 Comparative Analysis Summary

Results of the comparative analysis of alternatives are summarized in Table 8. Each of the alternatives is assigned a numeric rating for each of the criteria evaluated to assist the comparative analysis. Numeric ratings are semi-quantitative in that, while based on objective factors and data, they incorporate some degree of subjectivity as to the relative impact of the factors and data. The ratings are:

- 0—Not Applicable
- 1—Worst/Least
- 2—Worse/Less
- 3—Average/Neutral
- 4—Better/More
- 5—Best/Most

Table 8. Comparative analysis of alternatives

Criteria	Alternative 1: No Action	Alternative 2: Managed Discharge/Treat	Alternative 3: Treat at ORNL PWTC		Alternative 4: Treat at Outfall 200 MTF	
			Alternative 3a: Pipeline	Alternative 3b: Truck	Alternative 4a: Pipeline	Alternative 4b: Truck
Overall Protection of Human Health and the Environment	Not protective	Protective of human health and the environment; discharge limits met; easily adaptable to future COC changes	Protective of human health and the environment; COCs are treated after life-cycle extension and pre-treatment; adaptable to future COC changes; minimal risk due to the potential for pipeline failure; potential impact to Bear Creek aquatic life	Protective of human health and the environment; COCs are treated after life-cycle extension and pre-treatment; adaptable to future COC changes; minor risk due to potential for trucking incidents; potential impact to Bear Creek aquatic life	Protective of human health and the environment; COCs are treated with pre-treatment; adaptable to future COC changes; minimal risk due to the potential for pipeline failure; potential impact to Bear Creek aquatic life	Protective of human health and the environment; COCs are treated with pre-treatment; adaptable to future COC changes; minor risk due to the potential for trucking incidents; potential impact to Bear Creek aquatic life
Rating	1	5	3	3	4	4
Compliance with ARARs	Not applicable	Meets all ARARs	Meets all ARARs; PWTC WAC and NPDES permit will have to be revised to accept mercury and landfill wastewater, respectively	Meets all ARARs; PWTC WAC and NPDES permit will have to be revised to accept mercury and landfill wastewater, respectively	Meets all ARARs; UEFPC ROD will require revision	Meets all ARARs; UEFPC ROD will require revision
Rating	0	5	4	4	3	3
Long-Term Effectiveness and Permanence	Not applicable because threshold criteria not met	Effective	Effective with life-cycle extension and pre-treatment; minimal risk from long-term use of pipeline; adaptable to future COC changes	Effective with life-cycle extension and pre-treatment; long-term use of trucking involves risk; adaptable to future COC changes	Effective with pre-treatment; minimal risk from long-term use of pipeline; adaptable to future COC changes	Effective with pre-treatment; long-term use of trucks involves risk; adaptable to future COC changes
Rating	0	5	3	3	4	4

Table 8. Comparative analysis of alternatives (cont.)

Criteria	Alternative 1: No Action	Alternative 2: Managed Discharge/Treat	Alternative 3: Treat at ORNL PWTC		Alternative 4: Treat at Outfall 200	
			Alternative 3a: Pipeline	Alternative 3b: Truck	Alternative 4a: Pipeline	Alternative 4b: Truck
Reduction of Toxicity, Mobility, or Volume Through Treatment	Not applicable because threshold criteria not met	Reduction of toxicity through treatment	Reduction of toxicity through treatment; requires life-cycle extension and pre-treatment	Reduction of toxicity through treatment; requires life-cycle extension and pre-treatment	Reduction of toxicity through treatment; requires pre-treatment	Reduction of toxicity through treatment; requires pre-treatment
Rating	0	5	3	3	4	4
Short-Term Effectiveness	Not applicable because threshold criteria not met	Minor short-term impacts due to construction activities; uses existing facilities initially; standard construction risks to workers	Minor short-term impacts due to construction activities; plant expansion in heavily industrialized area; pipeline construction; standard construction risks to workers	Minor short-term impacts due to construction activities; plant expansion in heavily industrialized area; standard construction risks to workers	Minor short-term impacts due to construction activities; pipeline construction; standard construction risks to workers	Minor short-term impacts due to construction activities; standard construction risks to workers
Rating	0	5	3	3	3	3
Implementability	Not applicable because threshold criteria not met	Technically and administratively feasible; materials and services available; uses existing facilities; EMWMF and proposed EMDF CERCLA documents; easily adaptable to future COC changes	Technically and administratively feasible; materials and services available; life-cycle extension and pretreatment required to implement; WAC and NPDES permit will have to be revised; inherent risk associated with pipeline construction and operation; adaptable to future COC changes; EMWMF/proposed EMDF CERCLA documents	Technically and administratively feasible; materials and services available; life-cycle extension and pretreatment required to implement; WAC and NPDES permit will have to be revised; inherent risk associated with trucking; adaptable to future COC changes ; EMWMF/proposed EMDF CERCLA documents	Technically and administratively feasible; materials and services available; pre-treatment required to implement; inherent risk associated with pipeline construction and operation; adaptable to future COC changes; EMWMF/proposed EMDF and OF200 MTF CERCLA documents	Technically and administratively feasible; materials and services available; pre-treatment required to implement; inherent risk associated with trucking; adaptable to future COC changes; EMWMF/proposed EMDF and OF200 MTF CERCLA documents
Rating	0	5	3	3	4	4

Table 8. Comparative analysis of alternatives (cont.)

Criteria	Alternative 1: No Action	Alternative 2: Managed Discharge/Treat	Alternative 3: Treat at ORNL PWTC		Alternative 4: Treat at Outfall 200	
			Alternative 3a: Pipeline	Alternative 3b: Truck	Alternative 4a: Pipeline	Alternative 4b: Truck
Cost ($million)	Not applicable because threshold criteria not met	Capital = $13 O&M = $1.5/year during operation and closure O&M = $0.3/year during post-closure Present Value = $51	Capital = $20 O&M = $1.6/year during operation and closure O&M = $0.3/year during post-closure Present Value = $60	Capital = $17 O&M = $4/year during operation and closure O&M = $0.4/year during post-closure Present Value = $118	Capital = $20 O&M = $1.6/year during operation and closure O&M = $0.3/year during post-closure Present Value = $60	Capital = $17 O&M = $4/year during operation and closure O&M = $0.4/year during post-closure Present Value = 118
Rating	0	5 = Capital 5 = O&M 5 = Present Value	3 = Capital 3 = O&M 3 = Present Value	4 = Capital 1 = O&M 1 = Present Value	1 = Capital 3 = O&M 3 = Present Value	4 = Capital 1 = O&M 1 = Present Value
Irreversible and Irretrievable Commitment of Resources	Not applicable because threshold criteria not met	Minor energy requirements associated with LWTS construction and operation	Minor energy requirements associated with PWTC life-cycle extension and pre-treatment facility construction and operation; moderate construction and energy requirements for pipeline; removes water from Bear Creek	Minor energy requirements associated with PWTC life-cycle extension and pre-treatment facility construction and operation; moderate energy requirements for trucking; removes water from Bear Creek	Minor energy requirements associated with pre-treatment facility construction and operation; moderate energy requirements for pipeline; removes water from Bear Creek	Minor energy requirements associated with pre-treatment facility construction and operation; moderate energy requirements for trucking; removes water from Bear Creek
Rating	0	5	1	3	3	2

This focused feasibility study assumes that landfill wastewater quality and quantity will vary over time. Therefore, adaptability to manage these changes is the key criterion in determining the recommended alternative. Alternatives 3a and 4a are eliminated from further comparison because they are difficult to implement and have high present values. Table 9 provides a comparison of the remaining alternatives for adaptability, along with the major assumptions and cost.

Table 9. Analysis of alternatives for future water quality changes

Alternative	Summary evaluation	Capital cost/present value ($million)
2 - Managed Discharge/Treat	Alternative can be implemented immediately; meets discharge limits; easy to adapt to changing COCs.	$13/$51
3a - Treat at PWTC, transport by pipeline	Immediate capital costs required for the pipeline, pre-treatment, and life-cycle extension; less adaptable than Alternative 2	$20/$60
4a - Treat at OF200 MTF, transport by pipeline	Immediate capital costs required for the pipeline and pre-treatment; less adaptable than Alternative 2	$20/$60

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APPENDIX A.
BEAR CREEK BURIAL GROUNDS EVALUATION

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BEAR CREEK BURIAL GROUNDS ANALYSIS

A feasibility study is being conducted to determine the optimum approach for managing wastewater generated as a consequence of hazardous/radioactive landfill operations located on the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) west of the Y-12 National Security Complex (Y-12). There are several major landfills currently located or planned for this area. The Environmental Management Waste Management Facility (EMWMF) is currently operating to provide disposal services for contaminated waste materials being generated as a consequence of ORR demolition and remediation projects. An additional facility to be constructed adjacent to EMWMF for the same purpose, the Environmental Management Disposal Facility (EMDF), will also require water management capability. The Bear Creek Burial Grounds (BCBG) is a disposal area that is no longer operating, but has been used in the past to dispose of hazardous and radioactive materials, and currently generates leachate for collection and treatment. There are additional uncontrolled releases of dissolved uranium from BCBG that must be considered for collection and treatment. This analysis is being performed to evaluate the feasibility of a combined solution that addresses all wastewater sources from EMWMF, future EMDF, and BCBG.

EMDF will be located in the same vicinity as the existing EMWMF and is expected to produce leachate that is similar in composition to EMWMF, with the notable exception of mercury that will be present at higher concentration in EMDF leachate. The proximity of EMDF will be close enough to allow for shared infrastructure for leachate collection and management. Consequently, a combined wastewater management solution for these two facilities is considered feasible and appropriate. EMWMF currently transports leachate to the Oak Ridge National Laboratory Process Waste Treatment Complex by tanker where it is combined with other wastewaters for processing and discharge to White Oak Creek via an existing permitted outfall. Contact water, generated separately at EMWMF and consisting of stormwater that comes into contact with waste materials at the working face of the landfill, is collected and analyzed to verify discharge criteria are met prior to release to a stormwater retention basin. Contact water exceeding discharge criteria is transported to the PWTC for treatment and discharge

BCBG is located west of EMWMF at a distance of roughly 3000 ft (Fig. A.1) and was historically used for disposal of radiologically and chemically contaminated wastes generated primarily by Y-12 operations. The source and type of waste materials disposed at BCBG are significantly different from those being disposed or planned for disposal at EMWMF and EMDF. BCBG consist of several principal waste disposal units designated as BCBG Unit-A, -B, -C, -D, -E, -J, and Walk-in Pits. Each waste disposal unit consists of a series of trenches used for disposal of liquid and solid wastes. Contamination in these disposal units include depleted uranium, shock-sensitive acids (e.g., picric acid), chromic acid, various organic solvents, polychlorinated biphenyls (PCBs), beryllium, chromium, thorium, and other radionuclides (DOE/OR/01-2382&D1, *Focused Feasibility Study for the Bear Creek Burial Grounds at the Y-12 National Security Complex*).

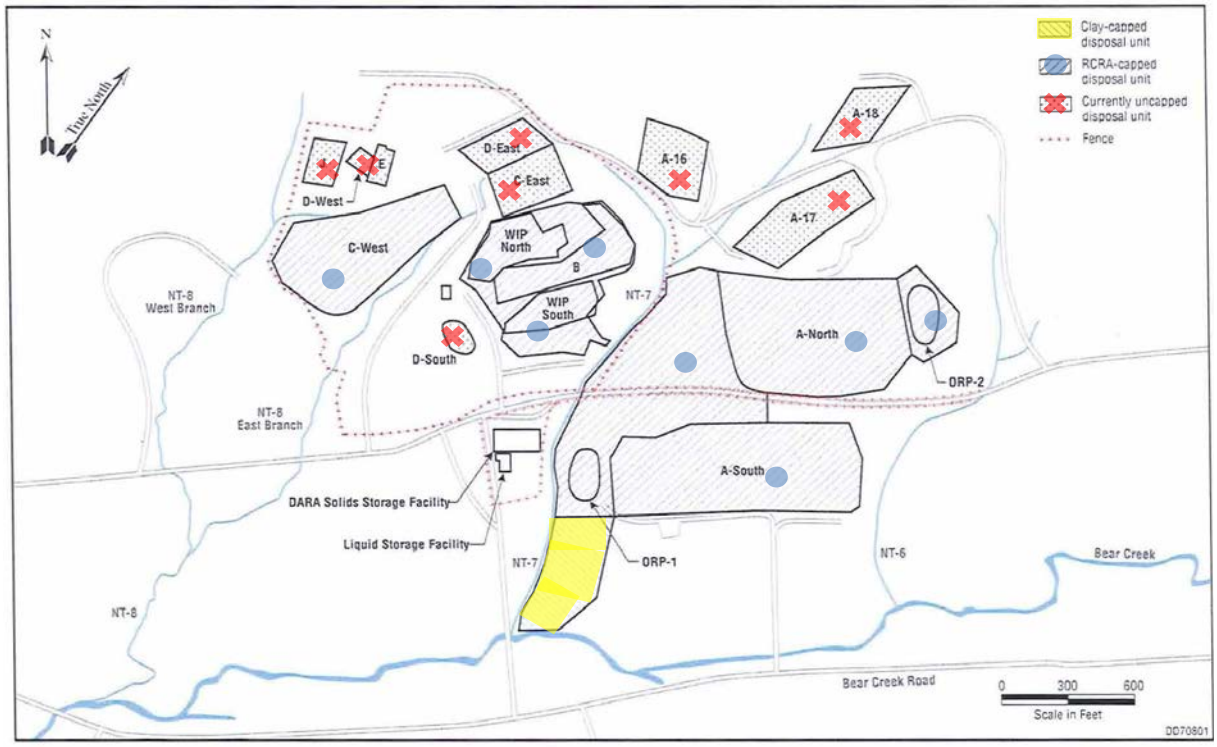


Fig. A.1. BCBG Waste Disposal Unit locations.

Disposal activities at BCBG ended in 1993, and several of the BCBG waste units have been closed under requirements of the Resource Conservation and Recovery Act (RCRA), including construction of multilayer caps. In 1989, a leachate collection system was installed in the North Tributary (NT)-7 catchment to intercept seepage from Unit A-North. A second leachate collection system was installed in the NT-8 catchment in 1993 to collect water from several seeps in this area. These leachate collection systems and associated storage comprise the Leachate Storage Facility (LSF). Collected leachate at the LSF is currently transported by tanker to the Y-12 Groundwater Treatment Facility (GWTF) for treatment and discharge through a permitted outfall. It has been determined; however, that there are additional uncontrolled releases of contaminated water from BCBG that contribute significant releases of dissolved uranium and other contaminants to surface water at NT-8 (DOE/OR/01-2638, *2014 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*).

As seen in the figure, several BCBG disposal units have not yet been remediated or capped. A Focused Feasibility Study (FFS) was written in 2008 (DOE/OR/01-2382&D1) to address remediation of these BCBG disposal units under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A future Record of Decision (ROD) is planned to develop a tri-party agreement regarding the approach for remediation of this area. Due to current issues associated with water-borne uranium being released from BCBG into NT-8, this analysis considers the feasibility of incorporating the management of BCBG-contaminated water along with EMWMF/EMDF wastewater.

Existing BCBG Leachate

The existing BCBG water collection and storage system for contaminated groundwater, the LSF, (see Fig. A.2) was built as part of the RCRA closure activities at BCBG. Leachate is collected from two locations at BCBG:

- BCBG NT-7: The leachate gravity flows from the burial grounds north of Tributary 7 into a holding tank and is pumped into the LSF.
- BCBG NT-8: The leachate gravity flows from underground Seeps 3 and 4 of C-West Burial Ground, Seep 2 of C-East Burial Ground, and the underground slope of C-West into a holding tank and is pumped into the LSF.

The LSF provides a gravity separator and storage tanks. The leachate collected from Tributary 7 area is primarily contaminated with depleted uranium, PCBs, VOCs, and iron whereas Tributary 8 area leachate contains depleted uranium, PCBs, volatile organic compounds (VOCs), lithium, iron, and moderately high sediment levels. The leachate carries the RCRA Hazard Code F039 waste (Y/ER-188, *Focused Feasibility Study Report for the Bear Creek Burial Grounds Leachate Collection System Project at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*).

Fig. A.2. Leachate Storage Facility.

GWTF (see Fig. A.3) receives tanker trucks from the LSF and also receives wastewater from the East Chestnut Ridge Waste Pile in 300-gal bulk containers for processing. Other contaminated groundwater seeps or other wastewaters appropriate to this treatment system may also be treated at this facility. After treatment, the water is discharged to Upper East Fork Poplar Creek through a National Pollution Discharge System permit. The facility operates 4 days a week, 10 hours per day. Contaminants of concern (COCs) include uranium-235 and -238, technetium-99, PCBs, VOCs, and beryllium. Unit operations include air stripping and activated carbon columns to remove contaminants. It operates at a nominal 25 gal per minute (gal/min) and an average of 2.1 million (M) gallons is treated annually, depending on rainfall. A continuous treatment of this volume would result in an average of 3 to 4 gal/min flow rate.

Fig. A.3. GWTF located in Bldg. 9616-7.

Bear Creek Uranium Flux Issue

Uranium contamination is a primary concern in Bear Creek. Uranium migration continues to be an issue, as noted in a review of past Remedial Effectiveness Reports (RERs), and specifically, the most recent RER (DOE/OR/01-2638). See Table A.1 for a summary of uranium flux in Bear Creek over time as given in the 2014 RER. More recently (2009 and later), the flux has increased more dramatically. The uranium measured at Bear Creek Kilometer (BCK) 9.2 in Zone 2 (see Fig. A.5) currently exceeds the ROD goal of 34 kg/year by about a factor of four. As shown in Fig. A.1, three tributaries (NT-6, NT-7, and NT-8) drain the BCBG area and flow into Bear Creek. NT-8 contributes heavily to the uranium flux migrating into Zone 2, at up to approximately half the total flux passing BCK 9.2. As noted in the RER, the NT-7 uranium flux of 1 to 2 kg per year in recent years has not been very significant, and NT-6 is not mentioned as a notable contributing factor to the contaminant load of Bear Creek. This information is corroborated by the fact that NT-7 is now mostly an engineered ditch with an existing groundwater seepage collection system, and that groundwater flow tends to flow towards the southwest and away from NT-6.

Table A.1. Uranium flux at flow-paced monitoring locations in BCV watershed (Table 4.7 from 2014 RER)

Fiscal year	BCK 9.2	SS-6	NT-8	BCK 11.54	NT-3	BCK 12.34	Average rainfall (in.)
2001	88.7	17.2	--	--	79.9	24.5	45.9
2002	**120.2**	13.1	--	158.2	**62.8**	25.4	52.7
2003	**165.4**	12.3	--	87.0	**4.6**	**44.3**	73.7
2004	**115.0**	9.5	--	45.8	1.2	**27.3**	56.4
2005	**115.4**	11.1	--	39.8	4.1	**40.3**	58.9
2006	**68.5**	--	--	25.2	1.7	21.3	46.4
2007	**59.5**	--	--	12.6	--[a]	15.8	36.8
2008	**73.2**	--	27.9	15.9	--[a]	23.0	49.3
2009	**147.7**	11.6	43.3[b]	27.2	--[a]	**32.9**	62.5
2010	**118.9**	9.9	61.0	32.5	**14.5**	**33.9**	55.8
2011	**108.7**	9.1	40	36.7	**16.3**	**37.8**	59.2
2012	**114.9**	9.2	43.3	45.4	**13.6**	**32.9**	61.75
2013	**122.3**	9.5	64.0	47.6	**22.3**	**40.3**	63.73
ROD Goals:	*34*				*4.3*	*27.2*	

Bold values indicate the *Record of Decision for the Phase 1 Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE/OR/01-1750&D4) goal for uranium flux has not been met**.**

[a] Goal attained; flux monitoring discontinued in FY2007 and reinstituted in FY2010.

[b] Uranium isotope mass balancing at BCK 9.2 suggests NT-8 contributed about 60 kg in FY2009. Approximately 17 kg infiltrated into karst seepage pathways upstream of the NT-8 flume.

BCK = Bear Creek kilometer
BCV = Bear Creek Valley
FY = fiscal year
kg = kilograms
NT = North Tributary
ROD = Record of Decision
SS = surface spring

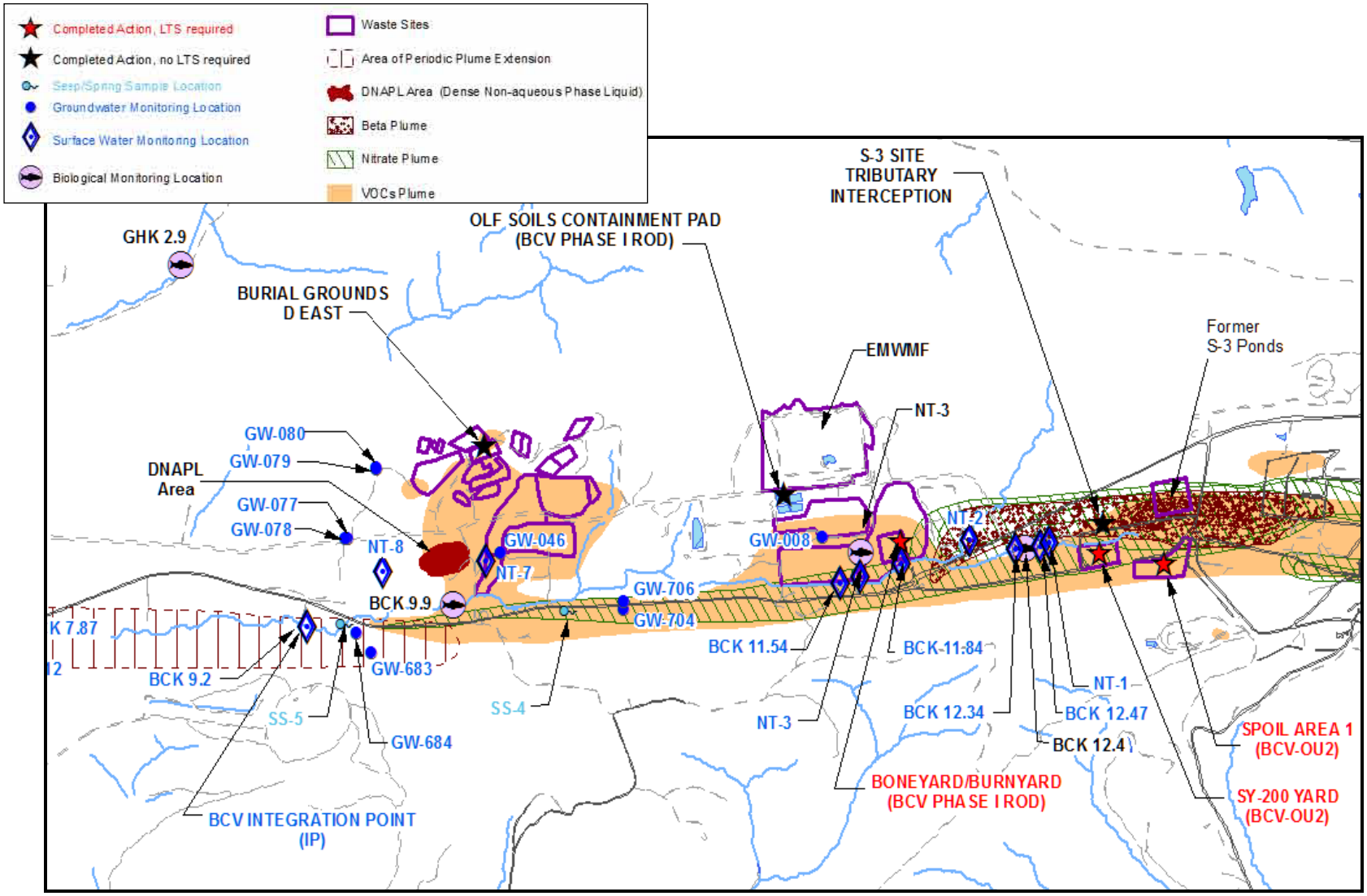


Fig. A.4. Bear Creek Valley points of interest in Zones 2 and 3—integration point BCK 9.2 and BCK 11.84; NT-3; NT-8 (portion of Fig 4.1 from 2014 RER).

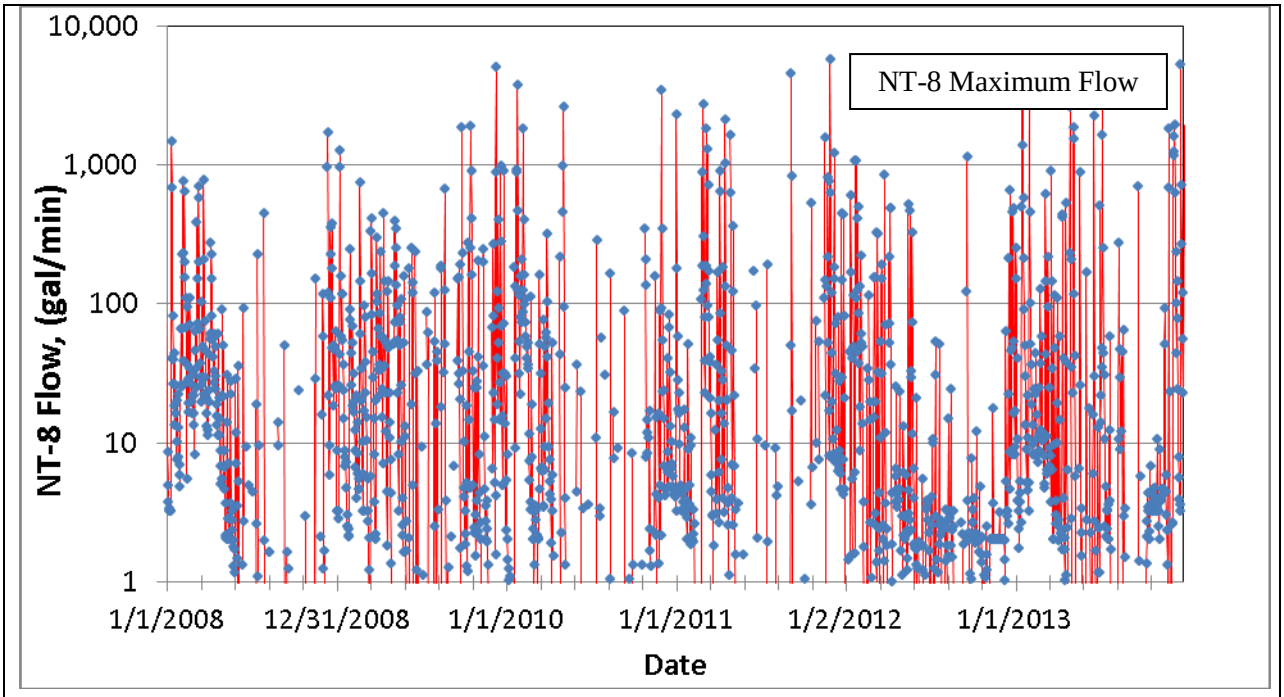
Per the 2008 BCBG FFS, tributaries NT-6, -7, and -8 are usually dry during the periods in the late summer and early fall. Base flow in each stream reaches a maximum between December and April, and peak storm flow for each tributary ranges from 900 to 27,000 gal/min. A more recent examination of flow in NT-8 alone indicates a wet season base flow of about 10 gal/min.2 Figure A.5 provides graphics of current NT-8 maximum and base flows. The NT-8 flow is measured from the RER monitoring flume just past the point in NT-8 where east and west branches merge to form a single stream channel. Figure A.5 demonstrates the highly variable flow rates that occur at the NT-8 flume. As seen in the top graph of Fig. A.5, flow rates have exceeded 1000 gpm, with rates over 5000 gpm on record. The bottom graph in Fig. A.5 clearly demonstrates that the creek is often dry during summer months. If NT-8 was targeted for treatment to reduce the Bear Creek uranium flux, a complex collection system and large equalization tanks would be required to provide a constant flow for processing. To reduce the flow to a more manageable rate, further investigation of the source of the existing contaminant issues at BCBG was completed, and is discussed in the following section.

Proposed Collection of Additional BCBG Wastewater

As described above, NT-8 appears to contribute a significant portion of the uranium flux in Bear Creek. Additional sampling data and field investigation has been performed at the BCBG area since the issuance of the 2008 BCBG FFS. The fiscal year (FY)2008 RER identified the need to install a continuous flow monitoring station in NT-8, since the ungauged uranium input at BCK 9.2 was increasing and uranium flux attributable to NT-8 had not been quantified since the Bear Creek Valley Remedial Investigation (DOE/OR/01-1455/V1–V4&D1, *Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*). The FY2009 RER reported that a new monitoring station demonstrated that NT-8 was contributing high levels of uranium to the watershed. As part of the FY2011 RER, a recommended action was identified to document the discharge of contaminants along NT-8 in order to determine where contaminants were entering the stream. Uranium, VOCs, and PCBs were listed as being of greatest concern. A secondary recommendation of the FY2011 RER was to review the engineering design, operational records, and system performance of the existing non-CERCLA groundwater seepage collection system in the NT-8 headwaters (associated with BCBG D-West). The secondary recommendation was deferred, but the investigation of NT-8 surface water was carried out and the results discussed in the FY2012 RER. Ten transects were examined along NT-8, starting from the NT-8 RER monitoring flume and moving north towards the buried waste. It was determined that the eastern branch of NT-8 was the principal source of uranium, with the highest concentrations occurring near the intersection of the fence line and the eastern branch of NT-8 (near C-West). Historical data collected from the area indicated dissolved uranium-238 concentrations at this location were as high as 1230 pCi/L. The eastern branch of NT-8 was also determined to be a significant source of PCBs. VOCs were highest near the confluence of the eastern and western branches of NT-8.

Knowledgeable subject matter experts have suggested that an interceptor trench located perpendicular to NT-8 East branch (see Fig. A.6) along the fence line could capture groundwater that likely contains some of the highest uranium concentrations, prior to its combining with surface water in NT-8. This interceptor trench would be 8- to 10-ft deep and entail a French drain collection system with a downgradient slurry wall barrier along the fence line next to C-West. The trench would include a cap to shed stormwater and would connect with the existing LSF collection system.

2 Data for BCK 9.2 and NT-8 flow, taken from Oak Ridge Environmental Information System (OREIS), April 2014.



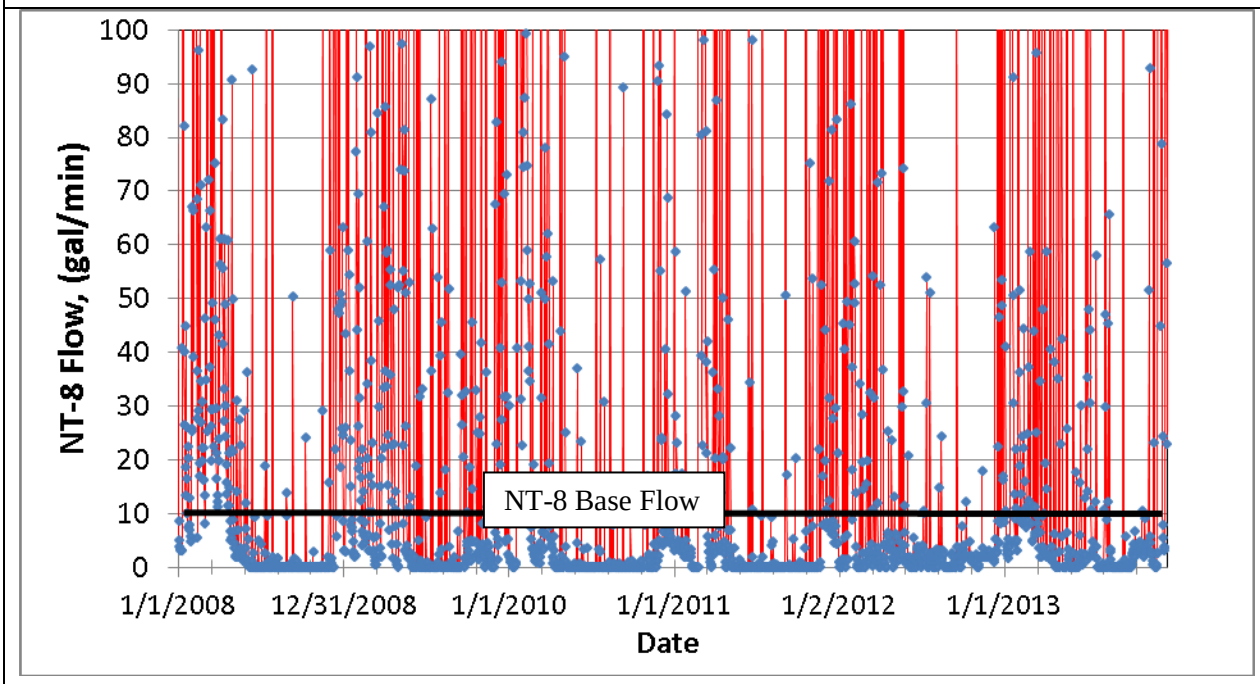


Fig. A.5. OREIS sampling location BC-NT8
(NT-8 continuous flow monitoring flume)—maximum and base flows.

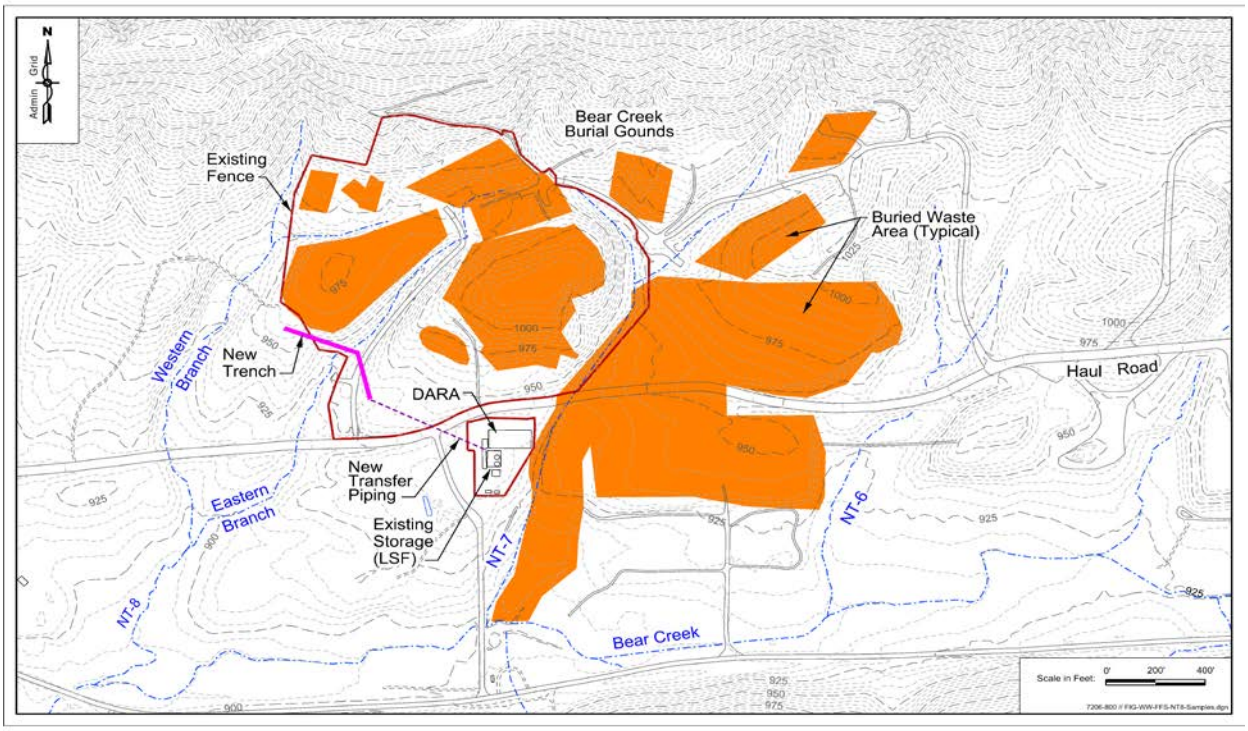


Fig. A.6. Proposed interceptor trench at BCBG.

This approach to collecting BCBG wastewater for treatment, however, would require additional data and engineering to evaluate the feasibility and cost. Data gaps include information that would require somewhat extensive investigation, for example:

- Depth to bedrock in order to determine collection trench size
- Flow information to determine collection trench dimensions, collection pipe size, the need for a booter pump, and storage needs
- Potential modifications to the existing GWTF to manage higher volumes of water
- More specific contaminant information (e.g., dissolved versus particle-bound contaminants)

<u>Management of Additional BCBG Wastewater</u>

Collecting the intercepted groundwater prior to combining with surface water would greatly reduce the volume of water to be treated and the associated cost of water management systems. Based on an anticipated continuous flow of less than 10 gal/min, this intercepted groundwater flow could be managed by incorporating it with the existing LSF collection system. It could be transferred to and treated at the GWTF along with the current BCBG leachate, or could be stored at the LSF and considered for incorporation into the EMWMF/EMDF water management FFS alternatives.

Connecting this intercepted groundwater flow to the existing LSF collection system would be straight forward. Transfer (currently trucking) to the existing GWTF and frequency of batch treatment operations would increase, but the combined flow would not likely exceed the current system treatment capacity. The COCs are the same as those currently managed by the GWTF. Considering drainage areas and speaking with subject matter experts, the NT-8 interceptor trench would probably double the flow that is

currently being collected at the LSF. The current system focuses on collection of seeps instead of a continuous trench that would be required for protecting the eastern branch of NT-8. However, as previously discussed, the design flow of the GWTF is nearly a factor of ten higher than the current average flow processed by the system. Treating the additional flow would result in more frequent trucking/transfer and batch treatment campaigns.

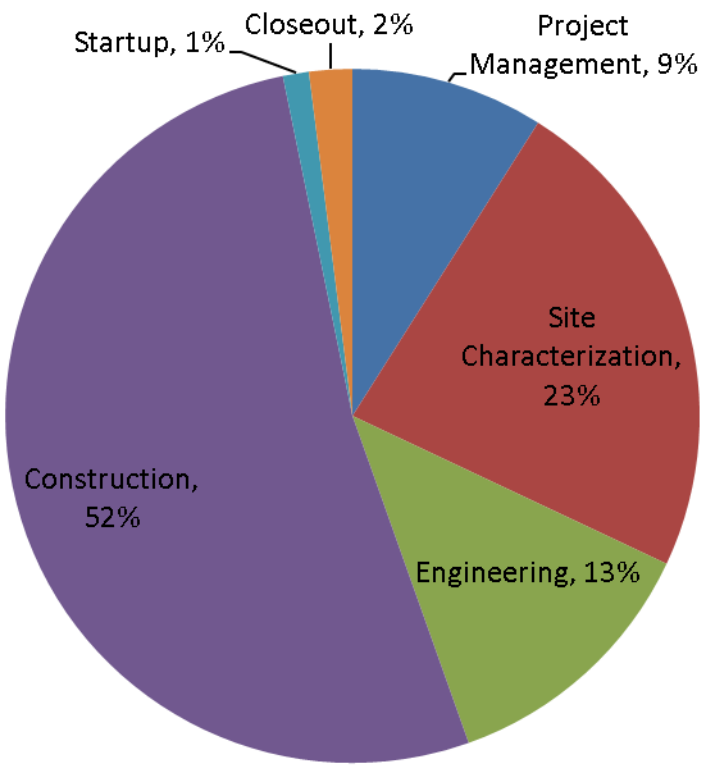
Although the anticipated flow collected by this trench system would be manageable within an EMWMF/EMDF wastewater analysis, contaminants must also be considered, and would necessarily need to be a subset of those contaminants that will be managed under the EMWMF/EMDF water management alternative. PCBs, F039-listed solvents, and uranium are the main COCs for BCBG. Uranium is also an expected COC for the EMWMF/EMDF; however, PCBs and F039-listed solvents have not been identified as COCs. Treatment of PCBs and F039-listed solvents would require additional RCRA considerations (requirements in terms of design and construction), and would greatly increase the cost of secondary waste disposal. Due to the F039-listed components, the secondary wastes from the EMWMF/EMDF leachate treatment system would also be listed with this constituent. Consequently, the secondary wastes would require additional processing and disposal at an off-site disposal facility as a mixed RCRA/radioactive waste material, and could not be considered for return to either disposal facility since neither facility accepts listed wastes. The existing GWTF currently manages these constituents and there would be no need to alter current disposal practices. It would therefore be advantageous to collect, transfer, and treat the NT-8 intercept trench water along with the current BCBG leachate stream at the GWTF.

Rough order-of-magnitude costs for the management of BCBG wastewater as proposed, via an interceptor trench, incorporating a slurry wall and cap, have been determined. These costs are summarized in Table A.2. Additional costs have not been delineated, but are noted as applicable.

Table A.2. Cost of proposed methods for capture of BCBG contaminated water management

Proposed method	ROM cost	Issues
Interceptor trench, slurry wall, cap, collect and treat with existing BCBG leachate stream at GWTF	• $1.4 M (interceptor trench, slurry wall, cap) • Additional cost to tie into existing BCBG leachate collection at LSF • Additional transfer/operations costs at GWTF	• Data gaps remain
Interceptor trench, slurry wall, cap, collect and manage with EMWMF/EMDF stream	• $1.4 M (interceptor trench, slurry wall, cap) • Additional cost to tie into existing BCBG leachate collection at LSF • Additional cost to transfer/tie into EMWMF/EMDF treatment • Additional capital costs for increased design flow and COC treatment • Additional permitting and operating costs for management of combined wastewater as F039-listed waste (projected to be a high cost)	• Data gaps remain • COCs outside of envelope of those to be treated for EMWMF/EMDF

As shown in Table A.2, treatment by the currently utilized method (e.g., collection within the LSF system, trucking to the GWTF for treatment) would be a more cost effective solution as opposed to combining the management of the waters with EMWMF/EMDF waters. Details of the cost estimate for the interceptor trench, slurry wall, and cap are given in Fig. A.7.



WBS	WBS Description	Cost
1.1	Project Management	$110,959.68
1.2	Site Characterization	$284,472.00
1.3	Engineering	$155,218.73
1.4	Construction	$645,117.33
1.5	Startup	$14,923.81
1.6	Closeout	$24,816.35
	Subtotal	$1,235,507.90
	Contingency - 30% of construction	$132,913.67
	Total Estimated Cost	**$1,368,421.57**

Fig. A.7. Detailed cost information for interceptor trench, slurry wall, and cap for BCBG.

Conclusions

This analysis indicates that the solution to address wastewater sources from EMWMF, future EMDF, and BCBG involves combined processing of EMWMF and EMDF wastewaters and treatment of BCBG wastewater separately. While the projected volume of BCBG wastewater to be treated would be capable of being managed within a future EMWMF/EMDF alternative, the list of COCs for BCBG wastewater precludes treatment with the EMWMF/EMDF wastewater. Listed F039 solvents and PCBs are not contaminants identified as requiring treatment for the EMWMF/EMDF wastewater. Additional equipment and operating costs to treat BCBG wastewater in combination with EMWMF/EMDF wastewater are projected to be much greater than the cost of processing BCBG wastewater at GWTF. Additionally, the wastewater would require transport by truck (or pipeline) from the LSF to a location for incorporation into a "new" EMWMF/EMDF option. Negative impacts, such as increased capital cost, increased complexity in terms of contaminants requiring treatment, and increased waste disposal costs are identified by incorporating a BCBG leachate waste stream into the EMWMF/EMDF wastewater management analysis.

A preferred solution would involve constructing an additional trench at BCBG to intercept contaminated groundwater entering NT-8 and transfer it to the existing LSF. The flow of the collected water would be within the existing capacity of the GWTF that currently processes leachate collected at the LSF. Additionally, the COCs to be addressed are the same as those currently managed by GWTF.

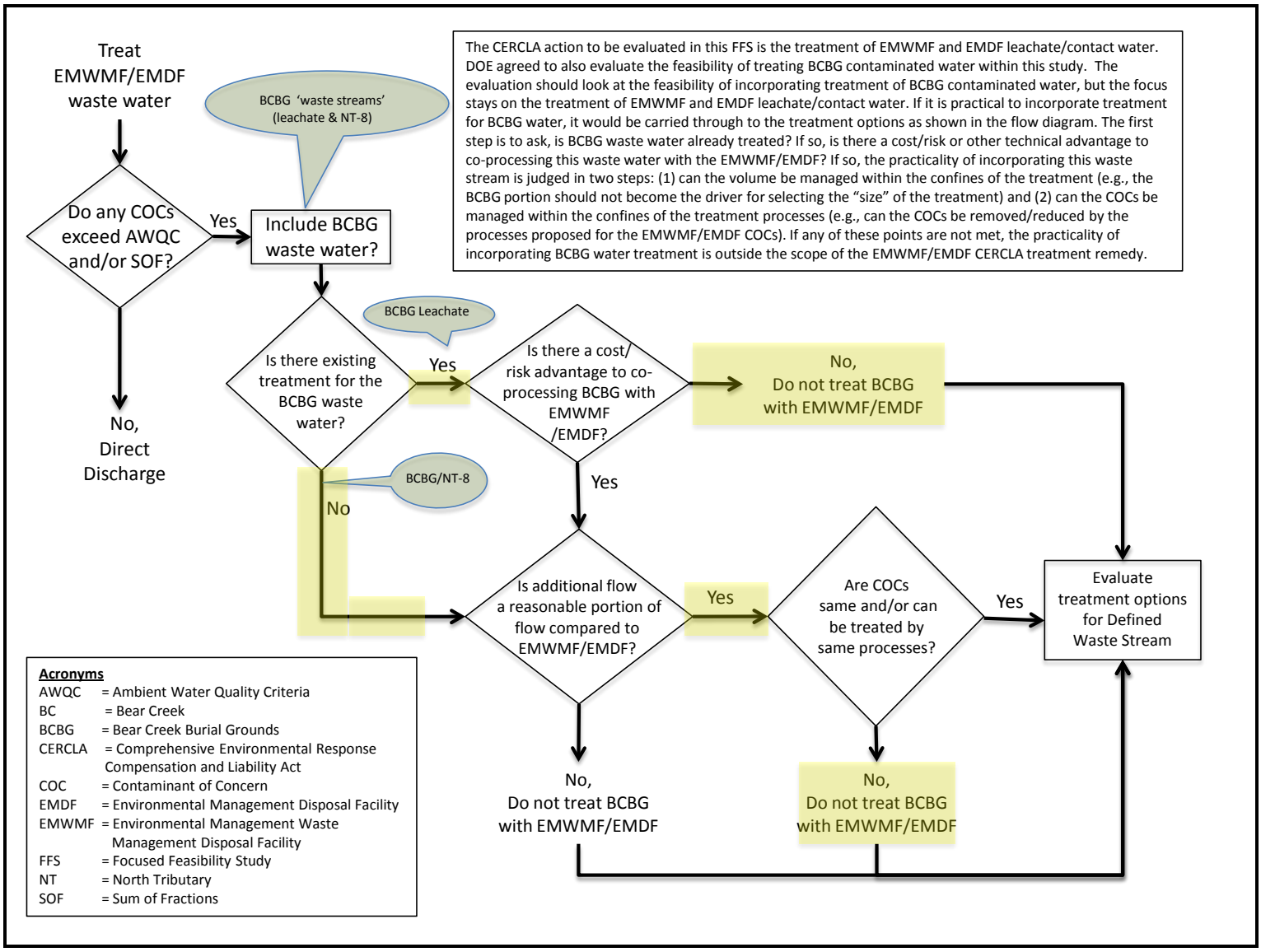


Fig. A.8. Flow sheet for determining the scope of the EMWMF/EMDF FFS.

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APPENDIX B.
CONTACT WATER AND LEACHATE FLOW RATE

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B.1 General Approach

The flow rates used in the focused feasibility study (FFS) were calculated with input from the Environmental Management Waste Management Facility (EMWMF) HELP model, the historical flow rate data, and the existing water balance that takes into account interim storage in tanks and ponds and the effect of varying water transfer rates. The historical data and HELP model output are useful in pointing to a range of values that are worth considering, but do not provide the precision required to calculate the future processing rates. Therefore, the water input was determined from a combination of HELP and historical data. The water balance was then used to evaluate the impact from changing storage volumes, transfer rates, and storm recurrence intervals to evaluate the risk of spillage from the system of storage units. The water storage requirement is provided in Appendix H.

B.2 Considerations When Using HELP Model Analysis Validated Against Historical Data to Establish Water Processing Rates

HELP Model Limitations:

It is difficult to model all variations in cover conditions that are possible during active cell operations. The enhanced operational cover and large areas with compacted, low permeability clay above waste that still shed water into the active cells likely result in more rainfall becoming contact water than HELP would forecast.

HELP modeling does not usually attempt to account for the large, multi-day, storm events that generated a tremendous amount of water. A good example is the 8.66 inches of rain that fell over the Labor Day weekend in 2011. That storm exceeded the 100-year, 24-hour storm by 2.16 inches. Another example is the 9.54 inches of rain that fell between February 14–16, 2003, exceeding the 100-year, 24-hour storm by slightly over 3 inches.

HELP does not account for storage of stormwater runoff (i.e., contact water) nor does it accurately account for the delay/damping of the peak leachate generation as the water percolates through the waste mass and into the collection system.

Comparison of HELP model predictions of leachate and contact water quantities to the measured volumes provides inconclusive results. Leachate predictions are generally more accurate than contact water and typically are higher than actual quantities. Contact water appears to be under-predicted by HELP, except for the larger storms (such as the 100-year, 24-hour storm) where the model significantly over-predicts the volume.

The EMWMF HELP modeling scenarios assume that as cells reach their final waste placement grades, the cells are quickly placed into a cover situation that diverts most of the precipitation out of the cell to the stormwater collection system. Although progress is being made, EMWMF has not been able to fully establish this cover to match the model's aggressive assumptions, resulting in contact water volumes that typically exceed the model-predicted values.

Actual Data Limitations:

Actual data can be misleading because measured values are only recorded when someone is on-site to do so. Thus, amounts of rainfall and leachate generated often represent the net total for a 3-day period (or more if a holiday weekend is involved).

When comparing to predicted quantities of leachate or contact water, the actual values are substantially influenced by storage and infrequent closures of the Leachate Collection System valves. This has the effect of reducing or damping the daily volumes to levels the existing water management system can accommodate.

Water inputs and outputs to leachate storage tanks, contact water ponds, and contact water tanks are monitored daily with good precision; however, the water level changes in the catchments is only monitored weekly or subsequent to large storm events. While there is no true daily record of contact water input to the catchments, the measured output from the catchments is recorded. The output volume is essentially equal to the input volume minus the fraction that evaporates or infiltrates the leachate system. As a result and as shown in Table B.1, leachate volumes are lower than the HELP model predicts, and contact water volumes are higher than the HELP model predicts.

Table B.1. Actual vs. HELP model leachate quantities (2004–2009)

Peak day generation rate	
Actual volume (gal/day)	56,300
Projected volume - rainfall adjusted (gal/day)	62,532
Percentage of actual to projected (%)	90
Average month generation rate	
Actual volume (gal/mon)	166,294
Projected volume - rainfall adjusted (gal/mon)	320,698
Percentage of actual to projected (%)	52
Wettest month generation rate	
Actual volume (gal/mon)	412,600
Projected volume (gal/mon)	549,300
Percentage of actual to projected (%)	75

Table B.2. Actual vs. HELP model contact water quantities (2004–2009)
(Note: In this analysis all stormwater runoff is included with contact water.)

Peak day generation rate	
Actual volume (gal/day)	490,000
Projected volume - rainfall adjusted (gal/day)	1,516,859
Percentage of actual to projected (%)	32
Average month generation rate	
Actual volume (gal/mon)	593,409
Projected volume - rainfall adjusted (gal/mon)	837,200
Percentage of actual to projected (%)	71
Wettest month generation rate	
Actual volume (gal/mon)	2,101,400
Projected volume (gal/mon)	995,000
Percentage of actual to projected (%)	211

Flow Rate Estimates

The following likely situations were evaluated for the Cell 6 Remedial Design Report and are used in the FFS flow rate calculations.

Table B.3. Landfill situation descriptions used in Cell 6 RDR HELP model calculation

Situation	Landfill layer descriptions
A—New cell	New cell with minimum waste plus water catchment
B1—Working face with 10-ft layer of waste	10-ft waste at K = 5.0 × 10E-4 cm/s
B2—Working face with 30-ft layer of waste	30-ft waste at K = 5.0 × 10E-4 cm/s
C1—Operational cover with 40-ft layer of waste	0.25-in. Posi-shell cover at K = 5.8 × 10E-6 cm/s 1-ft operational cover at K = 5.0 × 10E-6 cm/s 40 ft of waste at K = 5.0 × 10E-4 cm/s
C2—Operational cover with 70-ft layer of waste	0.25-in. Posi-shell cover at K = 5.8 × 10E-6 cm/s 1-ft operational cover at K = 5.0 × 10E-6 cm/s 70 ft of waste at K = 5.0 × 10E-4 cm/s

The EMWMF Help model was then used with the above scenarios to develop leachate and contact water generation rates.

Table B.4. Leachate and contact water generation rates from EMWMF HELP Model average for Cells 1–6 from prior analyses (Cell 6 RDR HELP calculation)

Cell	Peak day (CF/Ac/day)		Average month (CF/Ac/day)		Wettest month (CF/Ac/day)		Max month (CF/Ac/day)	
Situation	Leachate	CW	Leachate	CW	Leachate	CW	Leachate	CW
A	1,198	22,311	44	255	78	288	127	473
B1	1,235	17,175	212	76	305	76	501	125
B2	1,234	17,175	212	76	313	76	514	125
C1	480	22,719	14	328	44	374	72	615
C2	487	22,719	14	328	44	374	72	615

Peak day data based on 100-yr, 24-hr storm of 6.5 in.
Average month data based on 100 years of HELP model synthetically generated data
Wettest month data based on 5.72-in. rain
Max month data based on 9.39 in. of rain (avg. of highest single month rain over period)
Ac = acre
CF = cubic feet
CW = contact water

These data were then used to simulate the conditions where EMWMF Cells 5 and 6 were open concurrently with Environmental Management Disposal Facility Cell 1, the base case for the FFS evaluations.

Table B.5. Base case modeling scenario

	Cell area	Peak day (CF/day)		Average month (CF/day)		Wettest month (CF/day)		Max month (CF/day)	
Active cells/condition	(acres)	Leachate	CW	Leachate	CW	Leachate	CW	Leachate	CW
EMWMF Cell 5 Situation B2	6.0	7,404	103,050	1,272	456	1,878	456	3,084	750
EMWMF Cell 6 Situation B2	5.3	6,479	90,169	1,113	399	1,643	399	2,699	656
EMDF Cell 1 Situation A	6.2	7,440	138,551	273	1,584	484	1,788	789	2,937
Totals	17.5	21,322	331,770	2,658	2,439	4,006	2,643	6,571	4,344
Converting to gal/day		159,489	2,481,640	19,884	18,240	29,962	19,773	49,152	32,490
Converting to gal/min		111	1,723	14	13	21	14	34	23
leachate + CW gal/min			**1,834**		**26**		**35**		**57**

CF = cubic feet
CW = contact water

The resulting flow rates were then used in the FFS as follows:

- Average flow rate was rounded to 30 gpm

Maximum month flow rate was rounded to 60 gpm and was used as the design basis in the FFS as a conservative measure, given the uncertainty in the flow rates.

APPENDIX C.
EXPLANATION OF HOW THE KEY CONTAMINANTS OF CONCERN WERE DEVELOPED

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C.1 METHODOLOGY

The Environmental Management Waste Management Facility (EMWF) approach taken was to first compile the available data, then to qualitatively evaluate these for abundance in the waste lots, mobility, stability, and persistence in the EMWMF and surrounding environment, and potential risk concern. Following compilation and initial evaluation, the key contaminants of concern (COCs) were selected.

For the last several years, almost all of the waste disposed at the EMWMF consists of waste lots from the East Tennessee Technology Park (ETTP) site, with similar contaminants. Waste lots from the ETTP are expected to continue for several years as remediation activities at the ETTP are completed. Therefore, the last two years of data were analyzed to determine which of the current analytes would require treatment if a system was installed at this time.

As remediation activities increase at the Y-12 National Security Complex (Y-12) and the Oak Ridge National Laboratory (ORNL) sites, contaminants in the associated waste lots are expected to change and the key COCs may change. Additional evaluation was performed on the key COCs to determine trends and evaluate which COCs may require treatment at a future date as facilities with different characteristics are demolished. A process was also identified and will be documented in the EMWMF Sampling and Analysis Plan (SAP)/Quality Assurance Program Plan (QAPP) for ready evaluation of key COCs in the future.

The following information was considered as part of this process:

- Free liquids are not allowed to be disposed at EMWMF.
- No listed waste has been or is projected to be disposed at EMWMF. Therefore, no degreasers/solvents are expected, such as trichloroethene and tetrachloroethene. Instead, these materials are present as a result of intended use associated with the facilities that have been demolished and disposed at EMWMF, or as residual amounts in soil or debris from previous, remediated leaks or spills. Therefore, these materials may be present in minor amounts, rather than as primary contaminants.
- Wastes disposed at EMWMF must meet Land Disposal Restrictions, minimizing the concentrations available to potentially leach into water.
- Metals typically require a low pH environment to dissolve and be transported in water. Both the geologic environment and the disposed waste (primarily building debris) at EMWMF are carbonate-rich with historically higher pH levels. Therefore, many metals are not expected to dissolve and be transported in either the surface or groundwater.

C.2 DATA COMPILATION

The (over 11 years of) leachate and contact water analytical data was compiled. These analytical data included COCs and additional analytical data obtained by analyzing EMWMF wastewater for analytical suites instead of for COCs identified in the waste lots. The contact water analytical data are in Attachment 1 to this appendix and the leachate data are in Attachment 2. As shown in these attachments, the number of analytes routinely detected is much less than the analytes that are analyzed.

C.3 DATA EVALUATION

Following data compilation, the analytes were reviewed to evaluate abundance in the waste lots disposed at EMWMF, the contaminant mobility in water, the regulatory concern and/or risk, and other factors.

C.3.1 Analyte Abundance in EMWMF Waste

To determine the abundance in the waste, the number of waste lots with each analyte was compared against the number of waste lots where the analyte was detected during characterization. This comparison also determined that EMWMF was analyzing for many analytes not characterized in the waste. The abundance is provided per analyte in Attachment 3, the COC winnowing table. Analytes not characterized in the waste are indicated with a dash in the abundance table.

There have been 170 waste lots disposed to date at EMWMF. Analytes detected in waste in 0–50 waste lots were designated as low abundance. Analytes detected in 50–100 waste lots were designated as moderate abundance. Analytes detected in over 100 of the waste lots were designated as high abundance.

C.3.2 Mobility, Stability, and Persistence

Analytes were next evaluated for mobility in water, stability, and persistence. As a conservative approach, stability and persistence were assumed to be remain constant, and mobility in the landfill environment was expected to predict whether a contaminant could be present in the landfill water. The mobility class for the common organic analytes was derived from Applied Hydrogeology (Fetter, C. W., 1994, *Applied Hydrogeology*, Prentice-Hall, Upper Saddle River, New Jersey). The analytes specifically listed are highlighted in Attachment 3. For the remaining analytes not listed in Fetter, the following mobility class was assigned based upon the chemical properties:

Table C.1. Assigned mobility class for analyte families

Suffix	Assigned mobility	Suffix	Assigned mobility
-hexane	L	-nitrile	H
-ketone	M	-phenol	H
-benzene	H	-chlor	L
-ethene	M	-naphthalene	L
-ethane	H	-amine	L
-chloride	H		

H = high
L = low
M = moderate

Asbestos has not been seen in leachate or contact water and was assigned a low mobility due to its physical properties.

Several metals are not expected to be mobile within the cell or within the geologic setting because of the concrete in the waste cell and the carbonate-rich geologic environment. However, metals such as barium and cadmium are mobile in the environment and are designated as such. Chromium has a dual mobility designation. Chrome III has a low mobility, but Chrome VI is highly mobile.

C.3.3 Potential Risk Concern

Several analytes are of greater concern because of their carcinogenic risk and/or an underlying potential risk concern. These analytes were assigned a low, moderate, or high rating based on the level of concern.

Mercury, cadmium, and nitrogen compounds (including ammonia) are of high concern because of the potential harm to the ecosystem. Pesticides are also of high concern because the potential harm to the ecosystem. In addition, certain mobile radionuclides are of high concern because of the mobility combined with the persistence in the environment and the potential harm to the ecosystem.

Volatile organic compounds are of low concern because these are a relatively small component of the contamination associated with the waste. No free liquids or listed waste is allowed in the EMWMF, limiting the amount of volatile organic compounds to residual amounts in soil or debris from previous, remediated leaks or spills. Therefore, these are a low risk concern.

The assigned ratings are found in Attachment 3.

C.4 SELECTION OF KEY COCS

Based upon the preceding evaluation, the key COCs were identified (Table C.2) as analytes that present in the wastewater and are abundant in the waste, mobile in the local environment, and of high potential risk concern. Additional water quality parameters will be monitored based on the Tennessee Department of Environment and Conservation (TDEC) Water Pollution Control experience in assessing industrial wastewater and recognizing reasonable potential impacts to streams in this geographical region. For example, Total Organic Carbon will be monitored to indicate the presence of volatile organic compounds and semivolatile organic compounds. Additional analyses would be triggered if higher levels of TOCs are seen.

Details on the monitoring for the key COCs will be included in the subsequent SAP/QAPPs.

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Table C.2. Key COCs and summary statistics for 2011–2013

Analysis type	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
METAL	Arsenic, Tot + Diss	169	24	14.2%	ug/L	0.15	3.6	5	340	150	10		No	No	No	-
METAL	Cadmium, Tot + Diss	169	34	20.1%	ug/L	0.08	0.332	5	2.2*	0.27*	-		No	Yes	-	-
METAL	Chromium, Tot + Diss	201	119	59.2%	ug/L	0.3	16.7	5	625*	81*	-		No	No	-	-
METAL	Chromium, hexavalent	198	93	47.0%	ug/L	6	112	6	16	11			Yes	Yes	-	-
METAL	Copper, Tot + Diss	169	88	52.1%	ug/L	0.41	5	5	15*	9.9*	-		No	No	-	-
METAL	Lead, Tot + Diss	201	22	10.9%	ug/L	0.36	4.53	5	73*	2.8*	-		No	Yes	-	-
METAL	Mercury, Tot + Diss	188	7	3.7%	ug/L	0.065	0.22	5	1.4	0.77	0.051		No	No	Yes	-
METAL	Nickel, Tot + Diss	196	136	69.4%	ug/L	0.56	15	5	515*	57*	4600		No	No	No	-
METAL	Uranium	194	185	95.4%	ug/L	2.01	388	5	-	-	-		-	-	-	-
Other	Cyanide	303	14	4.6%	ug/L	1.84	14.9	5	22	5.2	140		No	Yes	No	-
Other	Dissolved Solids	41**	41	100.0%	mg/L	125	1410	2.5	-	-	-		-	-	-	-
Other	Suspended Solids	48**	27	56.3%	mg/L	1.15	1400	2.5	-	-	-		-	-	-	-
Other	Total Organic Carbon (TOC)	42**	41	97.6%	mg/L	0.86	12.1	1	-	-	-		-	-	-	-
PPCB	4,4'-DDD	318	23	7.2%	ug/L	0.011	0.0767	5	-	-	0.0031		-	-	Yes	-
PPCB	4,4'-DDE	318	26	8.2%	ug/L	0.0125	0.293	5	-	-	0.0022		-	-	Yes	-
PPCB	4,4'-DDT	312	6	1.9%	ug/L	0.013	0.05	5	1.1	0.001	0.0022		No	Yes	Yes	-
PPCB	Aldrin	307	7	2.3%	ug/L	0.011	0.04	5	3	-	0.0005		No	-	Yes	-
PPCB	beta-BHC	311	101	32.5%	ug/L	0.0104	0.289	5	-	-	0.17		-	-	No	-
PPCB	Dieldrin	324	8	2.5%	ug/L	0.011	0.02	5	0.24	0.056	0.00054		-	-	-	-
RAD	Iodine-129	347	15	4.3%	ug/L	0.39	12.8	5	0	0	0		-	-	-	-
RAD	Strontium-90	350	266	76.0%	ug/L	1.31	471	5	0	0	0		-	-	-	-
RAD	Technetium-99	347	307	88.5%	ug/L	4.11	983	5	0	0	0		-	-	-	-
RAD	Tritium	347	249	71.8%	ug/L	337	9234.86	5	0	0	0		-	-	-	-
RAD	Uranium-233/234	347	344	99.1%	ug/L	0.65	362	5	0	0	0		-	-	-	-
RAD	Uranium-235/236	347	301	86.7%	ug/L	0.26	27.4	5	0	0	0		-	-	-	-
RAD	Uranium-238	347	339	97.7%	ug/L	0.3	156.2	5	0	0	0		-	-	-	-

* Hardness corrected value based on average hardness of 112 mg/L in the North Tributary-05 receiving stream
** Historical data only available for leachate

Additional Water Quality Parameters

Other	Hardness, as CaCO3, mg/l	Because toxicity of some metals is directly related
Other	Nitrogen, Nitrate total (as N)	Nutrients, important to monitor health of the stream
Other	Nitrogen, total (as N)	Nutrients, important to monitor health of the stream
Other	Phosphorus, total (as P)	Nutrients, important to monitor health of the stream
Other	TDS or conductivity	Routine performance to determine if a pulse is moving through the system
Other	Total Organic Carbon	Indicates the presence of volatile organic compounds or semivolatile organic compounds
Other	TSS	Indicates the potential to transport adsorbed metals, affects benthics
Other	Whole effluent toxicity, both acute and chronic	Minimum - semi-annual, or upon major change in waste characteristics; at least one sample during Sept.–Nov. low-flow period.
Other	Ammonia Nitrogen, Total as N	Ubiquitous nature in most leachate streams
Other	Stream flow	Required to calculate mixing in stream if upset conditions occur
Other	Wastewater Flow	Required to calculate mixing in stream

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
DCG = derived concentration guidelines
FAL = fish and aquatic life
MDA = minimum detectable activity
PPCB = pesticides and polychlorinated biphenyls
RAD = radiological
TDS = total dissolved solids
TSS = total suspended solids

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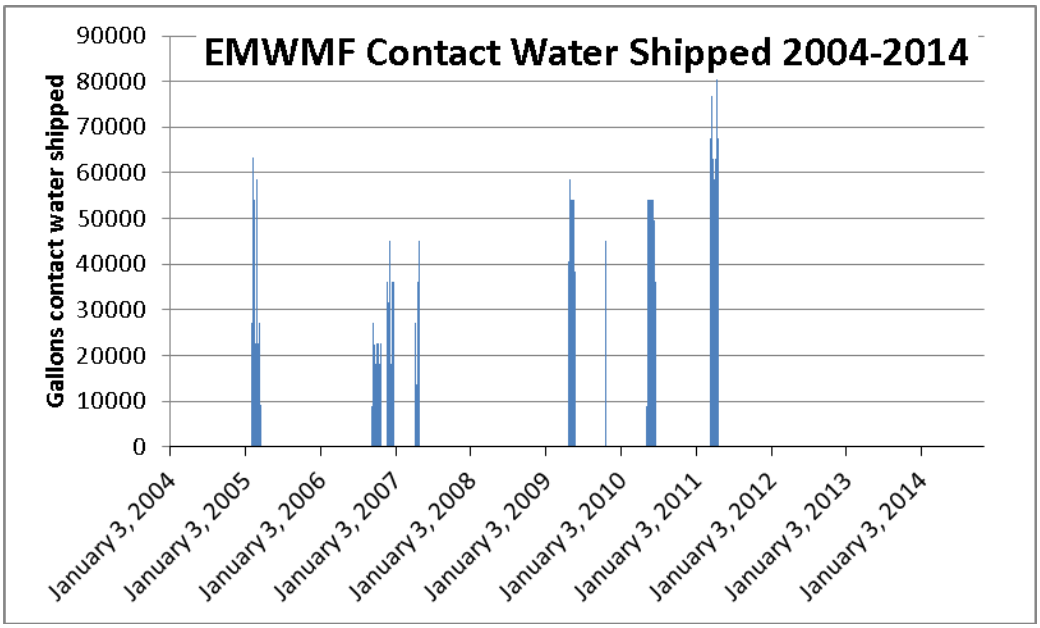
C.4.1 Additional Analysis

Each of the key COCs was evaluated over the EMWMF operating history to determine the trends. The data range from 2005 to 2014 was selected as the most complete, representative data set to evaluate and provides ten years of data. Contact water and leachate are graphed separately for each analyte, with the same axes for each analyte to facilitate the comparison between leachate and contact water. The following data were not filtered to show only the water released. Instead, all available analyses were used, including those from water that were treated. These graphs also indicate the changes in the analytical reporting limits over time, particularly for the analytes with minimal detects.

The following table and graph shows the water volumes that have been treated in the past ten years. As shown, no contact water has been shipped for treatment since April 2011.

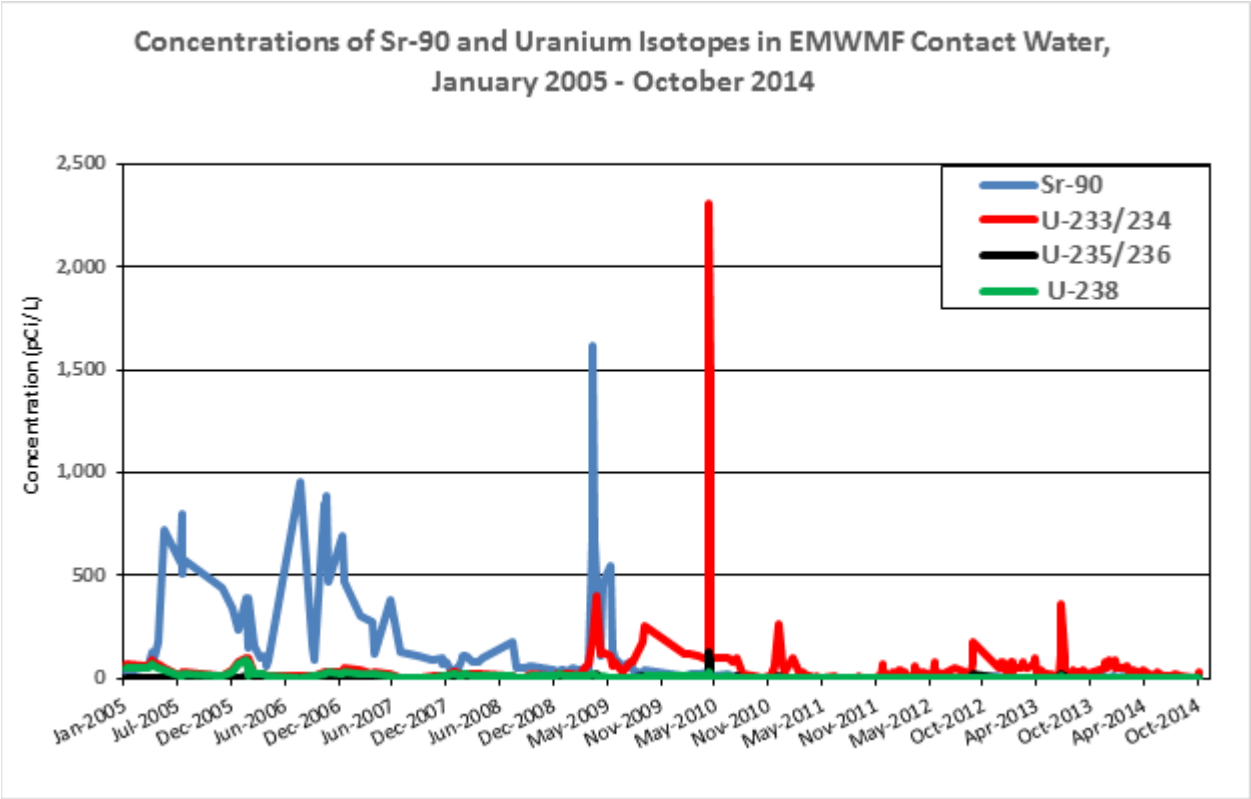
Table C.3. EMWMF contact water volume shipped by year (2004 to present)

Year	Months	Contact water shipped for treatment (gal)
2005	Jan–Mar	660,262
2006	Sep–Dec	831,187
2007	April	274,621
2009	April–May October	724,056 121,823
2010	May–June	1,191,035
2011	March–April	1,187,119
Total (2004–2014)		4,990,103



As shown in the following sections, concentrations of certain contaminants in contact water have changed over time, particularly as the origin of the waste received has changed. This is particularly noticeable in uranium (U) isotopes and strontium (Sr)as the origin of the waste has changed from Y-12 to ORNL to

ETTP. The following figure reflects these changes over time and indicates the changes expected to be seen as the origin of the waste changes in the future.



	2002–2006	2007–2010	2011–2014
Y-12	Boneyard/Burnyard		Old Salvage Yard, Biology Complex, Alpha 5
ORNL	Melton Valley closure soil and sediment, main plant surface impoundments	University of Tennessee-Battelle Bldg. 3026, 2000 complex	2000 complex, including slabs and soils
ETTP	K1070A burial ground, main facilities	K-25, Zone 1 and 2, Poplar Creek process facilities	K-33, K-25
Other	David Witherspoon 901	David Witherspoon 1630	

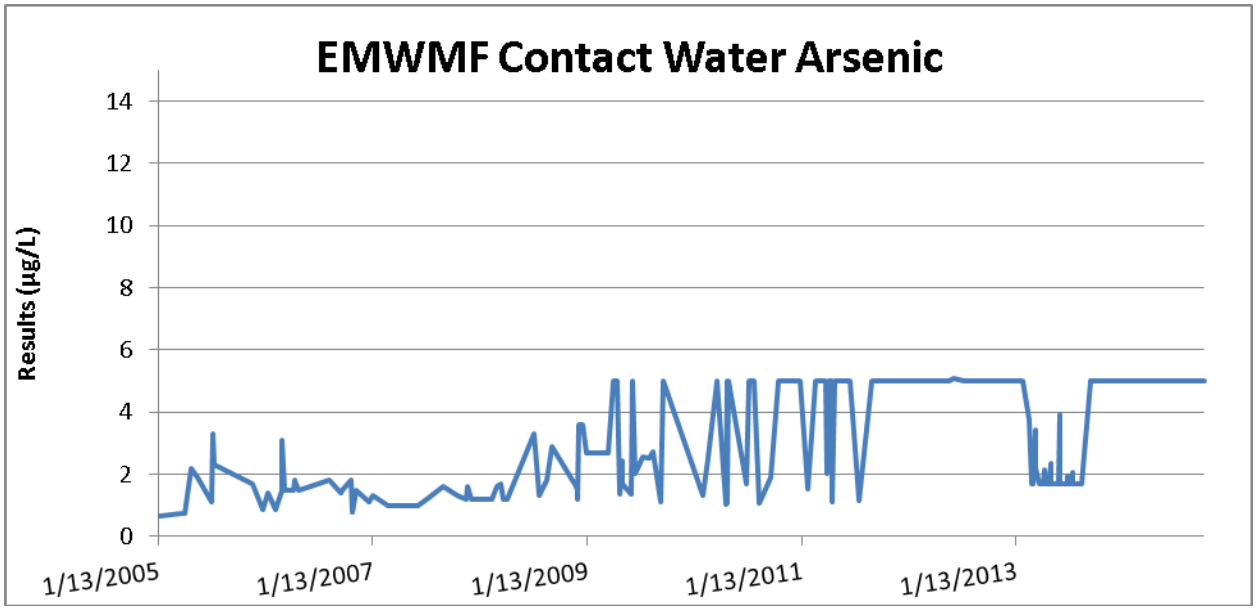
As shown above, prior to 2010, strontium was more prevalent in the contact water, representing the waste streams from Y-12 and ORNL. After 2010, U-233/234 is the prevalent radionuclide, representing a change in waste streams to primarily those originating at ETTP. U-235/236 is also more common in contact water prior to 2007, representing the portion of waste received from Y-12 and the Boneyard/Burnyard.

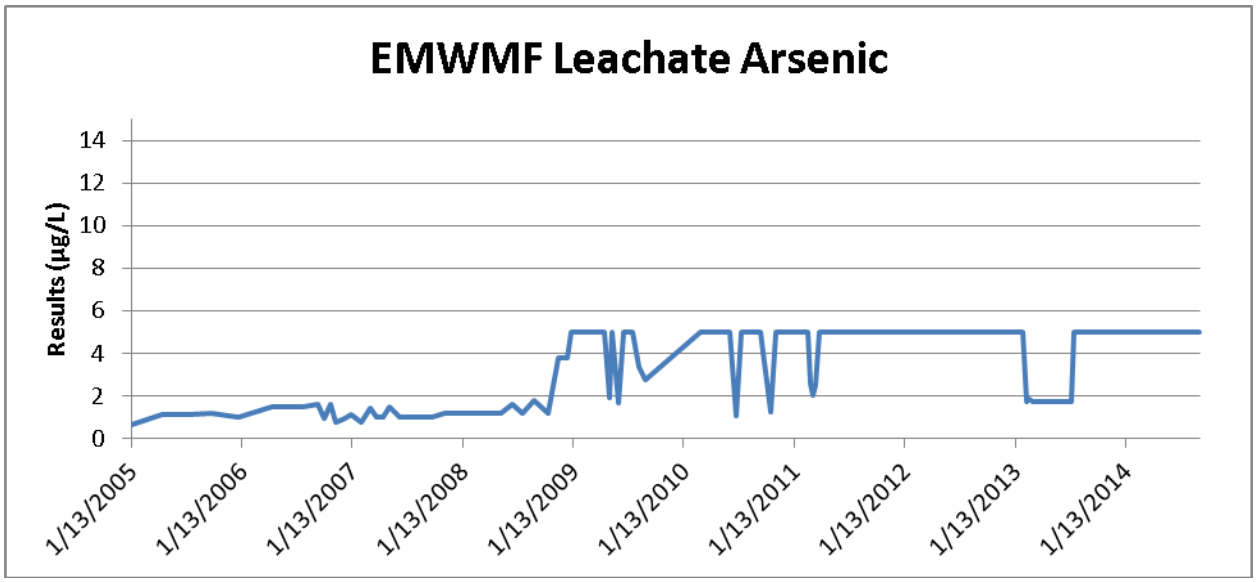
Following completion of the ETTP remedial actions, changes in the overall landfill wastewater concentrations are anticipated as Y-12 and ORNL waste again become the major waste lots received. Specifically, increases in mercury and strontium concentrations are anticipated.

Arsenic

Low levels of arsenic are detected in both the contact water and leachate. When detected, arsenic is well below the project quantitation level (PQL) of 5 ug/L. Arsenic is not expected to require treatment

Recreational ambient water quality criteria (AWQC) – 10 ug/L Criterion maximum concentration (CMC) – 340 ug/L Criterion continuous concentration (CCC) – 150 ug/L





Cadmium

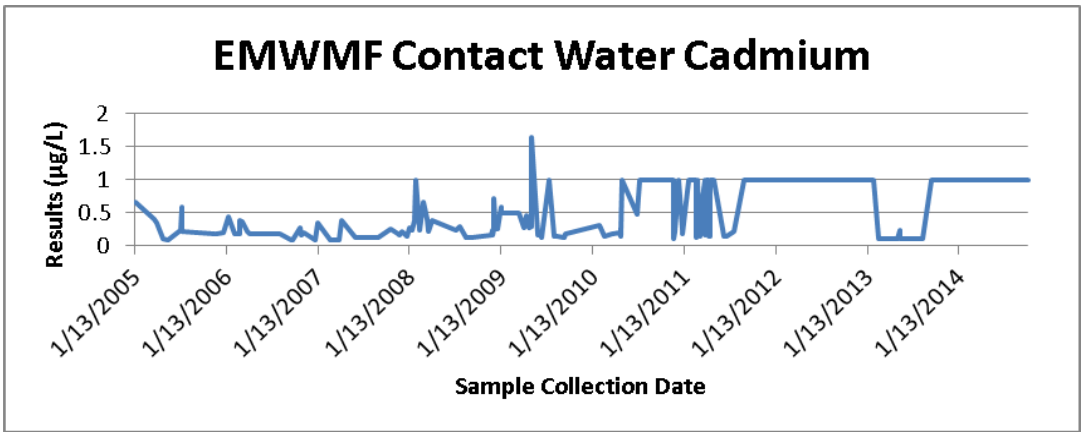
Cadmium was detected in about 20% of the leachate and contact water samples. Leachate typically contains lower cadmium than contact water. There have been no results higher than the CMC, but there are several instances, particularly in 2009, when results were higher than the CCC. The recent PQL is higher than what is required to demonstrate compliance with the CCC, but historical results occasionally exceed this value. Cadmium treatment is expected if continuous discharge is implemented.

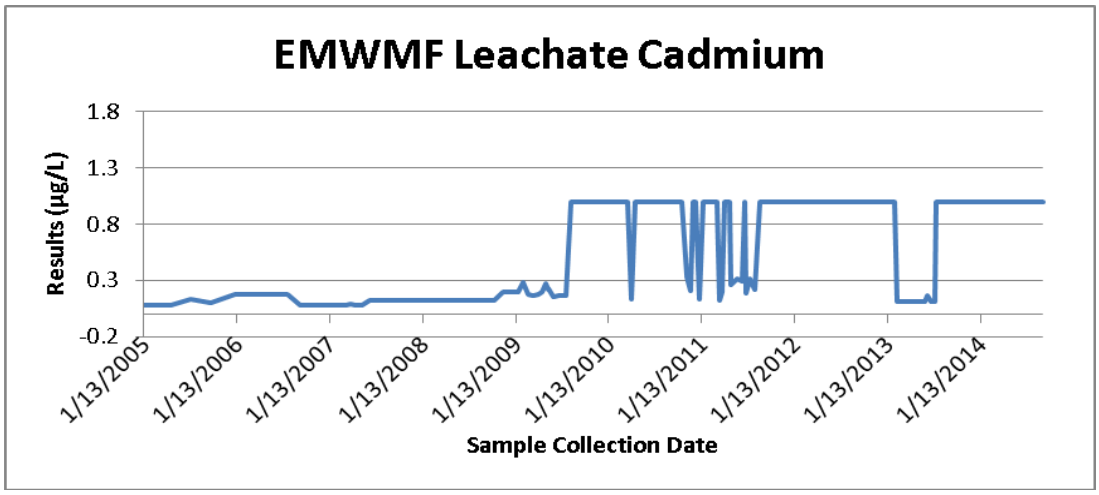
Recreational AWQC – n/a
Hardness corrected CMC – 2.2 ug/L
Hardness corrected CCC – 0.27 ug/L

Cadmium CW summary	No. samples	Detected	Min. detect (ug/L)	Max. detect (ug/L)
Total (Unfilt)	115	78	0.08	1
Dissolved (Filt)	216	36	0.105	1.65
Total	331	114		

CW = contact water

The highest value of 1.65 ug/L was a filtered sample collected on 5/13/2009 from Contact Water Pond (CWP) 2. However, this sample may not be representative of the actual water quality. The next highest sample result was 1.0 ug/L from an unfiltered sample collected from CWP 3 on 4/14/11, indicating that the highest result may not be representative of the actual water quality. The filtered sample collected from CWP 2 had a result of 0.28 ug/L. The comparison of filtered vs. unfiltered results does not show a consistent trend. For some pairs, filtered and unfiltered results are the same; for others, the filtered results are slightly higher; and for others, the unfiltered results are slightly higher. However, almost all are in the 0.1 to 0.2 ug/L range.

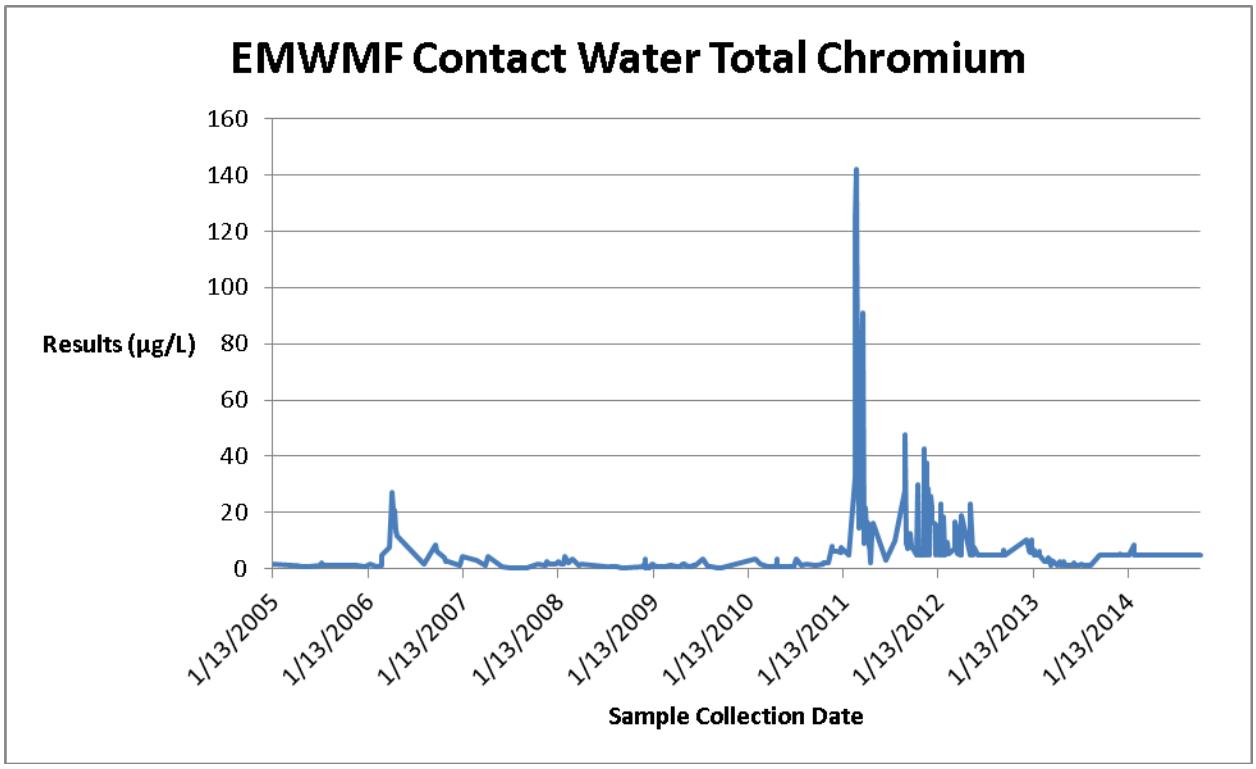


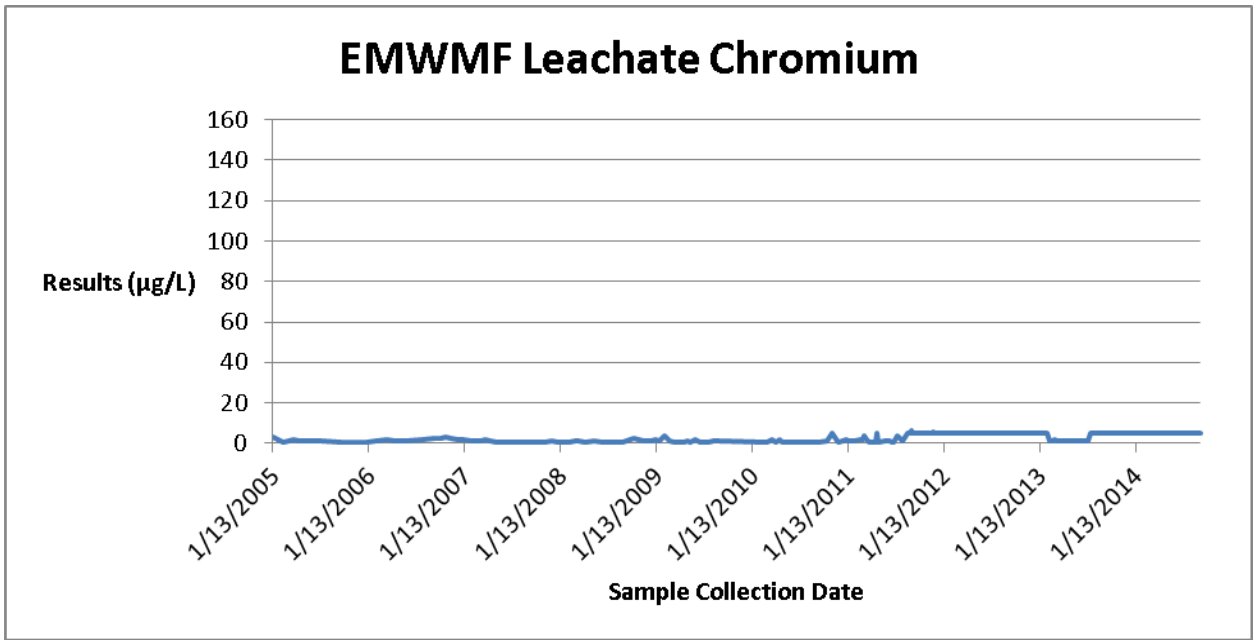


Chromium (total)

Historically, about 60% of the results have been detects. Total chrome has not been above the hardness corrected CMC, but exceeded the hardness corrected CCC in March 2011.

Recreational AWQC – n/a Hardness corrected CMC – 625 ug/L Hardness corrected CCC – 81 ug/L





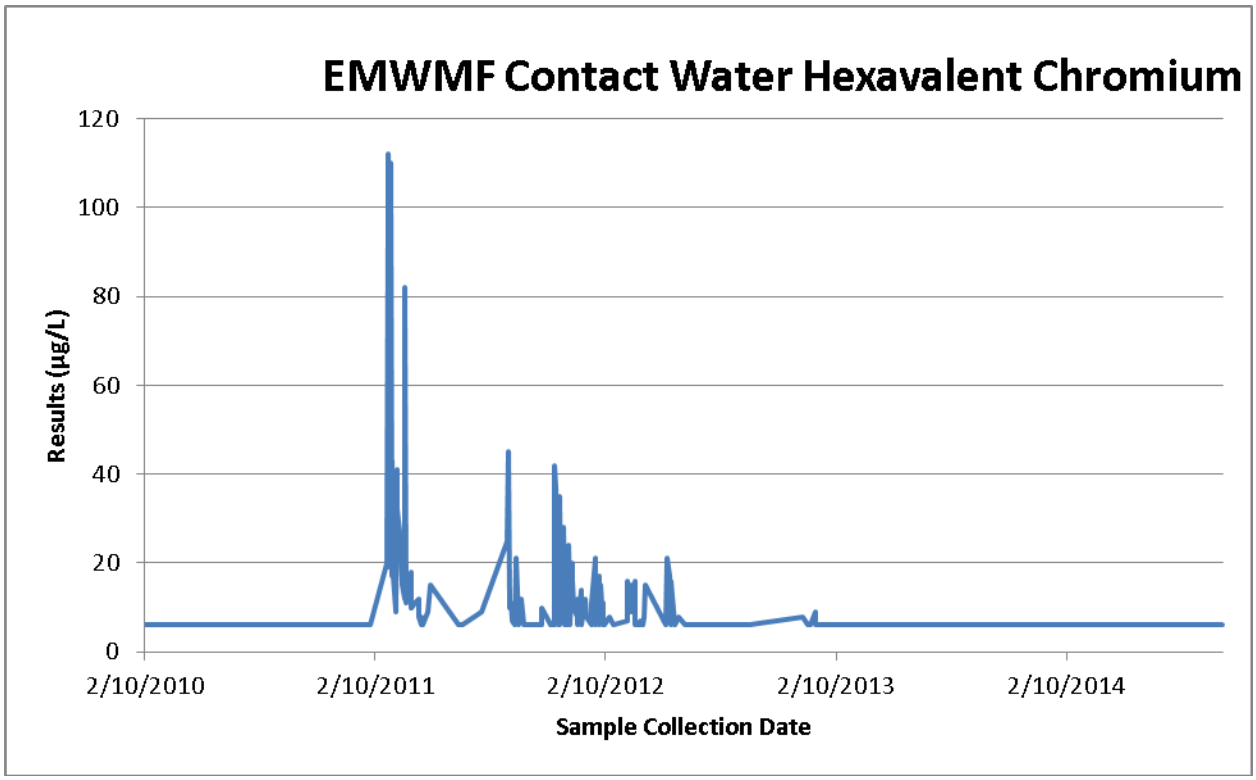
Hexavalent Chrome

Historically, about 60% of the results have been detects. Only contact water data is currently available for hexavalent chrome (Cr-VI) because this analysis is not required to prove compliance with the Liquid and Gaseous Waste Operations/Process Waste Treatment Complex waste acceptance criteria.

Recreational AWQC – n/a CMC – 16 ug/L CMC – 11

As shown in the graph below, hexavalent chrome was an issue in contact water between March 2011 and May 2012. Water with Cr-VI results higher than the AWQC of 16 ug/L were retained in the contact water ponds and tanks, and the Cr-VI was reduced to levels below 16 ug/L prior to release. Additional samples were collected to monitor the reduction and verify water was acceptable for release, resulting in the stair step pattern on the graph.

The Cr-VI was thought to result from disposal of K-33 debris at EMWMF during this time frame. A similar rise in Cr-VI levels was anticipated and has been seen for the ongoing K-31 demolition debris disposal (not shown). However, the EMWMF operations staff strives to place suspect debris in areas that are not impacted by accumulations of contact water to minimize the possibility of hexavalent chromium impacts, and maintains the capacity to reduce contact water when required.



Copper

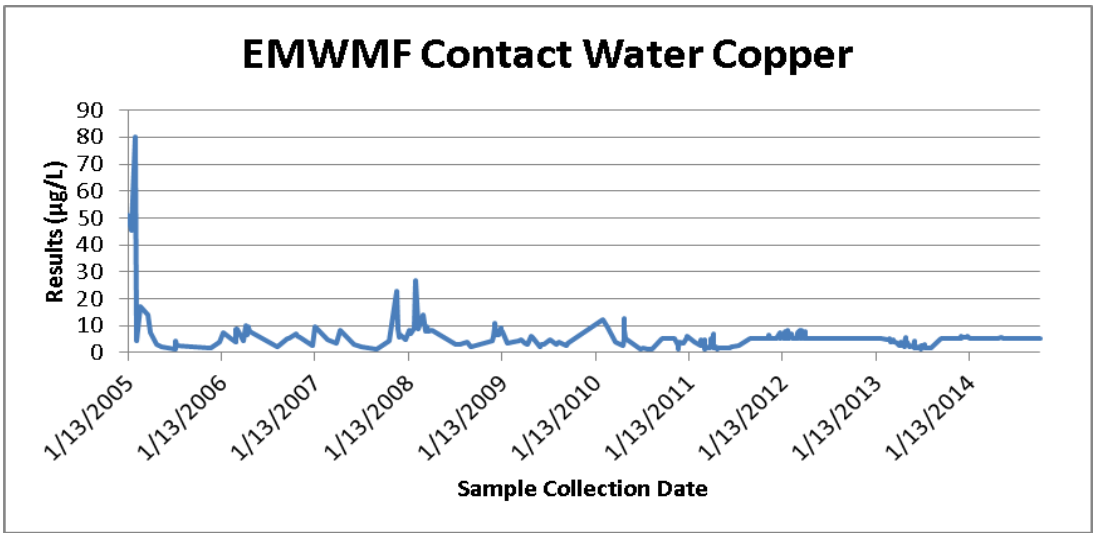
Historically, about 52% of the results have been detects. Higher copper levels were more prevalent in the past, with results above the CMC in February to March 2005, and again in November 2007 and February 2008. Since that time, there have been no results above the CMC. There have been no results above the CCC since May 2010. However, several results approached that amount in 2012.

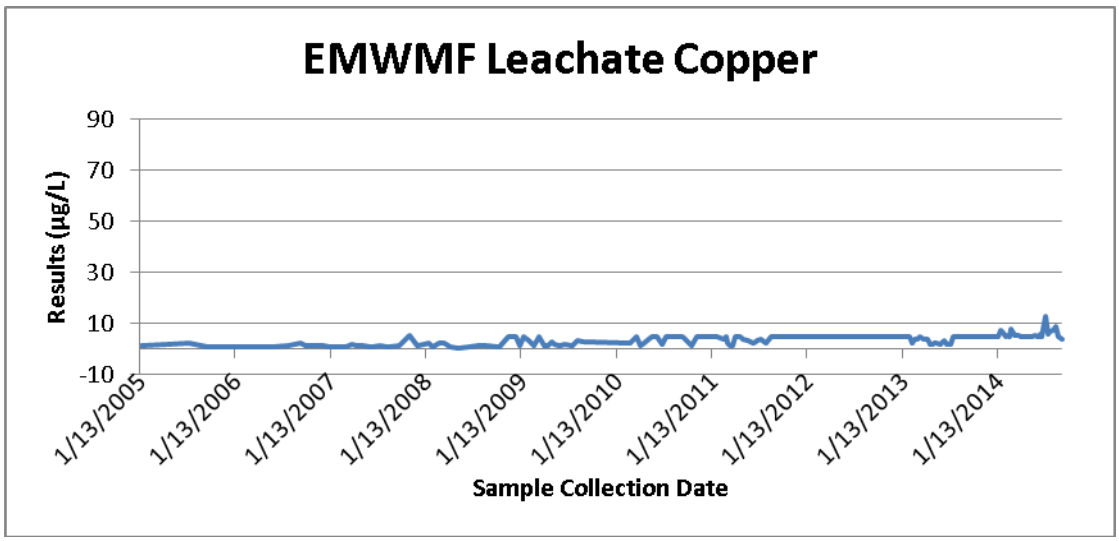
Recreational AWQC – n/a
Hardness corrected CMC – 15 ug/L
Hardness corrected CCC – 9.9 ug/L

Copper CW Summary	No. Samples	Detected	Min. detect (ug/L)	Max. detect (ug/L)
Total (Unfilt)	150	130	1	80.2
Dissolved (Filt)	221	123	1	36.5
Total	371	253		

CW = contact water

Leachate contains lower concentrations of copper. The highest result was 12.8 on July 14, 2014. This value was below the CMC, but exceeded the CCC. There was no concurrent elevation in contact water. The potential for copper treatment will be considered as a contingency in the future if continuous discharge is implemented.

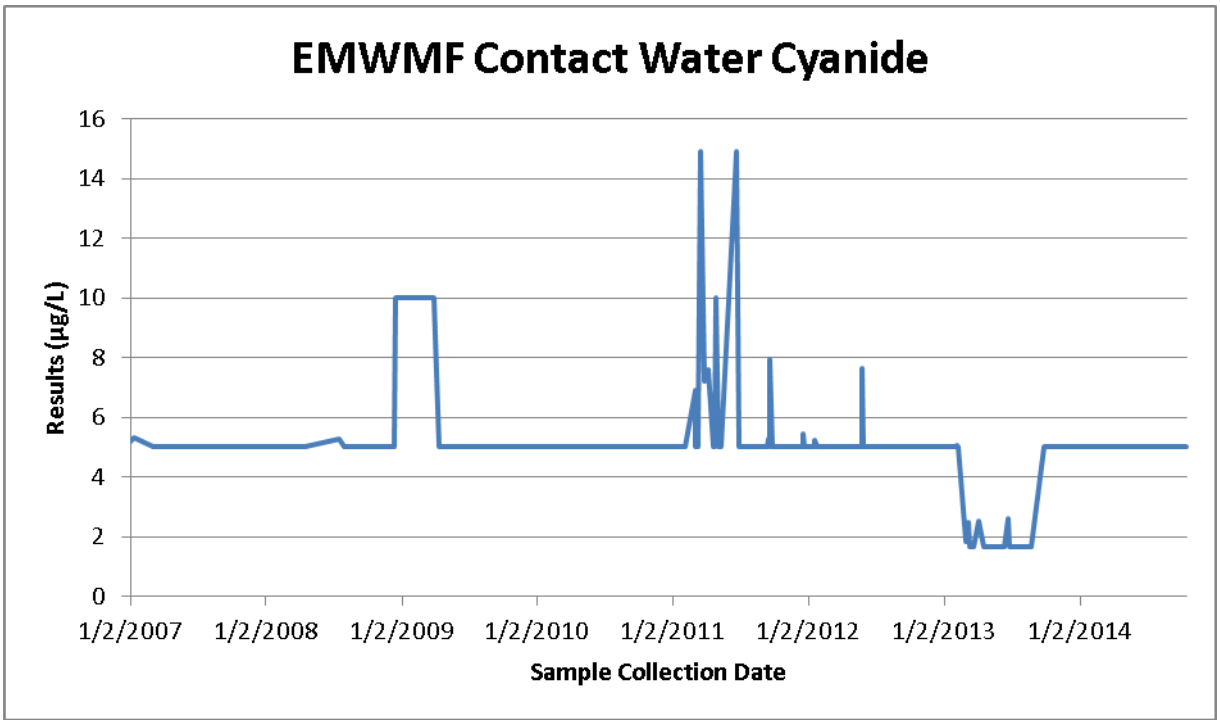


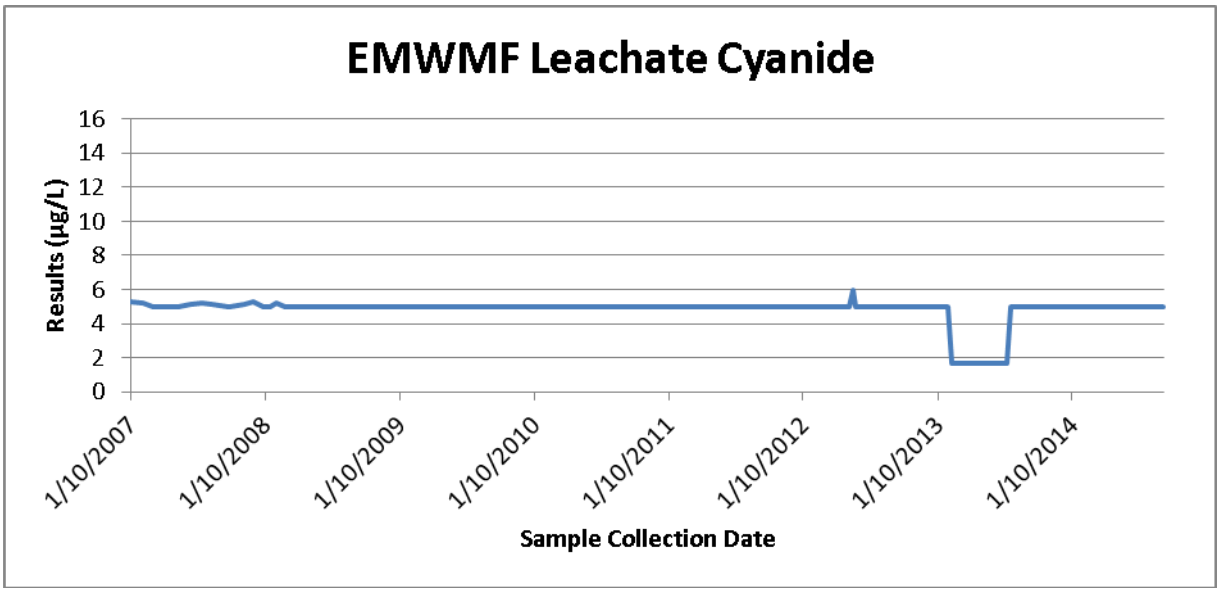


Cyanide

Historically, about 5% of the results have been detects. Results are well below the CMC. Most results have been below detection limits, but there were several results above the CCC during the period March 2011 to September 2011. One additional result exceeded the CCC in May 2012. The potential for cyanide treatment will be considered as a contingency if continuous discharge is implemented.

Recreational AWQC – 140 ug/L CMC – 22 ug/L CCC – 5.2 ug/L



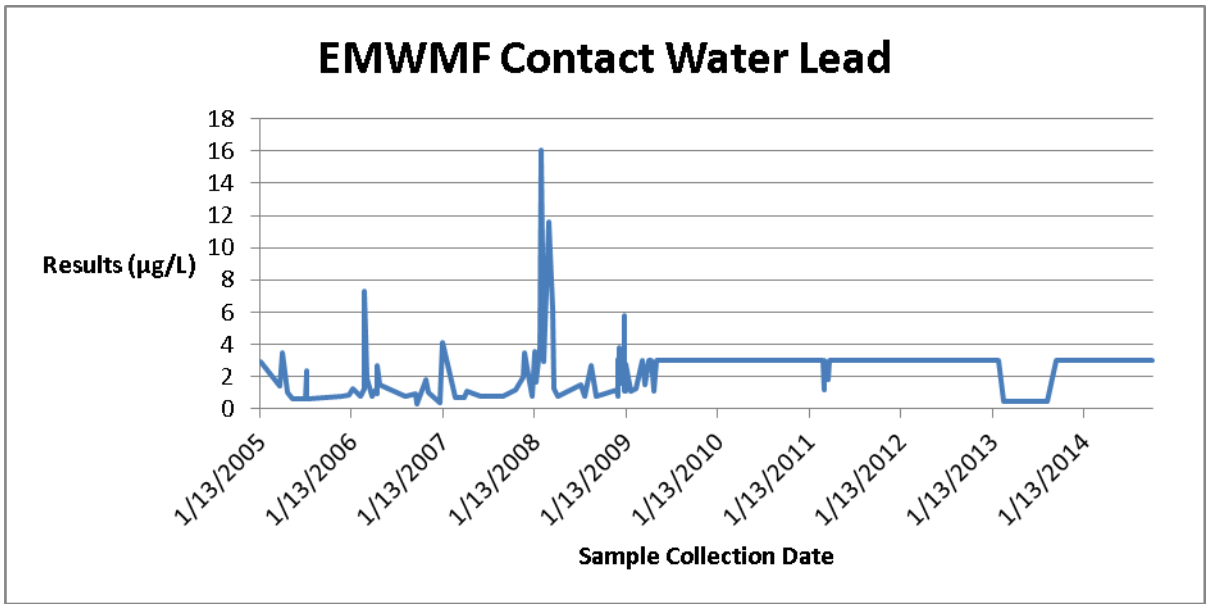


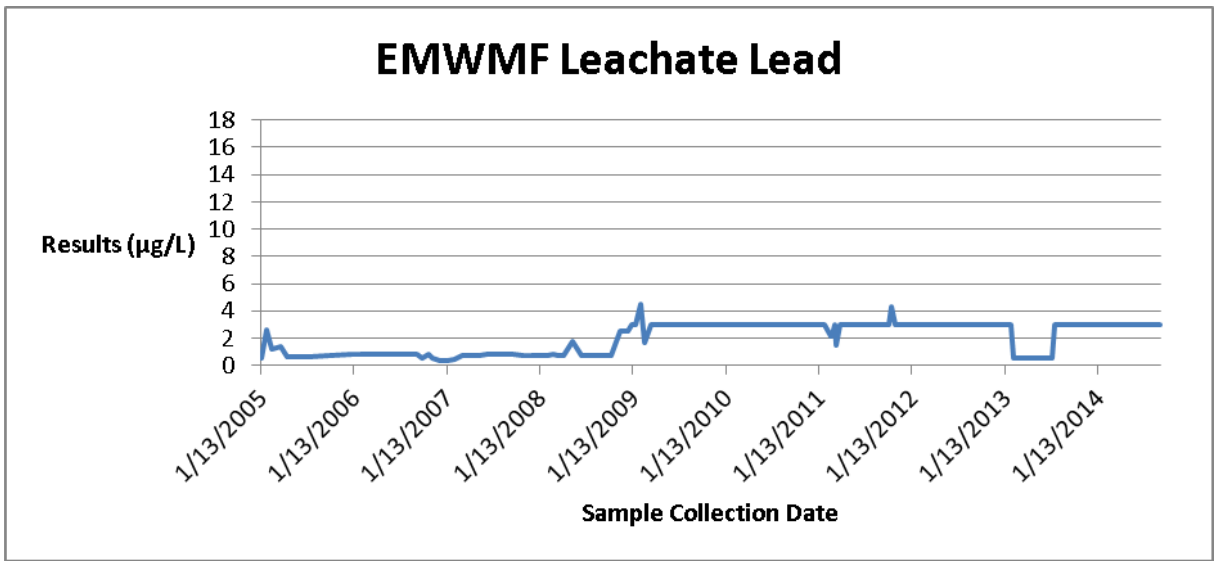
Lead

Historically, about 11% of the results have been detects. Results are below the CMC, but several have been above the CCC in the past. The highest contact water results were in February and March 2008.

Recreational AWQC – n/a
Hardness corrected CMC – 73 ug/L
Hardness corrected CCC – 2.8 ug/L

Since March 2009, no detected result has been above the CCC, although the detection limit was usually set at 3 ug/l. However, the lack of results above 3 ug/L and lack of results above the lower detection limits in early 2013 demonstrate that recent contact water met the hardness corrected CCC. The highest leachate value was 4.53 in February 2009, which is above the CCC. The potential for lead treatment will be considered as a contingency in the future if continuous discharge is implemented.





Mercury

Historically, about 11% of the results have been detects. Results are below the CMC, but several have been above the CCC in the past. The highest contact water results were in February and March 2008. Historically, about 4% of the results have been detects and many of the other results are B qualified, indicating that the results may be suspect. However, the recreational AWQC was not a discharge criterion and the detection limit was not low enough to determine if it can be met.

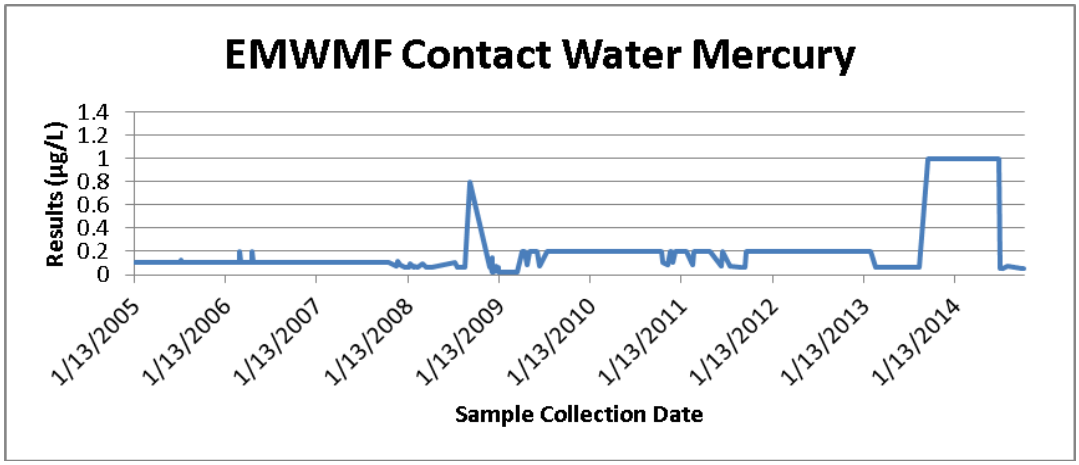
Recreational AWQC – 0.051 ug/L
CMC – 1.4 ug/L
CCC – 0.77 ug/L

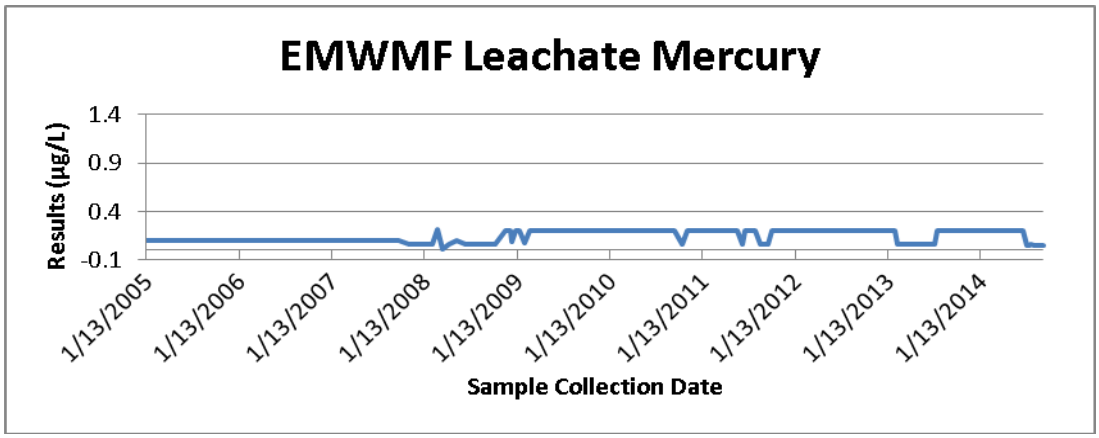
Mercury CW Summary	No. Samples	Detected	Min. detect (ug/L)	Max. detect (ug/L)
Total (Unfilt)	127	32	0.021	0.8
Dissolved (Filt)	201	9	0.02	0.109
Total	331	114		

CW = contact water

The highest detected result was 0.8 on Sept 15, 2008. This result was B qualified, indicating the result may not be accurate.

The results from filtered and unfiltered pairs show filtered sample results in a pair are generally slightly less than the total sample results. This indicates that mercury is present in both the dissolved and undissolved state. Mercury treatment is expected to be required because of the low recreational AWQC that will need to be met after implementation of this focused feasibility study (FFS), and because the Environmental Management Disposal Facility is expected to receive more mercury-contaminated waste.

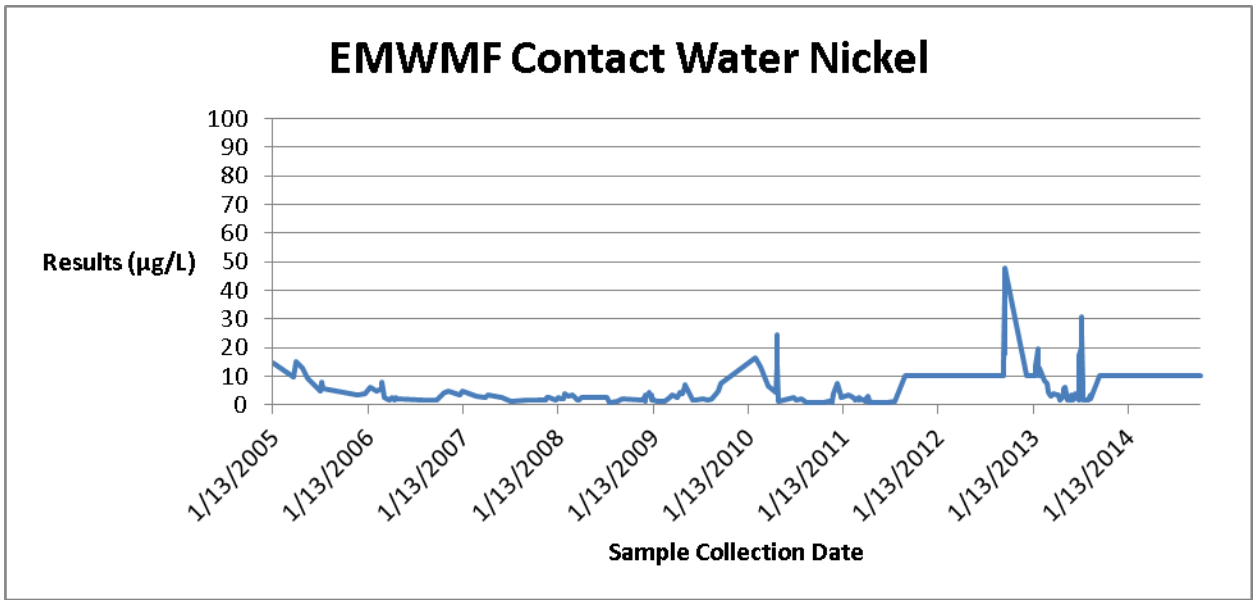


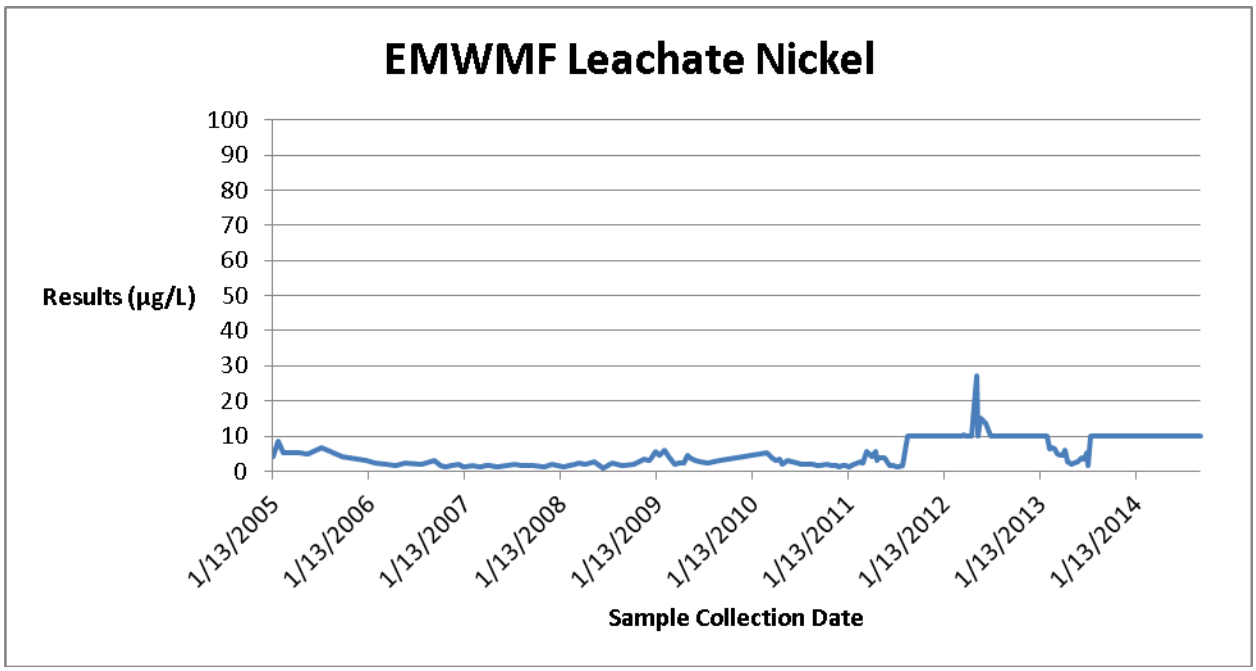


Nickel

Historically, about 70% of the results have been detects. Results are well below the CMC and CCC. The two highest results occurred in September 2012 and were well below the CCC, with the highest result (48 ug/L) on September 25, 2012.

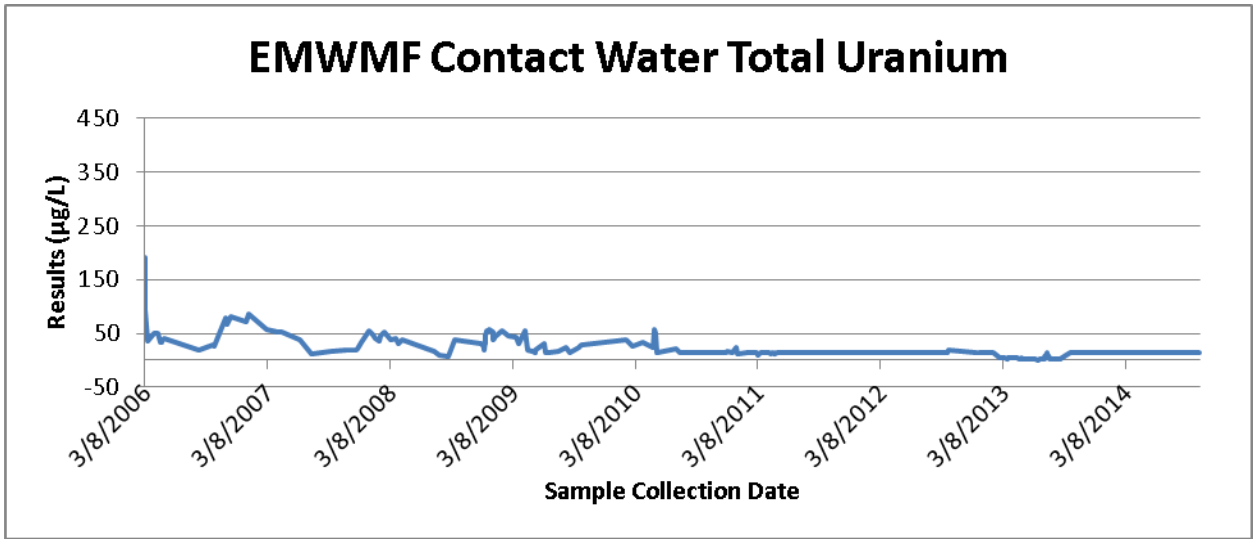
Recreational AWQC – 4,600 ug/L Hardness corrected CMC – 515 ug/L Hardness corrected CCC – 57 ug/L

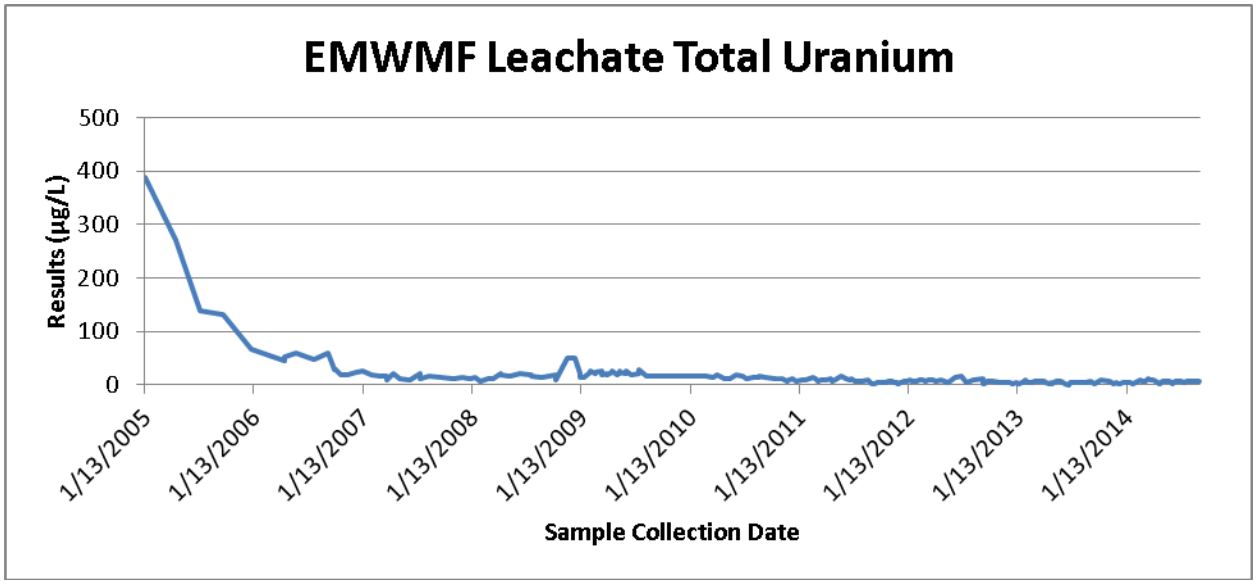




Uranium

AWQC are established for the uranium radionuclides present within EMWMF waste, but not for uranium as a metal. Total uranium is monitored in conjunction with the radionuclide analyses to show trends. There were higher levels of total uranium in the leachate early in the EMWMF history, followed by a declining trend with lower results since 2007. A similar trend can be inferred from the contact water data. However, there are no total uranium contact water results available from 2005 or earlier to evaluate.



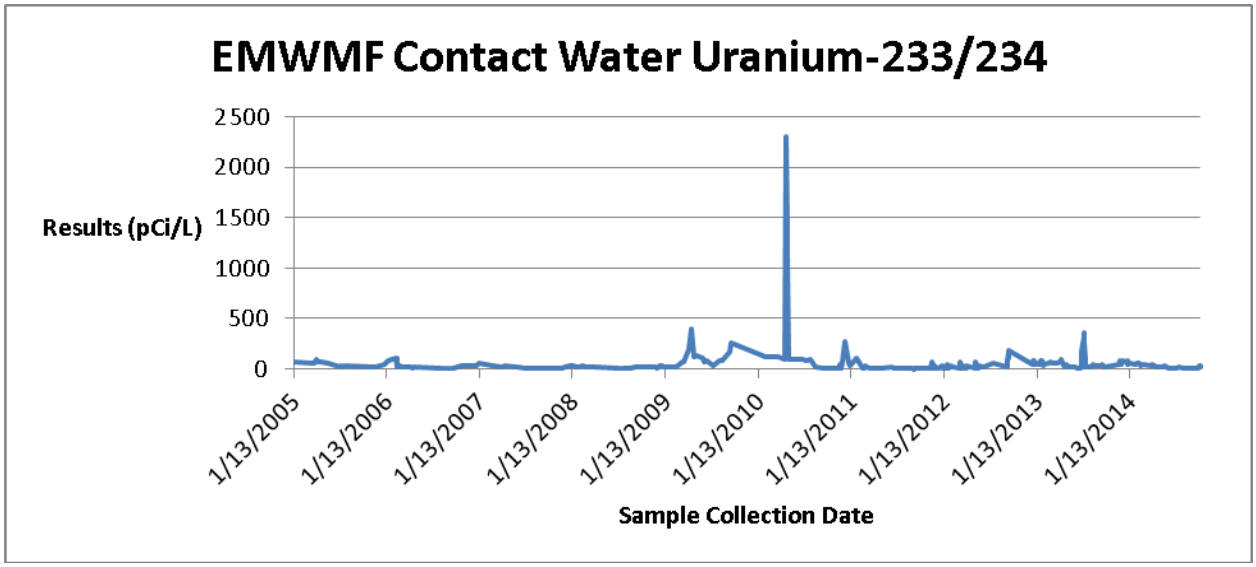


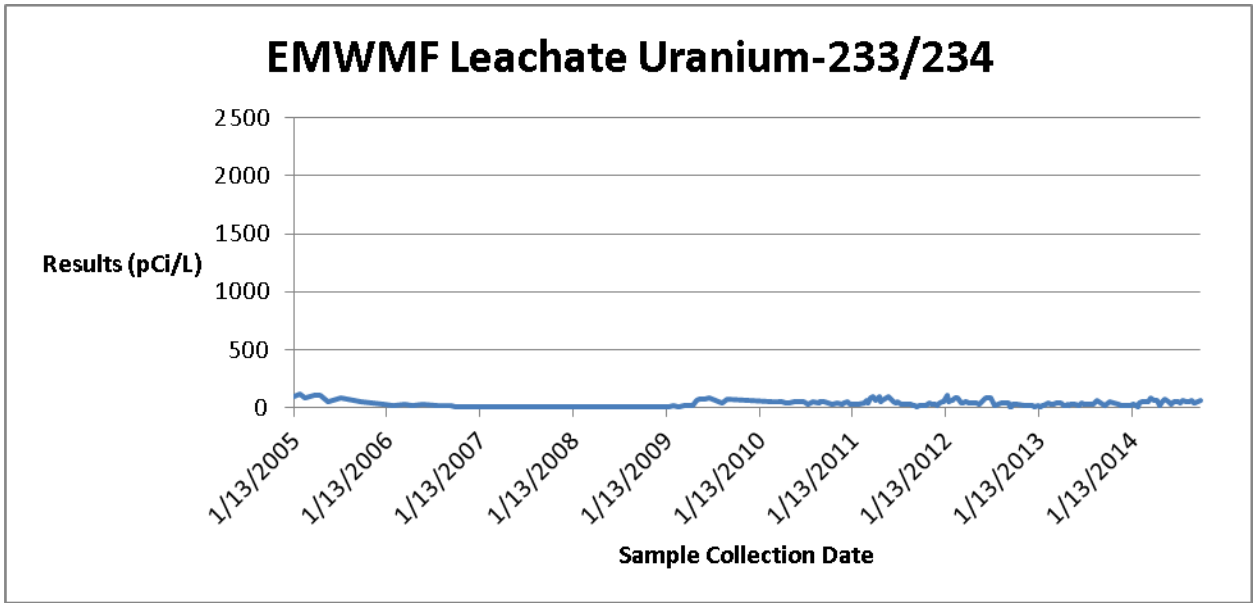
Uranium 233/234

There have been no recent results above the current criterion, but there were several results above this criterion in CWPs 1, 2, and 4 in May 2010. Leachate did not show a similar rise in activity at that time, and generally has lower results.

Current criterion – 480 pCi/L

The potential for uranium 233/234 treatment will be considered as a contingency in the future.

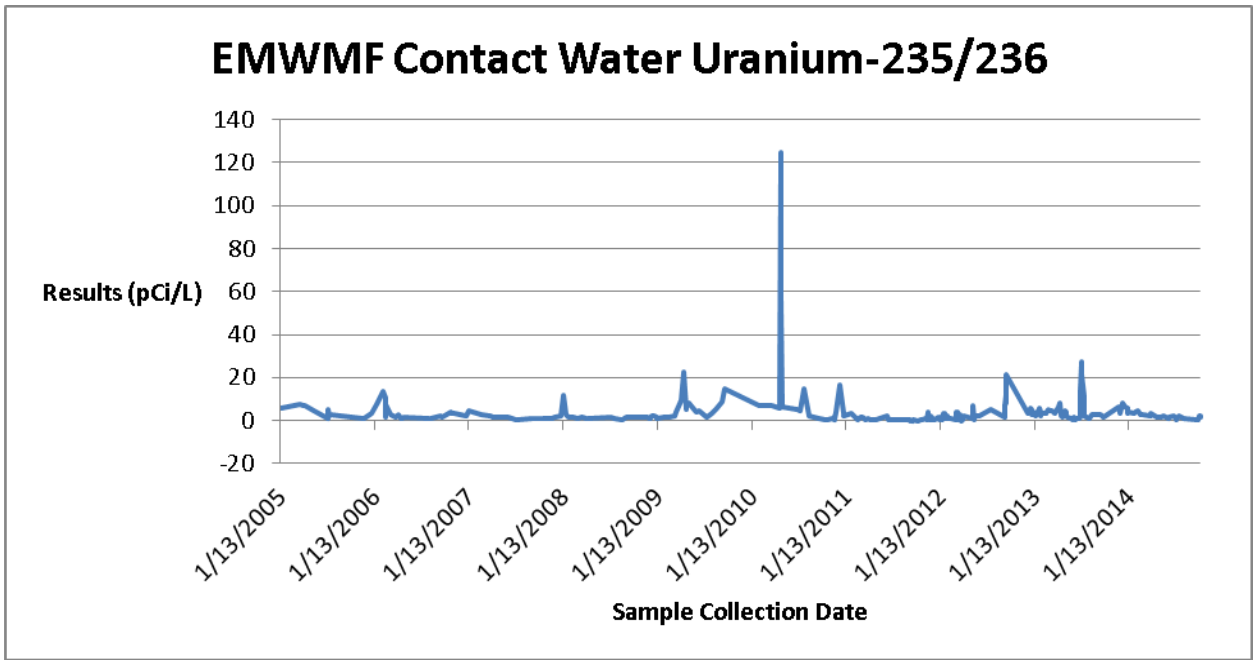


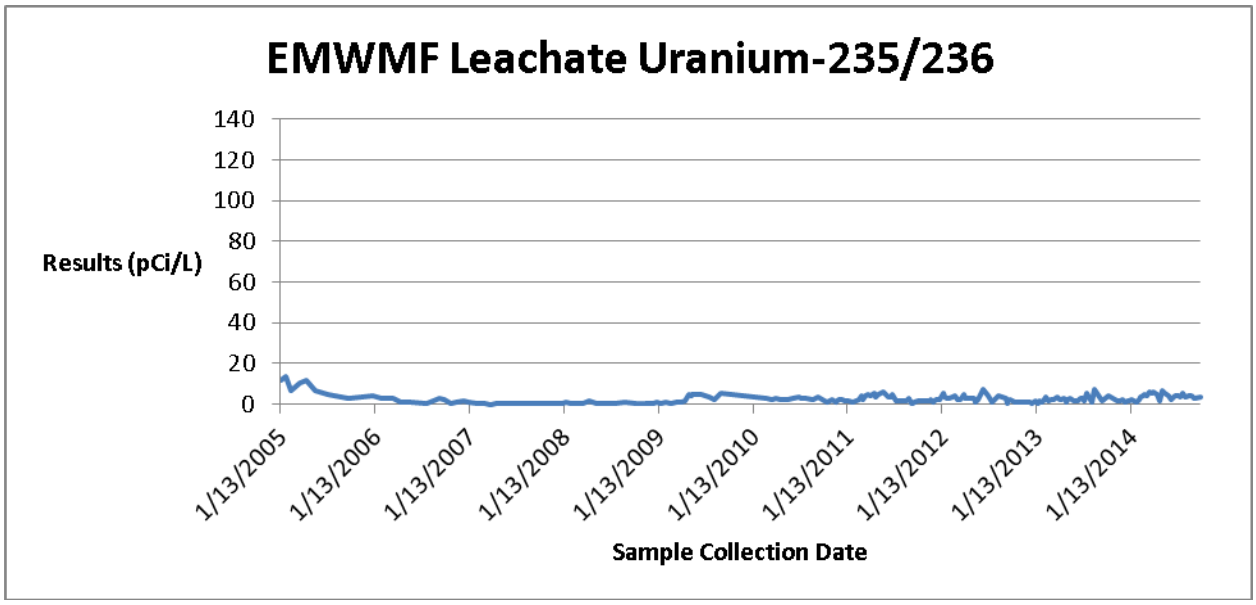


Uranium 235/236

There have been no results above that criterion. The highest result observed was in May 2010, concurrent with the elevated U-233/234 results. Leachate did not show a similar rise in activity at that time, and generally has lower, more consistent results.

Current criterion – 480 pCi/L

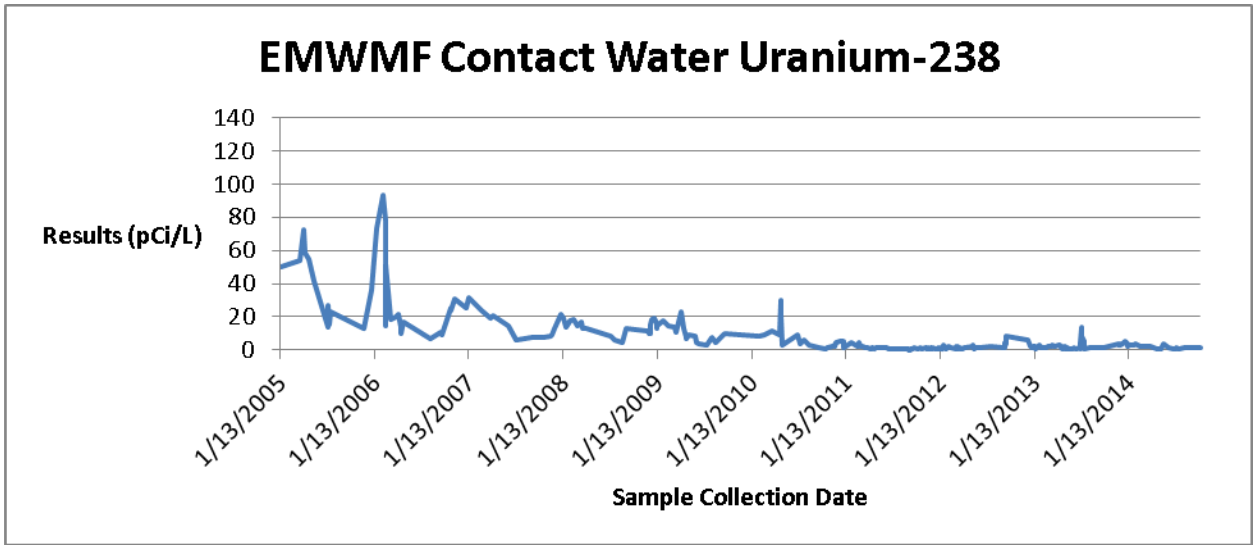


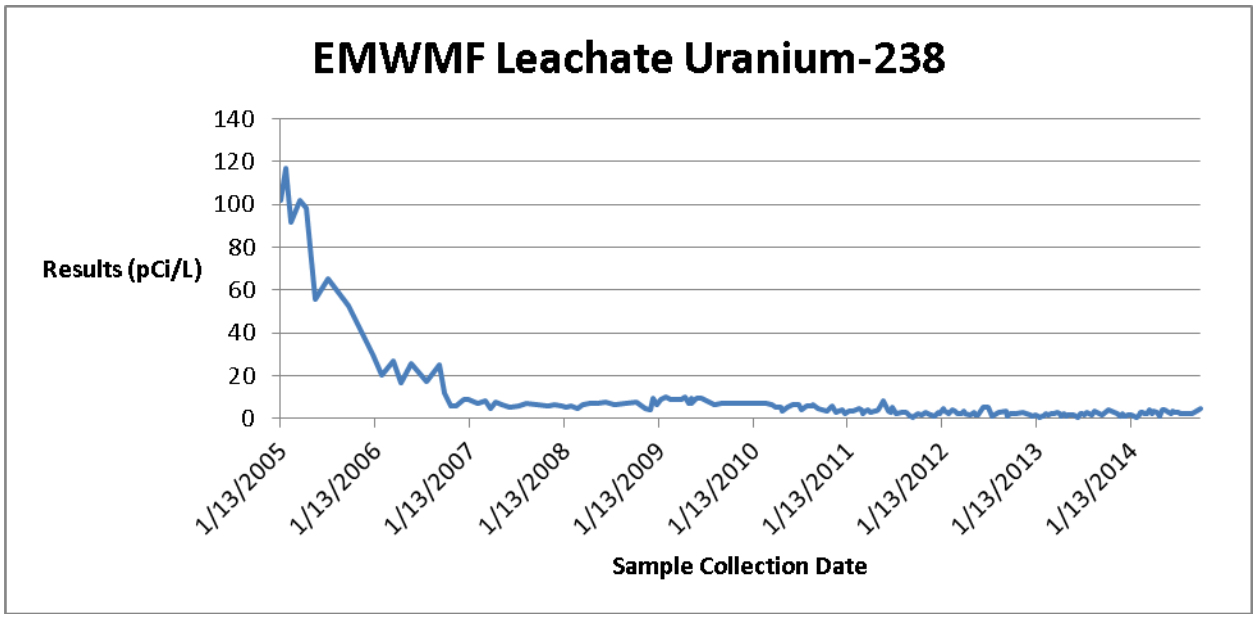


Uranium 238

There have been no results above that criterion in the last ten years. The highest result observed was in leachate in 2005 (117 pCi/L). Contact water showed elevated readings at that time, but not as consistently. The leachate and contact water trends for total uranium and U-238 are very similar, indicating U-238 is likely the basis of the total uranium results.

Current criterion – 576 pCi/L

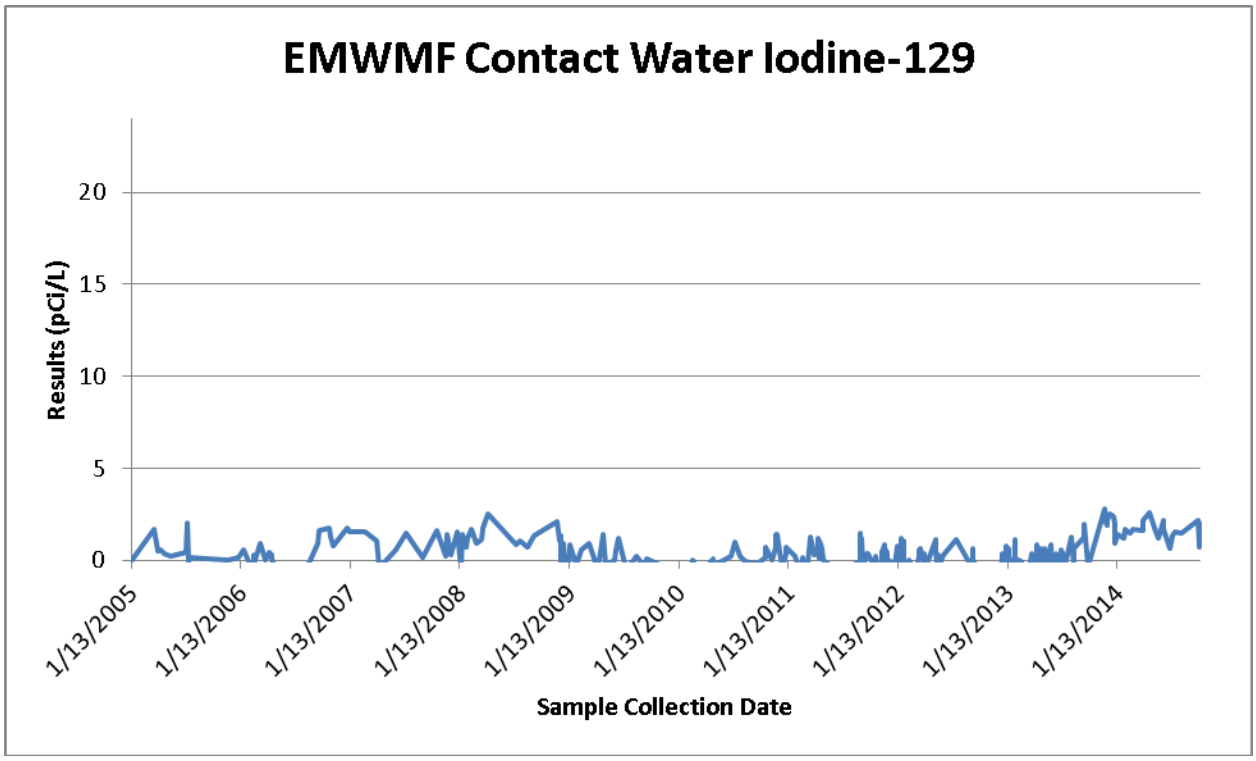


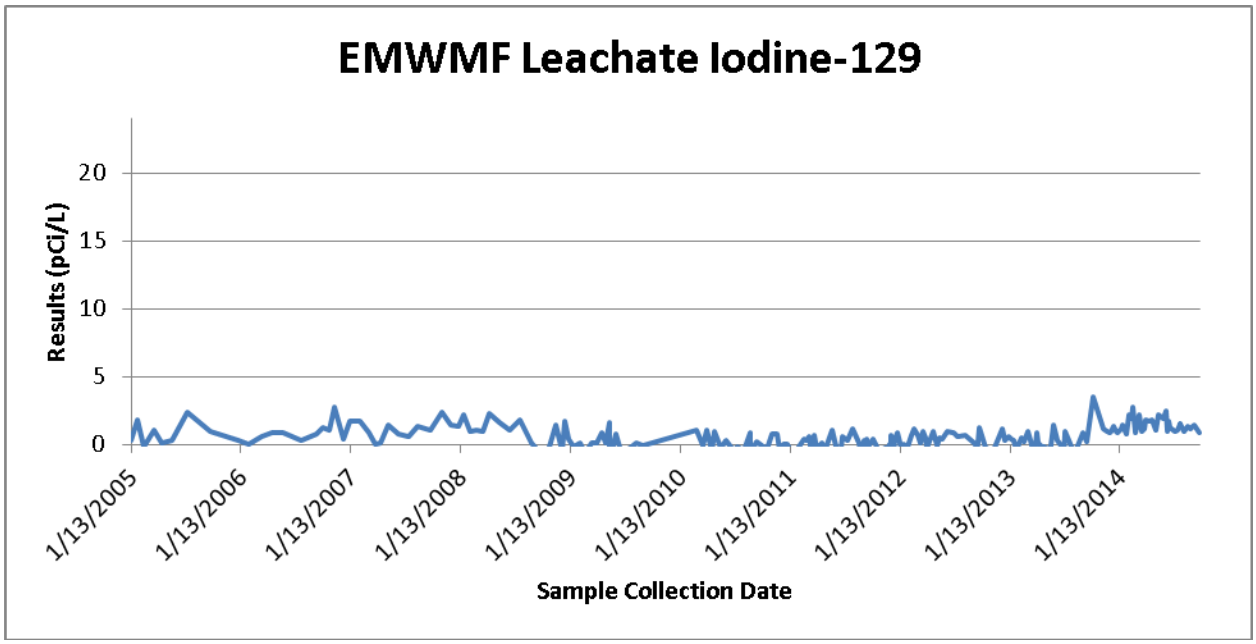


Iodine-129

Neither contact water nor leachate results have been above 5 pCi/L in the last ten years. The ranges in the graphs below were reduced to 1/20th of the current criterion (24 pCi/L) to show the variation in the results over time.

Current criterion – 480 pCi/L

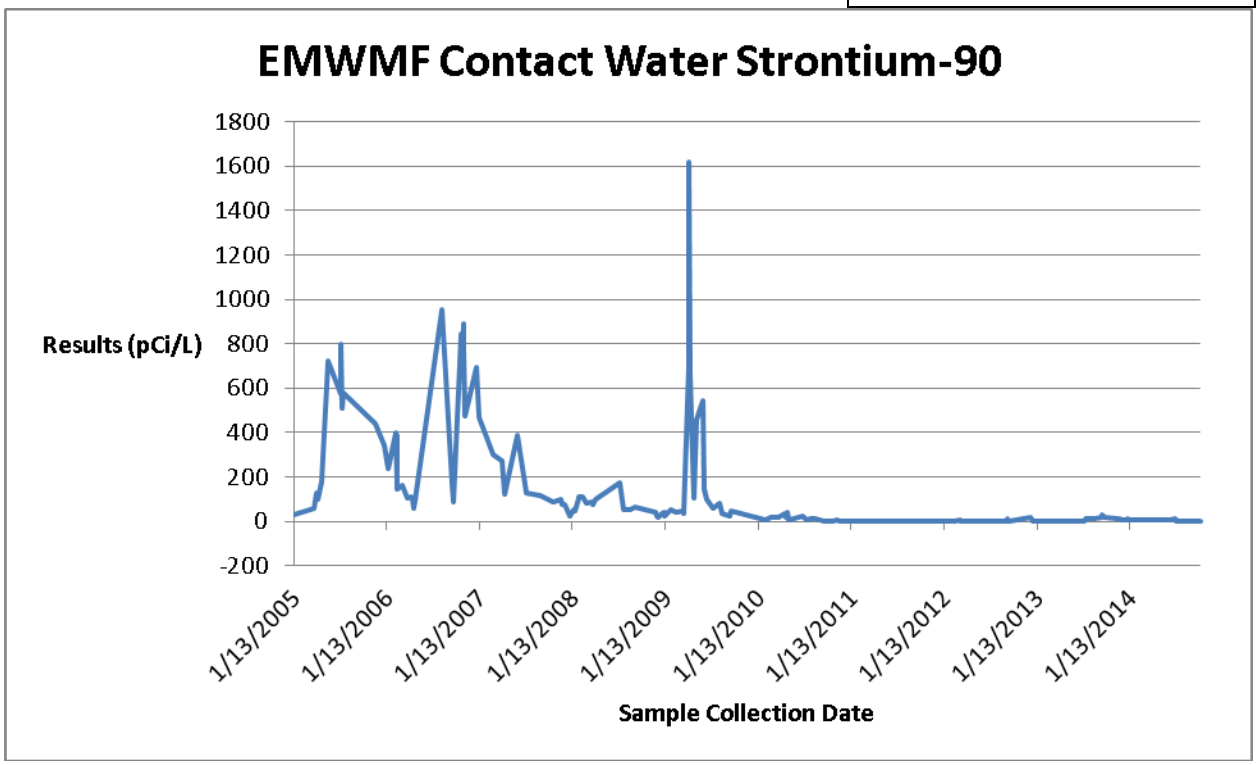


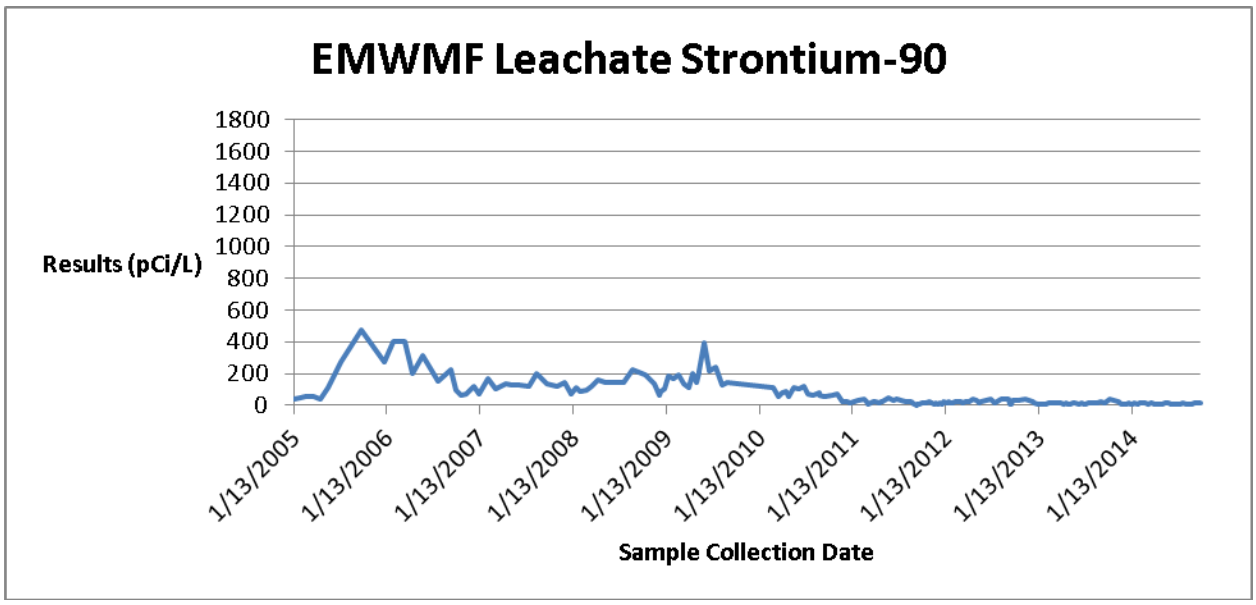


Strontium-90

Contact water results have approached this value in 2006 and 2007, and exceeded it in April 2009 (1620 pCi/L). Leachate showed a similar but muted trend, and has not approached the current criterion. Because of the higher activities in the past, the potential for Sr-90 treatment will be considered as a contingency in the future.

Current criterion – 960 pCi/L

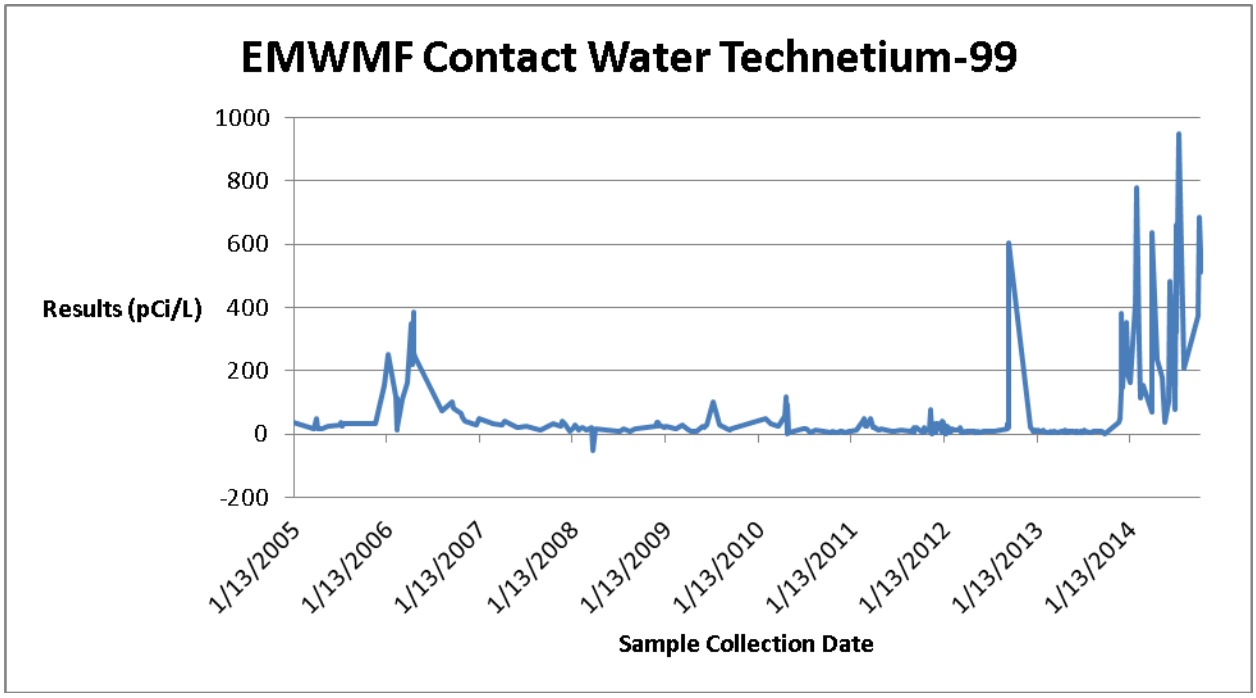


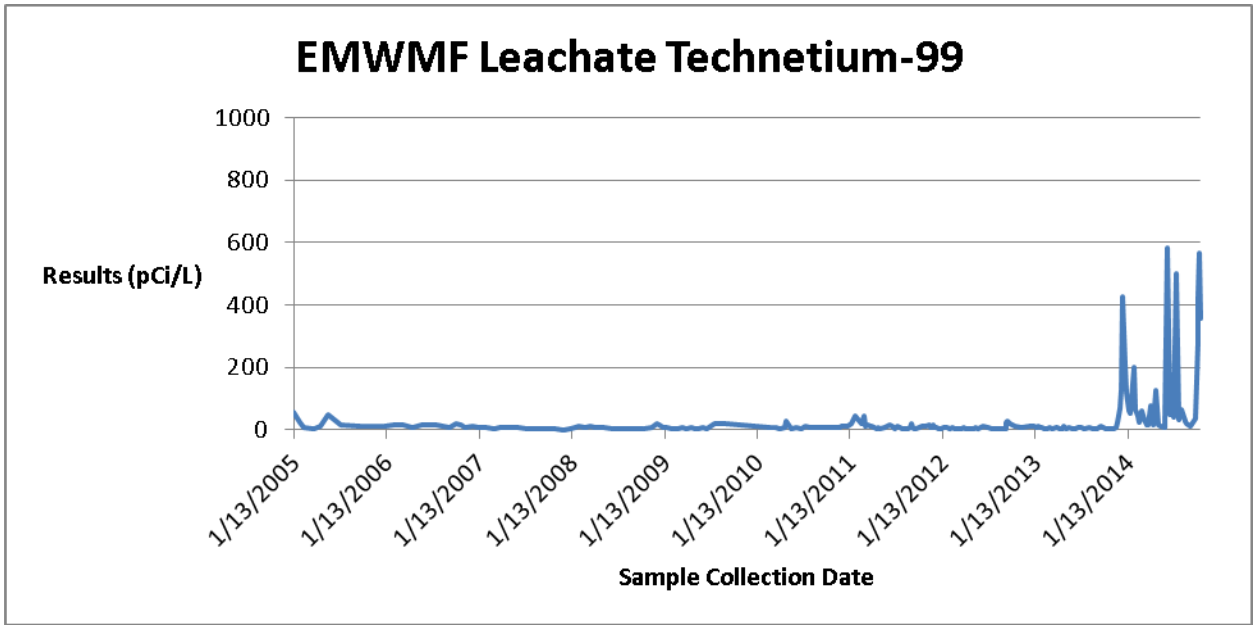


Technetium-99

Neither contact water nor leachate results are within an order of magnitude of this value within the last ten years. The results show the impact of the recent higher sum-of-fraction waste from K-25 on both the contact water and leachate. However, neither wastewater stream required treatment.

Current criterion – 96,000 pCi/L

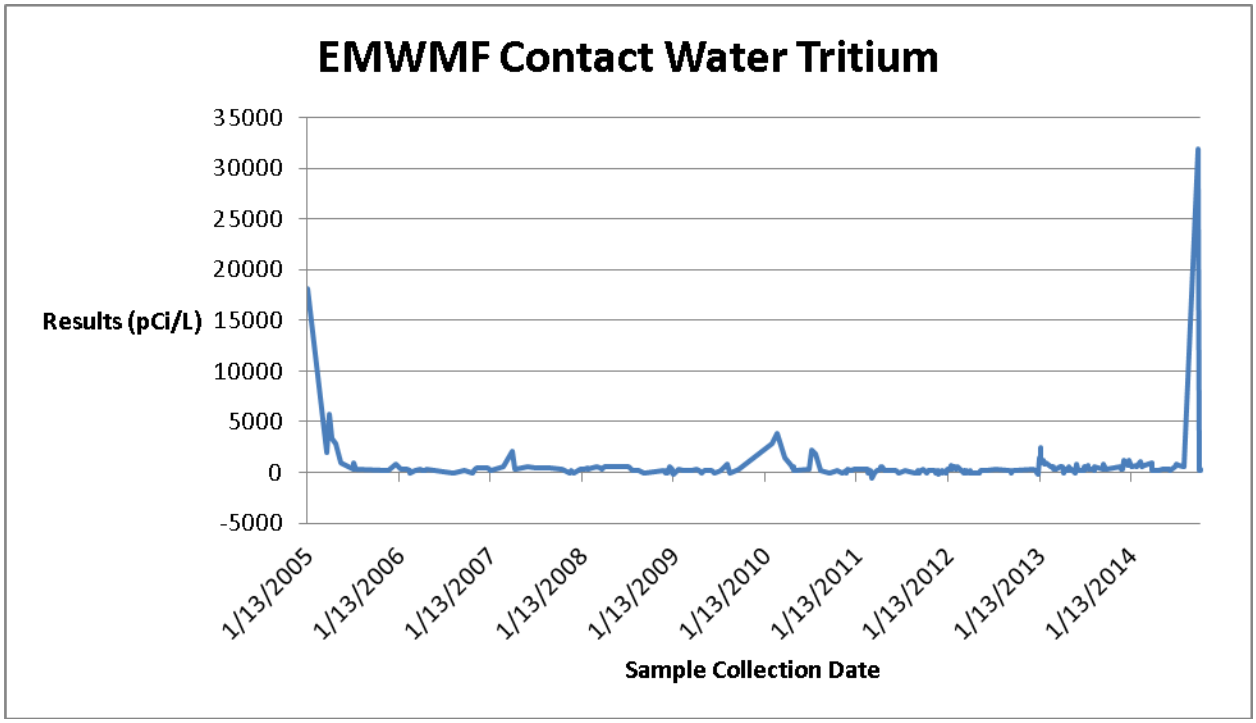


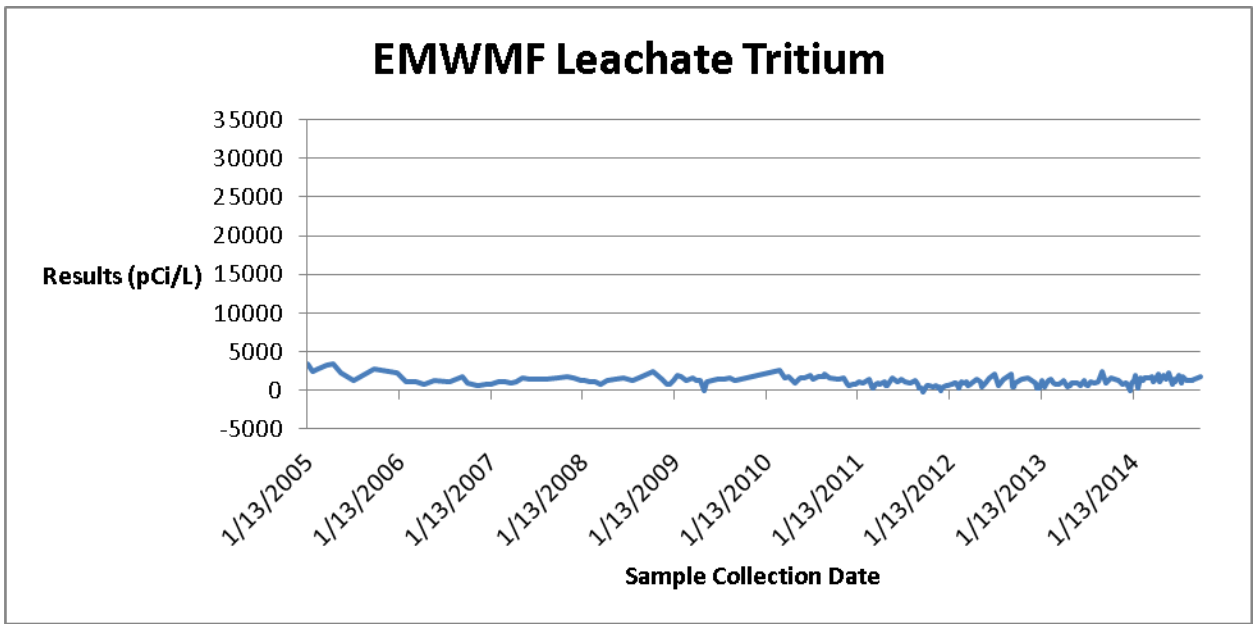


Tritium

Neither contact water nor leachate results have been close to this value over the last ten years. One result in October 2014 was approximately 32,000 pCi/L. However, this result is questionable because the results immediately before this result was below 1000 pCi/L and the result four days later was below 200 pCi/L. Because tritium behaves like water, a high spike in concentration, followed immediately by a decline, is unlikely.

Current criterion – 1,920,000 pCi/L





C.4.2 Pesticides

The proposed AWQC for EMWMF include the following pesticides:

- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Aldrin
- beta-BHC
- Dieldrin

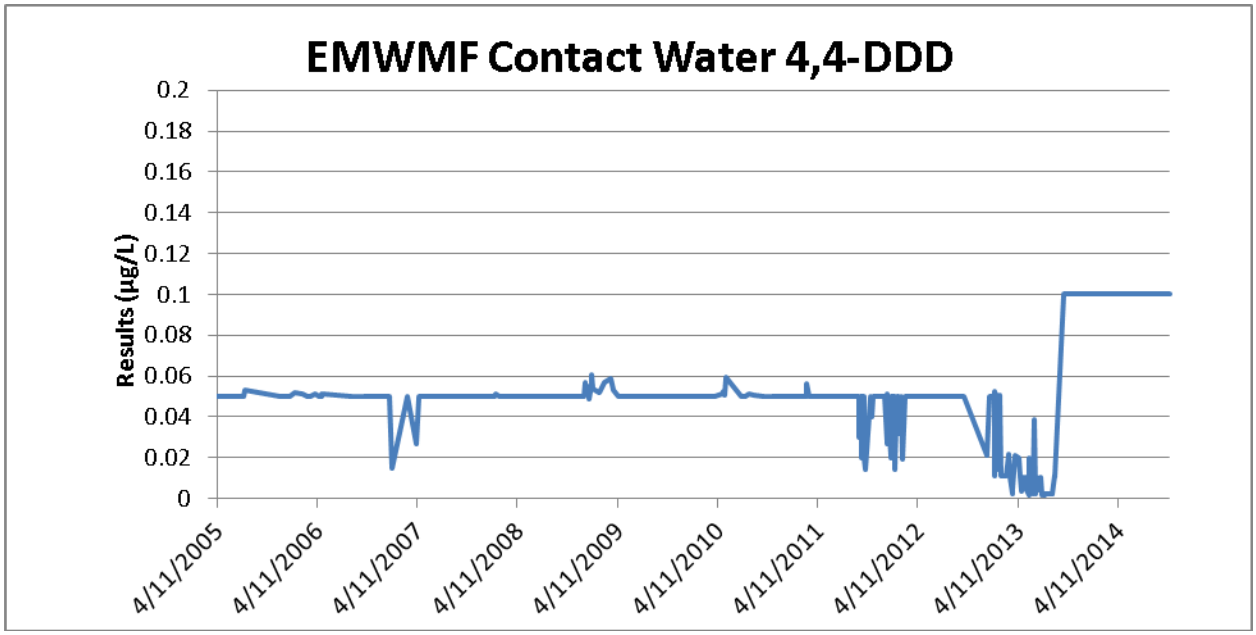
Significant quantities of these materials were not present in incoming waste lots disposed at EMWMF and were not identified as site-related contaminants. Instead, these materials are present as a result of intended use associated with the facilities that have been demolished and disposed at EMWMF, or as residual amounts in soil or debris from previous, remediated leaks or spills.

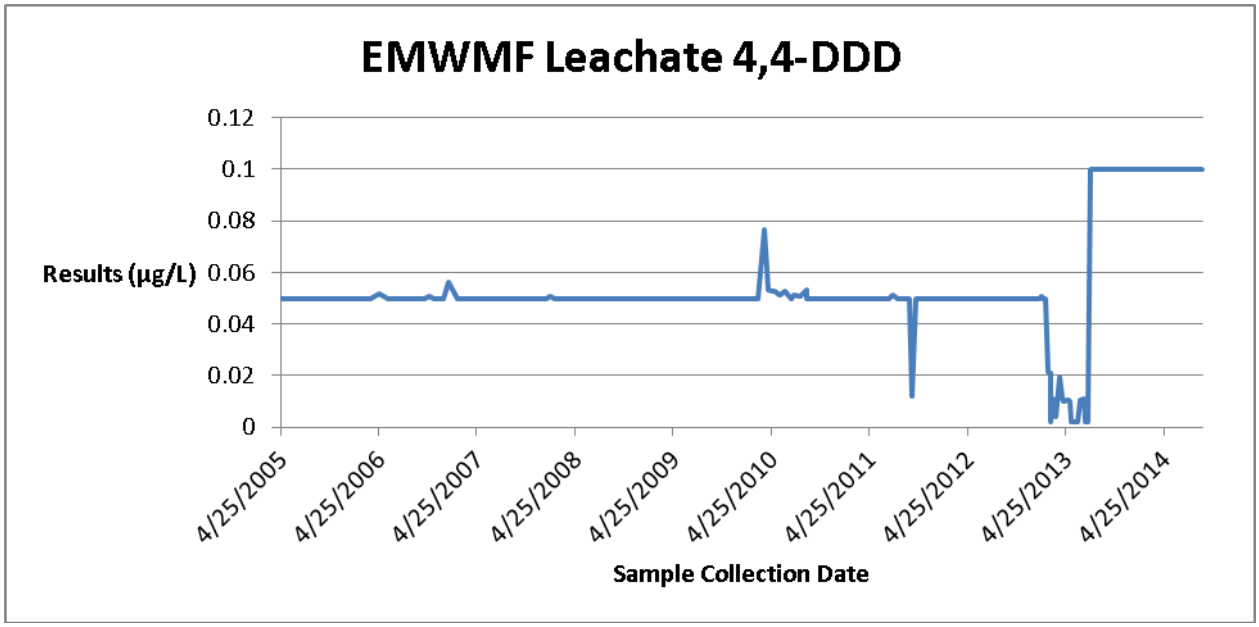
The contact water and leachate have been tested for these compounds for over 11 years at the detection limits, at or below the TDEC Rule 1200-04-03-.05-required method detection limits (RDLs). These results were lower than the applicable TDEC Fish and Aquatic Life discharge limits required for EMWMF. Almost all results have been non-detects. A few beta-BHC results were detected around April 2011 and the last quarter of calendar year 2011, but these were all below the RDL of 0.5 ug/l. A very small number of 4-4’-DDE results were above the RDL of 0.1 ug/l around the January 2013 time frame. Based on the presence of only residual amounts of these compounds in the waste, and that none of these were principle contaminants in the disposed waste, the required reporting limits are acceptable detection limits for these compounds.

4,4-DDD

Most of the variations in the graphs below are the result of changes in detection limits; however, there was one result greater than the AWQC and above the detection limit—0.051 ug/l on December 20, 2011. Samples were analyzed with lower detection limits, mostly lower than the AWQC, in late April through mid-August 2013. All results during this period were non-detects.

Recreational AWQC – 0.0031 ug/L CMC – n/a CMC – n/a RDL – 0.1 ug/L

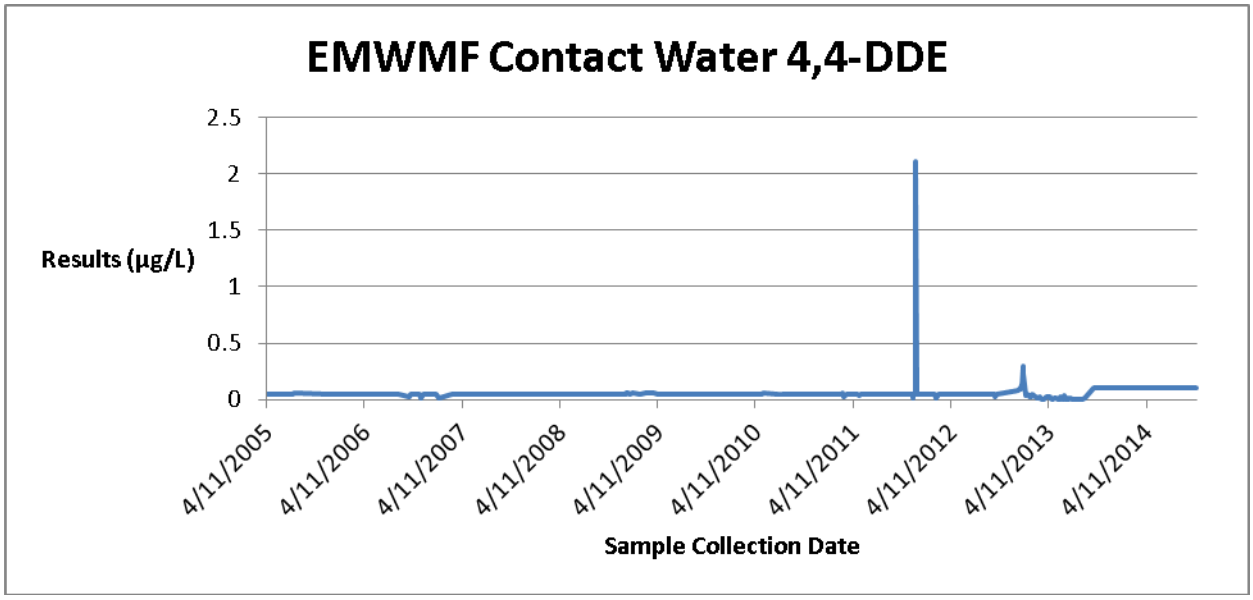


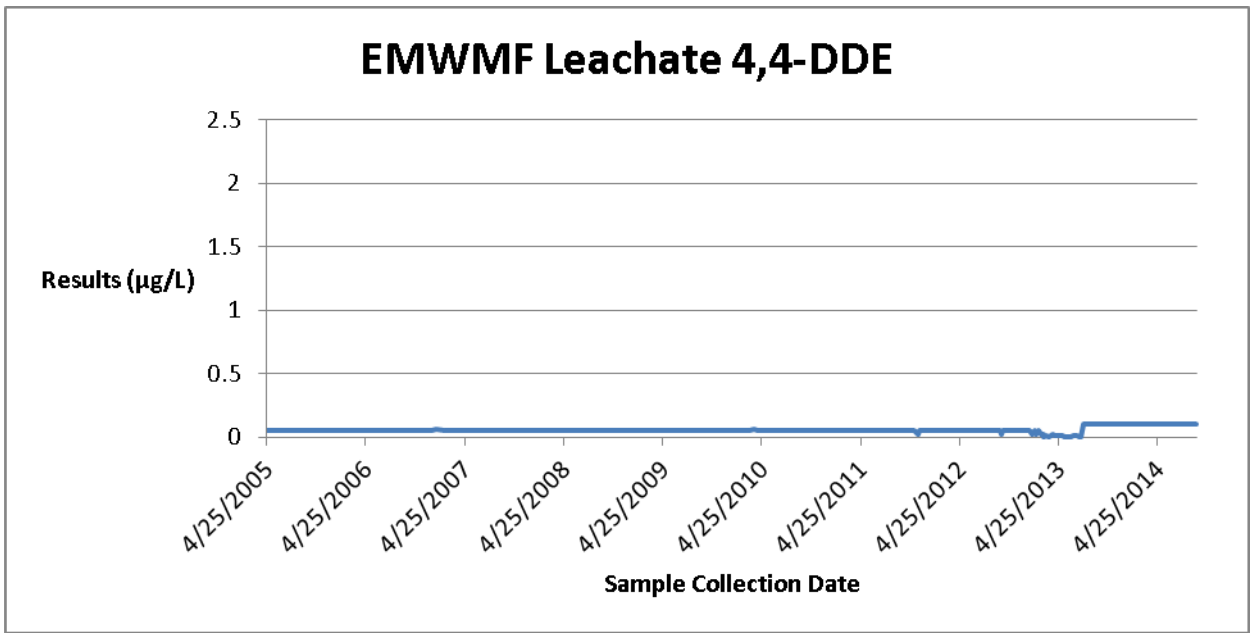


4,4-DDE

Most of the variations in the graphs below are the result of changes in detection limits; however, there was one result greater than the AWQC and above the detection limit—0.055 ug/l on March 2, 2011. Samples analyzed in December 2011 and January 2012 were mostly non-detects at the detection limit of 0.05. However, two samples had results of 2.11 and 1.96 ug/L. These results are suspect as these are orders of magnitude higher than the other, concurrent results. Samples were analyzed with lower detection limits, mostly lower than the AWQC, in late April through mid-August 2013. All results during this period were non-detects.

Recreational AWQC – 0.0022 ug/L
CMC – n/a
CMC – n/a
RDL – 0.1 ug/L

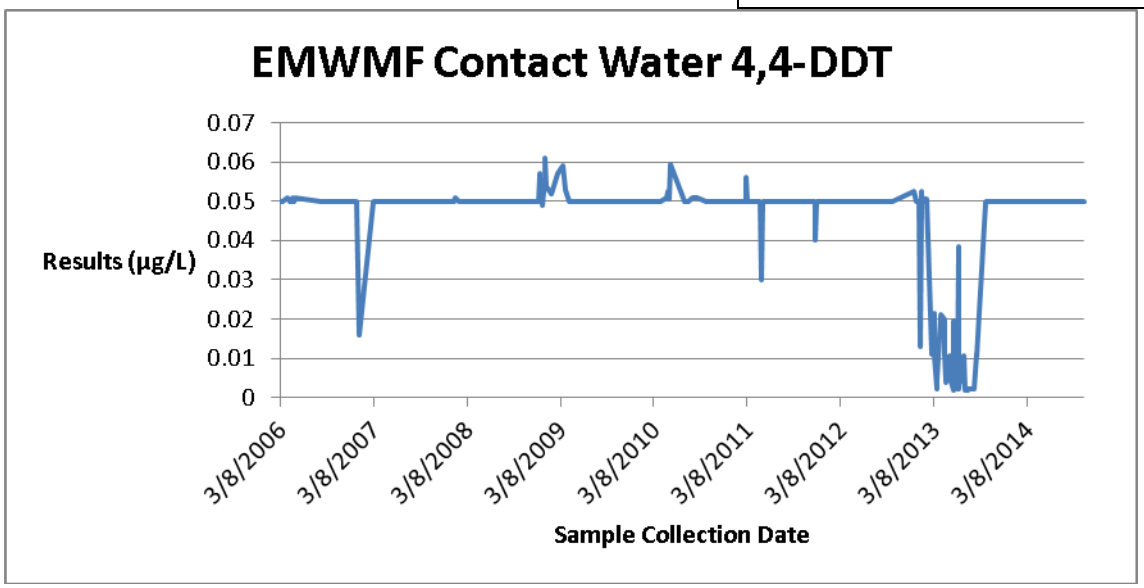


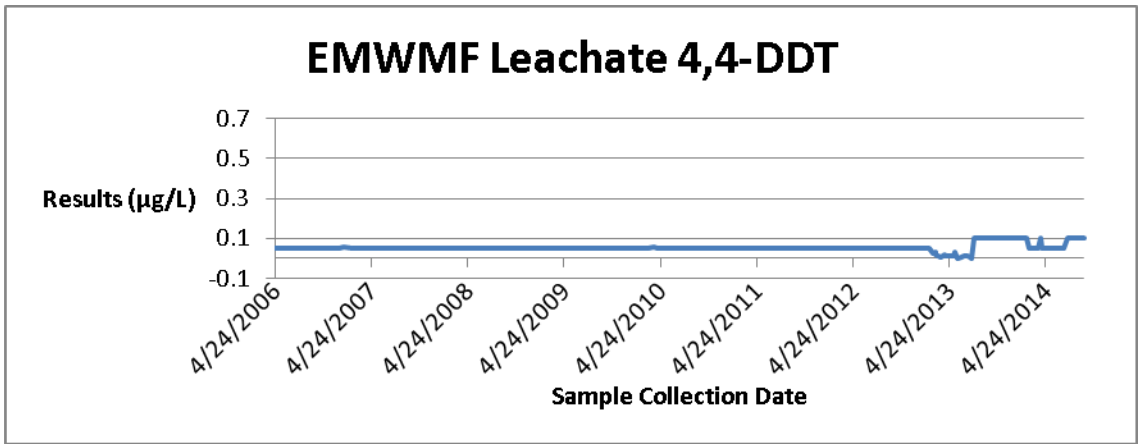


4,4-DDT

Most of the variations in the graphs below are the result of changes in detection limits, as only 2% of the results have been detected, although these have all been below the detection limit. However, from June 2014 on, the detection limit has been around 0.002 ug/L.

Recreational AWQC – 0.0022 ug/L
CMC – 1.1 ug/L
CMC – 0.001 ug/L
RDL – 0.1 ug/L

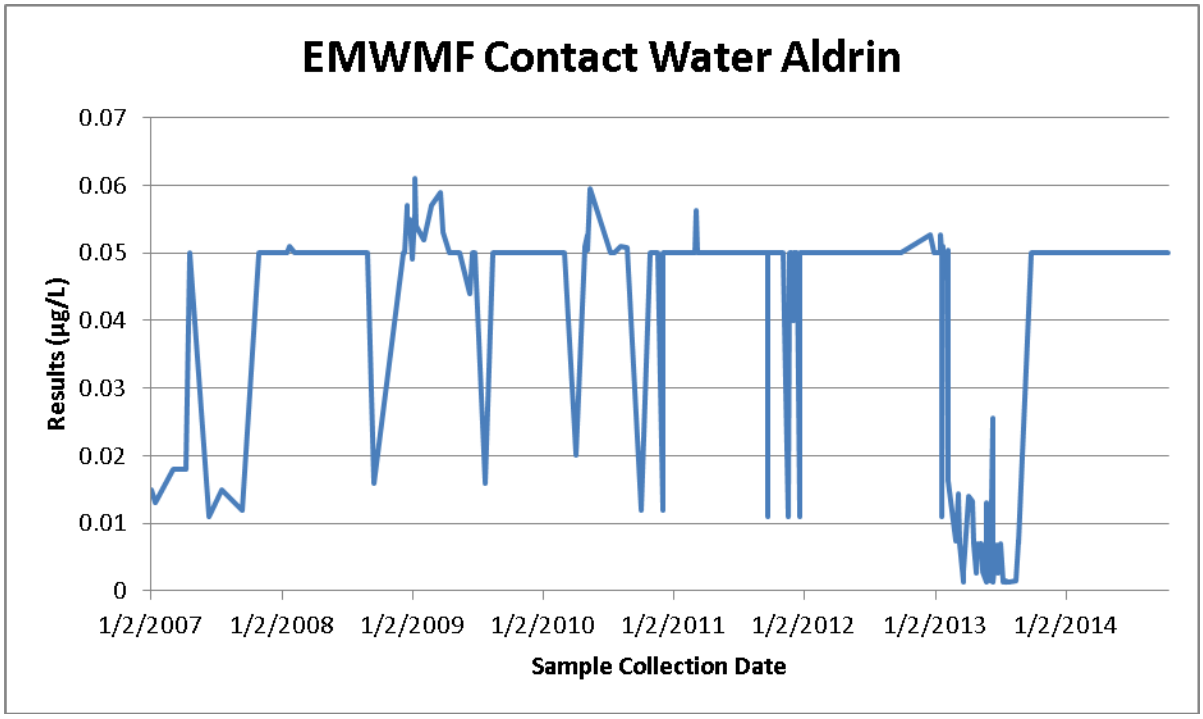


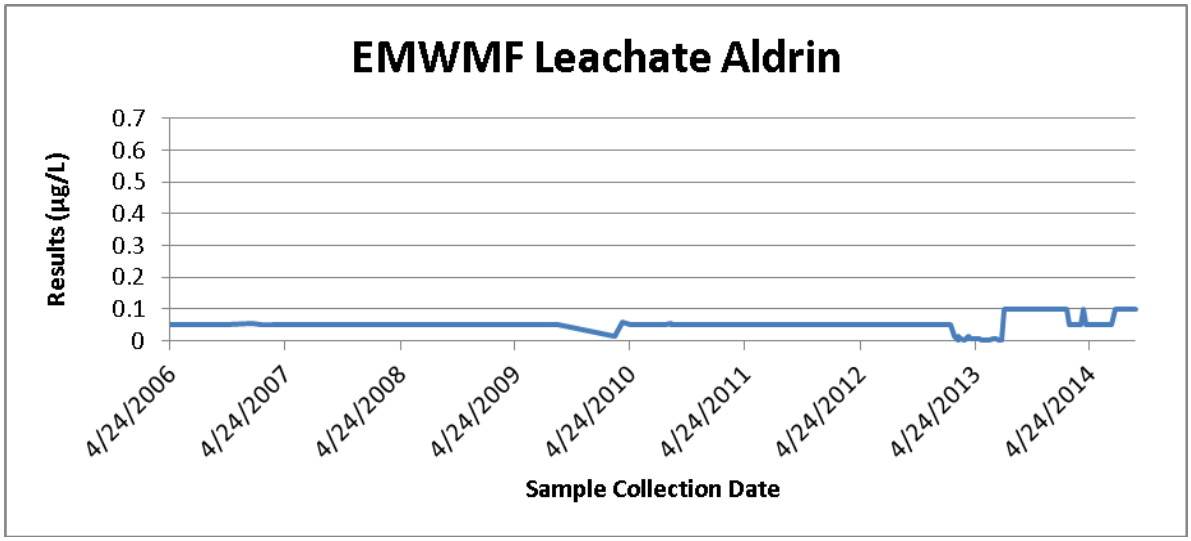


Aldrin

Most of the variations in the graphs below are the result of changes in detection limits, as only 2% of the results have been detected, although these have all been below the specified detection limit. However, from June 2014 on, the detection limit has been around 0.002 ug/L

Recreational AWQC – 0.0005 ug/L
CMC – 3 ug/L
CMC – 0.001 ug/L
RDL – 0.5 ug/L

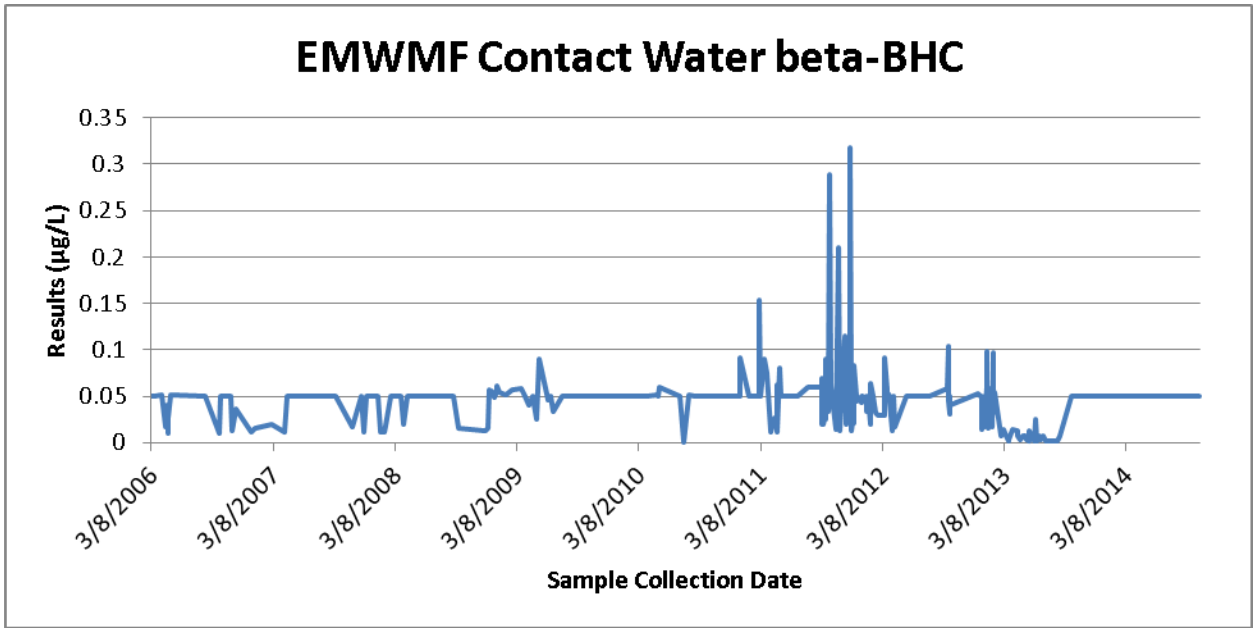


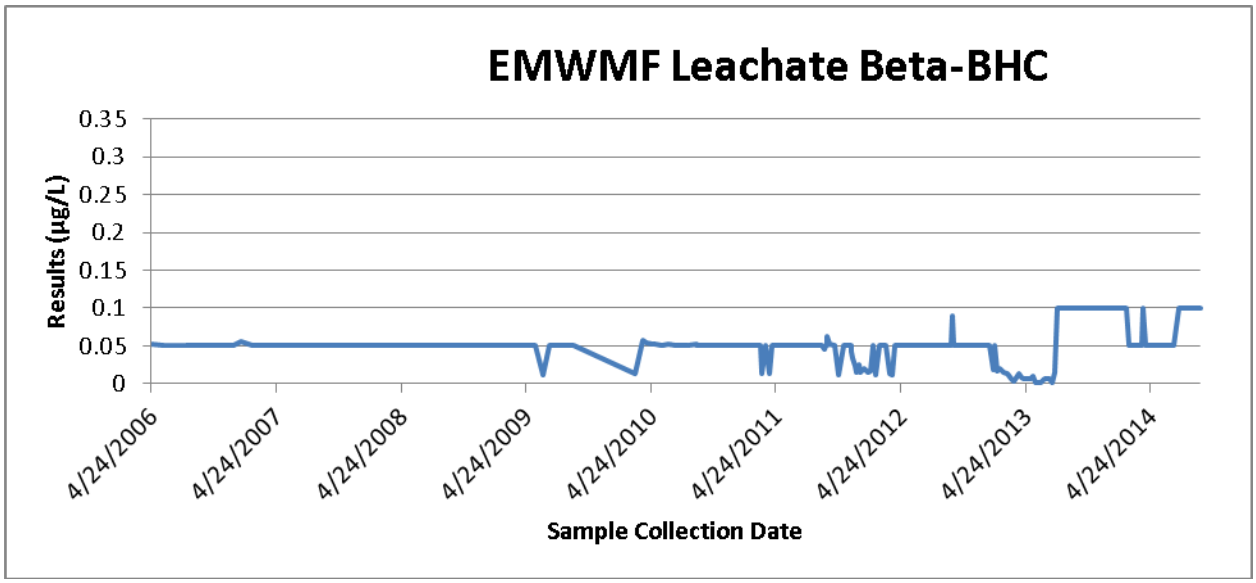


Beta BHC

There have been three instances in ten years, all within the same timeframe, when results were higher than the AWQC: September 29, 2011 (0.289 ug/L); October 26, 2011 (2.1 ug/L); and December 1, 2011 (0.318 ug/L). All other results are below the recreational AWQC and are mostly non-detects.

Recreational AWQC – 0.17 ug/L
CMC – n/a
CMC – n/a
RDL – 0.5 ug/L (gamma BHC)

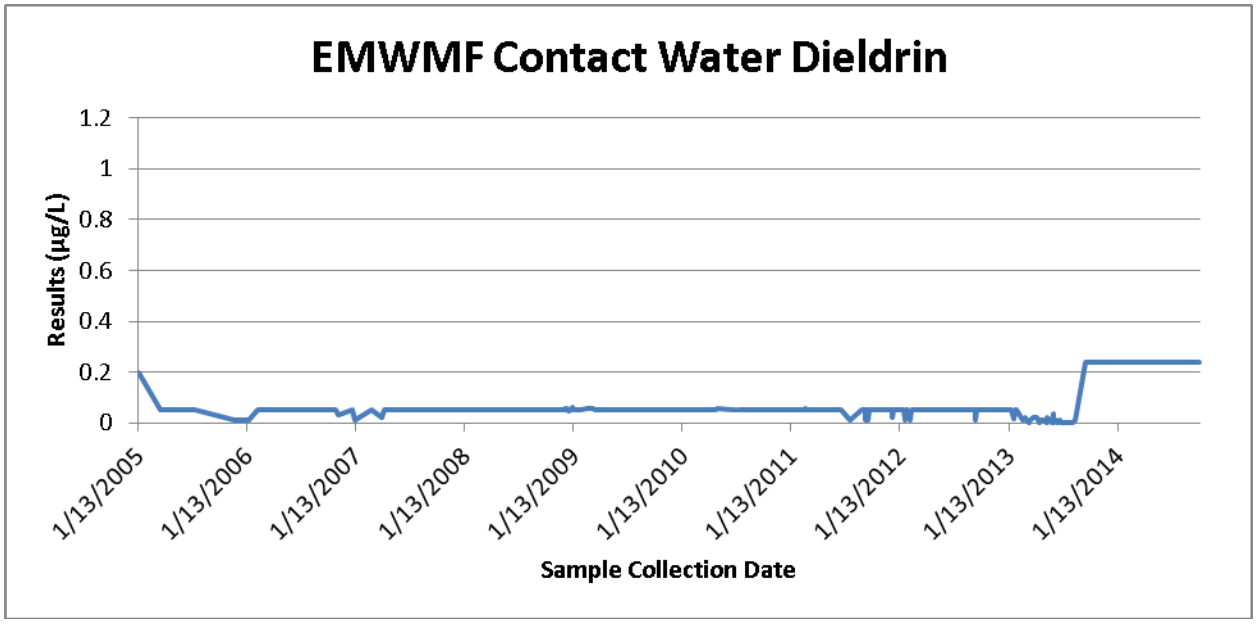


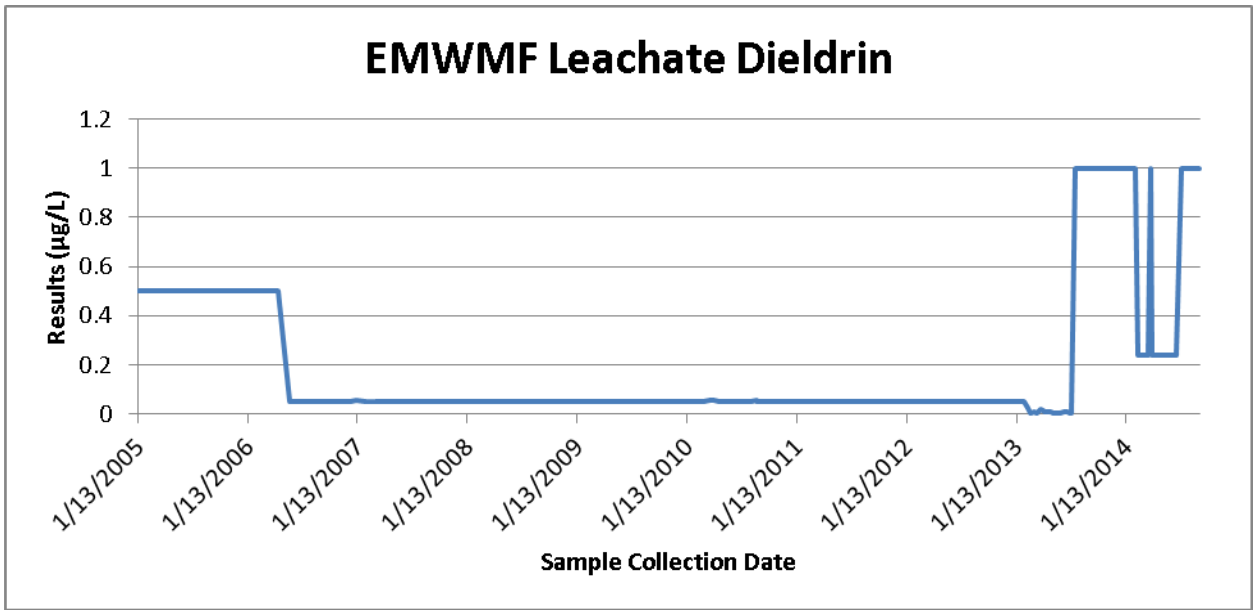


Dieldrin

The variation in the graphs below is the result of changes in detection limits, as only 2.5% of the results have been detected, all below the detection limit. The detection limit from May 2013 to mid-August 2013 was about 0.002 ug/L. All results during this period were non-detects.

Recreational AWQC – 0.00054 ug/L
CMC – 0.2 ug/L
CMC – 0.056 ug/L
RDL – 0.05 ug/L





C.5 SUMMARY

Based on the evaluation of the last two years of data, the COCs considered to require treatment for the FFS are mercury and cadmium if future operations rely on continuous release of wastewater to Bear Creek. Neither COC is currently expected to require treatment if there is batch release of waste water to Bear Creek.

Additional COCs that would have required treatment in the past under the FFS AWQC are:

- Copper
- Cyanide
- Lead
- U-238
- Sr-90

The potential that treatment may be required for these additional COCs will be considered during evaluation of the alternatives to determine if these could be effectively treated with minimal changes/upgrades.

Hexavalent chrome is anticipated to be reduced in the contact water ponds/tanks when this occurs.

As stated in Sect. C.4.2, pesticides are present in the waste because of their intended use at the facilities disposed at EMWMF. These are present in minor concentrations in the contact water and leachate. Therefore, the RDL will be used as the future detection limit. Concentrations are anticipated to be below these levels.

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APPENDIX C.
ATTACHMENT 1—CONTACT WATER DATA

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Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
HERB	2	2,4-D	2	0	0.0%	ug/L	.	.	0.5	-	-	-		-	-	-	-
HERB	2	Silvex	22	3	13.6%	ug/L	0.016	0.05	0.5	-	-	-		-	-	-	-
METAL	2	Aluminum	104	97	93.3%	ug/L	34.7	2490	50	-	-	-		-	-	-	-
METAL	2	Antimony	124	54	43.5%	ug/L	0.76	10.2	6	-	-	640		-	-	No	-
METAL	1	Arsenic	105	54	51.4%	ug/L	0.75	3.3	5	340	150	10		No	No	No	-
METAL	2	Barium	121	121	100.0%	ug/L	20.4	108	5	-	-	-		-	-	-	-
METAL	2	Beryllium	103	31	30.1%	ug/L	0.02	0.29	1	-	-	-		-	-	-	-
METAL	2	Boron	104	102	98.1%	ug/L	16.9	727	10	-	-	-		-	-	-	-
METAL	1	Cadmium	105	64	61.0%	ug/L	0.08	1	1	2.014	0.25	-		No	Yes	-	-
METAL	2	Calcium	104	104	100.0%	ug/L	18500	226000	250	-	-	-		-	-	-	-
METAL	1	Chromium	126	112	88.9%	ug/L	0.35	16.7	5	570	74	-		No	No	-	-
METAL	1	Chromium, hexavalent	202	93	46.0%	ug/L	6	112	6								
METAL	2	Cobalt	77	30	39.0%	ug/L	0.13	3.7	5	-	-	-		-	-	-	-
METAL	2	Copper	111	105	94.6%	ug/L	1.15	50.9	5	13	9	-		Yes	Yes	-	-
METAL	2	Hafnium	5	0	0.0%	ug/L			50	-	-	-		-	-	-	-
METAL	2	Iron	104	99	95.2%	ug/L	6.64	2490	50	-	-	-		-	-	-	-
METAL	1	Lead	121	61	50.4%	ug/L	0.64	6.2	3	64.581	2.5	-		No	Yes	-	-
METAL	2	Lithium	88	77	87.5%	ug/L	2.76	274	10	-	-	-		-	-	-	-
METAL	2	Magnesium	104	103	99.0%	ug/L	3760	33200	50	-	-	-		-	-	-	-
METAL	2	Manganese	104	101	97.1%	ug/L	0.734	736	5	-	-	-		-	-	-	-
METAL	1	Mercury	121	31	25.6%	ug/L	0.021	0.2	0.2	1.4	0.77	0.051		No	No	Yes	-
METAL	2	Molybdenum	78	77	98.7%	ug/L	1.5	24	5	-	-	-		-	-	-	-
METAL	1	Nickel	111	107	96.4%	ug/L	0.662	33.5	10	468.23	52	4600		No	No	No	-
METAL	2	Phosphorous	37	37	100.0%	ug/L	11	658	20	-	-	-		-	-	-	-
METAL	2	Potassium	104	103	99.0%	ug/L	938	7120	500	-	-	-		-	-	-	-
METAL	1	Selenium	270	56	20.7%	ug/L	0.24	8.1	5	20	5	-		No	Yes	-	-
METAL	1	Silver	105	4	3.8%	ug/L	0.22	0.47	1	3.217	-	-		No	-	-	-
METAL	2	Sodium	104	98	94.2%	ug/L	2890	31100	250	-	-	-		-	-	-	-
METAL	2	Strontium	119	118	99.2%	ug/L	40	625	50	-	-	-		-	-	-	-
METAL	1	Thallium	103	4	3.9%	ug/L	0.56	4.2	3	-	-	0.47		-	-	Yes	-
METAL	2	Tin	119	6	5.0%	ug/L	0.312	6.1	50	-	-	-		-	-	-	-
METAL	2	Titanium	67	60	89.6%	ug/L	0.19	19	5	-	-	-		-	-	-	-
METAL	1	Uranium	78	65	83.3%	ug/L	11.2	877	15	-	-	-		-	-	-	-
METAL	2	Vanadium	119	76	63.9%	ug/L	0.18	9.97	20	-	-	-		-	-	-	-
METAL	1	Zinc	112	102	91.1%	ug/L	2.7	187	10	117.18	120	-		Yes	Yes	No	-
METAL	2	Zirconium	10	9	90.0%	ug/L	0.736	2.77	50	-	-	-		-	-	-	-
Other	2	Asbestos	173	0	0.0%	fibers/L	.	.	200,000					-	-	-	-
Other	2	Chloride	2	2	100.0%	mg/L	15.1	17.4	0.1	-	-	-		-	-	-	-
Other	1	Cyanide	211	13	6.2%	ug/L	1.84	14.9	5	22	5.2	140		No	Yes	No	-
Other	2	Fluoride	2	2	100.0%	mg/L	0.5	0.59	0.05	-	-	-		-	-	-	-
Other	2	Nitrate	1	0	0.0%	mg/L	.	.	0.1	-	-	-		-	-	-	-

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Other	2	Suspended Solids	13	13	100.0%	mg/L	3.6	33.4	2.5	-	-	-		-	-	-	-
Other	2	Total Organic Carbon (TOC)	1	1	100.0%	mg/L	5.3	5.3	1	-	-	-		-	-	-	-
PPCB	1	4,4'-DDD	236	23	9.7%	ug/L	0.011	0.051	0.1	-	-	0.0031		-	-	Yes	-
PPCB	1	4,4'-DDE	236	25	10.6%	ug/L	0.01	0.293	0.1	-	-	0.0022		-	-	Yes	-
PPCB	1	4,4'-DDT	226	5	2.2%	ug/L	0.013	0.05	0.05	1.1	0.001	0.0022		No	Yes	Yes	-
PPCB	1	Aldrin	211	20	9.5%	ug/L	0.011	0.044	0.05	3	-	0.0005		No	-	Yes	-
PPCB	1	alpha-BHC	216	2	0.9%	ug/L	0.011	0.02	0.05	-	-	0.049		-	-	No	-
PPCB	2	alpha-Chlordane	238	3	1.3%	ug/L	0.01	0.023	0.05	-	-	-		-	-	-	-
PPCB	1	beta-BHC	226	97	42.9%	ug/L	0.001	0.289	0.05	-	-	0.17		-	-	Yes	-
PPCB	2	Chlordane	183	0	0.0%	ug/L	.	.	0.1	2.4	0.0043	0.0081		-	-	-	-
PPCB	2	delta-BHC	216	4	1.9%	ug/L	0.013	0.0372	0.05	-	-	-		-	-	-	-
PPCB	2	Dieldrin	273	15	5.5%	ug/L	0.001	0.03	0.24	0.24	0.056	0.00054		No	No	Yes	-
PPCB	1	Endosulfan I	211	12	5.7%	ug/L	0.011	0.026	0.05	0.22	0.056	89		No	No	No	-
PPCB	1	Endosulfan II	226	6	2.7%	ug/L	0.011	0.028	0.05	0.22	0.056	89		No	No	No	-
PPCB	1	Endosulfan sulfate	216	5	2.3%	ug/L	0.01	0.031	0.05	-	-	89		-	-	No	-
PPCB	1	Endrin	228	3	1.3%	ug/L	0.015	0.027	0.05	0.086	0.036	0.06		No	No	No	-
PPCB	1	Endrin aldehyde	236	1	0.4%	ug/L	0.012	0.012	0.05	-	-	0.3		-	-	No	-
PPCB	2	Endrin ketone	184	0	0.0%	ug/L	.	.	0.05	-	-	-		-	-	-	-
PPCB	2	gamma-Chlordane	238	11	4.6%	ug/L	0.011	0.045	0.05	-	-	-		-	-	-	-
PPCB	1	Heptachlor	186	7	3.8%	ug/L	0.011	0.015	0.05	0.52	0.0038	0.00079		No	Yes	Yes	-
PPCB	1	Heptachlor epoxide	228	8	3.5%	ug/L	0.011	0.0241	0.05	0.52	0.0038	0.00039		No	Yes	Yes	-
PPCB	1	Lindane	28	0	0.0%	ug/L	.	.	0.05	0.95	-	1.8		-	-	-	-
PPCB	2	Methoxychlor	212	21	9.9%	ug/L	0.011	0.05	0.05	-	-	-		No	-	No	-
PPCB	1	PCB-1016	269	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1221	258	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1232	258	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1242	269	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1248	258	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1254	269	22	8.2%	ug/L	0.0434	0.34	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1260	269	6	2.2%	ug/L	0.0151	0.14	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1262	224	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1268	226	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	Polychlorinated biphenyl	12	0	0.0%	ug/L	.	.	0.5	-	0.014	0.00064		-	-	-	-
PPCB		Toxaphene	2	0	0.0%	ug/L	.	.	5								
RAD	2	Actinium-227	107	7	6.5%	pCi/L	0.18	0.62	1.5				9.6	-	-	-	No
RAD	2	Alpha activity	62	60	96.8%	pCi/L	11.7	3,160					.	-	-	-	-
RAD	2	Aluminum-26	31	0	0.0%	pCi/L	.	.	10				9,600	-	-	-	-
RAD	1	Americium-241	273	17	6.2%	pCi/L	0.18	1.23	1				28.8	-	-	-	No
RAD	2	Americium-243	71	13	18.3%	pCi/L	0.19	0.5	1				28.8	-	-	-	No
RAD	1	Beta activity	62	59	95.2%	pCi/L	11.1	2,160	5				.	-	-	-	-
RAD		Californium-252	58	0	0.0%	pCi/L	-	-	10				96	-	-	-	-

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RAD	1	Carbon-14	274	28	10.2%	pCi/L	12.43	103.37	50				67,200				No
RAD	1	Cesium-137	272	13	4.8%	pCi/L	2.85	11.47	10				2,880	-	-	-	No
RAD	1	Chlorine-36	263	69	26.2%	pCi/L	2.03	302.36	50				48,000	-	-	-	No
RAD	1	Cobalt-60	239	1	0.4%	pCi/L	11.8	11.8	10				4,800	-	-	-	No
RAD	2	Curium-242	76	0	0.0%	pCi/L	.	.	10				960	-	-	-	-
RAD	2	Curium-243/244	76	3	3.9%	pCi/L	0.47	1.43	1				48	-	-	-	No
RAD	1	Curium-245	230	36	15.7%	pCi/L	0.18	0.83	1				28.8	-	-	-	No
RAD	1	Curium-246	230	36	15.7%	pCi/L	0.18	0.83	1				28.8	-	-	-	No
RAD	1	Curium-247	230	5	2.2%	pCi/L	0.23	0.94	1				28.8	-	-	-	No
RAD	2	Curium-248	104	12	11.5%	pCi/L	0.16	1.48	2				7.68	-	-	-	No
RAD	2	Europium-152	238	1	0.4%	pCi/L	26	26	10				19,200	-	-	-	No
RAD	2	Europium-154	238	0	0.0%	pCi/L	.	.	10				19,200	-	-	-	-
RAD	2	Europium-155	79	2	2.5%	pCi/L	3.9	6.21	10				96,000	-	-	-	No
RAD	1	Iodine-129	275	13	4.7%	pCi/L	0.65	5.15	5				480	-	-	-	No
RAD	2	Lead-210	185	17	9.2%	pCi/L	0.67	2.91	1				28.8	-	-	-	No
RAD	2	Neptunium-237	273	27	9.9%	pCi/L	0.12	4.2	1				28.8	-	-	-	No
RAD	2	Nickel-63	220	6	2.7%	pCi/L	24.8	78.7	7200				288,000	-	-	-	No
RAD	2	Plutonium-236	71	0	0.0%	pCi/L	.	.	1				96	-	-	-	-
RAD	2	Plutonium-238	242	5	2.1%	pCi/L	0.17	5.35	1				38.4	-	-	-	No
RAD	1	Plutonium-239/240	273	13	4.8%	pCi/L	0.13	3.84	1				28.8	-	-	-	No
RAD	2	Plutonium-241	222	1	0.5%	pCi/L	30	30	48				1,920	-	-	-	No
RAD	1	Plutonium-242	230	53	23.0%	pCi/L	0.09	1.58	1				28.8	-	-	-	No
RAD	2	Plutonium-244	71	0	0.0%	pCi/L	.	.	1				28.8	-	-	-	-
RAD	1	Potassium-40	233	31	13.3%	pCi/L	15.29	79.2	10				6,720	-	-	-	-
RAD	2	Protactinium-231	3	0	0.0%	pCi/L	.	.	300				9.6	-	-	-	-
RAD	2	Protactinium-234m	263	259	98.5%	pCi/L	0.3	637.6	100				67,200	-	-	-	No
RAD	1	Radium-226	261	68	26.1%	pCi/L	0.08	1.21	1				96	-	-	-	No
RAD	1	Radium-228	261	39	14.9%	pCi/L	0.57	83.1	1				96	-	-	-	No
RAD	1	Strontium-90	281	202	71.9%	pCi/L	1.31	953	4				960	-	-	-	No
RAD	1	Technetium-99	274	257	93.8%	pCi/L	3.98	4,840	10				96,000	-	-	-	No
RAD	2	Thorium-227	73	3	4.1%	pCi/L	0.18	0.62	1.5				3,840	-	-	-	No
RAD	1	Thorium-228	267	10	3.7%	pCi/L	0.17	0.55	1				384	-	-	-	No
RAD	1	Thorium-229	217	8	3.7%	pCi/L	0.09	1.48	9.6				38.4	-	-	-	No
RAD	1	Thorium-230	267	164	61.4%	pCi/L	0.15	3.08	1				288	-	-	-	No
RAD	1	Thorium-232	267	30	11.2%	pCi/L	0.13	0.85	1				48	-	-	-	No
RAD	1	Thorium-234	230	226	98.3%	pCi/L	0.3	93.1	240				9,600	-	-	-	No
RAD	1	Tritium	274	133	48.5%	pCi/L	283.13	7285.12	300				1,920,000	-	-	-	No
RAD	2	Uranium-232	71	9	12.7%	pCi/L	0.21	0.82	1				96	-	-	-	No
RAD	1	Uranium-233/234	274	267	97.4%	pCi/L	0.65	529.8	1				480	-	-	-	Yes
RAD	1	Uranium-235/236	273	242	88.6%	pCi/L	0.26	55.7	1				576	-	-	-	No
RAD	1	Uranium-236	6	5	83.3%	pCi/L	11.74	37.62	1				480	-	-	-	No

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RAD	1	Uranium-238	275	267	97.1%	pCi/L	0.3	749.6	1				576	-	-	-	Yes
RAD	2	Yttrium-90	233	152	65.2%	pCi/L	1.31	953	4				9,600	-	-	-	No
SVOA	2	1,2,4-Trichlorobenzene	247	0	0.0%	ug/L	.	.	10	-	-	70	-	-	-	-	-
SVOA	2	1,2-Dichlorobenzene	247	0	0.0%	ug/L	.	.	10	-	-	1300	-	-	-	-	-
SVOA	2	1,3-Dichlorobenzene	247	0	0.0%	ug/L	.	.	10	-	-	960	-	-	-	-	-
SVOA	2	1,4-Dichlorobenzene	249	1	0.4%	ug/L	1	1	10	-	-	190	-	-	-	No	-
SVOA	2	2,3,4,6-Tetrachlorophenol	229	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,5-Trichlorophenol	2	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,6-Trichlorophenol	2	0	0.0%	ug/L	.	.	10	-	-	24	-	-	-	-	-
SVOA	2	2,4-Dimethylphenol	225	23	10.2%	ug/L	2.03	7.27	10	-	-	850	-	-	-	No	-
SVOA	2	2,4-Dinitrophenol	225	0	0.0%	ug/L	.	.	25	-	-	5300	-	-	-	-	-
SVOA	2	2-Methylnaphthalene	235	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2-Methylphenol	227	11	4.8%	ug/L	2.02	3.39	10	-	-	-	-	-	-	-	-
SVOA	2	3- and 4- Methylphenol	185	41	22.2%	ug/L	2.02	22	10	-	-	-	-	-	-	-	-
SVOA	2	4-Chloro-3-methylphenol	215	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	4-Methylphenol	14	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Acenaphthene	273	3	1.1%	ug/L	0.165	0.328	10	-	-	990	-	-	-	No	-
SVOA	2	Acenaphthylene	220	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Acetophenone	205	2	1.0%	ug/L	2.05	4	10	-	-	-	-	-	-	-	-
SVOA	2	Anthracene	225	16	7.1%	ug/L	0.183	3.44	10	-	-	40000	-	-	-	No	-
SVOA	2	Benz(a)anthracene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzenemethanol	215	0	0.0%	ug/L	.	.	20	-	-	-	-	-	-	-	-
SVOA	2	Benzidine	96	0	0.0%	ug/L	.	.	50	-	-	0.002	-	-	-	-	-
SVOA	1	Benzo(a)pyrene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzo(b)fluoranthene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzo(ghi)perylene	225	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Benzo(k)fluoranthene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Benzoic acid	235	61	26.0%	ug/L	0.5	76.9	50	-	-	-		-	-	-	-
SVOA	1	Bis(2-ethylhexyl)phthalate	225	20	8.9%	ug/L	0.5	11	10	-	-	22	-	-	-	No	-
SVOA	2	Butyl benzyl phthalate	225	0	0.0%	ug/L	.	.	10	-	-	1900	-	-	-	-	-
SVOA	2	Carbazole	265	3	1.1%	ug/L	0.274	0.55	10	-	-	-	-	-	-	-	-
SVOA	2	Chrysene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Dibenz(a,h)anthracene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Dibenzofuran	225	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
		Dieldrin	1	0	0.0%	ug/L		.	0.24							-	
SVOA	1	Diethyl phthalate	225	9	4.0%	ug/L	0.5	2.02	10	-	-	44000	-	-	-	No	-
SVOA	1	Dimethyl phthalate	225	1	0.4%	ug/L	2.61	2.61	10	-	-	1100000	-	-	-	No	-
SVOA	1	Di-n-butyl phthalate	269	24	8.9%	ug/L	0.5	11	10	-	-	4500	-	-	-	No	-
SVOA	2	Di-n-octylphthalate	225	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA		Diphenylamine	26	0	0.0%	ug/L	.	.								-	
SVOA	2	Fluoranthene	225	5	2.2%	ug/L	0.172	0.265	10	-	-	140	-	-	-	No	-

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SVOA	2	Fluorene	225	2	0.9%	ug/L	0.2	0.242	10	-	-	5300	-	-	-	No	-
SVOA	2	Hexachlorobenzene	150	0	0.0%	ug/L	.	.	10	-	-	0.0029	-	-	-	-	-
SVOA	2	Hexachlorobutadiene	215	0	0.0%	ug/L	.	.	10	-	-	180	-	-	-	-	-
SVOA		Hexachloroethane	29	0	0.0%	ug/L	.	.	10							-	
SVOA	1	Indeno(1,2,3-cd)pyrene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Isophorone	225	0	0.0%	ug/L	.	.	10	-	-	9600	-	-	-	-	-
SVOA		m+p Methylphenol	39	1	2.6%	ug/L	2.35	2.35	10							-	
SVOA	2	Naphthalene	265	6	2.3%	ug/L	0.242	4.88	10	-	-	-	-	-	-	-	-
SVOA	2	Nitrobenzene	2	0	0.0%	ug/L	.	.	10	-	-	690	-	-	-	-	-
SVOA	1	Pentachlorophenol	227	2	0.9%	ug/L	8.94	12.9	10	19	15	30	-	No	No	No	-
SVOA	2	Phenanthrene	225	6	2.7%	ug/L	0.195	2.27	10	-	-	-	-	-	-	No	-
SVOA	1	Phenol	229	43	18.8%	ug/L	2.31	18.7	10	-	-	1700000	-	-	-	No	-
SVOA	2	Pyrene	225	0	0.0%	ug/L	.	.	10	-	-	4000	-	-	-	-	-
SVOA	2	Pyridine	2	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA		(1,1-Dimethylethyl)benzene	27	0	0.0%	ug/L	.	.									
SVOA		(1-Methylpropyl)benzene	27	0	0.0%	ug/L	.	.									
VOA	2	1,1,1-Trichloroethane	211	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1,2,2-Tetrachloroethane	16	0	0.0%	ug/L	.	.	5	-	-	40	-	-	-	-	-
VOA	2	1,1,2-Trichloroethane	185	0	0.0%	ug/L	.	.	5	-	-	160	-	-	-	-	-
VOA	2	1,1-Dichloroethane	211	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1-Dichloroethene	191	0	0.0%	ug/L	.	.	5	-	-	7100	-	-	-	-	-
		1,2,3-Trimethylbenzene	13	0	0.0%	ug/L	.	.									
VOA	2	1,2,4-Trimethylbenzene	202	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloroethane	18	0	0.0%	ug/L	.	.	5	-	-	370	-	-	-	-	-
VOA	2	1,2-Dichloroethene	10	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloropropane	16	0	0.0%	ug/L	.	.	5	-	-	150	-	-	-	-	-
VOA	2	1,2-Dimethylbenzene	239	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,3,5-Trimethylbenzene	202	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA		1,3-Dimethylbenzene	24	0	0.0%	ug/L	.	.									
VOA	2	1-Methyl-4-(1-methylethyl)benzene	27	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	2-Butanone	228	3	1.3%	ug/L	2	6	10	-	-	-	-	-	-	-	-
VOA	2	2-Hexanone	217	1	0.5%	ug/L	2	2	10	-	-	-	-	-	-	-	-
VOA	2	4-Methyl-2-pentanone	253	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Acetone	268	98	36.6%	ug/L	1	64.3	10	-	-	-	-	-	-	-	-
VOA	2	Acrylonitrile	149	0	0.0%	ug/L	.	.	20	-	-	2.5	-	-	-	No	-
VOA	2	Benzene	255	1	0.4%	ug/L	1.26	1.26	71	-	-	510	-	-	-	-	-
VOA	2	Bromodichloromethane	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Bromoform	42	0	0.0%	ug/L	.	.	5	-	-	1400	-	-	-	-	-
VOA	2	Bromomethane	16	0	0.0%	ug/L	.	.	10					-	-	-	-
VOA	2	Carbon disulfide	226	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Carbon tetrachloride	271	0	0.0%	ug/L	.	.	5	-	-	16	-	-	-	-	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
VOA	2	Chlorobenzene	250	0	0.0%	ug/L	.	.	5	-	-	1600	-	-	-	-	-
VOA	2	Chloroethane	211	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Chloroform	271	0	0.0%	ug/L	.	.	5	-	-	4700	-	-	-	-	-
VOA	2	Chloromethane	25	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	cis-1,2-Dichloroethene	211	1	0.5%	ug/L	0.31	0.31	5	-	-	-	-	-	-	-	-
VOA	2	cis-1,3-Dichloropropene	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Cumene	217	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	Dibromochloromethane	16	0	0.0%	ug/L	.	.	5	-	-	170	-	-	-	-	-
VOA	2	Ethylbenzene	217	0	0.0%	ug/L	.	.	5	-	-	2100	-	-	-	-	-
VOA	1	Hexane	14	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
		M + P Xylene	41	0	0.0%	ug/L	.	.	5								
VOA	2	Methanol	148	3	2.0%	ug/L	440	1330	5	-	-	-	-	-	-	-	-
VOA	2	Methylcyclohexane	99	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Methylene chloride	226	1	0.4%	ug/L	1.68	1.68	5	-	-	5900	-	-	-	Yes	-
VOA	2	Propylbenzene	176	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Propylene glycol	150	5	3.3%	mg/L	11.3	31.6	20	-	-	-	-	-	-	-	-
VOA	2	Styrene	186	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Tetrachloroethene	275	1	0.4%	ug/L	2	2	5	-	-	33	-	-	-	No	-
VOA	1	Toluene	273	1	0.4%	ug/L	1	1	5	-	-	15000	-	-	-	-	-
VOA	2	Total Xylene	241	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	trans-1,2-Dichloroethene	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	trans-1,3-Dichloropropene	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	1	Trichloroethene	275	1	0.4%	ug/L	0.33	0.33	5	-	-	300	-	-	-	-	-
VOA	1	Vinyl chloride	213	0	0.0%	ug/L	.	.	5	-	-	24		-	-	-	-

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
DCG = derived concentration guidelines
FAL = fish and aquatic life
MDA = minimum detectable activity
PPCB = pesticides and polychlorinated biphenyls
RAD = radiological
SVOA = semivolatile organic analysis
TDS = total dissolved solids
TSS = total suspended solids
VOA = volatile organic analysis

APPENDIX C.
ATTACHMENT 2—LEACHATE DATA

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Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
HERB	2	2,4,5-T	34	0	0.0%	ug/L	.	.	0.5	-	-	-		-	-	-	-
HERB	2	2,4-D	34	3	8.8%	ug/L	0.052	0.33	0.5	-	-	-		-	-	-	-
HERB	2	Silvex	134	2	1.5%	ug/L	0.174	0.386	0.5	-	-	-		-	-	-	-
METAL	2	Aluminum	182	169	92.9%	ug/L	21	2370	50	-	-	-		-	-	-	-
METAL	2	Antimony	194	21	10.8%	ug/L	0.62	3	6	-	-	640		-	-	No	-
METAL	1	Arsenic	164	23	14.0%	ug/L	0.15	3.6	5	340	150	10		No	No	No	-
METAL	2	Barium	196	195	99.5%	ug/L	29.5	137	5	-	-	-		-	-	-	-
METAL	2	Beryllium	162	11	6.8%	ug/L	0.02	0.12	1	-	-	-		-	-	-	-
METAL	2	Boron	182	181	99.5%	ug/L	25	1110	10	-	-	-		-	-	-	-
METAL	1	Cadmium	164	33	20.1%	ug/L	0.08	0.332	1	2.014	0.25	-		No	Yes	-	-
METAL	2	Calcium	182	182	100.0%	ug/L	30800	308000	250	-	-	-		-	-	-	-
METAL	1	Chromium	196	115	58.7%	ug/L	0.3	6.37	5	570	74	-		No	No	-	-
METAL	2	Cobalt	162	47	29.0%	ug/L	0.1	4.4	5	-	-	-		-	-	-	-
METAL	2	Copper	162	85	52.5%	ug/L	0.41	5	5	13	9	-		No	No	-	-
METAL	2	Hafnium	90	0	0.0%	ug/L	.	.	50	-	-	-		-	-	-	-
METAL	2	Iron	182	158	86.8%	ug/L	11.4	2390	50	-	-	-		-	-	-	-
METAL	1	Lead	196	21	10.7%	ug/L	0.36	4.53	3	64.581	2.5	-		No	Yes	-	-
METAL	2	Lithium	168	81	48.2%	ug/L	0.62	21.2	10	-	-	-		-	-	-	-
METAL	2	Magnesium	182	182	100.0%	ug/L	4730	38700	50	-	-	-		-	-	-	-
METAL	2	Manganese	182	182	100.0%	ug/L	0.87	1300	5	-	-	-		-	-	-	-
METAL	1	Mercury	183	7	3.8%	ug/L	0.065	0.22	0.2	1.4	0.77	0.051		No	No	Yes	-
METAL	2	Molybdenum	150	101	67.3%	ug/L	0.91	6.81	5	-	-	-		-	-	-	-
METAL	1	Nickel	191	132	69.1%	ug/L	0.56	15	10	468.23	52	4600		No	No	No	-
METAL	2	Phosphorous	135	101	74.8%	ug/L	12.7	74.2	20	-	-	-		-	-	-	-
METAL	2	Potassium	182	182	100.0%	ug/L	1600	10800	250	-	-	-		-	-	-	-
METAL	1	Selenium	196	21	10.7%	ug/L	0.48	4.46	5	20	5	-		No	-	-	-
METAL	1	Silver	171	2	1.2%	ug/L	0.15	0.24	1	3.217	-	-		-	-	-	-
METAL	2	Sodium	182	182	100.0%	ug/L	4380	72300	250	-	-	-		-	-	-	-
METAL	2	Strontium	194	194	100.0%	ug/L	80.7	886	5	-	-	-		-	-	-	-
METAL	1	Thallium	170	4	2.4%	ug/L	1.4	**2.02**	2	-	-	0.47		-	-	Yes	-
METAL	2	Tin	194	12	6.2%	ug/L	0.25	8.4	50	-	-	-		-	-	-	-
METAL	2	Titanium	146	86	58.9%	ug/L	0.259	40.1	5	-	-	-		-	-	-	-
METAL	1	Uranium	189	184	97.4%	ug/L	2.01	**388**	4	-	-	-		-	-	-	-
METAL	2	Vanadium	194	124	63.9%	ug/L	0.17	25.8	10	-	-	-		-	-	-	-
METAL	1	Zinc	182	126	69.2%	ug/L	0.53	97.5	10	117.18	120	-		No	No	-	-
METAL	2	Zirconium	126	28	22.2%	ug/L	0.81	5.21	50	-	-	-		-	-	-	-
Other	2	asbestos				fibers			200,000					-	-	-	-
Other	2	Bicarbonate EPA-310.1	38	38	100.0%	mg/L	113	318	na	-	-	-		-	-	-	-
Other	2	Carbonate EPA-310.1	38	0	0.0%	mg/L	.	.	na	-	-	-		-	-	-	-
Other	2	Chloride	41	41	100.0%	mg/L	4.25	36.6	0.1	-	-	-		-	-	-	-
Other	1	Cyanide	149	1	0.7%	ug/L	5.97	5.97	5	22	5.2	140		No	Yes	No	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
Other	2	Dissolved Solids	41	41	100.0%	mg/L	125	1410	2.5	-	-	-		-	-	-	-
Other	2	Fluoride	40	38	95.0%	mg/L	0.13	0.57	0.05	-	-	-		-	-	-	-
Other	2	Nitrite as Nitrogen	1	1	100.0%	mg/L	1.1	1.1	0.1	-	-	-		-	-	-	-
Other	2	Sulfate	40	40	100.0%	mg/L	37.4	518		-	-	-		-	-	-	-
Other	2	Suspended Solids	48	27	56.3%	mg/L	1.15	1400	2.5	-	-	-		-	-	-	-
Other	2	Total Organic Carbon (TOC)	42	41	97.6%	mg/L	0.86	12.1	1	-	-	-		-	-	-	-
PPCB	1	4,4'-DDD	164	2	1.2%	ug/L	0.012	0.0767	0.1	-	-	0.0031		-	-	Yes	-
PPCB	1	4,4'-DDE	164	4	2.4%	ug/L	0.016	0.02	0.1	-	-	0.0022		-	-	Yes	-
PPCB	1	4,4'-DDT	158	2	1.3%	ug/L	0.0284	0.0288	0.05	1.1	0.001	0.0022		No	Yes	Yes	-
PPCB	1	Aldrin	153	1	0.7%	ug/L	0.014	0.014	0.05	3	-	0.0005		No	-	Yes	-
PPCB	1	alpha-BHC	156	12	7.7%	ug/L	0.00653	0.046	0.05	-	-	0.049		-	-	No	-
PPCB	2	alpha-Chlordane	165	0	0.0%	ug/L	.	.	0.05	-	-	-		-	-	-	-
PPCB	1	beta-BHC	157	28	17.8%	ug/L	0.0104	0.09	0.05	-	-	0.17		-	-	No	-
PPCB	2	Chlordane	15	0	0.0%	ug/L	.	.	0.1	2.4	0.0043	0.0081		-	-	-	-
PPCB	2	delta-BHC	156	1	0.6%	ug/L	0.0153	0.0153	0.05	-	-	-		-	-	-	-
PPCB	2	Dieldrin	170	0	0.0%	ug/L	.	.	0.24	0.24	0.056	0.00054		-	-	-	-
PPCB	1	Endosulfan I	149	3	2.0%	ug/L	0.011	0.014	0.05	0.22	0.056	89		No	No	No	-
PPCB	1	Endosulfan II	158	0	0.0%	ug/L	.	.	0.05	0.22	0.056	89		-	-	-	-
PPCB	1	Endosulfan sulfate	154	5	3.2%	ug/L	0.014	0.035	0.05	-	-	89		-	-	-	-
PPCB	1	Endrin	158	1	0.6%	ug/L	0.0155	0.0155	0.05	0.086	0.036	0.06		No	No	No	-
PPCB	1	Endrin aldehyde	164	3	1.8%	ug/L	0.011	0.031	0.05	-	-	0.3		-	-	No	-
PPCB	2	Endrin ketone	136	1	0.7%	ug/L	0.027	0.027	0.05	-	-	-		-	-	-	-
PPCB	2	gamma-Chlordane	165	4	2.4%	ug/L	0.012	0.019	0.05	-	-	-		-	-	-	-
PPCB	1	Heptachlor	137	0	0.0%	ug/L	.	.	0.05	0.52	0.0038	0.00079		-	-	-	-
PPCB	1	Heptachlor epoxide	158	4	2.5%	ug/L	0.00705	0.0184	0.05	0.52	0.0038	0.00039		No	Yes	Yes	-
PPCB	1	Lindane	50	1	2.0%	ug/L	0.027	0.027	0.05	0.95	-	1.8		No	-	No	-
PPCB	2	Methoxychlor	152	7	4.6%	ug/L	0.011	0.015	0.05	-	-	-		-	-	-	-
PPCB	1	PCB-1016	171	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1221	161	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1232	161	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1242	191	1	0.5%	ug/L	0.276	0.276	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1248	161	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1254	191	1	0.5%	ug/L	0.19	0.19	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1260	191	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1262	147	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1268	148	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCBs-Total								-	0.014	0.00064		-	-	-	-
RAD	2	Actinium-225	38	3	7.9%	pCi/L	0.18	1.43	24				960	-	-	-	No
RAD	2	Actinium-227	190	17	8.9%	pCi/L	0.18	0.98	1.3				9.6	-	-	-	No
RAD	2	Alpha activity	46	43	93.5%	pCi/L	5.7	**350.82**	5				.	-	-	-	-
RAD	2	Aluminum-26	150	0	0.0%	pCi/L	.	.	10				9,600	-	-	-	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
RAD	2	Americium-243	162	30	18.5%	pCi/L	0.12	0.59	1				28.8	-	-	-	No
RAD	2	Antimony-126	45	0	0.0%	pCi/L	.	.	480				NA	-	-	-	-
RAD	2	Barium-133	27	0	0.0%	pCi/L	.	.	30				NA	-	-	-	-
RAD	1	Beta activity	46	44	95.7%	pCi/L	2.94	1240	5				.	-	-	-	No
RAD	2	Bismuth-207	45	0	0.0%	pCi/L	.	.	720				28,800	-	-	-	-
RAD	2	Californium-249	40	2	5.0%	pCi/L	0.12	0.31	1				28.8	-	-	-	No
RAD	2	Californium-250	40	0	0.0%	pCi/L	.	.	16.8				67.2	-	-	-	-
RAD	2	Californium-251	40	1	2.5%	pCi/L	0.39	0.39	0.072				28.8	-	-	-	No
RAD	2	Californium-252	147	0	0.0%	pCi/L	.	.	10				96	-	-	-	-
RAD	1	Carbon-14	193	10	5.2%	pCi/L	14.3	77.1	50				67,200	-	-	-	No
RAD	2	Cesium-135	45	0	0.0%	pCi/L	.	.	480				19,200	-	-	-	-
RAD	1	Cesium-137	195	1	0.5%	pCi/L	3.1	3.1	10				2,880	-	-	-	No
RAD	1	Chlorine-36	190	70	36.8%	pCi/L	2.51	75.72	50				48,000	-	-	-	No
RAD	1	Cobalt-60	171	2	1.2%	pCi/L	7.59	7.75	10				4,800	-	-	-	No
RAD	2	Curium-242	164	0	0.0%	pCi/L	.	.	10				960	-	-	-	-
RAD	2	Curium-243/244	168	3	1.8%	pCi/L	0.11	0.29	1				48	-	-	-	No
RAD	1	Curium-245	162	39	24.1%	pCi/L	0.12	0.62	1				28.8	-	-	-	No
RAD	1	Curium-246	162	39	24.1%	pCi/L	0.12	0.62	1				28.8	-	-	-	No
RAD	1	Curium-247	162	3	1.9%	pCi/L	0.25	0.51	1				28.8	-	-	-	No
RAD	2	Curium-248	190	14	7.4%	pCi/L	0.04	0.56	2				7.68	-	-	-	No
RAD	2	Europium-152	171	0	0.0%	pCi/L	.	.	10				19,200	-	-	-	-
RAD	2	Europium-154	171	0	0.0%	pCi/L	.	.	10				19,200	-	-	-	-
RAD	2	Europium-155	171	0	0.0%	pCi/L	.	.	10				96,000	-	-	-	-
RAD	1	Iodine-129	193	15	7.8%	pCi/L	0.39	12.8	5				480	-	-	-	No
RAD	2	Lead-210	141	20	14.2%	pCi/L	0.63	1.61	1				28.8	-	-	-	No
RAD	2	Lead-212	45	0	0.0%	pCi/L	.	.	72				2,880	-	-	-	-
RAD	2	Neptunium-237	193	17	8.8%	pCi/L	0.14	0.92	1				28.8	-	-	-	No
RAD	2	Nickel-59	40	0	0.0%	pCi/L	.	.	16800				672,000	-	-	-	-
RAD	2	Nickel-63	162	9	5.6%	pCi/L	18.6	60.14	7200				288,000	-	-	-	No
RAD	2	Niobium-93m	37	5	13.5%	pCi/L	56.63	1610	7200				288,000	-	-	-	No
RAD	2	Niobium-94	45	1	2.2%	pCi/L	4.36	4.36	720				28,800	-	-	-	No
RAD	2	Plutonium-236	149	1	0.7%	pCi/L	0.33	0.33	1				96	-	-	-	No
RAD	2	Plutonium-238	174	2	1.1%	pCi/L	0.15	0.25	1				38.4	-	-	-	No
RAD	1	Plutonium-239/240	193	7	3.6%	pCi/L	0.17	0.45	1				28.8	-	-	-	No
RAD	2	Plutonium-241	160	1	0.6%	pCi/L	30	30	48				1,920	-	-	-	No
RAD	1	Plutonium-242	160	42	26.3%	pCi/L	0.09	2.26	1				28.8	-	-	-	No
RAD	2	Plutonium-244	160	3	1.9%	pCi/L	0.16	0.54	1				28.8	-	-	-	No
RAD	2	Polonium-210	38	4	10.5%	pCi/L	0.28	0.57	2				76.8	-	-	-	No
RAD	1	Potassium-40	159	21	13.2%	pCi/L	28.3	183	10				6,720	-	-	-	No
RAD	2	Protactinium-231	30	0	0.0%	pCi/L	.	.	300				9.6	-	-	-	-
RAD	2	Protactinium-234m	190	187	98.4%	pCi/L	0.68	156.2	100				67,200	-	-	-	No

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RAD	2	Radium-223	45	2	4.4%	pCi/L	0.2	0.22	0.8				NA	-	-	-	-
RAD	2	Radium-225	45	2	4.4%	pCi/L	0.18	0.29	0.5				NA	-	-	-	-
RAD	1	Radium-226	178	20	11.2%	pCi/L	0.08	1.1	1				96	-	-	-	No
RAD	1	Radium-228	178	39	21.9%	pCi/L	0.52	9.11	1				96	-	-	-	No
RAD	2	Silver-108m	27	0	0.0%	pCi/L	.	.	30				NA	-	-	-	-
RAD	2	Strontium-89	39	0	0.0%	pCi/L	.	.	4				NA	-	-	-	-
RAD	1	Strontium-90	196	191	97.4%	pCi/L	2.94	471	4				960	-	-	-	No
RAD	1	Technetium-99	193	162	83.9%	pCi/L	4.11	983	10				96,000	-	-	-	No
RAD	2	Thorium-227	165	13	7.9%	pCi/L	0.18	0.48	1.5				3,840	-	-	-	No
RAD	1	Thorium-228	191	8	4.2%	pCi/L	0.17	2.91	1				384	-	-	-	No
RAD	1	Thorium-229	160	7	4.4%	pCi/L	0.12	17.7	9.6				38.4	-	-	-	No
RAD	1	Thorium-230	191	115	60.2%	pCi/L	0.14	74.49	1				288	-	-	-	No
RAD	1	Thorium-232	191	25	13.1%	pCi/L	0.16	5.57	1				48	-	-	-	No
RAD	1	Thorium-234	160	134	83.8%	pCi/L	0.68	140	240				9,600	-	-	-	No
RAD	2	Tin-126	38	0	0.0%	pCi/L	.	.	192				7,680	-	-	-	-
RAD	1	Tritium	193	181	93.8%	pCi/L	339	9234.86	300				1,920,000	-	-	-	No
RAD	2	Uranium-232	166	5	3.0%	pCi/L	0.29	0.76	1				96	-	-	-	No
RAD	1	Uranium-233/234	193	191	99.0%	pCi/L	3.92	127.7	1				480	-	-	-	No
RAD	1	Uranium-235/236	193	171	88.6%	pCi/L	0.29	20.21	1				576	-	-	-	No
RAD	1	Uranium-236	12	9	75.0%	pCi/L	0.72	8.18	1				480	-	-	-	No
RAD	1	Uranium-238	193	189	97.9%	pCi/L	0.68	156.2	1				576	-	-	-	No
RAD	2	Yttrium-90	160	158	98.8%	pCi/L	5.74	471	2				9,600	-	-	-	No
SVOA	2	1,2,4-Trichlorobenzene	161	0	0.0%	ug/L	0	0	10	-	-	70	-	No	No	No	-
SVOA	2	1,2-Dichlorobenzene	161	0	0.0%	ug/L	.	.	10	-	-	1300	-	-	-	Yes	-
SVOA	2	1,3-Dichlorobenzene	161	0	0.0%	ug/L	.	.	10	-	-	960	-	-	-	Yes	-
SVOA	2	1,4-Dichlorobenzene	161	0	0.0%	ug/L	.	.	10	-	-	190	-	-	-	Yes	-
SVOA	2	2,3,4,6-Tetrachlorophenol	150	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,5-Trichlorophenol	47	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,6-Trichlorophenol	35	0	0.0%	ug/L	.	.	10	-	-	24	-	-	-	Yes	-
SVOA	2	2,4-Dimethylphenol	154	0	0.0%	ug/L	.	.	10	-	-	850	-	-	-	-	-
SVOA	2	2,4-Dinitrophenol	155	0	0.0%	ug/L	.	.	25	-	-	5300	-	-	-	-	-
SVOA	2	2-Chloronaphthalene	39	0	0.0%	ug/L	.	.	10	-	-	1600	-	-	-	Yes	-
SVOA	2	2-Chlorophenol	47	0	0.0%	ug/L	.	.	10	-	-	150	-	-	-	Yes	-
SVOA	2	2-Methyl-4,6-dinitrophenol	47	0	0.0%	ug/L	.	.	10	-	-	280	-	-	-	Yes	-
SVOA	2	2-Methylnaphthalene	154	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2-Methylphenol	154	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2-Nitrobenzenamine	39	0	0.0%	ug/L	.	.	50	-	-	-	-	-	-	-	-
SVOA	2	2-Nitrophenol	35	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	3- and 4- Methylphenol	125	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	3,3'-Dichlorobenzidine	38	0	0.0%	ug/L	.	.	1	-	-	0.28	-	-	-	Yes	-
SVOA	2	4-Chloro-3-methylphenol	151	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
SVOA	2	4-Methylphenol	14	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	4-Nitrobenzenamine	38	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	4-Nitrophenol	27	0	0.0%	ug/L	.	.	25	-	-	-	-	-	-	-	-
SVOA	2	Acenaphthene	196	0	0.0%	ug/L	.	.	10	-	-	990	-	-	-	-	-
SVOA	2	Acenaphthylene	146	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Acetophenone	146	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Anthracene	159	0	0.0%	ug/L	.	.	10	-	-	40000	-	-	-	-	-
SVOA	2	Benz(a)anthracene	158	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzenemethanol	146	0	0.0%	ug/L	.	.	20	-	-	-	-	-	-	-	-
SVOA	2	Benzidine	121	0	0.0%	ug/L	.	.	50	-	-	0.002	-	-	-	-	-
SVOA	1	Benzo(a)pyrene	158	1	0.6%	ug/L	0.6	0.6	10	-	-	0.18	-	-	-	Yes	-
SVOA	2	Benzo(b)fluoranthene	158	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzo(ghi)perylene	147	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Benzo(k)fluoranthene	158	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Benzoic acid	153	9	5.9%	ug/L	0.6	5.68	50	-	-	-		-	-	-	-
SVOA	1	Bis(2-ethylhexyl)phthalate	159	22	13.8%	ug/L	0.5	15	10	-	-	22	-	-	-	No	-
SVOA	2	Butyl benzyl phthalate	147	0	0.0%	ug/L	.	.	10	-	-	1900	-	-	-	-	-
SVOA	2	Carbazole	194	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Chrysene	147	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Dibenz(a,h)anthracene	158	2	1.3%	ug/L	0.18	0.7	10	-	-	0.18	-	-	-	Yes	-
SVOA	2	Dibenzofuran	147	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	1	Diethyl phthalate	147	1	0.7%	ug/L	0.5	0.5	10	-	-	44000	-	-	-	No	-
SVOA	1	Dimethyl phthalate	147	1	0.7%	ug/L	1	1	10	-	-	1100000	-	-	-	No	-
SVOA	1	Di-n-butyl phthalate	194	11	5.7%	ug/L	0.8	2	10	-	-	4500	-	-	-	No	-
SVOA	2	Di-n-octylphthalate	149	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Fluoranthene	159	0	0.0%	ug/L	.	.	10	-	-	140	-	-	-	-	-
SVOA	2	Fluorene	159	0	0.0%	ug/L	.	.	10	-	-	5300	-	-	-	-	-
SVOA	2	Hexachlorobenzene	105	0	0.0%	ug/L	.	.	10	-	-	0.0029	-	-	-	-	-
SVOA	2	Hexachlorobutadiene	143	0	0.0%	ug/L	.	.	10	-	-	180	-	-	-	-	-
SVOA	1	Indeno(1,2,3-cd)pyrene	158	1	0.6%	ug/L	0.6	0.6	10	-	-	0.18	-	-	-	Yes	-
SVOA	2	Isophorone	159	0	0.0%	ug/L	.	.	10	-	-	9600	-	-	-	-	-
SVOA	2	Naphthalene	196	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Nitrobenzene	27	0	0.0%	ug/L	.	.	10	-	-	690	-	-	-	Yes	-
SVOA	2	N-Nitroso-di-n-propylamine	39	0	0.0%	ug/L	.	.	10	-	-	5.1	-	-	-	Yes	-
SVOA	2	N-Nitrosodiphenylamine	6	0	0.0%	ug/L	.	.	10	-	-	60	-	-	-	-	-
SVOA	1	Pentachlorophenol	167	21	12.6%	ug/L	0.104	1.75	10	19	15	30	-	No	No	No	-
SVOA	2	Phenanthrene	159	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	1	Phenol	168	2	1.2%	ug/L	1	1	10	-	-	1700000	-	-	-	No	-
SVOA	2	Pyrene	147	0	0.0%	ug/L	.	.	10	-	-	4000	-	-	-	-	-
SVOA	2	Pyridine	27	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	1,1,1-Trichloroethane	730	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
VOA	2	1,1,2,2-Tetrachloroethane	157	0	0.0%	ug/L	.	.	5	-	-	40	-	-	-	Yes	-
VOA	2	1,1,2-Trichloro-1,2,2-trifluoroethane	118	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1,2-Trichloroethane	673	0	0.0%	ug/L	.	.	5	-	-	160	-	-	-	-	-
VOA	2	1,1-Dichloroethane	730	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1-Dichloroethene	683	0	0.0%	ug/L	.	.	5	-	-	7100	-	-	-	-	-
VOA	2	1,2,4-Trimethylbenzene	640	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloroethane	157	0	0.0%	ug/L	.	.	5	-	-	370	-	-	-	Yes	-
VOA	2	1,2-Dichloroethene	125	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloropropane	157	0	0.0%	ug/L	.	.	5	-	-	150	-	-	-	Yes	-
VOA	2	1,2-Dimethylbenzene	698	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,3,5-Trimethylbenzene	640	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1-Methyl-4-(1-methylethyl)benzene	623	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	2-Butanone (Methyl Ethyl Ketone)	748	12	1.6%	ug/L	2	400	10	-	-	-	-	-	-	-	-
VOA	2	2-Hexanone	749	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	4-Methyl-2-pentanone	785	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Acetone	819	60	7.3%	ug/L	2	680	10	-	-	-	-	-	-	-	-
VOA	2	Acrylonitrile	517	0	0.0%	ug/L	.	.	20	-	-	2.5	-	-	-	-	-
VOA	2	Benzene	785	0	0.0%	ug/L	.	.	71	-	-	510	-	-	-	-	-
VOA	2	Bromodichloromethane	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Bromoform	218	0	0.0%	ug/L	.	.	5	-	-	1400	-	-	-	-	-
VOA	2	Bromomethane	157	0	0.0%	ug/L	.	.	10					-	-	-	-
VOA	2	Carbon disulfide	749	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Carbon tetrachloride	821	1	0.1%	ug/L	7.3	**7.3**	5	-	-	16	-	-	-	No	-
VOA	2	Chlorobenzene	776	0	0.0%	ug/L	.	.	5	-	-	1600	-	-	-	-	-
VOA	2	Chloroethane	730	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Chloroform	821	3	0.4%	ug/L	0.51	1.35	5	-	-	4700	-	-	-	No	-
VOA	2	Chloromethane	157	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	cis-1,2-Dichloroethene	730	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	cis-1,3-Dichloropropene	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Cumene	702	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	Dibromochloromethane	157	0	0.0%	ug/L	.	.	5	-	-	170	-	-	-	Yes	-
VOA	2	Ethane	105	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	Ethylbenzene	752	0	0.0%	ug/L	.	.	5	-	-	2100	-	-	-	-	-
VOA	2	Ethylene	105	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Hexane	603	1	0.2%	ug/L	1.22	1.22	10	-	-	-	-	-	-	-	-
VOA	2	Methane	105	10	9.5%	ug/L	1.01	8.15	10	-	-	-	-	-	-	-	-
VOA	2	Methanol	98	2	2.0%	ug/L	820	1800	5	-	-	-	-	-	-	-	-
VOA	2	Methylcyclohexane	752	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Methylene chloride	749	21	2.8%	ug/L	1	**7**	5	-	-	5900	-	-	-	No	-
VOA	2	Propylbenzene	623	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Propylene glycol	93	2	2.2%	mg/L	14.4	15.1	20	-	-	-	-	-	-	-	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
VOA	2	Styrene	678	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Tetrachloroethene	821	0	0.0%	ug/L	.	.	5	-	-	33	-	-	-	-	-
VOA	1	Toluene	821	4	0.5%	ug/L	0.97	12.8	5	-	-	15000	-	-	-	No	-
VOA	2	Total Xylene	785	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	trans-1,2-Dichloroethene	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	trans-1,3-Dichloropropene	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	1	Trichloroethene	821	2	0.2%	ug/L	3	**11**	5	-	-	300	-	-	-	No	-
VOA	2	Trimethylbenzene	66	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Vinyl chloride	733	0	0.0%	ug/L	.	.	5	-	-	24		-	-	-	-

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
DCG = derived concentration guidelines
FAL = fish and aquatic life
MDA = minimum detectable activity
PPCB = pesticides and polychlorinated biphenyls
RAD = radiological
SVOA = semivolatile organic analysis
TDS = total dissolved solids
TSS = total suspended solids
VOA = volatile organic analysis

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APPENDIX C.
ATTACHMENT 3—COC WINNOWING TABLE

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Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	POTENTIAL RISK CONCERN (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
DI/FURA	2,3,7,8-Tetrachlorodibenzo-p-dioxin			X	M	-	M	L				
HERB	2,4,5-T/Silvex	X		X	M	L	M	L				Incidental constituent from herbicide use
HERB	2,4-D	X			---	L	M	L				Incidental constituent from herbicide use
METAL	Aluminum	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Antimony	X	X	X	R,M	M	L	L				Low mobility based on geologic setting
METAL	Arsenic	X	X	X	B,C,R,M	-	L	H	X	X		Low mobility based on geologic setting
METAL	Barium	X	X	X	M	H	L	L				Common in geologic setting
METAL	Beryllium	X	X	X	M	-	L	L				Low mobility based on geologic setting
METAL	Boron	X	X	X	---	L	H	L				Low mobility based on geologic setting
METAL	Cadmium	X	X	X	B,C,M	-	L	L	X	X		Low mobility based on geologic setting
METAL	Calcium	X	X	X	---	-	H	H				Water quality concern, but common in EMWMF geologic setting
METAL	Chromium	X	X	X	B,C,M	H	L/H	L/H	X	X	X	Except for Cr VI, low mobility based on geologic setting
METAL	Cobalt	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Copper	X	X	X	B,C,M	-	L	H	X	X		Low mobility based on geologic setting
METAL	Hafnium	X	X	X	M	-	L	L				Low mobility based on geologic setting
METAL	Iron	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Lead	X	X	X	B,C,M	H	L	H	X	X		Low mobility based on geologic setting
METAL	Lithium	X	X	X	---	L	L	L				Low mobility based on geologic setting
METAL	Magnesium	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Manganese	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Mercury	X	X	X	B,C,R,M	L	H	H	X	X	X	Methylated mercury has high mobility
METAL	Molybdenum	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Nickel	X	X	X	B,C,R,M	-	L	L	X	X		Low mobility based on geologic setting
METAL	Phosphorous	X	X	X	---	-	H	L				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	POTENTIAL RISK CONCERN (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
METAL	Potassium	X	X	X	---	-	H	L				
METAL	Selenium	X	X	X	B,C,M	M	L	L				Low mobility based on geologic setting
METAL	Silver	X	X	X	B	-	L	L				Low mobility based on geologic setting
METAL	Sodium	X	X	X	---	-	H	L				
METAL	Strontium	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Thallium	X	X	X	R,M	-	L	L				Low mobility based on geologic setting
METAL	Tin	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Titanium	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Uranium	X	X	X	M	-	H	L	X	X	X	The radioactive isotopes will be included as COCs
METAL	Vanadium	X	X	X	---	H	L	L				Low mobility based on geologic setting
METAL	Zinc	X	X	X	B,C	-	L	L				Low mobility based on geologic setting
METAL	Zirconium	X	X	X	---	-	L	L				Low mobility based on geologic setting
Other	Ammonia Nitrogen. Total as N					-	H	H	X	X		Generally ubiquitous in leachate
Other	asbestos	X	X		---	-	L	L				Not detected in discharges
Other	Bicarbonate EPA-310.1	X			---	-	H	L				
Other	Carbonate EPA-310.1	X			---	-	H	L				
Other	Chloride	X			---	-	H	L				
Other	Cyanide	X	X	X	B,C,R,M	L	H	H	X	X		
Other	Total Dissolved Solids/Conductivity	X			---	-	H	H	X	X		Daily recommended to evaluate whether discharge changes have occurred (a pulse)
Other	Fluoride	X			---	-	H	L				
Other	Hardness as CaCO3, mg/l					-	-	-	x	x		Required to determine toxicity of the EMWMF some metal COCs
Other	Nitrite as Nitrogen	X			---	-	H	L				
Other	Nitrogen, total (as N)						H	H	x	x		Nutrient which may impact stream health
Other	Nitrogen, Nitrate total (N)					-	H	H	x	x		Nutrient which may impact stream health
Other	Phosphorous, total as P					-	H	H	x	x		Nutrient which may impact stream health
Other	Sulfate	X			---	-	H	-				

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Analysis type	Analyte								Leachate	CW	GW	
Other	Total Suspended Solids	X			---	-	H	H	X	X		Transports adsorbed metals/PCBs - affects benthics
Other	Total Organic Carbon (TOC)	X			---	-	L	H	X	X		Instead of multiple VOCs/SVOCs
Other	Whole effluent toxicity - chronic/acute					-	-	H	X	X		Semi-annual or after a major change in waste characteristics. One sample during Sept–Nov low-flow period
PPCB	4,4'-DDD	X	X	X	R	L	I	H	X	X		From incidental use for intended purpose.
PPCB	4,4'-DDE	X	X	X	R	L	I	H	X	X		From incidental use for intended purpose.
PPCB	4,4'-DDT	X	X	X	B,C,R	-	I	H	X	X		From incidental use for intended purpose.
PPCB	Aldrin	X	X	X	B,R	L	I	L	X	X		
PPCB	alpha-BHC	X	X	X	R	L	L	L				
PPCB	alpha-Chlordane	X	X	X	---	-	L	L				
PPCB	beta-BHC	X	X	X	R	L	L	H	X	X		
PPCB	Chlordane	X	X	X	B,C,R,M	L	I	L				
PPCB	delta-BHC	X	X	X	---	L	L	L				
PPCB	Dieldrin	X	X	X	B,C,R	L	I	H	X	X		
PPCB	Endosulfan I	X	X	X	B,C,R	L	L	L				
PPCB	Endosulfan II	X	X	X	B,C,R	L	L	L				
PPCB	Endosulfan sulfate	X	X	X	R	-	I	L				
PPCB	Endrin	X	X	X	B,C,R,M	L	I	L				
PPCB	Endrin aldehyde	X	X	X	R	L	L	L				
PPCB	Endrin ketone	X	X	X	---	L	M	L				
PPCB	gamma-Chlordane	X	X	X	---	-	L	L				
PPCB	Heptachlor	X	X	X	B,C,R,M	L	I	L				
PPCB	Heptachlor epoxide	X	X	X	B,C,R	L	L	L				
PPCB	Lindane	X	X	X	B,R,M	L	L	L				
PPCB	Methoxychlor	X	X	X	M	-	L	L				
PPCB	PCB-1016	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1221	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1232	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1242	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1248	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1254	X	X	X	B,R,M	-	I	L				
PPCB	PCB-1260	X	X	X	B,R,M	-	I	L				
PPCB	PCB-1262	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1268	X	X	X	B,R,M	-	L	L				
PPCB	PCBs-Total	X	X		C,R	-	L	L				
PPCB	Toxaphene			X	M	-	L	L				

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Analysis type	Analyte								Leachate	CW	GW	
RAD	Actinium-225	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Actinium-227	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Alpha activity	X	X	X	M	-	-	-				Screening level analysis only
RAD	Aluminum-26	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Americium-241	X	X	X	D	M	L	-				Minimal detects - no further evaluation
RAD	Americium-243	X		X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Antimony-126	X		X	---	-	-	-				Minimal detects - no further evaluation
RAD	Barium-133	X			---	-	-	-				Minimal detects - no further evaluation
RAD	Beta activity	X	X	X	M	-	-	-				Screening level analysis only
RAD	Bismuth-207	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-249	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-250	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-251	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-252	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Carbon-14	X	X	X	D	L	H	L				Minimal detects - no further evaluation
RAD	Cesium-135	X		X	D	-	H	-				Minimal detects - no further evaluation
RAD	Cesium-137	X	X	X	D	-	H	-				Minimal detects - no further evaluation
RAD	Chlorine-36	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Cobalt-60	X	X	X	D	-	M	-				Minimal detects - no further evaluation
RAD	Curium-242	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Curium-243/244	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Curium-245	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Curium-246	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Curium-247	X	X	X	D	-	-	-				Minimal detects - no further evaluation

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	POTENTIAL RISK CONCERN (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
RAD	Curium-248	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Europium-152	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Europium-154	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Europium-155	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Iodine-129	X	X	X	D	L	H	H	X	X	X	
RAD	Lead-210	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Lead-212	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Neptunium-237	X	X	X	D	M	H	L				Minimal detects - no further evaluation
RAD	Nickel-59	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Nickel-63	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Niobium-93m	X			D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Niobium-94	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-236	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-238	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-239/240	X	X	X	D	M	L	L				Minimal detects - no further evaluation
RAD	Plutonium-241	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-242	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-244	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Polonium-210	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Potassium-40	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Protactinium-231	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Protactinium-234m	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Radium-223	X		X	---	-	-	-				Minimal detects - no further evaluation
RAD	Radium-225	X		X	---	-	-	-				Minimal detects - no further evaluation
RAD	Radium-226	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	POTENTIAL RISK CONCERN (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
RAD	Radium-228	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Silver-108m	X			---	-	-	-				Minimal detects - no further evaluation
RAD	Strontium-89	X		X	---	-	H	-				Minimal detects - no further evaluation
RAD	Strontium-90	X	X	X	D,M	-	H	-	X	X	X	
RAD	Technetium-99	X	X	X	D	H	H	H	X	X	X	
RAD	Thorium-227	X		X	D,M	-	-	-				Minimal detects - no further evaluation
RAD	Thorium-228	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Thorium-229	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Thorium-230	X	X	X	D	-	-	-				U-234/238 daughter product (COCs)
RAD	Thorium-232	X	X	X	D	-	-	-				Not in waste lot/detects < 12% of DCG
RAD	Thorium-234	X	X	X	D	-	-	-				U-238 daughter/detects < 10% of DCG
RAD	Tin-126	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Total Radium Alpha			X	---	-	-	-				Screening level analysis only
RAD	Tritium	X	X	X	D,M	L	H	H	X	X	X	
RAD	Uranium-232	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Uranium-233/234	X	X	X	D	M	H	L	X	X	X	
RAD	Uranium-235/236	X	X	X	D	H	H	-	X	X	X	
RAD	Uranium-236	X	X	X	D	M	H	-				Minimal detects - no further evaluation
RAD	Uranium-238	X	X	X	D	H	H	-	X	X	X	
RAD	Yttrium-90	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
SVOA	1,2,4-Trichlorobenzene	X	X	X	R,M	L	M	L				
SVOA	1,2-Dichlorobenzene	X	X	X	R,M	L	M	L				
SVOA	1,3-Dichlorobenzene	X	X	X	R	L	M	L				
SVOA	1,4-Dichlorobenzene	X	X	X	R,M	L	L	L				
SVOA	2,3,4,6-Tetrachlorophenol	X	X	X	---	L	H	L				
SVOA	2,4,5-Trichlorophenol	X		X	---	-	H	L				
SVOA	2,4,6-Trichlorophenol	X			R	-	H	L				
SVOA	2,4-Dimethylphenol	X	X	X	R	L	H	L				
SVOA	2,4-Dinitrophenol	X	X	X	R	-	H	L				
SVOA	2-Chloronaphthalene	X		X	R	-	L	L				
SVOA	2-Chlorophenol	X		X	R	-	H	L				
SVOA	2-Methyl-4,6-dinitrophenol	X		X	R	-	H	L				
SVOA	2-Methylnaphthalene	X	X	X	---	L	L	L				

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Analysis type	Analyte								Leachate	CW	GW	
SVOA	2-MethylphenoL (*o*-cresol)	X	X	X	---	-	H	L				
SVOA	2-Nitrobenzenamine	X		X	---	-	L	L				
SVOA	2-Nitrophenol	X			---	-	H	L				
SVOA	3- and 4- Methylphenol (*p*-cresol)	X	X	X	---	-	H	L				
SVOA	3,3'-Dichlorobenzidine	X		X	R	-	L	L				
SVOA	4-Chloro-3-methylphenol	X	X	X	---	-	H	L				
SVOA	4-Methylphenol	X	X	X	---	-	H	L				
SVOA	4-Nitrobenzenamine	X			---	-	L	L				
SVOA	4-Nitrophenol	X			---	-	H	L				
SVOA	Acenaphthene	X	X	X	R	L	L	L				
SVOA	Acenaphthylene	X	X	X	---	L	L	L				
SVOA	Acetophenone	X	X	X	---	L	L	L				
SVOA	Anthracene	X	X	X	R	-	I	L				
SVOA	Benz(a)anthracene	X	X	X	R	-	I	L				
SVOA	Benzenemethanol	X	X	X	---	-	L	L				
SVOA	Benzidine	X	X	X	R	L	L	L				Detected in less than five waste lots
SVOA	Benzo(a)pyrene	X	X	X	R,M	-	I	L				
SVOA	Benzo(b)fluoranthene	X	X	X	R	-	I	L				
SVOA	Benzo(ghi)perylene	X	X	X	---	-	L	L				
SVOA	Benzo(k)fluoranthene	X	X	X	R	-	I	L				
SVOA	Benzoic acid	X	X	X	---	L	H	L				
SVOA	Bis(2-ethylhexyl)phthalate	X	X	X	R	-	L	L				
SVOA	Butyl benzyl phthalate	X	X	X	R	-	L	L				
SVOA	Carbazole	X	X	X	---	L	L	L				
SVOA	Chrysene	X	X	X	R	-	I	L				
SVOA	Dibenz(a,h)anthracene	X	X	X	R	-	L	L				
SVOA	Dibenzofuran	X	X	X	---	-	L	L				
SVOA	Diethyl phthalate	X	X	X	R	L	H	L				
SVOA	Dimethyl phthalate	X	X	X	R	L	L	L				
SVOA	Di-n-butyl phthalate	X	X	X	R	L	M	L				
SVOA	Di-n-octylphthalate	X	X	X	---	-	L	L				
SVOA	Diphenylamine			X	---	-	L	L				
SVOA	Fluoranthene	X	X	X	R	-	L	L				
SVOA	Fluorene	X	X	X	R	-	L	L				
SVOA	Hexachlorobenzene	X	X	X	R,M	-	L	L				
SVOA	Hexachlorobutadiene	X	X	X	R	L	L	L				
SVOA	Hexachloroethane			X	---	-	L	L				
SVOA	Indeno(1,2,3-cd)pyrene	X	X	X	R	-	L	L				
SVOA	Isophorone	X	X	X	R	L	H	L				
SVOA	m+p Methylphenol		X	X	---	-	H	L				
SVOA	Naphthalene	X	X	X	---	L	L	L				
SVOA	Nitrobenzene	X			R	-	L	L				
SVOA	N-Nitroso-di-n-propylamine	X		X	R	-	L	L				

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Analysis type	Analyte								Leachate	CW	GW	
SVOA	N-Nitrosodiphenylamine	X			R	L	L	L				
SVOA	Pentachlorophenol	X	X	X	B,C,R,M	-	L	L				
SVOA	Phenanthrene	X	X	X	---	-	I	L				
SVOA	Phenol	X	X	X	R	L	H	L				
SVOA	Pyrene	X	X	X	R	-	I	L				
SVOA	Pyridine	X			---	-	L	L				
VOA	(1,1-Dimethylethyl)benzene			X	---	-	H	L				
VOA	(1-Methylpropyl)benzene			X	---	L	H	L				
VOA	1,1,1-Trichloroethane	X	X	X	M	-	M	L				
VOA	1,1,2,2-Tetrachloroethane	X		X	R	-	H	L				
VOA	1,1,2-Trichloro-1,2,2-trifluoroethane	X			---	-	M	L				
VOA	1,1,2-Trichloroethane	X	X	X	R	-	H	L				
VOA	1,1-Dichloroethane	X	X	X	---	-	H	L				
VOA	1,1-Dichloroethene	X	X	X	R,M	-	M	L				
VOA	1,2,3-Trimethylbenzene			X	---	-	H	L				
VOA	1,2,4-Trimethylbenzene	X	X	X	M	L	H	L				
VOA	1,2-Dichloroethane	X		X	R,M	-	H	L				
VOA	1,2-Dichloroethene	X		X	-	-	M	L				
VOA	1,2-Dichloropropane	X		X	R,M	-	H	L				
VOA	1,2-Dimethylbenzene	X	X	X	---	L	H	L				
VOA	1,3,5-Trimethylbenzene	X	X	X	---	L	H	L				
VOA	1-Methyl-4-(1-methylethyl)benzene	X		X	---	L	H	L				
VOA	2-Butanone (Methyl Ethyl Ketone)	X	X	X	---	-	M	L				
VOA	2-Hexanone	X	X	X	---	L	H	L				
VOA	4-Methyl-2-pentanone	X	X	X	---	-	H	L				
VOA	Acetone	X	X	X	---	L	H	L				
VOA	Acrylonitrile	X	X	X	R	-	H	L				
VOA	Benzene	X	X	X	R,M	L	H	L				
VOA	Bromodichloromethane	X		X	---	-	H	L				
VOA	Bromoform	X	X	X	R	L	H	L				
VOA	Bromomethane	X		X	---	-	H	L				
VOA	Carbon disulfide	X	X	X	---	L	M	L				
VOA	Carbon tetrachloride	X	X	X	R,M	L	M	L				
VOA	Chlorobenzene	X	X	X	R	L	M	L				
VOA	Chloroethane	X	X	X	---	-	H	L				
VOA	Chloroform	X	X	X	R	L	H	L				
VOA	Chloromethane	X		X	---	-	H	L				
VOA	cis-1,2-Dichloroethene	X	X	X	M	L	M	L				
VOA	cis-1,3-Dichloropropene	X		X	---	-	H	L				
VOA	Cumene	X	X	X	---	L	H	L				
VOA	Dibromochloromethane	X		X	R	-	H	L				
VOA	Ethane	X			---	-	H	L				
VOA	Ethylbenzene	X	X	X	R,M	L	L	L				
VOA	Ethylene	X			---	-	H	L				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	POTENTIAL RISK CONCERN (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
VOA	Hexane	X	X	X	---	L	M	L				n-hexane detected in less than five waste lots
VOA	M + P Xylene		X	X	---	-	L	L				
VOA	Methane	X			---	-	H	L				
VOA	Methanol	X	X	X	---	-	H	L				
VOA	Methylcyclohexane	X	X	X	---	L	M	L				
VOA	Methylene chloride	X	X	X	R,M	L	H	L				
VOA	Propylbenzene	X	X	X	---	L	H	L				
VOA	Propylene glycol	X	X	X	---	L	H	L				
VOA	Styrene	X	X	X	M	L	M	L				
VOA	Tetrachloroethene	X	X	X	R,M	L	M	L				
VOA	Toluene	X	X	X	R,M	L	M	L				
VOA	Total Xylene	X	X	X	M	L	M	L				
VOA	trans-1,2-Dichloroethene	X		X	M	L	H	L				
VOA	trans-1,3-Dichloropropene	X		X	---	-	H	L				
VOA	Trichloroethene	X	X	X	R,M	L	M	L				
VOA	Trimethylbenzene	X		X	---	-	H	L				
VOA	Vinyl chloride	X	X	X	R,M	L	H	L				

B	AWQC CMC (Batch Discharge)
C	AWQC CCC (Continuous Discharge)
D	96% of the DCG (DOE O 5400.5)
H	High
I	Immobile
L	Low
M	MCL for GW/Medium
R	AWQC Recreation
-	Analyte not associated with a Waste Lot
Yellow	Mobility class for common organic pollutants from C. W. Fetter (1994) *Applied Hydrogeology*, Prentice-Hall, Upper Saddle River, New Jersey.

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
COC = contaminant of concern
CW = contact water
DCG = derived concentration guidelines
GW = groundwater
MCL = maximum contaminant level
MDA = minimum detectable activity
PCB = polychlorinated biphenyl
PPCB =pesticides and PCBs
RAD = radiological
SVOA = semivolatile organic analysis
SVOC = semivolatile organic compound
VOA = volatile organic analysis
VOC = volatile organic compound

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APPENDIX D.
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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D.1 INTRODUCTION

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 121 and 40 *Code of Federal Regulations* (CFR) 300.430(f)(1)(ii)(B) specify that removal actions for cleanup of hazardous substances must attain or have waived legally applicable or relevant and appropriate requirements (ARARs) under federal or more stringent state environmental laws.

Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (40 CFR 300.5). Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (40 CFR 300.5). Pursuant to U.S. Environmental Protection Agency (EPA) guidance, where EPA has delegated to the State of Tennessee the authority to implement a federal program, the Tennessee regulations replace the equivalent federal requirements as the potential ARARs.

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA Section 121(e)]. To ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [55 *Federal Register* (FR) 8756, March 8, 1990]. Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation (e.g., approval of or consultation with administrative bodies, documentation, permit issuance, reporting, record keeping, and enforcement).

The NCP at 40 CFR 300.400(e)(1) defines "on-site" as meaning "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action." CERCLA Sect. 104(d)(4) [as discussed further in the preamble to the final NCP, 55 FR 8690] states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit [i.e., manage as "on-site" waste]. This approach was proposed and agreed to by all Federal Facility Agreement (FFA) parties for the Oak Ridge Reservation (ORR) Environmental Management Waste Management Facility (EMWMF) project and was acknowledged and documented in the signed EMWMF Record of Decision (ROD) [U.S. Department of Energy (DOE), 1999] and reaffirmed in the East Tennessee Technology Park Zone 2 ROD (DOE, 2005). This agreement serves as the basis for designating waste TSD facilities on the ORR as "on-site" facilities not subject to the CERCLA Off-site Rule (40 CFR 300.440) when accepting wastes from CERCLA on-site response actions.

ARARs include those federal and state regulations that are designed to protect the environment; ARARs do not include occupational safety regulations. EPA requires compliance with occupational and worker protection standards in Section 300.150 of the NCP, independent of the ARARs process. Therefore, neither the regulations promulgated by the U.S. Occupational Safety and Health Agency (OSHA) nor DOE Orders related to occupational safety are addressed or included as ARARs.

In addition to ARARs, 40 CFR 300.400(g)(3) states that federal or state nonpromulgated advisories or guidance may be identified as "to be considered" (TBC) guidance for contaminants, conditions, and/or actions at the site. TBCs include non-promulgated criteria, advisories, guidance, and proposed standards. TBCs are not ARARs because they are neither promulgated nor enforceable. TBCs may be used to interpret ARARs and to determine preliminary remediation goals (PRGs) when ARARs do not exist for particular contaminants or are not sufficiently protective to develop cleanup goals.

Five alternatives are proposed and evaluated in this FFS: Alternative 1 – no action; Alternative 2 – on-site managed discharge/treatment; on-site treatment at EMWMF/EMDF (if necessary) in a constructed landfill wastewater treatment system (LWTS) and discharge to Bear Creek (batch or continuous), or transport by truck or pipeline to the proposed Environmental Management Disposal Facility (EMDF) site for treatment if the proposed LWTS is not sited adjacent to EMWMF; also includes, during managed discharge, that landfill wastewater exceeding discharge limits will be trucked to the Process Waste Treatment Complex (PWTC) for treatment. Alternative 3 – truck or pipe water to the PWTC at Oak Ridge National Laboratory (ORNL), an on-site (on-ORR) wastewater treatment facility for treatment and eventual discharge via a Clean Water Act (CWA) authorized outfall (pretreatment will be required); and Alternative 4 – truck or pipe water to the West End Treatment Facility (WETF) at Y-12, an on-site (on-ORR) wastewater treatment facility for treatment and eventual discharge via a CWA authorized outfall (pretreatment will be required).

This section provides an identification of potential federal and state chemical-, location-, and action-specific ARARs and TBC guidance that need to be added to the EMWMF Record of Decision to complete that set of ARARs, primarily to address water management and treatment under the Clean Water Act. The complete set of potential ARARs for the alternatives proposed under this focused feasibility study (FFS) to manage, treat (if necessary), and dispose of leachate and contact water (i.e., "landfill wastewater") generated by the EMWMF and the EMDF is included in the EMWMF-EMDF Remedial Investigation/Feasibility Study (RI/FS). The term "landfill wastewater" as used throughout the FFS is defined in 40 *CFR* 445.2 as "all wastewater associated with, or produced by the landfilling activities, including, but not limited to leachate, contaminated storm water, and contact wash water from washing trucks, equipment, and surface areas which have come in direct contact with waste at the facility).

Identification of ARARs is an iterative process; the ARARs listed in Table D.1 will be refined and changed as necessary as a remedial alternative is selected and the remedial design is further developed. The requirements listed in Table D.1 are triggered as ARARs if the particular jurisdictional prerequisite for that requirement (listed in Column 3 of the table) is met. For example, , if the response action does not involve constructing a new outfall, then the requirements addressing construction of a new outfall would not be triggered as ARARs. Final ARARs for the project will be set in the final decision document(s) when the preferred alternative is chosen.

D.2 CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs provide health-or risk-based concentrations limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, and air) for specific hazardous substances, pollutants, or contaminants. Chemical-specific ARARs identified for this action include Tennessee Department of Environment and Conservation (TDEC) ambient water quality criteria (AWQC) for surface waters of the state.

Surface water bodies in Tennessee are assigned use classifications by the Tennessee Water Quality Control Board. Those use classifications are not assigned based on surrounding land uses, and may have

no relationship to how the surface water is currently being used. Tennessee surface water use classifications are listed in TDEC 0400-40-04. Bear Creek, near the EMWMF and the proposed EMDF, is classified by the state for Fish and Aquatic Life (FAL), Recreation (REC), Irrigation (IRR), and Livestock Watering and Wildlife (LWW) uses. All other named and unnamed surface waters in the Clinch River Basin, with the exception of wet weather conveyances, which have not been specifically treated, are classified for FAL, REC, LWW, and IRR uses per TDEC 0400-40-04-.09. Each of the use classifications has water quality standards set under TDEC 0400-40-03, although only the FAL and REC uses have specific numeric AWQC set for particular compounds. The REC AWQC are human health criteria and the FAL criteria are set for the protection of aquatic life. Although all of these criteria, both numeric and narrative, are all potential ARARs for any effluent discharges to Bear Creek, the specific criteria that would be applied and enforced as final limits at a point source outfall, should the selected remedy include an on-site water treatment facility at the EMWMF/EMDF, would be negotiated and set in the final decision document for this action and could include any subset of these criteria, as determined by the regulatory authorities. A preliminary subset of key contaminants of concern in the leachate/contact water has been identified and agreed to by the Federal Facility Agreement (FFA) parties; this subset has been used during the development and screening of remedial alternatives under this FFS. AWQC for this subset of contaminants of concern are listed in Table D.2. Other narrative water quality standards are included in Table D.1 as potential chemical-specific ARARs .

Per TDEC 0400-40-05-.10(4), effluent discharges are required to meet the anti-degradation requirements of TDEC 0400-40-03-.06 to ensure that new or increased discharges do not cause measurable degradation of any parameter that is “unavailable.” Unavailable parameters exist where water quality is at, or fails to meet, the levels specified as water quality criteria in TDEC 0400-40-03-.03.

D.3 LOCATION-SPECIFIC ARARS

Location-specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted solely because they will take place in special locations. Several wetlands have been identified within or near the proposed area for siting the water treatment facilities. Potential additional location-specific ARARs to be added to those in the EMWMF ROD, as listed in Table D.1, include those addressing wetlands, aquatic resources, endangered species, and migratory birds. Selection of a final alternative, as well as final siting of a LWTS (under Alternative 2) or selection of a method of water transfer (truck or pipeline) under Alternatives 2, 3 or 4 will determine which of these are actually triggered as location-specific ARARs. Certainly any construction work within or near Bear Creek or its tributaries will trigger a number of ARARs designed to protect sensitive resources in or near those waters.

D.3.1 Wetlands

Activities that affect wetlands are regulated under state and federal law. Impacts to wetlands from siting a new water treatment facility under Alternative 3 will be avoided whenever possible. If impacts were unavoidable, they would be minimized through steps such as project design changes or the implementation of best management practices (BMPs), erosion and sedimentation controls, and site restoration. The extent of wetlands impact will be determined based on a wetlands survey and other detailed design considerations. Compensatory mitigation would be carried out as required by the ARARs if necessary.

Construction activities are assumed to impact these aquatic resources; mitigation activities are, therefore, assumed in the on-site treatment alternative.

D.3.2 Aquatic Resources

The TDEC Division of Water Pollution Control requires Aquatic Resource Alteration Permits (ARAPs) for alterations of waters of the state, including wetlands. Typical actions that trigger these requirements include the impoundment, diversion, stream relocation, or other control or modifications of any body of water or wetland. General permits are available for wet weather conveyances, minor wetland alterations, minor road crossings, utility line crossings of streams, bank stabilization, sand and gravel dredging, debris removal, culvert maintenance, construction of a new outfall structure, and stream restoration. Since this project will be implemented under CERCLA, activities would be required to meet only the substantive requirements of the ARAP process, including such elements as BMPs and erosion and sedimentation controls.

Construction of a new outfall in Bear Creek, if necessary, will have direct aquatic impacts, triggering a number of location-specific ARARs. Actual design considerations will determine whether and to what extent aquatic impacts will occur.

D.3.3 Endangered, Threatened or Rare Species

The EMWMF/EMDF site is not known to contain plants that are threatened or endangered, in need of management, or species of concern. A biologic and wetlands survey, however, is planned for the on-site disposal alternative for the proposed EMDF, which could discover sensitive species in need of protection in the area. In addition, the Tennessee dace (Phoxinus tennesseensis), which is listed as a “species in need of management” by the state of Tennessee, inhabit certain reaches of Bear Creek and several of its tributaries. Impacts associated with the selected remedy would be considered and mitigated as appropriate in accordance with the federal Endangered Species Act, as listed in Table D.1, and the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act and associated ARARs, as listed in the EMWMF ROD.

DOE recently signed a Memorandum of Understanding (MOU) with the DOE and the Fish and Wildlife Service (FWS) regarding implementation of Executive Order 13186 “Responsibilities of Federal Agencies to Protect Migratory Birds” (September 12, 2013). The MOU requires DOE to coordinate with the FWS prior to DOE operations and activities with significant adverse effects on migratory birds and their habitats, and to initiate appropriate actions to avoid or minimize the take of migratory birds. Although the MOU and the consultation it requires might be considered an administrative requirement under CERCLA, DOE will take appropriate actions, as necessary, to avoid or minimize the take of migratory birds as required by Executive Order 13186, which is listed as a TBC in Table D.1, should any migratory birds or their habitats be identified in the project area during implementation of the remedy.

D.3.4 National Environmental Research Park

Approximately 13,600 acres of the ORR have been designated as a DOE National Environmental Research Park to protect biological diversity through the protection of special habitats. The DOE research parks are used to evaluate the environmental consequences of energy use and development as well as strategies to mitigate these effects. They are also used to demonstrate possible environmental and land-use options. Portions of the ORR Research Park are located in the proximity of the Y-12 and ORNL sites. Some Research Park areas need to be protected from all manipulations for definite or indefinite periods of time in order to serve as controls. While execution of the program missions of DOE sites must be ensured, ongoing environmental research projects and protected natural areas must be given careful

consideration in any site-use decisions. Under Alternative 2, 3 or 4, if piping is selected as the mode of transport of wastewater to the PWTC, LWTS, or OF200 WTS, special consideration will need to be given to any research areas along the pipeline route.

D.4 ACTION-SPECIFIC ARARS

Performance, design, or action-specific requirements set controls or restrictions on particular kinds of activities related to the management of waste and are usually technology- or activity-based standards or limitations depending on the type of waste.

Pursuant to EPA guidance (EPA, 1991), there are no ARARs for a No Action alternative (Alternative 1). All three proposed action alternatives include water monitoring, management, and disposal; site preparation, construction or excavation activities; waste management and disposal; and some level of on-site transportation of potentially hazardous secondary wastes. All ARARs for these activities are listed in the EMWMF-EMDF RI/FS. Table D.1 of this Appendix lists a subset of these action-specific ARARs that are only those ARARs that need to be added to the EMWMF ROD to address landfill wastewater management. Table D.1 also includes some ARARs that were inadvertently left out of the EMWMF ROD (e.g., action leakage rate for the liner leak detection system; used oil and universal waste management and disposal).

Alternative 2 also includes on-site (at the EMWMF/EMDF) treatment of landfill wastewater, including construction of a wastewater treatment unit (WWTU), with on-site discharge to Bear Creek. Alternatives 3 and 4 include similar treatment but at the PWTC or at OF200 WTS (and may include construction of a pretreatment facility, if needed, at EMWMF or at OF200). ARARs specific to the water treatment facilities are listed under a special heading ("Water treatment") in the table.

Although the EMWMF and the proposed EMDF are designed to accept RCRA Subtitle C hazardous waste, no RCRA listed hazardous waste has been disposed at EMWMF and all RCRA characteristic waste sent to the EMWMF has been treated to meet RCRA land disposal restrictions (LDRs) prior to transfer. Years of leachate and contact water sampling data indicate none of the water contains RCRA characteristic waste. No RCRA listed waste is expected to be disposed at the proposed EMDF. Estimates of future waste streams at the EMDF, however, indicate there may be enough mercury to cause leachate or contact waters to fail TCLP for hazardous characteristics, which would cause the wastewater stream to be characteristically hazardous.

On-site wastewater treatment units that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are exempt from the requirements of RCRA Subtitle C for all tank systems, conveyance systems (whether piped or trucked), and ancillary equipment used to store or transport RCRA contaminated water. Therefore, RCRA requirements are not legally applicable to the wastewater treatment facility(ies), including any tanks, containers, trucks, pipelines, or surface impoundments. However, because the EMWMF and the proposed EMDF are designed to meet RCRA hazardous waste facility standards and the EMDF water may be characteristically hazardous, the situation is considered sufficiently similar and "well suited" to a RCRA site to consider certain of the RCRA standards "relevant and appropriate" requirements under the CERCLA ARARs process for this action [see 40 CFR 300.430(g)(2) for a discussion of the "relevant and appropriate" analysis process]. These include the design, construction, operation, and closure/post-closure standards for tanks and surface impoundments.

RCRA requirements for the characterization, management, and disposal of hazardous waste are ARARs in the event that secondary waste streams (e.g., spent filters) from the management/treatment of

wastewater are determined to be hazardous waste. RCRA requirements would be legally applicable to the management of these newly generated hazardous wastes. These requirements are not included in Table D.1 because they are already in the EMWMF ROD and are included in the EMWMF-EMDF RI/FS.

Although effluent from RCRA Subtitle C hazardous waste landfills is regulated under the CWA and subject to effluent limits set under 40 CFR 445.11, EPA notes that RCRA Subtitle C landfills that only receive wastes generated by the industrial operations directly associated with the landfill (i.e., "captive landfills") are exempt from these CWA effluent standards for Subtitle C hazardous waste landfills [40 CFR §445.1(e); 65 FR 3008, January 19, 2000]. EMWMF and the proposed EMDF qualify for this exemption, and the proposed WWTU would be part of the landfill complex, thus the §445.11 limits are not triggered as action-specific ARARs for the water treatment alternatives.

The surface water quality standards discussed as chemical-specific ARARs in Section D.2 and listed as chemical-specific ARARs in Table D.1 will be implemented through the state's action-specific effluent discharge requirements under the CWA. The state requires that point source discharges of wastewaters receive the degree of treatment or effluent reduction necessary to comply with water quality standards and, where appropriate, that such discharges comply with the "Standard of Performance" as required by TN Water Quality Control Act at TCA §§69-3-101, et seq. For industrial discharges without applicable National Pollutant Discharge Elimination System federal effluent guidelines for its particular category of industry, best professional judgment must be employed to determine appropriate effluent limitations and standards. As discussed in Section D.2, the specific effluent criteria and how and where they would be applied and enforced as final limits, should the selected remedy include an on-site WWTU, would be negotiated and set in the final decision document for this action and could include any subset of these criteria, as determined by the regulatory authorities.

It is possible that there may be air pollutant emissions from a constructed landfill wastewater treatment system, although the amounts are not expected to be large enough to be considered a "major source" or to exceed emission thresholds and offset ratios allowed under Clean Air Act (CAA) regulations. The National Ambient Air Quality Standards (NAAQS) are established as the criteria state and local governments must plan to achieve and thus are not directly enforceable in and of themselves. Under the CAA §110, states are required to promulgate regulations to achieve the NAAQS and these state regulations are then the potential ARARs. The CAA National Emission Standards for Hazardous Air Pollutants (NESHAPs) for various industrial sources that emit one of several pollutants are established in 40 CFR 61. Most of the NESHAPs are neither applicable nor relevant and appropriate to cleanup at CERCLA sites because they regulate particular types of sources that would not be expected to be found at a CERCLA site (EPA, 1989; EPA, 1990; EPA, 1992a). No NESHAPs were identified as ARARs for this particular response action. The RCRA air emission control requirements of 40 CFR 264 Subpart CC [air emission standards for tanks] do not apply to a waste management unit(s) that is used solely for on-site treatment or storage of hazardous waste that is generated as the result of implementing remedial activities required under CERCLA authorities [40 CFR 264.1080(b)(5); TDEC 0400-12-01-.32(a)(2)(v)]. On-site remediation and treatment of contaminated water using air strippers is also an exempted air contaminant source under TDEC regulations provided the emissions are no more than 5 tons per year of any regulated pollutant that is not a hazardous air pollutant and less than 1000 pounds per year of each hazardous air pollutant [TDEC 1200-03-09-.04(4)(d)(24)]. If on-site water treatment is selected as part of an alternative, the air regulations and available exemptions will be reexamined as ARARs as facility design is further developed and refined.

Per EPA regulation and guidance, reporting and recordkeeping requirements, as well as requirements related to training, inspections, contingency planning, test procedures, and sampling methods are considered administrative requirements, not substantive environmental protection standards, therefore are not ARARs [40 CFR 300.5; EPA, 1992b, pg. 2; Preamble to the Final NCP, 55 *FR* 8756, March 8, 1990;

EPA, 1988, pg. 1-11]. Although these requirements will be met as mandated by internal DOE and company policy and procedures, and will be completed in accordance with those procedures and CERCLA requirements and guidance and documented in project files, they are not listed as ARARs on Table D.1.

D.5 REFERENCES

DOE/OR/01-1791&D3. *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*, 1999, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

DOE/OR/01-2161&D2. *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee*, 2005, U.S. Department of Energy, Office of Environmental Management, Oak Ridge, TN.

EPA/540/G-89/006. *CERCLA Compliance with Other Laws Manual, Part I*, August 8, 1988, OSWER Directive 9234.1-01.

EPA/540/G-89/009. *CERCLA Compliance with Other Laws Manual, Part II*, August, 1989, OSWER Directive 9234.1-02.

EPA OSWER Directive 9200.4-18. *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, August, 1997.

EPA OSWER Directive 9234.2-01/FS-A. *ARARs Q's and A's: General Policy, RCRA, CWA, SDWA, Post-ROD Information, and Contingent Waivers*, June 1991.

EPA OSWER Directive 9345.3-03/FS. *Guide to Management of Investigation-Derived Wastes*, January, 1992.

EPA OSWER Directive 9234.2-07/FS. *CERCLA Compliance with Other Laws Manual: Summary of Part II – CAA, TSCA, and Other Statutes*, April, 1990.

EPA Publication 9234.2-22FS. *ARARs Fact Sheet: Compliance with the Clean Air Act and Associated Air Quality Requirements*, September, 1992.

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Table D.1. ARARs and TBC guidance for landfill wastewater management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee

Action	Requirements	Prerequisite	Citation
	Chemical-specific ARARs		
Instream water quality criteria for release of contact water and leachate into Bear Creek tributary	Dissolved oxygen shall not be less than 5.0 mg/l. Substantial or frequent variations in dissolved oxygen levels, including diurnal fluctuations, are undesirable if caused by man-induced conditions. Diurnal fluctuations shall not be substantially different than the fluctuations noted in reference streams in the region. There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.	Release of wastewater or effluents into surface water—**applicable** as instream criteria beyond the mixing zone	TDEC 0400-40-03-.03(3)(a) TDEC 0400-40-03-.03(4)(a) TDEC 0400-40-03-.03(5)(a) TDEC 0400-40-03-.03(6)(a)
	The pH value shall not fluctuate more than 1.0 unit over a period of 24 hours and shall not be outside the following ranges: 6.0-9.0.		TDEC 0400-40-03-.03(3)(b) TDEC 0400-40-03-.03(4)(b) TDEC 0400-40-03-.03(5)(b) TDEC 0400-40-03-.03(6)(b)
	The hardness of or the mineral compounds contained in the water shall not impair its use for irrigation or livestock watering and wildlife.		TDEC 0400-40-03-.03(5)(c) TDEC 0400-40-03-.03(6)(c)
	There shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life or recreation or impair its use for irrigation or livestock watering and wildlife.		TDEC 0400-40-03-.03(3)(c) TDEC 0400-40-03-.03(4)(c) TDEC 0400-40-03-.03(5)(d) TDEC 0400-40-03-.03(6)(d)
	There shall be no turbidity, total suspended solids, or color in such amounts or of such character that will materially affect fish and aquatic life or result in any objectionable appearance to the water, considering the nature and location of the water.		TDEC 0400-40-03-.03(3)(d) TDEC 0400-40-03-.03(4)(d)
	The maximum water temperature shall not exceed 3 degrees C relative to an upstream control point. The temperature of the water shall not exceed 30.5 degrees C and the maximum rate of change shall be 2 degrees C per hour. There shall be no abnormal water temperature changes that may affect aquatic life unless caused by natural conditions. The temperature in flowing streams shall be measured at mid-depth. Temperature shall not interfere with its use for irrigation or livestock watering and wildlife purposes.		TDEC 0400-40-03-.03(3)(e) TDEC 0400-40-03-.03(4)(e) TDEC 0400-40-03-.03(5)(e) TDEC 0400-40-03-.03(6)(e)
	Waters shall not contain substances that will impart unpalatable flavor to fish or result in noticeable offensive odors in the vicinity of the water or otherwise interfere with fish or aquatic life.		TDEC 0400-40-03-.03(3)(f) TDEC 0400-40-03-.03(4)(g)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Instream water quality criteria for release of contact water and leachate into Bear Creek tributary (continued)	Waters shall not contain substances or combination of substances including disease-causing agents which, by way of either direct exposure or indirect exposure through food chains, may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), physical deformations, or restrict or impair growth in fish or aquatic life or their offspring. See Table D.2 for list of criteria for key contaminants of concern.		TDEC 0400-40-03-.03(3)(g)
	Water shall not contain toxic substances that will render the water unsafe or unsuitable for water contact activities including the capture and subsequent consumption of fish and shellfish, or will propose toxic conditions that will adversely affect man, animal, aquatic life, or wildlife. See Table D.2 for list of criteria for key contaminants of concern.		TDEC 0400-40-03-.03(4)(j)
	Water shall not contain other pollutants that will be detrimental to fish or aquatic life, or adversely affect the quality of the waters for recreation, irrigation, or livestock watering and wildlife.		TDEC 0400-40-03-.03(3)(h) TDEC 0400-40-03-.03(4)(k) TDEC 0400-40-03-.03(5)(f) and (g) TDEC 0400-40-03-.03(6)(f) and (g)
	Water shall not contain iron at concentrations that cause toxicity or in such amounts that interfere with habitat due to precipitation or bacteria growth.		TDEC 0400-40-03-.03(3)(i)
	The one-hour and thirty-day average concentrations of ammonia shall not exceed the acute criterion and chronic criteria calculated using the equations given in TDEC 0400-40-03-.03(3)(j).		TDEC 0400-40-03-.03(3)(j)
	Water shall not contain nutrients in concentrations that stimulate aquatic plant and/or algae growth to the extent that aquatic habitat is substantially reduced and/or biological integrity fails to meet regional goals or that the public's recreational uses of the water body or downstream waters are affected. Quality of downstream waters shall not be detrimentally affected. Interpretation of this provision may be made using the document Development of Regionally-based Interpretations of Tennessee's Narrative Nutrient Criterion and/or other scientifically defensible methods.		TDEC 0400-40-03-.03(3)(k) TDEC 0400-40-03-.03(4)(h)
	The concentration of the *e. coli* group shall not exceed 126 per 100 ml as a geometric mean based on a minimum of 5 samples collected as specified in the regulation. The concentration of *e. coli* group in any individual sample shall not exceed 1 per 100 ml.		TDEC 0400-40-03-.03(3)(l) TDEC 0400-40-03-.03(4)(f)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Instream water quality criteria for release of contact water and leachate into Bear Creek tributary (continued)	Waters shall not be modified through the addition of pollutants or through physical alteration to the extent that diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or, in the case of wadeable streams, substantially different from conditions in reference streams in the same ecoregion. The parameters associated with this criterion are the aquatic biota measured. These are response variables.		TDEC 0400-40-03-.03(3)(m)
	Quality of stream habitat shall provide for development of a diverse aquatic community that meets regionally-based biological integrity goals. Types of habitat loss include channel and substrate alterations, rock and gravel removal, stream flow changes, accumulation of silt, precipitation of metals, and removal of riparian vegetation. For wadeable streams, instream habitat within each sub ecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.		TDEC 0400-40-03-.03(3)(n)
	Stream flow shall support fish and aquatic life criteria and recreational use.		TDEC 0400-40-03-.03(3)(o) TDEC 0400-40-03-.03(4)(m)
Antidegradation requirements	Effluent limitations may be required to insure [sic] compliance with the Antidegradation Statement in TDEC 0400-40-03-.06.	Point source discharge(s) of pollutants into waters of the U.S. **—applicable**	TDEC 0400-40-05-.10(4)
	New or increased discharges that would cause measurable degradation of the parameter that is unavailable shall not be authorized. Nor will discharges be authorized if they cause additional loadings of unavailable parameters that are bioaccumulative or that have criteria below current method detection levels.	Waters with “unavailable”[as defined in TDEC 0400-40-03-.06(2)] parameters**—applicable**	TDEC 0400-40-03-.06(2)(a)
	No new or expanded water withdrawals that will cause additional measurable degradation of the unavailable parameter shall be authorized.		TDEC 0400-40-03-.06(2)(b)
	Where one or more of the parameters comprising the habitat criterion are unavailable, activities that cause additional degradation of the unavailable parameter or parameters above the level of de minimis shall not be authorized.		TDEC 0400-40-03-.06(2)(c)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	Location-specific ARARs		
	Wetlands		
Presence of jurisdictional wetlands as defined in 40 CFR 230.3; 33 CFR 328.3(a), and 33 CFR 328.4	The discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands, is prohibited if there is a practical alternative that would have less adverse impact. No discharge shall be permitted that results in violation of state water quality standards, violates any toxic effluent standard, and/or jeopardizes an endangered species or its critical habitat. No discharge will be permitted that will cause significant degradation of waters of the United States. No discharge is permitted unless mitigation measures have been taken in accordance with 40 CFR 230, Subpart H.	Actions that involve the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands—**applicable**	40 CFR 230.10(a), (b), (c) and (d) 40 CFR 230, Subpart H
Mitigation of state wetlands as defined under TDEC 0400-40-07-.03	If an applicant proposes an activity that would result in an appreciable permanent loss of resource value of wetlands, the applicant must provide mitigation, which results in no overall net loss of resource value. Compensatory measures must be at a ratio of 2:1 for restoration, 4:1 for creation and enhancement, and 10:1 for preservation, or at a best professional judgment ratio agreed to by the state. For any mitigation involving the enhancement or preservation of existing wetlands, to the extent practicable, the applicant shall complete the mitigation before any impact occurs to the existing state waters. For any mitigation involving restoration or creation of a wetland, to the extent practicable, the mitigation shall occur either before or simultaneously with impacts to the existing state waters. Mitigation actions for impacts to wetlands are prioritized as listed in TDEC 0400-40-07-.04 (7)(b)(1)(i) – (viii).	Activity that would cause loss of wetlands as defined in TDEC 0400-40-07-.03—**applicable**	TDEC 0400-40-07-.04 (7)(b)
Presence of minor isolated wetlands of less than 0.25 acres – Minor alterations to wetlands	Alteration of up to 0.25 acre of wetlands that are degraded or of low functional capacity must meet certain requirements as follows: • The alteration shall not adversely affect the functions and classified use support of adjacent wetlands. • Any material discharged into wetlands shall be free of contaminants, including toxic pollutants, hazardous substances, waste metals, or construction debris, or other wastes. • Excavation and fill activities shall be kept to a minimum, and all excess material shall be hauled upland and properly stabilized or disposed of. • Erosion and sediment controls shall be designed according to the size and slope of disturbed or drainage to detain runoff and trap sediment, and shall be properly selected, installed, and maintained in accordance with manufacturer's specifications and good engineering practices.	Alteration of minor isolated wetlands of less than 0.25 acres—**applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP General Permit for Minor Alterations to Wetlands (effective July 1, 2010) (**TBC**)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	• Erosion and sedimentation control shall be in place and functional before earthmoving operations begin and must be maintained throughout the construction period. Temporary measures may be removed at the beginning of the work day but shall be replaced at the end of the work day. • Litter, construction debris, and construction chemicals exposed to stormwater shall be picked up prior to anticipated storm events or otherwise prevented from becoming a pollutant source for stormwater discharges. • Clearing, grubbing, or other disturbance of areas immediately adjacent to waters of the state shall be limited to the minimum necessary to accomplish the proposed activity. Unnecessary vegetation removal is prohibited, and disturbed areas shall be stabilized and revegetated as soon as practicable.		
	Aquatic resources		
Waters of the state as defined in *TCA* 69-3-103(42) – General permit conditions	Must comply with the [substantive] requirements of the ARAP for erosion and sediment control to prevent pollution of waters of the state. Pollution control requirements, as detailed in each particular General Permit, include but are not limited to, the following: • Activity must not result in discharge of waste or substances that may be harmful to humans or wildlife; • Material may not be placed in a location or manner so as to impair surface water flow into or out of any wetland area; • Work must be carried out in a manner that does not violate water quality criteria as stated in TDEC 0400-40-03-.03, including, but not limited to, prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the designated uses for that water body by TDEC 0400-40-04; • Excavation and fill activities shall be kept to a minimum, and all excess material shall be hauled upland and properly stabilized or disposed of. • Sediment shall be prevented from entering waters of the state; erosion and sediment controls shall be designed according to the size and slope of disturbed or drainage to detain runoff and trap sediment, and shall be properly selected, installed, and maintained in accordance with manufacturer's specifications and good engineering practices. • Erosion and sedimentation control shall be in place and functional before earthmoving operations begin and must be maintained throughout the construction period. Temporary measures may be removed at the beginning of the work day but shall be replaced at the end of the work day.	Action potentially altering the properties of any waters of the state**—applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP Program conditions common to all General Permits (**TBC)**

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	• Litter, construction debris, and construction chemicals exposed to stormwater shall be picked up prior to anticipated storm events or otherwise prevented from becoming a pollutant source for stormwater discharges. • Clearing, grubbing, or other disturbance of areas immediately adjacent to waters of the state shall be limited to the minimum necessary to accomplish the proposed activity. Unnecessary vegetation removal is prohibited, and disturbed areas shall be stabilized and revegetated as soon as practicable. • Appropriate steps shall be taken to ensure petroleum products or other chemical pollutants are prevented from entering waters of the state, including groundwater; • Adverse impacts to T&E species or cultural, historical, or archeological features or sites are prohibited.		
Waters of the state as defined in *TCA* 69-3-103(42) – Bank stabilization	Bank stabilization activities along state waters must be conducted in accordance with the requirements of the ARAP Program (Rules of the TDEC, Chap. 0400-40-07). The general permit requirements for stream bank stabilization include the following: • The erosion and sedimentation control practices indicated under the TDEC ARAP general conditions apply; in addition, • Stream beds must not be used as transport routes for construction equipment; • Temporary stream crossings shall be limited to one point in the construction area and erosion control measures shall be utilized where stream banks are disturbed; crossing shall be constructed so that stream flow is not obstructed; • Following construction, all materials used for the temporary crossing shall be removed and disturbed banks shall be restored and stabilized if needed; • Materials used in bank stabilization shall include clean rock, riprap, anchored trees or other non-erodible materials found in the natural environment; materials shall be free of contaminants including toxic pollutants, hazardous substances, waste metals, or construction debris, or other wastes. • Activity may not be conducted in a manner that would permanently disrupt the movement of fish and aquatic life; • Material may not be placed such that it impairs surface water flow into or out of any wetland area; • Except under certain conditions detailed in the permit, length of bank stabilization is limited to 300 linear ft.	Bank-stabilization activities affecting waters of the state—**applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP General Permit for Bank Stabilization Activities (effective July 1, 2010) (**TBC**)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Waters of the state as defined in *TCA* 69-3-103(42) – Culvert maintenance activities	The maintenance of existing serviceable structures or fills along waters of the state must be conducted in accordance with the requirements of the ARAP Program (Rules of the TDEC, Chap. 0400-40-07). The general permit requirements for maintenance activities include the following: • The erosion and sedimentation control practices indicated under the TDEC ARAP general conditions apply; in addition, • Placement of material for scour protection or repair shall be limited to clean rock, riprap, rock-filled wire baskets or mattresses, or concrete contained by formwork for footing repair. Clean rock can be of various type and sizes depending on application. Clean rock shall not contain fines, soils, or other wastes or contaminants. • Materials used in maintenance activities shall be free of contaminants, including toxic pollutants, hazardous substances, waste metal, construction debris and other wastes as defined by *TCA* 69-3-103-(18). • Placement of material shall not impair flow or be conducted in a manner that would permanently disrupt the movement of fish or aquatic life. • Streambeds shall not be used as transportation routes for construction equipment. Temporary stream crossings shall be limited to one point in the construction area and erosion control measures shall be utilized where stream banks are disturbed. Stream crossings shall be constructed of clean rock and stream flow shall be conveyed in appropriately sized pipe. Crossing shall be constructed so that stream flow is not obstructed. Following construction, all materials used for temporary crossing shall be removed and disturbed stream banks restored and stabilized if needed. • Excavation and fill activities shall be kept to a minimum and shall be separated from flowing waters to the extent practicable and necessary. Activities shall be conducted in the dry to the maximum extent practicable by diverting flow utilizing cofferdams, berms, temporary channels, or pipes. Temporary diversion channels shall be protected by non-erodible material and lined to the expected high water level. • Excavated materials, removed vegetation, construction debris, and other wastes shall be removed to an upland location and properly stabilized or disposed of in such a manner as to prevent reentry into the waterway. • The placement of riprap shall be the minimum necessary to protect the structure or to ensure the safety of the structure.	Maintenance activities affecting waters of the state—**applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP General Permit for Maintenance Activities (effective July 1, 2010) (**TBC**)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Waters of the state as defined in *TCA* 69-3-103(42) – Culvert maintenance activities (continued)	• Sediment shall be prevented from entering waters of the state. Erosion and sediment control measures shall be designed according to the size and slope of the disturbed or drainage areas to detain runoff and trap sediment and shall be properly selected, installed, and maintained in accordance with the manufacturer's specifications and good engineering practices.		
	• Erosion and sediment controls must be in place and functional before earth moving operations begin, and shall be constructed and maintained throughout the construction period. Temporary measures may be removed at the beginning of the work day but replaced at the end of the work day.		
	• Litter, construction debris, and construction chemicals exposed to storm water shall be picked up prior to anticipated storm events, or otherwise prevented from becoming a pollutant source for storm water discharges. After use, silt fences should be removed.		
	• Clearing, grubbing, and other disturbance to riparian vegetation shall be kept to minimum necessary for slope construction and equipment operations. Unnecessary riparian vegetation removal, including trees, is prohibited.		
	• Material may not be placed in a location or manner so as to impair surface water flow into or out of any wetland area.		
	• Appropriate steps shall be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the state. All spills shall be reported to the appropriate emergency response agency and to TDEC and all measures taken immediately to prevent pollution of waters of the state, including groundwater.		
Waters of the state as defined as *TCA* 69-3-103 – Wet weather conveyances	Wet-weather conveyances may be altered provided the following conditions are met:	Activities that alter wet-weather conveyances—**applicable**	TDEC 0400-40-07-.04(10)(a) TDEC ARAP General Permit for Alteration of Wet Weather Conveyances (effective July 1, 2010) (**TBC**)
	• The activity must not result in the discharge of waste or other substances that may be harmful to humans or wildlife;		TDEC 0400-40-07-.04(10)(a)(1)
	• Material must not be placed in a location or manner so as to impair surface water flow into or out of any wetland area; and		TDEC 0400-40-07-.04(10)(a)(2)
	• Sediment shall be prevented from entering other waters of the state:		TDEC 0400-40-07-.04(10)(a)(3)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	- Erosion/sediment controls shall be designed according to size and slope of disturbed or drainage areas to detain runoff and trap sediment and shall be properly selected, installed, and maintained in accordance with manufacturer's specifications and good engineering practices.		TDEC 0400-40-07-.04(10)(a)(3)(i)
	- Erosion/sediment control measures must be in place and functional before earthmoving operations begin, and must be constructed and maintained throughout construction period. Temporary measures may be removed at the beginning of the work day, but shall be replaced at end of the work day.		TDEC 0400-40-07-.04(10)(a)(3)(ii)
	- Checkdams must be utilized where runoff is concentrated. Clean rock, log, sandbag or straw bale checkdams shall be properly constructed to detain runoff and trap sediment. Checkdams or other erosion control devices are not to be constructed in stream. Clean rock can be of various type and size depending on the application and must not contain fines or other wastes or contaminants.		TDEC 0400-40-07-.04(10)(a)(3)(iii)
	• Appropriate steps must be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the state. All spills must be reported to the appropriate emergency management agency and TDEC. In event of spill, measures shall be taken immediately to prevent pollution of waters of the state, including groundwater.		TDEC 0400-40-07-.04(10)(a)(4)
Mitigation of state waters other than wetlands	Must provide mitigation that results in no overall net loss of resource values for any activity that would result in appreciable permanent loss of resource value of a state water. For any mitigation involving relocation or re-creation of a stream segment, to extent practicable must complete mitigation before any impact occurs to existing state waters. Mitigation measures include but are not limited to: restoration of degraded stream reaches and/or riparian zones; new (relocated) stream channels; removal of pollutants from and hydrologic buffering of stormwater runoff; and other measures which have a reasonable likelihood of increasing the resource value of a state water. Mitigation measures or actions should be prioritized in the following order: restoration, enhancement, re-creation, and protection.	Activity that would result in an appreciable permanent loss of resource value of a state water **—applicable**	TDEC 0400-40-07-.04(7)(a)
	Endangered, threatened, or rare species		
Presence of federally endangered or threatened species, as designated in 50 CFR 17.11 and 17.12 or critical habitat of such species	Actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken.	Action that is likely to jeopardize fish, wildlife, or plant species or destroy or adversely modify critical habitat—**applicable**	16 USC 1531 et seq., Sect. 7(a)(2)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Presence of migratory birds as defined in 50 CFR 10.13, and their habitats	Unlawful killing, possession, and sale of migratory bird species, as defined in 50 CFR 10.13, native to the U.S. or its territories is prohibited.	Federal agency action that is likely to impact migratory birds**—applicable**	16 USC 703-704
	Requirements are as follows: • avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency action; • restore and enhance the habitats of migratory birds, as practicable; • prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable.	Federal agency action that is likely to impact migratory birds**—TBC**	Executive Order 13186
Action-specific ARARs			
Waste characterization and management			
Characterization and management of universal waste	A large quantity handler of universal waste must manage universal waste in accordance with [substantive requirements of] 40 CFR 273 in a way that prevents releases of any universal waste or component of a universal waste to the environment.	Generation of universal waste [as defined in 40 CFR 273] for disposal—**applicable**	40 CFR 273 TDEC 0400-12-01-.12
	Must label or mark the universal waste to identify the type of universal waste.		40 CFR 273.34 TDEC 0400-12-01-.12(3)(e)
	A large quantity handler of universal waste must immediately contain all releases of universal wastes and other residues from universal wastes, and must determine whether any material resulting from the release is hazardous waste, and if so, must manage the hazardous waste in compliance with all applicable requirements.		40 CFR 273.37 TDEC 0400-12-01-.12(3)(h)
Disposal of universal waste	The generator of the universal waste must determine whether the waste exhibits a characteristic of hazardous waste. If it is determined to exhibit such a characteristic, it must be managed in accordance with 40 CFR 260 through 272 [TDEC 0400-1-11-.01 through .10]. If the waste is not hazardous, the generator may manage and dispose of it in any way that is in compliance with applicable federal, state, and local solid waste regulations.	Generation of universal waste [as defined in 40 CFR 273] for disposal—**applicable**	40 CFR 273.33 TDEC 0400-12-01-.12(3)(d)
Management and storage of used oil	Used oil shall not be stored in a unit other than a tank or container.	Generation and storage of used oil, as defined in 40 CFR 279.1]—**applicable**	40 CFR 279.22(a) TDEC 0400-12-01-.11(3)(c)(1)
	Containers and aboveground tanks used to store used oil must be in good condition (no severe rusting, apparent structural defects or deterioration); and not leaking (no visible leaks).		40 CFR 279.22(b)(1) and (2) TDEC 0400-12-01-.11(3)(c)(2)(i) and (ii)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	Containers and aboveground tanks used to store used oil and fill pipes used to transfer used oil into USTs must be labeled or marked clearly with the words "Used Oil."		40 CFR 279.22(c)(1) and (2) TDEC 0400-12-01-.11(3)(c)(3)(i) and (ii)
	Upon detection of a release of used oil to the environment, a generator must stop the release; contain, clean up, and properly manage the released used oil; and, if necessary, repair or replace any leaking used oil storage containers or tanks prior to returning them to service.	Release of used oil to the environment**—applicable**	40 CFR 279.22(d) TDEC 0400-12-01.11(3)(c)(4)
	Landfill liner system		
Leak detection system action leakage rate	Action leakage rate for liner system: (a) Action leakage rate is the maximum design flow rate that the leak detection system (LDS) can remove without fluid head on the bottom liner exceeding l foot. The action leakage rate must include an adequate safety margin to allow for uncertainties in the design (e.g., slope, hydraulic conductivity, thickness of drainage material), construction, operation, and location of the LDS, waste and leachate characteristics, likelihood and amounts of other sources of liquids in the LDS, and proposed response actions. (b) To determine if the action leakage rate has been exceeded, the owner or operator must convert the weekly or monthly flow rate from the monitoring data obtained under part 264.303(c) of this paragraph to an average daily flow rate (gallons per acre per day) for each sump.	Design and construction of a hazardous waste landfill - **applicable**	40 CFR 264.302 TDEC 0400-12-01-.06(c)
	Water treatment		
Construction of new outfall structure for discharge of wastewater	Construction, maintenance, repair, rehabilitation or replacement of intake or outfall structures shall be carried out in such a way that work: • Does not violate water quality criteria as stated in TDEC 0400-40-03-.03 including but not limited to prevention of discharges that causes a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the designated uses for that water body by TDEC 0400-40-04. • Activities in non-navigable streams shall be conducted in the dry; in navigable streams, where impracticable to work in the dry, work may be conducted within the water column.	Construction of intake and outfall structures in waters of the state—**applicable** to Alternative 2	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC General Permit for Construction of Intake and Outfall Structures (effective July 1, 2010) (**TBC**)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	• Shall be located and oriented so as to avoid permanent alteration or damage to the integrity of the stream channel including the opposite stream bank. Alignment of the structure (except for diffusers) should be as parallel to the stream flow as is practicable, with the discharge pointed downstream. Diffusers may be placed perpendicular to stream flow for more complex mixing.		
Construction of new outfall structure for discharge of wastewater (continued)	• Intake and outfall structures shall be designed to minimize harm and prevent impoundment of normal or base flows. • Velocity dissipation devices shall be placed as needed at discharge locations to provide a non-erosive velocity from the structure. • Activity may not be conducted in a manner that would permanently disrupt the movement of fish and aquatic life. • Material may not be placed in a location or manner so as to impair surface water flow into or out of any wetland area. • Backfill activities must be accomplished in a manner that stabilizes the streambed and banks to prevent erosion. All contours must be returned to pre-project conditions to the extent practicable and completed activities may not disrupt or impound stream flow. • Stream beds must not be used as transportation routes for construction equipment; • Temporary stream crossings shall be limited to one point in the construction area and erosion control measures shall be utilized where stream banks are disturbed. Crossing shall be constructed so that stream flow is not obstructed. Following work, all materials used for temporary crossing must be removed and disturbed stream banks restored and stabilized. • Materials used in intake and outfall structures must be free of contaminants and wastes as defined by TCA 69-3-103(18). • Clearing, grubbing and other disturbances to riparian vegetation shall be kept to a minimum necessary for slope construction and equipment operations. Unnecessary tree removal is prohibited. • Sediment shall be prevented from entering waters of the state. Erosion and sediment control measures shall be properly selected, installed, and maintained and must be in place and functional before earth moving operations begin.		*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC General Permit for Construction of Intake and Outfall Structures (effective July 1, 2010) (**TBC**)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	• Litter, construction debris, and construction chemicals exposed to storm water shall be picked up prior to anticipated storm events or otherwise prevented from becoming a pollutant source during storms. • Excavated materials, removed vegetation, construction debris, and other wastes shall be removed to an upland location and properly stabilized or disposed of to prevent reentry into the waterway. • Take appropriate steps to ensure petroleum products or other chemical pollutants are prevented from entering waters of the state. In event of a spill, take immediate measures to prevent pollution of waters of the state.		
Design and installation of a RCRA tank system (tanks and associated piping)	Must prepare an assessment attesting that the tank system design has sufficient structural integrity and is acceptable for the storing/treating of hazardous waste. The assessment must include the information specified in 40 CFR 264.192(a)(1)-(5) [TDEC 0400-12-01-.06(10)(c)(1)-(5)].	Storage of RCRA hazardous waste in a new tank system– **applicable** if water is determined to be hazardous	40 CFR 264.192(a) TDEC 0400-12-01-.06(10)(c)(1)
	Prior to use, must ensure that proper handling procedures are adhered to in order to prevent damage to the system during installation.		40 CFR 264.192(b) TDEC 0400-12-01-.06(10)(c)(2)
	Prior to use, must inspect the system for the presence of weld breaks, punctures, scrapes of protective coatings, cracks, corrosion, other structural damage, or inadequate construction/installation. All discrepancies must be remedied before the system is covered, enclosed or placed in use.		40 CFR 264.192(b)(1)-(6) TDEC 0400-12-01-.06(10)(c)(2)(i)-(vi)
	Prior to use, tanks and ancillary equipment must be tested for tightness. If a tank system is found not to be tight, all repairs necessary to remedy the leak(s) must be performed prior to the system being placed into use.		40 CFR 264.192(d) TDEC 0400-12-01-.06(10)(c)(4)
	Ancillary equipment (i.e., piping) must be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.		40 CFR 264.192(e) TDEC 0400-12-01-.06(10)(c)(5)
	Must provide the degree of corrosion protection based upon the information in 40 CFR 264.192(a)(3) [TDEC 0400-12-01-.06(10)(c)(1)(iii)] to ensure the integrity of the tank system during use. Installation of field fabricated corrosion protection system must be supervised by an independent corrosion expert.		40 CFR 264.192(f) TDEC 0400-12-01-.06(10)(c)(6)
	Must provide secondary containment in order to prevent release of hazardous waste or constituents into the environment.		40 CFR 264.193(a)(1) TDEC 0400-12-01-.06(10)(d)(1)
	Secondary containment systems must be: • designed, installed, and operated to prevent any migration of wastes or accumulated liquid out of the system to the soil, ground water, or surface water at any time during the use of the tank system;		40 CFR 264.193(b)(1) TDEC 0400-12-01-.06(10)(d)(2)(i)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	• capable of detecting and collecting releases and accumulated liquids until the collected material is removed;		40 CFR 264.193(b)(2) TDEC 0400-12-01-.06(10)(d)(2)(ii)
Design and installation of a RCRA tank system (tanks and associated piping) (continued)	• constructed of or lined with materials that are compatible with the wastes to be placed in the tank system and must have sufficient strength and thickness to prevent failure owing to pressure gradients (including static head and external hydrological forces), physical contact with the waste to which it is exposed, climatic conditions, and the stress of daily operation (including stresses from nearby vehicular traffic)		40 CFR 264.193(c)(1) TDEC 0400-12-01-.06(10)(d)(3)(i)
	• placed on a foundation or base capable of providing support to the secondary containment system, resistance to pressure gradients above and below the system, and capable of preventing failure due to settlement, compression, or uplift;		40 CFR 264.193(c)(2) TDEC 0400-12-01-.06(10)(d)(3)(ii)
	• provided with a leak-detection system that is designed and operated so it will detect the failure of either the primary or secondary containment structure or presence of any release of hazardous waste or accumulated liquid in the secondary containment system within 24 hours, or at the earliest practicable time if the owner can demonstrate that existing detection technologies or site conditions will not allow detection of a release within 24 hours; and		40 CFR 264.193(c)(3) TDEC 0400-12-01-.06(10)(d)(3)(iii)
	• sloped or otherwise designed or operated to drain and remove liquids resulting from leaks, spills, or precipitation. Spilled or leaked waste and accumulated precipitation must be removed from the secondary containment system within 24 hours, or in as timely a manner as is possible to prevent harm to human health and the environment, if the owner can demonstrate that removal of the released waste or accumulated precipitation cannot be accomplished within 24 hours.		40 CFR 264.193(c)(4) TDEC 0400-12-01-.06(10)(d)(3)(iv)
	The secondary containment for tanks must include one or more of the following devices: • a liner (external to the tank); • a vault; • a double-walled tank; or • an equivalent device as approved by the EPA.		40 CFR 264.193(d)(1-4) TDEC 0400-12-01-.06(10)(d)(4)(i-iv)
	External liner systems must be: • designed and operated to contain 100 percent of the capacity of the largest tank within its boundary;		40 CFR 264.193(e)(1)(i) TDEC 0400-12-01-.06(10)(d)(5)(i)(I)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Design and installation of a RCRA tank system (tanks and associated piping) (continued)	• designed or operated to prevent run-on or infiltration of precipitation into the secondary containment system unless the collection system has sufficient excess capacity to contain run-on or infiltration. [Such additional capacity must be sufficient to contain precipitation from a 25 year, 24-hour rainfall event];		40 CFR 264.193(e)(1)(ii) TDEC 0400-12-01-.06(10)(d)(5)(i)(II)
	• free of cracks or gaps; and		40 CFR 264.193(e)(1)(iii) TDEC 0400-12-01-.06(10)(d)(5)(i)(III)
	• designed and installed to surround the tank completely and to cover all surrounding earth likely to come into contact with the waste if the waste is released from the tank(s) (i.e., capable of preventing lateral as well as vertical migration of the waste).		40 CFR 264.193(e)(1)(iv) TDEC 0400-12-01-.06(10)(d)(5)(i)(IV)
	Vault system must be: • designed or operated to contain 100 percent of the capacity of the largest tank within its boundary;		40 CFR 264.193(e)(2)(i) TDEC 0400-12-01-.06(10)(d)(5)(ii)(I)
	• designed or operated to prevent run-on or infiltration of precipitation into the secondary containment system unless collection system has sufficient excess capacity to contain run-on or infiltration. [Such additional capacity must be sufficient to contain precipitation from a 25 year, 24-hour rainfall event];		40 CFR 264.193(e)(2)(ii) TDEC 0400-12-01-.06(10)(d)(5)(ii)(II)
	• constructed of chemical-resistant water stops in all joints (if any);		40 CFR 264.193(e)(2)(iii) TDEC 0400-12-01-.06(10)(d)(5)(ii)(III)
	• provided with an impermeable interior coating or lining that is compatible with the stored waste and that will prevent migration of the waste into the concrete;		40 CFR 264.193(e)(2)(iv) TDEC 0400-12-01- .06(10)(d)(5)(ii)(IV)
	• provided with a means to protect against formation of and ignition of vapors within the vault if the waste being stored or treated meets the definition of ignitable or reactive waste under 40 CFR 261.21 or 261.23; and		40 CFR 264.193(e)(2)(v) TDEC 0400-12-01-.06(10)(d)(5)(ii)(V)
	• provided with an exterior moisture barrier or otherwise designed or operated to prevent migration of moisture into the vault if the vault is subject to hydraulic pressure.		40 CFR 264.193(e)(2)(vi) TDEC 0400-12-01- .06(10)(d)(5)(ii)(VI)
	Double-walled tanks must be: • designed as an integral structure (i.e., an inner tank completely enveloped within and outer shell) so that any release from the inner tank is contained by the outer shell;		40 CFR 264.193(e)(3)(i) TDEC 0400-12-01-.06(10)(d)(5)(iii)(I)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Design and installation of a RCRA tank system (tanks and associated piping) (continued)	• protected, if constructed of metal, from both corrosion of the primary tank interior and of the external surface of the outer shell; and		40 CFR 264.193(e)(3)(ii) TDEC 0400-12-01-.06(10)(d)(5)(iii)(II)
	• provided with a built-in continuous leak detection system capable of detecting a release within 24 hours, or at the earliest practicable time.		40 CFR 264.193(e)(3)(iii) TDEC 0400-12-01-.06(10)(d)(5)(iii)(III)
	Ancillary equipment must be provided with secondary containment (e.g., trench, jacketing, double-walled piping) that meets the requirements of 40 CFR 264.193(b) and (c) [TDEC 0400-12-01-.06(10)(d)(2) and (3)] except for:		40 CFR 264.193(f) TDEC 0400-12-01-.06(10)(d)(6)
	• aboveground piping (exclusive of flanges, joints, valves, and other connections) that are visually inspected for leaks on a daily basis;		40 CFR 264.193(f)(1) TDEC 0400-12-01-.06(10)(d)(6)(i)
	• welded flanges, welded joints and welded connections, that are visually inspected for leaks on a daily basis;		40 CFR 264.193(f)(2) TDEC 0400-12-01-.06(10)(d)(6)(ii)
	• seamless or magnetic coupling pumps and seal-less valves, that are visually inspected for leaks on a daily basis; and		40 CFR 264.193(f)(3) TDEC 0400-12-01-.06(10)(d)(6)(iii)
	• pressurized aboveground piping systems with automatic shut-off devices (e.g., excess flow check valves, flow metering shutdown devices, loss of pressure actuated shut-off devices) that are visually inspected for leaks on a daily basis.		40 CFR 264.193(f)(4) TDEC 0400-12-01-.06(10)(d)(6)(iv)
Operation of RCRA tank system	Hazardous wastes or treatment reagents must not be placed in the tank system if they could cause the tank, its ancillary equipment or the containment system to rupture, leak, corrode, or otherwise fail.	Storage of RCRA hazardous waste in a new tank system—**applicable** if water is determined to be hazardous	40 CFR 264.194(a) TDEC 0400-12-01-.06(10)(e)(1)
	Must use appropriate controls and practices to prevent spills an overflows from the tank or containment system. These include at a minimum:		40 CFR 264.194(b) TDEC 0400-12-01-.06(10)(e)(2)
	• spill prevention controls (e.g., check valves, dry disconnect couplings);		40 CFR 264.194(b)(1) TDEC 0400-12-01-.06(10)(e)(2)(i)
	• overfill prevention controls (e.g., level sensing devices, high level alarms, automatic feed cutoff, or bypass to a standby tank; and		40 CFR 264.194(b)(2) TDEC 0400-12-01-.06(10)(e)(2)(ii)
	• maintenance of sufficient freeboard in uncovered tanks to prevent overtopping by wave or wind action or by precipitation		40 CFR 264.194(b)(3) TDEC 0400-12-01-.06(10)(e)(2)(iii)
	Must comply with the requirements of 40 CFR 264.196 [TDEC 0400-12-01-.06(10)(g)] if a leak or a spill occurs in the tank system.		40 CFR 264.194(c) TDEC 0400-12-01-.06(10)(e)(3)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Control of air emissions from an above-grade RCRA tank system, surface impoundment, or container	The requirements of 40 CFR 264 Subpart CC do not apply to a waste management unit that is used solely for on-site treatment or storage of hazardous waste that is generated as a result of implementing remedial activities required under CERCLA authorities.	Storage of RCRA hazardous waste in a new tank system, surface impoundment, or container — **applicable** if water is determined to be hazardous	40 CFR 264.1080(b)(5) TDEC 0400-12-01-.32(a)(2)(v)
Control of emissions from a WWTU treatment system	On-site remediation and treatment of contaminated water using air strippers is an exempted air contaminant source provided the emissions are no more than 5 tons per year of any regulated pollutant that is not a hazardous air pollutant and less than 1000 pounds per year of each hazardous air pollutant.	Emissions of air pollutants from new air contaminant sources —**applicable**	TDEC 1200-03-09-.04(4)(d)(24)
Design and installation of a RCRA surface impoundment	Must install a liner system consisting of two or more liners and a leachate collection and removal system, constructed in accordance with 40 CFR 264.221(c)(1)-(4) [TDEC 0400-12-01-.06(11)(b)(3)(i)-(iv)].	Storage of RCRA hazardous waste in a new surface impoundment—**applicable** if water is determined to be hazardous	40 CFR 264.221(c) TDEC 0400-12-01-.06(11)(b)(3)
	Must implement a leak detection system capable of detecting, collecting and removing leaks of hazardous constituents from all areas of the top liner during the active life and post-closure care period.		40 CFR 264.221(c)(2) TDEC 0400-12-01-.06(11)(b)(3)(ii)
	Must design, construct and maintain dikes with sufficient structural integrity to prevent massive failure.		40 CFR 264.221(h) TDEC 0400-12-01-.06(11)(b)(8)
	Alternative design practices to those in 40 CFR 264.221(c) [TDEC 0400-12-01-.06(11)(b)(3)] may be approved by the Regional Administrator.		40 CFR 264.221(d) TDEC 0400-12-01-.06(11)(b)(4)
Operation of RCRA surface impoundment	Design and operate facility to prevent overtopping resulting from normal or abnormal operations; overfilling; wind and wave action; rainfall; run-on; malfunctions of level controllers, alarms and other equipment; and human error.	Storage of RCRA hazardous waste in a new surface impoundment— **applicable** if water is determined to be hazardous	40 CFR 264.221(g) TDEC 0400-12-01-.06(11)(b)(7)
	Remove surface impoundment from operation if the dike leaks or if there is a sudden drop in liquid level.		40 CFR 264.227 TDEC 0400-12-01-.06(11)(h)
	Ignitable or reactive waste must not be placed in a surface impoundment unless it is treated so that it is no longer ignitable or reactive or is managed so that it is protected from materials or conditions that may cause it to ignite or react.		40 CFR 264.229 TDEC 0400-12-01-.06(11)(j)
Release of contact water and leachate into Bear Creek tributary	Shall receive the degree of treatment or effluent reduction necessary to comply with water quality standards and, where appropriate, will comply with the "Standard of Performance" as required by TN Water Quality Control Act at TCA §§69-3-101, et seq. For industrial discharges without applicable federal effluent guidelines, best professional judgment should be employed to determine appropriate effluent limitations and standards.	Point source discharge(s) of pollutants into waters of the U.S. **—applicable**	TCA §§69-3-101 *et seq.* TDEC 0400-40-03-.05(6) TDEC 0400-40-05-.09(1)(b)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Non-continuous batch discharges (those discharges which are not continuous as defined in 40 CFR 122.2) of leachate and contact water	Non-continuous discharges shall be particularly described and limited, considering the following factors, as appropriate: • Frequency • Total mass • Maximum rate of discharge of pollutants during the discharge; and • Mass or concentration of specified pollutants	Non-continuous discharge of pollutants to surface waters—**applicable** if water is released on a non-continuous batch basis rather than continuously	40 CFR 122.45(e) TDEC 0400-40-05-.08(1)(n)
Exclusion from 40 CFR 445 effluent discharge standards for RCRA Subtitle C landfills point source category	Pursuant to 40 CFR 445.1(e), RCRA Subtitle C landfills that only receive wastes generated by the industrial operations directly associated with the landfill are exempt from the CWA effluent standards under 40 CFR 445.11.	Point source discharge of wastewater from RCRA Subtitle C landfills [as defined in 40 CFR 445.2(f)] into waters of the U.S.**— applicable**	40 CFR 445.1(e)
Temporary bypass of waste stream	Bypass is prohibited unless: • Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage; • There were no feasible alternatives to bypass; condition not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance	Bypass, as defined in TDEC 0400-40-05-.02(15), of waste stream**—applicable**	TDEC 0400-40-05-.07(2)(l)
	A bypass that does not cause effluent limitations to be exceeded may be allowed only if bypass is necessary for essential maintenance to assure efficient operation.		TDEC 0400-40-05-.07(2)(m)
Wastewater transferred by truck or pipeline to on-site on-ORR CWA-authorized WWTU	A user may not introduce into a wastewater facility any pollutant(s) which causes pass through or interference, and wastewater must meet the pretreatment standards and prohibitions [waste acceptance criteria and limits] set by the wastewater facility prior to transfer.	Transfer of contaminated wastewater to a CWA-authorized wastewater facility for treatment **—applicable**	TDEC 0400-40-14-.05(1) – (2) and (4)
Management of water generated from EMWMF landfill	On-site wastewater treatment units that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are exempt from the requirements of RCRA Subtitle C for all tank systems, conveyance systems (whether piped or trucked), and ancillary equipment used to store or transport RCRA contaminated water.	On-site wastewater treatment units subject to regulation under §402 or §307(b) of the CWA—**applicable** if water is determined to be hazardous	40 CFR 264.1(g)(6) 40 CFR 260.10 40 CFR 270.1(c)(2)(v) TDEC 0400-12-01-.07(1)(b)(4)(iv) 53 FR 34079, September 2, 1988

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
Disposal of wastewaters containing RCRA hazardous constituents	Disposal is not prohibited if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. under the CWA unless the wastes are subject to a specified method of treatment other than DEACT in 40 CFR 268.40 or are D003 reactive cyanide.	Disposal of RCRA restricted hazardous wastes that are hazardous only because they exhibit a hazardous characteristic and are not otherwise prohibited under 40 CFR 268**—applicable** if water is determined to be hazardous	40 CFR 268.1(c)(4)(i) TDEC 0400-12-01-.10(1)(a)(3)(iv)(I)
Closure of a RCRA tank system	Must remove or decontaminate all waste residues, contaminated containment system components (liners, etc.) contaminated soils, and structures and equipment contaminated with waste, and manage them as hazardous waste, unless 40 CFR 261.3(d) [TDEC 0400-12-01-.02(1)(c)(4)] applies.	Closure of a hazardous waste tank system—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.197(a) TDEC 0400-12-01-.06(10)(h)(1)
	If all contents cannot be practicably removed or decontaminated, consider the tank system a landfill and close in accordance with the landfill closure requirements of 40 CFR 264.310 [TDEC 0400-12-01-.06(14)(k).		40 CFR 264.197(b) TDEC 0400-12-01-.06(10)(h)(2)
Closure and post-closure care of a surface impoundment	Must remove or decontaminate all waste residues and contaminated materials; otherwise free liquids must be removed, the remaining wastes stabilized to a bearing capacity sufficient to support final cover, and the facility closed and covered with a final cover designed in accordance with 40 CFR 264.228(a)(2)(iii)(A)-(E) [TDEC 0400-12-01-.06(11)(i)(1)(ii)(III)].	Closure of a hazardous waste surface impoundment—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.228(a) TDEC 0400-12-01-.06(11)(i)(1)
	If some waste residues or contaminated materials are left in place at final closure, must comply with all post-closure requirements contained in §§264.117 through 264.120 [TDEC 0400-12-01-.06(7)(h) through (k)], including maintenance and monitoring throughout the post-closure period. Must also:		40 CFR 264.228(b) TDEC 0400-12-01-.06(11)(i)(2)
	• maintain integrity and effectiveness of final cover, making repairs to the cap as necessary;		40 CFR 264.228(b)(1) TDEC 0400-12-01-.06(11)(i)(2)(i)
	• maintain and monitor leak detection system;		40 CFR 264.228(b)(2) TDEC 0400-12-01-.06(11)(i)(2)(ii)
	• maintain and monitor groundwater monitoring system;		40 CFR 264.228(b)(3) TDEC 0400-12-01-.06(11)(i)(2)(iii)
	• prevent run-on and runoff from eroding or otherwise damaging final cover.		40 CFR 264.228(b)(4) TDEC 0400-12-01-.06(11)(i)(2)(iv)

Table D.1. ARARs and TBC guidance (cont.)

Action	Requirements	Prerequisite	Citation
	Transportation		
Transportation of universal waste off-site	Off-site shipments of universal waste by a large quantity handler of universal waste shall be made in accordance with 40 CFR 273-38 [TDEC 0400-1-11-.12(3)(i)].	Off-site shipment of universal waste by a large quantity generator of universal waste—**applicable**	40 CFR 273.38 TDEC 0400-1-11-.12(3)(i)
Transportation of used oil off-site	Except as provided in paragraphs (a) to (c) of this rule, generators must ensure that their used oil is transported by transporters who have obtained U.S. EPA ID numbers.	Off-site shipment of used oil by generators of used oil—**applicable**	40 CFR 279.24 TDEC 0400-1-11-.11(3)(e)

ARAP = aquatic resource alteration permit
ARAR = applicable or relevant and appropriate requirement
BAT = best available technology
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR = *Code of Federal Regulations*
CWA = Clean Water Act of 1974
DOE = U.S. Department of Energy
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
EO = Executive Order
EPA = U.S. Environmental Protection Agency
FEMA = Federal Emergency Management Agency
FWS = U.S. Fish and Wildlife Service
NRC = Nuclear Regulatory Commission
ORR = Oak Ridge Reservation
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery Act of 1976
TBC = to be considered
TCA = *Tennessee Code Annotated*
TDEC = Tennessee Department of Environment and Conservation
T&E = threatened and endangered
TN = Tennessee
U.S. = United States
USC = *United States Code*
WWTU = wastewater treatment unit

Table D.2. Numeric ambient water quality criteria (AWQC) that are potential chemical-specific ARARs/TBCs for key COCs in EMWMF/EMDF landfill wastewater[a]

Chemical	Fish and Aquatic Life [TDEC 0400-40-03-.03(3)]		Recreation[b] [TDEC 0400-40-03-.03(4)]	Required reporting level[c] [TDEC 0400-40-03-.05(8)]
	Criterion maximum concentration (CMC) (µg/L or ppb)	Criterion continuous concentration (CCC) (µg/L or ppb)	Organisms only (µg/L or ppb)	(RRL) (µg/L or ppb)
Aldrin (c)	3.0		0.00050	0.5
Arsenic (c)			10.0	1.0
Arsenic (III)	340[d]	150[d]		1.0
b-BHC (c)			0.17	
Cadmium	2.0[e]	0.25[e]		1.0
Chromium (III)	570[e]	74[e]		1.0
Chromium (VI)	16[d]	11[d]		10.0
Copper	13[e]	9.0[e]		1.0
Cyanide	22	5.2	140	5.0
4,4'-DDT (b)(c)	1.1	0.001	0.0022	0.1
4,4'-DDE (b)(c)			0.0022	0.1
4,4'-DDD (b)(c)			0.0031	0.1
Dieldrin (b)(c)	0.24	0.056	0.00054	0.05
Lead	65[e]	2.5[e]		1.0
Mercury (b)	1.4[d]	0.77[d]	0.051	0.2
Nickel	470[e]	52[e]	4600	10.0

(b) = bioaccumulative parameter
(c) = carcinogenic parameter

[a] http://www.tn.gov/sos/rules/0400/0400-40/0400-40-03.20131216.pdf.
[b] A 10^{-5} risk level is used for setting TDEC recreational criteria for all carcinogenic pollutants. Recreational criteria for noncarcinogenic chemicals are set using a 10^{-6} risk level. [*Note*: All federal recreational criteria are set at a 10^{-6} risk level].
[c] In cases in which the in-stream AWQC or effluent limits established for an outfall are less than current chemical technological capabilities for analytical detection, compliance with the AWQC or limits will be determined using the higher RRLs, per TDEC 0400-40-03-.05(8).
[d] Criteria are expressed as dissolved.
[e] Criteria are expressed as dissolved and are a function of total hardness (mg/L). Criteria displayed correspond to a total hardness of 100 mg/L.

ARARs = applicable or relevant and appropriate requirements
AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
COCs = contaminants of concern
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
RRL = required reporting level
TBC = to-be-considered [guidance]
TDEC = Tennessee Department of Environment and Conservation

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APPENDIX E.
MERCURY CONCENTRATION IN ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY LEACHATE

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Predicting Mercury Concentrations in Leachate

Mercury-contaminated building demolition debris and soils resulting from cleanup of Y-12 National Security Complex (Y-12) are assumed to be disposed of in the Environmental Management Disposal Facility (EMDF). Oak Ridge Environmental Management forecasts a total of about 380,000 cubic yards (CY) of debris waste to be disposed from the four large mercury-contaminated buildings at Y-12. The forecasted soils and sediments to be disposed total approximately 100,000 CY. It was assumed in the Integrated Facility Disposition Program (IFDP) that a portion of the debris and soil/sediments would require treatment to meet land disposal restrictions (LDRs) prior to land disposal. The soils/debris portions requiring treatment are those that do not pass the toxicity characteristic leaching procedure (TCLP) testing. This analysis will evaluate the IFDP-assumed quantities and mercury content of waste debris and soil to be disposed of at the future EMDF, and estimate potential mercury concentrations in the landfill leachate.

For debris, LDR treatment was assumed to be macroencapsulation in place, in the landfill. For purposes of this analysis, macroencapsulation is assumed to totally stabilize the mercury, thus no mercury would leach from macroencapsulated debris during active landfill operations following treatment. Prior to treatment, however, the debris may be exposed to precipitation when it is placed in the landfill, and it is likely that some leaching of mercury prior to completion of the macroencapsulation may occur. Due to the short time that debris will be exposed prior to macroencapsulation, it is assumed this resulting contaminated leachate will be addressed similarly to leachate resulting from non-treated mercury waste, as discussed below. Debris that passes TCLP testing is assumed (for purposes of calculating a mercury leachate concentration) to exhibit the same characteristics as low mercury soil waste, since the debris would be surrounded within a soil matrix that would uptake the mercury leached from the debris.

For soils, it is assumed that treatment to meet LDRs would be carried out on the portion of waste that fails TCLP testing. This treatment method is assumed to be sulfur polymer stabilization/solidification (SPSS). URS | CH2M Oak Ridge LLC (UCOR) completed a study in which soils from Y-12 were treated by this method (UCOR-4323 and -4344, *Treatability Study Report for Y-12 Site Mercury Contaminated Soil, Oak Ridge, Tennessee*). The results of that study were used in this analysis to predict partition coefficients (Kd) for treated and untreated mercury-contaminated soils, and thus used to determine potential leachate mercury concentrations.

Mercury Concentrations in Building Debris

A thorough characterization was recently completed on the Alpha-5 Building at Y-12 (DOE-OR/01-2540&D2, *Characterization Report for Alpha 5 Building 9201-5 at the Y-12 National Security Complex, Oak Ridge, Tennessee*). Mercury characterization results are summarized here to give an indication of the expected concentrations in demolition debris that would be disposed of at EMDF.

Data taken from the Alpha-5 characterization report is given in Tables E.1 and E.2 (Tables 23 and 24 from the report). A discussion taken from the report is included, as well. The data show that 95% of mercury debris samples with a total mercury concentration of at least 247 mg/kg will exceed the Resource Conservation and Recovery Act (RCRA) limit of 0.2 mg/L in TCLP testing, and 95% of mercury samples with a total mercury concentration of up to 151 mg/kg would not exceed the TCLP RCRA limit. This implies that mercury-contaminated debris with mercury concentrations up to 151 mg/kg may pass TCLP and be placed in the landfill without treatment.

Summary statistics for total mercury concentrations (mg/kg) were developed (DOE-OR/01-2540&D2 and EPA/600/R-07/041, *Statistical Software for Environmental Applications for Data Sets with and without*

Non-detect Observations, ProUCL 5.0.00) using core samples from Alpha-5 Building 9201-5 media (concrete floor, ceiling, interior wall, exterior wall, and roof) on floors 1, 1M, 2, 2M, 3, and 4. Kaplan-Meier (KM) estimation methods were used to account for non-detects, and no substitution methods (replacing the non-detect value by the detection limit or ½-detection) were employed. Results are summarized in Table E.3. A description of the derivation of the data follows.

Table E.1. Detected mercury samples exceeding TCLP mercury RCRA limit (Table 23 from DOE/OR/01-2540&D2)

Intrusive (mg/kg)	Number TCLP Samples ≥ 0.2 mg/L	Number Samples ≥ Intrusive	Percent Samples > 0.2 mg/L
0.00438	32	247	13.0
1.01	32	167	19.2
6.77	31	77	40.3
15.5	30	59	50.8
20.5	29	52	55.8
23.3	28	46	60.9
27.9	27	42	64.3
40.3	26	40	65.0
57.6	25	37	67.6
78.6	24	34	70.6
127	22	27	81.5
161	21	25	84
228	20	22	90.9
247	18	19	94.7
727	9	9	100

Table 23 summarizes the number of TCLP and detected intrusive mercury samples at or above each detected intrusive concentration. Table 23 provides the data to create the empirical distribution function shown in Figure 44, which relates the percentage of TCLP samples exceeding 0.2 mg/L for each detected intrusive sample concentration. Table 23 and Figure 44 show that 95% (18 out of 19) of the TCLP mercury samples exceeding the RCRA limit of 0.2 mg/L were also analyzed for total mercury with concentrations at or above 247 mg/kg. All (100%) of the TCLP mercury samples exceeding the RCRA limit of 0.2 mg/L were also analyzed for total mercury with concentrations at or above 727 mg/kg. Ninety-one percent (91%) of the TCLP mercury samples exceeding the RCRA limit of 0.2 mg/L were also analyzed for total mercury with concentrations at or above 228 mg/kg. Based upon this empirical data, there is a 95% probability that an intrusive mercury sample with a mercury concentration of at least 247 mg/kg would also fail the TCLP RCRA limit of 0.2 mg/L.

Table E.2. Detected mercury samples meeting TCLP mercury RCRA limit (Table 24 from DOE/OR/01-2540&D2)

Intrusive (mg/kg)	Number TCLP Samples < 0.2 mg/L	Number Samples ≤ Intrusive	Percent Samples < 0.2 mg/L
0.94	80	80	100.0
6.59	169	170	99.4
14.8	186	188	98.9
20.3	192	195	98.5
23	197	201	98.0
27	200	205	97.6
28.1	201	207	97.1
49.8	203	210	96.7
66.7	205	213	96.2
125	210	220	95.5
151	211	222	95.0
224	213	225	94.7
243	214	228	93.9
542	215	238	90.3
4340	215	247	87.0

Table 24 summarizes the number of TCLP and detected intrusive mercury samples at or below each detected intrusive concentration. Table 24 provides the data to create the empirical distribution function shown in Figure 45, which relates the percentage of TCLP samples below 0.2 mg/L for each detected intrusive sample concentration. Table 24 and Figure 45 show that 95% (211 out of 222) of the TCLP mercury samples below the RCRA limit of 0.2 mg/L were also analyzed for total mercury, with concentrations at or below 151 mg/kg. All (100%) of the TCLP mercury samples below the RCRA limit of 0.2 mg/L were also analyzed for total mercury, with concentrations at or below 0.94 mg/kg. Ninety percent (90%) of the TCLP mercury samples below the RCRA limit of 0.2 mg/L were also analyzed for total mercury, with concentrations at or below 542 mg/kg. Based upon this empirical data, there is a 95% probability that an intrusive mercury sample with a mercury concentration of up to 151 mg/kg would also pass the TCLP RCRA limit of 0.2 mg/L. More data are needed to bring the percentage of samples below 0.2 mg/L to below 87%.

Table E.3. Summary statistics for Alpha-5 (Bldg. 9201-5) total mercury (mg/kg)

Parameter	Result	Units	Comment
Total number of samples	543	Count	
Probability distribution	N/A	None	Data do not fit normal, lognormal, gamma distributions, or other similar distributions
Number of detects	534	Count	
Minimum of detects	0.00438	mg/kg	
Median of detects	1.955	mg/kg	
Maximum of detects	4340	mg/kg	
Mean of detects	63.59	mg/kg	
Standard deviation of detects	325.6	mg/kg	
Coefficient of variation of detects	512%	mg/kg	
95% KM Chebyshev UCL	123	mg/kg	Non-parametric UCL
99% KM Chebyshev UCL	200.5	mg/kg	Non-parametric UCL
95% UTL with 95% coverage	360	mg/kg	Non-parametric UTL
95% UTL with 99% coverage	3170	mg/kg	Non-parametric UTL

UCL = upper confidence limit
UTL = upper tolerance limit

Sample results for 467 of the 543 samples are greater than 0.1 mg/kg. The number of sample results and the range of sample results for floors and media types are presented in Table E.4. For example, 126 sample results were collected from Floor 1-Floor, and the range of sample results is 0.102 mg/kg to 4340 mg/kg. Blank cells, such as Floor 1M Ceiling, indicate no sample results for the floor/media combination. The wide ranges indicate heterogeneity of mercury contamination greater than 0.1 mg/kg for all floors and all media.

Table E.4. Sample results greater than 0.1 mg/kg for Alpha-5 (Bldg. 9201-5) total mercury

Floor	Media					
	Floor	Ceiling	Interior wall	Exterior wall	Roof	Total
	Entries are number of samples and range (minimum to maximum) of sample results (mg/kg)					
1	126 0.102 to 4340	33 0.172 to 101	30 0.128 to 69.4	28 0.115 to 10.5		217 0.102 to 4340
1M	2 0.503 to 0.586		2 2.63 to 5.28			4 0.503 to 5.28
2	56 0.141 to 1130	26 0.101 to 8.09	25 0.296 to 40.3	21 0.186 to 24		128 0.101 to 1130
2M	4 0.409 to 42.6	4 1.49 to 3.85	4 1.32 to 58.1	5 0.973 to 4.1		17 0.409 to 58.1
3	25 0.168 to 1410	21 0.475 to 12.5	23 0.106 to 8.17	16 0.119 to 43.3		85 0.106 to 1410
4	4 0.137 to 0.436	5 1.04 to 3.14		2 0.26 to 0.738		11 0.137 to 3.14
Roof					5 0.109 to 0.637	5 0.109 to 0.637
Total	217 0.102 to 4340	89 0.101 to 101	84 0.106 to 69.4	72 0.115 to 43.3	5 0.109 to 0.637	467 0.101 to 4340

The upper confidence limit (UCL) is the upper boundary (or limit) of the population mean. The KM Chebyshev UCL is based upon Kaplan-Meier estimates using the Chebyshev inequality. The Chebyshev inequality is the sum of the arithmetic average and the weighted standard error of the mean. The Chebyshev inequality does not rely on any underlying probability distribution of the data (e.g., normal, lognormal, gamma). The weighting factor is proportional to the square root of the confidence level, e.g., 95%. The upper tolerance limit (UTL) is a confidence limit on a percentile of the population rather than a confidence limit on the mean. For example, a 95% one-sided UTL for 95% coverage represents the value below which 95% of the population values are expected to fall with 95% confidence. In other words, a 95% UTL with coverage coefficient 95% represents a 95% UCL for the 95th percentile.

Mercury Concentrations in Soils and Sediments

Information about the extent of mercury contamination in soils at Y-12 is very limited, as are data on the specific soil mercury concentrations. Figure E.1 is a map showing aerial extent and ranges of mercury concentrations, taken from the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-1951&D3). From the figure, it is assumed that the majority of soils would exhibit a mercury concentration of between 1 and 10 mg/kg.

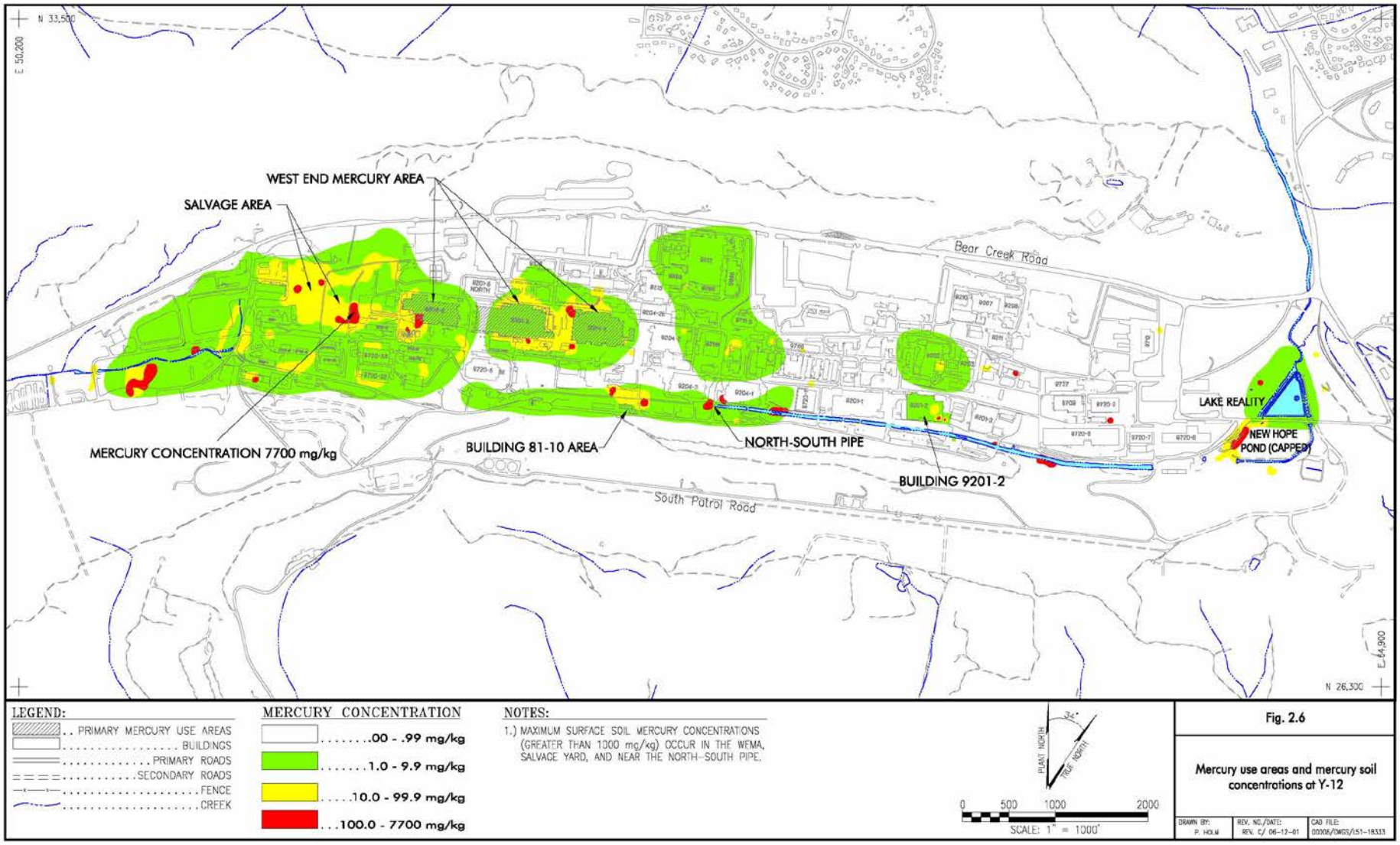

Fig. E.1. Upper East Fork Poplar Creek mercury soils concentrations.

Calculation of Kd

Kds indicate the equilibrium partitioning of a contaminant between the solid phase (in this case, soil) and the liquid phase (in this case leachate). High Kd indicates greater immobility, and low Kd indicates greater mobility in the soil-water environment. Kds were calculated for mercury based on the results of the UCOR soils study (UCOR-4323 and -4344). Kds for untreated soils were also taken from literature, for comparison purposes (EPA/600/R-05/074, *Partition Coefficients for Metals in Surface Water, Soil, and Waste*). Following is a summary of those calculations and results.

A. Calculation of Field Leachate Concentrations

Leachate concentrations measured in the SPLP test are not equivalent to those that would be observed under field conditions because the relative amounts of soil and water used in the SPLP test are completely different from those in a natural soil system. (For a detailed explanation of the issues involved, refer to Appendix C.) For this reason, field leachate concentrations must be calculated for each sample using the SPLP leaching test results and its corresponding measured total soil concentration. The procedure to calculate field leachate concentrations is described below.

1. For each sample, calculate a soil water-partition coefficient (K_d) for each contaminant:

$$K_d = \frac{(C_T M_S - C_{SPLP} V_L)/M_s}{C_{SPLP}} \quad (1)$$

where

K_d = is the soil-water partition coefficient (L/kg)
C_T = the total concentration of the contaminant in the SPLP soil sample (mg/kg)
M_S = the total weight of the soil sample submitted for SPLP analysis (~0.1 kg for inorganic chemicals and semivolatiles, or ~0.025 kg for volatiles)
C_{SPLP} = the concentration of contaminant in the SPLP leachate (mg/L)
V_L = the volume of the SPLP leachate (~2 L for inorganic chemicals and semivolatiles, or ~0.5 L for volatiles)

NOTE: C_{SPLP} in Equation 1 must have units of mg/L

The excerpt above is from a 2013 New Jersey Department of Environmental Protection (NJDEP) Guidance Document (NJDEP 2013, *Development of Site-Specific Impact to Groundwater Soil Remediation Standards Using the Synthetic Precipitation Leaching Procedure*). SPLP is the synthetic precipitation leaching procedure and, in regards to this analysis of potential mercury concentrations, analogous to TCLP, so that $C_{SPLP} = C_{TCLP}$ and the results of the UCOR Soils Study can be substituted into the equation above.

The following is a calculation of Kd values using the UCOR treatability study data (UCOR-4323 and -4344). Three separate vendor laboratories participated in the study: Brookhaven National Laboratory, Energy*Solutions*, and Materials and Energy Corporation. Each lab received spiked soil samples in order to test their treatment methods for immobilization of mercury to meet TCLP testing and allow land disposal of the treated forms. Soil samples were provided to the vendors that had been spiked with elemental mercury to produce mercury concentrations in the soil samples of nominally 2000 mg/kg and nominally 10,000 mg/kg. These mercury spiked soil samples were produced by a single separate lab and then supplied to the 3 vendor labs to perform the testing. The vendor labs then treated the samples with their respective methods of (some form of) SPSS. Prior to and after testing, the vendor laboratories calculated the total mercury concentrations in the soil samples. These actual measured values were used in the following calculations as the total concentration of the contaminant in the soil sample (C_T). See the previous equation for explanation.

Treated Soils*: Calculating Kd (L/kg) values for treated soils based on UCOR Soils Study data:*

C_T Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	1.91E+03	6.25E+03	Actual as Measured (mg/kg)
ES	1.36E+03	3.73E+03	
M&EC	1.60E+03	8.03E+03	

C_{TCLP} Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	0.0011	0.0013	TCLP (mg/L)
ES	0.00067	0.0233	
M&EC	0.00174	0.00067	

Kd:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	1.74E+06	4.81E+06	(L/kg)
ES	2.03E+06	1.60E+05	
M&EC	9.18E+05	1.20E+07	
AVERAGE:	3.61E+06	**Mercury Kd for Treated Soils**	

*Note BNL did not report starting soil concentrations, so averages from ES and M&EC used.

Untreated Soils: *Calculating Kd (L/kg) for untreated soils based on UCOR Soils Study data:*

C_T Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	1.91E+03	6.25E+03	Actual as Measured (mg/kg)
ES	2.96E+03	3.48E+03	
M&EC	2.28E+03	1.23E+04	

C_{TCLP} Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	6.5	11.9	TCLP (mg/L)
ES	11.2	6.86	
M&EC	7.71	6.97	

Kd:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	2.74E+02	5.05E+02	(L/kg)
ES	2.44E+02	4.87E+02	
M&EC	2.75E+02	1.75E+03	
AVERAGE:	5.89E+02	**Mercury Kd for Untreated Soils**	

BNL = Brookhaven National Laboratory
ES = Energy*Solutions*
M&EC = Materials and Energy Corporation

The average values for the treated and untreated soils (highlighted on the previous page) were carried forward for this evaluation. Further research of U.S. Environmental Protection Agency (EPA) literature was conducted in order to compare the Kds calculated above to other studies that have been performed. The EPA's 2005 report *Partition Coefficients for Metals in Surface Water, Soil, and Waste* cited mercury Kd values of 1000 L/kg and 3981 L/kg, which would represent untreated waste. Thus multiple Kd values for the untreated waste were examined at various mercury soil concentrations to predict leachate mercury concentrations. The following Kd values are those that were used in this analysis:

- 3.61E+06 L/kg for Treated Soil Waste, as calculated in UCOR Soils Study (see preceding Kd calc)
- 589 L/Kg for Untreated Soil Waste, as calculated in UCOR Soils Study (see preceding Kd calc)
- 1000 L/Kg for Untreated Soil Waste, quoted from reference as value used by EPA in studies (EPA/600/R-05/074).
- 3981 L/Kg for Untreated Waste, soil/water partition coefficient, mean from multiple data sets, per reference (EPA/600/R-05/074).

The following equation was then used to evaluate the potential leachate concentration range of future mercury-contaminated waste.

2. For each sample, substitute the K_d value in the following equation to calculate the estimated field leachate concentration:

$$C_L = \frac{C_T}{K_d + \frac{\theta_w + \theta_a H'}{\rho_b}} \qquad (2)$$

where
ρ_b = bulk density of the soil (1.6 kg/L)
θ_w = soil moisture content (0.23)
θ_a = soil air content (0.18)
H' = the dimensionless Henry's law constant
C_L = field leachate concentration (mg/L).

Equation 2 is a simple rearrangement of the USEPA Soil Screening Guidance soil-water partition equation. It is derived in Appendix C.

From the 2013 NJDEP Guidance Document

Equation Inputs to Estimate Mercury Concentrations in Leachate:

Kd, for treated soils:	3.61E+06	L/kg
Kd, for untreated soils: ***	(Varied)	L/kg
Henry's Law Constant for Hg:	0.467	dimensionless

	total, CY	Volume assumed to require treatment (from IFDP, CD-1)….CY	Volume, no treatment (IFDP, CD-1)…..CY
Total Bldg. Debris Volume	381,854	123,087	258,767
Total Soil Volume	95,574	53,882	41,692

***Vary Kd & Hg concentration:

Untreated Soil

Untreated Soil Hg concentration (mg/kg)	Kd = 589 L/kg	Kd = 1,000 L/kg	Kd = 3,981 L/kg	AWQC Hg Limits, ppt
	Leachate C_L in ppt	Leachate C_L in ppt	Leachate C_L in ppt	
0.01	17	10	3	51 (recreational)
0.1	170	100	25	
1	1,697	1,000	251	770 (fish/aquatic life, CCC)
10	16,972	9,998	2,512	
20	33,945	19,996	5,024	
40	67,889	39,992	10,047	1,400 (fish/aquatic life, CMC)
100	169,723	99,980	25,118	
200	339,445	199,961	50,236	

Treated Soil

Treated Soil Hg concentration (mg/kg)	Kd = 3.61e6 L/kg	AWQC Hg Limits, ppt
	Leachate C_L in ppt	
10	3	51 (recreational)
30	8	
100	28	770 (fish/aquatic life, CCC)
200	55	
500	139	
1000	277	1,400 (fish/aquatic life, CMC)
6000	1,662	
10000	2,770	

*** Various parameters were modified to better understand potential mercury concentrations in leachate under various circumstances

AWQC = ambient water quality criteria CCC = Criterion Continuous concentration CMC = Criterion Maximum Concentration

Graphs have been produced to predict a potential range of mercury concentrations in leachate as a function of the concentration of mercury in untreated and treated soils and varying Kd values. (See Figs. E.2 and E.3).

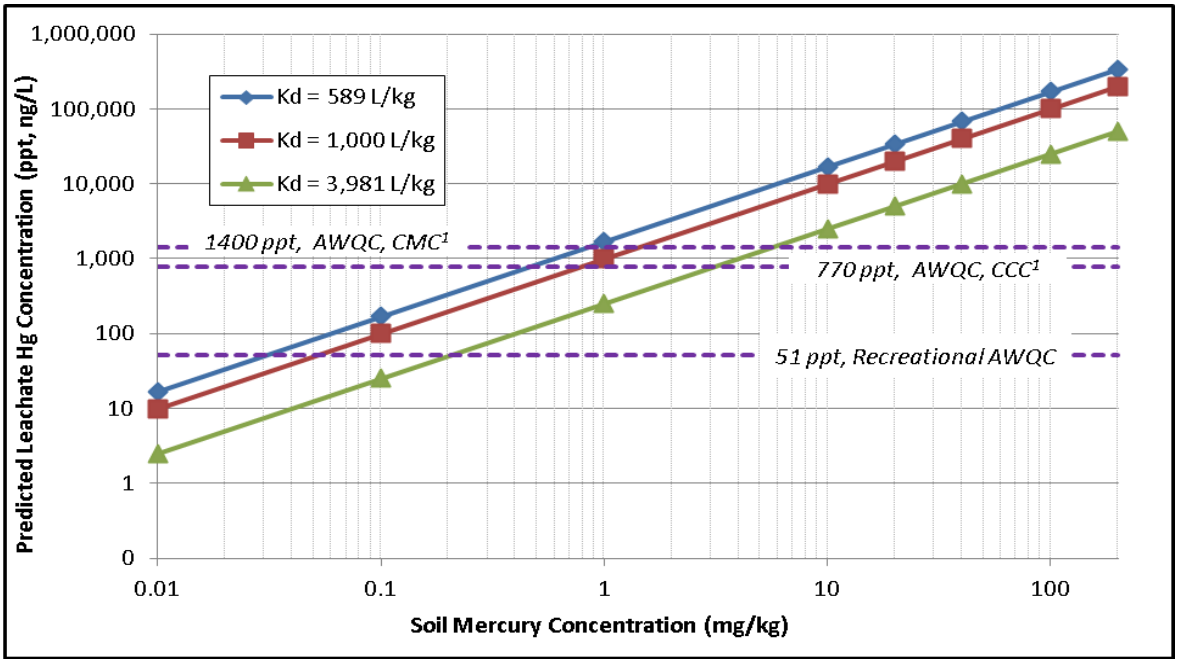

Fig. E.2. Predicted concentration of mercury in leachate given a soil concentration, for various untreated soil Kds.

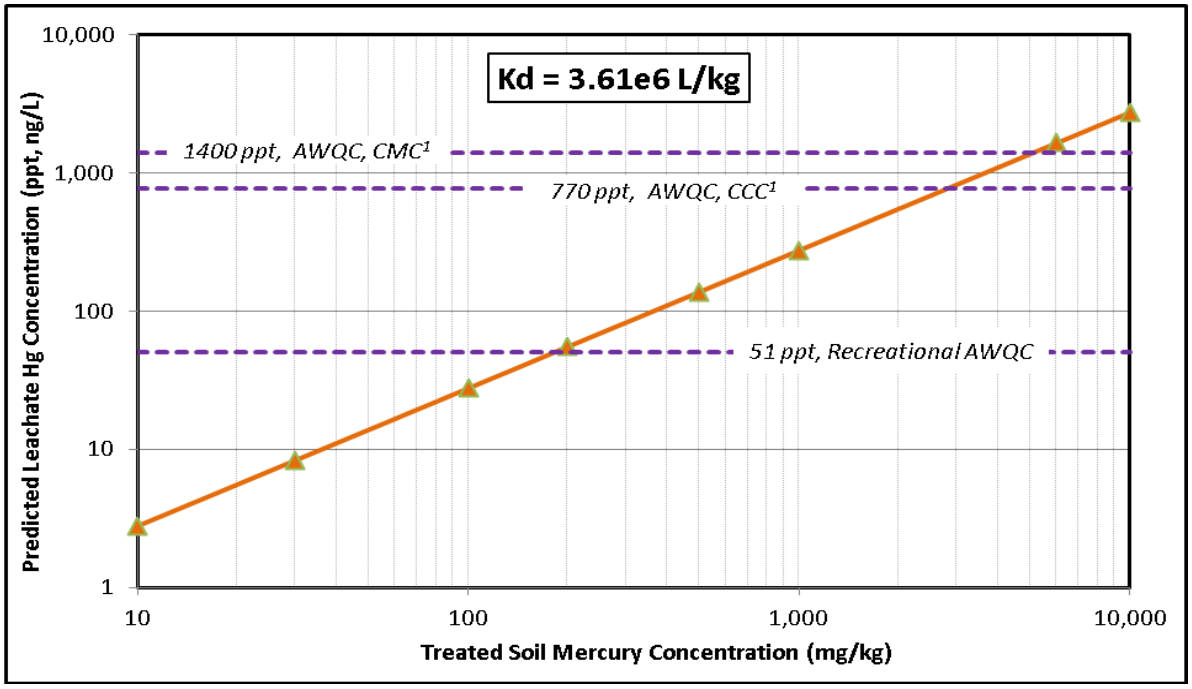

Fig. E.3. Predicted concentration of mercury in leachate given a treated (SPSS) Kd and soil concentration.

[1]CCC = Criterion Continuous Concentration, Fish & Aquatic Life; CMC = Criterion Maximum Concentration, Fish & Aquatic Life

Summary

Debris and soil wastes resulting from the demolition and remediation of Y-12 mercury-contaminated buildings and media will be disposed of in the future EMDF. Some of those wastes will require treatment to meet LDRs. Debris that fails TCLP are assumed to be macroencapsulated in place, in the future landfill; soil wastes that fail TCLP are assumed to be treated by SPSS prior to disposal in the future landfill. No measurable mercury leaching from these treated waste forms is expected during active operations of the landfill.

Untreated soils and debris that pass TCLP will be disposed of in the landfill. Although mercury has naturally high Kds, the amount of mercury-contaminated waste soil and debris expected to be disposed is large enough to result in significant "as-disposed" soil mercury concentrations that may result in measurable mercury concentrations in the leachate (see Fig. E.3). "As-generated" soil/debris mercury concentrations must be adjusted to account for the addition of soil fill, necessary for landfill stability, and the inclusion of other wastes in the landfill resulting in an "as-disposed" mercury concentration. The assumed volume of mercury-contaminated debris and soil to be disposed that will not require treatment to meet LDRs is approximately 300,000 CY. This material will be disposed along with the mercury-containing debris and soil within the first three cells resulting in a final as-disposed volume of approximately 1.25M CY. Consequently, the as-generated mercury concentrations would be reduced by a factor of about four. Assuming the resulting, as-disposed concentration is in the range of 0.03 to 0.25 mg/kg (equivalent to an as-generated waste mercury concentrations corresponding to 0.1 to ~1 mg/kg), leachate concentrations could exceed the 51 ppt ambient water quality criteria (AWQC) for mercury depending on the Kd exhibited (see Fig. E.3). As noted in the Alpha-5 characterization results, mercury concentrations are highly variable, and 95% of debris samples exhibiting mercury concentrations up to 151 mg/kg may pass TCLP. Taking this as an upper bound of the as-generated mercury concentration and assuming the Kds for contaminated debris would be the same as soil, a leachate mercury concentration in the range of 10,000 (highest Kd) to 90,000 ppt (lowest Kd) might be possible. With the uncertainty in volumes of soil/debris to be disposed, and the variability in as-generated mercury concentrations, predictions are highly uncertain. It is expected that leachate concentrations will vary widely for reasons such as variability in rainfall, sequencing of waste volumes, operations procedures, etc. Discussions and technology development activities are ongoing regarding the use of soil additives (for fill soil, landfill liner systems) that could help immobilize the mercury as well, thereby significantly reducing mercury leachate concentrations.

Soils that fail TCLP are assumed to be treated by SPSS. SPSS provides a large measure of protection against leaching, as seen by the very high calculated Kd (3.61e6 L/kg, see Fig. E.4). As-disposed soil mercury concentrations would have to exceed 200 mg/kg to result in leachate concentrations exceeding recreational AWQC. The mercury leached from these waste forms will not likely add significantly to mercury leachate concentrations, since the majority of the soils are expected to exhibit a concentration less than 10 mg/kg (refer to Fig. E.1)

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APPENDIX F.
LEACHATE AND CONTACT WATER WASTE DETERMINATION

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Leachate and Contact Water Waste Determination

This determination has been written to address the regulatory status of leachate and contact water under the Resource Conservation and Recovery Act of 1976 (RCRA).

Approach

Environmental Management Waste Management Facility (EMWMF) Operations has evaluated the regulations of 40 *CFR* 262.11, *Hazardous Waste Determination*, to ensure requirements were met for making a valid characterization decision. A combination of process knowledge, including physical characteristics of leachate and contact water, approved waste lots and disposal records, and historical analytical data, were then evaluated against the requirements of 40 *CFR* 262.11.

Requirements

40 *CFR* 262.11:

A person who generates a solid waste, as defined in 40 *CFR* 261.2, must determine if that waste is a hazardous waste using the following method:

(a) He should first determine if the waste is excluded from regulation under 40 *CFR* 261.4.

(b) He must then determine if the waste is listed as a hazardous waste in Subpart D of 40 *CFR* part 261.

NOTE: Even if the waste is listed, the generator still has an opportunity under 40 *CFR* 260.22 to demonstrate to the Administrator that the waste from his particular facility or operation is not a hazardous waste.

(c) For purposes of compliance with 40 *CFR* part 268, or if the waste is not listed in Subpart D of 40 *CFR* part 261, the generator must then determine whether the waste is identified in Subpart C of 40 *CFR* Part 261 by either:

(1) Testing the waste according to the methods set forth in Subpart C of 40 *CFR* part 261, or according to an equivalent method approved by the Administrator under 40 *CFR* 260.21; or

(2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.

Process Knowledge

EMWMF Leachate Physical Characteristics

EMWMF leachate and contact water are water-based liquids that are derived from precipitation and application of fire water (potable water) for dust control that flows over and through disposed waste and is collected either in catchments within the disposal cells or by the leachate collection system. There are no impacts to EMWMF leachate and contact water from disposed liquids, as free liquids are prohibited from disposal at EMWMF by the *Attainment Plan for Risk/Toxicity-Based Waste Acceptance Criteria at the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-1909&D3).

Approved Waste Lots and Disposal Record Information

Based on waste lots approved for disposal at EMWMF, no listed waste has been or is planned to be disposed at EMWMF. Therefore, EMWMF leachate and contact water are not listed waste.

Historical analytical data discussed below are based on analyses performed that include constituents identified as contaminants of concern (COCs) based on characterization information related to waste received. These COCs include all of the constituents identified in 40 *CFR* 261.24.

Historical Analytical Data

Historical EMWMF leachate and contact water data discussed in this waste determination were collected over the first 10 years of operations at EMWMF.

LEACHATE

EMWMF leachate samples were collected after the leachate from each active cell had been commingled in the leachate storage tanks. Leachate has been historically sampled and analyzed at a rate of one sample for every 140,000 gal generated, as well as one sample per calendar quarter for an expanded list of analytes.

Figure F.1 presents a timeline for when EMWMF Operations began managing leachate as each disposal cell came online:

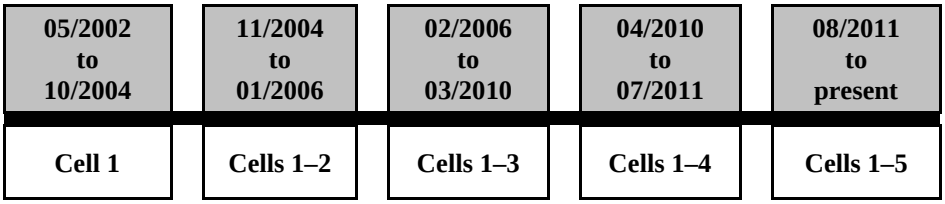

Fig. F.1. EMWMF leachate generation timeline.

The analyses performed on the leachate include the following U.S. Environmental Protection Agency-approved Methods, as defined in SW-846:

- Method 6010, Inductively Coupled Plasma-Atomic Emission Spectrometry (Metals)
- Method 7470, Mercury in Liquid Waste (Manual Cold-Vapor Technique)
- Method 8081, Organochlorine Pesticides by Gas Chromatography (GC)
- Method 8151, Chlorinated Herbicides by GC Using Methylation or Pentafluorobenzylation Derivatization
- Method 8260, Volatile Organic Compounds by GC/Mass Spectrometry (MS)
- Method 8270, Semivolatile Organic Compounds by GC/MS

CONTACT WATER

Contact water is collected in catchments within the disposal cell, then pumped to collection ponds or above-ground tanks. Each pond or tank is sampled when full; analytical results are compared against release criteria, and discharged to surface waters if the release criteria are met.

As shown in Table F.1, the maximum detected concentration values for toxicity characteristic (TC) constituents in leachate and contact water are well below regulatory levels. In all cases, the project quantitation levels are below the regulatory levels, but are greater that the method detection limits.

Table F.1. Comparison of 10-year leachate and contact water maximum values against 40 *CFR* 261.24 Table 1 regulatory levels

Chemical name	Maximum detected contact water value (mg/L)	Percent of regulatory level	Maximum detected leachate value (mg/L)	Percent of regulatory level	Regulatory level (mg/L)
Arsenic	0.0051	0.10%	0.00383 J	0.08%	5.0
Barium	0.0914	0.09%	0.46 N	0.46%	100.0
Benzene	0.005	1%	ND	N/A	0.5
Cadmium	0.001	0.1%	0.000712 J	0.07%	1.0
Carbon tetrachloride	0.005	0.1%	0.0082	1.64%	0.5
Chlordane	0.000119	0.4%	ND	N/A	0.03
Chlorobenzene	0.005	0.005%	ND	N/A	100.0
Chloroform	0.005	0.08%	0.00135 J	0.02%	6.0
Chromium	0.142	2.84%	0.00637	0.13%	5.0
2-Methylphenol (o-Cresol)	0.0112	0.056%	ND	N/A	200.0
3- and 4-Methylphenol (m-Cresol)	0.022	0.011%	ND	N/A	200.0
4-Methylphenol (p-Cresol)	0.022	0.011%	ND	N/A	200.0
Cresol	Not Applicable, based on 40 *CFR* 261.24, Table 1, Footnote 4.				
2,4-D	ND	N/A	0.00033 J	0.00%	10.0
1,4-Dichlorobenzene	0.0112	0.15%	ND	N/A	7.5
1,2-Dichloroethane	0.005	0.1%	ND	N/A	0.5
1,1-Dichloroethene	0.005	0.7%	ND	N/A	0.7
2,4-Dinitrotoluene	0.01	7.7%	ND	N/A	0.13
Endrin	0.0000595	0.3%	ND	N/A	0.02
Heptachlor	0.0000595	0.74%	ND	0.15%	0.008
Heptachlor epoxide	0.0000595	--	0.000012 J	--	--
Hexachlorobenzene	0.0112	8.6%	ND	N/A	0.13
Hexachlorobutadiene	0.0112	2.2%	ND	N/A	0.5
Hexachloroethane	0.01	0.33%	ND	N/A	3.0
Lead	0.005	0.1%	0.00453	0.09%	5.0
Lindane	0.00000133	0.0003%	0.000027 J	0.01%	0.4
Mercury	0.0002	0.1%	0.00022 *	0.11%	0.2
Methoxychlor	0.0000595	0.0006%	0.000015 J	0.00%	10.0
2-Butanone (MEK)	0.01	0.005%	1.77 D	0.89%	200.0
Nitrobenzene	0.01	0.5%	ND	N/A	2.0
Pentachlorophenol	0.025	0.025%	0.000124	0.00%	100.0
Pyridine	ND	N/A	ND	N/A	5.0
Selenium	0.01	1%	0.00446 J	0.45%	1.0
Silver	0.0025	0.05%	0.0088 N	0.18%	5.0
Tetrachloroethene	0.005	0.7%	ND	N/A	0.7
Toxaphene	ND	N/A	ND	N/A	0.5
Trichloroethene	0.005	1%	0.011	2.20%	0.5
2,4,5-Trichlorophenol	0.01	0.003%	ND	N/A	400.0
2,4,6-Trichlorophenol	0.01	0.5%	ND	N/A	2.0
Silvex	ND	N/A	0.000386 J	0.04%	1.0
Vinyl chloride	0.01	5%	ND	N/A	0.2

* = duplicate analysis not within control limits
D = identified at a secondary dilution factor
N = spike recovery not within control limits
ND = no detected values were identified
J = estimated value, between the project quantitation level and the method detection limit

As discussed above, the individual disposal cells were constructed and put into use sequentially, as necessary. Table F.2 presents the maximum detected values for TC constituents in EMWMF leachate during each phase noted in the timeline. Many TC constituents were not detected during analysis, and other TC constituent concentrations are estimated values. The results indicate that over time, most TC constituents are not present at detectable levels. Concentrations of those constituents that are detectable are estimated. As each EMWMF disposal cell came on line, there have been no notable increases in hazardous constituent concentrations, indicating negligible concentrations of hazardous constituents in leachate from each disposal cell. Therefore, analysis of samples from each disposal cell is not warranted.

Table F.2. Maximum detected values for TC constituents in EMWMF leachate

EPA HW No.	Chemical Name	Cell 1 Maximum Detected Results (05/02 - 10/04) (mg/L)	Qualifier	Cells 1-2 Maximum Detected Results (11/04 - 01/06) (mg/L)	Qualifier	Cells 1-3 Maximum Detected Results (02/06 - 03/10) (mg/L)	Qualifier	Cells 1-4 Maximum Detected Results (04/10 - 07/11) (mg/L)	Qualifier	Cells 1-5 Maximum Detected Results (08/11 - pres.) (mg/L)	Qualifier	Regulatory Level (mg/L)
D004	Arsenic	0.0011	B	0.0012	B	0.00383	J	0.00256	J	ND		5.0
D005	Barium	0.11	J	0.0954	*	0.46	*N	0.0804		0.12		100.0
D018	Benzene	ND		ND		ND		ND		ND		0.5
D006	Cadmium	0.00014	B	0.00013	B	0.000712	J	0.000332	J	0.000216	J	1.0
D019	Carbon tetrachloride	0.0082		ND		ND		ND		ND		0.5
D020	Chlordane	ND		ND		ND		ND		ND		0.0
D021	Chlorobenzene	ND		ND		ND		ND		ND		100.0
D022	Chloroform	0.00051	J	ND		0.00135	J	ND		ND		6.0
D007	Chromium	0.0031	B	0.004	B	0.00389	J	0.00387	J	0.00637		5.0
D023	2-Methylphenol (o-Cresol)	ND		ND		ND		ND		ND		200.0
D024	3- and 4- Methylphenol (m-Cresol)	ND		ND		ND		ND		ND		200.0
D025	4-Methylphenol (p-Cresol)	ND		ND		ND		ND		ND		200.0
D026	Cresol- NO DATA AVAILABLE	No data		No data		No data		No data		No data		200.0
D016	2,4-D	ND		ND		0.00033	J	ND		ND		10.0
D027	1,4-Dichlorobenzene	ND		ND		ND		ND		ND		7.5
D028	1,2-Dichloroethane	ND		ND		ND		ND		ND		0.5
D029	1,1-Dichloroethene	ND		ND		ND		ND		ND		0.7
D030	2,4-Dinitrotoluene	ND		ND		ND		ND		ND		0.13
D012	Endrin	ND		ND		ND		ND		ND		0.02
D031	Heptachlor	ND		ND		ND		ND		ND		0.008
	Heptachlor epoxide	ND		ND		0.000012	J	ND		ND		
D032	Hexachlorobenzene	ND		ND		ND		ND		ND		0.13
D033	Hexachlorobutadiene	ND		ND		ND		ND		ND		0.5
D034	Hexachloroethane	ND		ND		ND		ND		ND		3.0
D008	Lead	0.0023	B	0.0026	B	0.00453		0.00225	J	0.0043	J	5.0
D013	Lindane	ND		ND		ND		ND		0.000027	J	0.4
D009	Mercury	ND		0.0001	B	0.00022	*	0.000066	J	ND		0.2
D014	Methoxychlor	ND		ND		ND		ND		0.000015	J	10.0
D035	2-Butanone (MEK)	0.4		0.004	J	0.00908	J	ND		1.77	D	200.0
D036	Nitrobenzene	ND		ND		ND		ND		ND		2.0
D037	Pentachlorophenol	ND		ND		0.00025	J	0.00175		0.000384	J	100.0
D038	Pyridine	ND		ND		ND		ND		ND		5.0
D010	Selenium	0.0041	*	0.0011	B	0.00446	J	ND		ND		1.0
D011	Silver	0.00024	BJ	0.0088	N	ND		ND		ND		5.0
D039	Tetrachloroethene	ND		ND		ND		ND		ND		0.7
D015	Toxaphene	ND		ND		ND		ND		ND		0.5
D040	Trichloroethene	0.011		ND		ND		ND		ND		0.5
D041	2,4,5-Trichlorophenol	ND		ND		ND		ND		ND		400.0
D042	2,4,6-Trichlorophenol	ND		ND		ND		ND		ND		2.0
D017	Silvex	ND		ND		ND		0.000174	J	0.000386	J	1.0
D043	Vinyl chloride	ND		ND		ND		ND		ND		0.2

* – Duplicate analysis not within control limits
B – Result less than PQL but greater than IDL; analyte found in blank as well as sample
ND – No detected values were found in the database
D – Identified at a secondary dilution factor
J – Estimated value, btw. PQL and MDL
N – Spike recovery not within control limits

Waste Determination

This waste determination demonstrates (through a combination of process knowledge, historical analytical data, approved waste lots and disposal records, and physical characteristics) EMWMF leachate and contact water are neither a listed nor a characteristic hazardous waste under RCRA (see Table F.3). For planning purposes this same waste determination is assumed to apply to the landfill water from the proposed Environmental Management Disposal Facility.

Table F.3. Summary of 40 *CFR* 261 Subpart C criteria regarding EMWMF leachate

40 *CFR* 261 Subpart C criteria	EMWMF leachate status
§ 261.21 Characteristic of ignitability.	
(a) A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:	
(1) It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume and has flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D 93-79 or D 93-80 (incorporated by reference, see § 260.11), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D 3278-78 (incorporated by reference, see § 260.11).	**Addressed**; EMWMF leachate and contact water are aqueous solutions containing less than 24 percent alcohol by volume.
(2) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(3) It is an ignitable compressed gas.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(4) It is an oxidizer. An oxidizer for the purpose of this subchapter is a substance such as a chlorate, permanganate, inorganic peroxide, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter (see Note 4). [Note 4: The DOT regulatory definition of an oxidizer was contained in § 173.151 of 49 *CFR*, and the definition of an organic peroxide was contained in paragraph 173.151a. An organic peroxide is a type of oxidizer.]	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
§ 261.22 Characteristic of corrosivity.	
(a) A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:	
(1) It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using Method 9040C in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication SW-846, as incorporated by reference in § 260.11 of this chapter.	**Addressed**; Numerous field pH measurements range from 5.46 to 10.27. The typical range is 6.8–7.85 with an average of 7.21.
(2) It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by Method 1110A in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication SW-846, and as incorporated by reference in § 260.11 of this chapter.	**Addressed**; The leachate collection system and leachate and contact water transfer systems do not show evidence of excessive corrosion.

Table F.3. Summary of 40 *CFR* 261 Subpart C criteria regarding EMWMF leachate (cont.)

40 *CFR* 261 Subpart C criteria	EMWMF leachate status
§ 261.23 Characteristic of reactivity.	
(a) A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:	
(1) It is normally unstable and readily undergoes violent change without detonating.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(2) It reacts violently with water.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(3) It forms potentially explosive mixtures with water.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(4) When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(5) It is a cyanide or sulfide-bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.	**Addressed**; EMWMF leachate and contact water are aqueous solutions. Cyanides and Sulfides have not been identified as COCs in waste received to date at EMWMF and field pH measurements demonstrate that the leachate and contact water pH is greater than 2 and less than 12.5.
(6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(7) It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(8) It is a forbidden explosive as defined in 49 *CFR* 173.54, or is a Division 1.1, 1.2 or 1.3 explosive as defined in 49 *CFR* 173.50 and 173.53.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
§ 261.24 Toxicity characteristic.	
(a) A solid waste (except manufactured gas plant waste) exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure, test Method 1311 in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA Publication SW-846, as incorporated by reference in § 260.11 of this chapter, the extract from a representative sample of the waste contains any of the contaminants listed in Table 2 (1) at the concentration equal to or greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outlined in Method 1311, is considered to be the extract for the purpose of this section.	**Addressed**; Leachate and contact water samples have not been subjected to the TCLP Prep Method. Please refer to Table F.1 above for a comparison of historical leachate and contact water analytical data (“totals” analyses) against the regulatory levels.

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APPENDIX G.
ZERO DISCHARGE

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Zero Discharge Option for the EMWMF

Thermal processes, which include evaporation, are the only viable options for achieving zero discharge of leachate. This point was made at the Intercontinental Landfill Research Symposium at the Lulea University of Technology in Lulea, Sweden, December 11–13, 2000.

> Thermal processes, particularly evaporation, are the only "treatment" technologies available today that dispose of the water component of water-based waste streams, such as leachate. This technology can reduce the total volume of leachate to less than five percent of the original volume. Leachate evaporation systems generally are economically feasible at sites with an adequate supply of landfill gas (LFG) to evaporate the volume of leachate generated…
>
> The byproduct of these systems is a residual material that usually can be returned to the landfill for disposal…

Table G.1. Summary of selected treatment technologies with application for leachate service

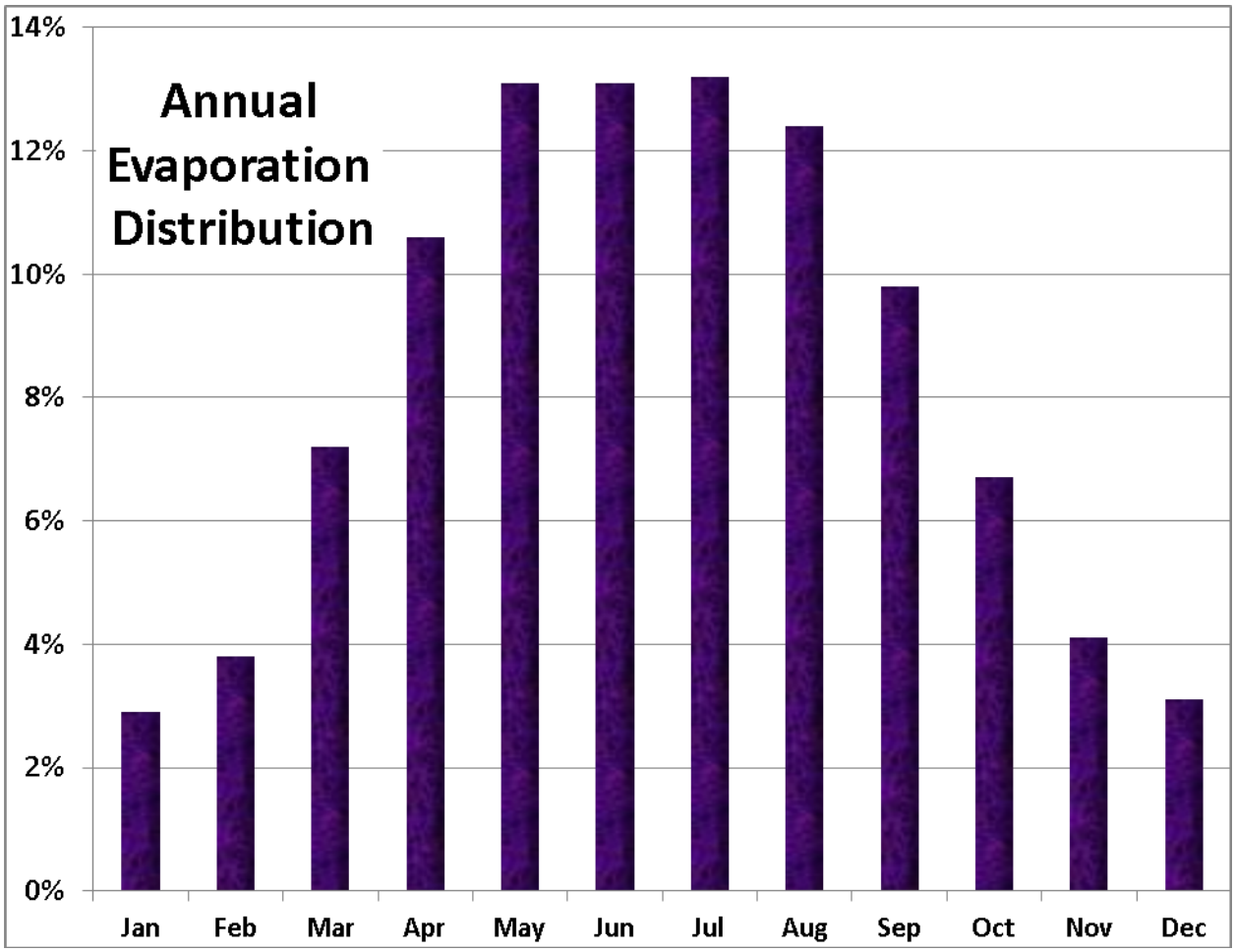
Treatment technology	Advantages	Disadvantages	Residuals
Thermal Evaporator	• No liquid effluent • Small footprint • Easy to operate	• Dependent on landfill gas supply for economical operation • Material compatibility	• Solids (minimal) • Flare emissions
Distillation	• Good VOC and Ammonia Removal • Energy Efficient • Small Footprint • High quality effluent	• Operational complexity	• VOC-laden liquid side stream • Concentrate • Air emission from boiler

Source: *Leachate Treatment Options for Sanitary Landfills* by J. M. Harris, D. E. Purschwitz, and C. D. Goldsmith, 2000.
VOC = volatile organic compound

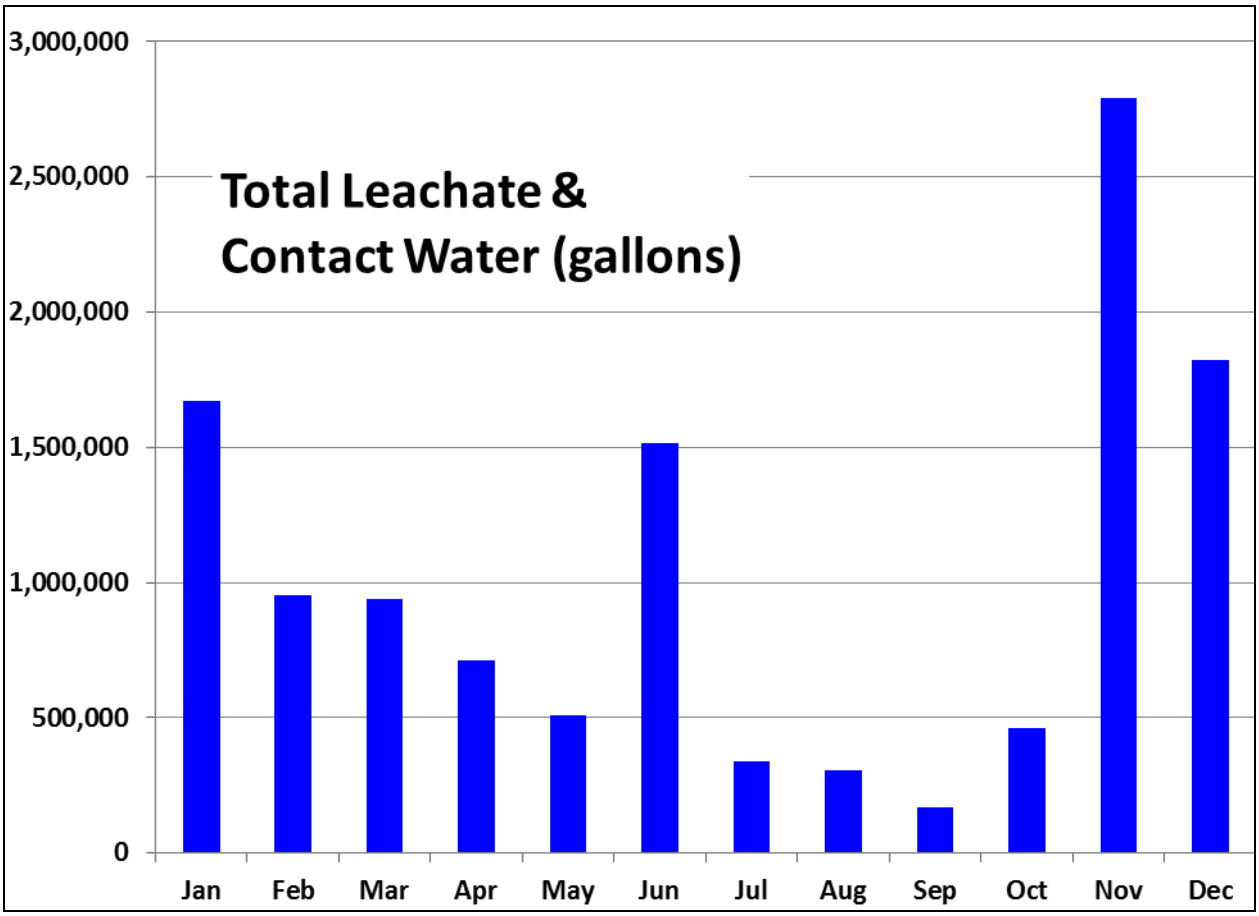
The above limitations were reiterated in the Environmental Research & Education Foundation Regional Summit on Sustainable Solid Waste Practices & Research [for] Managing & Treating Landfill Leachate in Philadelphia, Pennsylvania, October 8–9, 2013:

> …evaporation technology may be attractive due to discharge elimination but site constraints (e.g., availability of LFG or waste heat) may limit its application. (Source: *Leachate Management Decision Making & Available Technologies*, Kevin Torrens, Brown and Caldwell, 2013)

The most influential factors for evaporation are ambient relative humidity, ambient temperature, and the speed of turbulence when mixing the water and air. The Environmental Management Waste Management Facility (EMWMF) is located in a humid subtropical climate zone. Summers are hot and humid, and winters are cool to cold. As illustrated in the following figures, the evaporation potential at EMWMF is at its lowest when the amount of landfill water is at its greatest.



Source: http://knoxcounty.org/stormwater/pdfs/vol2/3-1-8%20Water%20Balance%20Calculations.pdf .



Source: EMWMF operational data for the past 12 months.

Zero discharge of leachate and contact water is not a viable option at the EMWMF for two key reasons:

- There is no landfill gas or waste heat to cost effectively evaporate these waters
- The lowest evaporation potential is present when water generation is greatest

Other factors that render thermal processing unattractive for EMWMF include:

- The droplets of water carried off in the air may have low levels of contaminants, with the potential for depositing contaminants downwind in previously un-impacted areas.
- The process is expected to require several large enclosed structures to prevent immediate precipitation of evaporated water, for which adequate footprint is not readily available.

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APPENDIX H.
WATER STORAGE REQUUIREMENTS

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Environmental Management Waste Management Facility/Environmental Management Disposal Facility's (EMWMF/EMDF's) existing and proposed water handling systems, including water storage features and water processing rates, within this focused feasibility study (FFS) were limited to managing design storm events using conventional stormwater analysis, as is standard industry practice. Conventional analysis uses intensity, aerial distribution of a storm, and a storm's recurrence interval. Intensity is the relationship between the volume of a precipitation event and the duration of the event, and a storm's recurrence interval is the average number of years between storms of a given intensity. High-intensity storm events generally occur at greater intervals, such as 25, 50, to 100 years or more apart.

For this FFS, the National Oceanic and Atmospheric Administration 100-year, 24-hour design storm event for Oak Ridge, Tennessee of 6.85 inches of precipitation was the selected intensity based on the reasonably low daily probability of the event, historical rainfall data at EMWMF, duration of stormwater management at EMWMF/EMDF, and professional judgment. As the design life of the facility increases, the probability of experiencing the design storm event increases; therefore, this risk must be mitigated through properly designed water storage and processing rates.

The design storm event, over an assumed aerial distribution, provided a reasonably high volume that is likely to occur, and was used to size a feasible storage capacity within the existing and proposed water handling systems. It is important to note that for these aerial distributions analyzed, it is not practical to design a water processing system that will keep up in real-time with the rate of precipitation of the design 100-year, 24-hour storm event, or the precipitation resulting from more frequently occurring, lower intensity storm events. Similarly, it is not reasonable to design water storage features that can accommodate all storm events larger than the design event for this large of an aerial distribution.

Flood routing and/or bypass of the water handling systems may be expected if a storm event larger than the design storm event occurs or if a high-intensity storm event occurs while stormwater inventory remains in the water storage system.

An appropriate water processing rate for the various FFS alternatives requires that the EMWMF quantify and specify the assumed relationship between the aerial distribution and available water storage capacity, as well as identify potential operational constraints that could limit the ability to handle the 100-year, 24-hour design storm event. EMWMF and EMDF are each delineated into six (6) waste placement areas known as cells, and each area is assigned a label of Cell 1 through Cell 6.

For the FFS, EMWMF Cells 1–3 were considered to be in an interim cover state and shedding stormwater that does not contribute to the water handling system at EMWMF. Cells 4–5 are considered open, active waste placement areas, and all stormwater contributes to the water handling system as either leachate or contact water. As landfill progression continues, it is possible that three (3) cells will be considered open and active at any given time, based on demolition strategies observed at the Oak Ridge Reservation in the past; however, for this FFS, three (3) open and active cells, the aerial distribution used in the analysis varied from approximately 13 to 18 acres, depending on which configuration of cells were open.

The FFS assumes that EMWMF Cells 5 and 6 and EMDF Cell 1 were the three (3) cells open at a given time. The aerial distribution was 17.1 acres versus 16.3 acres, if EMDF Cells 1–3 were open. While determining inputs and assumptions to this FFS, we determined that the existing storage capacity at EMWMF would only be utilized by open cells at EMWMF. No in-cell storage is planned for EMDF; therefore, water handling systems and storage would be constructed for the design storm event and assume complete runoff to storage.

To assess the risk of bypassing the existing water management system at EMWMF, a calculation was developed for management called the EMWMF Water Balance Model. This tool accounts for

configuration modifications of the facility, including aerial distribution and storage capacity increases and decreases while modeling design storm events over the design life of the facility. Using the daily probability of these design storm events occurring, the overall likelihood of a bypass can be quantified to a percent risk. Based on the design life expected of less than 50 years, a risk of less than 10% was considered an acceptable configuration, with little to no bypass volumes expected for the design 100-year, 24-hour storm event. Additionally, EMWMF Operations' continuing practice of processing water through the water handling system in a timely manner to keep water inventories low reduces the risk of a bypass.

Using the proposed maximum design flow rate of 60 gpm continuously taking away from the water management system, a worst-case scenario of existing EMWMF operational constraints, piping configurations, and pumping capacities (including the areal distribution referenced above of EMWMF Cells 5 and 6 and EMDF Cell 1) will require the minimum storage to be an EMWMF Cell 5 in-cell catchment reduced to 1.5 million gallons, EMWMF Cell 6 catchment of 2.0 million gallons, combined storage of Contact Water Ponds, Contact Water Tanks and Leachate Storage tanks of 3.0 million gallons, and proposed water storage feature for EMDF Cell 1 of 2.0 million gallons. As additional EMDF Cells are constructed and are opened, additional water storage must be constructed, or EMWMF water storage must be utilized.

APPENDIX I.
BASIS OF COST ESTIMATES

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EMWMF/EMDF LEACHATE FOCUSED FEASIBILITY STUDY	Alternative 2 Managed Discharge (20151112A_2_0)	Alternative 3A PWTC Treatment and Pipeline (20151112A_3A_0)	Alternative 3B PWTC Treatment and Trucking (20151112A_3B_0)	Alternative 4A OF200 Treatment and Pipeline (20151112A_4A_0)	Alternative 4B OF200 Treatment and Trucking (20151112A_4B_0)
Capital Costs During Design Phase (1 year duration):					
Perform Project Management During Design Phase	$ 342,509	$ 342,509	$ 342,509	$ 342,509	$ 342,509
Design Facilities	$ 898,674	$ 1,261,173	$ 1,182,128	$ 1,262,381	$ 1,186,327
Conduct Treatability Study	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000
Prepare Regulatory Documents	$ 248,817	$ 284,362	$ 284,362	$ 284,362	$ 284,362
Subtotal:	$ 1,540,000	$ 1,938,044	$ 1,858,999	$ 1,939,252	$ 1,863,198
DOE Prime Contractor G&A and Fee (36 percent)	$ 554,400	$ 697,696	$ 669,240	$ 698,131	$ 670,751
Subtotal:	$ 2,094,400	$ 2,635,739	$ 2,528,238	$ 2,637,383	$ 2,533,950
Contingency Percentage	15%	25%	15%	25%	15%
Contingency Amount	$ 545,160	$ 1,143,446	$ 658,086	$ 1,144,159	$ 659,572
Capital Cost 1:	*$ 2,639,559*	*$ 3,779,185*	*$ 3,186,324*	*$ 3,781,542*	*$ 3,193,522*
Capital Costs During Construction Phase (1 year duration):					
Perform Project Management During Construction Phase	$ 342,509	$ 342,509	$ 342,509	$ 342,509	$ 342,509
Perform Construction Management During Construction Phase	$ 479,293	$ 672,625	$ 630,468	$ 673,270	$ 632,708
Perform Operational Readiness and Startup	$ 86,417	$ 86,417	$ 86,417	$ 86,417	$ 86,417
Construct Treatment Plant at EMWMF	$ 5,991,158	$ 5,991,158	$ 5,991,158	$ 5,991,158	$ 5,991,158
Construct Pipeline from EMWMF to PWTC (or OF200) plus Lift Station	$ -	$ 2,416,660	$ -	$ 1,655,967	$ -
Construct Tanker Loading Stations at EMWMF plus Purchase Additional Tankers	$ -	$ -	$ 528,125	$ -	$ 528,125
Construct Tanker Unloading Stations at PWTC (or OF200)	$ -	$ -	$ 1,241,202	$ -	$ 620,815
Perform Soil Remediation at PWTC	$ -	$ -	$ 120,367	$ -	$ -
Construct Additional Water Storage at OF200	$ -	$ -	$ -	$ 768,750	$ 768,750
Subtotal:	$ 6,899,377	$ 9,509,369	$ 8,940,246	$ 9,518,071	$ 8,970,482
DOE Prime Contractor G&A and Fee (36 percent)	$ 2,483,776	$ 3,423,373	$ 3,218,489	$ 3,426,506	$ 3,229,373
Subtotal:	$ 9,383,152	$ 12,932,742	$ 12,158,735	$ 12,944,577	$ 12,199,855
Contingency Percentage	15%	25%	15%	25%	15%
Contingency Amount	$ 1,407,473	$ 3,233,186	$ 1,823,810	$ 3,236,144	$ 1,829,978

EMWMF/EMDF LEACHATE FOCUSED FEASIBILITY STUDY	Alternative 2 Managed Discharge (20151112A_2_0)	Alternative 3A PWTC Treatment and Pipeline (20151112A_3A_0)	Alternative 3B PWTC Treatment and Trucking (20151112A_3B_0)	Alternative 4A OF200 Treatment and Pipeline (20151112A_4A_0)	Alternative 4B OF200 Treatment and Trucking (20151112A_4B_0)
Capital Cost 2:	*$ 10,790,625*	*$ 16,165,928*	*$ 13,982,545*	*$ 16,180,721*	*$ 14,029,834*
O&M Costs During EMDF Operations and Closure (30 years duration):					
Perform Project Management During EMDF Operations and Closure	$ 6,676,527	$ 6,676,527	$ 6,676,527	$ 6,676,527	$ 6,676,527
Operate Onsite Treatment Plant During EMDF Operations and Closure	$ 8,366,769	$ 8,366,769	$ 8,366,769	$ 8,366,769	$ 8,366,769
Purchase GAC and/or Treatment Resins	$ 5,794,800	$ 5,794,800	$ 5,794,800	$ 5,794,800	$ 5,794,800
Freight Charges on Materials	$ 463,584	$ 463,584	$ 463,584	$ 463,584	$ 463,584
Operate Pipeline During EMDF Operations	$ -	$ 1,457,957	$ -	$ 1,457,957	$ -
Sample/Test Leachate During EMDF Operations	$ 6,375,510	$ 7,013,070	$ 7,013,070	$ 7,013,070	$ 7,013,070
Truck Leachate Plus Contact Water During EMDF Operations	$ -	$ -	$ 45,000,000	$ -	$ 45,000,000
Subtotal:	$ 27,677,190	$ 29,772,707	$ 73,314,750	$ 29,772,707	$ 73,314,750
DOE Prime Contractor G&A and Fee (36 percent)	$ 9,963,788	$ 10,718,175	$ 26,393,310	$ 10,718,175	$ 26,393,310
Subtotal:	$ 37,640,978	$ 40,490,882	$ 99,708,060	$ 40,490,882	$ 99,708,060
Contingency Percentage	20%	20%	30%	20%	30%
Contingency Amount	$ 7,528,196	$ 8,098,176	$ 29,912,418	$ 8,098,176	$ 29,912,418
Total O&M Cost 2:	*$ 45,169,174*	*$ 48,589,058*	*$ 129,620,478*	*$ 48,589,058*	*$ 129,620,478*
Annual O&M Cost 2:	*$ 1,505,639*	*$ 1,619,635*	*$ 4,320,683*	*$ 1,619,635*	*$ 4,320,683*
O&M Costs During Post-Closure EMDF (30 years duration):					
Perform Project Management During EMDF Post-Closure	$ 2,690,869	$ 2,690,869	$ 2,690,869	$ 2,690,869	$ 2,690,869
Operate Onsite Treatment Plant During Post-Closure EMDF	$ 1,473,363	$ 1,473,363	$ 1,473,363	$ 1,473,363	$ 1,473,363
Sample/Test Leachate During Post-Closure EMDF	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880
Truck EMDF Leachate During Post-Closure EMDF	$ -	$ -	$ 799,056	$ -	$ 799,056
Subtotal:	$ 5,262,112	$ 5,262,112	$ 6,061,168	$ 5,262,112	$ 6,061,168
DOE Prime Contractor G&A and Fee (36 percent)	$ 1,894,360	$ 1,894,360	$ 2,182,020	$ 1,894,360	$ 2,182,020
Subtotal:	$ 7,156,472	$ 7,156,472	$ 8,243,188	$ 7,156,472	$ 8,243,188
Contingency Percentage	20%	20%	30%	20%	30%
Contingency Amount	$ 1,431,294	$ 1,431,294	$ 2,472,957	$ 1,431,294	$ 2,472,957

EMWMF/EMDF LEACHATE FOCUSED FEASIBILITY STUDY	Alternative 2 Managed Discharge (20151112A_2_0)	Alternative 3A PWTC Treatment and Pipeline (20151112A_3A_0)	Alternative 3B PWTC Treatment and Trucking (20151112A_3B_0)	Alternative 4A OF200 Treatment and Pipeline (20151112A_4A_0)	Alternative 4B OF200 Treatment and Trucking (20151112A_4B_0)
Total O&M Cost 4:	*$ 8,587,767*	*$ 8,587,767*	*$ 10,716,145*	*$ 8,587,767*	*$ 10,716,145*
Annual O&M Cost 4:	*$ 286,259*	*$ 286,259*	*$ 357,205*	*$ 286,259*	*$ 357,205*
Unescalated Total Cost:	***$ 67,187,125***	***$ 77,121,938***	***$ 157,505,492***	***$ 77,139,087***	***$ 157,559,978***
Present Value:	***$ 50,886,150***	***$ 59,848,906***	***$ 118,338,338***	***$ 59,865,807***	***$ 118,392,035***

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Basis of Estimate
EMWMF/EMDF Leachate Focused
Feasibility Study: Alternative 2:
Managed Discharge
February 9, 2016

Objective/Scope:

Method of Accomplishment:

URS|CH2M Oak Ridge LLC (UCOR) provides project management during design of a new Treatment Plant at the Environmental Management Waste Management Facility, preparation of required regulatory documents, project and construction management/oversight during facility construction, facility operational readiness and startup, and oversight and operations of the facility for thirty years, as well as oversight and operations during post-closure, also for thirty years. Subcontractors will perform the actual design of the treatment facility, conduct necessary treatability studies, and the actual construction of the facility. Subcontract labs were also assumed to provide the analytical service of samples taken during operations and post-closure.

Estimate Type and Approach:

This feasibility estimate is based upon the existing work and past work experience. The estimate was developed using a combination of bottoms-up approach, actual costs of similar work, and estimator and team experience with the existing operations.

Key Financial Data:

1. The estimate was prepared in the second quarter of fiscal year (FY)2016.
2. Any actual costs of work or similar work were provided by the project team.
3. General and Administrative costs and fee are not included in this estimate.
4. All UCOR and Staff Augmentation rates are fully burdened, including fringes. Staff Augmentation rates include overhead and profit.
5. A sales tax of 9.75% has been included on all material.
6. All prices are in FY2016 dollars and no escalation has been included.
7. There is no contingency in this estimate.
8. UCOR and staff augmentation rates were used for the U.S. Department of Energy prime contractor.

Estimate Assumptions and Exclusions:

1. One Full Time Equivalent (FTE) is equal to 1880 man-hours per year.
2. One FTE for facility operations is 2080 man-hours per year.
3. The Conceptual Design Report and the Critical Decision (CD-1, -2, -3, and -4) process was not included in this estimate.
4. The cost for final closure of the Environmental Management Disposal Facility (EMDF) is not included in this estimate.
5. There are no decontamination and demolition costs included in this estimate.
6. Design of the treatment facility is estimated at 15% of the total construction cost for the facility.
7. Construction management for the treatment facility is estimated at 8% of the total construction cost of the facility.
8. The treatability study is based on an AECOM estimate for the construction of the treatment facility; reference Landfill Wastewater Treatment System, dated 10/23/2015.

9. The following regulatory documents are included in this estimate: Post Construction Closure Report), Remedial Action Work Plan, Remedial Action Work Plan/Remedial Design Report, and a Record of Decision/Environmental Stewardship Document.
10. The actual treatment facility construction estimate is based on an AECOM estimate, dated 10/23/2015. The estimate for the facility less additional storage capacity was $6,905,000. The preliminary and final design, along with the treatability study, was deducted and is shown elsewhere within the estimate.
11. Operations of the treatment facility during the EMDF operating period was estimated at 30 years.
12. An annual material allowance for treatment-related materials is included in the estimate. Activated Carbon was considered as the treatment technology initially and an estimate was provided of $88,000 per year for materials. The technology was later changed to Ion Exchange; subject matter experts estimate that the materials allowance for Ion Exchange should be twice the amount for Activated Carbon.
13. Freight for the treatment materials delivery is included in the estimate at 8% of the material cost. This is based on the AECOM estimate for the treatment facility, dated 10/23/2015.
14. Annual analytical cost allowances during the time of the facility operation are included in the estimate and they were provided by the Feasibility Study project team.
15. Operations of the treatment facility during the EMDF post-closure period were estimated at 30 years.
16. Annual analytical cost allowances during the time of the facility operation are included in the estimate and they were provided by the Feasibility Study project team.

Schedule Assumptions:

1. No funding limitation impacts will be experienced.
2. Design will take approximately 12 months.
3. All construction is expected to take approximately 12 months.
4. The operation and maintenance of the treatment system is expected to last 30 years.
5. Post-closure leachate management is expected to last 30 years.

Estimate Uncertainty:

The estimate was prepared in support of a Feasibility Study quality, which places it as a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International. The uncertainty range for Class 4 estimates can be as low as -30% to as high as +50%. The recommended level of uncertainty to apply to this estimate is -20% to +40%.

All signatures on file.

ESTIMATOR:	DATE:
PROJECT MANAGER:	DATE:
ESTIMATING MANAGER:	DATE:

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
01.01.01				Capital Costs During Design Phase																	
	0100			Perform Project Management During Design Phase																	
		0100		Perform Project Management During Design Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea 88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea 71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea 139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea 81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea 47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25 FTE	0.25	ea	1,880.00	hr/ea 75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea 120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0 .25 FTE	0.25	ea	1,880.00	hr/ea 98.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			3,760.00	ea		-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0100 Perform Project Management During Design Phase							3,760.00	340,487		2,022							342,509
				0100 Perform Project Management During Design Phase							3,760.00	340,487		2,022							342,509
	0200			Design Facilities																	
		0200		Design Facilities																	
			----	Design Facilities		Calculated based on 15% of total construction cost (5,991,158)	0.15	pct		-	-	-	-	-	-	-	-	-	5,991,158.00 /pct	898,674	898,674
				0200 Design Facilities																898,674	898,674
				0200 Design Facilities																898,674	898,674
	0300			Conduct Treatability Study																	
		0300		Conduct Treatability Study																	
			----	Treatability Study		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15 under Direct Field Cost, Acct **	1.00	ea		-	-	-	-	-	-	-	-	-	50,000.00 /ea	50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
	0400			Prepare Regulatory Documents																	
		PCCR		PCCR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea 180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea 56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea 120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			539.00	hr		-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				PCCR PCCR							539.00	70,807		284							71,090
		RAWP		RAWP																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea 180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea 56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea 120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			539.00	hr		-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP RAWP							539.00	70,807		284							71,090
		RAWP/RDR		RAWP/RDR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea 180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea 56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea 120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			539.00	hr		-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP/RDR RAWP/RDR							539.00	70,807		284							71,090
		ROD ESD		ROD ESD																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea 180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea 56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea 120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			269.50	hr		-	-	-	0.53 /hr	142	-	-	-	-	-	-	142
				ROD ESD ROD ESD							269.50	35,403		142							35,545
				0400 Prepare Regulatory Documents							1,886.50	247,823		994							248,817
				01.01.01 Capital Costs During Design Phase							5,646.50	588,310		3,016						948,674	1,539,999
01.01.02				Capital Costs During Construction Phase (1 yr duration)																	

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
	0120			**Perform Project Management During Construction Phase**																	
		0120		**Perform Project Management During Construction Phase**																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0.25 FTE	0.25	ea	1,880.00	hr/ea	99.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost.			3,760.00	ea			-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0120 Perform Project Management During Construction Phase								**3,760.00**	**340,487**		**2,022**						**342,509**
				0120 Perform Project Management During Construction Phase								**3,760.00**	**340,487**		**2,022**						**342,509**
	0220			**Perform Construction Management During Construction Phase**																	
		0220		**Perform Construction Management During Construction Phase**																	
			----	Construction Management		Calculated based on 8% of total construction cost (5,991,158)	0.08	pct			-	-	-	-	-	-	-	-	5,991,158.00 /pct	479,293	479,293
				0220 Perform Construction Management During Construction Phase																**479,293**	**479,293**
				0220 Perform Construction Management During Construction Phase																**479,293**	**479,293**
	0230			**Perform Operational Readiness and Startup**																	
		0231		**Procedures and Training**																	
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.50	ea	80.00	hr/ea	75.81 /hr	40.00	3,032	-	-	-	-	-	-	-	-	3,032
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	80.00	hr/ea	120.72 /hr	160.00	19,315	-	-	-	-	-	-	-	-	19,315
			----	Material Allowance			1.00	ls			-	-	-	3,292.50 /ls	3,293	-	-	-	-	-	-	3,293
				0231 Procedures and Training								**200.00**	**22,348**		**3,293**						**25,640**
		0232		**Readiness and Startup**																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			4.00	ea	120.00	hr/ea	52.83 /hr	480.00	25,406	-	-	-	-	-	-	-	-	25,406
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.10	ea	120.00	hr/ea	75.81 /hr	12.00	910	-	-	-	-	-	-	-	-	910
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	120.00	hr/ea	120.72 /hr	240.00	28,973	-	-	-	-	-	-	-	-	28,973
			----	Material Allowance			1.00	ls			-	-	-	5,487.50 /ls	5,488	-	-	-	-	-	-	5,488
				0232 Readiness and Startup								**732.00**	**55,289**		**5,488**						**60,776**
				0230 Perform Operational Readiness and Startup		**Reference EMWMF/EMDF Leachate Feasibility Study On-Site Treatment Estimate, log #20150324B_0 dated 4/8/15.**						**932.00**	**77,637**		**8,780**						**86,417**
	0240			**Construct Treatment Plant at EMWMF**																	
		0240		**Construct Treatment Plant at EMWMF**																	
			----	Construct Treatment Plant at EMWMF		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. Estimate less additional storage was calculated at $6,905,000. Remove Preliminary and Final Design and Treatability Study which are all covered elsewhere for a resulting total of 5,991,158.	1.00	ls			-	-	-	-	-	-	-	-	5,991,158.00 /ls	5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																**5,991,158**	**5,991,158**
				0240 Construct Treatment Plant at EMWMF																**5,991,158**	**5,991,158**
				01.01.02 Capital Costs During Construction Phase (1 yr duration)								**4,692.00**	**418,123**		**10,802**					**6,470,451**	**6,899,376**

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
01.01.05				O&M Costs During EMDF Operations and Closure (30 yrs duration)																	
	0510			Perform Project Management During EMDF Operations																	
		0510		Perform Project Management During EMDF Operations																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.13	ea	56,400.00	hr/ea	88.87 /hr	7,050.00	627,238	-	-	-	-	-	-	-	-	627,238
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.05	ea	56,400.00	hr/ea	71.30 /hr	2,820.00	201,066	-	-	-	-	-	-	-	-	201,066
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.25	ea	56,400.00	hr/ea	139.59 /hr	14,100.00	1,968,219	-	-	-	-	-	-	-	-	1,968,219
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.13	ea	56,400.00	hr/ea	81.42 /hr	7,050.00	574,011	-	-	-	-	-	-	-	-	574,011
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.13	ea	56,400.00	hr/ea	47.47 /hr	7,050.00	334,884	-	-	-	-	-	-	-	-	334,884
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.13	ea	56,400.00	hr/ea	75.81 /hr	7,050.00	534,461	-	-	-	-	-	-	-	-	534,461
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.25	ea	56,400.00	hr/ea	120.72 /hr	14,100.00	1,702,152	-	-	-	-	-	-	-	-	1,702,152
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.13	ea	56,400.00	hr/ea	99.16 /hr	7,050.00	699,078	-	-	-	-	-	-	-	-	699,078
			OffSpply	Office Supplies, from R.S. Means monthly Cost.			66,270.00	ea			-	-	-	0.54 /ea	35,638	-	-	-	-	-	-	35,638
				0510 Perform Project Management During EMDF Operations								66,270.00	6,640,889		35,638							6,676,527
				0510 Perform Project Management During EMDF Operations								66,270.00	6,640,889		35,638							6,676,527
	0520			Operate Onsite Treatment Plant During EMDF Operations																	
		0520		Operate Onsite Treatment Plant During EMDF Operations																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		30 years at 2080 hours per year = 62400 hours	2.00	ea	62,400.00	hr/ea	52.93 /hr	124,800.00	8,805,884	-	-	-	-	-	-	-	-	8,805,884
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			0.12	ea	62,400.00	hr/ea	52.93 /hr	7,488.00	396,340	-	-	-	-	-	-	-	-	396,340
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	75.81 /hr	3,744.00	283,833	-	-	-	-	-	-	-	-	283,833
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	120.72 /hr	3,744.00	451,876	-	-	-	-	-	-	-	-	451,876
			PPE DMod	PPE Level D Modified			139,776.00	hr			-	-	-	4.50 /hr	628,957	-	-	-	-	-	-	628,957
				0520 Operate Onsite Treatment Plant During EMDF Operations								139,776.00	7,737,812		628,957							8,366,769
				0520 Operate Onsite Treatment Plant During EMDF Operations								139,776.00	7,737,812		628,957							8,366,769
	0530			Purchase GAC and/or Treatment Resins																	
		0530		Purchase GAC and/or Treatment Resins																	
			----	Annual Material Allowance		(Per R. McDonnell - $88,000/year allowance for GAC treatment technology. Per Ray and Stephen Hahn new technology is Ion Exchange and material allowance for Ion Exchange is approximately twice the needed allowance for GAC, therefore use 2 x $88,000/year or $176,000/year for materials) (plus tax)	30.00	yr		-	-	-	193,160.00 /yr	5,794,800	-	-	-	-	-	-	-	5,794,800
				0530 Purchase GAC and/or Treatment Resins											5,794,800							5,794,800
				0530 Purchase GAC and/or Treatment Resins											5,794,800							5,794,800
	0540			Freight on Materials																	
		0540		Freight on Materials																	
			----	Freight on Materials		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. ACCT 60	0.08	pct			-	-	-	-	-	-	-	-	-	5,794,800.00 /pct	463,584	463,584
				0540 Freight on Materials																463,584	463,584
				0540 Freight on Materials																463,584	463,584
	0560			Sample/Test Leachate During EMDF Operations																	
		0560		Sample/Test Leachate During EMDF Operations																	
			----	Annual Analytical Costs		per FFS project team	30.00	yr			-	-	-	-	-	-	-	-	-	212,517.00 /yr	6,375,510	6,375,510
				0560 Sample/Test Leachate During EMDF Operations																6,375,510	6,375,510
				0560 Sample/Test Leachate During EMDF Operations																6,375,510	6,375,510

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
				01.01.05 O&M Costs During EMDF Operations and Closure (30 yrs duration)							**206,046.00**	**14,378,701**		**6,459,395**						**6,839,094**	**27,677,190**
01.01.07				**O&M Costs During Post-Closure EMDF (30 yrs duration)**																	
	0610			**Perform Project Management During EMDF Post-Closure**																	
		0610		**Perform Project Management During EMDF Post-Closure**																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.05	ea	56,400.00	hr/ea	88.97 /hr	2,820.00	250,895	-	-	-	-	-	-	-	-	250,895
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.03	ea	56,400.00	hr/ea	71.30 /hr	1,410.00	100,533	-	-	-	-	-	-	-	-	100,533
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.10	ea	56,400.00	hr/ea	139.59 /hr	5,640.00	787,288	-	-	-	-	-	-	-	-	787,288
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.05	ea	56,400.00	hr/ea	81.42 /hr	2,820.00	229,604	-	-	-	-	-	-	-	-	229,604
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.05	ea	56,400.00	hr/ea	47.47 /hr	2,820.00	133,865	-	-	-	-	-	-	-	-	133,865
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.05	ea	56,400.00	hr/ea	75.81 /hr	2,820.00	213,784	-	-	-	-	-	-	-	-	213,784
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.10	ea	56,400.00	hr/ea	120.72 /hr	5,640.00	880,861	-	-	-	-	-	-	-	-	880,861
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.05	ea	56,400.00	hr/ea	99.16 /hr	2,820.00	279,631	-	-	-	-	-	-	-	-	279,631
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			26,790.00	ea			-	-	-	0.54 /ea	14,407	-	-	-	-	-	-	14,407
				0610 Perform Project Management During EMDF Post-Closure							**26,790.00**	**2,676,462**		**14,407**							**2,690,869**
				0610 Perform Project Management During EMDF Post-Closure							**26,790.00**	**2,676,462**		**14,407**							**2,690,869**
	0620			**Operate Onsite Treatment Plant During Post-Closure EMDF**																	
		0620		**Operate Onsite Treatment Plant During Post-Closure EMDF**																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		1 day once a month for 30 years.	2.00	ea	3,600.00	hr/ea	52.93 /hr	7,200.00	381,096	-	-	-	-	-	-	-	-	381,096
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		1 day once a month for 30 years	0.50	ea	3,600.00	hr/ea	75.81 /hr	1,800.00	136,458	-	-	-	-	-	-	-	-	136,458
			RSISA09	Senior Staff Engineer/Scientist (FY16 Rev1 B06)		1 day once a month for 30 years	2.00	ea	3,600.00	hr/ea	108.11 /hr	7,200.00	778,392	-	-	-	-	-	-	-	-	778,392
			SPTSA03	Senior RPT (FY16 Rev1 B06)		1 day once a month for 30 years	0.50	ea	3,600.00	hr/ea	43.69 /hr	1,800.00	78,642	-	-	-	-	-	-	-	-	78,642
			----	Material Allowance			30.00	yr			-	-	-	3,292.50 /yr	98,775	-	-	-	-	-	-	98,775
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF							**18,000.00**	**1,374,588**		**98,775**							**1,473,363**
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF							**18,000.00**	**1,374,588**		**98,775**							**1,473,363**
	0630			**Sample/Test Leachate During Post-Closure EMDF**																	
		0630		**Sample/Test Leachate During Post-Closure EMDF**																	
			----	Sampling/Analytical		From FFS team	30.00	yr			-	-	-	-	-	-	-	-	36,598.00 /yr	1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF																**1,097,880**	**1,097,880**
				0630 Sample/Test Leachate During Post-Closure EMDF																**1,097,880**	**1,097,880**
				01.01.07 O&M Costs During Post-Closure EMDF (30 yrs duration)							**44,790.00**	**4,051,050**		**113,182**						**1,097,880**	**5,262,112**

Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	19,436,184		261,175 hrs				46.97%	
Material	6,586,395						15.92%	
Equipment								
Subcontract								
Other	15,356,098						37.11%	
	41,378,677	41,378,677					100.00	100.00%
Total		41,378,677						

Basis of Estimate
EMWMF/EMDF Leachate Focused Feasibility Study: Alternative 3a:
PWTC Treatment and Pipeline Alternative
February 9, 2016

Objective/Scope:

Method of Accomplishment:

URS|CH2M Oak Ridge LLC (UCOR) provides project management during design of a new Treatment Plant at the Environmental Management Waste Management Facility (EMWMF) and the pipeline from EMWMF to either Liquid and Gaseous Waste Operations, preparation of required regulatory documents, project and construction management/oversight during facility and pipeline construction, facility operational readiness and startup, and oversight and operations of the facility and pipeline for thirty years, as well as oversight and operations during post-closure, also for thirty years. Subcontractors will perform the actual design of the treatment facility and pipeline, conduct necessary treatability studies, and perform the actual construction of the facilities. Subcontract labs were also assumed to provide the analytical service of samples taken during operations and post-closure.

Estimate Type and Approach:

This feasibility estimate is based upon similar work proposed in the past and work experience. The estimate was developed using a combination of bottoms-up approach, parametric data from similar projects, actual costs of similar work, and estimator and team experience with similar projects and existing operations.

Key Financial Data:

1. The estimate was prepared in the second quarter of fiscal year (FY)2016.
2. Any actual costs of work or similar work were provided by the project team.
3. General and Administrative costs and fee are not included in this estimate.
4. All UCOR and Staff Augmentation rates are fully burdened, including fringes. Staff Augmentation rates include overhead and profit.
5. A sales tax of 9.75% has been included on all material.
6. All prices are in FY2016 dollars and no escalation has been included.
7. There is no contingency in this estimate.
8. UCOR and staff augmentation rates were used for the U.S. Department of Energy prime contractor.

Estimate Assumptions and Exclusions:

1. One Full Time Equivalent (FTE) is equal to 1880 man-hours per year.
2. One FTE for facility operations is 2080 man-hours per year.
3. The Conceptual Design Report and the Critical Decision (CD-1, -2, -3, and -4) process was not included in this estimate.
4. The cost for final closure of the Environmental Management Disposal Facility (EMDF) is not included in this estimate.
5. There are no decontamination and demolition costs included in this estimate.
6. Design of the facilities is estimated at 15% of the total construction cost for the facilities (water treatment, pipeline, and lift station).

7. Construction management for the facilities is estimated at 8% of the total construction cost for the facilities (water treatment, pipeline, and lift station).
8. The treatability study is based on an AECOM estimate for the construction of the treatment facility; reference Landfill Wastewater Treatment System, dated 10/23/2015.
9. The following regulatory documents are included in this estimate: National Pollutant Discharge Elimination System, Post Construction Closure Report, Remedial Action Work Plan, Remedial Action Work Plan/Remedial Design Report, and a Waste Acceptance Criteria.
10. The actual treatment facility construction estimate is based on an AECOM estimate, dated 10/23/2015. The estimate for the facility less additional storage capacity was $6,905,000. The preliminary and final design, along with the treatability study, was deducted and is shown elsewhere within the estimate.
11. Subcontractor Overhead and Profit is included in the estimate at 25% of the pipeline and lift station construction estimate. Overhead and Profit was not added to the treatment facility construction because it is already included in the AECOM estimate.
12. Operations of the treatment facility and pipeline during the EMDF operating period was estimated at 30 years.
13. An annual material allowance for treatment related materials is included in the estimate. Activated Carbon was considered as the treatment technology initially and an estimate was provided of $88,000 per year for materials. The technology was later changed to Ion Exchange; subject matter experts estimate that the material allowance for Ion Exchange should be twice the amount for Activated Carbon.
14. Freight for the treatment materials delivery is included in the estimate at 8% of the material cost. This is based on the AECOM estimate for the treatment facility, dated 10/23/2015.
15. Annual analytical cost allowances during the time of the facility operation are included in the estimate and they were provided by the Feasibility Study project team. Their estimate was increased by 10% to allow for additional sampling and analysis of water at the receiving facility.
16. Operations of the treatment facility during the EMDF post-closure period were estimated at 30 years.
17. Annual analytical cost allowances during the time of post-closure are included in the estimate for a period of 30 years and they were provided by the Feasibility Study project team.

Schedule Assumptions:

1. No funding limitation impacts will be experienced.
2. Design will take approximately 12 months.
3. All construction is expected to take approximately 12 months.
4. The operation and maintenance of the treatment system is expected to last 30 years.
5. Post closure leachate management is expected to last 30 years.

Estimate Uncertainty:

The estimate was prepared in support of a Feasibility Study quality, which places it as a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International. The uncertainty range for Class 4 estimates can be as low as -30% to as high as +50%. The recommended level of uncertainty to apply to this estimate is -20% to +40%.

All signatures on file.

ESTIMATOR:	DATE:
PROJECT MANAGER:	DATE:
ESTIMATING MANAGER:	DATE:

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
01.01.01				Capital Costs During Design Phase																	
	0100			Perform Project Management During Design Phase																	
		0100		Perform Project Management During Design Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	139.59 /hr	470.00	65,807	-	-	-	-	-	-	-	-	65,807
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25 FTE	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0..25 FTE	0.25	ea	1,880.00	hr/ea	99.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			3,760.00	ea			-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0100 Perform Project Management During Design Phase								3,760.00	340,487		2,022							342,509
				0100 Perform Project Management During Design Phase								3,760.00	340,487		2,022							342,509
	0200			Design Facilities																	
		0200		Design Facilities																	
			----	Design Facilities		Calculated based on 15% of total construction cost (5,991,158+2,416,880=8,407,818)	0.15	pct			-	-	-	-	-	-	-	-	8,407,818.00	/pct	1,261,173	1,261,173
				0200 Design Facilities																1,261,173	1,261,173
				0200 Design Facilities																1,261,173	1,261,173
	0300			Conduct Treatability Study																	
		0300		Conduct Treatability Study																	
			----	Treatability Study		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15 under Direct Field Cost, Acct **	1.00	ea			-	-	-	-	-	-	-	-	50,000.00	/ea	50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
	0400			Prepare Regulatory Documents																	
		NPDES Permit Revisio		NPDES																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030
			OffSpply	Office Supplies, from R.S. Means monthly Cost, 4Q CY2014			268.50	hr			-	-	-	0.53 /hr	142	-	-	-	-	-	-	142
				NPDES Permit Revisio NPDES								269.50	35,403		142							35,545
		PCCR		PCCR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				PCCR PCCR								539.00	70,807		284							71,090
		RAWP		RAWP																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	248.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP RAWP								539.00	70,807		284							71,090
		RAWP/RDR		RAWP/RDR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP/RDR RAWP/RDR								539.00	70,807		284							71,090
		WAC Revision		WAC Revision																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		WAC Revision		WAC Revision																	
			OffSpply	Office Supplies, from R.S. Means monthly Cost, 4Q CY2014			269.50	hr		-	-	-	0.53 /hr	142	-	-	-	-	-	-	142
				WAC Revision WAC Revision							269.50	35,403		142							35,545
				0400 Prepare Regulatory Documents							2,166.00	283,226		1,136							284,362
				01.01.01 Capital Costs During Design Phase							5,916.00	623,713		3,158						1,311,173	1,938,043
01.01.02				Capital Costs During Construction Phase (1 yr duration)																	
	0120			Perform Project Management During Construction Phase																	
		0120		Perform Project Management During Construction Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY18 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY18 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	138.58 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0.25 FTE	0.25	ea	1,880.00	hr/ea	98.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			3,760.00	ea		-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
	0220			Perform Construction Management During Construction Phase																	
		0220		Perform Construction Management During Construction Phase																	
			----	Construction Management		Calculated based on 8% of total construction cost (5,991,158+2,416,660=8,407,818)	0.08	pct		-	-	-	-	-	-	-	-	-	8,407,818.00 /pct	672,625	672,625
				0220 Perform Construction Management During Construction Phase																672,625	672,625
				0220 Perform Construction Management During Construction Phase																672,625	672,625
	0230			Perform Operational Readiness and Startup																	
		0231		Procedures and Training																	
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.50	ea	80.00	hr/ea	75.81 /hr	40.00	3,032	-	-	-	-	-	-	-	-	3,032
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	80.00	hr/ea	120.72 /hr	160.00	19,315	-	-	-	-	-	-	-	-	19,315
			----	Material Allowance			1.00	ls		-	-	-	3,292.50 /ls	3,293	-	-	-	-	-	-	3,293
				0231 Procedures and Training							200.00	22,348		3,293							25,640
		0232		Readiness and Startup																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			4.00	ea	120.00	hr/ea	52.93 /hr	480.00	25,406	-	-	-	-	-	-	-	-	25,406
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.10	ea	120.00	hr/ea	75.81 /hr	12.00	910	-	-	-	-	-	-	-	-	910
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	120.00	hr/ea	120.72 /hr	240.00	28,973	-	-	-	-	-	-	-	-	28,973
			----	Material Allowance			1.00	ls		-	-	-	5,487.50 /ls	5,488	-	-	-	-	-	-	5,488
				0232 Readiness and Startup							732.00	55,289		5,488							60,776
				0230 Perform Operational Readiness and Startup		Reference EMWMF/EMDF Leachate Feasibility Study On-Site Treatment Estimate, log # 20150324B_0 dated 4/8/15.					932.00	77,637		8,780							86,417
	0240			Construct Treatment Plant at EMWMF																	
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		Reference AECOM estimate for Landfill Wastewater Treatment System, dated	1.00	ls		-	-	-	-	-	-	-	-	-	5,991,158.00 /ls	5,991,158	5,991,158

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		10/23/15. Estimate less additional storage was calculated at $8,905,000. Remove Preliminary and Final Design and Treatability Study which are all covered elsewhere for a resulting total of 5,991,158.	1.00	ls		-	-	-	-	-	-	-	-	-	5,991,158.00	/ls	5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																**5,991,158**	**5,991,158**
	0250			**Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station**																	
		0250A		Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station																	
			Field Clerk 01	Field Clerk, Average, R.S. Means CostWorks, Bare Cost			28.00	wk		-	-	-	-	-	-	-	450.00	/wk	12,600	-	-	12,600
			Field Engr. 01	Field Engineer, Maximum, from R.S. Means CostWorks		2 each	56.00	wk		-	-	-	-	-	-	-	1,575.00	/wk	88,200	-	-	88,200
			Field Engr. 01	Field Engineer, Maximum, from R.S. Means CostWorks		Safety Rep.	28.00	wk		-	-	-	-	-	-	-	1,575.00	/wk	44,100	-	-	44,100
			Proj. Mgr. 01	Project Manager, Maximum,from R.S. Means CostWorks, with O&P			28.00	wk		-	-	-	-	-	-	-	2,600.00	/wk	72,800	-	-	72,800
			Suptdt 01	Superintendent, Maximum,from R.S. Means CostWorks, w/O&P			28.00	wk		-	-	-	-	-	-	-	2,400.00	/wk	67,200	-	-	67,200
			----	Rent Office Trailer, 50' X 10'		Assumes utilities are covered by site.	6.00	mnt		-	-	-	-	-	-	-	298.29	/mnt	1,790	-	-	1,790
				0250A Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station														286,690			286,690
		0250B																			
			Laborer II	Laborer, Group II, CLA + Burden		1 week of safety/site/procedure training per person	240.00	hr		-	-	-	-	-	-	-	33.62	/hr	8,069	-	-	8,069
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden		1 week of safety/site/procedure training per person	40.00	hr		-	-	-	-	-	-	-	50.56	/hr	2,022	-	-	2,022
			PipeFttr	Pipe Fitter - Journeyman, CLA + Burden		1 week of safety/site/procedure training per person	160.00	hr		-	-	-	-	-	-	-	47.26	/hr	7,562	-	-	7,562
			PipeFttr - Frmn	Pipe Fitter - Foreman, CLA + Burden		1 week of safety/site/procedure training per person	40.00	hr		-	-	-	-	-	-	-	49.69	/hr	1,988	-	-	1,988
			Trmstr Drvr	Teamster - Truck Driver, CLA + Burden		1 week of safety/site/procedure training per person	40.00	hr		-	-	-	-	-	-	-	35.57	/hr	1,423	-	-	1,423
			----	Mob. Equipment & Job Trailer			1.00	ls		-	-	-	-	-	-	-	8,000.00	/ls	8,000	-	-	8,000
				0250B														29,063			29,063
		0250C																			
			Laborer II	Laborer, Group II, CLA + Burden		2 each to run concrete saw and tarp trucks for 4 weeks	320.00	hr		-	-	-	-	-	-	-	33.62	/hr	10,758	-	-	10,758
			Trmstr Drvr	Teamster - Truck Driver, CLA + Burden		w/o O&P	80.00	hr		-	-	-	-	-	-	-	35.57	/hr	2,846	-	-	2,846
			----	Rent Backhoe-Loader, 5/8 CY		Assume 2 week total. Includes operating rate.	2.00	wk		-	-	-	-	-	-	-	1,276.10	/wk	2,552	-	-	2,552
			----	Rent Concrete Saw		Assume 2 weeks total. Includes $14.18/hr operating cost.	2.00	wk		-	-	-	-	-	-	-	207.00	/wk	414	-	-	414
			----	PPE Level D			400.00	hr		-	-	-	-	-	-	-	5.00	/hr	2,000	-	-	2,000
			----	Dump Truck Rental		Assume 2 weeks total. Includes $14.18/hr operating cost.	2.00	wk		-	-	-	-	-	-	-	3,402.20	/wk	6,804	-	-	6,804
				0250C														25,375			25,375
		0250D																			
			Laborer II	Laborer, Group II, CLA + Burden		2 each for 8 weeks = 640 Hrs	640.00	hr		-	-	-	-	-	-	-	33.62	/hr	21,517	-	-	21,517
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden		8 weeks	320.00	hr		-	-	-	-	-	-	-	50.56	/hr	16,179	-	-	16,179
			----	Rent Wheel Trencher		Average 1,000 LF per day	2.00	mnt		-	-	-	-	-	-	-	17,005.90	/mnt	34,012	-	-	34,012
			----	Rent Wheel Trencher Operatng Rate			320.00	hr		-	-	-	-	-	-	-	88.11	/hr	31,395	-	-	31,395
			----	PPE Level D			1,282.00	hr		-	-	-	-	-	-	-	5.00	/hr	6,410	-	-	6,410
				0250D														109,513			109,513
		0250E																			
			Laborer II	Laborer, Group II, CLA + Burden		3 each to lay sand bedding in bottom of trench	2,250.00	hr		-	-	-	-	-	-	-	33.62	/hr	75,645	-	-	75,645
			PipeFttr	Pipe Fitter - Journeyman, CLA + Burden		4 each	3,000.00	hr		-	-	-	-	-	-	-	47.26	/hr	141,780	-	-	141,780
			PipeFttr - Frmn	Pipe Fitter - Foreman, CLA + Burden		1 each	750.00	hr		-	-	-	-	-	-	-	49.69	/hr	37,268	-	-	37,268
			----	Leak Detection Sensors & Alarms		Price from P2S	1.00	ls		-	-	-	-	-	-	-	31,080.00	/ls	31,080	-	-	31,080
			----	Power & Communication		from P2S	1.00	ls		-	-	-	-	-	-	-	39,885.00	/ls	39,885	-	-	39,885
			----	Manufactured Sand , Delivered		.5'X1.5'X26,500' /27CF/CY= 736 CY @ 2,850 lb/CY /2,000lb/tn = 1,049 Tn with waste call it 1,060 tons	1,060.00	ton		-	-	-	-	-	-	-	18.50	/ton	19,610	-	-	19,610
			----	SDR11 4" X 8" SDR17 HDPE Double Wall Pipe		RS Means 22.11.13.79.5090	26,500.00	lf		-	-	-	-	-	-	-	19.75	/lf	523,375	-	-	523,375
			----	Allowance for Fittings at 10%			1.00	ls		-	-	-	-	-	-	-	52,388.00	/ls	52,388	-	-	52,388
			----	Rent Welding Machine Means 22.11.13.78.9390			75.00	day		-	-	-	-	-	-	-	207.00	/day	15,525	-	-	15,525

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0250E																			
			----	PPE Level D			6,000.00	hr		-	-	-	-	-	-	-	5.00 /hr	30,000	-	-	30,000
				0250E														966,666			966,666
		0250F																			
			----	Install 2 Pumps, Concr. Pad, Prefab. Metal Bldg.		from P2S	1.00	ls		-	-	-	-	-	-	-	110,000.00 /ls	110,000	-	-	110,000
			----	Install Emergency Generator		from P2S	1.00	ls		-	-	-	-	-	-	-	15,000.00 /ls	15,000	-	-	15,000
			----	Install Emergency Generator		from P2S	1.00	ls		-	-	-	-	-	-	-	15,000.00 /ls	15,000	-	-	15,000
				0250F														140,000			140,000
		0250G																			
			Laborer II	Laborer, Group II, CLA + Burden		2 each for 19 weeks = 1520 Hrs	1,520.00	hr		-	-	-	-	-	-	-	33.62 /hr	51,102	-	-	51,102
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden		19 weeks	760.00	hr		-	-	-	-	-	-	-	50.56 /hr	38,426	-	-	38,426
			----	Replace Asphalt & Concrete Allowance		from P2S	1.00	ls		-	-	-	-	-	-	-	52,564.00 /ls	52,564	-	-	52,564
			----	Manufactured Sand , Delivered		1 foot for around pipe and cover is double needed for bedding. Rogers price.	2,120.00	ton		-	-	-	-	-	-	-	18.50 /ton	39,220	-	-	39,220
			----	Underground Safety Tape Alum Backing			265.00	clf		-	-	-	-	-	-	-	19.25 /clf	5,101	-	-	5,101
			----	Rent Manual Guided Compactor		Follow Pipe Installation	19.00	wk		-	-	-	-	-	-	-	898.66 /wk	17,075	-	-	17,075
			----	Rent Backhoe-Loader, 5/8 CY			19.00	wk		-	-	-	-	-	-	-	1,276.10 /wk	24,246	-	-	24,246
			----	Seed & Mulch by Hand Allowance			1.00	ls		-	-	-	-	-	-	-	5,000.00 /ls	5,000	-	-	5,000
			----	PPE Level D			2,280.00	hr		-	-	-	-	-	-	-	5.00 /hr	11,400	-	-	11,400
				0250G														244,134			244,134
		0250H																			
			Laborer II	Laborer, Group II, CLA + Burden		2 each	80.00	hr		-	-	-	-	-	-	-	33.62 /hr	2,690	-	-	2,690
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden		19 weeks	40.00	hr		-	-	-	-	-	-	-	50.56 /hr	2,022	-	-	2,022
			----	Demobilization Allowance			1.00	ls		-	-	-	-	-	-	-	8,000.00 /ls	8,000	-	-	8,000
			----	Rent Backhoe-Loader, 5/8 CY			1.00	wk		-	-	-	-	-	-	-	1,276.10 /wk	1,276	-	-	1,276
			----	PPE Level D			120.00	hr		-	-	-	-	-	-	-	5.00 /hr	600	-	-	600
				0250H														14,588			14,588
		0250I																			
			----	Component Testing & System Operability Allowance		from P2S	1.00	ls		-	-	-	-	-	-	-	117,300.00 /ls	117,300	-	-	117,300
				0250I														117,300			117,300
		0250J		Subcontract Overhead and Profit																	
			----	Subcontract Overhead and Profit		Overhead and profit at 25% of subcontract construction cost	0.25	pct		-	-	-	-	-	-	-	1,933,328.00 /pct	483,332	-	-	483,332
				0250J Subcontract Overhead and Profit														483,332			483,332
				0250 Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station														**2,416,660**			**2,416,660**
				01.01.02 Capital Costs During Construction Phase (1 yr duration)							**4,692.00**	**418,123**		**10,802**				**2,416,660**		**6,663,783**	**9,509,369**
01.01.05				**O&M Costs During EMDF Operations and Closure (30 yrs duration)**																	
	0510			**Perform Project Management During EMDF Operations**																	
		0510		Perform Project Management During EMDF Operations																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.13	ea	56,400.00	hr/ea	88.97 /hr	7,050.00	627,239	-	-	-	-	-	-	-	627,239
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.05	ea	56,400.00	hr/ea	71.30 /hr	2,820.00	201,088	-	-	-	-	-	-	-	201,088
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.25	ea	56,400.00	hr/ea	139.59 /hr	14,100.00	1,968,219	-	-	-	-	-	-	-	1,968,219
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.13	ea	56,400.00	hr/ea	81.42 /hr	7,050.00	574,011	-	-	-	-	-	-	-	574,011
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.13	ea	56,400.00	hr/ea	47.47 /hr	7,050.00	334,864	-	-	-	-	-	-	-	334,864
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.13	ea	56,400.00	hr/ea	75.81 /hr	7,050.00	534,461	-	-	-	-	-	-	-	534,461
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.25	ea	56,400.00	hr/ea	120.72 /hr	14,100.00	1,702,152	-	-	-	-	-	-	-	1,702,152
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.13	ea	56,400.00	hr/ea	99.16 /hr	7,050.00	699,078	-	-	-	-	-	-	-	699,078
			OffSpply	Office Supplies, from R.S. Means monthly Cost.			66,270.00	ea		-	-	-	0.54 /ea	35,638	-	-	-	-	-	-	35,638
				0510 Perform Project Management During EMDF Operations							66,270.00	6,640,889		35,638							6,676,527
				0510 Perform Project Management During EMDF Operations							**66,270.00**	**6,640,889**		**35,638**							**6,676,527**
	0520			**Operate Onsite Treatment Plant During EMDF Operations**																	
		0520		Operate Onsite Treatment Plant During EMDF Operations																	

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0520		Operate Onsite Treatment Plant During EMDF Operations																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		30 years at 2080 hours per year = 62400 hours	2.00	ea	62,400.00	hr/ea	52.93 /hr	124,800.00	6,605,664	-	-	-	-	-	-	-	-	6,605,664
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			0.12	ea	62,400.00	hr/ea	52.93 /hr	7,488.00	396,340	-	-	-	-	-	-	-	-	396,340
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	75.81 /hr	3,744.00	283,833	-	-	-	-	-	-	-	-	283,833
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	120.72 /hr	3,744.00	451,976	-	-	-	-	-	-	-	-	451,976
			PPE DMod	PPE Level D Modified			139,776.00	hr			-	-	-	4.50 /hr	628,957	-	-	-	-	-	-	628,957
				0520 Operate Onsite Treatment Plant During EMDF Operations								139,776.00	7,737,812		628,957							8,366,769
				0520 Operate Onsite Treatment Plant During EMDF Operations								**139,776.00**	**7,737,812**		**628,957**							**8,366,769**
	0530			**Purchase GAC and/or Treatment Resins**																	
		0530		Purchase GAC and/or Treatment Resins																	
			----	Annual Material Allowance		(Per R. McDonnell - $88,000/year allowance for GAC treatment technology. Per Ray and Stephen Hahn new technology is Ion Exchange and material allowance for Ion Exchange is approximately twice the needed allowance for GAC, therefore use 2 x $88,000/year or $176,000/year for mateirals) (plus tax)		30.00	yr			-	-	-	193,180.00	/yr	5,794,800	-	-	-	-	-	-	5,794,800
				0530 Purchase GAC and/or Treatment Resins											5,794,800							5,794,800
				0530 Purchase GAC and/or Treatment Resins											**5,794,800**							**5,794,800**
	0540			**Freight on Materials**																	
		0540		Freight on Materials																	
			----	Freight on Materials		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. ACCT 80	0.08	pct			-	-	-	-	-	-	-	-	-	5,794,800.00 /pct	463,584	463,584
				0540 Freight on Materials																463,584	463,584
				0540 Freight on Materials																**463,584**	**463,584**
	0550			**Operate Pipeline During EMDF Operations**																	
		0550		Operate Pipeline During EMDF Operations																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		Assume 1/3 of a FTE to cover incremental work. (30 yrs)	0.33	ea	62,400.00	hr/ea	52.93 /hr	20,592.00	1,089,935	-	-	-	-	-	-	-	-	1,089,935
			PPE DMod	PPE Level D Modified			20,592.00	hr			-	-	-	9.88 /hr	203,397	-	-	-	-	-	-	203,397
			----	Annual Material Allowance			30.00	yr			-	-	-	5,487.50 /yr	164,625	-	-	-	-	-	-	164,625
				0550 Operate Pipeline During EMDF Operations								20,592.00	1,089,935		368,022							1,457,957
				0550 Operate Pipeline During EMDF Operations								**20,592.00**	**1,089,935**		**368,022**							**1,457,957**
	0560			**Sample/Test Leachate During EMDF Operations**																	
		0560		Sample/Test Leachate During EMDF Operations																	
			----	Annual Analytical Costs		per FFS project team (include additional 10% for analysis at receiving facility, 212,517+10%=233,769)	30.00	yr			-	-	-	-	-	-	-	-	-	233,769.00 /yr	7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations																7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations																**7,013,070**	**7,013,070**
				01.01.05 O&M Costs During EMDF Operations and Closure (30 yrs duration)								**226,638.00**	**15,468,635**		**6,827,418**						**7,476,654**	**29,772,707**
01.01.07				**O&M Costs During Post-Closure EMDF (30 yrs duration)**																	
	0610			**Perform Project Management During EMDF Post-Closure**																	
		0610		Perform Project Management During EMDF Post-Closure																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.05	ea	56,400.00	hr/ea	88.97 /hr	2,820.00	250,895	-	-	-	-	-	-	-	-	250,895
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.03	ea	56,400.00	hr/ea	71.30 /hr	1,410.00	100,533	-	-	-	-	-	-	-	-	100,533
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.10	ea	56,400.00	hr/ea	139.59 /hr	5,640.00	787,288	-	-	-	-	-	-	-	-	787,288

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0610		Perform Project Management During EMDF Post-Closure																	
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.05	ea	56,400.00	hr/ea	81.42 /hr	2,820.00	229,804	-	-	-	-	-	-	-	-	229,804
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.05	ea	56,400.00	hr/ea	47.47 /hr	2,820.00	133,865	-	-	-	-	-	-	-	-	133,865
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.05	ea	56,400.00	hr/ea	75.81 /hr	2,820.00	213,784	-	-	-	-	-	-	-	-	213,784
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.10	ea	56,400.00	hr/ea	120.72 /hr	5,640.00	680,861	-	-	-	-	-	-	-	-	680,861
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.05	ea	56,400.00	hr/ea	99.16 /hr	2,820.00	279,631	-	-	-	-	-	-	-	-	279,631
			OffSpply	Office Supplies, from R.S. Means monthly Cost,			26,790.00	ea			-	-	-	0.54 /ea	14,407	-	-	-	-	-	-	14,407
				0610 Perform Project Management During EMDF Post-Closure								26,790.00	2,676,462		14,407							2,690,869
				0610 Perform Project Management During EMDF Post-Closure								26,790.00	2,676,462		14,407							2,690,869
	0620			Operate Onsite Treatment Plant During Post-Closure EMDF																	
		0620		Operate Onsite Treatment Plant During Post-Closure EMDF																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		1 day once a month for 30 years.	2.00	ea	3,600.00	hr/ea	52.93 /hr	7,200.00	381,096	-	-	-	-	-	-	-	-	381,096
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		1 day once a month for 30 years	0.50	ea	3,600.00	hr/ea	75.81 /hr	1,800.00	136,458	-	-	-	-	-	-	-	-	136,458
			RSISA08	Senior Staff Engineer/Scientist (FY16 Rev1 B06)		1 day once a month for 30 years	2.00	ea	3,600.00	hr/ea	108.11 /hr	7,200.00	778,392	-	-	-	-	-	-	-	-	778,392
			SPTSA03	Senior RPT (FY16 Rev1 B06)		1 day once a month for 30 years	0.50	ea	3,600.00	hr/ea	43.69 /hr	1,800.00	78,642	-	-	-	-	-	-	-	-	78,642
			----	Material Allowance			30.00	yr			-	-	-	3,292.50 /yr	98,775	-	-	-	-	-	-	98,775
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF								18,000.00	1,374,588		98,775							1,473,363
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF								18,000.00	1,374,588		98,775							1,473,363
	0630			Sample/Test Leachate During Post-Closure EMDF																	
		0630		Sample/Test Leachate During Post-Closure EMDF																	
			----	Sampling/Analytical		From FFS team	30.00	yr			-	-	-	-	-	-	-	-	36,596.00 /yr	1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF																1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF																1,097,880	1,097,880
				01.01.07 O&M Costs During Post-Closure EMDF (30 yrs duration)								44,790.00	4,051,050		113,182					1,097,880	5,262,112

Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	20,561,521		282,036 hrs				44.24%	
Material	6,954,560						14.96%	
Equipment								
Subcontract	2,416,660						5.20%	
Other	16,549,490						35.60%	
	46,482,231	46,482,231					100.00	100.00%
Total		46,482,231						

Basis of Estimate
EMWMF/EMDF Leachate Focused Feasibility Study: Alternative 3b:
PWTC Treatment and Trucking Alternative
February 10, 2016

Objective/Scope:

Method of Accomplishment:

URS|CH2M Oak Ridge LLC (UCOR) provides project management during design of a new Treatment Plant at the Environmental Management Waste Management Facility (EMWMF) and the loading and unloading stations at EMWMF and the Liquid Gaseous Waste Operations (LGWO), preparation of required regulatory documents, project and construction management/oversight during facility and transfer station construction, facility operational readiness and startup, oversight and operations of the facility for thirty years (as well as oversight and operations during post-closure, also for thirty years), and the trucking of leachate and contact water from the landfill to LGWO. Subcontractors will perform the actual design of the treatment facility and transfer stations, conduct necessary treatability studies, and perform the actual construction of the facilities. Subcontract labs were also assumed to provide the analytical service of samples taken during operations and post-closure.

Estimate Type and Approach:

This feasibility estimate is based upon similar work proposed in the past and work experience. The estimate was developed using a combination of bottoms-up approach, parametric data from similar projects, actual costs of similar work, and estimator and team experience with similar projects and existing operations.

Key Financial Data:

1. The estimate was prepared in the second quarter of fiscal year (FY)2016.
2. Any actual costs of work or similar work were provided by the project team.
3. General and Administrative costs and fee are not included in this estimate.
4. All UCOR and Staff Augmentation rates are fully burdened, including fringes. Staff Augmentation rates include overhead and profit.
5. A sales tax of 9.75% has been included on all material.
6. All prices are in FY2016 dollars and no escalation has been included.
7. There is no contingency in this estimate.
8. UCOR and staff augmentation rates were used for the U.S. Department of Energy prime contractor.

Estimate Assumptions and Exclusions:

1. One Full Time Equivalent (FTE) is equal to 1880 man-hours per year.
2. One FTE for facility operations is 2080 man-hours per year.
3. The Conceptual Design Report and the Critical Decision (CD-1, -2, -3, and -4) process was not included in this estimate.
4. The cost for final closure of the Environmental Management Disposal Facility (EMDF) is not included in this estimate.
5. There are no decontamination and demolition costs included in this estimate.

6. Design of the facilities is estimated at 15% of the total construction cost for the facilities (water treatment, transfer stations at the landfill and the receiving site, and for one small soil remediation task at the receiving facility).
7. Construction management for the facilities is estimated at 8% of the total construction cost for the facilities (water treatment, transfer stations at the landfill and the receiving site, and for one small soil remediation task at the receiving facility).
8. The treatability study is based on an AECOM estimate for the construction of the treatment facility, reference Landfill Wastewater Treatment System, dated 10/23/2015.
9. The following regulatory documents are included in this estimate: National Pollutant Discharge Elimination System, Post Construction Closure Report, Remedial Action Work Plan, Remedial Action Work Plan/Remedial Design Report, and a Waste Acceptance Criteria).
10. The actual treatment facility construction estimate is based on an AECOM estimate, dated 10/23/2015. The estimate for the facility less additional storage capacity was $6,905,000. The preliminary and final design, along with the treatability study, was deducted and is shown elsewhere within the estimate.
11. Subcontractor Overhead and Profit is included in the estimate at 25% of the construction estimate for the transfer stations at the landfill and the receiving site, and for one small soil remediation task at the receiving facility. Overhead and Profit was not added to the treatment facility construction because it is already included in the AECOM estimate.
12. Operations of the treatment facility during the EMDF operating period was estimated at 30 years.
13. An annual material allowance for treatment related materials is included in the estimate. Activated Carbon was considered as the treatment technology initially and an estimate was provided of $88,000 per year for materials. The technology was later changed to Ion Exchange, subject matter experts estimate that the material allowance for Ion Exchange should be twice the amount for Activated Carbon.
14. Freight for the treatment materials delivery is included in the estimate at 8% of the material cost. This is based on the AECOM estimate for the treatment facility, dated 10/23/2015.
15. Annual analytical cost allowances during the time of the facility operation are included in the estimate and they were provided by the Feasibility Study project team. Their estimate was increased by 10% to allow for additional sampling and analysis of water at the receiving facility.
16. Leachate and contact water transportation costs during the 30 years of facility operations are included in the estimate. The annual value is based on FY15 actual transportation costs adjusted to remove elements not directly associated with transportation of the water and to cover projected increases in the number of truck load required during operations.
17. Operations of the treatment facility during the EMDF post-closure period were estimated at 30 years.
18. Annual analytical cost allowances during the time of post-closure are included in the estimate for a period of 30 years and they were provided by the Feasibility Study project team.
19. The estimate includes trucking of EMDF leachate water during post-closure. The estimate is based on two tractor/tankers one day per month for 30 years.

Schedule Assumptions:

1. No funding limitation impacts will be experienced.
2. Design will take approximately 12 months.
3. All construction is expected to take approximately 12 months.
4. The operation and maintenance of the treatment system is expected to last 30 years.
5. Post closure leachate management is expected to last 30 years.

Estimate Uncertainty:

The estimate was prepared in support of a Feasibility Study quality, which places it as a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International. The uncertainty range for Class 4 estimates can be as low as -30% to as high as +50%. The recommended level of uncertainty to apply to this estimate is -20% to +40%.

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ESTIMATOR:	DATE:
PROJECT MANAGER:	DATE:
ESTIMATING MANAGER:	DATE:

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
01.01.01				Capital Costs During Design Phase																	
	0100			Perform Project Management During Design Phase																	
		0100		Perform Project Management During Design Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Managerment (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25 FTE	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0..25 FTE	0.25	ea	1,880.00	hr/ea	99.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost			3,760.00	ea			-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0100 Perform Project Management During Design Phase								3,760.00	340,487		2,022							342,509
				0100 Perform Project Management During Design Phase								3,760.00	340,487		2,022							342,509
	0200			Design Facilities																	
		0200		Design Facilities																	
			----	Design Facilities		Calculated based on 15% of total construction cost (120,368+1,241,203+528,125+5,991,158=7,880,854)	0.15	pct			-	-	-	-	-	-	-	-	7,880,854.00	/pct	1,182,128	1,182,128
				0200 Design Facilities																1,182,128	1,182,128
				0200 Design Facilities																1,182,128	1,182,128
	0300			Conduct Treatability Study																	
		0300		Conduct Treatability Study																	
			----	Treatability Study		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15 under Direct Field Cost, Acct **	1.00	ea			-	-	-	-	-	-	-	-	50,000.00	/ea	50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
	0400			Prepare Regulatory Documents																	
		NPDES Permit Revisio		NPDES																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030
			OffSpply	Office Supplies, from R.S. Means monthly Cost			269.50	hr			-	-	-	0.53 /hr	142	-	-	-	-	-	-	142
				NPDES Permit Revisio NPDES								269.50	35,403		142							35,545
		PCCR		PCCR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				PCCR PCCR								539.00	70,807		284							71,090
		RAWP		RAWP																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP RAWP								539.00	70,807		284							71,090
		RAWP/RDR		RAWP/RDR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP/RDR RAWP/RDR								539.00	70,807		284							71,090
		WAC Revision		WAC Revision																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		WAC Revision		WAC Revision																	
			OffSpply	Office Supplies, from R.S. Means monthly Cost			269.50	hr		-	-	-	0.53 /hr	142	-	-	-	-	-	-	142
				WAC Revision WAC Revision							269.50	35,403		142							35,545
				0400 Prepare Regulatory Documents							2,156.00	283,226		1,136							284,362
				01.01.01 Capital Costs During Design Phase							5,916.00	623,713		3,158						1,232,128	1,858,999
01.01.02				Capital Costs During Construction Phase (1 yr duration)																	
	0120			Perform Project Management During Construction Phase																	
		0120		Perform Project Management During Construction Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0.25 FTE	0.25	ea	1,880.00	hr/ea	99.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost			3,760.00	ea		-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
	0220			Perform Construction Management During Construction Phase																	
		0220		Perform Construction Management During Construction Phase																	
			----	Construction Management		Calculated based on 8% of total construction cost (120,368+1,241,203+528,125+5,991,158=7,880,854)	0.08	pct		-	-	-	-	-	-	-	-	7,880,854.00 /pct	630,468	630,468
				0220 Perform Construction Management During Construction Phase																630,468	630,468
				0220 Perform Construction Management During Construction Phase																630,468	630,468
	0230			Perform Operational Readiness and Startup																	
		0231		Procedures and Training																	
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.50	ea	80.00	hr/ea	75.81 /hr	40.00	3,032	-	-	-	-	-	-	-	-	3,032
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	80.00	hr/ea	120.72 /hr	160.00	19,315	-	-	-	-	-	-	-	-	19,315
			----	Material Allowance			1.00	ls		-	-	-	3,292.50 /ls	3,293	-	-	-	-	-	-	3,293
				0231 Procedures and Training							200.00	22,348		3,293							25,640
		0232		Readiness and Startup																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			4.00	ea	120.00	hr/ea	52.93 /hr	480.00	25,408	-	-	-	-	-	-	-	-	25,408
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.10	ea	120.00	hr/ea	75.81 /hr	12.00	910	-	-	-	-	-	-	-	-	910
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	120.00	hr/ea	120.72 /hr	240.00	28,973	-	-	-	-	-	-	-	-	28,973
			----	Material Allowance			1.00	ls		-	-	-	5,487.50 /ls	5,488	-	-	-	-	-	-	5,488
				0232 Readiness and Startup							732.00	55,289		5,488							60,776
				0230 Perform Operational Readiness and Startup		Reference EMWMF/EMDF Leachate Feasibility Study On-Site Treatment Estimate, log #20150324B_0 dated 4/8/15.					932.00	77,637		8,780							86,417
	0240			Construct Treatment Plant at EMWMF																	
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		Reference AECOM estimate for Landfill	1.00	ls		-	-	-	-	-	-	-	-	5,991,158.00 /ls	5,991,158	5,991,158

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		Wastewater Treatment System, dated 10/23/15. Estimate less additional storage was calculated at $6,905,000. Remove Preliminary and Final Design and Treatability Study which are all covered elsewhere for a resulting total of 5,991,158.	1.00	ls		-	-	-	-	-	-	-	-	-	5,991,158.00	/ls	5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																**5,991,158**	**5,991,158**
	0260			**Construct Tanker Loading Stations at EMWMF plus Purchase Additional Ta**																	
		0261		Construct New Loading Stations																	
			----	Remove Existng Loading		from FFS Team	1.00	ls		-	-	-	-	-	-	-	2,000.00	/ls	2,000	-	-	2,000
			----	Install New Footing/Foundation for Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	15,000.00	/ls	15,000	-	-	15,000
			----	Procure Loaing Arm & Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	65,000.00	/ls	65,000	-	-	65,000
			----	Modify Existing Loading Arm Support		from FFS Team	1.00	ls		-	-	-	-	-	-	-	8,000.00	/ls	8,000	-	-	8,000
			----	Install Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	8,000.00	/ls	8,000	-	-	8,000
			----	Install Loading Arm		from FFS Team	1.00	ls		-	-	-	-	-	-	-	3,000.00	/ls	3,000	-	-	3,000
			----	Piping, Electrical, Insulation Allowance		from FFS Team	1.00	ls		-	-	-	-	-	-	-	10,500.00	/ls	10,500	-	-	10,500
			----	Prepare Subgrade for Unloading Slab		from FFS Team	1.00	ls		-	-	-	-	-	-	-	6,500.00	/ls	6,500	-	-	6,500
			----	Excavate & Form Slab, Access Platform, & Sump		from FFS Team	1.00	ls		-	-	-	-	-	-	-	9,500.00	/ls	9,500	-	-	9,500
			----	Place & Tie Rebar, Waterstop, Set Anchor Bolts, Etc.		from FFS Team	1.00	ls		-	-	-	-	-	-	-	11,500.00	/ls	11,500	-	-	11,500
			----	Place & Finish Concrete		from FFS Team	1.00	ls		-	-	-	-	-	-	-	9,000.00	/ls	9,000	-	-	9,000
			----	Rack Forms & Backfill to Finished Grade		from FFS Team	1.00	ls		-	-	-	-	-	-	-	2,000.00	/ls	2,000	-	-	2,000
			----	Procure Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	65,000.00	/ls	65,000	-	-	65,000
			----	Install Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	8,000.00	/ls	8,000	-	-	8,000
			----	Install Loading Arm		from FFS Team	1.00	ls		-	-	-	-	-	-	-	3,000.00	/ls	3,000	-	-	3,000
			----	Matl's/Labor for CWT's to Tanker Transfer Ancillary Equip		from FFS Team	1.00	ls		-	-	-	-	-	-	-	25,000.00	/ls	25,000	-	-	25,000
			----	Remove Existing Transfer Pump		from FFS Team	1.00	ls		-	-	-	-	-	-	-	1,500.00	/ls	1,500	-	-	1,500
			----	Install New 250 GPM Pump		from FFS Team	1.00	ls		-	-	-	-	-	-	-	8,000.00	/ls	8,000	-	-	8,000
				0261 Construct New Loading Stations															262,500			262,500
		0262		Purchase New Tankers																	
			----	Purchase Water Tanker Trailers			2.00	ea		-	-	-	-	-	-	-	-	-	80,000.00	/ea	160,000	160,000
				0262 Purchase New Tankers																160,000	160,000
		0263		Subcontract Overhead and Profit																	
			----	Subcontract Overhead and Profit		Subcontractor Overhead and Profit @ 25%	0.25	ls		-	-	-	-	-	-	-	422,500.00	/ls	105,625	-	-	105,625
				0263 Subcontract Overhead and Profit															105,625			105,625
				0260 Construct Tanker Loading Stations at EMWMF plus Purchase Additional Ta															**368,125**		**160,000**	**528,125**
	0270			**Construct Tanker Unloading Stations at LGWO (or OF200)**																	
		0270		Construct Tanker Unloading Stations at LGWO (or OF200)																	
			SPTSA03	Senior RPT (FY16 Rev1 B06)		Oversight During Excavation	1.00	ea	200.00	hr/ea	43.69	/hr	200.00	8,738	-	-	-	-	-	-	8,738
			Field Engr. 01	Field Engineer, Maximum, R.S. Means CostWorks, Bare Cost		1 Safety & 1 Field Engr	18.00	wk			-	-	-	-	-	-	1,575.00	/wk	28,350	-	-	28,350
			Proj. Mgr. 01	Project Manager, Maximum, R.S. Means CostWorks, Bare Cost			9.00	wk			-	-	-	-	-	-	2,600.00	/wk	23,400	-	-	23,400
			Suptdt 01	Superintendent, Maximum, R.S. Means CostWorks, Bare Cost			9.00	wk			-	-	-	-	-	-	2,400.00	/wk	21,600	-	-	21,600
			TFE1.3.1.0	TFE: Straight Frame Tri-Axle Dump Truck, Regulated; Fueling,		Assume soil & concrete goes to EMWMF	2,000.00	hr			-	-	-	-	-	-	6.55	/hr	13,100	-	-	13,100
			TFE1.4.3.1	TFE: Staright Frame Tri-Axle Dump Truck, Non-Regulated; Incl All Maintenance; 1-10 Trks		10 trucks for 5 weeks	200.00	day			-	-	-	-	-	-	474.71	/day	94,942	-	-	94,942
			TFE1.6.1.3	TFE: Truck Operator; Fully Trained & Certified			2,000.00	hr			-	-	-	-	-	-	40.84	/hr	81,680	-	-	81,680
			TFE1.7.7.0	TFE: Clean Fill Haul; Includes Material;		3,300#/CY Bank. (2500 CY* 3,300#/CY) / 2,000 /Ton =	4,125.00	ton			-	-	-	-	-	-	8.31	/ton	34,279	-	-	34,279
			----	Selective demolition, retaining walls, concrete retaining wall, 10' high, includes reinforcing			310.00	lf			-	-	-	-	-	-	284.49	/lf	88,192	-	-	88,192
			----	Cast-in place retaining walls, reinforced concrete cantilever, 33 degree slope embankment, 10' high, includes excavation, backfill & reinforcing			325.00	lf			-	-	-	-	-	-	333.80	/lf	108,485	-	-	108,485

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0270		Construct Tanker Unloading Stations at LGWO (or OF200)																	
			----	Excavating, trench or continuous footing, dense hard clay, 3/4 C.Y. excavator, 8' to 10' deep, excludes sheeting or dewatering		Additional excavation not included demolition and retaining wall	35,000.00	bcy		-	-	-	-	-	-	-	7.42 /bcy	259,700	-	-	259,700
			----	Pipe, stainless steel, threaded, 2" diameter, schedule 40, type 304, includes couplings and hangers 10' OC		Relocated pipe	180.00	lf		-	-	-	-	-	-	-	68.34 /lf	12,301	-	-	12,301
			----	Structural concrete, in place, slab on grade (3500 psi), 6" thick, includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), and plac		Tanker spill containment slab	30.00	cy		-	-	-	-	-	-	-	152.70 /cy	4,581	-	-	4,581
			----	Structural concrete, thickened edge for slab on grade (3500 psi), depth is added to and poured monolithically with slab, 12" wide x 12" deep, unreinfo		Use price for curb	60.00	lf		-	-	-	-	-	-	-	8.75 /lf	525	-	-	525
			----	Sump and pipe Allowance			1.00	LS		-	-	-	-	-	-	-	1,500.00 /LS	1,500	-	-	1,500
			----	Pipe, stainless steel, threaded, 4" diameter, schedule 40, type 304, includes couplings and hangers 10' OC		Unloading pipe header	110.00	lf		-	-	-	-	-	-	-	173.80 /lf	19,118	-	-	19,118
			----	Asphaltic concrete paving, parking lots & driveways, 6" stone base, 4" binder course, 4" topping, no asphalt hauling included		Asphalt repair	6,000.00	sf		-	-	-	-	-	-	-	4.20 /sf	25,200	-	-	25,200
			----	Unidentified Upgrades Allowance			1.00	ls		-	-	-	-	-	-	-	150,000.00 /ls	150,000	-	-	150,000
			----	Seeding, mechanical seeding grass seed, 4.5 lbs per M.S.F., hand push spreader			7.50	msf		-	-	-	-	-	-	-	20.80 /msf	156	-	-	156
			----	Seeding, mechanical apply fertilizer, 35 lbs per M.S.F., hand push spreader			7.50	msf		-	-	-	-	-	-	-	15.31 /msf	115	-	-	115
			----	Mobilization & Training			1.00	ls		-	-	-	-	-	-	-	12,000.00 /ls	12,000	-	-	12,000
			----	Demobilization			1.00	ls		-	-	-	-	-	-	-	5,000.00 /ls	5,000	-	-	5,000
				0270 Construct Tanker Unloading Stations at LGWO (or OF200)							200.00	8,738						984,224			992,962
		0271		Subcontract Overhead and Profit																	
			----	Subcontract Overhead and Profit		Subcontractor Overhead and Profit @ 25%	0.25	ls		-	-	-	-	-	-	-	992,962.00 /ls	248,241	-	-	248,241
				0271 Subcontract Overhead and Profit														248,241			248,241
				0270 Construct Tanker Unloading Stations at LGWO (or OF200)							**200.00**	**8,738**						**1,232,464**			**1,241,202**
	0280			**Perform Soil Remediation at LGWO**																	
		0280		Perform Soil Remediation at LGWO																	
			13Craft	Building Trades Skilled Craft (FY16 Rev1 B06)		Foreman - 5 days	1.00	ea	50.00	hr/ea	38.12 /hr	50.00	1,906	-	-	-	-	-	-	-	-	1,906
			13Craft	Building Trades Skilled Craft (FY16 Rev1 B06)		Excavator Operator - 5 days	1.00	ea	50.00	hr/ea	38.12 /hr	50.00	1,906	-	-	-	-	-	-	-	-	1,906
			13Labor	Building Trades Craft Laborers (FY16 Rev1 B06)		Spotter for Trucks	1.00	ea	50.00	hr/ea	28.12 /hr	50.00	1,406	-	-	-	-	-	-	-	-	1,406
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Allow for 5 days	1.00	ea	50.00	hr/ea	139.59 /hr	50.00	6,980	-	-	-	-	-	-	-	-	6,980
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		Allow for 5 days	1.00	ea	50.00	hr/ea	75.81 /hr	50.00	3,791	-	-	-	-	-	-	-	-	3,791
			RSISA06	Staff Engineer/Scientist (FY16 Rev1 B06)		Collect Samples	3.00	ea	50.00	hr/ea	84.83 /hr	150.00	12,725	-	-	-	-	-	-	-	-	12,725
			SPTSA03	Senior RPT (FY16 Rev1 B06)		Allow for 5 days	1.00	ea	50.00	hr/ea	43.69 /hr	50.00	2,185	-	-	-	-	-	-	-	-	2,185
			----	SR-90 by Beta GPC		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	114.45 /ea	572	-	-	572
			----	TH ISO by Alpha		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	111.51 /ea	558	-	-	558
			----	PU ISO by Alpha		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	111.51 /ea	558	-	-	558
			Excav2.5-Op n	Excavator, 2.5 CY, Operating Rate for Rental		Allow for 5 days	50.00	hr			-	-	-	-	-	100.27 /hr	5,014	-	-	-	-	5,014
			Excav2.5-Wk	Excavator, 2.5 CY, Rental, Weekly Rate		Allow for 5 days - Assume 50 CY/hr & 2500 CY Total	2.00	wk			-	-	-	-	-	3,764.89 /wk	7,530	-	-	-	-	7,530
			AVGLAB089	SW846-1311/7470: TCLP Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Technique) SOLID 30Day		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	23.97 /ea	120	-	-	120
			AVGLAB099	SW846-8082: Polychlorinated Biphenyls (PCBs) by Gas Chromatography SOLID 30 Day		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	81.93 /ea	410	-	-	410
			AVGLAB101	SW846-8260: Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) SOLID 30 Day		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	108.35 /ea	542	-	-	542
			AVGLAB102	SW846-8270: Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) SOLID 30 Day		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	183.87 /ea	919	-	-	919
			AVGLAB117	GAMMA SPECTROSCOPY: Gamma Spectroscopy SOLID 30 Day		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	78.40 /ea	392	-	-	392
			AVGLAB118	GROSS A/B GFPC: Gross Alpha/Beta by GFPC SOLID 30 Day		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	48.70 /ea	244	-	-	244
			AVGLAB125	TC-99 BY BETA LSC: Technetium-99 by Beta Liquid Scintillation Counting SOLID 30 Day		Allow for 1 per day for 5 days	5.00	ea			-	-	-	-	-	-	-	96.00 /ea	480	-	-	480

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0280		Perform Soil Remediation at LGWO																	
			AVGLAB128	U ISO BY ALPHA: Isotopic Uranium by Alpha Spectroscopy SOLID 30 Day		Allow for 1 per day for 5 days	5.00	ea		-	-	-	-	-	-	-	100.40 /ea	502	-	-	502
			TFE1.3.1.0	TFE: Straight Frame Tri-Axle Dump Truck,; Regulated; Fueling,		Assume contaminated soil goes to EMWMF	50.00	hr		-	-	-	-	-	-	-	6.55 /hr	328	-	-	328
			TFE1.4.3.1	TFE: Staright Frame Tri-Axle Dump Truck,; Non-Regulated; Incl All Maintenance; 1-10 Trks		Allow for 5 days	5.00	day		-	-	-	-	-	-	-	474.71 /day	2,374	-	-	2,374
			TFE1.8.1.3	TFE: Truck Operator; Fully Trained & Certified		Allow for 5 days	50.00	hr		-	-	-	-	-	-	-	40.84 /hr	2,042	-	-	2,042
			TFE1.7.7.0	TFE: Clean Fill Haul; Includes Material;		3,300#/CY Bank: (2500 CY* 3,300#/CY) / 2,000 /Ton =	4,125.00	ton		-	-	-	-	-	-	-	8.31 /ton	34,279	-	-	34,279
			----	Seeding, mechanical seeding grass seed, 4.5 lbs per M.S.F., hand push spreader			1.00	msf		-	-	-	-	-	-	-	20.80 /msf	21	-	-	21
			----	Seeding, mechanical apply fertilizer, 35 lbs per M.S.F., hand push spreader			1.00	msf		-	-	-	-	-	-	-	15.31 /msf	15	-	-	15
			----	Mobilization & Training			1.00	ls		-	-	-	-	-	-	-	6,000.00 /ls	6,000	-	-	6,000
			----	Demobilization			1.00	ls		-	-	-	-	-	-	-	2,500.00 /ls	2,500	-	-	2,500
				0280 Perform Soil Remediation at LGWO							450.00	30,897				12,543		52,863			96,294
		0281		Subcontract Overhead and Profit																	
			----	Subcontract Overhead and Profit		Subcontractor Overhead and Profit @ 25%	0.25	ls		-	-	-	-	-	-	-	96,294.00 /ls	24,074	-	-	24,074
				0281 Subcontract Overhead and Profit														24,074			24,074
				0280 Perform Soil Remediation at LGWO							**450.00**	**30,897**				**12,543**		**76,927**			**120,367**
				01.01.02 Capital Costs During Construction Phase (1 yr duration)							**5,342.00**	**457,758**		**10,802**		**12,543**		**1,677,516**		**6,781,626**	**8,940,246**
01.01.05				**O&M Costs During EMDF Operations and Closure (30 yrs duration)**																	
	0510			**Perform Project Management During EMDF Operations**																	
		0510		Perform Project Management During EMDF Operations																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.13	ea	56,400.00	hr/ea	88.97 /hr	7,050.00	627,239	-	-	-	-	-	-	-	627,239
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.05	ea	56,400.00	hr/ea	71.30 /hr	2,820.00	201,066	-	-	-	-	-	-	-	201,066
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.25	ea	56,400.00	hr/ea	139.59 /hr	14,100.00	1,968,219	-	-	-	-	-	-	-	1,968,219
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.13	ea	56,400.00	hr/ea	81.42 /hr	7,050.00	574,011	-	-	-	-	-	-	-	574,011
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.13	ea	56,400.00	hr/ea	47.47 /hr	7,050.00	334,864	-	-	-	-	-	-	-	334,864
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.13	ea	56,400.00	hr/ea	75.81 /hr	7,050.00	534,461	-	-	-	-	-	-	-	534,461
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.25	ea	56,400.00	hr/ea	120.72 /hr	14,100.00	1,702,152	-	-	-	-	-	-	-	1,702,152
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.13	ea	56,400.00	hr/ea	99.16 /hr	7,050.00	699,078	-	-	-	-	-	-	-	699,078
			OffSpply	Office Supplies, from R.S. Means monthly Cost			88,270.00	ea			-	-	-	0.54 /ea	35,638	-	-	-	-	-	-	35,638
				0510 Perform Project Management During EMDF Operations							66,270.00	6,640,889		35,638							6,676,527
				0510 Perform Project Management During EMDF Operations							**66,270.00**	**6,640,889**		**35,638**							**6,676,527**
	0520			**Operate Onsite Treatment Plant During EMDF Operations**																	
		0520		Operate Onsite Treatment Plant During EMDF Operations																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		30 years at 2080 hours per year = 62400 hours	2.00	ea	62,400.00	hr/ea	52.93 /hr	124,800.00	6,605,664	-	-	-	-	-	-	-	6,605,664
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			0.12	ea	62,400.00	hr/ea	52.93 /hr	7,488.00	396,340	-	-	-	-	-	-	-	396,340
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	75.81 /hr	3,744.00	283,833	-	-	-	-	-	-	-	283,833
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	120.72 /hr	3,744.00	451,976	-	-	-	-	-	-	-	451,976
			PPE DMod	PPE Level D Modified			139,778.00	hr			-	-	-	4.50 /hr	628,957	-	-	-	-	-	628,957
				0520 Operate Onsite Treatment Plant During EMDF Operations							139,776.00	7,737,812		628,957							8,366,769
				0520 Operate Onsite Treatment Plant During EMDF Operations							**139,776.00**	**7,737,812**		**628,957**							**8,366,769**
	0530			**Purchase GAC and/or Treatment Resins**																	
		0530		Purchase GAC and/or Treatment Resins																	
			----	Annual Material Allowance		(Per R. McDonnell - $88,000/year	30.00	yr		-	-	-	193,160.00 /yr	5,794,800	-	-	-	-	-	-	5,794,800

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0530		Purchase GAC and/or Treatment Resins																	
			----	Annual Material Allowance		allowance for GAC treatment technology. Per Ray and Stephen Hahn new technology is Ion Exchange and material allowance for Ion Exchange is approximately twice the needed allowance for GAC, therefore use 2 x $88,000/year or $176,000/year for mateirals) (plus tax)	30.00	yr		-	-	-	193,160.00 /yr	5,794,800	-	-	-	-	-	-	5,794,800
				0530 Purchase GAC and/or Treatment Resins										5,794,800							5,794,800
				0530 Purchase GAC and/or Treatment Resins										5,794,800							5,794,800
	0540			Freight on Materials																	
		0540		Freight on Materials																	
			----	Freight on Materials		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. ACCT 00	0.08	pct		-	-	-	-	-	-	-	-	-	5,794,800.00 /pct	463,584	463,584
				0540 Freight on Materials																463,584	463,584
				0540 Freight on Materials																463,584	463,584
	0560			Sample/Test Leachate During EMDF Operations																	
		0560		Sample/Test Leachate During EMDF Operations																	
			----	Annual Analytical Costs		per FFS project team (plus 10% for additional analysis for receiving site = 212,517x1.1=233,769)	30.00	yr		-	-	-	-	-	-	-	-	-	233,769.00 /yr	7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations																7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations																7,013,070	7,013,070
	0570			Truck Leachate Plus Contact Water During EMDF Operations																	
		0570		Truck Leachate Plus Contact Water During EMDF Operations																	
			----	Leachate and Contact Water Transportation Cost		Based on FY15 actual transportation costs (reference ROS 280) adjusted to remove elements not associated with transportation costs, adjusted up to cover projected increases in number of truck loads	30.00	yr		-	-	-	-	-	-	-	-	-	1,500,000.00 /yr	45,000,000	45,000,000
				0570 Truck Leachate Plus Contact Water During EMDF Operations																45,000,000	45,000,000
				0570 Truck Leachate Plus Contact Water During EMDF Operations																45,000,000	45,000,000
				01.01.05 O&M Costs During EMDF Operations and Closure (30 yrs duration)							206,046.00	14,378,701		6,459,395						52,476,654	73,314,750
01.01.07				O&M Costs During Post-Closure EMDF (30 yrs duration)																	
	0610			Perform Project Management During EMDF Post-Closure																	
		0610		Perform Project Management During EMDF Post-Closure																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.05	ea	56,400.00	hr/ea	88.97 /hr	2,820.00	250,895	-	-	-	-	-	-	-	-	250,895
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.03	ea	56,400.00	hr/ea	71.30 /hr	1,410.00	100,533	-	-	-	-	-	-	-	-	100,533
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.10	ea	56,400.00	hr/ea	139.59 /hr	5,640.00	787,288	-	-	-	-	-	-	-	-	787,288
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.05	ea	56,400.00	hr/ea	81.42 /hr	2,820.00	229,804	-	-	-	-	-	-	-	-	229,804
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.05	ea	56,400.00	hr/ea	47.47 /hr	2,820.00	133,865	-	-	-	-	-	-	-	-	133,865
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.05	ea	56,400.00	hr/ea	75.81 /hr	2,820.00	213,784	-	-	-	-	-	-	-	-	213,784
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.10	ea	56,400.00	hr/ea	120.72 /hr	5,640.00	680,861	-	-	-	-	-	-	-	-	680,861
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.05	ea	56,400.00	hr/ea	88.16 /hr	2,820.00	279,631	-	-	-	-	-	-	-	-	279,631
			OffSpply	Office Supplies, from R.S. Means monthly Cost			26,790.00	ea		-		-	-	0.54 /ea	14,407	-	-	-	-	-	-	14,407
				0610 Perform Project Management During EMDF Post-Closure							26,790.00	2,676,462		14,407							2,690,869
				0610 Perform Project Management During EMDF Post-Closure							26,790.00	2,676,462		14,407							2,690,869

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
	0620			**Operate Onsite Treatment Plant During Post-Closure EMDF**																
		0620		**Operate Onsite Treatment Plant During Post-Closure EMDF**																
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		1 day once a month for 30 years.	2.00 ea	3,600.00 hr/ea	52.93 /hr	7,200.00	381,096	-	-	-	-	-	-	-	-	381,096
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		1 day once a month for 30 years	0.50 ea	3,600.00 hr/ea	75.81 /hr	1,800.00	136,458	-	-	-	-	-	-	-	-	136,458
			RSISA09	Senior Staff Engineer/Scientist (FY16 Rev1 B06)		1 day once a month for 30 years	2.00 ea	3,600.00 hr/ea	108.11 /hr	7,200.00	778,392	-	-	-	-	-	-	-	-	778,392
			SPTSA03	Senior RPT (FY16 Rev1 B06)		1 day once a month for 30 years	0.50 ea	3,600.00 hr/ea	43.69 /hr	1,800.00	78,642	-	-	-	-	-	-	-	-	78,642
			----	Material Allowance			30.00 yr		-	-	-	3,292.50 /yr	98,775	-	-	-	-	-	-	98,775
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF						**18,000.00**	**1,374,588**		**98,775**							**1,473,363**
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF						**18,000.00**	**1,374,588**		**98,775**							**1,473,363**
	0630			**Sample/Test Leachate During Post-Closure EMDF**																
		0630		**Sample/Test Leachate During Post-Closure EMDF**																
			----	Sampling/Analytical		From FFS team	30.00 yr		-	-	-	-	-	-	-	-	-	36,596.00 /yr	1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF															**1,097,880**	**1,097,880**
				0630 Sample/Test Leachate During Post-Closure EMDF															**1,097,880**	**1,097,880**
	0640			**Truck EMDF Leachate During Post-Closure EMDF**																
		0640		**Truck EMDF Leachate During Post-Closure EMDF**																
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		1 day once a month for 30 years. 2 personnel, drivers.	2.00 ea	3,600.00 hr/ea	52.93 /hr	7,200.00	381,096	-	-	-	-	-	-	-	-	381,096
			GFETrkTrctr	GFE Truck Tractor (Semi), 8X4, 400HP, Oper Cost		Assume 2 tractors @ 1 day/month for 30 years = 10 hrs X 12 months X 30 yrs X 2 ea = 7,200 hrs	7,200.00 hr		-	-	-	-	-	51.05 /hr	367,560	-	-	-	-	367,560
			GFEWtrTrlr	GFE Water Trailer, 5K Gallons, Oper Cost		2 trailers	7,200.00 hr		-	-	-	-	-	7.00 /hr	50,400	-	-	-	-	50,400
				0640 Truck EMDF Leachate During Post-Closure EMDF						**7,200.00**	**381,096**				**417,960**					**799,056**
				0640 Truck EMDF Leachate During Post-Closure EMDF						**7,200.00**	**381,096**				**417,960**					**799,056**
				01.01.07 O&M Costs During Post-Closure EMDF (30 yrs duration)						**51,990.00**	**4,432,146**		**113,182**		**417,960**				**1,097,880**	**6,061,168**

Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	19,892,318		269,294 hrs				22.06%	
Material	6,586,537						7.30%	
Equipment	430,503		14,530 hrs				0.48%	
Subcontract	1,677,516						1.86%	
Other	61,588,288						68.30%	
	90,175,163	90,175,163					100.00	100.00%
Total		90,175,163						

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Basis of Estimate
EMWMF/EMDF Leachate Focused Feasibility Study: Alternative 4a:
OF200 Treatment and Pipeline Alternative
February 9, 2016

Objective/Scope:

Method of Accomplishment:

URS|CH2M Oak Ridge LLC (UCOR) provides project management during design of a new Treatment Plant at the Environmental Management Waste Management Facility (EMWMF) and the pipeline from EMWMF to OF200, preparation of required regulatory documents, project and construction management/oversight during facility, pipeline, and additional storage capacity construction, facility operational readiness and startup, oversight and operations of the facility and pipeline for thirty years, as well as oversight and operations during post-closure, also for thirty years. Subcontractors will perform the actual design of the treatment facility and pipeline, conduct necessary treatability studies and perform the actual construction of the facilities. Subcontract labs were also assumed to provide the analytical service of samples taken during operations and post-closure.

Estimate Type and Approach:

This feasibility estimate is based upon similar work proposed in the past and work experience. The estimate was developed using a combination of bottoms-up approach, parametric data from similar projects, actual costs of similar work, and estimator and team experience with similar projects and existing operations.

Key Financial Data:

1. The estimate was prepared in the second quarter of fiscal year (FY)2016.
2. Any actual costs of work or similar work were provided by the project team.
3. General and Administrative costs and fee are not included in this estimate.
4. All UCOR and Staff Augmentation rates are fully burdened, including fringes. Staff Augmentation rates include overhead and profit.
5. A sales tax of 9.75% has been included on all material.
6. All prices are in FY2016 dollars and no escalation has been included.
7. There is no contingency in this estimate.
8. UCOR and staff augmentation rates were used for the U.S. Department of Energy prime contractor.

Estimate Assumptions and Exclusions:

1. One Full Time Equivalent (FTE) is equal to 1880 man-hours per year.
2. One FTE for facility operations is 2080 man-hours per year.
3. The Conceptual Design Report and the Critical Decision (CD-1, -2, -3, and -4) process was not included in this estimate.
4. The cost for final closure of the Environmental Management Disposal Facility (EMDF) is not included in this estimate.
5. There are no decontamination and demolition costs included in this estimate.
6. Design of the facilities is estimated at 15% of the total construction cost for the facilities (water treatment, pipeline, and additional storage capacity).

7. Construction management for the facilities is estimated at 8% of the total construction cost for the facilities (water treatment, pipeline, and additional storage capacity).
8. The treatability study is based on an AECOM estimate for the construction of the treatment facility; reference Landfill Wastewater Treatment System, dated 10/23/2015.
9. The following regulatory documents are included in this estimate: Post Construction Closure Report, Remedial Action Work Plan, Remedial Action Work Plan/Remedial Design Report, Record of Decision/Environmental Stewardship Document, and a Waste Acceptance Criteria.
10. The actual treatment facility construction estimate is based on an AECOM estimate, dated 10/23/2015. The estimate for the facility less additional storage capacity was $6,905,000. The preliminary and final design, along with the treatability study, was deducted and is shown elsewhere within the estimate.
11. Subcontractor Overhead and Profit is included in the estimate at 25% of the pipeline and additional storage capacity construction estimate. Overhead and Profit was not added to the treatment facility construction because it is already included in the AECOM estimate.
12. Operations of the treatment facility and pipeline during the EMDF operating period was estimated at 30 years.
13. An annual material allowance for treatment related materials is included in the estimate. Activated Carbon was considered as the treatment technology initially and an estimate was provided of $88,000 per year for materials. The technology was later changed to Ion Exchange; subject matter experts estimate that the material allowance for Ion Exchange should be twice the amount for Activated Carbon.
14. Freight for the treatment materials delivery is included in the estimate at 8% of the material cost. This is based on the AECOM estimate for the treatment facility, dated 10/23/2015.
15. Annual analytical cost allowances during the time of the facility operation are included in the estimate and they were provided by the Feasibility Study project team. Their estimate was increased by 10% to allow for additional sampling and analysis of water at the receiving facility.
16. Operations of the treatment facility during the EMDF post-closure period were estimated at 30 years.
17. Annual analytical cost allowances during the time of post-closure are included in the estimate for a period of 30 years and they were provided by the Feasibility Study project team.

Schedule Assumptions:

1. No funding limitation impacts will be experienced.
2. Design will take approximately 12 months.
3. All construction is expected to take approximately 12 months.
4. The operation and maintenance of the treatment system is expected to last 30 years.
5. Post-closure leachate management is expected to last 30 years.

Estimate Uncertainty:

The estimate was prepared in support of a Feasibility Study quality, which places it as a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International. The uncertainty range for Class 4 estimates can be as low as -30% to as high as +50%. The recommended level of uncertainty to apply to this estimate is -20% to +40%.

All signatures on file.

ESTIMATOR: DATE:

PROJECT MANAGER: DATE:

ESTIMATING MANAGER: DATE:

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
01.01.01				Capital Costs During Design Phase																	
	0100			Perform Project Management During Design Phase																	
		0100		Perform Project Management During Design Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25 FTE	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0..25 FTE	0.25	ea	1,880.00	hr/ea	99.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost			3,760.00	ea			-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0100 Perform Project Management During Design Phase								3,760.00	340,487		2,022							342,509
				0100 Perform Project Management During Design Phase								3,760.00	340,487		2,022							342,509
	0200			Design Facilities																	
		0200		Design Facilities																	
			----	Design Facilities		Calculated based on 15% of total construction cost (5,991,158+1,655,988+768,750=8,415,874)	0.15	pct			-	-	-	-	-	-	-	-	8,415,874.00	/pct	1,262,381	1,262,381
				0200 Design Facilities																1,262,381	1,262,381
				0200 Design Facilities																1,262,381	1,262,381
	0300			Conduct Treatability Study																	
		0300		Conduct Treatability Study																	
			----	Treatability Study		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15 under Direct Field Cost, Acct **	1.00	ea			-	-	-	-	-	-	-	-	50,000.00	/ea	50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
	0400			Prepare Regulatory Documents																	
		PCCR		PCCR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				PCCR PCCR								539.00	70,807		284							71,090
		RAWP		RAWP																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP RAWP								539.00	70,807		284							71,090
		RAWP/RDR		RAWP/RDR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr			-	-	-	0.53 /hr	284	-	-	-	-	-	-	284
				RAWP/RDR RAWP/RDR								539.00	70,807		284							71,090
		ROD ESD		ROD ESD																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030
			OffSpply	Office Supplies, from R.S. Means monthly Cost			269.50	hr			-	-	-	0.53 /hr	142	-	-	-	-	-	-	142
				ROD ESD ROD ESD								269.50	35,403		142							35,545
		WAC Revision		WAC Revision																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030
			OffSpply	Office Supplies, from R.S. Means monthly Cost			269.50	hr			-	-	-	0.53 /hr	142	-	-	-	-	-	-	142

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
				WAC Revision WAC Revision							269.50	35,403		142							35,545
				0400 Prepare Regulatory Documents							2,156.00	283,226		1,136							284,362
				01.01.01 Capital Costs During Design Phase							5,916.00	623,713		3,158						1,312,381	1,939,252
01.01.02				Capital Costs During Construction Phase (1 yr duration)																	
	0120			Perform Project Management During Construction Phase																	
		0120		Perform Project Management During Construction Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,818	-	-	-	-	-	-	-	-	41,818
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,287	-	-	-	-	-	-	-	-	38,287
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0.25 FTE	0.25	ea	1,880.00	hr/ea	99.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost			3,760.00	ea			-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
	0220			Perform Construction Management During Construction Phase																	
		0220		Perform Construction Management During Construction Phase																	
			----	Construction Management		Calculated based on 8% of total construction cost (5,991,158+1,655,966+768,750=8,415,874)	0.08	pct		-	-	-	-	-	-	-	-	8,415,874.00	/pct	673,270	673,270
				0220 Perform Construction Management During Construction Phase																673,270	673,270
				0220 Perform Construction Management During Construction Phase																673,270	673,270
	0230			Perform Operational Readiness and Startup																	
		0231		Procedures and Training																	
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.50	ea	80.00	hr/ea	75.81 /hr	40.00	3,032	-	-	-	-	-	-	-	-	3,032
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	80.00	hr/ea	120.72 /hr	160.00	19,315	-	-	-	-	-	-	-	-	19,315
			----	Material Allowance			1.00	ls			-	-	-	3,292.50 /ls	3,293	-	-	-	-	-	-	3,293
				0231 Procedures and Training								200.00	22,348		3,293						25,640
		0232		Readiness and Startup																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			4.00	ea	120.00	hr/ea	52.93 /hr	480.00	25,406	-	-	-	-	-	-	-	-	25,406
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.10	ea	120.00	hr/ea	75.81 /hr	12.00	910	-	-	-	-	-	-	-	-	910
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	120.00	hr/ea	120.72 /hr	240.00	28,973	-	-	-	-	-	-	-	-	28,973
			----	Material Allowance			1.00	ls			-	-	-	5,497.50 /ls	5,498	-	-	-	-	-	-	5,498
				0232 Readiness and Startup								732.00	55,289		5,488						60,776
				0230 Perform Operational Readiness and Startup		Reference EMWMF/EMDF Leachate Feasibility Study On-Site Treatment Estimate, log # 20150324B_0 dated 4/8/15.					932.00	77,637		8,780							86,417
	0240			Construct Treatment Plant at EMWMF																	
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. Estimate less additional storage was calculated at $6,905,000. Remove Preliminary and Final Design and Treatability Study which are all covered	1.00	ls		-	-	-	-	-	-	-	-	5,991,158.00	/ls	5,991,158	5,991,158

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		elsewhere for a resulting total of 5,991,158	1.00	ls		-	-	-	-	-	-	-	-	-	5,991,158.00 /ls	5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																5,991,158	5,991,158
	0250			Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station																	
		0250A		Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station																	
			Field Clerk 01	Field Clerk, Average, R.S. Means CostWorks, Bare Cost			18.00	wk		-	-	-	-	-	-	-	450.00 /wk	8,100	-	-	8,100
			Field Engr. 01	Field Engineer, Maximum, from R.S. Means CostWorks			18.00	wk		-	-	-	-	-	-	-	1,575.00 /wk	28,350	-	-	28,350
			Field Engr. 01	Field Engineer, Maximum, from R.S. Means CostWorks			18.00	wk		-	-	-	-	-	-	-	1,575.00 /wk	28,350	-	-	28,350
			Proj. Mgr. 01	Project Manager, Maximum,from R.S. Means CostWorks, with O&P			18.00	wk		-	-	-	-	-	-	-	2,600.00 /wk	46,800	-	-	46,800
			Suptdt 01	Superintendent, Maximum,from R.S. Means CostWorks, wO&P			18.00	wk		-	-	-	-	-	-	-	2,400.00 /wk	43,200	-	-	43,200
			----	Rent Office Trailer, 50' X 10'			4.00	mnt		-	-	-	-	-	-	-	298.29 /mnt	1,193	-	-	1,193
				0250A Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station														155,993			155,993
		0250B																			
			Laborer II	Laborer, Group II, CLA + Burden			240.00	hr		-	-	-	-	-	-	-	33.82 /hr	8,089	-	-	8,089
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden			40.00	hr		-	-	-	-	-	-	-	50.56 /hr	2,022	-	-	2,022
			PipeFttr	Pipe Fitter - Journeyman, CLA + Burden			160.00	hr		-	-	-	-	-	-	-	47.26 /hr	7,562	-	-	7,562
			PipeFttr - Frmn	Pipe Fitter - Foreman, CLA + Burden			40.00	hr		-	-	-	-	-	-	-	49.69 /hr	1,988	-	-	1,988
			Tmstr Drvr	Teamster - Truck Driver, CLA + Burden			40.00	hr		-	-	-	-	-	-	-	35.57 /hr	1,423	-	-	1,423
			----	Mob. Equipment & Job Trailer			1.00	ls		-	-	-	-	-	-	-	8,000.00 /ls	8,000	-	-	8,000
				0250B														29,063			29,063
		0250C																			
			Laborer II	Laborer, Group II, CLA + Burden		2 each for 6 weeks = 480 Hrs	480.00	hr		-	-	-	-	-	-	-	33.82 /hr	16,138	-	-	16,138
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden		6 weeks	240.00	hr		-	-	-	-	-	-	-	50.56 /hr	12,134	-	-	12,134
			----	Rent Wheel Trencher		Average 1,000 LF per day	1.30	mnt		-	-	-	-	-	-	-	17,005.90 /mnt	22,108	-	-	22,108
			----	Rent Wheel Trencher Operatng Rate			240.00	hr		-	-	-	-	-	-	-	98.11 /hr	23,546	-	-	23,546
			----	PPE Level D			720.00	hr		-	-	-	-	-	-	-	5.00 /hr	3,600	-	-	3,600
				0250C														77,526			77,526
		0250D																			
			Laborer II	Laborer, Group II, CLA + Burden		3 each to lay sand bedding in bottom of trench - 380 hrs/ea	1,140.00	hr		-	-	-	-	-	-	-	33.82 /hr	38,327	-	-	38,327
			PipeFttr	Pipe Fitter - Journeyman, CLA + Burden		4 each	1,520.00	hr		-	-	-	-	-	-	-	47.26 /hr	71,835	-	-	71,835
			PipeFttr - Frmn	Pipe Fitter - Foreman, CLA + Burden		1 each	380.00	hr		-	-	-	-	-	-	-	49.69 /hr	18,882	-	-	18,882
			----	Leak Detection Sensors & Alarms		Price from P2S - add 8% to WBCV estimate	1.00	ls		-	-	-	-	-	-	-	33,566.00 /ls	33,566	-	-	33,566
			----	Power & Communication		from P2S - add 8% to WBCV estimate	1.00	ls		-	-	-	-	-	-	-	43,195.00 /ls	43,195	-	-	43,195
			----	Manufactured Sand , Delivered		.5'X1.5'X18,975' /27CF/CY= 527 CY @ 2,850 lb/CY /2,000lb/tn = 751 Tn with waste call it 760 tons	760.00	ton		-	-	-	-	-	-	-	18.85 /ton	14,326	-	-	14,326
			----	SDR11 4" X 8" SDR17 HDPE Double Wall Pipe		RS Means 22.11.13.78.5080. Approx. 17,250 feet + 10% for waste and hook-ups = 18,975 LF. 20 foot lengths - 18,980	18,980.00	lf		-	-	-	-	-	-	-	20.50 /lf	389,090	-	-	389,090
			----	Allowance for Fittings at 5%			0.05	pct		-	-	-	-	-	-	-	389,090.00 /pct	19,455	-	-	19,455
			----	Rent Welding Machine Means 22.11.13.78.9380			40.00	day		-	-	-	-	-	-	-	207.00 /day	8,280	-	-	8,280
			----	PPE Level D			3,040.00	hr		-	-	-	-	-	-	-	0.24 /hr	730	-	-	730
				0250D														637,686			637,686
		0250E																			
			----	Install 2 Pumps, Concr. Pad, Prefab. Metal Bldg.		from P2S	1.00	ls		-	-	-	-	-	-	-	110,000.00 /ls	110,000	-	-	110,000
			----	Install Emergency Generator		from P2S	1.00	ls		-	-	-	-	-	-	-	15,000.00 /ls	15,000	-	-	15,000
			----	Install Emergency Generator		from P2S	1.00	ls		-	-	-	-	-	-	-	15,000.00 /ls	15,000	-	-	15,000
				0250E														140,000			140,000
		0250F																			
			Laborer II	Laborer, Group II, CLA + Burden		2 each for 9 weeks = 720 Hrs	720.00	hr		-	-	-	-	-	-	-	33.82 /hr	24,206	-	-	24,206
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden		9 weeks	360.00	hr		-	-	-	-	-	-	-	50.56 /hr	18,202	-	-	18,202
			----	Replace Asphalt & Concrete Allowance		from P2S - add 8% to WBCV estimate	1.00	ls		-	-	-	-	-	-	-	56,769.00 /ls	56,769	-	-	56,769
			----	Manufactured Sand , Delivered		1 foot for around pipe and cover is double needed for bedding. Rogers price	1,555.00	ton		-	-	-	-	-	-	-	18.85 /ton	29,312	-	-	29,312
			----	Underground Safety Tape Alum Backing		add 8% to WBCV estimate	192.00	clf		-	-	-	-	-	-	-	22.87 /clf	4,391	-	-	4,391
			----	Rent Manual Guided Compactor		Follow Pipe Installation	9.00	wk		-	-	-	-	-	-	-	898.88 /wk	8,088	-	-	8,088

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0250F																			
			----	Rent Backhoe-Loader, 5/8 CY		includes operating rate	9.00	wk		-	-	-	-	-	-	-	1,296.88 /wk	11,670	-	-	11,670
			----	Seed & Mulch by Hand Allowance		add 8% to WBCV estimate	1.00	ls		-	-	-	-	-	-	-	2,700.00 /ls	2,700	-	-	2,700
			----	PPE Level D			1,080.00	hr		-	-	-	-	-	-	-	0.24 /hr	259	-	-	259
				0250F														155,597			155,597
		0250G																			
			Laborer II	Laborer, Group II, CLA + Burden		2 each	80.00	hr		-	-	-	-	-	-	-	33.82 /hr	2,890	-	-	2,890
			Oper A - Frmn	Equip. Operator, Group A, Foreman. CLA + Burden		1 week	40.00	hr		-	-	-	-	-	-	-	50.56 /hr	2,022	-	-	2,022
			----	Demobilization Allowance			1.00	ls		-	-	-	-	-	-	-	5,000.00 /ls	5,000	-	-	5,000
			----	Rent Backhoe-Loader, 5/8 CY			1.00	wk		-	-	-	-	-	-	-	1,296.88 /wk	1,297	-	-	1,297
			----	PPE Level D			120.00	hr		-	-	-	-	-	-	-	5.00 /hr	600	-	-	600
				0250G														11,609			11,609
		0250H																			
			----	Component Testing & System Operability Allowance		from P2S	1.00	ls		-	-	-	-	-	-	-	117,300.00 /ls	117,300	-	-	117,300
				0250H														117,300			117,300
		0250I		Subcontract Overhead and Profit																	
			----	Subcontract Overhead and Profit		Subcontractor Overhead and Profit at 25%	0.25	ls		-	-	-	-	-	-	-	1,324,773.00 /ls	331,193	-	-	331,193
				0250I Subcontract Overhead and Profit														331,193			331,193
				0250 Construct Pipeline from EMWMF to LGWO (or OF200) Plus Lift Station														**1,655,967**			**1,655,967**
	0290			**Construct Additional Water Storage at OF200**																	
		0290		Construct Additional Water Storage at OF200																	
			----	New Tank and associated pumps, foundations, etc		From Tyler Searle - Exclude Markups & Fee	1.00	ls		-	-	-	-	-	-	-	615,000.00 /ls	615,000	-	-	615,000
				0290 Construct Additional Water Storage at OF200														615,000			615,000
		0291		Subcontract Overhead and Profit																	
			----	Subcontract Overhead and Profit		Subcontractor Overhead and Profit at 25%	0.25	ls		-	-	-	-	-	-	-	615,000.00 /ls	153,750	-	-	153,750
				0291 Subcontract Overhead and Profit														153,750			153,750
				0290 Construct Additional Water Storage at OF200														**768,750**			**768,750**
				01.01.02 Capital Costs During Construction Phase (1 yr duration)							**4,692.00**	**418,123**		**10,802**				**2,424,717**		**6,664,428**	**9,518,070**
01.01.05				**O&M Costs During EMDF Operations and Closure (30 yrs duration)**																	
	0510			**Perform Project Management During EMDF Operations**																	
		0510		Perform Project Management During EMDF Operations																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.13	ea	56,400.00	hr/ea	88.97 /hr	7,050.00	627,239	-	-	-	-	-	-	-	-	627,239
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.05	ea	56,400.00	hr/ea	71.30 /hr	2,820.00	201,066	-	-	-	-	-	-	-	-	201,066
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.25	ea	56,400.00	hr/ea	139.59 /hr	14,100.00	1,968,219	-	-	-	-	-	-	-	-	1,968,219
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.13	ea	56,400.00	hr/ea	81.42 /hr	7,050.00	574,011	-	-	-	-	-	-	-	-	574,011
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.13	ea	56,400.00	hr/ea	47.47 /hr	7,050.00	334,864	-	-	-	-	-	-	-	-	334,864
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.13	ea	56,400.00	hr/ea	75.81 /hr	7,050.00	534,461	-	-	-	-	-	-	-	-	534,461
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.25	ea	56,400.00	hr/ea	120.72 /hr	14,100.00	1,702,152	-	-	-	-	-	-	-	-	1,702,152
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.13	ea	56,400.00	hr/ea	99.16 /hr	7,050.00	699,078	-	-	-	-	-	-	-	-	699,078
			OffSpply	Office Supplies, from R.S. Means monthly Cost			66,270.00	ea			-	-	-	0.54 /ea	35,638	-	-	-	-	-	-	35,638
				0510 Perform Project Management During EMDF Operations							66,270.00	6,640,889		35,638							6,676,527
				0510 Perform Project Management During EMDF Operations							**66,270.00**	**6,640,889**		**35,638**							**6,676,527**
	0520			**Operate Onsite Treatment Plant During EMDF Operations**																	
		0520		Operate Onsite Treatment Plant During EMDF Operations																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		30 years at 2080 hours per year = 62400 hours	2.00	ea	62,400.00	hr/ea	52.93 /hr	124,800.00	6,605,664	-	-	-	-	-	-	-	-	6,605,664
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			0.12	ea	62,400.00	hr/ea	52.93 /hr	7,488.00	396,340	-	-	-	-	-	-	-	-	396,340

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0520		Operate Onsite Treatment Plant During EMDF Operations																
			59Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.06 ea	62,400.00 hr/ea	75.81 /hr	3,744.00	283,833	-	-	-	-	-	-	-	-	283,833
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			0.06 ea	62,400.00 hr/ea	120.72 /hr	3,744.00	451,976	-	-	-	-	-	-	-	-	451,976
			PPE DMod	PPE Level D Modified			139,776.00 hr		-	-	-	4.50 /hr	628,957	-	-	-	-	-	-	628,957
				0520 Operate Onsite Treatment Plant During EMDF Operations						139,776.00	7,737,812		628,957							8,366,769
				0520 Operate Onsite Treatment Plant During EMDF Operations						139,776.00	7,737,812		628,957							8,366,769
	0530			Purchase GAC and/or Treatment Resins																
		0530		Purchase GAC and/or Treatment Resins																
			----	Annual Material Allowance		(Per R. McDonnell - $88,000/year allowance for GAC treatment technology. Per Ray and Stephen Hahn new technology is Ion Exchange and material allowance for Ion Exchange is approximately twice the needed allowance for GAC, therefore use 2 x $88,000/year or $176,000/year for materials) (plus tax)	30.00 yr		-	-	-	193,160.00 /yr	5,794,800	-	-	-	-	-	-	5,794,800
				0530 Purchase GAC and/or Treatment Resins									5,794,800							5,794,800
				0530 Purchase GAC and/or Treatment Resins									5,794,800							5,794,800
	0540			Freight on Materials																
		0540		Freight on Materials																
			----	Freight on Materials		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. ACCT 80	0.08 pct		-	-	-	-	-	-	-	-	-	5,794,800.00 /pct	463,584	463,584
				0540 Freight on Materials															463,584	463,584
				0540 Freight on Materials															463,584	463,584
	0550			Operate Pipeline During EMDF Operations																
		0550		Operate Pipeline During EMDF Operations																
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		Assume 1/3 of a FTE to cover incremental work. (30 yrs)	0.33 ea	62,400.00 hr/ea	52.93 /hr	20,592.00	1,089,935	-	-	-	-	-	-	-	-	1,089,935
			PPE DMod	PPE Level D Modified			20,592.00 hr		-	-	-	9.88 /hr	203,397	-	-	-	-	-	-	203,397
			----	Annual Material Allowance			30.00 yr		-	-	-	5,487.50 /yr	164,625	-	-	-	-	-	-	164,625
				0550 Operate Pipeline During EMDF Operations						20,592.00	1,089,935		368,022							1,457,957
				0550 Operate Pipeline During EMDF Operations						20,592.00	1,089,935		368,022							1,457,957
	0560			Sample/Test Leachate During EMDF Operations																
		0560		Sample/Test Leachate During EMDF Operations																
			----	Annual Analytical Costs		per FFS project team (plus additional 10% for analysis at receiving facility 212,517 x 1.1=233,769)	30.00 yr		-	-	-	-	-	-	-	-	-	233,769.00 /yr	7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations															7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations															7,013,070	7,013,070
				01.01.05 O&M Costs During EMDF Operations and Closure (30 yrs duration)						226,638.00	15,468,635		6,827,418						7,476,654	29,772,707
01.01.07				O&M Costs During Post-Closure EMDF (30 yrs duration)																
	0610			Perform Project Management During EMDF Post-Closure																
		0610		Perform Project Management During EMDF Post-Closure																
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.05 ea	56,400.00 hr/ea	88.97 /hr	2,820.00	250,895	-	-	-	-	-	-	-	-	250,895
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.03 ea	56,400.00 hr/ea	71.30 /hr	1,410.00	100,533	-	-	-	-	-	-	-	-	100,533
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.10 ea	56,400.00 hr/ea	139.59 /hr	5,640.00	787,288	-	-	-	-	-	-	-	-	787,288
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.05 ea	56,400.00 hr/ea	81.42 /hr	2,820.00	229,604	-	-	-	-	-	-	-	-	229,604
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.05 ea	56,400.00 hr/ea	47.47 /hr	2,820.00	133,865	-	-	-	-	-	-	-	-	133,865

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0610		Perform Project Management During EMDF Post-Closure																	
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.05	ea	56,400.00	hr/ea	75.81 /hr	2,820.00	213,784	-	-	-	-	-	-	-	-	213,784
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.10	ea	56,400.00	hr/ea	120.72 /hr	5,640.00	680,861	-	-	-	-	-	-	-	-	680,861
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.05	ea	56,400.00	hr/ea	99.16 /hr	2,820.00	279,631	-	-	-	-	-	-	-	-	279,631
			OffSpply	Office Supplies, from R.S. Means monthly Cost			26,790.00	ea			-	-	-	0.54 /ea	14,407	-	-	-	-	-	-	14,407
				0610 Perform Project Management During EMDF Post-Closure								26,790.00	2,676,462		14,407							2,690,869
				0610 Perform Project Management During EMDF Post-Closure								26,790.00	2,676,462		14,407							2,690,869
	0620			Operate Onsite Treatment Plant During Post-Closure EMDF																	
		0620		Operate Onsite Treatment Plant During Post-Closure EMDF																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		1 day once a month for 30 years. 2 personnel ont including drivers.	2.00	ea	3,600.00	hr/ea	52.93 /hr	7,200.00	381,096	-	-	-	-	-	-	-	-	381,096
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		1 day once a month for 30 years	0.50	ea	3,600.00	hr/ea	75.81 /hr	1,800.00	136,458	-	-	-	-	-	-	-	-	136,458
			RSISA09	Senior Staff Engineer/Scientist (FY16 Rev1 B06)		1 day once a month for 30 years	2.00	ea	3,600.00	hr/ea	108.11 /hr	7,200.00	778,392	-	-	-	-	-	-	-	-	778,392
			SPTSA03	Senior RPT (FY16 Rev1 B06)		1 day once a month for 30 years	0.50	ea	3,600.00	hr/ea	43.69 /hr	1,800.00	78,642	-	-	-	-	-	-	-	-	78,642
			----	Material Allowance			30.00	yr			-	-	-	3,292.50 /yr	98,775	-	-	-	-	-	-	98,775
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF								18,000.00	1,374,588		98,775							1,473,363
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF								18,000.00	1,374,588		98,775							1,473,363
	0630			Sample/Test Leachate During Post-Closure EMDF																	
		0630		Sample/Test Leachate During Post-Closure EMDF																	
			----	Sampling/Analytical		From FFS team	30.00	yr			-	-	-	-	-	-	-	-	36,596.00 /yr	1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF																1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF																1,097,880	1,097,880
				01.01.07 O&M Costs During Post-Closure EMDF (30 yrs duration)								44,790.00	4,051,050		113,182					1,097,880	5,262,112

Estimate Totals

Description	Amount	Totals	Hours	Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	20,561,521		282,036 hrs				44.23%	
Material	6,954,560						14.96%	
Equipment								
Subcontract	2,424,717						5.22%	
Other	16,551,343						35.60%	
	46,492,141	46,492,141					100.00	100.00%
Total		46,492,141						

Basis of Estimate
EMWMF/EMDF Leachate Focused Feasibility Study: Alternative 4b:
OF200 Treatment and Trucking Alternative
February 10, 2016

Objective/Scope:

Method of Accomplishment:

URS|CH2M Oak Ridge LLC (UCOR) provides project management during design of a new Treatment Plant at the Environmental Management Waste Management Facility (EMWMF) and the loading and unloading stations at EMWMF and OF200, preparation of required regulatory documents, project and construction management/oversight during facility and transfer station and additional storage capacity construction, facility operational readiness and startup, oversight and operations of the facility for thirty years (as well as oversight and operations during post-closure, also for thirty years), and the trucking of leachate and contact water from the landfill to OF200. Subcontractors will perform the actual design of the treatment facility and transfer stations, conduct necessary treatability studies, and perform the actual construction of the facilities. Subcontract labs were also assumed to provide the analytical service of samples taken during operations and post-closure.

Estimate Type and Approach:

This feasibility estimate is based upon similar work proposed in the past and work experience. The estimate was developed using a combination of bottoms-up approach, parametric data from similar projects, actual costs of similar work, and estimator and team experience with similar projects and existing operations.

Key Financial Data:

1. The estimate was prepared in the second quarter of fiscal year (FY)2016.
2. Any actual costs of work or similar work were provided by the project team.
3. General and Administrative costs and fee are not included in this estimate.
4. All UCOR and staff augmentation rates are fully burdened, including fringes. Staff augmentation rates include overhead and profit.
5. A sales tax of 9.75% has been included on all material.
6. All prices are in FY2016 dollars and no escalation has been included.
7. There is no contingency in this estimate.
8. UCOR and staff augmentation rates were used for the U.S. Department of Energy prime contractor.

Estimate Assumptions and Exclusions:

1. One Full Time Equivalent (FTE) is equal to 1880 man-hours per year.
2. One FTE for facility operations is 2080 man-hours per year.
3. The Conceptual Design Report and the Critical Decision (CD-1, -2, -3, and -4) process was not included in this estimate.
4. The cost for final closure of the Environmental Management Disposal Facility (EMDF) is not included in this estimate.
5. There are no decontamination and demolition costs included in this estimate.

6. Design of the facilities is estimated at 15% of the total construction cost for the facilities (water treatment, transfer stations at the landfill and the receiving site, and for increased storage capacity).
7. Construction management for the facilities is estimated at 8% of the total construction cost for the facilities (water treatment, transfer stations at the landfill and the receiving site, and for increased storage capacity).
8. The treatability study is based on an AECOM estimate for the construction of the treatment facility; reference Landfill Wastewater Treatment System, dated 10/23/2015.
9. The following regulatory documents are included in this estimate: Post Construction Closure Report, Remedial Action Work Plan, Remedial Action Work Plan/Remedial Design Report, Record of Decision/Environmental Stewardship Document, and a Waste Acceptance Criteria.
10. The actual treatment facility construction estimate is based on an AECOM estimate, dated 10/23/2015. The estimate for the facility less additional storage capacity was $6,905,000. The preliminary and final design, along with the treatability study, was deducted and is shown elsewhere within the estimate.
11. Subcontractor Overhead and Profit is included in the estimate at 25% of the construction estimate for the transfer stations at the landfill and the receiving site, and for increased storage capacity. Overhead and Profit was not added to the treatment facility construction because it is already included in the AECOM estimate.
12. Operations of the treatment facility during the EMDF operating period was estimated at 30 years.
13. An annual material allowance for treatment related materials is included in the estimate. Activated Carbon was considered as the treatment technology initially and an estimate was provided of $88,000 per year for materials. The technology was later changed to Ion Exchange; subject matter experts estimate that the material allowance for Ion Exchange should be twice the amount for Activated Carbon.
14. Freight for the treatment materials delivery is included in the estimate at 8% of the material cost. This is based on the AECOM estimate for the treatment facility dated 10/23/2015.
15. Annual analytical cost allowances during the time of the facility operation are included in the estimate and they were provided by the Feasibility Study project team. Their estimate was increased by 10% to allow for additional sampling and analysis of water at the receiving facility.
16. Leachate and contact water transportation costs during the 30 years of facility operations are included in the estimate. The annual value is based on FY15 actual transportation costs adjusted to remove elements not directly associated with transportation of the water and to cover projected increases in the number of truck loads required during operations.
17. Operations of the treatment facility during the EMDF post-closure period were estimated at 30 years.
18. Annual analytical cost allowances during the time of post-closure are included in the estimate for a period of 30 years and they were provided by the Feasibility Study project team.
19. The estimate includes trucking of EMDF leachate water during post-closure. The estimate is based on two tractor/tankers one day per month for 30 years.

Schedule Assumptions:

1. No funding limitation impacts will be experienced.
2. Design will take approximately 12 months.
3. All construction is expected to take approximately 12 months.
4. The operation and maintenance of the treatment system is expected to last 30 years.
5. Post-closure leachate management is expected to last 30 years.

Estimate Uncertainty:

The estimate was prepared in support of a Feasibility Study quality, which places it as a Class 4 estimate as defined by the Association for the Advancement of Cost Engineering International. The uncertainty range for Class 4 estimates can be as low as -30% to as high as +50%. The recommended level of uncertainty to apply to this estimate is -20% to +40%.

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All signatures on file.

ESTIMATOR: DATE:

PROJECT MANAGER: DATE:

ESTIMATING MANAGER: DATE:

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
01.01.01				Capital Costs During Design Phase																	
	0100			Perform Project Management During Design Phase																	
		0100		Perform Project Management During Design Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00	hr/ea	88.97 /hr	470.00	41,816	-	-	-	-	-	-	-	-	41,816
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00	hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00	hr/ea	139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00	hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00	hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25 FTE	0.25	ea	1,880.00	hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00	hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0..25 FTE	0.25	ea	1,880.00	hr/ea	99.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost			3,760.00	ea		-	-	-		0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0100 Perform Project Management During Design Phase							3,760.00	340,487		2,022							342,509
				0100 Perform Project Management During Design Phase							3,760.00	340,487		2,022							342,509
	0200			Design Facilities																	
		0200		Design Facilities																	
			----	Design Facilities		Calculated based on 15% of total construction cost (820,815+528,125+5,891,158+768,750=7,908,848)	0.15	pct		-	-	-	-	-	-	-	-	-	7,908,848.00 /pct	1,186,327	1,186,327
				0200 Design Facilities																1,186,327	1,186,327
				0200 Design Facilities																1,186,327	1,186,327
	0300			Conduct Treatability Study																	
		0300		Conduct Treatability Study																	
			----	Treatability Study		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15 under Direct Field Cost, Acct **	1.00	ea		-	-	-	-	-	-	-	-	-	50,000.00 /ea	50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
				0300 Conduct Treatability Study																50,000	50,000
	0400			Prepare Regulatory Documents																	
		PCCR		PCCR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr		-	-	-		0.53 /hr	284	-	-	-	-	-	-	284
				PCCR PCCR							539.00	70,807		284							71,090
		RAWP		RAWP																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr		-	-	-		0.53 /hr	284	-	-	-	-	-	-	284
				RAWP RAWP							539.00	70,807		284							71,090
		RAWP/RDR		RAWP/RDR																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			197.00	ea	1.00	hr/ea	180.10 /hr	197.00	35,480	-	-	-	-	-	-	-	-	35,480
			RSISA05	Technician (FY16 Rev1 B06)			93.00	ea	1.00	hr/ea	56.64 /hr	93.00	5,268	-	-	-	-	-	-	-	-	5,268
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			249.00	ea	1.00	hr/ea	120.72 /hr	249.00	30,059	-	-	-	-	-	-	-	-	30,059
			OffSpply	Office Supplies, from R.S. Means monthly Cost			539.00	hr		-	-	-		0.53 /hr	284	-	-	-	-	-	-	284
				RAWP/RDR RAWP/RDR							539.00	70,807		284							71,090
		ROD ESD		ROD ESD																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030
			OffSpply	Office Supplies, from R.S. Means monthly Cost			269.50	hr		-	-	-		0.53 /hr	142	-	-	-	-	-	-	142
				ROD ESD ROD ESD							269.50	35,403		142							35,545
		WAC Revision		WAC Revision																	
			RSISA04	Principal Engineer (FY16 Rev1 B06)			98.50	ea	1.00	hr/ea	180.10 /hr	98.50	17,740	-	-	-	-	-	-	-	-	17,740
			RSISA05	Technician (FY16 Rev1 B06)			46.50	ea	1.00	hr/ea	56.64 /hr	46.50	2,634	-	-	-	-	-	-	-	-	2,634
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			124.50	ea	1.00	hr/ea	120.72 /hr	124.50	15,030	-	-	-	-	-	-	-	-	15,030
			OffSpply	Office Supplies, from R.S. Means monthly Cost			269.50	hr		-	-	-		0.53 /hr	142	-	-	-	-	-	-	142

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
				WAC Revision WAC Revision							269.50	35,403		142							35,545
				0400 Prepare Regulatory Documents							2,156.00	283,226		1,136							284,362
				01.01.01 Capital Costs During Design Phase							5,916.00	623,713		3,158						1,236,327	1,863,198
01.01.02				Capital Costs During Construction Phase (1 yr duration)																	
	0120			Perform Project Management During Construction Phase																	
		0120		Perform Project Management During Construction Phase																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer - 0.25 FTE	0.25	ea	1,880.00 hr/ea	88.97 /hr	470.00	41,818	-	-	-	-	-	-	-	-	41,818
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement - 0.25 FTE	0.25	ea	1,880.00 hr/ea	71.30 /hr	470.00	33,511	-	-	-	-	-	-	-	-	33,511
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager - .25 FTE	0.25	ea	1,880.00 hr/ea	139.59 /hr	470.00	65,607	-	-	-	-	-	-	-	-	65,607
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA - 0.25 FTE	0.25	ea	1,880.00 hr/ea	81.42 /hr	470.00	38,267	-	-	-	-	-	-	-	-	38,267
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin - 0.25 FTE	0.25	ea	1,880.00 hr/ea	47.47 /hr	470.00	22,311	-	-	-	-	-	-	-	-	22,311
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H - .25	0.25	ea	1,880.00 hr/ea	75.81 /hr	470.00	35,631	-	-	-	-	-	-	-	-	35,631
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr - .25 FTE	0.25	ea	1,880.00 hr/ea	120.72 /hr	470.00	56,738	-	-	-	-	-	-	-	-	56,738
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE - 0.25 FTE	0.25	ea	1,880.00 hr/ea	98.16 /hr	470.00	46,605	-	-	-	-	-	-	-	-	46,605
			OffSpply	Office Supplies, from R.S. Means monthly Cost			3,760.00	ea		-	-	-	0.54 /ea	2,022	-	-	-	-	-	-	2,022
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
				0120 Perform Project Management During Construction Phase							3,760.00	340,487		2,022							342,509
	0220			Perform Construction Management During Construction Phase																	
		0220		Perform Construction Management During Construction Phase																	
			----	Construction Management		Calculated based on 8% of total construction cost (620,815+528,125+5,991,158+768,750=7,908,848)	0.08	pct		-	-	-	-	-	-	-	-	7,908,848.00 /pct	632,708	632,708
				0220 Perform Construction Management During Construction Phase																632,708	632,708
				0220 Perform Construction Management During Construction Phase																632,708	632,708
	0230			Perform Operational Readiness and Startup																	
		0231		Procedures and Training																	
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.50	ea	80.00 hr/ea	75.81 /hr	40.00	3,032	-	-	-	-	-	-	-	-	3,032
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	80.00 hr/ea	120.72 /hr	160.00	19,315	-	-	-	-	-	-	-	-	19,315
			----	Material Allowance			1.00	ls		-	-	-	3,292.50 /ls	3,293	-	-	-	-	-	-	3,293
				0231 Procedures and Training							200.00	22,348		3,293							25,640
		0232		Readiness and Startup																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			4.00	ea	120.00 hr/ea	52.93 /hr	480.00	25,406	-	-	-	-	-	-	-	-	25,406
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.10	ea	120.00 hr/ea	75.81 /hr	12.00	910	-	-	-	-	-	-	-	-	910
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			2.00	ea	120.00 hr/ea	120.72 /hr	240.00	28,973	-	-	-	-	-	-	-	-	28,973
			----	Material Allowance			1.00	ls		-	-	-	5,487.50 /ls	5,488	-	-	-	-	-	-	5,488
				0232 Readiness and Startup							732.00	55,289		5,488							60,776
				0230 Perform Operational Readiness and Startup		Reference EMWMF/EMDF Leachate Feasibility Study On-Site Treatment Estimate, log #20160324B_0 dated 4/8/15.					932.00	77,637		8,780							86,417
	0240			Construct Treatment Plant at EMWMF																	
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. Estimate less additional storage was calculated at $6,905,000. Remove Preliminary and Final Design and Treatability Study which are all covered	1.00	ls		-	-	-	-	-	-	-	-	5,991,158.00 /ls	5,991,158	5,991,158

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0240		Construct Treatment Plant at EMWMF																	
			----	Construct Treatment Plant at EMWMF		elsewhere for a resulting total of 5,991,158.	1.00	ls		-	-	-	-	-	-	-	-	-	5,991,158.00 /ls	5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																5,991,158	5,991,158
				0240 Construct Treatment Plant at EMWMF																**5,991,158**	**5,991,158**
	0260			**Construct Tanker Loading Stations at EMWMF plus Purchase Additional Ta**																	
		0261		Construct New Loading Stations																	
			----	Remove Existing Loading		from FFS Team	1.00	ls		-	-	-	-	-	-	-	2,000.00 /ls	2,000	-	-	2,000
			----	Install New Footing/Foundation for Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	15,000.00 /ls	15,000	-	-	15,000
			----	Procure Loaing Arm & Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	65,000.00 /ls	65,000	-	-	65,000
			----	Modify Existing Loading Arm Support		from FFS Team	1.00	ls		-	-	-	-	-	-	-	8,000.00 /ls	8,000	-	-	8,000
			----	Install Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	8,000.00 /ls	8,000	-	-	8,000
			----	Install Loading Arm		from FFS Team	1.00	ls		-	-	-	-	-	-	-	3,000.00 /ls	3,000	-	-	3,000
			----	Piping, Electrical, Insulation Allowance		from FFS Team	1.00	ls		-	-	-	-	-	-	-	10,500.00 /ls	10,500	-	-	10,500
			----	Prepare Subgrade for Unloading Slab		from FFS Team	1.00	ls		-	-	-	-	-	-	-	6,500.00 /ls	6,500	-	-	6,500
			----	Excavate & Form Slab, Access Platform, & Sump		from FFS Team	1.00	ls		-	-	-	-	-	-	-	9,500.00 /ls	9,500	-	-	9,500
			----	Place & Tie Rebar, Waterstop, Set Anchor Bolts, Etc.		from FFS Team	1.00	ls		-	-	-	-	-	-	-	11,500.00 /ls	11,500	-	-	11,500
			----	Place & Finish Concrete		from FFS Team	1.00	ls		-	-	-	-	-	-	-	9,000.00 /ls	9,000	-	-	9,000
			----	Rack Forms & Backfill to Finished Grade		from FFS Team	1.00	ls		-	-	-	-	-	-	-	2,000.00 /ls	2,000	-	-	2,000
			----	Procure Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	65,000.00 /ls	65,000	-	-	65,000
			----	Install Access Platform		from FFS Team	1.00	ls		-	-	-	-	-	-	-	9,000.00 /ls	9,000	-	-	9,000
			----	Install Loading Arm		from FFS Team	1.00	ls		-	-	-	-	-	-	-	3,000.00 /ls	3,000	-	-	3,000
			----	Matl's/Labor for CWT's to Tanker Transfer Ancillary Equip		from FFS Team	1.00	ls		-	-	-	-	-	-	-	25,000.00 /ls	25,000	-	-	25,000
			----	Remove Existing Transfer Pump		from FFS Team	1.00	ls		-	-	-	-	-	-	-	1,500.00 /ls	1,500	-	-	1,500
			----	Install New 250 GPM Pump		from FFS Team	1.00	ls		-	-	-	-	-	-	-	8,000.00 /ls	8,000	-	-	8,000
				0261 Construct New Loading Stations														262,500			262,500
		0262		Purchase New Tankers																	
			----	Purchase Water Tanker Trailers			2.00	ea		-	-	-	-	-	-	-	-	-	80,000.00 /ea	160,000	160,000
				0262 Purchase New Tankers																160,000	160,000
		0263		Subcontractor Overhead and Profit																	
			----	Subcontractor Overhead and Profit		25% of subcontractor cost	0.25	ls		-	-	-	-	-	-	-	422,500.00 /ls	105,625	-	-	105,625
				0263 Subcontractor Overhead and Profit														105,625			105,625
				0260 Construct Tanker Loading Stations at EMWMF plus Purchase Additional Ta														**368,125**		**160,000**	**528,125**
	0270			**Construct Tanker Unloading Stations at LGWO (or OF200)**																	
		0270		Construct Tanker Unloading Stations at LGWO (or OF200)																	
			SPTSA03	Senior RPT (FY16 Rev1 B06)		Oversight During Excavation	1.00	ea	100.00	hr/ea	43.69 /hr	100.00	4,369	-	-	-	-	-	-	-	4,369
			Field Engr. 01	Field Engineer, Maximum, R.S. Means CostWorks, Bare Cost		1 Safety & 1 Field Engr	9.00	wk			-	-	-	-	-	-	1,575.00 /wk	14,175	-	-	14,175
			Proj. Mgr. 01	Project Manager, Maximum, R.S. Means CostWorks, Bare Cost			4.50	wk			-	-	-	-	-	-	2,600.00 /wk	11,700	-	-	11,700
			Suptdt 01	Superintendent, Maximum, R.S. Means CostWorks, Bare Cost			4.50	wk			-	-	-	-	-	-	2,400.00 /wk	10,800	-	-	10,800
			TFE1.3.1.0	TFE: Straight Frame Tri-Axle Dump Truck, Regulated; Fueling,		Assume soil & concrete goes to EMWMF	1,000.00	hr			-	-	-	-	-	-	6.55 /hr	6,550	-	-	6,550
			TFE1.4.3.1	TFE: Staright Frame Tri-Axle Dump Truck, Non-Regulated; Incl All Maintenance; 1-10 Trks		10 trucks for 2.5 weeks	100.00	day			-	-	-	-	-	-	474.71 /day	47,471	-	-	47,471
			TFE1.6.1.3	TFE: Truck Operator; Fully Trained & Certified			1,000.00	hr			-	-	-	-	-	-	40.84 /hr	40,840	-	-	40,840
			TFE1.7.7.0	TFE: Clean Fill Haul; Includes Material;		3,300#/CY Bank. (1250 CY* 3,300#/CY) / 2,000 /Ton =	2,063.00	ton			-	-	-	-	-	-	8.31 /ton	17,144	-	-	17,144
			----	Selective demolition, retaining walls, concrete retaining wall, 10' high, includes reinforcing			155.00	lf			-	-	-	-	-	-	284.49 /lf	44,096	-	-	44,096
			----	Cast-in place retaining walls, reinforced concrete cantilever, 33 degree slope embankment, 10' high, includes excavation, backfill & reinforcing			163.00	lf			-	-	-	-	-	-	333.80 /lf	54,409	-	-	54,409
			----	Excavating, trench or continuous footing, dense hard clay, 3/4 C.Y. excavator, 6' to 10' deep, excludes sheeting or dewatering		Additional excavation not included demolition and retaining wall	17,500.00	bcy			-	-	-	-	-	-	7.42 /bcy	129,850	-	-	129,850
			----	Pipe, stainless steel, threaded, 2" diameter, schedule 40, type 304, includes couplings and hangers 10' OC		Relocated pipe	90.00	lf			-	-	-	-	-	-	68.34 /lf	6,151	-	-	6,151

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0270		Construct Tanker Unloading Stations at LGWO (or OF200)																	
			----	Structural concrete, in place, slab on grade (3500 psi), 6" thick, includes forms(4 uses), Grade 60 rebar, concrete (Portland cement Type I), and plac		Tanker spill containment slab	15.00	cy		-	-	-	-	-	-	-	152.70 /cy	2,291	-	-	2,291
			----	Structural concrete, thickened edge for slab on grade (3500 psi), depth is added to and poured monolithically with slab, 12" wide x 12" deep, unreinfo		Use price for curb	30.00	lf		-	-	-	-	-	-	-	8.75 /lf	263	-	-	263
			----	Sump and pipe Allowance			1.00	LS		-	-	-	-	-	-	-	750.00 /LS	750	-	-	750
			----	Pipe, stainless steel, threaded, 4" diameter, schedule 40, type 304, includes couplings and hangers 10' OC		Unloading pipe header	55.00	lf		-	-	-	-	-	-	-	173.80 /lf	9,559	-	-	9,559
			----	Asphaltic concrete paving, parking lots & driveways, 8" stone base, 4" binder course, 4" topping, no asphalt hauling included		Asphalt repair	3,000.00	sf		-	-	-	-	-	-	-	4.20 /sf	12,600	-	-	12,600
			----	Unidentified Upgrades Allowance			1.00	ls		-	-	-	-	-	-	-	75,000.00 /ls	75,000	-	-	75,000
			----	Seeding, mechanical seeding grass seed, 4.5 lbs per M.S.F., hand push spreader			3.75	msf		-	-	-	-	-	-	-	20.80 /msf	78	-	-	78
			----	Seeding, mechanical apply fertilizer, 35 lbs per M.S.F., hand push spreader			3.75	msf		-	-	-	-	-	-	-	15.31 /msf	57	-	-	57
			----	Mobilization & Training			1.00	ls		-	-	-	-	-	-	-	6,000.00 /ls	6,000	-	-	6,000
			----	Demobilization			1.00	ls		-	-	-	-	-	-	-	2,500.00 /ls	2,500	-	-	2,500
				0270 Construct Tanker Unloading Stations at LGWO (or OF200)							100.00	4,369						492,283			496,652
		0271		Subcontractor Overhead and Profit																	
			----	Subcontractor Overhead and Profit		25% of subcontractor cost	0.25	ls		-	-	-	-	-	-	-	496,652.00 /ls	124,163	-	-	124,163
				0271 Subcontractor Overhead and Profit														124,163			124,163
				0270 Construct Tanker Unloading Stations at LGWO (or OF200)		**Estimated to be 50% of that required for Tanker Unloading Station for Alternative 3B**					**100.00**	**4,369**						**616,446**			**620,815**
	0290			**Construct Additional Water Storage at LGWO**																	
		0290		**Construct Additional Water Storage at LGWO**																	
			----	Construct Additional Water Storage at LGWO		New tank and associated pumps, foundations, etc.. from Tyler Searle - Exclude Markups and fee	1.00	ls		-	-	-	-	-	-	-	615,000.00 /ls	615,000	-	-	615,000
				0290 Construct Additional Water Storage at LGWO														615,000			615,000
		0291		Subcontractor Overhead and Profit																	
			----	Subcontractor Overhead and Profit		25% of subcontractor cost	0.25	ls		-	-	-	-	-	-	-	615,000.00 /ls	153,750	-	-	153,750
				0291 Subcontractor Overhead and Profit														153,750			153,750
				0290 Construct Additional Water Storage at LGWO														**768,750**			**768,750**
				01.01.02 Capital Costs During Construction Phase (1 yr duration)							**4,792.00**	**422,492**		**10,802**				**1,753,321**		**6,783,866**	**8,970,481**
01.01.05				**O&M Costs During EMDF Operations and Closure (30 yrs duration)**																	
	0510			**Perform Project Management During EMDF Operations**																	
		0510		**Perform Project Management During EMDF Operations**																	
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.13	ea	56,400.00	hr/ea	88.97 /hr	7,050.00	627,239	-	-	-	-	-	-	-	-	627,239
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.05	ea	56,400.00	hr/ea	71.30 /hr	2,820.00	201,066	-	-	-	-	-	-	-	-	201,066
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.25	ea	56,400.00	hr/ea	139.59 /hr	14,100.00	1,968,219	-	-	-	-	-	-	-	-	1,968,219
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.13	ea	56,400.00	hr/ea	81.42 /hr	7,050.00	574,011	-	-	-	-	-	-	-	-	574,011
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.13	ea	56,400.00	hr/ea	47.47 /hr	7,050.00	334,664	-	-	-	-	-	-	-	-	334,664
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.13	ea	56,400.00	hr/ea	75.81 /hr	7,050.00	534,461	-	-	-	-	-	-	-	-	534,461
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.25	ea	56,400.00	hr/ea	120.72 /hr	14,100.00	1,702,152	-	-	-	-	-	-	-	-	1,702,152
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.13	ea	56,400.00	hr/ea	99.16 /hr	7,050.00	699,078	-	-	-	-	-	-	-	-	699,078
			OffSpply	Office Supplies, from R.S. Means monthly Cost			66,270.00	ea			-	-	-	0.54 /ea	35,838	-	-	-	-	-	-	35,838
				0510 Perform Project Management During EMDF Operations							66,270.00	6,640,889		35,638							6,676,527

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY	UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
				0510 Perform Project Management During EMDF Operations							**66,270.00**	**6,640,989**		**35,638**							**6,676,627**
	0520			**Operate Onsite Treatment Plant During EMDF Operations**																	
		0520		Operate Onsite Treatment Plant During EMDF Operations																	
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		30 years at 2080 hours per year = 62400 hours	2.00	ea	62,400.00	hr/ea	52.93 /hr	124,800.00	6,605,664	-	-	-	-	-	-	-	6,605,664
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)			0.12	ea	62,400.00	hr/ea	52.93 /hr	7,488.00	396,340	-	-	-	-	-	-	-	396,340
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	75.81 /hr	3,744.00	283,833	-	-	-	-	-	-	-	283,833
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)			0.06	ea	62,400.00	hr/ea	120.72 /hr	3,744.00	451,976	-	-	-	-	-	-	-	451,976
			PPE DMod	PPE Level D Modified			139,776.00	hr			-	-	-	4.50 /hr	628,957	-	-	-	-	-	628,957
				0520 Operate Onsite Treatment Plant During EMDF Operations								**139,776.00**	**7,737,812**		**628,957**						**8,366,769**
				0520 Operate Onsite Treatment Plant During EMDF Operations							**139,776.00**	**7,737,812**		**628,957**							**8,366,769**
	0530			**Purchase GAC and/or Treatment Resins**																	
		0530		Purchase GAC and/or Treatment Resins																	
			----	Annual Material Allowance		(Per R. McDonnell - $88,000/year allowance for GAC treatment technology. Per Ray and Stephen Hahn new technology is Ion Exchange and material allowance for Ion Exchange is approximately twice the needed allowance for GAC, therefore use 2 x $88,000/year or $176,000/year for mateirals) (plus tax)	30.00	yr			-	-	-	193,160.00 /yr	5,794,800	-	-	-	-	-	-	5,794,800
				0530 Purchase GAC and/or Treatment Resins										5,794,800							5,794,800
				0530 Purchase GAC and/or Treatment Resins										**5,794,800**							**5,794,800**
	0540			**Freight on Materials**																	
		0540		Freight on Materials																	
			----	Freight on Materials		Reference AECOM estimate for Landfill Wastewater Treatment System, dated 10/23/15. ACCT 80	0.08	pct			-	-	-	-	-	-	-	-	5,794,800.00 /pct	463,584	463,584
				0540 Freight on Materials																463,584	463,584
				0540 Freight on Materials																**463,584**	**463,584**
	0560			**Sample/Test Leachate During EMDF Operations**																	
		0560		Sample/Test Leachate During EMDF Operations																	
			----	Annual Analytical Costs		per FFS project team (plus 10% for additional analysis at receiving facility 212,517 x 11=233,769)	30.00	yr			-	-	-	-	-	-	-	-	233,769.00 /yr	7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations																7,013,070	7,013,070
				0560 Sample/Test Leachate During EMDF Operations																**7,013,070**	**7,013,070**
	0570			**Truck Leachate Plus Contact Water During EMDF Operations**																	
		0570		Truck Leachate Plus Contact Water During EMDF Operations																	
			----	Leachate and Contact Water Transportation Cost		Based on FY15 actual transportation costs (reference ROS 280) adjusted to remove elements not associated with transportation costs, adjusted up to cover projected increases in number of truck loads	30.00	yr			-	-	-	-	-	-	-	-	1,500,000.00 /yr	45,000,000	45,000,000
				0570 Truck Leachate Plus Contact Water During EMDF Operations																45,000,000	45,000,000
				0570 Truck Leachate Plus Contact Water During EMDF Operations																**45,000,000**	**45,000,000**
				01.01.05 O&M Costs During EMDF Operations and Closure (30 yrs duration)							**206,046.00**	**14,378,701**		**6,459,395**						**52,476,654**	**73,314,750**
01.01.07				**O&M Costs During Post-Closure EMDF (30 yrs duration)**																	
	0610			**Perform Project Management During EMDF Post-Closure**																	

WBS	Activity	Task	Item	Description	Ex-hibit	Notes	QTY UM	Labor Hours	Labor Rate	Total Labor Hours	Total Labor	Unit Material Price	Total Material	Unit Equip Price	Total Equip	Unit Sub Price	Total Sub	Unit ODC Price	Total ODC	Total Amount
		0610		Perform Project Management During EMDF Post-Closure																
			32Labor	UCOR - Engineering (FY16 Rev1 B06)		Project Engineer	0.05 ea	56,400.00 hr/ea	88.97 /hr	2,820.00	250,895	-	-	-	-	-	-	-	-	250,895
			41Labor	UCOR - Procurement (FY16 Rev1 B06)		Procurement	0.03 ea	56,400.00 hr/ea	71.30 /hr	1,410.00	100,533	-	-	-	-	-	-	-	-	100,533
			51Labor	UCOR - Project Management (FY16 Rev1 B06)		Project Manager	0.10 ea	56,400.00 hr/ea	139.59 /hr	5,640.00	787,200	-	-	-	-	-	-	-	-	787,200
			52Labor	UCOR - Quality Assurance (FY16 Rev1 B06)		QA	0.05 ea	56,400.00 hr/ea	81.42 /hr	2,820.00	229,804	-	-	-	-	-	-	-	-	229,804
			55Labor	UCOR - Administrative Services (FY16 Rev1 B06)		Admin	0.05 ea	56,400.00 hr/ea	47.47 /hr	2,820.00	133,865	-	-	-	-	-	-	-	-	133,865
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		ES&H	0.05 ea	56,400.00 hr/ea	75.81 /hr	2,820.00	213,784	-	-	-	-	-	-	-	-	213,784
			RSISA08	Senior Engineer/Scientist (FY16 Rev1 B06)		Environmental Engr	0.10 ea	56,400.00 hr/ea	120.72 /hr	5,640.00	680,861	-	-	-	-	-	-	-	-	680,861
			SATCH03	SA Technical - Level 3 (FY16 Rev1 B06)		PCE	0.05 ea	56,400.00 hr/ea	99.16 /hr	2,820.00	279,631	-	-	-	-	-	-	-	-	279,631
			OffSpply	Office Supplies, from R.S. Means monthly Cost			26,790.00 ea		-	-	-	0.54 /ea	14,407	-	-	-	-	-	-	14,407
				0610 Perform Project Management During EMDF Post-Closure						26,790.00	2,676,462		14,407							2,690,869
				0610 Perform Project Management During EMDF Post-Closure						26,790.00	2,676,462		14,407							2,690,869
	0620			Operate Onsite Treatment Plant During Post-Closure EMDF																
		0620		Operate Onsite Treatment Plant During Post-Closure EMDF																
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		1 day once a month for 30 years.	2.00 ea	3,600.00 hr/ea	52.93 /hr	7,200.00	381,096	-	-	-	-	-	-	-	-	381,096
			58Labor	UCOR - Environmental Safety & Health (FY16 Rev1 B06)		1 day once a month for 30 years	0.50 ea	3,600.00 hr/ea	75.81 /hr	1,800.00	136,458	-	-	-	-	-	-	-	-	136,458
			RSISA08	Senior Staff Engineer/Scientist (FY16 Rev1 B06)		1 day once a month for 30 years	2.00 ea	3,600.00 hr/ea	108.11 /hr	7,200.00	778,382	-	-	-	-	-	-	-	-	778,382
			SPTSA03	Senior RPT (FY16 Rev1 B06)		1 day once a month for 30 years	0.50 ea	3,600.00 hr/ea	43.69 /hr	1,800.00	78,842	-	-	-	-	-	-	-	-	78,842
			----	Material Allowance			30.00 yr		-	-	-	3,292.50 /yr	98,775	-	-	-	-	-	-	98,775
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF						18,000.00	1,374,588		98,775							1,473,363
				0620 Operate Onsite Treatment Plant During Post-Closure EMDF						18,000.00	1,374,588		98,775							1,473,363
	0630			Sample/Test Leachate During Post-Closure EMDF																
		0630		Sample/Test Leachate During Post-Closure EMDF																
			----	Sampling/Analytical		From FFS team	30.00 yr		-	-	-	-	-	-	-	-	-	36,596.00 /yr	1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF															1,097,880	1,097,880
				0630 Sample/Test Leachate During Post-Closure EMDF															1,097,880	1,097,880
	0640			Truck EMDF Leachate During Post-Closure EMDF																
		0640		Truck EMDF Leachate During Post-Closure EMDF																
			10Craft	Maintenance Skilled Craft Workers (FY16 Rev1 B06)		1 day once a month for 30 years. 2 personnel, drivers.	2.00 ea	3,600.00 hr/ea	52.93 /hr	7,200.00	381,096	-	-	-	-	-	-	-	-	381,096
			GFETrkTrctr	GFE Truck Tractor (Semi), 6X4, 400HP, Oper Cost		Assume 2 tractors @ 1 day/month for 30 years = 10 hrs X 12 months X 30 yrs X 2 ea = 7,200 hrs	7,200.00 hr		-	-	-	-	-	51.05 /hr	367,560	-	-	-	-	367,560
			GFEWtrTrlr	GFE Water Trailer, 5K Gallons, Oper Cost		2 trailers	7,200.00 hr		-	-	-	-	-	7.00 /hr	50,400	-	-	-	-	50,400
				0640 Truck EMDF Leachate During Post-Closure EMDF						7,200.00	381,096				417,960					799,056
				0640 Truck EMDF Leachate During Post-Closure EMDF						7,200.00	381,096				417,960					799,056
				01.01.07 O&M Costs During Post-Closure EMDF (30 yrs duration)						51,990.00	4,432,146		113,182		417,960				1,097,880	6,061,168

Estimate Totals

Description	Amount	Totals	Hours		Rate	Cost Basis	Cost per Unit	Percent of Total	
Labor	19,857,052		268,744	hrs				22.01%	
Material	6,586,537							7.30%	
Equipment	417,960		14,400	hrs				0.46%	
Subcontract	1,753,321							1.94%	
Other	61,594,727							68.28%	
	90,209,597	90,209,597						100.00	100.00%
Total		90,209,597							

APPENDIX J.
SCREENING WATER SAMPLING RESULTS FOR EVALUATING COMPLIANCE WITH ARARs

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Screening Water Sampling Results for Evaluating Compliance With ARARs

From Tennessee Department of Environment and Conservation (TDEC) regs:

The point of compliance for the discharge limits for Alternative 3 (on-site wastewater treatment) is prior to leachate and contact water combining with stormwater. For determining compliance with the aquatic water quality criteria for treated wastewater under this alternative, the U.S. Department of Energy is proposing that compliance with the discharge limits be based on a running annual average. Per TDEC's drinking water regulations [TDEC 0400-45-01-.04(55)], "locational running annual average (LRAA)" is defined as the "average of sample analytical results for samples taken at a particular monitoring location during the previous four calendar quarters."

From the U.S. Environmental Protection Agency's (EPA's) *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (PB85-227049, December 2010):

A statement of a criterion as a number that is not to be exceeded any time or place is not acceptable because few, if any, people who use criteria would take it literally and few, if any, toxicologists would defend a literal interpretation. The Criterion Continuous Concentration (CCC) is intended to be a good estimate of this threshold of unacceptable effect. If maintained continuously, any concentration above the CCC is expected to cause an unacceptable effect. On the other hand, the concentration of a pollutant in a body of water can be above the CCC without causing an unacceptable effect if (a) the magnitudes and durations of the excursions above the CCC are appropriately limited and (b) there are compensating periods of time during which the concentration is below the CCC. The higher the concentration is above the CCC, the shorter the period of time it can be tolerated. But it is unimportant whether there is any upper limit on concentrations that can be tolerated instantaneously, or even for one minute, because concentrations outside mixing zones rarely change substantially in such short periods of time. An elegant, general approach to the problem of defining conditions (a) and (b) would be to integrate the concentration over time, taking into account uptake and depuration rates, transport within the organism to a critical site, etc. Because such an approach is not currently feasible, an approximate approach is to require that the average concentration not exceed the CCC. The average concentration should probably be calculated as the arithmetic average, rather than the geometric mean 5. If a suitable averaging period is selected, the magnitudes and durations of concentrations above the CCC will be appropriately limited, and suitable compensating periods below the CCC will be required.

From EPA's *Technical Support Document for Water Quality-based Toxics Control*:

A typical aquatic life water quality criteria statement contains a concentration, averaging period, and return frequency, stated in the following format:

The procedures described in the *Guidelines for Deriving National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* indicate that, except possibly where a locally important species is very sensitive, (1) aquatic organisms and their uses should not be affected unacceptably if the four-day average concentration of (2) does not exceed (3) ug/L more than once every three years on the average and if the one-hour average concentration does not exceed (4) ug/L more than once every three years on the average. [In this generic example statement, the following terms are inserted at: (1) either "freshwater" or "saltwater," (2) pollutant name, (3) the CCC number, and (4) the CMC number].

From EPA's *Water Quality Guidance for the Great Lakes System: Supplementary Information Document (SID)*, EPA-820-B-95-001, March, 1995

Current National guidance (*see above guidelines document*), requires that, except possibly where a locally important species is very sensitive, aquatic organisms and their uses should not be affected unacceptably if the following conditions are met: for chronic criteria, the four-day average concentration of a chemical does not exceed the CCC or Secondary Continuous Concentration more than once every three years on the average; for acute criteria, the one-hour average concentration of a chemical does not exceed the CMC or Secondary Maximum Concentration more than once every three years on the average. Averaging periods are time periods over which ambient concentrations are to be averaged to determine whether criteria are exceeded. If the mean ambient concentration of a pollutant exceeds the criteria over the averaging period, adverse impacts on the resident aquatic life could occur.

Averaging periods are one means of accounting for the exposure time required to elicit toxic effects. An allowable frequency for exceeding the criteria is incorporated into the criteria because it is not necessary for concentrations to be below criteria at all times in order to adequately protect aquatic ecosystems. Also, it is not generally possible to ensure that criteria are never exceeded. Frequently, concentrations above criteria may occur without corresponding impacts on the aquatic biota if the duration is less than the averaging period. This is dependent on the magnitude and duration of the exceedance.

APPENDIX K.
REVISED DISCHARGE LIMITS FOR LANDFILL WASTEWATER

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REVISED DISCHARGE LIMITS FOR LANDFILL WASTEWATER

1. INTRODUCTION

The current non-radiological and radiological landfill wastewater discharge limits for the Environmental Management Waste Management Facility (EMWMF) were negotiated by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) in 2002 and documented in the *Environmental Monitoring Plan* which is an appendix to the *Addendum to the Remedial Design Report for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* (DOE/OR/01-1873&D2/A1/R2). Subsequent revisions to the *Environmental Monitoring Plan* were agreed to by DOE, EPA, and TDEC, and annual reports of the monitoring to verify compliance with the current discharge limits have been submitted by DOE to EPA and TDEC.

This *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2664&D2) (FFS) evaluates the management of landfill wastewater generated from EMWMF and the proposed Environmental Management Disposal Facility (EMDF). In order to ensure that the discharge of landfill wastewater is protective of human health and the environment and complies with applicable or relevant and appropriate requirements, revised discharge limits for landfill wastewater into Bear Creek or its tributaries must be developed. Following is a discussion of how the revised non-radiological and radiological discharge limits were developed.

2. NON-RADIOLOGICAL DISCHARGE LIMITS

2.1 Introduction

This FFS is being prepared to evaluate the management of landfill wastewater generated from EMWMF and the proposed EMDF. A key component of the evaluation is the discharge limits for landfill wastewater into Bear Creek or its tributaries. Following is a discussion of how the revised non-radiological discharge limits were developed to meet the TDEC recreational ambient water quality criteria (AWQC) (TDEC 0400-40-03-.03) and anti-degradation requirements (TDEC 0400-40-03-.06).

2.2 Bear Creek Water Quality

Bear Creek currently is listed as impaired [Year 2012 303(d) List] for nitrates and Escherichia coli, neither of which is a concern for current or future landfill wastewater discharges. Based on discussions among DOE, EPA, and TDEC, the bio-accumulative contaminants listed in Table K.1 were identified as those potentially to be addressed by the anti-degradation requirements. The contaminants in Table K.1 were evaluated further based upon the information in the 2015 *Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2675&D2) (2015 RER) and supplemental data. This evaluation is below, and the locations referenced are in Fig K.1.

Table K.1. Potential contaminants to consider for anti-degradation requirements

Potential contaminant	Present in water column above AWQC	Present in fish
Mercury	No – recreational ambient water quality criteria (AWQC 0.051 µg/L)	Yes –above EPA recommended levels of 0.3 µg/g
PCBs	No – near EMWMF Yes – at North Tributary-8	Yes - above EPA recommended levels
Cadmium	Yes – upstream at Bear Creek Kilometer 12.34 near the S3 ponds No – EMWMF area and downstream	No
Pesticides	No	No

EMWMF = Environmental Management Waste Management Facility
EPA = U.S. Environmental Protection Agency

2.3 Evaluation

As described in the 2015 RER, the Bear Creek Valley watershed contains closed and active waste disposal facilities. As a result, Bear Creek may be impacted by bio-accumulative contaminants in addition to the Year 2012 303(d) List contaminants of nitrates and Escherichia coli. The following evaluation was performed for the bio-accumulative contaminants, e.g., mercury, polychlorinated biphenyls (PCBs), cadmium, and pesticides, described in the 2015 RER, that potentially may need to be controlled to prevent degradation of Bear Creek.

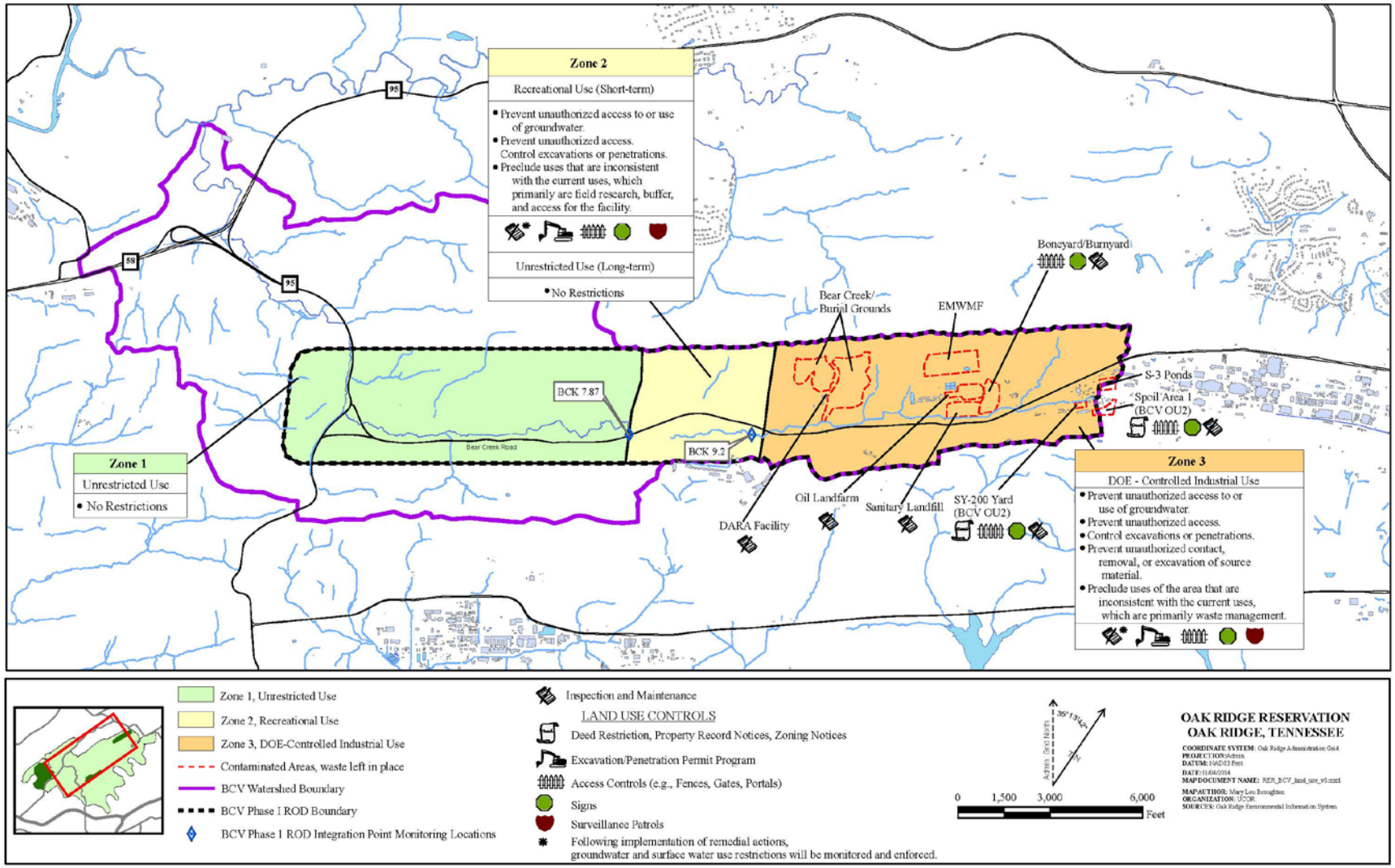

Fig. K.1. Bear Creek Valley locations (from 2015 RER).

Mercury

As shown on Fig. K.1, the Bear Creek watershed begins at the eastern edge of the Y-12 National Security Complex and is east of the primary area impacted by mercury operations. In the past, the Bone Yard Burn Yard (BYBY) east of EMWMF was a source of mercury contamination in Bear Creek. The highest contaminant concentration seen in the creek was 0.66 ug/L in 2001. Mercury concentrations decreased rapidly after completion of the *Phased Construction Completion Report for the Bear Creek Valley Boneyard/Burnyard Remediation Project at the Y-12 National Security Complex, Oak ridge, Tennessee* in 2002 (DOE/OR/01-2077&D2). Since December 2006, mercury concentrations at North Tributary (NT)-3 have been below the recreational AWQC of 0.051 ug/L. The October 2013 total mercury result at NT-3 was 4.1 ng/L (0.004 ug/l) and the May 2014 result was 11.5 ng/L (0.0115 ug/L) (DOE/OR/01-2675&D2).

However, while mercury concentrations in Bear Creek water column are below the recreational AWQC of 0.051 ug/L, fish contain measurable amounts of mercury above the EPA recommended levels of 0.3 µg/g (Table K.2). Therefore, mercury is considered to be of concern for landfill wastewater discharges. A mass loading was calculated as discussed below.

Table K.2. Mercury and PCB concentrations in Bear Creek fish (2009 to 2014)

Location	Number of samples	Average fish length (cm)	Average fish weight (g)	Average mercury (µg/g)	Average PCB-1254 (µg/g)	Average PCB-1260 (µg/g)	Total PCBs* (µg/g)
BCK 12.4	1	15	62.7	0.27	0.19	0.91	1.10
BCK 9.9	73	14.1	49.5	0.33	0.20	0.57	0.77
BCK 3.3	84	17.9	104.4	0.73	0.11	0.23	0.34
Total	158	16.1	78.6	0.55	0.15	0.39	0.54

*Non-detect results for Aroclors not included in the total, resulting in a higher value.
Note 1: Data were provided via email from Mark Peterson, Oak Ridge National Laboratory, on January 8, 2016.
Note 2: All sunfish results represent concentrations in fish fillets. Whole body fish results from Bear Creek, primarily of common stonerollers and creek chubs, are not presented here.
BCK = Bear Creek kilometer
PCT = polychlorinated biphenyls

PCBs

PCBs are occasionally above the analytical detection limits in downstream tributary NT-8, but are at non-detectable levels in the tributaries near EMWMF and in general in Bear Creek (Table K.3). There have been nine detects of PCB-1260 above the detection limit in the 879 samples collected (1.02%). In addition, there have been three detects each of PCB-1254 (0.34%) and PCB-1248, (0.34%) as well as 11 detects of undifferentiated PCBs, which were collected for a shorter period of time (5.21%). There were no detects of PCBs in Bear Creek, other tributaries, or EMWMF contact water during this same period. As shown in Table K.2, PCBs in fish continue to be above levels recommended in TDEC stream evaluation criteria.

Table K.3. PCBs in Bear Creek watershed surface water

Analyte	Samples	Average result	Unit	Comment	% detects
PCB-1016	870	0.361	ug/L	all non-detects	0.00%
PCB-1221	870	0.361	ug/L	all non-detects	0.00%
PCB-1232	870	0.361	ug/L	all non-detects	0.00%
PCB-1242	880	0.361	ug/L	all non-detects	0.00%
PCB-1248	870	0.361	ug/L	3 detects NT-8	0.34%
PCB-1254	879	0.359	ug/L	3 detects NT-8	0.34%
PCB-1260	879	0.361	ug/L	9 detects, NT-8	1.02%
PCB-1262	749	0.404	ug/L	all non-detects	0.00%
PCB-1268	751	0.404	ug/L	all non-detects	0.00%
PCBs-Total	211	0.094	ug/L	11 detects, NT-8	5.21%

PCB = polychlorinated biphenyls
NT = North Tributary

The PCB wastes disposed in EMWMF are primarily painted surfaces on demolition debris, not mobile waste forms. As a result, PCBs are not seen in contact water above detection limits, and there have been very minor detects in leachate. Therefore, PCBs are not key contaminants of concern and are not evaluated further as an anti-degradation parameter. In the event that PCBs are seen above the historical levels, mass loading will be evaluated as was done for mercury.

Cadmium

Cadmium is present in the upper stretches of Bear Creek at NT-01 and Bear Creek kilometer (BCK) 12.34 (Fig. K.1). During 2014, the average concentration was 2.5 ug/L above the AWQC of 0.25 ug/L. The principal source of cadmium is disposed liquids from the S-3 ponds (DOE/OR/01-2675&D1). The cadmium is thought to enter Bear Creek through seeps in the S-3 ponds area.

Downstream of the S-3 ponds at BCK 9.2 (Fig. K.1), 11 monthly samples were non-detects at a detection limit of 0.13 ug/L, well below the lowest AWQC of 0.25 ug/L. The remaining sample had a concentration of 1.6 ug/L, which does exceed the AWQC. The preponderance of non-detects indicates that the cadmium from the S-3 Ponds is strongly attenuated before Bear Creek reaches BCK 9.2.

Cadmium will not be evaluated further as an anti-degradation parameter, but will continue to be evaluated and monitored as an EMWMF and future EMDF contaminant of concern.

Pesticides

While many pesticides are not detected, some pesticides are occasionally present above the applicable detection limit (Table K.4). The greatest numbers of analyses above the detection limit were in 40 of 621 analyses (6.44%) for beta-BHC across Bear Creek followed by 10 detects in 643 analyses (1.56%) for 4,4'-DDE. Another eight pesticides have three or fewer detects (Table K.4).

EMWMF does not manufacture or accept pesticide product wastes and does not accept liquid wastes. The pesticides that may be present in the waste are as a result of using pesticides for the intended purpose of controlling pests in and around buildings and other materials that are now disposed in EMWMF.

Therefore, applicable pesticide parameters will not be evaluated as an anti-degradation parameter, but will continue to be evaluated and monitored as an EMWMF and future EMDF key contaminant of concern. The presence of pesticides in landfill wastewater is a result of use at DOE facilities for their intended

purposes (pest control), and not from the disposal of waste products from DOE operations. Therefore, the TDEC Required Reporting Limits [TDEC 0400-40-03-.05(8)] are appropriate for the revised discharge limits.

Table K.4. Pesticides in Bear Creek watershed surface water

Analyte	Samples	Average result	Unit	Comment	% detects
4,4'-DDD	643	0.045	ug/L	2 detects, BCK 11.84 2009, EMWMF	0.31%
4,4'-DDE	643	0.053	ug/L	10 detects EMWMF 2011-2013	1.56%
4,4'-DDT	663	0.043	ug/L	all non-detects	0.00%
Aldrin	605	0.040	ug/L	1 detect, NT-1 2010	0.17%
alpha-BHC	596	0.042	ug/L	all non-detects	0.00%
alpha-Chlordane	676	0.043	ug/L	1 detect, NT-3 2010	0.15%
beta-BHC	621	0.041	ug/L	40 detects, EMWMF, BCK 9.2, S06, S24, NT-8, BCK 07.87, SS-8, NT-1	6.44%
Chlordane	353	0.113	ug/L	all non-detects	0.00%
delta-BHC	508	0.048	ug/L	all non-detects	0.00%
Dieldrin	668	0.100	ug/L	all non-detects	0.00%
Endosulfan I	605	0.042	ug/L	3 detects, NT-1, S07	0.50%
Endosulfan II	663	0.051	ug/L	all non-detects	0.00%
Endosulfan sulfate	594	0.042	ug/L	2 detects, EMWMF	0.34%
Endrin	663	0.043	ug/L	1 detect, NT-1	0.15%
Endrin aldehyde	643	0.042	ug/L	all non-detects	0.00%
Endrin ketone	372	0.049	ug/L	all non-detects	0.00%
gamma-Chlordane	676	0.043	ug/L	3 detects, NT8, SS6.6	0.44%
Heptachlor	496	0.040	ug/L	all non-detects	0.00%
Heptachlor epoxide	663	0.042	ug/L	all non-detects	0.00%
Lindane	219	0.028	ug/L	1 detect, NT-3	0.46%
Methoxychlor	480	0.061	ug/L	all non-detects	0.00%

BCK = Bear Creek kilometer
EMWMF = Environmental Management Waste Management Facility
NT = North Tributary

2.4 Mass Loading Calculations

The volume of landfill wastewater varies over time and is dependent on the amount of precipitation received, the disposal area open, and the area covered by the enhanced operational cover. The annual volume of landfill wastewater generated at EMWMF is in Fig. K.2.

When the final cell opens for waste disposal, expected in 2016, the calculated volume of landfill wastewater was calculated assuming only Cells 5 and 6 are active during a year with normal precipitation of 50.91 inches. Approximately 12.2 million gallons of landfill wastewater is expected to be generated, based upon the projected active cell footprint and the amount of rainfall received. This amount is comparable and slightly less than the volume generated in 2014.

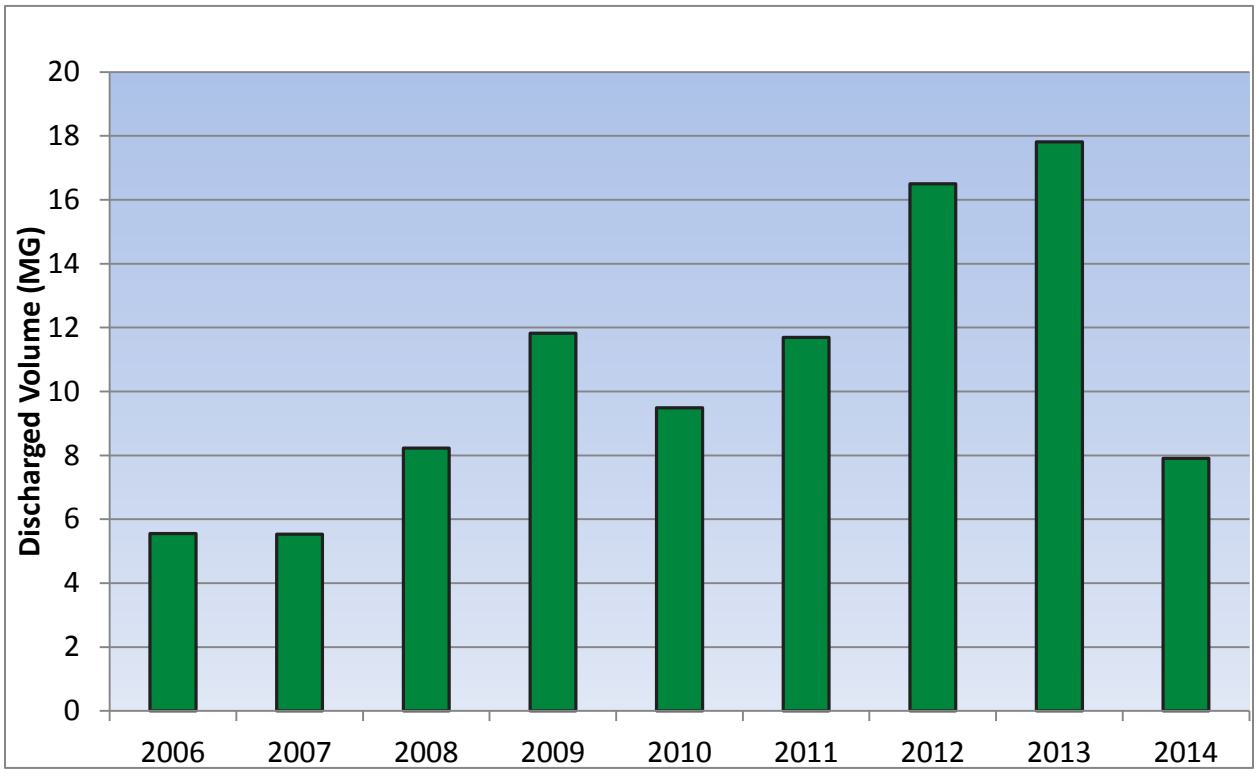

Fig. K.2. EMWMF discharged landfill wastewater volume by fiscal year.

The mass loading for mercury was calculated by taking the fish and aquatic life Concentration Maximum Concentration (CMC) AWQC times the volume of landfill wastewater discharged. That mass represents the maximum load that can be discharged if an increase in the volume of landfill wastewater is planned (Table K.5). The data range from 2011 to 2014 was evaluated to ensure the most representative data for the current conditions was used.

Table K.5. Calculated mercury mass loading for EMWMF contact water (2011 to 2014)

Year	Discharged volume (gallons)	CMC AWQC (ug/L)	Mercury loading (g)
2011	11,697,000	1.4	62
2012	16,505,215	1.4	87
2013	17,817,500	1.4	94
2014	7,909,000	1.4	42

AWQC = ambient water quality criteria
CMC = concentration maximum concentration

Based upon these data, the mass loading of 94 grams will be used as the maximum loading for future anti-degradation calculations.

2.5 Recommendations

- Landfill wastewater (Managed Discharge) will initially be discharged to Bear Creek in accordance with current discharge limits based on fish and aquatic life CMC.

- Following construction of the leachate water treatment system (LWTS), landfill wastewater will be discharged to Bear Creek in accordance with the lowest applicable AWQC. For the bioaccumulative constituent mercury, the lower of the AWQC or the historical allowable mass loadings calculated for EMWMF will apply. If the levels of mercury in fish decline below levels of concern, the anti-degradation requirements will no longer apply.

3. RADIOLOGICAL DISCHARGE LIMITS

3.1 Introduction

This evaluation of landfill wastewater discharge limits includes key radioisotopes and total uranium identified in this FFS. Landfill wastewater from EMWMF currently is being discharged in accordance with dose-based discharge limits per DOE Order 5400.5. In order to calculate possible, revised discharge limits, the equivalent risk associated with these current discharge limits was determined, and risk-based, revised discharge limits were calculated utilizing standard EPA risk assessment protocols for landfill wastewater.

3.2 Current Discharge Limits

DOE Order 5400.5-Based Discharge Limits

Landfill wastewater from EMWMF currently must comply with discharge limits based on 24% of the DOE-derived concentration guidelines (DCGs) upon discharge to surface water. These discharge limits reflect annual radiological doses of 24 mrem/yr under a drinking water scenario (2 L/d, 350 d/yr), with an exposure duration of 10 years. Equivalent excess lifetime cancer risks (ELCRs) for these dose-based discharge limits were calculated with the following equation:

$$\text{Equivalent ELCR} = \text{discharge limit} \times \text{annual water intake} \times \text{slope factor}$$

Table K.6 presents the current dose-based discharge limits and equivalent ELCRs for the key radioisotopes.

Table K.6. Current discharge limits and equivalent risk

		Equivalent excess lifetime cancer risk for residential exposure scenario
Radioisotope	**Current discharge limits at 24% of DOE O 5400.5 DCG (pCi/L)**	**ELCR at 24% of DCG**
Iodine-129	120	1×10^{-4}
Strontium-90	240	9×10^{-5}
Technitium-99	24,000	5×10^{-4}
Tritium	480,000	2×10^{-4}
Uranium-233/-234[1]	120	6×10^{-5}
Uranium-235/-236[1]	120	6×10^{-5}
Uranium-238	144	6×10^{-5}

DCG = derived concentration guideline
[1]lowest value of the two radioisotopes selected as representative
slope factors from EPA PRG calculator at http://epa-prgs.ornl.gov/radionuclides/

As noted in Table K.6, six of the seven radioisotopes current discharge limits at 24% of the DCGs, under a residential drinking water scenario, equate to an ELCR that is within the EPA acceptable risk range, the exception being those for technetium-99, which is above the upper bound of the residential drinking water scenario risk range.

DOE Order 458.1-Based Discharge Limits

DOE Order 5400.5 has been replaced by DOE Order 458.1, *Radiation Protection of the Public and the Environment*. This Order presents concentrations of radionuclides in discharges, called derived concentrations standards (DCSs). Like DCGs, DCSs assume a residential drinking water exposure scenario. Table K.7 presents the DCSs at 25 percent to reflect an annual radiological dose limit of 25 mrem/yr and the equivalent ELCRs for these dose-based discharge limits calculated using the same exposure scenario as those for Table K.6 for the drinking water scenario, as well as equivalent ELCRs under a site-specific recreational exposure scenario.

Table K.7. DCSs and equivalent risk

		Equivalent excess lifetime cancer risk for residential exposure scenario	**Equivalent excess lifetime cancer risk for site-specific recreational exposure scenario**
Radioisotope	**25% of DOE Order 458.1 DCS (pCi/L)**	**ELCR at 25% of DCS**	**ELCR at 25% of DCS**
Iodine-129	83	9×10^{-5}	8×10^{-7}
Strontium-90	275	1×10^{-4}	1×10^{-6}
Technitium-99	11,000	2×10^{-4}	2×10^{-6}
Tritium	215,000	8×10^{-5}	7×10^{-7}
Uranium-233/234[1]	170	8×10^{-5}	8×10^{-7}
Uranium-235/236[1]	180	8×10^{-5}	8×10^{-7}
Uranium-238	188	8×10^{-5}	8×10^{-7}

DCS = derived concentration standards
[1]lowest value of the two radioisotopes selected as representative
slope factors from EPA PRG calculator at http://epa-prgs.ornl.gov/radionuclides/

As noted in Table K.7, the seven radioisotopes DCSs equate to an ELCR that is within the EPA acceptable risk range under a drinking water scenario. However, Bear Creek is not classified as a drinking water source; therefore, a recreational exposure scenario is more appropriate for evaluating discharge limits. Accordingly, Table K.7 also presents the ELCRs associated with the radioisotopes assuming a site-specific recreational exposure scenario for exposure to surface water only (i.e., 0.05 L/day, 45 days/yr, 30 years). Under the recreational exposure scenario, all discharge limits based on 25% of the DCSs are either within the EPA acceptable risk range or are below the lower bound of the risk range.

Use of 24% of the DCGs or 25% of the DCSs for discharge limits, assuming the drinking water scenario, is conservative, since surface water in Bear Creek is not used as a drinking water source and it is not classified for drinking water by TDEC (TDEC 0400-40-04, *Use Classifications for Surface Water*). Further, this exposure scenario is inconsistent with the end use established for Bear Creek Valley in *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE/OR/01-1750&D4) (BCV ROD). The EMWMF and proposed EMDF are located in an area that consists of waste management units and designated as industrial due to current and past industrial activities and waste disposal within Zone 3. Figure K.3 presents the end uses established in

the BCV ROD. Therefore, a recreational exposure scenario is more appropriate for supporting landfill water discharge limits based on DOE orders.

3.3 Risk-Based Revised Discharge Limits

The calculation of the revised discharge limits for the protection of human health for the key radioisotopes and total uranium in landfill wastewater is discussed below. The human health exposure scenario for the human health-based surface water discharge limits is recreational, with the exposure medium being surface water in Bear Creek. This scenario is consistent with the stream use classification for Bear Creek (TDEC 0400-40-04), which identifies Bear Creek as recreational. EMWMF and the proposed EMDF are located in the industrial end use area designated in the approved BCV ROD. However, a credible industrial scenario that includes contact with surface water in Bear Creek that will result in incidental ingestion (e.g., periodic water sampler) will be less conservative than the recreational scenario because of much reduced surface water intake as compared to the recreational exposure, resulting in higher discharge limits than those calculated under a recreational scenario.

Figure K.4 illustrates the conceptual site model under a recreational exposure scenario indicating surface water and fish as the exposure media. Exposure routes include incidental ingestion and dermal exposure during wading for surface water and ingestion for fish.

While Bear Creek is classified as recreational, there is considerable uncertainty as to whether or not it is large enough to support a viable fishery that will sustain significant populations of fish large enough to be edible. This is particularly true for the upper stretch of Bear Creek where the EMWMF and proposed EMDF are located. This stretch of Bear Creek near NT-4, NT-5, and NT-6 remained dry in *Gaining, Losing, and Dry Stream Reaches at Bear Creek Valley, Oak Ridge, Tennessee March and September 1994* (U.S. Geological Survey Open-File Report 96-557). It is more plausible that edible size fish may be caught in Bear Creek below BCK 9.2, which is just over 2.3 kilometers (1.42 miles) downstream. Thus, the analysis performed herein is conservative.

Radionuclide surface water discharge limits for use in determining the appropriate management of landfill wastewater are calculated using the EPA Radionuclide Preliminary Remediation Goal (PRG) calculator and the EPA Chemical Contaminants Regional Screening Level (RSL) calculator. Both the PRG calculator and the RSL calculator are appropriate approaches for calculating discharge limits since both calculators have multiple modules that represent different exposure scenarios and use both EPA-approved input parameters, including agency approved carcinogenic slope factors (from *Cancer Risk Coefficients for Environmental Exposure to Radionuclides, Federal Guidance Report 13*, EPA 402-R-99-001) and the option to include site-specific input parameters.

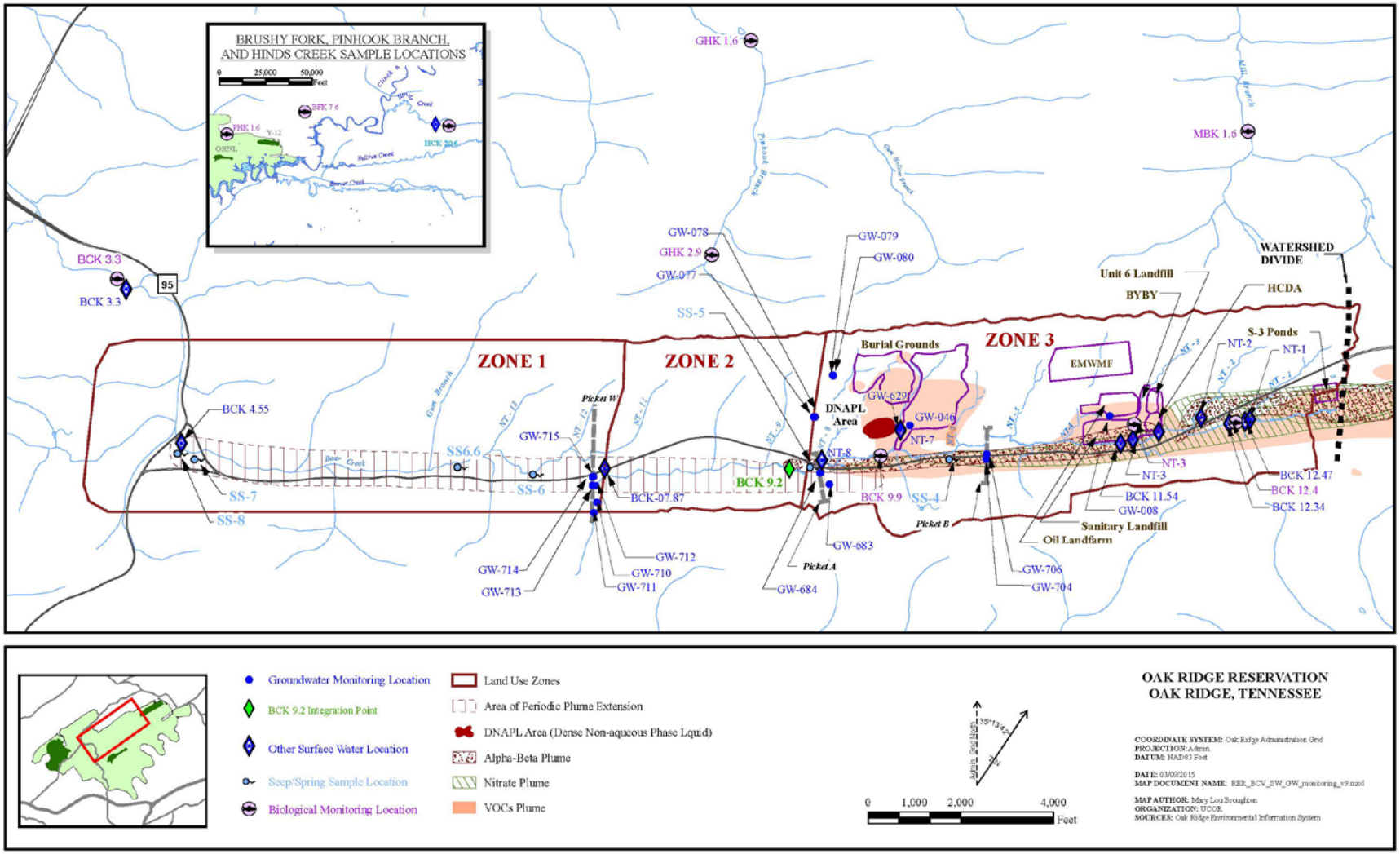

Fig. K.3. Bear Creek Valley end use map.

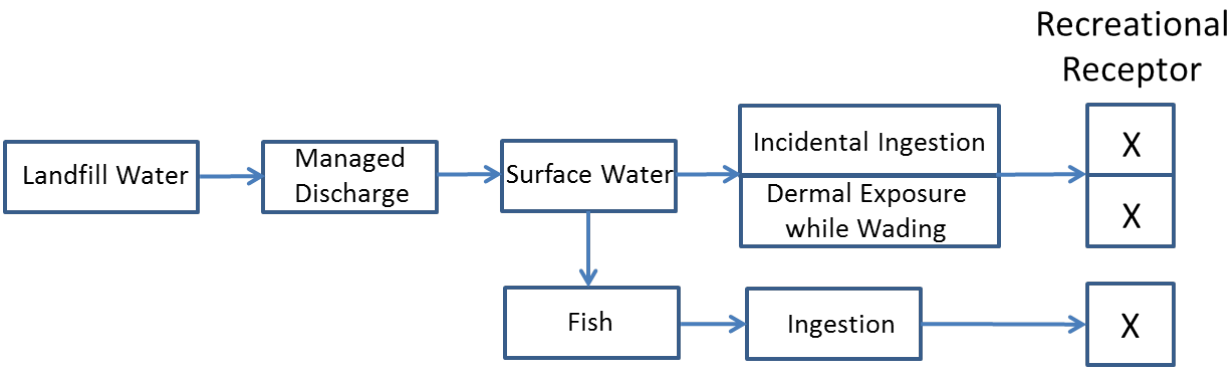

Fig. K.4. Conceptual site model for recreational land use.

Surface Water Exposure Pathways

Input parameters for the surface water pathway used in the PRG calculator and the RSL calculator are shown in Table K.8. The sources of the values are shown in the third columns.

Table K.8. Input parameters for recreator surface water exposure pathways

Variable	Value	Source
TR (target cancer risk) unit less	1×10^{-6}	Default
THQ (target hazard quotient) unit less	1	Default
ED_{rec} (exposure duration - recreator) year	30	Default
$ED_{rec\text{-}a}$ (exposure duration - adult) year	26	Site-specific
$ED_{rec\text{-}c}$ (exposure duration - child) year	4	Site-specific
THQ (target hazard quotient) unit less	1	Default
LT (lifetime - recreator) year	70	Default
EF (exposure frequency) day/year	45	EPA recommended Site-specific
$EF_{rec\text{-}a}$ (adult exposure frequency) day/year	45	EPA recommended Site-specific
$EF_{rec\text{-}c}$ (child exposure frequency) day/year	45	EPA recommended Site-specific
$ET_{rec\text{-}adj}$ (age-adjusted exposure time) hour/event	1	Site-specific
$ET_{rec\text{-}a}$ (adult exposure time) hour/event	1	Site-specific
$ET_{rec\text{-}c}$ (child exposure time) hour/event	1	Site-specific
$EV_{rec\text{-}a}$ (adult) events/day	1	Site-specific
$EV_{rec\text{-}c}$ (child) events/day	1	Site-specific
$BW_{rec\text{-}c}$ (body weight - child) kg	15	Default
$BW_{rec\text{-}a}$ (body weight - adult) kg	80	Default
$SA_{rec\text{-}c}$ (skin surface area - child) cm^2	2690	EPA Exposure Factors Handbook
$SA_{rec\text{-}a}$ (skin surface area - adult) cm^2	6032	EPA Exposure Factors Handbook
$IFW_{rec\text{-}adj}$ (age-adjusted water intake rate) L/kg	1.331	model calculated
$DFW_{rec\text{-}adj}$ (age-adjusted dermal factor) cm^2-event/kg	120498	model calculated
$IRW_{rec\text{-}a}$ (water intake rate - adult) L/day	0.05	Default
$IRW_{rec\text{-}c}$ (water intake rate - child) L/day	0.05	Default
l_{sc} (apparent thickness of stratum corneum) cm	0.001	Default

Below is a brief explanation of each of the parameters used for the surface water exposure medium:

- Exposure Frequency. EPA recommends under a recreator swimming scenario an exposure frequency (EF) of 45 days/yr [*Region 4 Human Health Risk Assessment Supplemental Guidance*. Technical Services Section, Superfund Division, EPA Region 4, Section 4.10, January 2014 Final Draft]. An EF of 45 days/yr was used in the approved *Final Sitewide Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge, Tennessee, Sitewide Baseline Human Health Risk Assessment for Residual Contamination at Mitchell Branch and in Groundwater at the East Tennessee Technology Park* (DOE/OR/01-2279&D3). Further, the EF used in this analysis (45 days/yr) is consistent with that used in the approved *Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee, Baseline Human Health Risk Assessment Report* (DOE/OR/01-1455/V5&D1), which used 45 days/yr and 1 hour/day exposure time (total 45 hours/yr exposure).
- Exposure Duration. The exposure duration used in this analysis is that which is generally accepted in EPA risk assessments (30 years). This default value is consistent with the 90th percentile estimate of time spent at a single residence from *Exposure Factors Handbook: 2011 Edition* (EPA/600/R-090/052F).
- Exposure Time. The exposure time used in this analysis is from *Dermal Exposure Assessment: Principals and Applications* (EPA/600/8-91/011B), Table 8-6; upper bound value (1 hour/event) is a default value.
- Water Intake Rate. The water intake rate used in this analysis (0.05 L) is from *Exposure Factors Handbook: 2011 Edition* (EPA/600/R-090/052F), Table 3-5, which assumes an exposure time of 45 minutes while swimming, scaled to 60 minutes (i.e., 0.037 L/45 minutes × 60 minutes = 0.0493 L; with the value rounded to 0.05 L).
- Skin Surface Area. Under the recreational scenario it is assumed that wading occurs with potential exposure to the legs and arms. Thus, the surface areas for these extremities from the EPA memorandum *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*, OSWER Directive 9200.1-120, are used.

Table K.9 presents the output from both the PRG calculator and the RSL calculator for the radioisotopes and soluble uranium associated with incidental contact with surface water associated with the two exposure pathways calculated at the specific risk levels (i.e., ELCR of 1×10^{-4}, 1×10^{-5}, and 1×10^{-6}) or at the reference dose (i.e., hazard quotient = 1).

Table K.9. Recreator scenario surface water risk-based discharge limits

Radioisotope	Risk-based concentration in surface water; (pCi/L) or (mg/L)		
	Incidental water contact		
	10^{-4}	10^{-5}	10^{-6}
Iodine-129	9,810	981	98
Strontium-90	26,500	2,650	265
Technetium-99	539,000	53,900	5,390
Tritium	29,200,000	2,920,000	292,000
Uranium-233/-234[1]	20,600	2,060	206
Uranium-235/-236[1]	21,300	2,130	213
Uranium-238	23,100	2,310	231
Constituent	**HI = 1**		
Uranium (soluble salts)	69		

[1]lower value for the two radioisotopes selected as representative

Fish Ingestion Pathway

Input parameters for the fish ingestion pathway used in the PRG calculator and the RSL calculator are shown in Table K.10. All input values are default values from the calculators, except fish exposure frequency (EF_f) (analogous to meals/yr). The EF_f of 45 days per year is considered site-specific and is consistent with the EF associated with surface water. Further, this factor is reasonable due to the fact that other nearby water bodies are much larger and thus more supportive of a viable fishery than Bear Creek. Therefore, it is plausible that fish caught at alternate locations may be consumed.

Table K.10. Input parameters for recreational fish consumption exposure pathway

Variable	Value	Source
TR (target cancer risk) unit less	1×10^{-6}	Default
THQ (target hazard quotient) unit less	1	Default
FI (fraction ingested) unit less	1	Default
EF_f (exposure frequency) days/yr	45	Site-specific
ED_f (exposure duration) yr	30	Default
LT (lifetime) yr	70	Default
AT (averaging time) days/yr	365	Default
BWa (body weight) kg	80	Default
IRFa (fish consumption rate) mg/day	54000	Default

According to Sect. 4.12 of *Region 4 Human Health Risk Assessment Supplemental Guidance*, Technical Services Section, Superfund Division, EPA Region 4, January 2014 Final Draft, a fraction ingested (FI) of 1 (i.e., 100%) should be used. However, it is further stated that for exposure evaluations associated with intermittent streams (which the upper reaches of Bear Creek are), adjustments to the FI may be acceptable, pending consultation with EPA.

Table K.11 presents the results from the PRG and RSL calculators. Note that both the PRG and RSL calculators result in values for fish flesh, in terms of pCi/g or mg/kg, respectively. Multiplying these

values by the respective radioisotope-specific and constituent-specific bioconcentration factor (values from EPA PRG calculator) results in the associated water concentration (i.e., pCi/L and mg/L).

Table K.11. Recreator scenario fish ingestion surface water risk-based discharge limits

Radioisotope	BCF (L/kg)	Risk-based discharge limits in surface water based on fish ingestion		
		10^{-4} ELCR (pCi/L)	10^{-5} ELCR (pCi/L)	10^{-6} ELCR (pCi/L)
Iodine-129	30	232	23.2	2.3
Strontium-90	2.9	6,875	687	69
Technetium-99	20	17,147	1714	171
Tritium	1	9,525,987	952,599	95,260
Uranium-233/-234[1]	0.96	14,746	1474	147
Uranium-235/-236[1]	0.96	15,137	1513	151
Uranium-238	0.96	16,500	1650	165
Constituent		**HI = 1 (mg/L)**		
Uranium (soluble salts)	0.96	37		

[1]lower value for the two radioisotopes selected as representative
BCF = bioconcentration factor

Table K.12 presents the integrated exposure pathway risk-based discharge limits (total DL) calculated for the recreational exposure scenario. To arrive at the total discharge limits, the following equation is used:

$$Total\ DL = 1/((1/SWdl) + (1/Fishdl))$$

Table K.12. Total recreational risk-based discharge limits

Radioisotope	Total risk-based discharge limits in based on incidental water contact and fish ingestion		
	10^{-4} ELCR (pCi/L)	10^{-5} ELCR (pCi/L)	10^{-6} ELCR (pCi/L)
Iodine-129	227	23	2.3
Strontium-90	5,459	546	55
Technetium-99	16,618	1,662	166
Tritium	7,182,743	718,274	71,827
Uranium-233/-234[1]	8,594	859	86
Uranium-235/-236[1]	8,849	885	88
Uranium-238	9,625	962	96
Constituent	**HI = 1 (mg/L)**		
Uranium (soluble salts)	24		

[1]lower value for the two radioisotopes selected as representative

3.4 Conclusions

- Six of the seven current EMWMF and the seven DOE Order 458.1 dose-based discharge limits based on a residential drinking water scenario, as defined above, equate to an ELCR that is within the EPA risk range of 10^{-4} to 10^{-6}.
- The DOE O 5400.5 DCGs have been replaced by DOE O 458.1 DCSs.
- All DCS-based discharge limits converted to equivalent risk for exposure to surface water under a recreational scenario result in ELCRs that are approximately two orders of magnitude lower than ELCRs calculated under a residential drinking water scenario.
- The DCS-based discharge limits are within the range of risk-based discharge limits calculated for the recreational exposure scenario (including both surface water and fish exposure pathways), representing the EPA acceptable risk range.
- A recreational exposure scenario is consistent with the stream use classification for Bear Creek per Rules of TDEC, Chapter 0400-40-04.
- The revised conceptual site model under a recreational exposure scenario indicates potential exposure pathways including incidental ingestion and dermal absorption while wading and fish ingestion for calculating risk-based discharge limits, with fish consumption being the limiting exposure pathway and the conditions to support a viable fishery within Bear Creek are highly uncertain, particularly for the upper reaches of Bear Creek.

3.5 Recommendation

- Revise the current discharge limits to 25% of the DOE O 458.1 DCSs for Managed Discharge and add a limit for total uranium of 24 mg/L, based on:
  - Revised discharge limits result in acceptable risk under a recreational exposure scenario (Table K.7)
  - Calculated value for total uranium is from EPA RSL calculator
  - Revised discharge limits compliant with ARARs in the EMWMF Record of Decision
- When the leachate water treatment system (LWTS) is online, continue to use the same discharge limits since they are within or below the EPA acceptable risk range.

4. OVERALL CONCLUSIONS

- Landfill wastewater (Managed Discharge) will be discharged to Bear Creek in accordance with current discharge limits for non-radiological contaminants and revised discharge limits based on 25% of DCSs (Table K.7) for radiological contaminants and the risk-based limit for total uranium.
- Following construction of LWTS, landfill wastewater will be discharged to Bear Creek in accordance with the lowest applicable AWQC for non-radiological contaminants and revised discharge limits based on 25% of the DCSs (Table K.7) for radiological contaminants and the-risk based limit for total uranium. For the bioaccumulative constituent mercury, the lower of the AWQC or the historical allowable mass loadings calculated for EMWMF will apply. If the levels of mercury in fish decline below levels of concern, the anti-degradation requirements will no longer apply.

5. REFERENCES

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APPENDIX L.
PROPOSED SAMPLING APPROACH FOR THE WATER MANAGEMENT FFS

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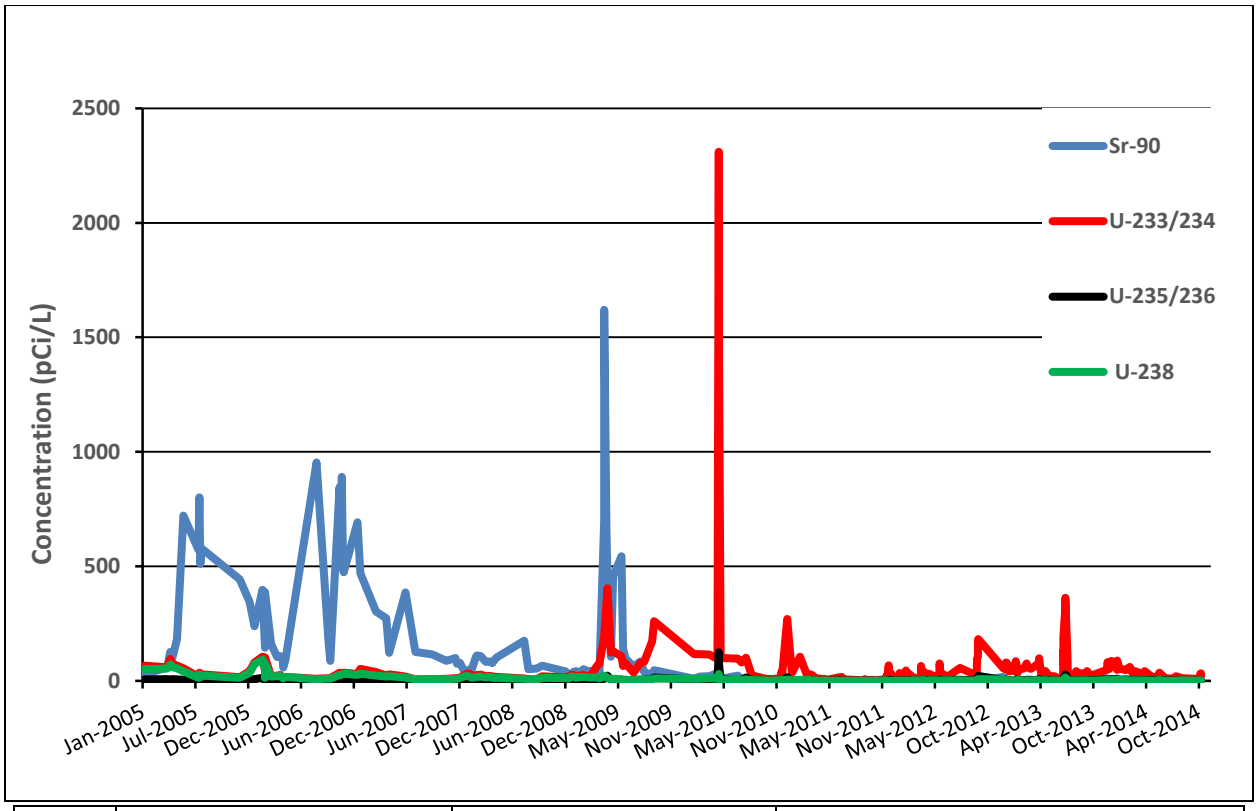
PROPOSED SAMPLING APPROACH FOR THE WATER MANAGEMENT FOCUSED FEASIBILITY STUDY

Appendix C of the Water Management Focused Feasibility Study reviewed the existing Environmental Management Waste Management Facility (EMWMF) contact water and leachate data to select the key contaminants of concern (COCs) that will be used to determine compliance for the Landfill Wastewater Treatment System. As shown below (Fig. L.1), the contaminants in the waste lots, and therefore in the landfill wastewater, change over time as different groups of facilities and projects are remediated.



	2002–2006	2007–2010	2011–2014
Y-12	Boneyard/Burnyard		Old Salvage Yard, Biology Complex, Alpha 5
ORNL	Melton Valley closure soil and sediment, main plant surface impoundments	University of Tennessee-Battelle Bldg. 3026, 2000 complex	2000 complex, including slabs and soils
ETTP	K1070A burial ground, main facilities	K-25, Zone 1 and 2, Poplar Creek process facilities	K-33, K-25
Other	David Witherspoon 901	David Witherspoon 1630	

Fig. L.1 Concentrations of strontium-90 and uranium isotopes in EMWMF contact water, Jan. 2005 to Oct. 2014.

ETTP = East Tennessee Technology Park
ORNL = Oak Ridge National Laboratory
Y-12 = Y-12 National Security Complex

Prior to 2010, strontium was more prevalent in the contact water, representing the waste streams from the Y-12 National Security Complex (Y-12) and the Oak Ridge National Laboratory (ORNL). After 2010,

uranium (U)-233/234 is the prevalent radionuclide, representing a change in waste streams to primarily those originating at the East Tennessee Technology Park (ETTP). U-235/236 was also more common in contact water prior to 2007, representing the portion of waste received from Y-12, including the Boneyard/Burnyard.

Since 2010, the primary source of waste disposed at EMWMF has been from demolition projects at ETTP. Therefore, the contaminants within the landfill wastewater have not changed significantly during that time. However, when demolition of contaminated facilities is completed at ETTP, demolition of facilities at Y-12 and ORNL are scheduled. At that time, the contaminants in the landfill wastewater are expected to change.

The major contaminants expected at all locations are already included as key COCs (Table L.1). Additional water quality or flow parameters that will be monitored are provided in Table L.2. However, to ensure that the key COC is appropriate for the waste disposed, a process was developed to add key COCs as necessary.

Table L.1. Key contaminants of concern in contact water and leachate

Analysis type	Analyte	Analysis type	Analyte
METAL	Arsenic	PPCB	4,4'-DDD
METAL	Cadmium	PPCB	4,4'-DDE
METAL	Chromium	PPCB	4,4'-DDT
METAL	Hexavalent Chromium	PPCB	Aldrin
METAL	Copper	PPCB	beta-BHC
METAL	Lead	PPCB	Dieldrin
METAL	Mercury	RAD	Iodine-129
METAL	Nickel	RAD	Strontium-90
METAL	Uranium	RAD	Technetium-99
Other	Cyanide	RAD	Tritium
Other	Dissolved Solids	RAD	Uranium-233/234
Other	Suspended Solids	RAD	Uranium-235/236
Other	Total Organic Carbon (TOC)	RAD	Uranium-238

PPCB = pesticide/polychlorinated biphenyl
RAD = radiological

Table L.2. Additional water quality or flow parameters to be monitored

Analysis type	Analyte	Explanation
Other	Hardness, as $CaCO_3$	Toxicity of some metals is directly related
Other	Nitrogen, Nitrate total (as N)	Nutrients, important to monitor health of the stream
Other	Nitrogen, total (as N)	Nutrients, important to monitor health of the stream
Other	Phosphorus, total (as P)	Nutrients, important to monitor health of the stream
Other	Total Dissolved Solids or conductivity	Routine performance to determine if a pulse is moving through the system
Other	Total Organic Carbon	Indicates the presence of volatile organic compounds or semi-volatile organic compounds
Other	Total Suspended Solids	Indicates the potential to transport sorbed metals, affects benthics
Other	Whole effluent toxicity, both acute and chronic	Semi-annual, or upon major change in waste characteristics; at least one sample during Sept.–Nov. low-flow period.
Other	Ammonia Nitrogen, total (as N)	Ubiquitous nature in most leachate streams
Other	Stream flow	Required to calculate mixing in stream if upset conditions occur
Other	Wastewater Flow	Required to calculate mixing in stream

$CaCO_3$ = calcium carbonate

Process for Adding Key COCs

Landfill wastewater will be monitored to determine if additional key COCs need to be added to the list. The process uses the following approach:

- Total Organic Carbon will be used as an indicator of the potential presence of volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Because elevated Total Organic Carbon can also result from other causes, evaluation will be performed to determine why the results are elevated.
- Annual samples of additional waste COCs will be conducted. The first year, a select, more mobile set of COCs will be analyzed. The next year, the full set of waste COCs will be analyzed, including the more mobile COCs. This pattern will continue until no additional changes in key COCs are expected.

Known, new COCs in new waste streams will be evaluated for mobility, persistence, risk, and abundance/volume. Total Organic Carbon will be analyzed for all discharges. Increasing trends will require evaluation, including performing analyses of VOCs and SVOCs that have been identified in the waste lots if a specific, unrelated cause cannot be identified.

If VOCs and/or SVOCs are present in the discharged landfill wastewater at more than 50% of the ambient water quality criteria, then the specific analyte(s) will be added to the key COC list and treatment options will be identified for implementation, if necessary.

Annual samples—more mobile constituents. These samples will be collected from the landfill wastewater discharge every other year and analyzed for the analytes in Table L.3. Selection of these metals and organic compounds was based on their prevalence in wastes disposed in EMWMF; concentration and detection frequency in contact water and leachate; and physical/chemical characteristics, such as toxicity, mobility, and persistence in the environment.

Table L.3. Annual mobile constituent analyte list

Metals	Organic compounds
Antimony	Acetone
Barium	Benzene
Beryllium	Benzoic acid
Cadmium	Carbon tetrachloride
Nickel	Chloroform
Selenium	Tetrachloroethene
Thallium	Trichloroethene
	Vinyl chloride
	1,1-Dichloroethane
	1,1-Dichloroethene
	1,1,1-Trichloroethane

If the analytical results are consistent with the historical results, then no additional action is required. Analytical results that are above the historical results will be evaluated further. If the evaluation determines radionuclides are present at greater than historical values by more than the uncertainty or other constituents are greater than two sigma of the historical values, additional monitoring of the specific analytes will be performed for three months as part of discharge monitoring to determine if these values represent an increasing trend. If an increasing trend is determined, the results will be presented to the Federal Facility Agreement (FFA) Project Team for review and discussion to determine if these specific analytes should be added to the key COCs.

Bi-annual samples—full suite of COCs. These samples will be collected from the landfill wastewater discharge every other year and analyzed for analytes expected to be present in the landfill waste.

If the analytical results are consistent with the historical results, then no additional action is required. Analytical results that are inconsistently higher than the historical results will be evaluated further. If the evaluation determines radionuclides are present at greater than historical values by more than the uncertainty or other constituents are greater than two sigma of the historical values, additional monitoring of the specific analytes will be performed for three months as part of discharge monitoring to determine if these represent an increasing trend. If an increasing trend is determined, the results will be presented to the FFA Project Team for review and discussion to determine if these specific analytes should be added to the key COCs. Pesticide results will be specifically reviewed and evaluated for indications of increasing trends.

New COCs in new incoming waste streams. Known, new COCs in new waste streams will be evaluated for mobility, persistence, risk, and abundance/volume. Based on the results, COC-specific sampling may be performed ahead of the annual sampling, particularly in the contact water, to determine if the COC is, or is not, a soluble discharge issue. Results of the evaluation will be provided to the FFA Project Team for review and discussion to determine if these specific analytes should be added to the key COCs.

The details of the sampling approach will be included in the Sampling and Analysis Plan/Quality Assurance Project Plan.

Reporting

The results of sampling and any additional evaluation will be reported in the Annual Post-Closure Completion Report for EMWMF.

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DOCUMENT REVIEW FORM

DOCUMENT TITLE: *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste*	**DOCUMENT NO.** DOE/OR/OR/01-2664&D1
NAME OF REVIEWER: Jeffrey L. Crane	**ORGANIZATION:** EPA
DATE COMMENTS TRANSMITTED: July 31, 2015	

COMMENT NO.	SECT/PAGE	COMMENT	RESPONSES
GENERAL			
1.	General	The FFS does not adequately address the management of landfill generated water (contact water and leachate) with respect to radiological contamination. For example, Section 1.7, EMWMF and EMDF Landfill Water Quality, does not discuss radionuclides. While Section 1.7 discusses hazardous waste related constituents with respect to ambient water quality criteria (AWQC), radionuclides do not have AWQC and therefore other discharge criteria are needed for these constituents. Identifying the discharge criteria for all contaminants of concern (COCs) is necessary in determining the appropriate remedy for water management and demonstrating attainment of the remedy selection threshold criteria. Where ARARs do not exist for the Table 2 Key COCs (i.e., U metal and radionuclides), describe and include release limits based on risk protection. EPA has previously informed DOE on this matter during several scoping sessions that discharges of radionuclides must be shown to be protective of human health and the environment. The document disregarded any of these scoping discussions and does not include any consideration of developing risk-based discharge requirements, or other discharge limits.	Agree. Risk-based surface water discharge limits for the key radiological contaminants of concern (COCs) and uranium (metal) were calculated using the U.S. EPA Radionuclide Preliminary Remediation Goal (PRG) calculator under a recreational scenario. The description of the calculations has been included in an appendix to the Focused Feasibility Study (FFS). If other contaminants become key COCs, then this same approach will be used to develop risk-based discharge criteria in the absence of ARARs.

		To address the threshold requirement for evaluation of remedial alternatives in this FFS, EPA request DOE use the EPA Headquarters radiation risk assessment calculators that are found at: http://www.epa.gov/superfund/health/contaminants/radiation/radrisk.htm These radiation risk assessment tools are developed with assistance from the Oak Ridge National Laboratory. These tools will guide the risk assessor to generating a site-specific risk-based treatment/discharge level for exposure to radionuclide contaminants. Specifically, the "Preliminary Remediation Goals (PRGs) for Radionuclides Calculator should be used to tailor the PRG for the site-specific exposure scenarios (e.g., surface water) for this FFS. The FFS can then evaluate alternatives consistent with the National Contingency Plan to consider the best balance of trade offs of the nine criteria for a range of alternatives that use final risk-based radionuclide contaminant concentrations at various risk-based levels that are protective within Superfund the risk range (i.e., 10^{-6} to 10^{-4}). These protective risk-based levels for discharge in the detailed analysis of alternatives will support a final risk management decision for establishing final remediation goals (i.e., radionuclide discharge level to surface water) in the Record of Decision. Finally, the website referenced above also includes a general Q&A discussion pertaining to radiation risk assessment for Superfund. Although dose-based ARARs have not been identified, the website also includes tools for assessing dose-based radionuclide exposure. However, as described in the website, EPA recommends that dose assessments should only be conducted under CERCLA where necessary to demonstrate ARAR compliance.	

		It should also be noted that EPA R4 and DOE PGDP have held discussions regarding the best approach for determining protective discharge limits, either by developing release limits based on risk protection or identifying the CWA and its implementing regulations as relevant and appropriate requirements and developing discharge limits using CWA methodology.	
2.	General	The FFS does not describe the proposed treatment methods for hexavalent chromium. Section 1.6, EMWMF and EMDF Landfill Water Management Operations, describes the current process at the EMWMF by stating, *"If the discharge limits are not met due to elevated concentrations of hexavalent chromium, the contact water is conditioned to meet the discharge limits (for hexavalent chrome) or transferred by tanker truck to the Process Water Treatment Complex (PWTC) at ORNL [Oak Ridge National Laboratory] for treatment and disposal."* However, the FFS does not propose hexavalent chromium as a Key COC and as such, it is not clear if hexavalent chromium would be treated. While Appendix C, Explanation of How the Key COCs were Developed, indicates that hexavalent chromium analysis is not required to prove compliance with the PWTC waste acceptance criteria, this does not appear to eliminate hexavalent chromium as a potential COC. Include hexavalent chromium as a Key COC and address its current pre-treatment and any treatment under the alternatives as part of this FFS.	Agree. Hexavalent chromium has been added as a key COC, and pre-treatment and treatment have been included in the appropriate alternatives.

3.	General	The FFS evaluates the alternatives based on the premise that primary contaminants potentially requiring treatment are mercury and cadmium; however, the basis for selection of only these two chemicals does not appear adequate. For example, as stated in Appendix C, Explanation of How the Key Contaminants of Concern were Developed, Section C.5, Summary, additional COCs have historically required treatment at EMWMF including copper, cyanide, lead, Sr-90, U-238 and as such, it is not clear why they are not included as COCs in the treatment alternatives. Based on the reasons for selection of Key COCs and the recognition for future treatment needs and adaptability, all Key COCs should be considered for treatment as part of the alternatives under consideration, even if some Key COCs are treated as contingencies. Revise the FFS to include these additional COCs or provide a basis for excluding them.	Agree. The alternatives have been revised to address all key COCs. Since the concentration of key COCs will vary with the sites being remediated, the need for treatment, if any, will vary over time, so the treatment unit processes will vary over time to match the key COCs requiring treatment.
4.	General	Sections 1.6 and Appendix C.1 indicate that two years of data were used to select the current Key COCs; however, the basis for using a two-year timeframe is not presented or justified. In Section 1.7, the text in the 1st Paragraph on Page 10 states the contamination in the EMWMF landfill water has varied over time and that specific contaminants have appeared for a short time, but are not currently in the landfill water. The text further states it is expected that this situation will continue in the future so that the contaminants in the landfill water will vary over time and for varying periods of time. As such, it is not clear if the selected Key COCs are appropriate. Revise the FFS to provide a basis for using a two-year data set to evaluate COCs.	Agree. Appendix C of the FFS already includes all data associated with the COCs that was used to select the key COCs. The text has been revised to explain better how the landfill wastewater quality is expected to vary over time and how the key COCs were selected. The scopes of the alternatives have been revised to address all key COCs (see response to General Comment #3). Since the EMWMF currently receives waste from ETTP, the last two years of landfill wastewater data is representative of the waste received, which is important for Managed Discharge. The text has been revised to explain this basis for using a two-year data set to evaluate key COCs.

5.	General	The remedial action objectives (RAOs) presented in the FFS lack sufficient detail. Section 4.1.2.1 (Development and Screening of Alternatives) of the Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA/540/G-89/004), (OSWER Directive 9355.3-01), dated October 1988 (RI/FS Guidance) states that RAOs should specify the contaminants and media of interest, exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed. However, the RAO presented in Section 2.2, Remedial Action Objectives, only states, "meet AWQC" and does not specify the COCs, media of interest, exposure pathways or preliminary remediation goals that permit a range of treatment and containment alternatives to be developed. Revise the FFS to provide more clearly-defined RAOs that specify the COCs, media of interest, and exposure pathways in accordance with the RI/FS guidance.	Agree. The RAO has been revised as follows: "Meet discharge criteria for the key COCs to protect surface water for designated uses."
6.	General	The evaluation of technologies/process options in Table 4, Evaluation of process options, is not complete. For example, constructed wetlands is not retained; however, the basis for not retaining this process option is not described in the last column of the table and the effectiveness, implementability and cost columns of Table 4 are somewhat ambiguous for this process option. For clarity, it appears the final column of the Table 4 should briefly describe why process options were not retained. Revise the final column in Table 4 to include a conclusion on why certain process options were not retained.	Agree. The final column of Table 4 has been revised to include a conclusion on why certain process options were not retained.

7.	General	Based on review of the FFS, it appears that Alternative 2 (Managed Discharge) is not a viable alternative. Section 4.3.2, Alternative 2: Managed Discharge, states that Alternative 2 *"will comply with all chemical-specific, location-specific, and action-specific ARARs [applicable or relevant and appropriate requirements], unless and until the AWQC for mercury or other key COCs is exceeded in landfill water."* Also, Section 4.3.2, Alternative 2: Managed Discharge, states, *"If the mercury concentration in the proposed EMDF [Environmental Management Disposal Facility] leachate exceeds AWQC, managed discharge will not be protective of human health and the environment and cannot be performed."* Based on these statements, it appears that Alternative 2 does not meet the NCP threshold criteria and must be met by any alternative in order for it to be eligible for selection. While it is understood that the preferred alternative presented in the FFS includes a combination Alternative 2 and Alternative 3 (Treat at EMWMF/EMDF), it appears that as presented in the FFS, Alternative 2 is more applicable as a process option. As such, alternatives which include both managed discharge and treatment may be more appropriate. Revise the FFS to remove Alternative 2 as a stand-alone alternative since it does not achieve the threshold criteria.	Agree. An alternative has been added that includes a combination of Alternative 2, Managed Discharge and Alternative 3, Treat at EMWMF/EMDF.

8.	General	The basis for retaining the ORNL PWTC and Y-12 WETF process options in Table 4, Evaluation of process options, is not clear. For example: a. Section 3.3.6.1 Common Components, describing West End Treatment Facility (WETF), states *"additional treatment capacity will be required at this location, identical to the EMWMF-/EMDF-based treatment system described in Alternative 3 because the complexity and cost of modifying WETF for the additional flow will be cost prohibitive. Therefore, a separate treatment system will be built at a location in the WETF proximity."* This section also states, *"The selected area [WETF] has not been thoroughly evaluated and may not be suitable."* As such, the effectiveness and cost of WETF do not appear adequate to make it through the screening process in Table 4. b. Section 4.3.4, Alternative 4: Treat at PWTC, indicates that Process Water Treatment Complex (PWTC) does currently accept uranium. In addition, Section 3.3.5.1, Common Components, states, *"Since the concentration of mercury in EMDF landfill water is estimated and uncertain, the actual concentration may exceed the ability of the PWTC to reduce it sufficiently to meet the discharge permit limits."* As such, the effectiveness and cost of PWTC do not appear adequate to make it through the screening process in Table 4. While it appears appropriate to screen these process options in Table 4, revise the FFS to remove Alternatives 4 and 5 or provide additional detail to support their inclusion after the screening process in Table 4.	a. Agree. Table 4 has been revised to indicate treatment at Y-12 WETF is not a retained process option. b. Clarify. ORNL PWTC has been retained as a process option, as agreed by the Project Team. Table 4 has been revised to support inclusion.

9.	General	The FFS is not clear on whether managed discharge will be operated on a continuous or batch basis. For example, Section 3.3.3, Alternative 2: Managed Discharge, states, *"This process can be operated on either a batch or continuous basis."* However, the next sentence in this section states, *"Sample will collected from a continuous, flow proportional sampler during release,"* which implies that the landfill water will be discharged continuously. Further, Section 3.3.3, on page 28 states that managed discharge for cadmium will operate on a batch basis. Section 4.3.2, Alternative 2: Managed Discharge, also states, *"To meet AWQC, the release of EMWMF landfill water must be performed on a batch basis only."* These conflicting statements make it unclear if managed water will be discharged on a continuous or batch basis. Finally, a discussion should be included to address when frequent batch releases essentially constitute a continuous release that should be monitored for compliance with CCC standards. Revise the FFS to address this issue.	Agree. Section 3.3.3, Managed Discharge has been revised to state it will be operated on a batch basis.
10.	General	The source of and/or basis for each of the costs presented in the cost estimates (Appendix I, Basis of Cost Estimates, Table I.1, Basis of estimates summary) are not presented. In addition, the majority of the costs are presented on a lump sum basis. As such, it is unclear if the remedial alternatives were appropriately scoped and costed so as to reflect a -30%/+50% margin as allowed for during the FS process. The cost estimates should be revised to present the costs in the format specified in A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002, dated July 2000, and to provide sufficient detail to independently verify the units and costs such that the cost estimates can be verified. Revise the costs to provide sufficient detail to support the cost estimates, ensuring that a line-item breakdown of costs is provided for each alternative.	Agree. The cost estimates were prepared in accordance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. Documentation of the cost estimates in Appendix I, Basis of Cost Estimates has been revised consistent with this guidance.

11.	General	Appendix I, Basis of Cost Estimates, Table I.1, Basis of estimates summary, presents the same lump sum cost for line item, Construct Treatment Plant at EMWMF to Remove Hg and C for treatment Alternatives 3 (On-Site Treatment), 4 (LGWO Treatment) and 5 (WETF Treatment); however, Alternatives 4 and 5 include treatment at already existing treatment plants. As such, it is not clear why costs for construction of a new treatment plant are included in Alternatives 4 and 5. If the existing treatments plants require replacement or upgrades for Alternatives 4 and 5, then these costs should be included separately. Revise Table I.1 to address these issues.	Clarify. The text has been revised to state clearly what pretreatment is required, and the cost estimates reflect these costs.

12.	General	The FFS discusses several components, or potential components of the alternatives, but does not include costs for these items in Appendix I, Basis of Cost Estimates, Table I.1, Basis of estimates summary. For example: a. Section 3.3.5.1, Common Components, states, "Elevated levels of mercury above the current PWTC will require additional pretreatment prior to treatment at the PWTC;" however, pretreatment costs are not included in Table I.1. b. Section 3.3.5.1, Common Components, states, "If radiological treatment of the landfill water were required, pretreatment at EMWMF/EMDF will be required;" however, pretreatment costs are not included in Table I.1. c. Section 3.3.5.1, Common Components, states "Longer-term treatment of mercury-containing landfill water will require a NPDES permit modification;" however, National Pollutant Discharge Elimination System (NPDES) permit modification costs are not included in Table I.1. d. Section 3.3.5.2, Alternative 4a: Pipeline Transport to PWTC, states "An environmental survey of the pipeline route will be required;" however, environmental survey costs are not included in Table I.1. e. Section 3.3.5.3, Alternative 4b: Truck transport to PWTC, indicates that a second, accessible tanker unloading station or bay will be required at the PWTC; however, costs for this station is not included in Table I.1. f. Section 4.3.4, Alternative 4: Treat at PWTC, discusses the age of PWTC and the possibility of its replacement; however, replacement costs are not included in Table I.1.	Agree. The cost estimates have been revised to reflect the additional costs associated with the alternatives.

	General	g. Section 4.3.6, Alternative 6: Treat at Outfall 200 MTF, indicates Outfall 200 Mercury Treatment Facility (MTF) is not currently designed to handle radionuclides; however, costs for modifications to the system or on-site treatment to address radionuclides are not included in Table I.1. Revise Table I.1 to include these costs or alternatively explain in the text of the FFS why these costs do not need to be included.	
13.	General	The FFS adds a separate criterion, Adaptability, to the evaluation criteria in the FFS; however, it appears that the existing nine criterion in the CERCLA process are adequate to evaluate the alternatives, and that the adaptability can be assessed under the effectiveness and/or implementability criteria. Revise the FFS to address this issue.	Agree. Section 4.2, Evaluation Criteria has been revised to include adaptability under the implementability criterion.
14.	General	The FFS does not assess the environmental effects of the proposed remedial alternatives in accordance with Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites (EPA 542-R-08-002), dated April 2008 (EPA Green Remediation Guidance) or Methodology for Understanding and Reducing a Project's Environmental Footprint (EPA 542-R-12-002), dated February 2012 (EPA Environmental Footprint Guidance). For example, energy consumption, greenhouse gas emissions (carbon dioxide, methane, and nitrous oxides), pollutant emissions (carbon monoxide, oxides of sulfur, oxides of nitrogen, and particulate matter), water consumption, ecological impacts/change in resource use, resource consumption, and worker safety are not used to evaluate the environmental footprint of the remedial action alternatives. Revise the FFS to meet the level of detail specified in the EPA Green Remediation Guidance and EPA Environmental Footprint Guidance.	Agree. Section 4.2, Evaluation Criteria already includes the criterion Green Remediation Considerations per EPA policy EPA 542-R-12-002. A reference to EPA 542-R-08-002 has been added to the FFS.

15.	General	The subsections of Section 4.4, Comparative Analysis of Alternatives, do not always include a comparison against Alternative 1, No Action. For completeness, revise these subsections to ensure the comparison is made to Alternative 1.	Agree. The text has been revised to include a comparison against Alternative 1, No Action for all evaluation criteria.
16.	General	Table 7, Comparative analysis of alternatives, under the Reduction of Toxicity, Mobility, or Volume Through Treatment criteria includes a higher rating for Alternative 3 than Alternative 4 and 5; however, neither Table 7, nor Section 4.4.3.2, Reduction of Toxicity, Mobility, or Volume Through Treatment, describes the basis for the higher rating for Alternative 3. Revise Table 7 and/or Section 4.4.3.2 to address this issue.	Agree. The text has been revised to ensure the bases for the comparative ratings are described.
17.	General	The basis for the cost ratings in Table 7, Comparative analysis of alternatives, is not clear. For example, it is not clear if the ratings are based on the present value, capital costs, or combination of both. Revise Table 7 to clarify the ratings for costs.	Agree. The text has been revised to clarify the basis for the comparative analysis of costs.
18.	General	Section 5 of the FFS recommends selection of a combination of Alternative 2 and Alternative 3 as the water management remedy at EMWMF/EMDF; however, presentation and documentation of a recommended remedy is inappropriate at this time as this is performed during the Proposed Plan stage. As specified in the National Contingency Plan (NCP) and RI/FS Guidance, the FS documents the development and analysis of alternatives only. In addition, modifying criteria (i.e., State and community acceptance) have not yet been addressed. Revise the FFS to remove all language which discusses Alternative 2/3 as the recommended remedy. Also, see General Comment 7 above, which advises that only Alternatives that are independently viable should be retained in the FS as alternatives. That is, they should not be “combined” in order to gain viability (i.e., meet the two CERCLA threshold criteria).	Agree. Section 5, Recommended Alternative has been removed from the FFS. The agreed upon path forward for implementation of the FFS evaluation is included in Section 1.10, Estimated Timeline.

19.	General	Appendix A, Bear Creek Burial Grounds Evaluation, concludes that the additional equipment and operating costs to treat Bear Creek Burial Grounds (BCBG) wastewater in combination with EMWMF/EMDF wastewater are projected to be much greater than the cost of processing BCBG wastewater at the Y-12 Groundwater Treatment Facility (GWTF); however, Appendix A does not quantify these additional costs. As such, it is difficult to determine if BCBG wastewater should be treated separately. Revise Appendix A to provide some quantification of the additional costs of treating at EMWMF/EMDF to support conclusions of the study.	Agree. Appendix A has been revised to provide high level cost information.
20.	General	Appendix C, Explanation of How the Key Contaminants of Concern were Developed, Section C.3, Data Evaluation, indicates that analytes were reviewed to evaluate abundance in the waste lots disposed at EMWMF, the contaminant mobility in water, the regulatory concern and/or risk, and other factors; however, CFR 264.98 (a) (2) indicates that the stability and persistence of constituents should also be evaluated. Revise Appendix C to evaluate stability and persistence or provide a rationale for not addressing these factors.	Agree. Contaminant mobility in water has already been addressed, and this essentially evaluates stability and persistence. Appendix C has been revised to include this rationale and to include an enhanced evaluation, where appropriate.
21.	General	Appendix C, Explanation of How the Key Contaminants of Concern were Developed, Section C.3.3, Regulatory Concern/Risk, does not provide an adequate basis for the regulatory concern ranking. As such, it is not clear if the rankings are appropriate. For example, the ranking of “Low” for vinyl chloride does not appear to be appropriate. Revise this section to provide a reference or explanation for determining regulatory concern ranking of analytes.	Agree. Appendix C has been revised and Section C.3.3. Regulatory Concern/Risk was retitled “Potential Risk Concern” to better reflect the intent of the section. The column heading in Attachment 3—COC Winnowing Table was also revised to reflect the changed title. Additional text was added to describe why vinyl chloride and similar contaminants are a lower risk concern in the EMWMF environment based upon the low incidence in the waste.

22.	General	The text in Section 2.1, Anticipated Future Land Use, on Page 17 states the EMWMF and EMDF are located in the Bear Creek watershed, entirely within the ORR, where public access is restricted and additional security and access limitations apply. The text further indicates the area in which the EMWMF is located and the area where EMDF is proposed by DOE to be located is an area designated for waste management. While this section states that access restrictions will be applied and the land use is limited, the text does not state what the human exposure restrictions (e.g., industrial use) are anticipated for the future land use. Revise the FFS to address this issue to ensure the selected remedy is consistent with the anticipated future land use and human exposure restrictions.	Agree. The text has been revised to explain that the *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plan, Oak Ridge, Tennessee* (DOE/OR/01-17*50&D4)* is consistent with the anticipated future land use and human exposure restrictions.
23.	General	Alternative 4 (PWTC) appears to not be suitable for onsite treatment. See Specific Comment 23 which raises questions about implementing this alternative. Similar concerns in this specific comment may also be relevant for Alternative 5 (WETF). Clarify these matters and revise the FFS for both alternatives.	Agree. Alternative 5, Treat at WETF has been removed from the FFS. Treat at ORNL PWTC has been retained as a process option, as agreed by the Project Team. Table 4 has been revised to support inclusion. (see response to General Comment #8).

24.	General	Section 1.5 and Appendix A conclude that the EMWMF/EMDF would not be suitable for uncontrolled releases entering NT-8 from the Bear Creek Burial Grounds. Key reasons listed include differing COCs, wastewater transport, implications of listed waste and capital cost. These issues are part of the analysis of alternatives retained for detailed analysis in Section 4 and adaptability was argued as a key factor in addressing many of these issues. Describe why adaptability cannot address different COCs, wastewater transport and why capital costs and increased complexity of treatment cannot support NT-8 uncontrolled releases. Although issues remain open for adaptation and eventually treating NT-8 uncontrolled discharges impacting Bear Creek with EMWMF/EMDF wastewater, EPA concurs with conclusions in Section 1.5 and Appendix A that a CERCLA response action evaluation leading to an NT-8 response action is necessary and that one of these alternatives to address the NT-8 contamination may include the preferred solution DOE ORR describes in Appendix A: *"A preferred solution would involve constructing an additional trench to BCBG to intercept contaminated groundwater entering NT-8 and transfer it to the existing LSF. The flow of the collected water would be within the existing capacity of the GWTF that currently process leachate collected at the LSF."* A past FFA milestone for this project was removed from the FFA due to DOE ORR's position on funding limitations and other priorities. A CERCLA evaluation of this DOE ORR preferred solution along with other alternatives (e.g., manage with EMWMF/EMDF waste water) should be prioritized with milestones added back into the FFA Appendix E and/or early in Appendix A and a transparent commitment to pursue funding for his response action should be included in DOE ORR's Dynamic Planning Model.	Clarify. Section 1.5 and Appendix A explain why it is not appropriate to include Bear Creek Burial Ground in this FFS. Section 1.5 has been revised to explain the limits of adaptability. This comment has been provided to the FFA Project Managers.

25.	General	Section 1.6 and Appendix F should thoroughly discuss why listed wastes cannot be accepted in a RCRA Subtitle C compliant hazardous waste landfill. This discussion should also discuss why precluding listed wastes in the EMWMF/EMDF is not detrimental to cleanup of DOE ORR CERCLA wastes. As discussed in General Comment 23, the listed waste implications appears to be the primary constraint for not considering adaptability for EMWMF/EMDF combined wastewater management of RCRA listed wastes from the BCBG leachate. In the response to this comment, and in the revised FFS, specifically address: a. Discuss the implication of a RCRA Hazardous Waste Determinations for rain water that accumulates in the landfill but is managed as contact water or leachate; b. The EMDF may consider a design where no Contact Water is generated and all rain water is funneled into the leachate collection system (see Section 1.6, p. 9, last paragraph Note - revise this page to replace “low” with “high” in the second sentence of this page); c. Discuss why wastewater management is the only constraint for EMWMF/EMDF receipt of listed wastes; d. Why adaptability cannot be used to address listed wastes in EMWMF/EMDF wastewater management as is argued a key factor in adaptability (p. 65); and, e. Include a discussion of which CERCLA OUs include listed wastes (e.g., BCBGs), the estimated volume of these listed wastes, and how the inability to adapt for listed wastewater management of RCRA listed wastes will be managed.	Agree. If listed wastes are accepted at EMWMF and EMDF, then landfill wastewater will be listed. The disposal of listed wastes will change the basis of this FFS. Section 1.7, EMWMF and EMDF Landfill Wastewater Quality has been revised to explain why EMWMF and EMDF are designed to accept listed waste but are operated (EMWMF) and are planned to be operated (EMDF) not to accept listed waste.

26.	General	Alternative 2 is a managed discharge alternative that will allow discharge of untreated landfill leachate unless the AWQC for mercury or other key constituents is exceeded. The state standards for ambient water quality include the use designation for the water body. Meeting water quality standards is more than simply meeting the numerical criteria. Regular monitoring of the benthic community composition and fish community at a downstream monitoring station is recommended to ensure that Bear Creek is meeting its designated uses. The remedy should include monitoring the biological communities. If biological communities are observed to degrade, this information should factor into the decision to treat the landfill water.	Clarify. The text has been revised to indicate that monitoring will comply with ARARs and calculated radiological discharge limits. The details on monitoring will be included in the subsequent SAP/QAPP.
27.	General	Uranium lacks a state standard for surface water. Uranium flux in Bear Creek currently exceeds its ROD goal. The proposed landfill will contribute to the uranium flux. Surface water in Bear Creek is currently at elevated concentrations of uranium. The literature should be reviewed to determine a protective concentration of uranium in surface water to trigger treatment of the landfill water prior to discharge to Bear Creek. Articles to review include: Horemans et al. 2015 and Goulet et al. 2015 and Sheppard et al. 2005.	Agree. See response to General Comment #1.
28.	General	Cadmium concentrations are currently above the AWQC in surface water of Bear Creek at sampling stations NT-01 and BCK 12.34. The concentration that will trigger treatment of the landfill water should take into account the fact that the receiving water body has extremely limited capacity to dilute additional influxes of cadmium.	Clarify. The discharge limits for landfill wastewater will comply with the Fish & Aquatic Life and Recreational AWQC. An appendix has been added to the FFS explaining the discharge limits.

29.	General	The ambient water quality criterion of 0.77 µg/L for mercury in surface water will prevent toxicity to fish but is not sufficiently protective to prevent bioaccumulation of mercury to concentrations in fish tissue that exceed the EPA-recommended fish tissue concentration (i.e., 0.3 µg/g). Concentrations of mercury in rockbass tissue from Bear Creek currently exceed the 0.3 µg/g. A lower criterion for mercury concentrations in the landfill effluents (e.g., 51 ppt) is required to allow recovery of the resource.	Clarify. The discharge limits for landfill wastewater will comply with the Fish & Aquatic Life and Recreational AWQC. An appendix has been added to the FFS explaining the discharge limits. See response to General Comment #28.
30.	General	The human health mercury limit of 51 ppt (and similarly for other contaminants) should be imposed as a <u>daily maximum limit</u> because the water body is already impaired for this pollutant. "Criterion continuous concentration (CCC) is the EPA national water quality criteria recommendation for the highest in stream concentration of a toxicant or an effluent to which organisms can be exposed indefinitely without causing unacceptable effect." The use of CCC is typically applied in NPDES permit as a chronic limit for non-intermittent discharges to non-impaired water bodies. However, it can be applied to any duration of discharge that goes to an impaired water body, such as in the case of discharges from the landfill contact water and leachate. Revise the FFS to use CCC AWQC limits for batch discharges and not to exceed daily maximum limits for the treatment plant effluent discharges.	Clarify. The discharge limits for landfill wastewater will comply with the Fish & Aquatic Life and Recreational AWQC. An appendix has been added to the FFS explaining the discharge limits. See response to General Comment #28. A discussion on the monitoring approach to demonstrate compliance with AWQC has been included in the FFS.
SPECIFIC			

1.	Executive Summary, page ix, 2nd para, 1st sentence	Describes "approved" discharge limits. Please note that limits currently being utilized, based upon fish and aquatic life, are not the appropriate limits for Bear Creek. Bear Creek is categorized for recreational use and criteria based on this use are the legally-required limits. EPA, TDEC and DOE have agreed that DOE could use the CERCLA process (as it is herein) as a compliance schedule to bring the discharge of contact water into compliance with the Clean Water Act.	Agree. "Approved" has been removed from the text. This FFS serves as the mechanism to update the previously agreed upon discharge criteria.
2.	Executive Summary, pg. ix	The Executive Summary indicates that the preferred alternative includes treatment at the EMWMF/EMDF and states, "when the need for treatment arises, the location of the treatment facility will be determined based upon the conditions at that time;" which implies the treatment facility will be built at some undetermined later date. As such, it is not clear how the preferred alternative will meet the remedial action objective (i.e., meet AWQC) and be protective of human health and the environment if leachate and contact water exceed AWQC, or other appropriate discharge criteria, prior to construction and use of the treatment facility. Revise the Executive Summary to clarify how leachate and contact water exceeding AWQC will be handled prior to completion of construction of the treatment facility. Only alternatives that meet both CERCLA threshold criteria – protection of human health and the environment and meeting ARARs – can be considered viable and, as such, included in the Feasibility Study. Alternative 2 is not a viable alternative (it does not meet ARARs under all facts as presented), and should be removed as a stand-alone alternative. Given this comment, Alternative 2 plus Alternative 3 are not appropriate as separate alternatives.	Agree. The preferred alternative has been removed. An alternative has been added that includes a combination of Alternative 2, Managed Discharge and Alternative 3, Treat at EMWMF/EMDF. (See response to General Comment #7).
3.	Sect. 1.6, pg. 8, 3nd of 1st para.	Please add the following statement, "Stormwater will be addressed in the Remedial Investigation/ Feasibility Study for EMDF." Please substitute the correct document name for "EMDF" in that statement.	Agree. The following sentence has been added to Section 1.6: "Stormwater will be addressed in the *Remedial Investigation/ Feasibility Study for EMDF* (DOE/OR/01-2535&D3)."

4.	Sect. 1.6, pg. 8, middle para.	Should replace CrVI "conditioning" with "treatment. Please clarify whether this is the only contaminant that is evaluated in order to determine proper disposition of contact water.	Agree. Section 1.6 has been revised to replace "conditioning" with "treatment." Contact water is evaluated against all discharge limits prior to discharge. Currently, hexavalent chromium is the only contaminant routinely requiring treatment. Section 1.6 has also been revised as follows: "If the discharge limits are not met, the contact water is treated to meet the discharge limits (currently performed for hexavalent chromium) or transferred by tanker truck to the Process Water Treatment Complex (PWTC) at ORNL for treatment and disposal."
5.	Sect. 1.7, pg. 10, 3rd full para	There is a statement that presence of pesticides is a result of their use for their intended purposes and not from the disposal of waste products at DOE. While this may be a factual statement, the question under CERCLA is whether the release of a hazardous substance poses an unacceptable risk, or in the case of a landfill waters, whether the presence of such substance in the contact water or leachate is at levels above those that are identified as protective of the receiving surface water. Whether they were from application or disposal does not change the number that is protective of the receiving water.	Clarify. TDEC 0400-040-03, General Water Quality Criteria includes Required Reporting Limits (RRLs). By mutual agreement of DOE, EPA, and TDEC prior to preparation of the FFS, RRLs are used as the discharge limits for pesticides because the landfills do not accept waste with high levels of pesticides, such as from manufacture of pesticides. As a result, only waste with low levels of pesticides are as a result of use at DOE facilities for their intended purpose (pest control). As a result, landfill waste water does not contain high levels of pesticides. Therefore, TDEC RRLs [TDEC 0400-40-03-.05(8)] are appropriate. Additionally, toxicity testing will be performed periodically to verify discharge of landfill water is acceptable. If an increasing trend is observed, pesticides will be further addressed. An appendix has been added to the FFS describing the pesticides levels in the environment and explaining the discharge limits.
6.	Sect. 1.7, pg. 11, last para	Add "thus far" after "are shown."	Agree. Section 1.7 has been revised as follows: "Based on a combination of process knowledge, historical analytical data, approved EMWMF waste lots and disposal records, and physical characteristics, EMWMF leachate and contact water are shown thus far to be neither listed nor characteristic hazardous waste under RCRA."
7.	Table 2, pg. 12	While concentrations that are considered protective have not been promulgated as Ambient Water Quality Criteria (AWQC) under the Clean Water Act, protective discharge levels must be developed for radionuclides. See General Comment 1.	Agree. See response to General Comment #1.

8.	Fig. 7 and Sect. 1.10	Expand the discussion and the figure to describe how this FFS will fold into both EMWMF and EMDF Operations. The selected remedy should not wait for EMDF operations of the FFS should be revised to evaluate the cost of implementing managed/discharge with transport/treatment at other DOE ORR treatment facilities prior to EMWMF/EMDF treatment. Unless the alternatives from this FFS can be "wrapped into" the alternatives for the EMDF remedial action, the EMDF alternatives will not be able to demonstrate that they meet the two threshold criteria, will not be considered viable, and will have to be removed from the EMDF FS.	Agree. Section 1.10, Timeline has been revised to explain how the evaluation in this FFS will be approved via the CERCLA process.
9.	Sect. 1.11, pg. 15	Revise the third bullet to address potential treatment for all Key COCs.	Agree. The third bullet has been revised as follows: "Alternatives will address all key COCs, but treatment unit operations will be used when appropriate."
10.	Sect. 2.1	Any references to EMDF should include potential or proposed. The second paragraph should refer to the End Use Work Group Recommendations for future land use. References to FFA document numbers here and throughout the FFS should also include an abbreviated document title.	Agree. "Proposed" has been included prior to EMDF. Agree. The End Use Working Group document has been referenced. The abbreviated document title has been added.
11.	Sect. 2.3, pg. 18	The third paragraph discussed DOE ORR's position that shipment and treatment at other treatment facilities on the ORR be considered a part of the CERCLA onsite response actions. EPA acknowledges this approach can be used in lieu of the offsite rule. However, all on-site response actions, including those at permitted facilities, must be documented in FFA Primary Documents consistent with the remedy evaluation, selection and implementation requirements of the NCP.	Agree. Any treatment facility on the ORR that is part of an alternative will be included in the description of that alternative in the FFS.
12.	Sect. 2.3, pg. 19	In the first partial paragraph, please delete the word "preliminary." It is too limiting of the use of TBCs, since TBCs can be used to determine final remediation goals, not merely preliminary ones.	Agree. Preliminary has been removed.

13.	Sect. 2.3, pg. 19	The second paragraph states DOE Orders cannot be TBCs, as a general matter. Explain why DOE ORR has used DOE Orders in other RODs and why this position has changed. The *CERCLA Compliance with Other Laws Manual* notes that TBCs are non-promulgated Federal or State advisories or guidance that are non-binding and do not have the status of potential ARARs. TBCs may, however, be used in determining the level of cleanup or how to achieve protectiveness for CERCLA response actions. "… if no ARARs address a particular situation, or if existing ARARs do not ensure protectiveness, to-be-considered advisories, criteria or guidelines should be used to set cleanup targets." (p. 1-76). While not all parts of DOE Orders are necessarily TBCs, parts of guidance or advisories that help determine protectiveness of a remedy, those parts can be identified as a TBC. Clarify why DOE ORR has used DOE Orders in other RODs and why this position has changed.	Clarify. DOE Orders are included in the EMWMF ROD and their inclusion in the EMDF ROD will be resolved through the FFA process.

14.	Sect. 2.3, pg. 19, 4th full para	In the fourth full paragraph, DOE explains why the TDEC-equivalent NRC rule is not relevant and appropriate, citing language from the NCP preamble as the basis. Please note that EPA does not agree with DOE's interpretation of its rule and advises DOE that nothing in the NCP preamble would preclude the TDEC rule from being considered a relevant and appropriate requirement. DOE suggests that because the DOE Order is binding on DOE, this precludes identifying the TDEC rule as relevant and appropriate. There are at least a couple of oddities in this position. First, the only thing that is precluded in this CERCLA action to design how to safely dispose of radiological waste is identifying the TDEC rule as applicable, which our agencies agree it is not. But whether it may be relevant and appropriate is determined by looking at the rule itself, not by the existence of DOE guidance, however binding it may be outside the CERCLA context. Second, and perhaps most odd, is that DOE wants to rely on the existence of the DOE Order to preclude identifying the Rule as relevant and appropriate while at the same time saying that the Order cannot be identified as a CERCLA TBC. To the degree that TDEC regulations assist in designing a safe radiological waste disposal unit, they can be identified as relevant and appropriate requirements.	Clarify. State-equivalent NRC requirements are included in the EMWMF ROD and their inclusion in the EMDF ROD will be resolved through the FFA process.
15.	Sect. 2.3, pg. 19	The citation to TDEC 0400-45-01-.04(55) of the definition of "locational running annual average" is misapplied and should be removed. This citation is from the regulations on public water systems and appears to conflict with those that are applicable to the discharge of waters from water treatment systems at TDEC 0400-40-05-.08 and -.10. Further, the discussion of EPA guidance, which DOE uses to justify this averaging, is from guidance on developing ambient water quality criteria, and appears to be, likewise, misapplied.	Agree. The use of a "locational running annual average" has been removed from the FFS, but the use of an average still is included in the description of the alternatives. The appropriate averaging period will be determined in the SAP/QAPP.

16.	Sect. 3.1, Purpose, pg. 21	This section states, *"The primary problem addressed in this study is ensuring that the landfill water discharge meets ARARs. Existing land use controls are effective in preventing unacceptable risks to current receptors, and EMWMF and EMDF are expected to remain under DOE control in perpetuity. Therefore, land use controls are expected to be useful tools to be used in conjunction with other technology options, for consideration in the technology screening."* First, add the words "on-site human" prior to the first occurrence of "receptors." In addition, this statement implies there are secondary problems (i.e., unacceptable risk to current receptors) that are addressed by the FFS (i.e., via land use controls). As such, it appears that a land use control related RAO may be appropriate for the FFS that is based on the outcome of a risk assessment. Revise the FFS to address this issue.	Clarify. Since land use controls are not included in the management of landfill wastewater, this reference to land use controls has been removed from Section 3.1.
17.	Table 4, pg. 24	Under the "technology type" column and bottom row, revise to read "Treat on site on ORR under the scope of this remedy." On p. 25, under the same column, revise "Off-site" to "Off-site under the Off-site Rule."	Agree. Table 4 has been revised accordingly.
18.	Sect. 3.2, pg. 26	The final sentence of this section implies the Table 5 Process Options are available for determining post ROD. These are the alternatives under considerations and are not Process Options. General Response actions are not simply where waste waters are managed. Revise the FS and follow the FS guidance.	Agree. Section 3.2 has been revised as follows: "The specific treatment unit operations assumed in this FFS might change during design, but they will be substantively equivalent for the treatment of the key COCs."
19.	Sect. 3.3.3, pg. 27	As stated in the Summary, *"water will not be expected to meet AWQC at all times."* This alternative should then be screened out for not meeting the threshold criteria. This alternative of managed discharge could include transport and treatment at the DOE ORR treatment facilities for those discharges exceeding discharge standards. Eliminate the alternative or include treatment.	Clarify. The referenced text is in Section 3.3.2, Alternative 1: No Action. Section 3.3.3, Alternative 2: Managed Discharge already includes transport and treatment: "For temporary exceedances of AWQC, there will be the ability to retain landfill water for conditioning or transport to an on-site treatment facility."

20.	Sect. 3.3.3, Alternative 2: Managed Discharge, pg. 27	This section states, *"In accordance with TDEC [Tennessee Department of Environment and Conservation] regulations and EPA guidance, a running annual average is appropriate;"* however, the references to TDEC regulations and EPA guidance are not provided. While references to ARARs are not included in this section, an appropriate citation would appear to be to TN 0400-40-05-.08(1)(m) for continuous discharges (specifies the use of daily maximum and monthly average) or TN 0400-40-05-.08(1)(n) for non-continuous discharges (all effluent limitations shall be limited in terms of frequency, total mass, maximum rate of discharge and mass or concentrations of specified pollutants) (see comment 9 for request for clarification of whether continuous or non-continuous discharge is intended). Further, the proposed approach of using a running annual average does not address radiological constituents. As discussed in other comments, revise the FFS to address the appropriate legal requirements for compliance monitoring.	Agree. This citation has been removed, but the use of an average still is included in the description of the alternatives. The appropriate averaging period will be determined in the SAP/QAPP (see response to Specific comment #15).
21.	Sect. 3.3.3, pg. 28	Include the following in the bullets at the top of the page. A bullet stating "AWQCs are not available for radionuclides and U metal." A bullet discussing Lead and Cyanide.	Agree. A bullet stating "AWQCs are not available for radionuclides and U metal" has been added. Bullets for cyanide and lead have been added.
22.	Sect. 3.3.3, Alternative 2: Managed Discharge, pg. 28	This section states, one sample will be collected per week for indicator contaminants; a sample will be collected every two years for the full suite of COCs; and, once a final cover is placed on EMWMF, sampling frequency will be reduced to once a month. However, the basis for these sampling frequencies is not presented. As such, it is not clear if sampling frequencies are appropriate. Similar statements are included in other sections describing the other alternatives. Revise the FFS to include a basis for all proposed sampling frequencies.	Clarify. The sampling frequencies are assumptions for the purpose of preparing a cost estimate. The actual sampling frequencies will be determined in the SAP/QAPP. The text has been revised to include the sampling approach and to explain the basis for this assumption.

23.	Sect. 3.3.3, Alternative 2: Managed Discharge, pg. 29	This section states, *"The nutrient loading, total suspended solids, and/or total dissolved solids sample results may require additional management controls to reduce these to acceptable levels;"* however, it is not clear if costs are included in the FFS for these management controls. If these controls are reasonably anticipated based on past EMWMF detections, it appears appropriate to include these costs to ensure that the FFS costs reflect a -30%/+50% margin as allowed for during the FS process.	Clarify. Monitoring costs are included in the estimates for each alternative. Management controls are included in the disposal facility operations cost which is not part of this FFS.
24.	Sect. 3.3.4, pg. 33	In the time frame discussion, there is no reason why this alternative should be delayed whereas Alternative 2 implemented immediately. This alternative is required for the EMWMF and should not be placed as a lower priority tied only to the EMDF operations. While there has been some general agreement that the CERCLA process may be used as part of a "schedule of compliance" to bring EMWMF discharges into compliance with the Clean Water Act, an indefinite time frame (or trigger) for the implementation of this alternative is unsatisfactory.	Clarify. Section 1.10, Estimated Timeline has been revised to discuss the approach for implementing the evaluation in this FFS for EMWMF and EMDF (see response to Specific Comment 38).
25.	Sect. 3.3.5.1, pg. 35 and Sect. 3.3.6, pg. 45	The background discussion for the PWTC does not mention compliance with ARARs whereas it does in the discussion for the WETF. All onsite response actions must meet ARARs. Explain the discrepancy and revise the FFA accordingly. The WETF ARARs should also be listed as should the ARARs for other onsite treatment actions.	Clarify. PWTC is an onsite disposal facility operating under a National Pollutant Discharge Elimination System permit, as described in the description of this alternative. The specific standards and requirements listed in its permit govern its operations under the CWA and the facility is controlled by its permit, not by our ROD. Once our wastewater meets the WAC and is accepted for treatment, the ARARs process stops so that there are not dueling regulatory programs (CERCLA ROD vs CWA permit) managing PWTC operations, which process both CERCLA and non-CERCLA waters. This approach is consistent with past interpretations given to DOE by EPA Region IV.

26.	Sect. 3.3.5.1, pg. 35	The final sentence of the background discussion states: *"Only the upgrades needed to process landfill water are included in this alternative."* This statement appears to indicate that the current use of the PWTC is not a part of the EMWMF response action. This statement is unclear and needs to be revised to be consistent with the full scope of onsite response actions, both current operations and future upgrades.	Agree. The current use of PWTC still is part of Managed Discharge and is included in the description of that alternative.
27.	Sect. 3.3.5.1, pg. 36	The second to last paragraph refers to pretreatment, but does not specify any pretreatment as part of this response action. Clarify and revise the FFS.	Agree. PWTC is at its design life, and there are plans to extend the life of PWTC. The text has been revised to state: "Therefore, pretreatment of EMWMF and proposed EMDF landfill wastewater and the extension of the design life are required for the long-term viability of this alternative."
28.	Table 6, Footnote C	Explain under what authority is the treatment system being modified. Is this modification necessary for CERCLA onsite response actions? Clarify and revise the FFS accordingly.	Agree. PWTC is at its design life, and there are plans to extend the life of PWTC. This modification is not being performed for a CERCLA onsite response action, but it will be necessary if this alternative is selected. The text has been revised to explain this.
29.	Sect. 3.3.5.1, pg. 38 and 40	The treatment system describes different influents and treatments based on rad and non-rad. Describe how the system handles mixed rad/ non-rad. The final paragraph describes discharges under an NPDES permit. Describe how the permit establishes requirements for the rad portion of the system and its discharge limits. The summary description states mercury can be accepted under limited situations. How does the permit or on-site response actions justify and document the limited situations? Clarify and revise the FFS.	Agree. PWTC is an onsite treatment facility operating under an NPDES permit. PWTC is at its design life, and there are plans to extend the life of PWTC. This modification is not being performed for a CERCLA onsite response action, but it will be necessary if this alternative is selected. The text has been revised to explain this.
30.	Sect. 3.3.5.1, pg. 40	The discussion on monitoring does not include PWTC discharge monitoring. As part of the onsite remedy, include on-site discharge monitoring.	Agree. The description of this alternative has been revised to include monitoring per the NPDES permit.

31.	Sect. 3.3.5.1, pg. 41	There are several aspects of this alternative that are not clear. U cannot be treated. The facility appears to require significant design changes and new systems that raise questions about whether this alternative should be screened out. Additionally, these questions raise significant issues about DOE ORR's proposal to delay implementation of a treatment alternative that is necessary for EMWMF operations. The following statement raises considerable questions about the implementation of this remedy: *"While it is assumed that PWTC will bear the costs of any required replacements or upgrades, this is an area of uncertainty."* EPA agrees this funding statement and other aspects of this alternative represent major uncertainties that should be considered for screening out this alternative. This FFS is the appropriate part of the CERCLA process to evaluate alternatives against the two threshold and seven other criteria. If unknowns remain at the time of the FFS that would impact whether an alternative met the two threshold criteria, it should be removed from the FFS as an alternative. See General Comment 7.	Agree. PWTC is an onsite treatment facility operating under an NPDES permit. PWTC is at its design life, and there are plans to extend the life of PWTC. This modification is not being performed for a CERCLA onsite response action, but it will be necessary if this alternative is selected. The text has been revised to explain this.
32.	Sect. 3.3.5.1, pg. 41	The discussion of documents indicates a remedial action work plan/remedial design report will be required. Clarify if this is already a part of the EMWMF ROD whether these documents already exist and would be modified and explain why if not available for modification.	Clarify. If this alternative is selected, then a new remedial action work plan/remedial design report will be prepared as part of the EMWMF and EMDF projects.
33.	Sect. 3.3.5.1, pg. 57	The distance for piping is the same as the WETF. This appears incorrect. Also, DOE ORR is considering to move the OF 200 MTF further away from the landfills.	Agree. The distance of piping has been reviewed and revised as needed.

34.	Sect. 4.3.1, pg. 65	It is incorrect that the No Action alternative will result in EMDF water flowing freely. This FFS is part of the EMDF FS; no EMDF action, no water. In contrast, to the degree that this FFS is intended to address water at the EMWMF, a no action alternative would result in EMWMF water being sent to the PWTC for treatment. A no action alternative does not condone further direct discharge of EMWMF water to Bear Creek in excess of legal limits	Agree. Section 4.3.1 has been revised accordingly.
35.	Sect. 4.3.2, pgs. 66-68	The final sentence under Protection of HH&E states this alternative will be protective when AWQC batch discharges are met. Explain when they are not met. LTE&P and Short-term E imply discharge of only AWQC compliant batches and then are silent when not AWQC are not met. The adaptability discussion on p. 68 sums why this alternative alone should be screened out. If there remains a question whether this alternative meets the two threshold criteria under CERCLA and the NCP, it should be eliminated from the FFS as an alternative.	Agree. Alternative 2, Managed Discharge has been combined with Treat at EMWMF/EMDF for a new alternative. This combined alternative meets the two threshold criteria.
36.	Sect. 4.3.3, pg. 70	Adaptability emphasizes rapid implementation of new treatment systems. Describe what happens in the interim. Also, describe why rapid implementation of any treatment system is appropriate to be delayed to await opening the EMDF.	Agree. The treatment system will be designed for all key COCs but specific unit operations may not be installed until needed. Trucking, as needed, to PWTC is a contingent action in the alternatives. The text has been revised to reflect this.

37.	Sect. 4.3.4, pg. 71	The first paragraph under Protection of HH&E states *"If the landfill water becomes radiologically contaminated with constituents other than those currently treated at PWTC, the complexity and cost of retrofitting PWTC radiological treatment system will be significant."* Discuss why this is not an issue for the current EMWMF landfill operations that uses both managed discharge of contact water and leachate treatment at the PWTC. Clarify whether the PWTC rad constituents that can be effectively treated has been established in any FFA Primary document. While beyond the scope of this FFS, if these limits have not been established under CERCLA or included as part of the PWTC's permit, this must be addressed on a schedule milestoned in Appendix E.	Agree. PWTC is an onsite treatment facility operating under an NPDES permit. PWTC is at its design life, and there are plans to extend the life of PWTC. This extension is not being performed for a CERCLA onsite response action. Additionally, the text has been revised to explain pre-treatment will be required for EMWMF and proposed EMDF landfill wastewater.
38.	Sect. 4.3.4, pgs. 72 and 74	In the compliance with ARARs, it is mentioned that pretreatment for mercury will be effective. Pretreatment needs to be a part of the alternative. The statement on page 74 that WAC revision or waiver will be needed. This kind of uncertainty raises more questions about the viability of this alternative, and as stated in other comments, if the alternative is not viable, it must be screened out.	Agree. Pre-treatment will be required for EMWMF and proposed EMDF landfill wastewater. The text has been revised to explain this. Changes to the WAC are considered as part of the uncertainty analysis.
39.	Sect. 4.3.4, pg. 74	The cost must include mercury pretreatment and system upgrades. Clarify and revise the FFS.	Agree The estimate includes pretreatment and treatment upgrades specifically for the landfill wastewater.
40.	Sect. 4.3.6 and Table 7	Revise this section to be consistent with the OF200 Formal Dispute Resolution Agreement pertaining to the AWQC discharge standard not being waived. As the dispute has been resolved, the mercury discharge limits are not being negotiated, and no action-specific ARAR waiver is being considered.	Agree. Section 4.3.6 and Table 7 have been revised accordingly.
41.	Sect. 4.4.2.3	The first sentence states that Alternatives 2-6 will meet AWQC standards but numerous other portions of the FFS raises questions about this matter. Clarify and revise the FFS accordingly per all related comments on this matter.	Agree. Section 4.4.2.3 has been revised accordingly.

42.	Appendix C, Explanation of the How Key Contaminants of Concern were Developed, Sect. C.4.1, Additional Analysis, pg. C-13	The text under the section Chromium (total) states *"Total Chromium has not been detected above either AWQC."* However, the graph presenting the EMWMF Total Chromium Concentrations in Contact Water over time shows that the Criterion Continuous Concentration (CCC) AWQC of 81 micrograms per liter (µg/L) was exceeded in 2011. Revise the FFS to address this issue.	Agree. Appendix C has been revised accordingly.
43.	Appendix C, Contact Water Data and Leachate Data	The tables in Appendix C include project quantification limits. Section 0400-40-03-.05 part (8) provides required reporting levels. Appendix C is probably reporting what was observed in the past rather than specifying reporting limits to be used for future monitoring of landfill waters. However, some reporting levels required by the Tennessee Department of Environmental Conservation are lower than those currently used and might result in increased frequency of detections. Please discuss the reporting levels in the appropriate section of the document.	Clarify. The future SAP/QAPP will address this issue.
44.	Table D.2, Numerical Ambient Water Quality Criteria	Clarify why beta-BHC is on Table D.2 and not alpha-BHC. Nitrogen, ammonia compounds and pH should be considered for addition to Table D.2.	Clarify. Table D.2 includes AWQCs only for those contaminants that are identified as COCs for this action. Alpha-BHC was not identified as a COC by the project team. Nitrogen, ammonia compounds and pH are already included under the narrative chemical-specific ARARs in Table D.1 (*Note*: originally listed as action-specific ARARs, now moved to chemical-specific ARARs section). The citations on Table D.1 for these three are, respectively, TDEC 0400-40-03.03(3)(k), (3)(j), and (4)(b).
45.	Appendix D, pg. D-18	For the second citation (TDEC 0400-40-07-.04(7)), please add the following text under "Prerequisite": "If an applicant proposes an activity that would result in an appreciable permanent loss of resource value of a state water – **applicable**."	Agree. This text has been added.

46.	Appendix D, pg. D-20	In the first set of citations (TDEC 1200-3-8-.01(1) and the three following), please confirm that this is the current citation. Further, please revise the "Prerequisite" to read, "Use, construction, alteration, repair or demolition of a building, or appurtenances or a road or the handling transport or storage of material – **applicable**."	Clarify. The Appendix D ARARs have been revised to include only those ARARs that need to be added to the EMWMF ROD (primarily those addressing water treatment/discharge under the CWA). All other ARARs for the EMWMF-EMDF action, including those for water management, will be combined and listed in the revised EMDF RI/FS and appropriate subsequent CERCLA documents for the response action. This comment will be addressed and incorporated as necessary. Note that this is a current citation. Prerequisite text will be revised as requested.
47.	Appendix D, pg. D-25	This begins a series of ARARs that identified as "Additional ARARs for Alternatives 3 and 5." Please clarify why the ARARs on pages D-25 and the following page regarding the action "Construction of new outfall structure for discharge of wastewater" is not applicable to Alternative 2.	Clarify. Alternative 2 in the FFS D1 did not require a new outfall structure. In the FFS D2 the alternatives have been revised, and the ARARs have been revised accordingly.
48.	Appendix D	Given the comment above that Alternative 2 is not a viable alternative and must be combined with treatment in order to meet ARARs, the structure and organization of the table should be revised to reflect that.	Agree. Table has been revised as needed.
49.	Appendix D	No ARARs have been identified for Alternative 4. As mentioned above, an alternative may be identified as "on-site" for purposes of conducting remedial action and any permits would not be required, per CERCLA §121(e). All ARARs must be identified in the RI/FS and the ROD for any "on-site" alternatives (and in the ROD, for the selected remedy). If, on the other hand, DOE would not want to identify an alternative as "on-site", then it will need to obtain a determination of Offsite Acceptability, per 40 *CFR* 300.440, before completing the RI/FS and ROD.	Clarify. PWTC is an onsite treatment facility operating under an NPDES permit. The specific standards and requirements listed in its permit govern its operations under the CWA and the facility is controlled by its permit, not by our ROD. Once landfill wastewater meets the WAC and is accepted for treatment, the ARARs process stops so that there are not dueling regulatory programs (CERCLA ROD vs CWA permit) managing PWTC operations, which process both CERCLA and non-CERCLA waters. This approach is consistent with past interpretations given to DOE by EPA Region IV.

50.	Appendix D, pg. D-31 to D-33	The in-stream requirements are chemical-specific ARARs that would apply to all alternatives that impact surface waters. Please move it to the front of the table and identify as Chemical-Specific ARARs. Since the last part of the table intends to be reserved certain alternatives/actions, once the Chemical-Specific ARARs are moved, it will remove the confusion for the requirements that currently follow them in the table, which are Action-Specific Requirements.	Agree. These requirements were initially listed under action-specific ARARs because it is the action of discharging treated effluent that triggers them but they could validly also be considered chemical-specific ARARs. The requirements have been moved to the front of the table as requested and identified as chemical-specific ARARs.
51.	Appendix D, pg. D-33	Please clarify why the citation to TDEC 0400-40-05-.09(1)(b) is applicable and how it works - and whether it is consistent - with the requirements in TDEC 0400-40-05-.08.	Clarify. Since our "industry" (i.e., environmental remediation/water treatment) does not have federal NPDES effluent discharge guidelines and standards set under 40 CFR 122, per TDEC 0400-40-05-.09(1)(b), best professional judgment is to be used to determine what the appropriate effluent limits and standards should be. This appeared to be an appropriate ARAR to cite in this case where AWQCs are being set as effluent limits based on designated uses for Bear Creek and negotiating how and where those limits will be measured and monitored. This does not appear to preclude citing additional appropriate requirements in TDEC 0400-40-05-.08 for this situation.
52.	Appendix D, pg. D-34	Please note that the requirement that describes "Non-continuous batch discharges" may not be appropriate. EPA is not recommending removing it at this time, until further information about how the leachate and contact water will be discharged. It appears, however, that the discharge of the "batches" may well be so nearly continuous as to be considered continuous discharge and to use the continuous discharges requirements, which follow. Other requirements may be added if it is determined that non-continuous discharge standards should apply.	Noted.

<table>
<tr>
<td>53.</td>
<td></td>
<td>Appendix D, Page D-34 - Please add the following citations to the Action-Specific ARARs:
<table>
<tr>
<td>Discharge of treated water</td>
<td>Shall receive, prior to discharge, the degree of treatment or effluent reduction necessary to comply with water quality standard and, where appropriate, will comply with the standard of performance as required by the Tennessee Water Quality Control Act of 1977 at TCA 69-3-103(3)

For continuous discharges, all effluent limitations, standards, and prohibitions shall be expressed as maximum daily, and month average, unless impracticable.</td>
<td>Point-source discharge(s) of pollutants into surface waters of the state as defined in TCA 69-3-103(33) – applicable

TDEC 0400-40-05-.08(m)</td>
</tr>
</table>
</td>
<td>Agree and clarify.

The first requirement listed here is already listed as an action-specific ARAR on Table D.1 on page D-33 along with the TDEC implementing regulation for the statute [TDEC 0400-40-03-.05(6)], as the NCP preamble indicates a preference for listing the citations for the implementing regulations rather than statutes for requirements. However, the original TCA statute has been added to the table. The statute citation listed in the comment is to a definition of “sewerage systems” and is not correct.

The second requirement will be not be included on the ARARs table at this time since the appropriate averaging period and monitoring requirements are still being negotiated and determined. Final ARARs will be included in the CERCLA decision document and detailed monitoring requirements will be included in the SAP/QAPP.</td>
</tr>
<tr>
<td>54.</td>
<td>Appendix D</td>
<td>Please add the citations found in the Outfall 200 FFS, pages A-12 and A-13, that address (1) the release to surface water of water containing radioactivity and (2) radionuclides in the environment.</td>
<td>Clarify. DOE Orders and state-equivalent NRC requirements are included in the EMWMF ROD and their inclusion in the EMDF ROD will be resolved through the FFA process. Once resolved, these ARARs will be considered for inclusion for this action.</td>
</tr>
<tr>
<td>55.</td>
<td>Appendix D</td>
<td>Please add the citations found in the Outfall 200 FFS, page A-22 through A-27, that address the characterization, temporary storage, storage, packaging, management and disposal of LLW and PCB waste (or combination).</td>
<td>Clarify. The Appendix D ARARs have been revised to include only those ARARs that need to be added to the EMWMF ROD (primarily those addressing water treatment/ discharge under the CWA). All other ARARs for the EMWMF-EMDF action, including those for water management, will be combined and listed in the revised EMDF RI/FS and appropriate subsequent CERCLA documents for the response action. The EMDF RI/FS already includes the requested ARARs.</td>
</tr>
</table>

DOCUMENT REVIEW FORM

DOCUMENT TITLE: *Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste*	**DOCUMENT NO.** DOE/OR/OR/01-2664&D1
NAME OF REVIEWER: Randy Young	**ORGANIZATION:** TDEC
DATE COMMENTS TRANSMITTED: August 20, 2015	

COMMENT NO.	SECT/PAGE	COMMENT	RESPONSE
		GENERAL	
1.	General	DOE has taken the position (page 19 of the FFS) that state regulations governing the disposal of Low Level Radioactive Waste (LLRW) are not relevant and appropriate to the disposal of DOE radioactive wastes on the ORR; therefore the state rules should not be considered Applicable or Relevant and Appropriate Requirements (ARARs). While DOE states it is obligated to abide by DOE Orders, it is also DOE's position that the orders should not be cited as requirements or to be considered guidance (TBC) in Records of Decision and other CERCLA agreements. It is TDEC's position that the substantive requirements of TDEC 0400-20-11, *Licensing Requirements for Land Disposal of Radioactive Waste*, are relevant and appropriate to the management and disposal of LLRW authorized by the FFA parties under CERCLA and intrinsic to the CERCLA process. While TDEC agrees DOE Orders are not ARARs as defined in CERCLA, the orders nevertheless represent DOE's regulatory responsibilities under the Atomic Energy Act, as well as its obligation to maintain the facilities in perpetuity. Consequently, the orders require consideration in Records of Decision and associated CERCLA documentation to the extent that they form a basis for more stringent requirements than the TDEC rules.	Clarify. DOE Orders are included in the EMWMF ROD and their inclusion in the EMDF ROD will be resolved through the FFA process.

2.	General	The *Focused Feasibility Study (FFS) for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-2664&D1) was prepared as a companion document to the *Remedial Investigation/Feasibility Study* [RI/FS] *for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, TN* (DOE/OR/01-2535&03). Alternatives were evaluated assuming treatment of landfill wastewater from both the current disposal facility and a future facility identified as the preferred alternative in the RI/FS. However, the RI/FS failed to provide a sufficient range of alternatives or an adequate technical and regulatory basis for the preferred alternative. On-site waste disposal alternatives could also include landfills with smaller footprints, smaller operating cells, and sites not adjacent to the current facility. Consequently, the alternatives evaluated in this FFS should be modified and expanded to assure the key parameters such as the quantity of water generated and the cost of pumping or trucking water to treatment reflect additional scenarios that might be used for future disposal of CERCLA waste. One approach might be to evaluate alternatives based on the assumption of another EMWMF-like facility adjacent to the current facility as one bounding scenario and evaluate treatment for wastewater generated only at the EMWMF as another bounding scenario. The FFS presents some analysis of the former case, and the latter would be less complicated by uncertainty, particularly with regard to the volume and characteristics of the wastewater to be treated.	Agree. Section 1.8, Flow Rates has been revised to indicate that the bounding condition is when both EMWMF and the proposed EMDF are operational.

3.	General	While both the EMWMF and the proposed EMDF are primarily low-level radioactive waste (LLRW) disposal facilities, neither TDEC Rules nor DOE Orders regulating releases of radionuclides are addressed in the FFS. The FFS also fails to assess the risk posed by the radionuclides in landfill effluents relative to CERCLA requirements. In order to evaluate alternatives for the management of effluents, the FFS must first establish release criteria for all contaminants of concern, including radionuclides. Considerations should include: • The limits imposed by the performance objectives of TDEC rules and DOE Orders; • The protectiveness required under CERCLA's risk range of 10^{-4} to 10^{-6}; and • The contribution to exceedances of remedial goals at BCK 9.2 in the *Record of Decision for the Phase 1 Activities in Bear Creek Valley* (DOE/OR/01-1750&D4). The expectation is the most restrictive requirements would apply.	Agree. Risk-based surface water discharge limits for the key radiological contaminants of concern (COCs) were calculated using the U.S. EPA Radionuclide Preliminary Remediation Goal (PRG) calculator under a recreational scenario. The comparative dose was also calculated to show protectiveness under dose-based criteria. The description of the calculations has been included in an appendix to the Focused Feasibility Study (FFS).
4.	General	During the stream assessment process in the watershed cycle, TDEC's Division of Water Resources (DWR) uses DOE data from DOE's Remediation Effectiveness Reports (RER) as the best data source on water quality conditions. The RER data persistently indicate that Bear Creek suffers from significant pollutant loadings upstream and downstream of the proposed CERCLA waste disposal facility. Because of the significant adverse impact on Bear Creek from these upstream discharges, it will be difficult if not impossible to measure any improvements downstream of this facility no matter what remedial option is chosen. TDEC stresses that DOE must pursue corrective actions in the headwaters of the watershed.	This information was provided to the DOE FFA Project Manager for planning purposes.

5.	General	While the FFS does take a comprehensive look at the analytical data generated by wastewater monitoring at the EMWMF since 2005, the document does not try to anticipate contaminants of concern for future candidate waste streams. Some information on the hazardous and radiological characteristics of future waste would allow for a more rigorous evaluation of alternatives. Some preliminary characterization data for candidate waste should have been gathered prior to drafting both this document and DOE/OR/01-2535&03, *Remedial Investigation/Feasibility Study (RI/FS) for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge, TN.*	Clarify. Section 1.7 acknowledges that waste contaminants have and will vary over time, and Appendix C contains the historical data for the COCs. The projected increase in mercury-contaminated waste was the most significant change over historical values, and potential impacts were included in this document.
6.	General	The document remains at high level when discussing alternatives. A more thorough analysis of alternatives would include more information on treatment efficiency and cost for portable treatment units that might be deployed at the disposal facility and units that might be used for pre-treatment prior to treatment at PWTP or Outfall 200. Treatment efficiency for various unit operations and process that could remove metals, radionuclides, and organic compounds that screening has shown would likely require treatment would contribute to an informed choice between alternatives.	Noted. The FFS focuses on determining whether the landfill wastewater needs to be treated, and, if so, where the treatment system should be located. Treatment unit operations are assumed for the purposes of the FFS, but they will not be selected until design.

7.	General	This document is one of the first CERCLA documents to explicitly incorporate the Tennessee Anti-degradation Statement as an Applicable or Relevant and Appropriate Requirement. Specific comments relevant to the Anti-degradation Statement may be useful for future projects, as a number of streams have been impacted by Oak Ridge Operations. Limits placed on concentrations of mercury and cadmium in effluents from the on-site waste disposal facilities that discharge to Bear Creek or its tributaries required to demonstrate compliance with the anti-degradation requirements listed in Appendix D of the document should be discussed and evaluated under Alternative 2. Whether or not the quantity of water requiring treatment is over-estimated in this FFS, other information provided in the document indicates that some component of on-site treatment or pre-treatment will be necessary, unless wastewater volume is minimized to allow for treatment at WETF without modification of the facility.	Agree. The evaluations of the alternatives address anti-degradation.
SPECIFIC			
1.	Pg IX, para 1	"*The purpose of this focused feasibility study is to evaluate options and recommend a solution for the management of leachate and contact water (**landfill water**) generated from the on-site disposal of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) waste from the Oak Ridge Reservation and associated sites."* The term "*landfill water"* as used throughout the FFS is inappropriate when addressing leachate and associated effluents. The regulatory term would be landfill wastewater as defined in 40 *CFR* 445.2 (i.e., all wastewater associated with, or produced by the landfilling activities, including, but not limited to leachate, contaminated storm water, and contact wash water from washing trucks, equipment, and surface areas which have come in direct contact with waste at the facility).	Agree. The text has been revised accordingly.

2.	Pg 3, Sect. 1.3, Site Description:	The site description **c**orrectly states that **Bear Creek has unavailable capacity** for nitrates, cadmium, mercury, PCBs and uranium. This statement is supported by data from the DOE 2014 Remedial Effectiveness Report (RER). • Nitrates: refers to the TDEC 2012 303(d) list; TDEC's Division of Water Resource's 2014 proposed final version of the 303(d) list retains this impairment. See page 88 at http://www.tn.gov/assets/entities/environment/attachments/2014-proposed-final-303d-list.pdf. The 2014 RER report agrees; Section 4.2.1.2.1.2 states that the headwaters portion of Bear Creek, known as Zone 3 and the receiving stream for EMWMF/EMDF, had ~40 mg/l since 2009. • Cadmium: = 2.4 ug/l (WQC is 0.25) – page 4-23 reporting 2013 data • Mercury: ~ 0.8 ppm, indicates fish tissue values increasing - page 4-40, Figure 4.14. • PCBs: ~ 0.6 ppm, indicates fish tissue declining - page 4-40, Fig 4.15. • Uranium: indicates uranium flux increasing at headwaters. Further, the state reported Biological Integrity data in the 2014 Environmental Monitoring Report showing Bear Creek's aquatic community is impaired in waters of this stream segment (with a score of 18 versus reference stream score of 32). See Table 7, pg. 44 at http://www.tn.gov/assets/entities/environment/attachments/rem_2014-environmental-monitoring-report.pdf. To be clear, there are no data to explicitly attribute the cause of this impaired biology to either the ongoing discharges from EMWMF or to upstream exceedances.	Noted.

3.	Pg 7, Sect. 1.6: EMWMF and EMDF Landfill Water Management	"*The scope of this focused feasibility study is the management of EMWMF and EMDF* ***landfill water****. The definitions of leachate and contact water follow (UCOR-4135/R1, Environmental Management Waste Management Facility (EMWMF) Operation Plan, Oak Ridge, Tennessee), and Fig. 5 illustrates how landfill water is managed:* • *Contact water—Contact water is precipitation that falls into an active EMWMF cell, comes in direct contact with waste, is pumped to the contact water tanks from the liner, and does not infiltrate into the leachate collection system. Because contact water contacts the waste, it potentially is contaminated.* • *Leachate—Leachate is precipitation that falls into an active cell, infiltrates through the waste, infiltrates through the liner, is collected by the leachate collection system, and is pumped to the leachate storage tanks."* As defined in TDEC 0400-11-01: "*Leachate means a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.*" RCRA (40 *CFR* 260.10) provides a similar definition: "*Leachate means any liquid, including any suspended components in the liquid that has percolated through or drained from hazardous waste*." Based on the definitions contained in these rules and elsewhere, leachate is not precipitation; although, precipitation can become leachate, if it passes through, drains from, or mixes with waste or waste constituents. The definitions of leachate in the rules do not limit the term to a location or provide that a liquid that drains from the waste must infiltrate through the liner ***and*** be collected by the leachate collection system ***and*** be pumped to leachate storage tanks to become leachate. As a large part of the regulations focus on minimizing the generation of leachate and controlling its release and migration, redefining what leachate is undermines the intent of the law and / or regulations.	Agree. The text has been revised to use the term "landfill wastewater" (see response to Specific Comment #1). The current management of leachate and contact water still will be described in the FFS.

3. (cont.)		The definition of contact water provided in the text cited in the FFS, basically describes leachate and/or contaminated storm water as defined in TDEC 0400-11-01 and RCRA 40 *CFR* 445.2(b) respectively. Leachate, contaminated storm water, and non-contaminated storm water are all defined in the regulations with specific regulatory requirements addressing each. Please use the regulatory definitions and nomenclature provided in the rules, to do otherwise only serves to confuse the issues.	
4.	Pg 9, para 1	"*The EMDF approach to landfill water collection may differ from EMWMF. A low permeability material in the catchment areas (referred to as "windows") is being considered to allow contact water to percolate quickly into the leachate collection system, thus allowing collection and management as one stream."* Was the intent to say "high permeability" rather than "*low permeability*"?	Agree. The text has been revised to replace "low permeability" with "high permeability."

5.	Pg 12, Table 2	The table appears to accurately capture numeric AWQC for Fish and Aquatic Life and Recreation use classifications, including hardness-adjusted metals, as well as the narrative criteria, especially the biological integrity provisions and anti-degradation requirements. TDEC suggests the contaminant names shown in this table should either indicate “total” or “dissolved”, not both. A “total” sample represents an unfiltered sample whereby all the constituents, including settleable/suspended/dissolved, are analyzed. A “dissolved” sample represents a filtered sample, whereby the contaminant attached to particulate matter is physically separated from the portion in solution (i.e., in a dissolved state). This total-versus-dissolved issue may affect the treatability for mercury. It matters for the Alternative 4 treatment at PWTC-ORNL whether the contaminants are present as particulate-based or not, since the facility stopped using the multi-media filters last year. At present the waste acceptance criteria for PWTC for total suspended solids is 1,000 mg/l. The proposed EMDF wastewater’s composition of total-versus-dissolved mercury has not been defined, only modelled to date. Although this wastewater will experience settling in the EMWMF ponds, additional solids removal at either EMDF or PWTC may be required and should be evaluated in the FFS.	Agree. Table 2 has been revised to match TN 0400-40-03, General Water Quality Criteria. Evaluation of the need for solids removal will be performed during the design phase.

6.	Pg 17, para 4	"*Since the scope of this focused feasibility study is limited to evaluating alternatives for the management of landfill water, the remedial action objective is to:* • *Meet AWQC."* It is not clear why the FFS would limit its remedial objectives to meeting AWQC, when the EMWMF and the proposed EMDF are primarily Low Level Radioactive Waste Disposal Facilities. In order to evaluate alternatives for the management of effluents, the FFS needs to establish release criteria for all contaminants of concern, including radionuclides. Other remedial actions that should be considered include: • Prevent further degradation of water resources in Bear Creek Valley. • Meet the dose limits imposed by the performance objectives for LLRW Disposal Facilities by TDEC 0400-20-11-.16(2) and DOE Orders M 435.1-1 IV.P.(1)(a). • Meet the Superfund risk based levels imposed by CERCLA. The DOE Order requirements may be met indirectly for some alternatives as they are presumably incorporated into waste acceptance criteria for the existing treatment facilities, but they play a role in the establishing the basis for implementing all alternatives.	Agree. The RAO has been revised as follows: "Meet discharge criteria for the key COCs to protect surface water for designated uses."
7.	Pgs 17-18, "Applicable or Relevant and Appropriate Requirements" and Table D.1 Page D-33 "ARARs and TBC guidance…"	Under Rule 0400-40-03-.06, the Tennessee Antidegradation Statement is an Applicable Requirement. Due to the existing WQ conditions in Bear Creek which cause the designation as "Unavailable Waters", any future discharge of nitrates mercury, PCBs, cadmium, or pesticides must not cause measurable degradation. Measurable means not detectable by chemical-specific laboratory methods having sufficient sensitivity during monitoring activities used to document compliance with ARARs.	Agree. The evaluations of the alternatives address anti-degradation (see response to General Comment #7).

8.	Pg 19, para 2 and 5	"*DOE Orders are neither ARARs nor TBC guidance. DOE Orders are not ARARs because they are not promulgated". ….." DOE Orders…issued under the Atomic Energy Act [that] have the same force for DOE facilities or 'within DOE' as does a regulation."* The FFS seems to argue on one hand that DOE Orders are equivalent to state and federal regulations and on the other they are not. TDEC agrees DOE Orders are not ARARs as defined in CERCLA. Nevertheless, the orders represent DOE's responsibilities under the Atomic Energy Act and therefore need to be considered in CERCLA actions, as has been the case historically on the ORR and at other DOE facilities. While the FFS makes the statement that DOE Orders are not TBC, it never explains why that would be the case in this instance or why on the ORR and not at other facilities in the DOE complex. For example, the Record of Decision for the Portsmouth CERCLA on-site disposal facility signed in June of this year included DOE Orders as TBC and Ohio LLRW regulations as ARARs. Is there any other CERCLA LLRW Disposal Facility authorized by FFA parties under CERCLA authority where this DOE position has been accepted?	Clarify. DOE Orders are included in the EMWMF ROD and their inclusion in the EMDF ROD will be resolved through the FFA process (see response to General Comment #1).

9.	Pg 19, para 5	"*NRC regulations and the TDEC rule equivalents (NRC/TDEC) are also not relevant and appropriate based on the preamble to the final rule establishing the NCP (55 FR 8744, March 8, 1990): "EPA believes it is reasonable to consider the existence of waivers, exemptions, and variances under other laws because generally there are environmental or technical reasons for such provisions…These provisions are generally incorporated into national regulations because there are specific circumstances where compliance with a requirement may be inappropriate for technical reasons or unnecessary to protect human health and the environment." Since DOE is specifically exempted from NRC regulations and the TDEC rule equivalents and has equivalent requirements in its internal Orders, it is per EPA's own language, inappropriate and unnecessary to cite these as relevant and appropriate requirement*s." TDEC does not understand how the language in the preamble of the NCP cited here is used to conclude that the state equivalents of NRC regulations (Tennessee Rules, Chapters 400-20-04 through 400-20-12) are not relevant and appropriate. In any case, Tennessee Rule 0400-40-05-.04, paragraph (1), subparagraph (b), which is not an NRC equivalent, prohibits the permitting of *"the discharge of radioactive waste into waters (though this does not prohibit radioactivity from authorized discharges provided such discharge is in accordance with state water quality standards)."* The definition of "radioactive waste" in Tennessee water rules (see paragraph 3 of Rule 0400-45-06-.02) refers to Chapter 0400-20-05: *"Radioactive waste" means any waste which contains radioactive material in concentrations which exceed those listed in Rule 0400-20-05-.161, Schedule RHS 8-30, Table II, Column 2*. This state prohibition is more restrictive then the analogous federal requirement under 40 *CFR* 122.4, which prohibits the	Clarify. TDEC's water discharge prohibition rule in 0400-40-05-.04(1)(b) relies on a definition of radioactive waste in 0400-45-06-.02 that defers to the definition in the state's NRC-equivalent regulations in Chapter 0400-20-05-.32. DOE Orders and NRC/state-equivalent NRC regulations are included in the EMWMF ROD. Their inclusion in the EMDF ROD will be resolved through the FFA process (see response to General Comment #1).

9. (cont.)		discharge of radioactive warfare agents or high-level radioactive waste.	
10.	Pg. 19, ARARs, last para	"*TDEC regulations allow for a "locational running average…"* This is an incorrect application of rules from the Safe Drinking Water Act to a discharge to surface waters. Although TDEC Division of Water Resources uses an annual running average for nutrients in NPDES permits, it's only for continuous discharges of non-toxic substances, and only based on loading, not concentration. Compliance must be based on testing in a comprehensive monitoring plan to ensure that all discharges meet the WQC identified in Table D.1., and for toxics, based on reasonable potential analysis for toxicity, using the daily maximum and monthly average concentrations of treated effluent to address acute and chronic toxicity, respectively. For continuously treated discharges to Bear Creek, representative sampling can be provided on a weekly or monthly basis. The reporting frequency can be reviewed following development of a statistically valid analytical data set. For batch treated discharges to Bear Creek, sampling of each release from individual treated wastewater ponds or tanks is required.	Agree. This citation has been removed, but the use of an average still is included in the description of the alternatives. The appropriate averaging period will be determined in the SAP/QAPP.
11.	Pg 27, Alternative 2, Managed Discharge, Last Paragraph	For the proposed combined discharge, "*The quality of the landfill water will be determined on the basis of a running annual average."* In order to comply with the Tennessee Antidegradation Statement, the proposed discharge of combined wastewater from EMWMF and EDMF for <u>Alternative 2 must meet no detectable concentrations</u> of these pollutants – mercury, cadmium, PCBs, and nitrates. See comment 17 regarding the monitoring basis for discharge.	Clarify. The evaluations of the alternatives address anti-degradation (see response to General Comment #7).

12.	Pg 27, para 5 (last paragraph)	"*This process can be operated on either a batch or continuous basis. Samples will be collected from a continuous, flow proportional sampler during release."* If managed discharge is to be preserved as an alternative, then additional sampling will need to be performed prior to the release. How and where would continuous sampling be implemented during discharge of batch releases?	Clarify. The text has been revised to indicate that monitoring will comply with ARARs. The details on monitoring will be included in the subsequent SAP/QAPP. Appendix C will be revised to reflect that the monitoring provisions will be included in the SAP/QAPP.
13.	Pg 32, para 1	"*If storm flow above the design storm rates occurs that exceeds the storage capacity, the stormwater will be released through a bypass pipeline without active management. If this occurs, the surrounding streams will also be flowing at high levels, minimizing any potential impacts from this release."* This would typically constitute a bypass of treatment as defined under Rule 0400-40-05-.02, paragraph (15) and prohibited, subject to exceptions, under Rule 0400-40-05-.07, subparagraph (2)(l). While these rules apply to permitted facilities, prohibitions on bypass or discharge would appear to be substantive rather than administrative requirements.	Agree. As allowed by the cited Rule 0400-40-05-.07(2)(l), bypass is acceptable if the design storm rate is exceeded to protect the treatment system equipment and staff. The text has been revised to better describe this approach. These bypass requirements and exceptions are included as ARARs in Table D.1.
14.	Pg 32, Alternative 3: Treat at EMWMF/EMDF, 2nd para	*"The treatment system will be designed to meet AWQC."* As stated above, the treated effluent must be designed to meet no detectable concentrations of mercury or cadmium.	Clarify. The evaluations of the alternatives address anti-degradation (see response to General Comment #7).
15.	Pg 32, Alternative 3, last paragraph	*"…running annual average…"* Compliance must be based on testing in a comprehensive monitoring plan to ensure that all discharges meet the WQC identified in Table D.1., and for toxics, based on reasonable potential analysis for toxicity, using the daily maximum and monthly average concentrations of treated effluent to address acute and chronic toxicity, respectively.	Clarify. The text has been revised to indicate that monitoring will comply with ARARs. The details on monitoring will be included in the subsequent SAP/QAPP.

16.	Pg 33, Alternative 3, Monitoring and Land Use Controls, 2nd para	Monitoring of most physical-chemical treatment systems for mercury/cadmium/PCBs/pesticides will require daily analyses during the startup period and shakedown operations, and during development of a routine operating scheme. Influent sampling is always necessary during this time to evaluate treatment system performance. Following that period, weekly sampling may be adequate.	Clarify. The text has been revised to indicate that monitoring will comply with ARARs. The details on monitoring will be included in the subsequent SAP/QAPP.
17.	Pg 33, para 4	*"Operating the treatment system will require trained chemical operators and an operations supervisor to oversee the processing activities."* Does this mean a certified operator, as defined and described in TN Rule Chapter 0400-49-01, *Rules Governing Water and Wastewater Operator Certification*?	Clarify. The text has been eliminated since it is not necessary for the FFS.
18.	Pg 35, para 5	"*The average flow rate is 30 gpm, an 18 gpm increase over the current yearly average for EMWMF leachate volume of approximately 12 gpm*." TDEC anticipates the future generation of landfill wastewater will be constrained by changes to the proposed conceptual design of any additional land disposal facility in Bear Creek Valley. Some changes from operational practices that have minimized waste handling costs at the expense of wastewater generation are also anticipated. Thus, an evaluation of alternatives using the average flow generated at the EMWMF may already be a conservative approach, without the need to increase treatment capacity to 30 gpm/60 gpm. While this change in discharge may not influence the analysis of contaminants of potential concern or the discussion of sampling frequency and protocols, the reduced flow might alter the alternatives analysis.	Noted. This more conservative approach was agreed to in Project Team meetings.
19.	Pg 36, Alternative 4, 2nd para	Has DOE estimated the volume of additional water storage at EMWMF, and the resulting residence time in the storage ponds?	Clarify. Section 1.9 of the FFS discusses storage requirements.

20.	Pg 36, Alternative 4, 3rd para and Fig. 13. PWTC Process Flow Diagram (pg 39)	"Elevated levels of mercury above the current PWTC [WAC] will require additional pretreatment prior to treatment at the PWTC." This statement acknowledges the issue for solids removal discussed in previous comments. Revise Figure 13 to indicate that current PWTC treatment causes flow to bypass the Dual Media Filters.	Clarify. Figure 13 is a high-level, conceptual diagram, not a detailed operational flow diagram.
21.	Pg 41, Alternative 4, Documents *and* Pg 48, Alternative 5, Documents	Modification of the NPDES permits for ORNL (Alt 4-PWTC) or Y-12 (Alt 5 – WETF) in 2021 may or may not be required, depending on the significance of the change in effluent. Part II of each NPDES permit requires the facility to notify TDEC of Planned Changes.	Noted.
22.	Pg 66, para 8	"The Managed Discharge alternative will be protective of human health and the environment for the batch discharge of landfill water that meets AWQC. Bear Creek already exceeds AWQC for cadmium and mercury (TDEC 2014a). The landfill water from EMWMF may contain cadmium at concentrations above the criterion continuous concentration AWQC, but below the criterion maximum concentration AWQC applicable to batch discharges. To meet AWQC, the release of EMWMF landfill water must be performed on a batch basis only. If the mercury concentration in the proposed EMDF leachate exceeds AWQC, managed discharge will not be protective of human health and the environment and cannot be performed. Therefore, the Managed Discharge alternative will be protective of human health and the environment for the batch discharge of landfill water when AWQC are met prior to batch discharge." TDEC agrees with this conclusion, but emphasizes that environmental protection includes meeting the requirements of the anti-degradation statement as well as AWQC. It would seem that the need to restrict managed discharge to batch operations would complicate the use of this alternative in conjunction with continuous treatment at a treatment facility.	Clarify. The evaluations of the alternatives address anti-degradation (see response to General Comment #7). Appendix K has been added that includes the anti-degradation evaluation.

23.	Pg 68, para 8	"Construction time is estimated to be approximately one year. Treatment technologies for removal of mercury and cadmium are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill water composition changes and additional contaminants must be addressed, the treatment system can be modified easily due to its modular design to include the necessary unit operations." TDEC does not contest these conclusions, but there is not enough supporting information in the document with regard to availability and cost for small treatment facilities that can effectively remove hazardous and radioactive constituents from wastewater. Since the other alternatives use existing or proposed facilities, where costs and treatment technologies are already established, the need for more detail is primarily in support of alternative 3.	Agree. The cost estimates have been revised to include additional detail.
24.	Pg 91, para 3, last para	"*The recommended alternative is a combination of Alternative 2, Managed Discharge, and Alternative 3, Treat at EMWMF/EMDF. Since the landfill water from EMWMF currently meets the AWQC without treatment, Alternative 2, is recommended to be implemented immediately*." While managed discharge remains an option at the EMWMF, it is not clear how often landfill wastewater will meet ARARs for anti-degradation requirements. Mercury and cadmium detections occur less than half the time, but with some regularity. Recommending a combination of alternatives as "preferred" may be premature at this point.	Agree. Section 5, Recommended Alternative has been removed from the FFS. Section 1.10, Estimated Timeline has been revised to discuss the approach for implementing the evaluation in this FFS for EMWMF and EMDF.
25.	Pg F-9, para 1	*"This same waste determination applies to the landfill water from the Environmental Management Disposal Facility."* For any future waste disposal facility for CERCLA generated waste, both waste characteristics and waste acceptance criteria are likely to be different from those at EMWMF. Consequently, this statement is premature.	Agree. The text has been revised as follows: "For planning purposes this same waste determination is assumed to apply to the landfill wastewater from the Environmental Management Disposal Facility."