UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

August 29, 2019

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. John Michael Japp
Federal Facility Agreement Manager
Oak Ridge Office for Environmental Management
Department of Energy
P.O. Box 2001
Oak Ridge, TN 37831

Dear Mr. Japp:

The U.S. Environmental Protection Agency has completed review of the document titled, *Technical Memorandum #2, Environmental Management Disposal Facility, Phase 1 Monitoring, Oak Ridge, Tennessee* (DOE/OR/01-2819&D1). This document was generated in support of the proposed Comprehensive Environmental Response, Compensation, and Liability Act (1980, as amended) Environmental Management Disposal Facility (EMDF). A lack of site-specific characterization data for the Central Bear Creek Valley (CBCV) Site 7c location initiated the work conveyed in this document.

Technical Memorandum #2 presents a full year of monitoring data for surface water and groundwater at the EMDF Site 7c location. This work was conducted to satisfy conditions outlined in the Dispute Resolution Agreement (DRA - December 2017) for the *Remedial Investigation/Feasibility Study (RI/FS) for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Waste Disposal for Oak Ridge Reservation Waste Disposal Oak Ridge, Tennessee* (DOE/OR/01-2535&D5). According to DRA-Resolution 3:

> "The results and analysis of the field investigation in accordance with the FSP [Field Sampling Plan] shall be included in the administrative record and the Proposed Plan public comment period shall be provided thereafter. <u>This field investigation, and EPA/TDEC's review of the results thereof, shall be conducted prior to execution of the Record of Decision (ROD) and shall be used in selecting the remedy.</u>" (Underline and brackets added)

The EPA received Technical Memorandum #1(TM-1) before the Proposed Plan was issued for public comment on September 10, 2018. That document did not contain the planned full winter season of surface water and groundwater data. The DOE then notified EPA and documented in the Proposed Plan the necessity to collect a full year of surface water and groundwater data. According to the approved Proposed Plan (September 5, 2018):

"Surface water and groundwater data would continue to be collected and reported (Technical Memorandum #2 [TM-2]) to support remedy selection in the ROD and to ensure that the design protects human health and the environment and complies with ARARs. All data collected to support the ROD or design will be available to the public." (p. 26) (Brackets EPA)

The partial results presented in TM-1 and concluded in TM-2 indicate the groundwater elevation across Site 7c is higher than predicted in the previously approved DOE Field Sampling Plan (DOE/OR/01-2739&D2, March 2018, See Figure 5, p. 10,). This is documented from data presented in TM-2, Table 6.2 (p. 6-5), where six monitoring wells within the footprint of the proposed landfill (Site 7c) indicate groundwater is within ten (10) ft of the existing ground surface:

Location ID	Depth to Groundwater from Surface (ft)
GW-986	-4.18
GW-992R	-2.38
GW-994	-4.78
GW-995	-9.43
GW-987	-7.09
GW-993	-3.35

This new information should be used to define applicable or relevant and appropriate siting requirements (ARARs), waste cell/control berm design, and possibly near-surface water management issues across portions of Site 7c (including the adjacent wetlands). Possible ARARs waivers should be addressed using the historical highest groundwater data available from this investigation (recorded February 2019) in the EMDF D1 Record of Decision (ROD).

The DOE's position conveyed in TM-2 is to defer the landfill protectiveness determination at Site 7c to post-ROD design documents. This is not acceptable. This determination must be defined and presented in the ROD. The statement in TM-2:

"The intent of the engineering design will be to establish the lowest allowable elevation of the CBCV site landfill bottom and still maintain a minimum 10-ft buffer between the bottom of the liner system and the estimated seasonal high piezometric surface. It is anticipated that the post-construction piezometric surface will be lower than the current lowest piezometric surface observed in the shallow piezometers due to the elimination of groundwater recharge over the footprint of the landfill because of the placement of the impermeable barriers in the bottom of the landfill. This lack of recharge will also reduce the degree of response in the piezometric surface to precipitation events and seasonal fluctuations from what is currently observed at the site." (p. 7-1, underline added for emphasis)

This paragraph suggests no consideration is being made for periods of elevated precipitation during the projected 22-year landfill operational period. The hazardous waste landfill will be constructed cell by cell so high precipitation events will impact Site 7c until the entire landfill is constructed and eventually capped.

Several figures in TM-2 trace the groundwater elevation across portions of the landfill footprint using an "Average Seasonal High Potentiometric Surface" line which was exceeded during March 2018 and February 2019 by above average precipitation.

The DOE's desire to design the landfill using the seasonal average instead of the historical highest groundwater elevation is not conservative and could create problems with the liner/leachate collection systems during the estimated 22-year operational period and its capped/closed estimated 500-year liner life.

Unresolved and updated comments from TM-1 along with comments specific to TM-2 are attached. The DOE should address these comments and modify the D1 ROD (before submittal) as appropriate.

If you have any questions or concerns regarding this matter or need any additional information, then please contact me at (404) 562-8550, and electronically at froede.carl@epa.gov.

Sincerely,

Carl Froede Jr.

Carl R. Froede Jr.
Senior Remedial Project Manager
Restoration and DOE Coordination Section
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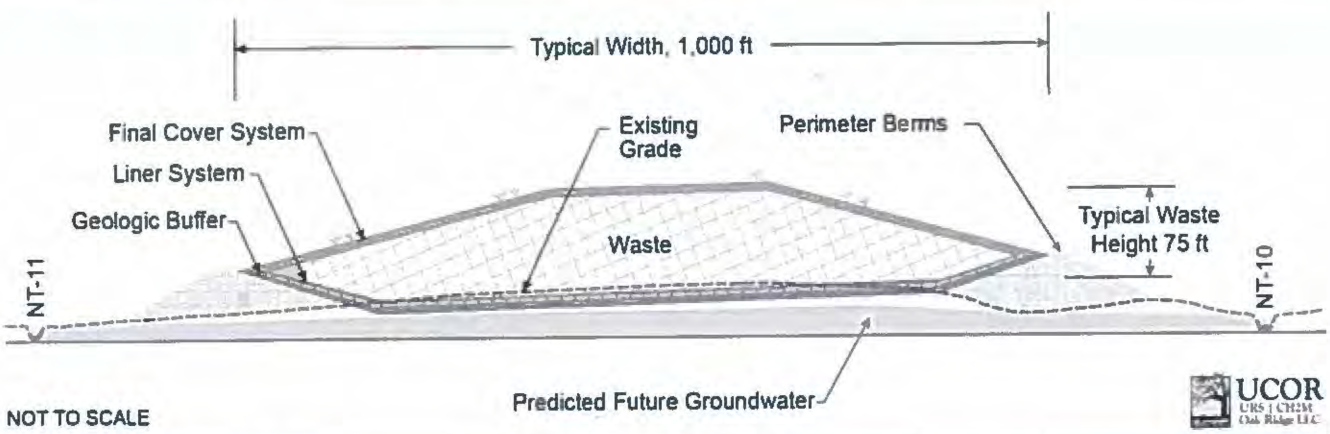
EPA Comments on Technical Memorandum #2, Environmental Management Disposal Facility Phase 1 Monitoring, Oak Ridge, Tennessee (DOE/OR/01-2819&D1)

REVIEWER 1 COMMENTS

1. **Conceptual Site Suitability** – Interest in the Bear Creek Valley, Site 7c location is based on several factors presented in the Environmental Management Disposal Facility (EMDF) D5 Remedial Investigation/Feasibility Study (RI/FS) Report. One of the most important is the location of the groundwater table beneath the site:

> a. "…the water table is assumed to remain below the geologic buffer material at all locations (i.e. the thickness of the <u>unsaturated buffer zone is everywhere ≥ 15 ft</u>)…" (underline added, p. 7-7).
>
> b. "More importantly, leaks …must penetrate at least 15 ft or more of low permeability clay liner and geobuffer materials and native low permeability materials in the <u>unsaturated zone</u> before reaching the water table…" (underline added, p. 6-42).

This concept is presented graphically in Figure 8 of the Final EMDF Proposed Plan (08/30/18, p. 12 – see below)



008_PP-D1R1_F8_TypicalsectionEMDF_2_21_18.ai

<u>**EPA Comment Based on TM#2 groundwater data**</u>: The Administrative Record (AR) does not contain documentation that describes how the propose landfill at Site 7c will be protective of elevated groundwater based on the data presented in TM-1 and TM-2. The EMDF Landfill Site Conceptual Model has not been revised and is inaccurate in its portrayal of elevated groundwater. The inaccurate site conceptual model and new elevated groundwater data create issues that cannot be deferred to a post-ROD landfill design document. It must be addressed in the EMDF ROD.

Additionally, to facilitate a decision regarding site suitability for Site 7c, the DOE must be granted an exemption under the state radioactive waste disposal rules and two waivers under the Federal Toxic Substances Control Act (TSCA, 1980). TSCA requires, (1) no hydraulic connection occur between the site and standing or flowing surface water, and (2) the bottom of the landfill liner system or natural in-place soil barrier of a chemical waste landfill shall be at least 50 feet above the historical high-water table (40 CFR 761.75[b][3]).

Regarding (1) above, wetlands occur on both east and west sides of Site 7c with the eastern wetlands extending beneath the proposed waste cell. In reference to (2), the construction of a disposal facility anywhere in Bear Creek Valley would not meet the 50-foot distance requirement. Therefore, the TSCA waiver will be required under that statute for all onsite disposal alternatives. Such a waiver is granted through 40 CFR 761.75(c)(4) by providing "...evidence to the EPA Regional Administrator that operation of the landfill will not present an unreasonable risk of injury to health or the environment from polychlorinated biphenyls (PCBs)...." This information must be included in the ROD.

2. In TM-2, the DOE states the:

> "Piezometric surface response to precipitation events in both the shallow and intermediate zone piezometers is more subdued in the drier months of summer and early fall than in the wetter months of winter and early spring when a much greater response is evident to individual precipitation events. In general, the piezometric response in both the shallow and intermediate zones tracks closely with no significant lag in time of response between the two zones, and the slight downward vertical hydraulic gradient between the shallow and intermediate zones is maintained throughout the responses to precipitation." (p. 7-8)

COMMENT: Several hydrogeologic conditions can be derived from this information: 1) there is no hydrogeologic difference between the shallow and deep groundwater zones – it is a single aquifer, 2) precipitation events raise groundwater levels not tributary bank storage, 3) shallow groundwater drainage occurs along the periphery of Site 7c into the eastern and western tributaries, 4) the groundwater rise associated with precipitation events occurs rapidly. All these issues impact landfill design.

The current conceptual design of the proposed Site 7c landfill uses a 10-ft thick clay geobuffer covered by 5-ft of clay/leachate collection layers below the hazardous waste (D5 RI/FS, p. 6-37). The DOE will not construct the entire landfill at one point in time, rather it will be built out cell by cell (see D5 RI/FS, p. 2-13, and p. 6-2) consistent with operations that have occurred at the EMWMF.

Cell construction in this manner does not cut off excessive precipitation events across Site 7c. Presently, groundwater rises with precipitation (as stated above) and conditions would remain that way until the entire landfill is constructed. Therefore, the landfill design and elevation must be based on the most conservative prediction for the highest groundwater elevation created by precipitation (i.e., February 2019). This will require a completely unsaturated clay geobuffer layer to demonstrate the protectiveness requirements necessary to obtain waivers.

REVIEWER 2 COMMENTS

1. In Section ES.1 and in Section 2.1, text refers to two constructed wetlands. These features are graphically shown but no description is provided in reference to the proposed EMDF berm boundary (e.g. Figure ES.2; Figure 2.1). Their relevance to the development of the EMDF at Site 7c should be explained.

2. Figure 4.1 shows a buffer zone around the boundary of waste and the only mention of this buffer zone appears to be on page A-9. On page A-9 or elsewhere as appropriate, TM-2 should identify the function and nature of this buffer zone.

3. In Appendix A, the January 30, 2018 and February 27, 2018 temperature profiles show something of a decreasing surface-water temperature moving from upstream to downstream (apparent for NT-11 and D-10W for both periods; for NT-10 only the January results show a generally decreasing temperature proceeding downstream). There may also be less difference between dry (or warm season) and wet (or cool season) stream temperatures for upstream locations versus downstream locations (refer to Figure A-12 through Figure A-14). Streamflow temperature is somewhat modulated by groundwater inflow, such that a greater groundwater inflow component relative to direct runoff (or for this setting, direct runoff plus stormflow) tends to create warmer streamflow conditions in cold weather conditions and cooler streamflow in warm-weather conditions. This suggests a deeper groundwater inflow component in the upstream reaches relative to the downstream reaches, which seems to be somewhat at odds with the conceptual model of the area as well as the pH and conductivity profiles (Figure A-15 through Figure A-20), which show the pH and conductivity tend to increase proceeding from upstream to downstream. The pH and conductivity profiles are more consistent with the conceptual model of greater contribution to streamflow from deeper groundwater flow proceeding from upstream to downstream. Is there any explanation for the seemingly inverted stream temperature profiles?

4. The DOE responses to the EPA specific comments on TM-1 have been satisfactorily addressed.

<u>REVIEWER 3 COMMENTS</u>

1. There is conflicting information regarding the number and location of wetlands at CBCV Site 7c:

<u>1a) Executive Summary states:</u> "A smaller stream at the site, Drainage (D)-10 West (W), is located just west of NT-10 (Fig. ES.2). The area is mostly forested, except for a cleared area with a large soil pile and two constructed wetlands for the Y-12 National Security Complex." (p. ES-1)
<u>1b) Section 5.1 states:</u> "Figure 4.1 also indicates the locations of the three surface water basins (wetlands, identified by Rosensteel and Trettin, 1993) that occupy the valleys of NT-11 and D-10W..." (p. 5-1)

COMMENT: Please clarify or correct. How will they be addressed since they represent a surface water-groundwater interface which is a TSCA ARAR to be waived? There is no information presented in TM-2 that conveys the relocation of the wetlands or how they impact the hazardous waste disposal area on both sides of Site 7c or how the wetlands will be addressed where it encroaches into the landfill footprint. This information should be added to TM-2 and addressed in the upcoming ROD submittal.

2. Section 7, p.7-1: The text states "The FS phase (DOE 2017) provided conceptual landfill base elevations that would ensure long-term protection from groundwater intrusion based on informed assumptions regarding local conditions at the CBCV site."

COMMENT: This text should be removed or clarified because the FS information cited above states "almost no site-specific data are available for Site 7a or Site 7c for estimating a seasonal high water table....Engineering judgment was used to estimate a seasonal high water table for Site 7a and 7c based on high water levels observed at similar sites such as EBCV and WBCV..." (p. 6-82). For the CBCV site, the FS references Figure 6-29 (p. 6-74) which presents the estimated groundwater position elevated in places to the base of the waste cell and in one instance up into the waste cell. The groundwater position presented in Figure 6-29 is not protective and is contrary to the text cited in TM-2.

3. Section 7, p. 7-1: The text states "The intent of the engineering design will be to establish the lowest allowable elevation of the CBCV site landfill bottom and still maintain a minimum 10-ft buffer between the bottom of the liner system and the estimated seasonal high piezometric surface."

COMMENT: Please define what constitutes the "landfill bottom/liner system." Is it the base of the leachate collection system, the multiple liners, the three-ft of clay, the underlying 10-ft thick clay geobuffer, or something else? **Note:** Precipitation events in March 2018 and February 2019 raised groundwater elevations across the Site 7c footprint above the projected "Average Seasonal High (ASH) Potentiometric Surface." Using the ASH value line to define the distance to the bottom of the landfill would not be conservative.

4. Section 7, p. 7-1: The text states "Cut and fill will be required for site construction. Fill is necessary to raise the bottom of the waste to maintain the appropriate minimum buffer between the waste and the potentiometric surface, and provide a level footprint, while cuts are necessary in some areas to also provide a level footprint."

COMMENT: Groundwater data from TM-2 now allows the DOE to roughly calculate the landfill base-level elevation (i.e., bottom of the "Geologic Buffer Layer") at minimum 15-ft above the historic highest groundwater levels measured in February 2019 (see Figure in Reviewer 1/Comment 1). This information should be updated in TM-2 and presented in the ROD.

5. Figures 7.2, 7.3, and 7.4 present a groundwater "Peak Potentiometric Surface" line that traces in places above the "Average Seasonal High Potentiometric Surface" line.

COMMENT: Conservative landfill design should use the highest point on the Peak Surface line (February 2019) rather than the elevationally lower "average" to calculate a bottom elevation for the 10-ft landfill clay geobuffer. The landfill is projected to have a liner life of 500 years (FS, p. 6-55) and having it elevationally above the groundwater table for that period should extend the geobuffer and liner functionality and longevity.

REVIEWER 4 COMMENTS

GENERAL COMMENTS

1. Section 3.1 (Approach) indicates site walkdowns were performed during the wet season and during the dry season and included further characterization of surface geology. However, it does not appear that geologic mapping was conducted along the tributaries to verify/confirm the location of the existing geologic contacts on the proposed Central Bear Creek Valley (CBCV) site. As indicated in Section 4 (Maynardville Contact Evaluation), the location of the Maynardville/Nolichucky geologic contacts observed in the field were approximately 50 feet further south than represented on the geologic maps prior to the field mapping effort. Based on this observation, there is uncertainty in the accuracy of the geologic contacts presented for the Rome Formation / Pumpkin Valley / Rutledge / Rogersville / Maryville / Nolichucky lithologic units. Revise Technical Memorandum #2, Environmental Management Disposal Facility, Phase 1 Monitoring, Oak Ridge, Tennessee (DOE/OR/01-2819&D1), dated May 2019 (Tech Memo #2) to address this issue to ensure a complete and accurate understanding of current site conditions is presented.

2. Based on the directions of the gradients and the locations of the well pairs as presented on Table 7.3 (Vertical gradients at the CBCV site, September 2018 and February 2019) and Figure 6.1 (Phase 1 piezometer locations at the CBCV Site), it appears that the vertical hydraulic gradients are indicative of "Toth flow" [Toth, J., 1963, A theoretical analysis of groundwater flow in small drainage basins. Journal of Geophysical Research, v. 68, pp. 4795-4812]. Toth flow includes local flow systems that occur in small basins, similar to the CBVC site. Under natural conditions, flow is downward at the tops of hills or ridges, then switches to upward toward the bottom of the hill and is upward in the valleys. Currently, it is unclear how landfill construction would impact the local flow conditions due to cutting, grading and filling activities that would be required. Also, capillary action and recharge tend to result in groundwater mounding beneath unlined landfills. However, it is unclear to what extent this would occur beneath the proposed landfill as pore size and variability are unclear. It would be helpful if cross-sections with flow nets were constructed to illustrate flow directions that occurred before the underdrain was constructed and after the underdrain was in operation at the nearby Environmental Management Waste Management Facility (EMWMF). Cross-sections with flow nets illustrating what happens to local flow direction beneath a lined landfill in the EMWMF area can be compared with the "natural" conditions flow nets in the CBCV area. Considering whether Toth flow conditions exist may change the discussions in the subsections of Section 7.4 (Potential for Upwelling beneath the Knoll), particularly for well pairs at lower elevations where upward gradients were observed. Cross-sections with flow nets also would aid in identifying relative areas of alternating groundwater recharge and discharge due to fluctuations in the potentiometric surface. Revise Tech Memo #2 to provide cross-sections with flow nets constructed to illustrate flow directions that occurred before the underdrain was constructed and after the underdrain was in operation at the nearby EMWMF. In addition, revise the text to consider the impact of groundwater mounding beneath EMDF and the role that Toth flow will have at Site 7c.

3. Tech Memo #2 does not discuss how wetlands impact the hydrogeology at the site. Based on Figure 2.1 (General features of the CBCV site), wetlands are located within the proposed boundary of the Central Bear Creek Valley (CBCV) waste. In addition, Section 2.1 (General Site Location) indicates that constructed wetland basins, completed in 2015 for the Y-12 National Security Complex compensatory wetland mitigation, are located along the southern side of the CBCV site. However, Tech Memo #2 does not discuss how and where these compensatory wetlands will be placed. Revise Tech Memo #2 to clarify how the wetlands in the vicinity of the CBCV site impact the hydrogeology at the site. In addition, revise Tech Memo #2 to discuss how and where the compensatory wetlands will be placed.

4. Tech Memo #2 includes several assumptions that could impact the understanding of the hydrogeology at the site. Yet, it is unclear if information was collected during the Phase I investigation to support or refute these assumptions. For example:

a. Section 2.2 (Hydrogeology) states, "In BCV [Bear Creek Valley] the average dip of the bedrock formations is approximately 45°, to the southeast (Figure 2.3); a similar dip was assumed for the formations lying directly underneath the CBCV site."

b. Section 2.2 states, "A key assumption was that the geology is typical of BCV with steeply dipping, fractured bedrock, and there are no major karstic features in the Maryville, Nolichucky, or Rogersville formations underlying the CBCV site."

c. Section 2.2 states, "Thin layers of alluvial and colluvial soils may be present along streams, drainage ways, and the base of steeper slopes."

d. Section 2.2 states, "Depending on the site topography and local conditions, the saprolite zone at the Environmental Management Disposal Facility (EMDF) site may include surficial soils (organic-rich topsoil and clayey residual subsoils), colluvium and alluvium along flanks and floors of the NT valleys, and the underlying saprolite, which is bedrock that has been completely chemically weathered but remains otherwise undisturbed."

e. Section 2.2 states, "For practical purposes, the depth of the saprolite zone may be considered as auger refusal drilling depth, which typically ranges from 10 to 30 ft [feet] but can exceed 50 ft in some locations. Saprolite retains the fabric and structure of the parent sedimentary rocks, including fracture sets."

f. Section 2.2 states, "Colluvial deposits may occur along the lower slopes of these valleys" and "Colluvial or alluvial deposits also may occur in places outside of the current stream valleys as demonstrated by detailed site soil surveys completed for a waste disposal demonstration project in West Bear Creek Valley [Lietzke et al. 1988]."

g. Section 2.3 (Surface Water Hydrology) states, "A key assumption for the CBCV site was that precipitation primarily runs off as surface water and shallow groundwater in the stormwater flow zone."

h. Section 2.4 (Groundwater) states, "Deeper groundwater that does not discharge to the tributaries moves southward toward Bear Creek along pathways through the bedrock zone. Most of the groundwater flux within the saturated zone has been demonstrated to occur via the saprolite zone with progressively less flux occurring at greater depth."

i. Section 2.4 states, "A key assumption going into this investigation was that potentiometric surface elevations are typical of other BCV wells in similar settings."

Revise Tech Memo #2 to discuss how the data collected during the investigation supports or refutes each of the assumptions made, including relevant citations. Include relevant information in the ROD.

5. While Tech Memo #2 includes annual precipitation data for Oak Ridge, Tennessee, additional climatic information and its impact on the hydrogeologic conditions at the CBCV site are not included. Based on Section 1.6.3 (Climatic Criteria) of the Draft Technical Guidance for RCRA/CERCLA Final Covers, EPA 540-R-04-007, dated April 2004 (Cover Guidance), "[T]he design of a cover system should include the amount and seasonal distribution of precipitation, duration of specific storm events (e.g., 1-hour storm event, 24-hour storm event, etc.), intensity of specific storm events (e.g., 25-year recurrence interval storm event, 100-year recurrence interval storm event, probable maximum precipitation (PMP), etc.)." Revise Tech Memo #2 to present additional climatic data including the amount and seasonal distribution of precipitation, duration of specific storm events (e.g., 1-hour storm event, 24-hour storm event), and intensity of specific storm events (e.g., 25-year recurrence interval storm event, 100-year recurrence interval storm event, PMP).

6. Based on Section 3.1 (Approach), only two site walkdowns were performed during the wet season (i.e., January 30 and February 27, 2018) and three walkdowns were performed during the dry season (May 1, June 4, and October 10, 2018) to further characterize surface geology; examine hydrogeologic areas of interest; and identify seeps, springs, and other expressions of shallow groundwater at North Tributary (NT)-10, Drainage (D)-10 West (W), D-11 East (E), and NT-11. However, it is unclear if two site walkdowns during a single wet season and three site walkdowns during a single dry season are sufficient to characterize surface geology; examine hydrogeologic areas of interest; and identify seeps, springs, and other expressions of shallow groundwater at NT-10, D-10W, D-11E, and NT-11.

For example, Section 3.2.1 (Parameter Results) concludes that groundwater influence is minimal in the tributaries and drainages, especially in D-10W and NT-10 along the eastern side of the site, based on data collected during a single dry season; it is unclear if sufficient data have been collected to support this conclusion. Revise Tech Memo #2 to clarify why two site walkdowns during a single wet season and three site walkdowns during a single dry season are sufficient to characterize surface geology; examine hydrogeologic areas of interest; and identify seeps, springs, and other expressions of shallow groundwater at NT-10, D-10W, D-11E, and NT-11.

7. Tech Memo #2 does not account for potential tornados and their impact on the remedial design. Based on Oak Ridge Reservation Meteorology (http://metweb.ornl.gov/page5.htm), one F0 [<73 miles per hour (mph)], one F1 (73-112 mph), one F3 (158-206 mph), and two EF0 (65-85 mph) tornadoes have impacted Roane County, where the CBCV site is located. Revise Tech Memo #2 to discuss the potential for tornados and how the remedial design will address the potential for tornados to impact the designed structures.

8. Based on Section 2.2 (Hydrogeology), "There is little limestone present in the bedrock lying directly beneath the proposed CBCV site, even in the Maryville Formation;" however, several boring logs provided in Appendix B (Boring Logs) note limestone in several depth intervals below 25 feet below ground surface (bgs). For example:

a. Boring Log 978, which is the boring log located farthest from the Maynardville limestone unit, notes limestone in several depth intervals below 25 feet bgs;
b. Boring Log 980 notes limestone interbedded with shale below 26.3 feet bgs;
c. Boring Log 981 notes interbedded limestone below 23 feet bgs;
d. Boring Log 982 notes limestone interbedded with shale below 47.3 feet bgs;
e. Boring Log 986 notes interbedded limestone layers below 21 feet bgs;
f. Boring Log 987 notes shale and limestone layers below 17.5 feet bgs;
g. Boring Log 988 notes shale and limestone interbedded below 37.2 feet bgs;
h. Boring Log 989 notes interbedded limestone below 32 feet bgs;
i. Boring Log 992 notes limestone clasts below 28 feet bgs and limestone layers below 33.4 feet bgs;
j. Boring Log 993 notes interbedded limestone and shale below 25 feet bgs;
k. Boring Log 994 notes interbedded shale and limestone below 28 feet bgs;
l. Boring Log 995 notes interbedded shale and limestone below 25.9 feet bgs; and,
m. Boring Log 998 notes interbedded shale and limestone below 23.8 feet bgs.

This is of concern given that limestone can dissolve and provide a conduit for groundwater and/or leachate transport. Calcite in calcite-healed fractures also may be subject to dissolution. Revise Tech Memo #2 to discuss the presence of limestone in several depth intervals beneath the proposed CBCV site and its potential impact on landfill design.

9. Based on several boring logs provided in Appendix B (Boring Logs), a possible fault zone exists beneath the proposed CBCV site; however, Tech Memo #2 does not discuss this possibility. Specifically, Boring Log 981 notes from 23 to 24 feet bgs (and possibly into the broken-up zone between 24 to 24.9 feet bgs) that the bedding is at a 45-degree angle. Below the broken-up zone, from at least 25.5 to 27 feet bgs, the bedding is horizontal, then below this zone is another broken-up zone, and below 27 feet bgs, the bedding is again at a 45-degree angle. These changes in Boring Log 981 likely indicate a fault zone. In addition, several boring logs note slickensides. For example:

a. Boring Log 978 notes slickensides below 13.7 feet bgs and below 25 feet bgs;
b. Boring Log 981 notes slickensides at approximately 31.1, 33.5, and 37.9 to 39.2 feet bgs;
c. Boring Log 981 also notes slickensides at 28.1 to 28.4 feet bgs which are not parallel to bedding plane surfaces which strongly suggests a fault with movement;
d. Boring Log 982 notes slickensides below 77 feet bgs;
e. Boring Log 986 notes slickensides from 45 to 47 feet bgs;
f. Boring Log 988 notes slickensides below 37.4 feet bgs;
g. Boring Log 998 notes slickensides at 28.2 and 32.8 feet bgs; and,
h. Boring Log 992 notes a highly fractured zone from 28 to 33.4 feet bgs, slickensides from 31.4 to 33.4 feet bgs, and another highly fractured zone with slickensides between 41.8 and 44.3 feet bgs.

Slickensides indicate friction between two rocks and typically occurs in a fault zone. They are directional and indicate the general direction of movement. In addition, Figure 2-2 (Geologic map of CBCV and the surrounding area) notes several mapped thrust faults to the north and south of the proposed CBCV site. Further, there is a seismically active zone called the Eastern Tennessee Seismic Zone within which Oak Ridge appears to be located; it has experienced earthquakes with magnitude 6 or greater (https://phys.org/news/2017-06-evidence-large-earthquakes-eastern-tennessee.html). Given these issues, revise Tech Memo #2 to discuss seismic issues associated with the proposed CBCV site.

SPECIFIC COMMENTS

1. Section 1.0, Introduction, Page 1-2, and Figure 1.2, Annual precipitation records for Oak Ridge, TN, Page 1-4: According to Section 1.0, the 30-year average precipitation from 1981 to 2010, as reported on the Oak Ridge National Laboratory meteorology webpage, is included on Figure 1.2; however, it is unclear why more current data (i.e., 1988 to 2018) was not utilized to establish a 30-year annual average precipitation. In addition, while it is assumed that the Y-12 Tower W station data is presented on Figure 1.2, Section 1.0 and Figure 1.2 do not include such a citation. Further, the location of the station utilized relative to the CBCV site is not provided on a figure in Tech Memo #2. As a result, it is unclear if the precipitation data being utilized is representative of the CBCV site. Revise Tech Memo #2 to utilize more current data (i.e., 1988 to 2018) to establish the 30-year annual average precipitation. In addition, revise Tech Memo #2 to specify the station which was utilized to generate the data presented on Figure 1.2. Also, clarify the location of the station relative to the CBCV site and discuss why it is representative of site conditions.

2. Section 2.1, General Site Location, Page 2-1: Section 2.1 states, "An additional shallow east-west trending drainage was present in the southern part of the area prior to construction of the Uranium Processing Facility (UPF) wet spoils pile. This drainage was noted as dry when observed prior to the Phase 1 investigation, is now covered by the UPF wet spoils pile; however, there was a seep within this drainage area downgradient of the wet spoils pile that is now covered by a sediment basin;" yet the location of the UPF wet spoils pile and the referenced east-west trending drainage, relative to the CBCV site and the boundary of the CBCV waste, are not provided on a figure in Tech Memo #2. Revise Tech Memo #2 to provide the location of the UPF wet spoils pile, the seep, and the referenced east-west trending drainage, relative to the CBCV site and the boundary of the CBCV waste.

3. Section 2.5, Site Conceptual Model, Pages 2-11 and 2-12: The text in these sections discussing the groundwater flow direction based on the conceptual site model requires clarification. For example, the text on Page 2-11 indicates an important aspect of the conceptual site model relates to groundwater flow paths and rates that are dominant along fractures that trend parallel to geologic strike. However, the text on Page 2-12 states, "Across the clastic outcrop belts, groundwater at shallow to intermediate depth tends to flow south to southwest, whereas flow within the Maynardville and along Bear Creek tends to more closely parallel the geologic strike toward the southwest." Revise Tech Memo #2 to ensure that the hydrogeologic conceptual site model regarding shallow, intermediate, and deep groundwater flow paths is fully defined and clearly presented.

4. Figure 2.6, BCV Groundwater flow patterns, Page 2-13: The BCV groundwater flow patterns presented on Figure 2.6 are from 1994 (i.e., approximately 25 years old). As a result, it is unclear if these BCV groundwater flow patterns are reflective of current site conditions. Revise Tech Memo #2 to provide updated BCV groundwater flow patterns or provide information to substantiate that they are still representative of current BCV conditions.

5. Section 3.2, Results, Page 3-1: The text indicates a shallow macropore/soil channel transmits percolation water from soils to the NT-11 stream channel in the Nolichucky Shale outcrop area. Figure 2.1 (General features of the CBCV site) shows the NT-11 stream channel also crosses the Maryville Limestone (Dismal Gap Formation) outcrop and wetland area. However, it is unclear if there are also areas in the Maryville Limestone where shallow macropore/soil channel transmits percolation water from soils to the NT-11 stream channel. Revise the text to address this issue to ensure all lithologic areas where shallow macropore/soil transmits percolation water from soils are clearly identified and documented.

6. Section 5.1, Approach, Page 5-1: As discussed in this section, the locations of the three surface water basins (wetlands, identified by Rosensteel and Trettin, 1993) that occupy the valleys of NT-11 and D-10W and the surface expression of the geologic contact between the Maynardville Limestone and the Nolichucky Shale are shown on Figure 4-1 (Surface water monitoring locations and field-verified contact for Maynardville Limestone at the CBCV site). However, the text further indicates that the wetlands delineation available at the time the field sampling plans (FSPs) was developed is shown instead of the newer boundaries to illustrate the information available when the sample locations were established. It is unclear why the most recent wetlands delineation was not presented in Tech Memo #2. In order to have a complete understanding of the current site conditions and conceptual site model, revise Tech Memo #2 to include a figure depicting the most recent wetlands delineation boundaries.

7. Section 6.3.2, Slug Test Results, Page 6-7, and Appendix C, Slug Test Data: The text indicates slug tests were conducted in the shallow piezometers (i.e., essentially water-table piezometers). Additionally, according to Appendix C, the slug test analysis was performed using a confined aquifer model. However, it is unclear why a confined aquifer model was utilized instead of an unconfined aquifer model. For example, the aquifer was assumed to be only 9.7 or 9.8 feet thick; it is unclear whether this was appropriate as the wells were not "fully penetrating" (i.e., based on this aquifer thickness, it appears that portions of the 10-foot well screens were exposed above the water table). As such, it appears an unconfined aquifer model is appropriate for slug test analysis in most of the shallow water table wells. Note that based on the hydrographs presented in Section 7 (Long-Term Monitoring Results from Phase 1 Wells – Through April 2019), many of the well pairs had virtually the same water levels and responses to precipitation. Those that had greater responses to precipitation events are probably not under confined conditions. Immediate response to precipitation events, like that at GW-986/GW-987, is typical of relatively shallow water table wells and unconfined aquifers. Revise the text to explain why it is appropriate to analyze all slug tests conducted in shallow piezometers using a confined aquifer model or reanalyze most of the tests using an unconfined aquifer model.

8. Section 7.2, Potentiometric Fluctuations Over Time, Page 7-7: It is unclear if the average seasonal low potentiometric surface was calculated using one piezometer or both (note that the text states that the average seasonal high was based on the shallow well in the pair). Revise the text to address this issue to ensure the method of calculating the average seasonal low potentiometric surface is clearly documented.

9. Section 7.2, Potentiometric Fluctuations Over Time, Page 7-18: The text indicates an overall fluctuation in the shallow piezometric surface of approximately 12.9 feet has occurred, and an overall fluctuation of approximately 113.3 feet has occurred in the intermediate zone of piezometer pair GW998/GW999 over the year-long monitoring period. However, the reported fluctuation of 113.3 feet that occurred in the intermediate zone seems to be erroneous and does not appear to be supported by the monitoring data. Revise Tech Memo #2 to address this issue to ensure the correct fluctuation that occurred in the intermediate zone over the year-long period is clearly defined and documented.

10. Section 7.2, Potentiometric Fluctuations Over Time, Pages 7-18 and 7-21 and Figure 7.14, Measurements of pH at the CBCV site piezometers, Page 7-20: Based on the available pH information, it unclear whether the elevated pH in GW-981 was due to grout, or due to a pH probe malfunction from November 2018 to mid-April 2019. For example, if the high pH was due to grout, it is unclear why these changes began in November, when there was little precipitation and did not occur late in the previous spring when there was more rainfall and recharge. Also, if pH in GW-981 is being impacted from grout, it is unclear how this will be verified (e.g., whether the well will be videoed to evaluate if the screen is compromised with grout). Revise the text to address this issue to ensure the integrity of the well was not compromised by grout and the pH probe was working properly.

11. Section 7.3, Potentiometric Surface Maps, Gradients, and Flow Rate, Page 7-22, and Figure 7.19, Piezometric surface map of the peak high conditions at the CBCV site, February 24, 2019, Page 7-26: The second sentence of Section 7.3 is incorrect. According to Figure 7.19, the potentiometric surface is based on water levels collected on February 24, 2019, not September 24, 2018, as indicated in the text. It appears that Figure 7.21 should have been cited instead. Revise the text to address this discrepancy.

12. Figures 7.19 through 7.21, Page 7-26 through 7-28: It is unclear what data were used to generate contours at the edges of these figures as there are no wells installed to constrain the contours. For example, the contours should be truncated as they are in the southwestern portion of Figure 7.19 or dashed (i.e., inferred) along the edges where there are no wells. Revise the figures as appropriate to show dashed contours where the groundwater elevation and potentiometric surface is inferred and not constrained by groundwater elevation data.

13. Section 7.3, Potentiometric Surface Maps, Gradients, and Flow Rates, Page 7-29: The text states that vertical hydraulic gradients "were determined based on the piezometric surface." However, the noted method can result in errors as vertical gradients should be calculated from measured groundwater elevations. Revise the text to address this issue to ensure the method of determining vertical hydraulic gradients is accurate and meets the data quality objectives.

14. Appendix B, Boring Logs: The boring logs for GW-980 (26.3 to 27.2 feet bgs, below 42.9 feet bgs, 43.2 to 44.1 feet bgs, 67 to 67.3 feet bgs, and 72.4 to 72.5 feet bgs), GW-982 (112 feet bgs), and GW-993 (25 to 27.9 feet bgs, 27.9 to 31.1 feet bgs, 31.1 to 35.5 feet bgs), incorrectly note that slickensides can be depositional or that they are due to "depositional slump" (GW-981, 27 to 27.2 feet bgs). Slickensides are always caused by friction between rocks and do not occur in soft materials or by deposition. Revise Tech Memo #2 to resolve this discrepancy.

(End of Comments)