TDEC/Neptune Concerns Related to EMDF WAC and PA Modeling
June 17, 2021

This document provides DOE-requested feedback on DOE's May 25, 2021 responses to comments offered in TDEC's October 15, 2020 letter, including Neptune's October 12, 2020 review of the EMDF PA/CA (dated April 28, 2020).

1. Bathtubbing analysis

Response 3 (resolution of Critical Issue 2, Bathtubbing Assessment) states:

> "Given the pessimistic assumption regarding cover performance over 1000 years, development of bathtub conditions is unlikely during the compliance period. This justifies treatment of the bathtub scenario as a separate case (unexpected performance condition) rather than including bathtubbing in the base case."

The base case scenario evaluated in the PA assumes intact cover performance with zero infiltration up to model year 200, followed by the gradual and linear degradation in performance over 800 years to an infiltration rate of 0.88 in./year at model year 1000. Over a landfill area of 95,000 m^2 (RESRAD-OFFSITE Summary Report; PA Appendix G), an infiltration rate of 0.88 in./year equates to approximately 1.1 gal/min. Therefore, the base case condition as presented in the PA assumes a linear increase of leachate production from zero at model year 200 to approximately 1.1 gal/min at model year 1000. Appendix C of the PA (Cover System Analysis) provides descriptions of anticipated cover performance that indicates bathtubbing related to leachate production is anticipated, because cover performance is expected to degrade more quickly than liner performance with regard to infiltration:

> "Eventually, severe weather events and progressive climate and vegetation changes can lead to erosion of the protective cover components and accelerate degradation of the clay barrier in the cover, increasing the likelihood of greater water infiltration over time."

> "Because liner system clays are more isolated from environmental fluctuations than cover system clay barriers, the liner barriers may retain their safety functions for a longer period."

The PA base case and the proposed groundwater pathways analytic WAC should be revised to include the anticipated volumetric release of leachate from bathtubbing, consistent with the assumed infiltration rates. Exposure and dose calculations, consistent with potential human uses of surface water and groundwater impacted by bathtubbing, should be integrated in the base case analysis.

2. Erosion/Cover degradation assumptions

The resolution of Critical Issues 2 and 3 argues that assumptions for cover performance with respect to infiltration are "pessimistic" and that expected cover performance over time is likely to be better than that evaluated in the base case model. Information provided in Appendix C.2 of the PA (HELP Model Evaluation of EMDF Water Balance) indicates that the long-term

infiltration rate is highly sensitive to the value of the saturated hydraulic conductivity (K_{sat}) of the amended clay barrier of the cover, with infiltration being "roughly proportional to the increase in clay K_{sat}." This is reflected in Table C.4 of the PA , where the change from partial cover design performance with a degraded cover HDPE geomembrane (0.43 in./year) to the long-term 1000+ year performance of 0.88 in./year is associated with an assumed change in amended clay layer K_{sat} from 3.5E-08 to 7.0E-08 cm/sec.

The protectiveness of the assumed twofold increase in the amended clay layer K_{sat} value over a 1000-year period, resulting in a long-term degraded-condition infiltration rate of 0.88 in./year, is not apparent from review of the main text and Appendix C of PA. For example, Section C.2.5 of the PA provides this characterization of uncertainty in long-term cover performance:

> "Uncertainty in using the HELP model to predict long-term hydrologic performance of the EMDF cover system is due in part to the difficulty of specifying representative degraded-condition hydraulic conductivity (K) values based on very limited understanding of the long-term performance evolution of earthen barriers and engineered drainage systems. The degree of degradation of clay barrier performance and increased cover infiltration that could occur due to natural processes over hundreds of years (assuming stable climate conditions) is plausibly bounded by the estimated range of natural annual average rates of recharge to groundwater in BCV, estimated at 7 to 12 in./year (DOE 1997, Volume 2, Appendix F, pages F-36 and F-40)."

To support groundwater pathways dose estimates and associated analytic WAC, there must be a clear basis for the protectiveness of the base case assumption of a twofold increase (0.43 to 0.88 in./year) in the amended clay layer K_{sat} value for the cover over the performance period of 1000 years.

The importance of the amended clay layer K_{sat} cannot be overstated. The PA identifies it as the most sensitive parameter in the HELP model and the basis for the long-term infiltration rate of 0.88 in/year, which is in turn the most important parameter in the STOMP and MODFLOW/MT3D models. The entirety of the numerical modeling in the PA is therefore dependent on the assumption that the K_{sat} of the amended clay layer will be no greater than 7E-08 cm/sec in perpetuity. Not only does this impact the groundwater and the vadose zone flow modeling, it also affects the release model.

Contrary to the narrow band within which the base case PA varies K_{sat} of the amended clay layer, NUREG/CR-7028 design guidance for performance assessment suggests long-term values ranging between 1E-05 and 5E-04 cm/sec. These values are derived from a study of in-service cover systems similar to that proposed for EMDF; evaluated approximately 5-10 years after construction.

The PA should also provide rationale for assuming no further degradation of cover performance after 1000 years. Specifically, why is it assumed that cover degradation from natural processes will lead to a gradual increase in the amended clay layer K_{sat} value up to year

1000, but that these processes result in no further degradation from model year 1000 to model year 10,000?

3. Clarification whether formerly characteristic RCRA wastes will be accepted

The draft WAC explicitly prohibit listed hazardous waste under RCRA but the draft information is silent on if or how characteristic waste codes will be handled. Will they be accepted?

TDEC understand issues involving mercury are not yet final, but the likely final outcome is the total prohibition of mercury-contaminated characteristic (D009) hazardous wastes. Also, not final has been some discussion of the advantage of additional treatment of wastes even if not mandated by the LDR requirements. While DOE has expressed some reluctance to this approach, TDEC maintains it should still be considered as an option, regardless of whether required. Because treatment to reduce leachability of wastes could be an effective approach to mitigate higher treatment costs during the operational and post-closure periods in the event of a release and required corrective action. TDEC is concerned about the effects of disposal of such a large volume of mercury, albeit in lower concentrations than the threshold for hazardous waste. TDEC would like to reserve further discussion of this issue and look at the potential impact of removal of all D009 hazardous wastes on earlier predictions of concentrations in leachate.

4. Removal of H-3, Tc-99, I-129, and C-14 during operations via wastewater management

Resolution of Critical Issue 5 (Waste Leaching) states:

> "The EMDF PA base case scenario is conceptually consistent in applying a common [*RESRAD*] release model [*instantaneous equilibrium desorption*] to pre- and post-closure periods."

Practically, use of this release model in the PA groundwater pathways base case results in the substantial removal of mobile radionuclides from the disposed inventory during the operational period. Specifically, the PA assumes that 59% of H-3, 81% of C-14, 44% of Tc-99, and 14% of 1-129 will be recovered in leachate during the operational period. The groundwater pathways WAC for H-3, C-14, and Tc-99, given as total activity limits (Ci) in Table 2.5 of the draft EMDF ROD, are based on these assumed operational period losses.

Resolution of Critical Issue 5 (Waste Leaching) states:

> "Taking credit for waste forms and containers to limiting leaching in the operational period would be more pessimistic for highly mobile radionuclides, but DOE and LFRG do not endorse adopting worst case technical assumptions for Order 435.1 compliance determinations."

The PA description of anticipated waste forms and radiological contamination does not support an expectation that much of the inventory of H-3, C-14, and Tc-99 will be lost during the operational period. Section B.2.1 of the PA states:

> "EMDF waste forms will include contaminated soil (including contaminated sediment and other soil-like waste) and debris. The bulk of the debris expected from demolition

activities will be concrete and masonry (walls, floors, ceilings, and building structure), steel (building structural members, rebar, piping, and some equipment), and process equipment (gloveboxes, machining equipment, pumps, and other)."

Review of Table B.1 indicates the anticipated volume of debris is approximately twice that of soil and soil-like waste. Release of radionuclides from surface or bulk contaminated debris may be delayed as these materials degrade over time in the landfill. Furthermore, according to Section B.2.1 of the PA , approximately 14% of both debris and soil related to Y-12 facility waste is expected to require packaging and treatment to meet land disposal restrictions for mercury. Therefore, assuming some of this inventory is unavailable for release until sometime post-closure is not a "worst case" assumption, but rather a "most-likely case" assumption.

The PA, and the proposed groundwater pathways analytic WAC for H-3, C-14, and Tc-99 in Table 2.5 of the proposed EMDF ROD, should be revised to include realistic and protective assumptions for operational period losses of soluble radionuclides.

5. Potential for EMDF to contain massive amounts of U at WAC limits

Uranium toxicity is not addressed; yet is more likely to be limiting in terms of allowable inventory than uranium's radiological effects.

6. BTP on waste classification as an ARAR to support Class C limits

Industry-standard guidance for defining Class C waste is provided in NRC's Concentration Averaging and Encapsulation Branch Technical Position (BTP). Citing this guidance would complement the prohibition on Class C or greater waste in Table 2.4.

7. Waste 'package' not defined in context with Table 2.6 limits

Table 2.6 limits are described as being "applicable to individual waste lots or smaller units such as disposal packages." Clarification of the terms "waste lot" and "package" is needed in order to understand the maximum potential volume over which Table 2.6 limits might be averaged in the case of wastes that have a combination of higher and lower concentrations of limiting radionuclides.