NRC Clarification Questions and Summaries of DOE Responses

For Meeting Held in July
2013
as part of the
Consultation on the
Draft Basis for Section 3116 Determination
for Closure of H-Tank Farm
at the
Savannah River Site

ID	TITLE	NRC QUESTION	SUMMARY OF DOE RESPONSE
Meeting Date: July 3, 2013			
1	Inadvertent Intrusion Wells in GoldSim Model	Clarify what wells are considered for intruders in GoldSim modeling. Is the maximum of concentrations/dose for the seven intruder wells, plus 1 m locations considered, or just the maximum of the seven intruder wells considered?	DOE indicated that it considered seven intruder wells, but didn't evaluate at the 1-m boundary in GoldSim. DOE also indicated that it didn't perform a study to evaluate locations of wells. Rather, placement was done by professional judgment.

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2	Saturated Zone Dilution in GoldSim Model	Clarify the components/parameters of the GoldSim modeling that effect saturated zone dilution including the following potential mechanisms: a. Mixing vertically over aquifer thickness b. Dilution due to flow of clean water into cell/pipe elements c. Dispersion along the flow path d. Additional mixing at the end of the pipe element Provide a ball-park estimate of dilution factors for a conservative tracer from different waste tanks.	DOE indicated that vertical mixing is controlled by vertical dispersivity. The GoldSim pipe element calculates 1-D transport including dispersion over the aquifer thickness. DOE uses the GoldSim plume function to recalculate concentrations based on the assumed source dimensions and dispersivities. DOE used a source thickness of 3-m, which is comparable to the thickness of a numerical cell in the PORFLOW modeling. In PORFLOW, DOE indicated that the radionuclide flux from the near-field modeling was loaded into the saturated zone in the cell with the highest elevation that is fully saturated and has a centroid within the tank footprint. For tanks that are submerged, DOE indicated that the source cell was located at the saturated elevation closest to the basemat. DOE indicated that it believes that the sensitivity of concentrations to loading cell dimensions is insignificant. DOE provided estimates based on GoldSim pipe element for saturated zone dilution factors: 24 from the GoldSim pipe element if assuming full aquifer thickness of 130-m and 1.8 when using plume function and source zone thickness of 3-m with no dispersion. DOE also estimated saturated zone dilution factors from the plume function accounting for source zone thickness of 5 (500ft pipe element length), 9 (1000 ft. pipe element length), 13 (1500ft pipe element length), and 16 (2000ft pipe element length) - estimated from plume function. Only transverse dispersion was considered in calculating these dilution factors. DOE indicated that it estimated a saturated zone dilution/mixing factor at the end of the pipe element for GoldSim modeling calculated as the ratio of the Darcy velocity near the compliance point to the Darcy velocity along the flow path to the compliance point. This factor was needed to account for increased velocity nearer the compliance point and was found to be more significant for FTF. DOE indicated that it would need to go back and check and see how significant this factor was for HTF.

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3	Representation of Saturated Zone Flow and Transport Path in GoldSim Model	Clarify transport along the flow path in the saturated zone. Do the distances reflect both horizontal and vertical transport lengths? What portion of the flow path is represented by the pipe elements versus the cell elements upgradient of the pipe elements?	DOE clarified that the length of the pipe element pathway in GoldSim is determined solely by horizontal distance to the boundary and covers the distance from the tank footprint to the 100-m boundary.
4	Transport of Plumes in Aquifers in GoldSim Model	Clarify the sources whose plumes are expected to be spread over both Upper Three Runs and Gordon aquifers.	DOE indicated that it believed that most sources probably spread over both the UTRA and GA. DOE will confirm if needed.
5	Basis for Vertical Dispersion in Saturated Zone Aquifers in GoldSim Model	Clarify why vertical dispersion is needed (particularly for the eastern plumes) when the plumes are spread across the aquifer thickness.	See response to 2 above. Vertical dispersion is simulated by the plume function. The plume function corrects the concentrations calculated by the pipe element that assumes the total thickness of the aquifer.
6	Treatment of Dispersivity in Saturated Zone Aquifers in GoldSim Model	When flow is primarily in the vertical direction, longitudinal dispersivity is applied in the vertical direction. If plumes are assumed to be spread across the aquifer, then is it appropriate to disperse the plumes through use of the longitudinal dispersivity? Or does the dispersivity only get used for that portion of flow that is longitudinal?	See response to 2 above that partially addresses this question. Vertical dispersion is simulated by the plume function. The plume function corrects the concentrations calculated by the pipe element that assumes the plume is spread over the total thickness of the aquifer. NRC noted the difficulty in assigning longitudinal and transverse dispersivities in the abstracted model due to issues with changing vertical and horizontal flow directions in the 3D model that are simplified to 1D horizontal flows in GoldSim.
7	Transverse Horizontal Dispersivity Adjustment in GoldSim Model	Clarify the increase in transverse horizontal dispersivity to represent the spreading of plume laterally due to changing flow direction.	DOE indicated that Figures 7.1-1 to 7.1-7 in the H-Area Tank Farm Stochastic Fate and Transport Model Report (SRR-CWDA-2010-00093, Rev. 2) depict the plumes formed by conservative tracers for Tanks 9 (Type I), 12 (Type I), 15 (Type II), 24 (Type IV), 29 (Type III), 40 (Type IIIA), and 49 (Type IIIA) .

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8	Relationship of Darcy Velocity and Dilution at the 100-m Boundary in GoldSim Model	Is the transport time a function of the Darcy velocity from stream traces only? Is the degree of dilution a function of the Darcy velocity at the 100 m boundary for the 100 m well concentrations? What are the Darcy velocities at the 100 m boundary or what level of dilution is seen at the 100 m boundary?	DOE indicated that the Darcy velocity is based on breakthrough curves and where peak comes in. See response 2 above that indicates that the mixing at the end of the pipe occurs and is a function of the ratio of the Darcy velocities over the pipe length and the end of the pipe (velocities increase nearer the 100 m boundary). DOE did not provide specific details on dilution factors (or Darcy velocity ratios) at the end of the pipe.
9	Abstraction of PORFLOW Flows in GoldSim	Clarify if/when deterministic flows abstracted from PORFLOW modeling are used in the GoldSim simulation.	DOE indicated that the GoldSim modeling selects only from the 72 flows profiles. Case B-D flows were placeholders and were not used. Deterministic runs in GoldSim use a Base Case flow and basecase flows were used for benchmarking.
10	Consistency of Flow Fields with GoldSim Probabilistic Realizations	Clarify how the flow fields generated for Cases A, C, and E comport with the actual conceptual models being simulated. Specifically comment on the apparent lack of direct correlation between parameters varied to reproduce alternative flow cases and the presence of active fast flow pathways that are central to several alternative scenarios. For example, Case E is inherently a by-passing scenario. However, assumptions regarding degradation of cementitious materials considered in alternative flow cases implemented in GoldSim probabilistic modeling will impact the amount of flow through the fast flow pathway with the potential for many of the cases to effectively inactivate or limit the impact of the fast flow pathway. Provide information on the range of flows simulated in the fast, by-passing pathway in Case E (and alternative cases), including a comparison of flow through the fast pathway for alternative flow cases E1 through E22 and the deterministic Case E flow case. Consider whether a subset of flows should be considered for each Case consistent with the conceptual model, or alternative flow parameters altered to more accurately reflect the conceptual model.	DOE indicated that they attempted to represent flow field variability with each of the cases to produce a more robust probabilistic analysis. However, no consideration was given to how much flow was through the preferential pathway in Case E.

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11	Basis for Basemat By-Pass Fraction in GoldSim	Clarify the basis for the basemat by-pass fraction used in GoldSim modeling. Confirm the correlation between bypass flow and bypass fraction in individual realizations.	DOE indicated that there was no correlation between by-pass flow and by-pass fraction. DOE indicated that the probabilistic model evaluated the range of potential dose as insufficient information is available to predict exactly how and to what degree preferential flow will occur. Review of maximum realizations is helpful in this regard.
12	Simulation of Ancillary Equipment in GoldSim Modeling	Clarify if you are able to turnoff ancillary equipment when running individual sources in GoldSim modeling.	DOE indicated that individual sources can be simulated in the GoldSim modeling without including the ancillary equipment. DOE clarified that if GoldSim will not zero-out the ancillary time-series elements in the TransportModel_Results container, however.
13	TSProc.dll Source Code	Provide documentation for the TSProc.dll used in the GoldSim modeling including source code.	DOE will provide the TSProc.dll
14	Intermediate Outputs from GoldSim Transport Model	Clarify what intermediate outputs are or can be saved in the HTF Transport Model.	DOE clarified that intermediate outputs can be saved for the HTF Transport model. DOE indicated that in order to do so, the user would have to select that results be saved in the GoldSim modeling HTFTransport Submodel container properties. DOE cautioned that GoldSim has a limit to the amount of data that can be saved and the intermediate results from this submodel may overwhelm that limit..
15	Other Dynamically-Linked Library Source Codes	Provide source code for other *.dlls used with the HTF Goldsim model.	DOE will provide source codes for all DLLs used in GoldSim.

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16	Benchmarking of GoldSim and PORFLOW Models	SRR-CWDA-2010-0009 indicates that benchmarking comparisons are only carried out for the Base Case. Potentially higher risk alternative cases are not benchmarked. For example, Case E represents a by-pass scenario where releases could occur significantly earlier in time at significantly higher magnitude. Benchmarking of Goldsim modeling to PORFLOW modeling results would be instructive to ensure all significant transport processes are adequately simulated for these higher-risk alternative cases, if these results are available or could easily be generated (FN1: It is not clear that Case E transport is simulated in PORFLOW modeling) Additionally, benchmarking is only performed for a limited number of radionuclides (e.g., Ra-226, Tc-99, I-129, and Cs-135) all of which are relatively long-lived radionuclides. Because risk-significant quantities of short-lived radionuclides may remain in Type I and II tank annuli, benchmarking of results to simulations performed in PORFLOW modeling for relatively short-lived radionuclides that are more sensitive to travel times would be beneficial. Finally, only certain exposure point locations are benchmarked. For example, only doses calculated at a well next to Tank 12 were evaluated for the inadvertent intruder. It is not clear that alternative configurations were simulated for the inadvertent intruder. However, alternative configurations should also be benchmarked against PORFLOW modeling if these results are available or could be easily generated.	DOE indicated that it chose not to benchmark PORFLOW and GoldSim model results for the alternative cases. Benchmarking was only performed for the Base Case. DOE indicated that the HTF PA (SRR-CWDA-2010-00128, Rev. 1), Section 5.6.7.1.1 (pg. 688) discusses the alternative cases that were evaluated in PORFLOW modeling for the 100-m compliance boundary. DOE will check to see where PORFLOW files are stored in the set of PORFLOW modeling files previously sent to NRC.

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17	Wall Flux Benchmark Factor	Clarify the use of the benchmarking factor of 0.08 to adjust the wall flux.	DOE indicated that it believed the radionuclide flux in the wall would be convective with upward and downward components. The GoldSim modeling originally resulted in more radionuclide flux coming out of the wall than from the PORFLOW modeling results. DOE indicated that it approximated the factor to match the PORFLOW results. DOE stated that it believes the factor enhances diffusion of radionuclides relative to advection.

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18	Annular Flow Abstraction From PORFLOW to GoldSim Model	The PA, Section 5.6.2.2.1 states: *As Figure 5.6-2 illustrates, after liner failure, the GoldSim Tc-99 release overlies the PORFLOW release, indicating that the solubility control associated with the CZ* [Contaminated Zone] *is being accurately approximated in the HTF GoldSim Model. Prior to liner failure, the Tc- 99 release is dominated by the release of an inventory initialized at the bottom of the annulus. The differences between the two curves prior to liner failure are caused by differences in the manner that the annulus chemistry transition times are evaluated in the two models. In the PORFLOW model, the transition times are based on the pore volume of the entire annulus and the volumetric flow through that pore volume. In the GoldSim model, the transition times are based on the pore volume of the annulus located below the secondary liner and the volumetric flow through that abbreviated pore volume.* Clarify how the flow tracked in the annulus in PORFLOW modeling differentiates the entire annulus versus the abbreviated annulus beneath the secondary pan. It appears that only two flows for the inner and outer annulus are tracked in PORFLOW modeling. How are the PORFLOW model flows then aggregated to compute the volumetric flow through just the abbreviated portion of the annulus to calculate chemical transition times in GoldSim modeling? Although the peak dose for Tc-99 is similar between the PORFLOW and GoldSim model results, the chemical transition time is significantly different. Clarify if the difference in chemical transition time could be risk-significant for other radionuclides that are more sensitive to timing of release.	DOE stated that it modeled an abbreviated portion of annulus to calculate chemical transitions in GoldSim modeling. Therefore, the GoldSim modeling uses a smaller volume because it only includes everything below the secondary liner. DOE indicated that the difference in volumes used to represent the annulus between the GoldSim and PORFLOW models is the cause for the difference in chemical transition times. DOE also indicated that its modeling approaches assumed annulus inventory was not a dose driver because it was not expected to contain significant quantities of radionuclides compared to the contaminated zones within the primary tank liners. DOE discussed Tc-99 solubility studies and explained that the peak dose was approximately 40 mrem/yr after 10,000 years.

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19	Inventory Multipliers in GoldSim Model	Section 5.6.3.1 of the PA, "Radiological Inventory," describes how a minimum of 0.01 and a maximum of 10 were applied as multipliers for the inventory estimates for most radionuclides based on the samples from Tanks 5, 18 and 19. a. Given that the sample results for several of the HRRs (e.g., Tc-99, Cs-137, Pu-240) were more than one order of magnitude greater than the projected values, please clarify how you are confident that a one order of magnitude multiplier is adequate for these radionuclides. b. The multipliers used in the model are based on SRR-CWDA-2010-00023, Rev. 1 instead of Rev 3. For the most part the differences in multipliers is conservative (for Pu-241 (in Tanks 9 and 10), Th-232 (in Tanks 9 and 10), U-236 (in the Type III and IIIA tanks), and U-238 (in Tanks 21, 22, and 23), the current estimate (10) is higher than the previous value (1). However, for a few radionuclides the use of the previous value is non-conservative. The PA states that this is not significant. Please clarify why the maximum multiplier was revised to be 10 in Rev 3 instead of 1 in Rev 1 for some radionuclides and why DOE is confident that the difference is not significant.	DOE indicated that although certain specific radionuclides were greater than one order of magnitude over the projected values, the general trends from sample results did not suggest that a multiplier more than an order-of-magnitude (i.e., 10x) would be necessary. Importantly, DOE stated that it wanted to avoid 'double-counting' conservatism with inventory multipliers since it also increased estimated volumes in comparison to FTF volume assumptions and increased concentrations used in response to the Tanks 5 and 6 final sample analyses. DOE expects the estimated volume of 4,000 gallons to be conservative. DOE plans to focus on updating inventory projections rather than adjusting multipliers in special analyses as tanks are cleaned. DOE indicated that it revised inventories from SRR-CWDA-2010-00023 Rev 1 to Rev 3, but that the models for the PA were not updated because of schedule conflicts. DOE evaluated whether updating the model to Rev. 3 values was risk-significant on a rad-by-rad basis by inspection. The PA (SRR-CWDA-2010-00128, Rev. 1), on page 609, discusses the risk significance for specific radionuclides including Pu-241, Th-232, U-236, U-238. DOE indicated that these radionuclides were not Highly Radioactive Radionuclides (HRRs) and that the non-conservatism was limited to small number of tanks. Therefore, DOE concluded that updating the inventory multipliers in the model was not necessary.

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20	Solubility Limits in Contaminated Zone for Diffused Radionuclides	Although no solubility control is assumed for contaminants located in tank annuli, solubility controls are realized for contaminants that are able to diffuse into the contaminated zone (CZ) from the annuli prior to significant release. For example, Tc-99 in Tank 16 is present in higher quantities in the annulus (primary sand pad) compared to the CZ with no effective transport barrier between the two (Tank 16 is assumed to have a failed liner at time=0 years; the tank liner would constitute a transport barrier if it were effective). The Tc-99 inventory located in the primary liner is constrained to low aqueous concentrations owing to solubility controls placed on this constituent in the CZ. Given the large concentration gradient and small diffusion length between the primary sand pad, where the bulk of Tank 16 annulus contamination is placed in the PORFLOW model, and the CZ, a significant portion of Tc-99 diffuses into the CZ where it is retained for most of the simulation timeframe. Although Tc-99 in Tank 16 may not be risk-significant, risk-significant quantities of key radionuclides may be present in Tank 16 or other tanks and experience the same phenomena. Clarify the impact on release (or dose) of solubility control on that portion of annular inventory that diffuses into the CZ or clarify the basis for the assumption of solubility control for annular waste that diffuses into the CZ.	DOE confirmed the NRC staff observation that radionuclides diffuse from the annulus into the contaminated zone and become solubility limited. DOE reiterated its belief that sources associated with the annular contamination (rather than the contamination within the primary liner) are not significant to overall dose.

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21	Type I Annular Contamination Abstraction	DOE assumes that waste located in the annulus of Type I tanks is located in the bottom inch of reducing grout. Therefore, the reducing grout can constitute a barrier to waste release for key radionuclides. It is plausible that the barrier effectively retains key radionuclides until chemical transition takes place at which time flow through the system may be higher leading to higher releases. However, it is also plausible that hold-up of waste in the reducing grout can lead to an under-prediction of dose. Clarify if there are any non-conservative impacts associated with loading the annular source in the reducing grout in Type I tanks or provide a defensible basis for assuming that the waste is effectively mixed in the annular reducing grout.	DOE reiterated its belief that sources associated with the annular contamination (rather than the contamination within the primary liner) are not significant to overall dose. NRC indicated that peak realization GoldSim results show that Sr-90 can be a dose driver (e.g., Tank 15 Sr-90 doses were in the rem range with comparable inventories for Case E).
22	Liner Integrity for Leaking Tanks	The PA, Section 5.6.2.1.1, "Representative Contaminant Sources," states that Tank 9 was modeled with an intact liner. However, Tank 9 (as well as Tank 10 and 14) is assumed to have significant quantities in the annulus. Clarify the basis that the primary liner is assumed to be an effective barrier given releases of material.	DOE indicated that its modeling does not allow consideration of partial liner capabilities. DOE stated that Leak sites are higher than CZ. Tank inspection reports report both the coverage of the annulus and the tank wall.

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23	Cementitious Material Transport Path from Annulus	The PA, Section 5.6.2.2.2 states: *For Tank 13, a Type II tank with an intact liner, the initial exit route is from the sand pad to the annulus and upward through the annulus. The mass must first migrate above the 5-foot secondary liner vertical extension, before it can leave the system by migrating through the vault wall, into the concrete basemat, and finally into the saturated zone.* This states that the waste goes through the basemat, but Figure 4.4-2 in the PA (SRR-CWDA-2010-00128, Rev. 1) shows that the basemat does not extend out to the sides from beneath the annulus. Clarify the material property assignments at the base of the wall (adjacent to the basemat) in PORFLOW modeling and in Goldsim modeling and if they differ from the actual materials in the real system. If the material zones differ from reality or each other, clarify how the representation of this zone in PORFLOW modeling and/or GoldSim modeling is adequate for the purpose of PA modeling. Clarify whether PORFLOW models diffusion through the vault wall to the near-field environment, thereby bypassing the concrete basemat.	DOE noted that flow modeling suggests that flow beneath the tank generally proceeds towards the interior of the tank. DOE stated that in PORFLOW modeling flow proceeds from the wall to the basemat on the underside of the tank. DOE also indicated that its GoldSim modeling simulates diffusion from the concrete vault wall to the concrete basemat and not directly from the vault wall to the surrounding soil.

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24	Annular Fast Flow Paths	HTF tanks contain construction features that may represent potential preferential or by-passing pathways through the annulus, although these features are not explicitly represented in the models. For example, direct releases of radioactivity into the environment occurred from leakage of primary waste from Tank 16 into secondary containment. From secondary containment, it is believed that waste overtopped the secondary annulus pan and was released directly into the environment through construction features (e.g., joints) in the tank vault (DP-1358). Although Case E represents a scenario where a fast-flow pathway exists through the tank system, the fast-flow pathway only comes into contact with a portion of annular contamination located in the primary (and secondary) sand pads near the fast flow pathway in Type II tanks. Annular contamination in Type I tanks is loaded into reducing grout that will be used to stabilize the annuli during the closure process. Thus, Type I annular contamination is not in direct contact with fast flow pathways in Configuration E. Although contamination could be transported from the outer sand pads towards the inner sand pad where the fast flow pathway exists in Type II tanks, it is not clear that this mechanism adequately evaluates the potential risk of the release of contamination from tank annuli through construction joints that have already shown to transmit significant quantities of waste as well as allow in-leakage of groundwater back into the tanks due to water table rise (DP-1358) and meteoric groundwater infiltration following precipitation events. Clarify whether fast flow paths through the annular contamination in Type I tanks are modeled.	DOE confirmed that NRC's understanding of its modeling of fast flow paths through the annuli is correct. DOE stated that it doesn't think lateral flow through submerged tanks from groundwater would increase peak doses, but that it hasn't modeled lateral fast flow. DOE indicated that it believed that in order to increase peak doses, downward flows would need to be maximized and that lateral flows would likely increase travel times and decrease peak doses. NRC noted that for submerged tanks, that travel times would not be increased with lateral flows.
25	Location of Transfer Lines in Modeling	Clarify basis for location of transfer lines in modeling. Transfer lines are located within the immediate footprint of HTF (see figure below). However, in reality transfer lines could be located closer to the 100 m boundary.	DOE indicated that it doesn't believe that simulating transfer lines closer to compliance boundary would be significant. The doses at 1 m were insignificant. DOE indicated that the doses were maximized by putting all the transfer line inventory within the 1 m boundary.

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26	Waste Classification Calculations in GoldSim Model	Provide GoldSim files for the waste classification calculations.	DOE indicated that it performed separate simulations for waste classification, but didn't believe that the simulations were distinct from intruder dose calculations. DOE stated that it will send waste classification calculations simulation files to NRC staff.
27	Alternative Configuration Results from PORFLOW Model	Provide results of alternative configurations using PORFLOW.	DOE agreed to provide PORFLOW transport modeling files of alternative configurations, if not already provided to NRC.
28	Biosphere Pathway Dose Conversion Factors	Provide PDCFs for HTF. Clarify what changes were made to the biosphere modeling since FTF.	DOE summarized changes to the biosphere modeling: (i) new pathways for chicken and egg ingestion; (ii) leachate factor based on water introduction from precipitation and irrigation; (iii) garden crop yield increased from 0.7 to 2.2; (iv) stochastic sampling of transfer factor for beef ingestion; (v) transfer coefficients aligned with IAEA report; (vi) updated 15 cm exposure depth external DCF for Ra 2-3 orders of magnitude; (vii) ignore holdup times; (viii) annual time spent swimming increased 75%; and (ix) time boating increased 5%.
29	Portage PORFLOW Modeling Files	Provide PORFLOW modeling files constructed by Portage.	DOE agreed to provide modeling files performed by Portage.
30	Portage PORFLOW Modeling Flow Vectors	Provide information on flow vectors (magnitude) for submerged tanks initially, for fully degraded conditions, and capped conditions based on the Portage modeling results.	DOE indicated that they were not able to use Tecplot tools to to extract data from irregular grid in Portage modeling and that it had to rely instead on PORFLOW's graphical user interface. NRC staff will use the PORFLOW graphical user interface to gain the information when it gains the Portage modeling.

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31	Comparison of Near-Field Fluxes from PORFLOW and Portage Modeling	Compare flux through the near-field model domain versus flux that would occur through the Portage model for submerged tanks under various conditions (initial, degraded, capped). Note that DOE provides a rationale for why horizontal flow doesn't need to be considered, but a direct comparison of the magnitude of flow rates through the tank for submerged tanks in the Portage modeling was not provided.	NRC staff indicated that it will look at this more when we get the files.

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