U.S. Department of Energy
Hanford Site

August 6, 2020

20-TF-0060

Ms. Alexandra K. Smith, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Dear Ms. Smith:

U.S. DEPARTMENT OF ENERGY RESPONSE TO ECOLOGY LETTER FROM J. J. LYONS TO B. A. HARKINS, "RE: WASTE MANAGEMENT AREA C (WMA C) CLOSURE PERFORMANCE STANDARD," 20-NWP-062, DATED APRIL 1, 2020

References: See Attachment 1

The U.S. Department of Energy (DOE) has the following significant concerns with several of the assertions made by the Washington State Department of Ecology's (Ecology) Nuclear Waste Program in its April 1, 2020, letter 20-NWP-062, "Re: Waste Management Area C (WMA C) Closure Performance Standard."

First, DOE is concerned that Ecology has attempted to reverse its previous decision-making with regard to Waste Management Area (WMA) C. Ecology purports to reserve its right to require clean closure of all, or a portion of, WMA C (depending on the outcome of the U.S. Nuclear Regulatory Commission's [NRC] review of DOE/ORP-2018-01, *Draft Waste Incidental to Reprocessing Evaluation for Closure of Waste Management Area C at the Hanford Site*, Draft D) despite Ecology's previous agreement with DOE's determination of landfill closure for WMA C, as communicated by Ecology in its June 12, 2019, letter 19-NWP-090, "Re: Transmittal of Supplemental Information to the *Clean Closure Practicability Demonstration for the Single Shell Tanks*, DOE/ORP-2014-02-SUPP1, Revision 0."

This causes concern, in part, because the source of Ecology's regulatory authority over WMA C closure decisions is the *Washington Administrative Code*. DOE, pursuant to its authority under the *Atomic Energy Act of 1954* (AEA) and DOE O 435.1, *Radioactive Waste Management*, requested NRC's consultative review of DOE/ORP-2018-01, to the extent that the document relates to AEA materials. Ecology lacks regulatory authority over AEA materials and does not have decision-making authority over management decisions made pursuant to DOE's authority, which stems from federal regulations, agency orders, manuals, or guidance related to AEA materials. Document DOE/ORP-2018-01 exclusively analyzes radionuclides regulated under the

AEA, pursuant to DOE O 435.1 procedure for waste incidental to reprocessing (WIR). To the extent that Ecology appears to suggest that it will condition (hazardous waste) closure decisions on the outcome of the NRC's consultative review of DOE's WIR processes, DOE disagrees. Although Ecology may be authorized to regulate certain aspects of DOE's management of WMA C, the source of that authority is separate and distinct from DOE's AEA authority for WIR.

Furthermore, procedures, requirements, and criteria that Ecology is authorized to administer are separate and distinct from AEA and DOE O 435.1 processes.

DOE evaluated options for clean closure in single-shell tank (SST) WMAs, including, but not limited to, those SSTs in WMA C in DOE/EIS-0391, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*; DOE/ORP-2014-02, *Clean Closure Practicability Demonstration for Single-Shell Tanks*; and DOE/ORP-2014-02-SUPP1, *Supplemental Information to the Clean Closure Practicability Demonstration for the Single-Shell Tanks* (together, the "practicability demonstration evaluation and supplemental information"). In Ecology's forward to DOE/EIS-0391, Ecology did not disagree with DOE's landfill closure decision, stating only, "These closure plans will be subject to public comment and agency response before landfill decisions can be implemented." Ecology's agreement with DOE's determination that landfill closure will proceed for WMA C, since clean closure is not practicable, is memorialized in 19-NWP-090. Pursuant to WAC 173-303-640, "Tank Systems," these analyses set forth in the practicability demonstration evaluation and supplemental information demonstrate that it is necessary and appropriate to close WMA C and other SST WMAs via the landfill closure approach.

DOE acknowledges that Ecology is developing closure performance standards in support of decisions related to the landfill closure of WMA C. Document RPP-ENV-58806, *RCRA Closure Analysis of Tank Waste Residuals Impacts at Waste Management Area C, Hanford Site, Washington*, provides a specific analysis evaluating the groundwater impacts of hazardous chemicals from residual waste left in tanks and ancillary equipment under these anticipated landfill closure conditions at WMA C. This analysis is one of several analyses identified by Appendix I of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement [TPA]) to support closure actions at WMA C. The overall results of the evaluation of residual waste impacts in RPP-ENV-58806 demonstrate that use of landfill closure at WMA C will be protective of groundwater. DOE will comply with the applicable landfill closure standard outlined in paragraph (6) of WAC 173-303-665, "Landfills," as described in the WMA C Closure Plan.

Second, DOE is concerned that Ecology's requests related to the technical analysis for WMA C are inappropriate. The request for analysis, as set forth in 20-NWP-062, is neither technically defensible nor relevant to the decisions regarding the WMA C landfill closure. For example, Ecology questions whether DOE's model is consistent with Ecology's model criteria, which are contained in paragraph (8) of WAC 173-340-747, "Deriving Soil Concentrations for Groundwater Protection." The site-specific flow and transport model used in this evaluation of

the impacts of landfill closure at WMA C is not used to derive soil cleanup levels protective of groundwater, and the review of alternative models using the regulatory framework and related criteria outlined in WAC 173-340-747(8) do not apply specifically. The screening evaluation requested by Ecology in Appendix E of RPP-ENV-58806 (comparing *Model Toxic Control Act* soil cleanup values to tank waste residuals) misinterprets and misapplies WAC 173-340-747.

The Ecology-requested screening analysis does not consider any of the key elements of landfill closure (for instance, the effects of grout-filled tanks, the use of engineered surface barriers, and site-specific hydrologic conditions), such that the requested comparisons of residual waste concentrations with soil cleanup values are not technically defensible or relevant to specific decisions related to the landfill closure at WMA C.

Notwithstanding DOE's concerns with the analysis Ecology suggests in support of RPP-ENV-58806, and in the spirit of cooperation, DOE will provide the requested information for Ecology's awareness. The information DOE provides will not be included in the final RPP-ENV-58806 that DOE will submit to Ecology.

The focus and purpose of RPP-ENV-58806 is to provide the specific analysis of the groundwater impacts of hazardous chemicals from residual waste left in tanks and ancillary equipment under landfill closure conditions at WMA C. This analysis is necessary to support decisions related to the final closure of WMA C.

To be clear, the sorption values used in RPP-ENV-58806 are consistent with the sorption values used for uranium, as recommended in *Technical Guidance Document for Tank Closure Environmental Impact Statement Vadose Zone and Groundwater Revised Analyses* (ORP 2005), which is the technical guidance document that provided the basis for those used in DOE/EIS-0391.

Site-Specific Conditions

The site-specific modeling of dilution rates in RPP-ENV-58806 accounts for local-scale hydrologic conditions. Key aspects of these conditions include: 1) low effective infiltration rates and fluxes from vadose zone to groundwater; 2) high flow rates in the underlying permeable unconfined aquifer; and 3) the groundwater flux in the unconfined aquifer, which is based on the calibrated Central Plateau Groundwater Model, as discussed in Appendix C of RPP ENV-58806.

DOE does not agree that a statewide default value should be used as Ecology suggests. DOE's position is that Hanford Site conditions should be considered for modeling. DOE values public and stakeholder knowledge and input and is concerned that a sitewide default value would ignore public and stakeholder input. The high hydraulic conductivities and low hydraulic gradient in the gravels deposited in the paleo channel that runs underneath WMA C affect the amount of dilution estimated in the saturated zone. DOE has documented independent analysis that justifies the use of a range of dilution rates examined in RPP-ENV-58806 and is confident that this range

is justified technically. In RPP-ENV-58806, the dilution factor for the base case can be estimated by comparing peak concentration in Figure 7-43 for vadose zone with the saturated zone in Figure 7-44. A range of hydraulic conductivities and resultant groundwater flux values were evaluated in sensitivities studies. This overall range evaluated encompasses the values used in DOE/EIS-0391. The range of dilution rates considered for WMA C is consistent with dilution rates developed within the DOE/EIS-0391 modeling framework. In 20-NWP-062, Ecology cites the incorrect document in its comments on dilution rates. The correct document is RPP-ENV-58782, *Performance Assessment of Waste Management Area C, Hanford Site, Washington,* not RPP-ENV-58792. DOE remains unclear as to how Ecology estimated dilution rates from the tables cited in its letter.

Given the basic assumptions used in the generic screening-level default three-phase model recommended in WAC 173-340-747, comparisons of dilution rates from this generic model with those derived from the WMA C site-specific detailed numerical modeling are inappropriate, would not be relevant to specific closure conditions, and contrary to site conditions and information known to DOE and stakeholders.

With regard to Ecology's comment on information needed for criteria in WAC 173-340-747(8)(c), DOE's position is that the site-specific flow and transport model used in this evaluation of the impacts of landfill closure at WMA C is not used to derive soil cleanup levels protective of groundwater. As such, the review of alternative models using the regulatory framework and related criteria outlined in WAC 173-340-747 does not apply. DOE notes that, in the spirit of cooperation with Ecology and to support its review of this modeling effort, the current version of the draft modeling-related crosswalk is being provided formally to support Ecology efforts (see Attachment 2). The crosswalk has been updated to better address the latest Ecology comments and is meant to be generally consistent with the criteria defined in WAC 173-340-747(8) for use of alternative fate and transport models to standard methods used to establish soil cleanup levels protective of groundwater. This crosswalk includes all information about key model assumptions and parameterization of the detailed numerical flow and transport model used in this impact analysis of waste residuals left in tanks and ancillary equipment under landfill closure conditions at WMA C.

DOE has compared results using the methodologies from RPP-ENV-58806 with available published results on the impacts from WMA C in DOE/EIS-0391 (see Appendix G of RPP-ENV-58806). These comparisons show good agreement of modeled results when the same inventories and release models are used (see Section G.4 of RPP-ENV-58806). DOE acknowledged, in DOE/EIS-0391, that the WMA-specific analysis would be able to address items in more detail than DOE/EIS-0391, including evaluation of the actual post-retrieval inventory (versus the estimate done in DOE/EIS-0391).

Third, although DOE supports Ecology's intention to complement its regulatory role with contractor technical expertise, DOE will apply the appropriate scrutiny when considering any technical analysis provided by Ecology's contractors. As a regulated party, and to the extent that Ecology's analysis is not supported via citation to Ecology's regulations, DOE expects that

Ecology will demonstrate the technical justification. By way of reminder, DOE provided numerical input files to Ecology to facilitate Ecology's review of the impact analysis from waste residuals and past leaks.

Lastly, DOE is concerned that Ecology has demonstrated a resistance to continuing to follow established TPA processes.

DOE expects that Ecology will communicate its planned schedule for the new contractor review, along with any impacts that Ecology anticipates to any established TPA milestones or milestones that are under negotiation. DOE intends to document in TPA Project Manager Meetings that Ecology is responsible for communicating those items under the TPA Action Plan, Section 4.0, "Agreement Management," and Section 4.1, "Project Manager Role." DOE expects that Ecology will include the results of contractor review in Ecology's agency record in support of forthcoming permit conditions and closure plans and expects that Ecology will provide the same for DOE's meaningful review in advance of Ecology's decisions.

DOE requests that Ecology provide periodic updates to enable assessment of any impacts this last minute review by its technical contractor may have on current schedules and current efforts to complete TPA Appendix I analyses and closure documents. Additionally, DOE wants to note that any delays will be documented in TPA monthly Project Manager Meetings. Ecology and DOE are both responsible for milestone achievements.

DOE will provide ample technical justification to support WMA C closure decisions. DOE will make the requisite showing of a reasonable expectation that WMA C, when closed, will be protective of human health and the environment. DOE encourages Ecology to re-commit to the intent and letter of the TPA. Although Ecology's letters can provided useful summaries and confirmation of detailed technical discussions, DOE strongly believes that letters that contain detailed technical information detract from Hanford Site cleanup progress. DOE encourages Ecology to resume its participation in those formal discussions contemplated in the TPA, as the Tri Parties intended, to add value to and facilitate the progress of Hanford Site cleanup.

I would appreciate a meeting with you or John Price to discuss our shared goal of Hanford Site progress. If you have any technical or document-related questions, please contact Rod Lobos, Environmental Compliance Division, Technical and Regulatory Support, Office of River Protection, on (509) 376-0095.

Sincerely,

Brian A. Harkins

Digitally signed by Brian A. Harkins
Date: 2020.08.06 13:02:11 -07'00'

Brian A. Harkins, Deputy Assistant Manager
Tank Farms Project
Office of River Protection

TRS:RAL

Attachments and cc: See page 6

Attachments:
1. References
2. RPP-ENV-58806

cc w/attachs:
J. Alzheimer, Ecology
M. Barnes, Ecology
J. Bell, NPT
M. Bergeron, WRPS
R. Buck, Jr., Wanapum
L. Contreras, YN
D. Delistraty, Ecology
D. R. Einan, EPA
D. Goswami, Ecology
T. Howell, Ecology
S. Leckband, HAB
J. Lindberg, Ecology
J. J. Lyon, Ecology
N. Menard, Ecology
M. Murphy, CTUIR
K. Niles, ODOE
J. Perry, MSA
B. Rochette, Ecology
K. Rucker, Ecology
P. Rutland, WRPS
D. Silva, Ecology
M. Skorska, Ecology
Administrative Record
Environmental Portal
WRPS Correspondence

Attachment 1
20-TF-0060

References

(3 Pages Including Cover Sheet)

References

19-NWP-090, 2019, "Re: Transmittal of Supplemental Information to the *Clean Closure Practicability Demonstration for the Single Shell Tanks*, DOE/ORP-2014-02-SUPP1, Revision 0," (external letter to B.T. Vance, U.S. Department of Energy, Office of River Protection) from J.J. Lyon, Washington State Department of Ecology, Richland, Washington, June 12.

20-NWP-062, 2020, "Re: Waste Management Area C (WMA C) Closure Performance Standard," (external letter to B.A. Harkins, U.S. Department of Energy, Office of River Protection) from J.J. Lyon, Washington State Department of Ecology, Richland, Washington, April 1.

Atomic Energy Act of 1954, 42 USC 2011, et seq.

DOE/EIS-0391, 2012, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, U.S. Department of Energy, Office of River Protection, Richland, Washington, December.

DOE O 435.1, 2007, *Radioactive Waste Management*, Chg. 1, U.S. Department of Energy, Washington, D.C., January 9.

DOE/ORP-2014-02, 2014, *Clean Closure Practicability Demonstration for the Single-Shell Tanks*, U.S. Department of Energy, Office of River Protection, Richland, Washington.

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DOE/ORP-2018-01, 2018, *Draft Waste Incidental to Reprocessing Evaluation for Closure of Waste Management Area C at the Hanford Site*, Draft D, U.S. Department of Energy, Office of River Protection, Richland, Washington.

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Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

ORP 2005, 2005, *Technical Guidance Document for Tank Closure Environmental Impact Statement Vadose Zone and Groundwater Revised Analyses*, Rev. 0, U.S. Department of Energy, Office of River Protection, Richland, Washington, March 25.

PNNL-13895, 2003, *Hanford Contaminant Distribution Coefficient Database and Users Guide*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-16688, 2007, *Recharge Data Package for Hanford Single-Shell Tank Waste Management Areas*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-19945, 2010, *Soil Water Balance and Recharge Monitoring at the Hanford Site – FY 2010 Status Report*, Pacific Northwest National Laboratory, Richland, Washington.

RPP-ENV-58782, 2016, *Performance Assessment of Waste Management Area C, Hanford Site, Washington*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington, September.

RPP-ENV-58806, 2016, *RCRA Closure Analysis of Tank Waste Residuals Impacts at Waste Management Area C, Hanford Site, Washington*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington.

RPP-PLAN-47559, 2010, *Single-Shell Tank Waste Management Area C Pipeline Feasibility Evaluation*, Rev. 0, Washington River Protection Solutions LLC, Richland, Washington, December.

RPP-RPT-44042, 2016, *Recharge and Waste Release Within Engineered System in Waste Management Area C*, Rev. 1, Washington River Protection Solutions LLC, Richland, Washington, September.

WAC 173-303-640, "Tank Systems," *Washington Administrative Code*, as amended.

WAC 173-303-665, "Landfills," *Washington Administrative Code*, as amended.

WAC 173-340-747, "Deriving Soil Concentrations for Groundwater Protection," *Washington Administrative Code*, as amended.

Attachment 2
20-TF-0060

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

(21 Pages Including Cover Sheet)

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
General Assumptions. Assumptions related to chemical partitioning and advective flow in contaminant fate and transport in the hazardous chemical impact evaluation from waste residuals let in tanks and ancillary equipment under landfill closure conditions at WMA C are provided below.		
Sorption	**The basis for sorption used in this for flow and transport analysis of hazardous chemical impacts from waste residual left in tanks and ancillary equipment under landfill closure conditions at WMA C is provided below.**	**Yes**
	Explanation: The long-term evaluation of the impacts from landfill closure at WMA C used the linear sorption isotherm (constant K_d) to approximate the effects of sorption. This overall approach is a reasonable representation for modelling sorption of contaminants on the sediments and environment when released from residual waste left in tanks and ancillary equipment. Distribution coefficient (K_d) for the hazardous chemicals used in the analysis were based on estimates available from the scientific literature. Justification: Two different sets of K_d values are used in the RCRA Closure Analysis. K_d values were developed for contaminant transport through cementitious materials (i.e., grout and cement) and subsurface sediments. • The basis for the conceptual model of source-term release is provided in Section 6.2.1.1 • A linear sorption isotherm (using a K_d approach) is considered for determining sorption within grout and concrete layers of the tank wall as contaminants undergo diffusive (and advective) transport when released from tank residuals. The basis for these K_d values is described in Section 6.3.1.3 and K_d values are listed in Table 6-4. • A linear sorption isotherm (constant K_d) is considered for modeling sorption of contaminants to the vadose zone and saturated zone sediments once they are released from tank walls and ancillary equipment. As discussed in Section 6.2.2.1.5, the thick vadose zone sediments will not only buffer the residual-waste derived water within a short distance but also provide significant capacity for sorption. • The basis for the K_d values is described in Section 6.3.2.2.6 and K_d values are listed in Table 6-10. Documented: K_d values for cementitious materials were obtained from the following sources (see Table 6-4): • NAGRA NTB 02-20, “Cementitious Near-Field Sorption Data Base for Performance Assessment of an ILW Repository in Opalinus Clay.” • NIROND-TR 2008-23 E, “Review of sorption values for the cementitious near field of a near surface radioactive waste disposal facility, Project near surface disposal of category A waste at Dessel.”	

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	• PSI Bericht Nr. 95-06, "Sorption Databases for the Cementitious Near-Field of a L/ILW Repository for Performance Assessment." • SKB Rapport R-05-75, "Assessment of uncertainty intervals for sorption coefficients SFR-1 uppföljning av SAFE." K_d values for subsurface sediments were obtained from the following sources (see Table 6-10): • PNNL-16663, "Geochemical Processes Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site." • PNNL-17154, "Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site. • RPP-RPT-46088, "Flow and Transport in the Natural System at Waste Management Area C." Because K_d values were obtained from scientific literature, the following approaches do not apply to K_d values used in the RCRA Closure Analysis: • Use of default K_d values for non-ionic organics, ionizing organics, and metals • Use of the soil organic carbon-water partition coefficient (Koc) values to derive K_d values for non-ionic organics and ionizing organics • Use of fraction of organic carbon (foc) to derive K_d values • Use of site data to derive K_d values • Use of batch tests to derive K_d values	
Vapor phase partitioning	**Vapor phase partitioning was not considered in this fate and transport modeling. Further evaluation of the source of the Henry's law constant is not applicable.**	**N/A**
Natural biodegradation	**Biodegradation is not incorporated into this set of fate and transport modelling calculations.**	**N/A**
Dispersion	**Dispersivity estimates used in this fate and transport modelling were based on results of stochastic theory, evaluation of literature, experimental observations, and numerical simulations.**	**Yes**
	Explanation: • Field-scale dispersivities are referred to as macrodispersivities. Dispersivities are a function of matric potential (or soil moisture content) in unsaturated media and hydraulic conductivity in saturated media. Heterogeneities that exist at various length scales also result in a scale dependence of macrodispersivities in both unsaturated and saturated media. The use of a constant (asymptotic) macrodispersivity is considered appropriate for large transport distances considered at WMA C and are calculated separately for the unsaturated media and saturated	

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	media. The macrodispersivity estimates for unsaturated zone transport are estimated separately from saturated zone transport since the primary transport direction in the unsaturated media is perpendicular to the sediment layering while it is parallel to the sediment layering in the saturated media. Justification: • Details on how the macrodispersivity estimates for unsaturated media are made using different methods are provided in Section B.4.3.1 (Numerical Simulations), Section B.4.3.2 (Stochastic Theory), and Section B.4.3.3 (Experimental Observations). Section B.4.3.4 provides the recommended values for the macrodispersivity. • Details on macrodispersivity estimates for the saturated zone are provided in Section C.3.5.2 and presented in Table C-2. Documented: **Vadose Zone** • The basis for vadose zone dispersivity estimates is summarized in Chapter 6, Section 6.3.2.2.4 and the recommended values for various strata at WMA C used in the Base Case Evaluations of Alternative Geological Models I and II are presented in Table 6-8. • A detailed discussion and description of the data available and the methods used to develop the parameters are described in Appendix B, Section B.4. **Saturated Zone** • The basis for saturated zone dispersivity estimates is summarized in Chapter 6, Section 6.3.2.2.5 and the recommended value is summarized in Table 6-9. • Appendix C, Section C.3.5.2 describes the approach used to develop the parameter estimate. The relationship between longitudinal and transverse macrodispersivity estimates are presented in Section C.4.2.2. **Sensitivity Analysis** • Vadose zone flow and dispersion sensitivity analysis is provided in Chapter 8, Section 8.3.	
Decaying source	**Fate and transport models used for this hazardous chemical impact evaluation only accounts for decay of radionuclides.**	**No**
	Explanation: • Decay of hazardous chemical decay is not accounted for the modelling calculations. • However, radionuclide decay and ingrowth are key components of the fate and transport modelling. The calculations performed for source term and transport through the vadose and saturated zone account for	

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	radionuclide decay and ingrowth. Furthermore, the starting inventory was decay corrected to the assumed closure date of 2020. Justification: • Radionuclide decay and ingrowth was considered and accounted for in the modelling calculations. Documented: • Section 3.2.2.3 provides the residual inventory estimates that are decay corrected to January 1, 2020. • Section 6.3.1.6 provides the mathematical model used for source term calculations. The decay and ingrowth are accounted for in the mass balance equations. • Transport models for vadose zone and saturated zone developed using STOMP and GoldSim consider radionuclide decay and ingrowth.	
Dilution	**Effect of dilution in the saturated zone was incorporated in this fate and transport modelling using site-specific characteristics.**	**Yes**

	Explanation:
	• Because of usage of integrated 3-D STOMP flow and transport model for the vadose zone and saturated zone, the effects of dilution in the saturated zone for the mass flux arriving from the vadose zone are implicitly accounted. The vertical flow through the vadose zone is driven by the imposed recharge boundary conditions while the groundwater flow in the aquifer are based on imposed hydraulic head boundary, hydraulic gradient, and hydraulic conductivity of the aquifer. The saturated zone parameters are based on calibrated Central Plateau Groundwater Model.
	
	Justification:
	• Appendix C provides the technical basis for choice of hydraulic properties for the unconfined aquifer. C.3.3 provides the estimate for hydraulic gradient and flow direction. Section C.4 summarizes the parameter values used for the saturated zone. The recharge rates (net infiltration) considered for the Base Case vary spatially and temporally as summarized in Table 7-5. For the area covered by surface barrier, a recharge rate of 0.5 mm/yr. is applied for 500 years after closure followed by 3.5 mm/yr.
	
	• Site-specific modeling of dilution accounts for local-scale hydrologic conditions based on:
	  • Low effective infiltration rates and fluxes from vadose zone to groundwater
	  • High flow rates in the underlying unconfined aquifer.	

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	• The groundwater flux in the unconfined aquifer is based on calibrated Central Plateau Groundwater Model as discussed in Appendix C. • The dilution factor for the base case can be estimated by comparing peak concentration in Figure 7-43 for vadose zone with Figure 7-44 in the saturated zone. The dilution factor is approximately a factor of 10,000. • Uncertainty in dilution factor occurs from uncertainty in estimating saturated hydraulic conductivity, hydraulic gradient, and recharge rates. As a result, the dilution factors can range from 1,000 to 100,000 at WMA C. Documented: Vadose Zone • The conceptual model of vadose zone flow and transport is described in Chapter 6, Section 6.2.2.1.3 "Vadose Zone beneath Waste Management Area C". • The parameterization of vadose zone hydrogeology and transport is summarized in Chapter 6, Section 6.3.2.2.4 and base case recharge rates are summarized in Table 6-5. Saturated Zone • The conceptual model of groundwater flow and transport is provided in Chapter 6, Section 6.2.2.1.4 "Aquifer System beneath Waste Management Area C". • The parameterization of the groundwater domain and characteristics is described in Chapter 6, Section 6.3.2.2.5. • Additional information on the development of parameters is provided in Appendix C.	
Recharge/infiltration	**Recharge values used in the fate and transport model evaluation are based on site-specific data and consistent with choice of values used in other approved modeling studies.**	**Yes**
	Explanation: Recharge (net infiltration) estimates are based on studies conducted at Hanford Site over past several decades under variety of precipitation rates, soil type, and vegetation cover, including conditions representative of evapotranspiration barriers. The parameters selected to represent the post-closure recharge conditions are consistent with other modeling studies that have been approved for the Hanford Site (e.g., TC&WM EIS). Justification Basis for Recharge/Infiltration is provided in the following sections	

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	• Section 3.1.5.2.2 provides a summary of studies on estimate of natural recharge. • Section 3.1.5.2.3 provides an overview of anthropogenic recharge. • Section 6.4.1 provides the basis for recharge estimates. <u>Documented:</u> • The basis for the conceptual model on temporal changes in recharge is provided in Section 6.2.2.1.2 • The basis for the parameterization of recharge is provided in Section 6.3.2.2.3 and summarized in Table 6-5. • Sensitivity analysis case results related to recharge are provided in Section 8.2 <u>The following do not apply to recharge/infiltration in the closure analysis.</u> • WAC 173-340-747-5 was not used A default annual infiltration value was not used	
Other Key Model Parameterization and Assumptions used in this Impact Evaluation of Landfill Closure		
Waste inventory	**Basis for waste inventory used in the fate and transport model evaluation is provided below.**	Yes
	<u>Explanation</u>: The waste inventory evaluated in this analysis was based on the Best Basis Inventory information available on September 30, 2014. <u>Justification</u> As of September 2014, waste was retrieved from 13 of 16 SSTs in C Farm (C-101, C-103, C-104, C-106, C-107, C-108, C-109, C-110, C-112, C-201, C-202, C-203, and C-204) and was in progress for the remaining 3 tanks (C-102, C-105 and C-111). Only BBI inventory estimates based on pre-retrieval samples and model estimates are currently available for the three unretrieved tanks (i.e., C-102, C-105, and C-111). A variety of methods, including some engineering judgement, and assumptions used to estimate the inventories and concentrations of hazardous chemicals in residual waste in the WMA C SSTs and ancillary equipment at closure. The ancillary equipment includes the C-301 catch tank, the 244-CR vault, diversion boxes and pits, and pipelines associated with WMA C. <u>Documented:</u> Basis for Waste Inventory is provided in Section 3.2.2. • Inventories for retrieved tanks with post-retrieval sampling is discussed in Section 3.2.2.3.1 • Inventories for retrieved tanks without post-retrieval sampling is discussed in Section 3.2.2.3.2 • Inventories for tanks undergoing retrieval is discussed in Section 3.2.2.3.3	

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	• Inventories for ancillary equipment is discussed in Section 3.2.2.3.4 • The inventory used in the source term model includes the current estimate of the inventory and residual volume in Tables 3-13 through 3-15. • Final inventories evaluated in the base case is provided in Table 4.2 in Section 4.2 A detailed report on the hazardous chemical (and radiological) inventory estimates for waste residuals in tanks and ancillary equipment in C Farm at the time of closure is provided in RPP-RPT-42323, "Hanford C-Farm Tank and Ancillary Equipment Residual Waste Inventory Estimates."	
Constituent identification and screening	**Basis for constituent identification/screening used in the fate and transport model evaluation is provided below.**	**Yes**
	Explanation: The approach taken for identifying specific chemical constituents for more detailed analysis in this impact analysis based on evaluation of inventory-related information is discussed below. • The evaluation began with all chemicals for which WMA C tank inventory information is available in the BBI within the official Tank Waste Information Network System (TWINS) database. The BBI contains inventory estimates for 24 chemicals. • The next step in the evaluation process considered known toxicity information. Chemicals tracked in the BBI with no known toxicity information were excluded as COPCs. Twelve constituents (Bi, Ca, Cl, K, La, Na, PO_4, Si, SO_4, total inorganic carbon, total organic carbon, and Zr) were excluded from further consideration. The results of this overall COPC identification process identified a total of 12 chemical COPCs (Al, Cr, F, Fe, Hg, Mn, Ni, NO_2, NO_3, Pb, Sr, and total Uranium) for further evaluation in this analysis Justification An additional evaluation was conducted to identify any supplemental analytes in residual inventory estimates for retrieved tanks that were not included in the BBI but may be of interest in this impacts analysis. Residual inventory estimates for retrieved tanks were obtained from RPP-RPT-42323, Table D-1. A comprehensive list of C Farm analytes is provided in RPP-RPT-42323, Table D-1; this list of analytes was reduced to identify supplemental analytes based on the following exclusion criteria: • Analytes not required to be sampled in RPP-23403, • Analytes without known toxicity information (analytes excluded due to no know toxicological information is a source of uncertainty), • Analytes with nominal inventories less than 0.1 kg at each retrieved tank, as such small inventories were judged to have insignificant effect on the system performance, and	

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	• Analytes with K_d values greater than 3 mL/g (see Sections 6.3.2.3 and 7.2.1)[1]. The process of identifying supplemental analytes, resulted in six analytes (B, Co, CN, Se, Sn, and TBP) being identified for further evaluation in this analysis. A list of the supplemental analytes that were excluded from further consideration is provided in Appendix I. <u>Documented:</u> Basis for Constituent Identification/Screening is provided in the following sections • The basis for identification and screening of contaminants of potential concern are provided in Section 4.1. • The basis for a groundwater pathway screening analysis is provided in Section 6.3.2.3 and Section D6-5 (Appendix D). Results from the groundwater pathway screening analysis are provided in Section 7.2.1, and Section D6.5 (Appendix D).	
Source-term release	**Basis for source-term release used in the fate and transport model evaluation is provided below.**	**<u>Yes</u>**
	<u>Explanation</u>: The source term considers processes associated with release of contaminants from residual waste into the natural environment. Separate source terms are considered for each of the twelve 100-series tanks, four 200-series tanks, C-301 catch tank, 244-CR vault, and pipelines, resulting in 19 separate source terms. The inventory used in the source term model includes the current estimate of the inventory and residual volume (Tables 3-13 through 3-15). Source terms for pits and diversion boxes are not explicitly considered but are incorporated as part of the pipeline source term. <u>Justification:</u> Both mineral phase solubility-limited and matrix degradation rate-limited processes are considered for release of contaminant from the waste. These conceptual models are based on observations made through multi-year leaching tests and identification of mineral phases as presented in Chapter 6. The only constituent-specific release model considered in this analysis is based on empirical evidence of dissolved concentration limits for chromium. <u>Documented:</u>	

[1] Additional COPC identification was performed using the 3-D STOMP©-based flow and transport model to determine the maximum K_d value of COPCs in the WMA C tank residuals that are capable of reaching the water table in 1,000 and 10,000 years. Methodology used in that COPC identification analysis is presented in Section 6.3.2.3, and results are provided in Section 7.2.1.

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	Basis for the conceptual model of source-term release is provided in the following sections: • The basis for the conceptual model of source-term release is provided in Section 6.2.1. • The basis for tank residual waste leaching parameterization is provided in Sections 6.2.1 and 6.3.1. • The basis for diffusion coefficient parameterization is provided in Section 6.3.1.2. Basis for tank residual waste leaching and diffusion coefficients used in source-term release analysis is provided in following sections: • The basis for the source-term mathematical model is provided in Section 6.3.1.6. • Base case results for source-term release are provided in Section 7.1 • Sensitivity analysis case results related to source-term release are provided in Sections 8.4, 8.5, 8.6 and 8.7	
Tank stability and concrete and grout degradation	**Basis for tank stability and concrete/grout degradation used in the fate and transport model evaluation is provided below.**	**Yes**
	Explanation: At closure, the tanks will be filled in with grout to provide structural and chemical stability and low permeability. During the placement of grout, the tank structure itself acts as a form into which the grout is poured. If the placement is not significantly interrupted, and if the grout mixes meet the placement specifications, the result will be a large monolith of emplaced grout. For the purpose of this impacts analysis, the thickness of the infill grout is assumed to be 5 m (16.4 ft.). As the grout is not yet specified, reasonable assumptions are made about its likely composition and behaviour. A possible tank fill is described in WSRC-TR-2005-00195, "Summary of Grout Development and Testing for Single Shell Tank Closure at Hanford" as consisting of three layers of grout: free flowing layer, structural stability layer, and a high compressive strength layer. The grout is anticipated to be formulated to meet the following core functions of the tank fill materials: • To confine residual waste through limitation of flow and through chemical stabilization of the residual material • To provide stability and minimize maintenance • To reduce potential for infiltration or inadvertent intrusion. After closure, the tank concrete and grout is exposed to a combination of physical and chemical processes. Some processes may be beneficial (for example, continuing hydration and self-sealing of cracks), while others may create deleterious changes, such as shrinkage and thermal cracking. Although the geochemical conditions at the Hanford Site are favorable to preventing grout and concrete degradation, there are potential chemical degradation mechanisms that	

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Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	under certain conditions could lead to degradation of grout and concrete forming the tank wall and the infill grout material. These key chemical degradation mechanisms are discussed and evaluated below along with the reasoning as to why these mechanisms are not carried forward into the numerical modeling. Justification Analysis of tank stability and degradation evaluation examined key processes of degradation including carbonation, sulfate attack, alkali-aggregate attack and acid leaching and found that carbonation was most important. The analysis examined results of concrete cores from tanks in WMA C and WMA A. As part of the initiative to evaluate the structural integrity of the tanks (called Single-Shell Tank Integrity Project or SSTIP), a 1.4-m (55 in.)-diameter reinforced concrete dome "Plug" was removed from tank C-107 in December 2010. More recently, an 11.6-m (38 ft.) sidewall concrete core was removed from 241 A 106 tank (located in WMA A-AX south of WMA C) in May 2014. Results from inspection, physical testing, and petrographic examination of the concrete cores are reported in RPP RPT 50934, "Inspection and Test Report for the Removed 241-C-107 Dome Concrete," and RPP-RPT-58254, "Concrete Core Testing Report for the Single-Shell Tank 241-A-106 m[act Sidewall Coring Project." These analyses are very important in predicting the tank wall degradation because they provide direct empirical evidence on the state of concrete wall material after being left underground for 60 to 70 years. The results of analyses are relevant for this impact analysis. This analysis also examined other selective evidence of concrete degradation both and off-site that are relevant to tank degradation and estimated that tanks in the dry subsurface environment at last a very long time. Documented: Basis for tank stability and concrete and grout degradation and its long-term importance for WMA C is provided in the following sections. • Basis for tank stability and degradation are provided in Section 6.2.1.2 • Results of sensitivity analyses related to tank stability and concrete and grout degradation are provided in Chapter 8.	
Other evaluation criteria relevant to the fate and transport models, input parameters, and assumptions include (1) burden of proof, (2) new scientific information, and (3) criteria for quality of information.		
1) Burden of proof	**Any person responsible for undertaking a clean-up action shall have the burden of demonstrating that requirements ensure protection of human health and environment.**	

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Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	(a) Use a reasonable maximum exposure scenario other than the default provided for each medium;	**Yes**
	Explanation: • The default reasonable maximum exposure scenario (WAC 173-340-720(4) was used to calculate 2007 MTCA Method B groundwater clean-up levels. • The default reasonable maximum exposure scenario (EPA tap water [residential] exposure scenario was used to calculate cancer risks and noncancerous hazards. Justification: • No further justification is necessary for using the default maximum exposure scenario. Documented: • The conceptual exposure model for EPA tap water (residential) scenario and the 2007 MTCA B groundwater clean-up levels is presented in Figure 6-1. • Exposure pathways and scenarios are presented in Chapter 6, Section 6.2.3. • Exposure assumptions for the Tap Water (residential) scenario are presented in Table 6 -17 for radiological contaminants and Table 6-18 for hazardous chemicals.	
	(b) Use assumptions other than the default values provided for in WAC 173-340-202;	**Yes**
	Several site-specific parameters are used for modeling fate and transport of hazardous chemicals in this impact evaluation of landfill closure conditions. The justification for choice of parameters related to sorption, dispersion, dilution, recharge, and other key areas of model parameterizations (waste inventory, constituent identification, source term release and other tank stability and concrete and grout degradation) have been discussed earlier.	
	(c) Establish a clean-up level under Method C	**Yes**
	Explanation: A clean-up level was not established under Method C, the MTCA Method B groundwater clean-up levels and exposure scenarios used to evaluate the groundwater pathway are based on highest beneficial use (drinking water). Justification:	

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Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	• The focus of the impact analysis is on evaluating the groundwater pathway. The analysis of the groundwater pathway comprises evaluations directed at two different performance measures. The first is a comparison of groundwater concentrations to Federal and State maximum contaminant levels (MCLs) and 2007 MTCA potable groundwater clean-up levels. The second is an assessment of cancer risk and non-cancer hazards for hazardous substances and cancer risk for radionuclides in groundwater using the EPA tap water (residential) scenario. <u>Documented:</u> • The conceptual exposure model for the groundwater pathway is presented in Figure 6-1. • Section 6.2.3 describes the exposure pathways and scenarios.	
	(d) Use a conditional point of compliance,	**No**
	<u>Explanation</u>: • This assessment does not establish a conditional point of compliance • To determine protection of water resources, two points of calculation were used to evaluate chemical concentrations in groundwater. The facility boundary (fence line) was used as the point of assessment for the operational and active institutional control periods and 100 m (328 ft.) down gradient from WMA C (i.e., the fence line surrounding WMA C) was used as the point of assessment for the post-institutional control period. These locations are also termed the point of calculation (PoCal). • Points of calculation used in the RCA were selected where the highest contamination from WMA C crossed a plane perpendicular to the groundwater flow direction located 100 m (328 ft.) from the down gradient from the boundary of WMA C (i.e., the fence line surrounding WMA C). <u>Justification:</u> • The points of calculation corresponded to the highest projected dose or concentration beyond a 100-m buffer zone surrounding the disposed waste. A larger or smaller buffer zone may be used if adequate justification is provided. • Consistent with NUREG-1854, a disposal site consists of disposal units and a buffer zone [10 CFR 61.7(a) (2)]. A buffer zone is a portion of the disposal site that lies under the site and between the boundary of the disposal site and any disposal unit. The buffer zone provides space to establish monitoring locations and to take mitigative measures if needed [10 CFR 61.7(a) (2)]. An appropriate buffer zone is expected to extend approximately 100 m [330 ft.] from the disposal area in most cases. • In the case of a WMA C, the tanks and ancillary equipment is expected to be regarded as a disposal unit and the typical buffer zone is expected to extend approximately 100 m (330 ft.) beyond the fence line of the WMA C.	

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Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	Groundwater concentrations are evaluated at points of calculation at 100 m down gradient from the WMA C fence line. Additional points of calculation at the fence line are provided as additional information. Documented: • Chapter 2, Section 2.2.1 "Point of Assessment and Timing Assumptions" Chapter 7, Section 7.3.2.2.7 "Point of Calculation, Protectiveness Metric, and Time Frame Considerations".	
(2) New scientific information.	**Did the proposal to use new scientific information meet the quality of information requirements in (3)? (required)** **Any proposal to use new scientific information should be introduced as early in the clean-up process as possible.** **Proposals to use new scientific information may be considered up to the time of issuance of the final clean-up action plan governing the clean-up action for a site unless triggered as a part of a periodic review under WAC 173-340-420 or through a reopener under RCW 70.105D.040 (4)(c)**	**Generally not applicable.** Some limited information is provided below that may be helpful in Ecology's review of fate and transport modelling used in this analysis of landfill closure.
	Explanation: Fate and transport modelling in this specific impact evaluation is not being used to establish clean-up levels and remediation levels. The modelling calculations here are being to evaluate the hazardous chemical impacts from waste residuals left in tank and ancillary equipment under landfill closure conditions. Standard default methods associated with WAC 173-340-747 are appropriate for establishing clean-up levels for contaminated soils but are not an appropriate set of methodologies for evaluation of groundwater impacts from residual wastes left in tanks and ancillary equipment under landfill closure conditions proposed for WMA C. Justification:	

Crosswalk of Model Parameterization and Assumptions for Fate and Transport Modeling Used in the WMA C RCRA Closure Analysis of Residual Waste Impacts under Landfill Closure Conditions (RPP-ENV-58806)

Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	The parameters used in the fate and transport models are based on published literature and use data developed using standard scientific methods accepted by the scientific community. See information in the specific areas of model parameters provided above. The key processes and features needed to evaluate flow and transport under the landfill closure configuration are examined and incorporated into the modelling calculations. <u>Documented:</u> Discussion of conceptual and mathematical models used in this impacts evaluation are provided in Section 6.2.2 and 6.3.2, respectively.	
(3) Criteria for quality of information.	**A) The intent of this subsection is to establish minimum criteria to be considered when evaluating information used by or submitted to the department proposing to modify the default methods or assumptions specified in this chapter or proposing methods or assumptions not specified in this chapter for calculating clean-up levels and remediation levels. This subsection does not establish a burden of proof or alter the burden of proof provided for elsewhere in this chapter.**	**Generally Not applicable.** Some limited information is provided below that may be helpful in Ecology's review of fate and transport modelling used in this analysis of landfill closure.

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Categories of Model Assumptions and Parameters	Model Parameters and Evaluation Criteria	Response
	Explanation: Fate and transport modelling in this specific impact evaluation is not being used to establish clean-up levels and remediation levels. The modelling calculations here are being to evaluate the hazardous chemical impacts from waste residuals left in tank and ancillary equipment under landfill closure conditions. Standard default methods associated with WAC 173-340-747 are appropriate for establishing clean-up levels for contaminated soils but are not an appropriate set of methodologies for evaluation of groundwater impacts from residual wastes left in tanks and ancillary equipment under landfill closure conditions proposed for WMA C. Justification: The parameters used in the fate and transport models are based on published literature and use data developed using standard scientific methods accepted by the scientific community. See information in the specific areas of model parameters provided above. The key processes and features needed to evaluate flow and transport under the landfill closure configuration are examined and incorporated into the modelling calculations. Documented: Discussion of conceptual and mathematical models used in this impacts evaluation are provided in Section 6.2.2 and 6.3.2, respectively.	
	(i) Whether the information is based on a theory or technique that has widespread acceptance within the relevant scientific community	**Yes**
	Explanation: The general modeling approach for using the STOMP code to evaluate landfill closure conditions is discussed in Chapter 7, Section 7.3.2.1, Chapter 11, and is provided in Appendix D. The application of STOMP for specific applications at the Site like being done here for landfill closure conditions at WMA C is accepted within the relevant scientific community at Hanford and across the DOE complex. Justification: Use of STOMP is an adequate computational code to implement a numerical model for this evaluation of landfill closure at WMA C. Specific applications of the use of STOMP require presentation and justification of model implementation	

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	(construction and parameterization) in application-specific documents. This specific application of STOMP constitutes such an application-specific analysis of landfill closure at WMA C. Documented: The specific conceptual model and parameterization to be implemented in STOMP are presented and justified in Section 7.3.2.1 Chapter 11, and Appendix D.	
	(ii) Whether the information was derived using standard testing methods or other widely accepted scientific methods;	**Yes**
	Explanation: Fate and transport modelling in this specific impact evaluation is not being used to establish clean-up levels and remediation levels. The modelling calculations here are being to evaluate the hazardous chemical impacts from waste residuals left in tank and ancillary equipment under landfill closure conditions. Standard default methods associated with WAC 173-340-747 are appropriate for establishing clean-up levels for contaminated soils but are not an appropriate set of methodologies for evaluation of groundwater impacts from residual wastes left in tanks and ancillary equipment under landfill closure conditions proposed for WMA C. Justification: The parameters used in the fate and transport models are based on published literature and use data developed using standard scientific methods accepted by the scientific community. See information in the specific areas of model parameters provided above. The key processes and features needed to evaluate flow and transport under the landfill closure configuration are examined and incorporated into the modelling calculations. Documented: Discussion of conceptual and mathematical models used in this impacts evaluation are provided in Section 6.2.2 and 6.3.2, respectively.	
	(iii) Whether a review of relevant available information, both in support of and not in support of the proposed modification, has been provided along with the rationale explaining the reasons for the proposed modification;	**Not Applicable**

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	Explanation: Fate and transport modelling in this specific impact evaluation is not being used to establish clean-up levels and remediation levels. The modelling calculations here are being to evaluate the hazardous chemical impacts from waste residuals left in tank and ancillary equipment under landfill closure conditions. Standard default methods associated with WAC 173-340-747 are appropriate for establishing clean-up levels for contaminated soils but are not an appropriate set of methodologies for evaluation of groundwater impacts from residual wastes left in tanks and ancillary equipment under landfill closure conditions proposed for WMA C. Justification: The parameters used in the fate and transport models are based on published literature and use data developed using standard scientific methods accepted by the scientific community. See information in the specific areas of model parameters provided above. The key processes and features needed to evaluate flow and transport under the landfill closure configuration are examined and incorporated into the modelling calculations. Documented: Discussion of conceptual and mathematical models used in this impacts evaluation are provided in Section 6.2.2 and 6.3.2, respectively.	
	(iv) Whether the assumptions used in applying the information to the facility are valid and would ensure the proposed modification would err on behalf of protection of human health and the environment;	**Yes**
	Explanation: The assumptions used in applying the information to the facility are valid and would err on behalf of human health and the environment. Some examples of this conservatism that would lead to this err on behalf of human health and environment are found in the listing of key assumptions found in Appendix A and are evaluated in a range of sensitivity cases. Justification: The base case is a single deterministic evaluation of future impacts to the public and environment because of the anticipated retrieval and closure actions taken at WMA C. It represents the scenario in which the safety functions behave	

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	as expected as the facility evolves into the future. The base case assumptions and parameters generally are based on best available information, but some parameter estimates related to future conditions do have a conservative bias. The results of the base case are used to evaluate compliance with regulatory standards established for evaluating risk and hazard impacts to groundwater. It is emphasized that the structure of the impacts analysis is founded on the extensive use of sensitivity analyses that explore the consequences if alternative assumptions about conceptual models and loss of safety functions are assumed. The alternative analyses include sensitivity cases evaluating conditions well outside the range of the base case analysis. In all cases, the calculations produced results that are below the regulatory standards <u>Documented:</u>: • Key modelling assumptions associated with this analysis are summarized in Appendix A. • Specific key assumptions of this analysis are presented here that specifically relate to potential decisions regarding design features and closure of the facility are also listed in Section 1.8	
	(v) Whether the information adequately addresses populations that are more highly exposed than the population as a whole and are reasonably likely to be present at the site; and	**No**
	<u>Explanation:</u> • The default reasonable maximum exposure scenario (WAC 173-340-720(4) was used to calculate 2007 MTCA Method B groundwater clean-up levels used in evaluate the performance of landfill closure conditions • The default reasonable maximum exposure scenario (EPA tap water [residential] exposure scenario was also used to calculate cancer risks and noncancerous hazards. • No scenarios were developed for other sensitive subpopulations. <u>Justification:</u> • Reasonable maximum exposure assumptions are based on exposure scenarios used to derive regulatory standards, and therefore assumed protective of all populations and adequate to restore the resource to beneficial use. <u>Documented:</u> • The conceptual exposure model for the groundwater pathway is presented in Figure 6-1. • Section 6.2.3 describes the exposure pathways and scenarios.	

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	(vi) Whether adequate quality assurance and quality control procedures have been used, any significant anomalies are adequately explained, the limitations of the information are identified, and the known or potential rate of error is acceptable.	**Yes**
	Explanation: Quality assurance for use of modeling to develop the impacts from landfill closure was performed following EPA guidance (EPA/240/R-02/007, EPA QA/G-5M, *Guidance for Quality Assurance Project Plans for Modeling*). Requirements addressed modeler training, software and model documentation and configuration control, model application checking, and controlled software use in the preparation of calculations using STOMP to evaluate impacts from landfill closure at WMA C. No significant anomalies were found during implementation of the STOMP model. The STOMP code solves the numerical equations to a defined level of precision; hence, effectively any error would be associated with model uncertainties, scenario uncertainties, and parameter uncertainties. Judicious use of conservatism is made in the development of the model, scenarios, and parameterization to ensure that errors are biased in a conservative direction relative to protection of groundwater. That is, conservatism with regard to these areas where uncertainty in the model exists is used to cause impacts from landfill closure to be lower than would be calculated with reduced uncertainty and/or with less conservative bias in model development. Quality assurance for use of software used to implement the model was performed in accordance with the requirements of DOE Order 414.1, *Quality Assurance*, which imposes NQA-1 standards on software use. The STOMP software was tested and qualified before use for modeling under procedures that implement the requirements of DOE Order 414.1 and guidance of NQA-1. Justification: Approved quality assurance plans and procedures written to meet the requirements of DOE and the guidance of the EPA were adhered to throughout the modeling process. Limitations of the model are discussed in the primary categories of (1) model uncertainties, (2) scenario sensitivity analysis include the impacts of loss of key safety functions, and (3) parameter uncertainties. Documented: Demonstration of quality assurance and quality control procedure use is demonstrated in the following:	

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	The summary of this guidance provided in Chapter 11 which includes subsections related to: • Environmental Model Lifecycle Quality Assurance Process (Section 11.1) • Controlled Software Use (Section 11.2) • Model Documentation, Control, And Preservation (Section 11.3) Information in Chapter 11 and in the Environmental Model Calculation Files (EMCFs) associated with this impact evaluation provides demonstration of documentation of model application in compliance with a plan that followed the guidance provided in: • EPA/240/R-02/007, EPA QA/G-5M, *Guidance for Quality Assurance Project Plans for Modeling* • DOE O 414.1D, *Quality Assurance*	