

**Review of the  
U.S. Department of Energy Responses to the  
U.S. Nuclear Regulatory Commission  
Requests for Additional Information on the West  
Valley Demonstration Project Phase 1  
Decommissioning Plan**

Prepared for  
**New York State Energy Research and Development Authority**  
West Valley, New York  
December 14, 2009

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Prepared by the  
**Independent Expert Review Team**

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## **ACKNOWLEDGMENTS**

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## SECTION 1

### INTRODUCTION

This report documents a review of the U.S. Department of Energy's (DOE) responses to the U.S. Nuclear Regulatory Commission's (NRC) requests for additional information (RAIs) concerning the West Valley Demonstration Project's Phase 1 Decommissioning Plan (DP). The review was conducted by the New York State Energy Research and Development Authority's (NYSERDA) Independent Expert Review Team (IERT). The names and qualifications of the IERT are provided in Appendix A. The IERT review focused on topics originally identified in the March 25, 2009, report titled, "Independent Review of the Phase 1 Decommissioning Plan for the West Valley Demonstration Project." Many of the issues commented on in the March 25<sup>th</sup> report are discussed in this report. This review is guided by the following questions:

- Did the NRC RAI comment reflect an IERT issue? If so, was the IERT issue adequately described?
- Does DOE's response reflect a suitable interpretation of the RAI comment? If not, what aspects of the RAI are not being addressed?
- Does DOE's response and change to the DP adequately resolve the issue? If not, what aspects of the issue are not being addressed and why is that important?
- What, if any, new issues have been raised by the DOE response?

The RAIs and the DOE responses are specific in nature, but most of them are intended to address one overarching question. Do the DOE cleanup goals (Section 5.4 of the DP) adequately protect each potential receptor from each potential residual radioactive material source within the Phase 1 cleanup scope without compromising the decision-making flexibility for the Phase 2 cleanup?

The DOE approach to assuring an affirmative answer to this question is the conventional one of computing derived concentration guideline level (DCGL) values for radionuclides in different source units—residual soils bearing radionuclides. For example, the purpose of the streambed scenario is to compute DCGL values for streambed sediments. This may require evaluation of not just exposure of a receptor to these sediments in place, but also evaluation during transport. In particular, such dynamics as radionuclide content and release rates as a function of location and downstream receptors may be important considerations. Questions about future transport of radionuclides to streambed sediments should be part of the computation of DCGL values for materials constituting the potential radionuclide sources feeding the streams. Also, there is the problem of accommodating multiple sources feeding into the streams simultaneously, presumably the function of the limited integrated assessment described in Section 5.3 of the DP. DOE has addressed nearly all, but not yet all, of the particular aspects of this problem. The complexity of the West Valley site makes it very difficult to mentally construct a coherent overview to determine whether all significant gaps have been identified. As is noted in the next section, a narrative or graphic that would aid in connecting the various elements of the DP would greatly improve its transparency.

The complete IERT reviews of the DOE responses are included in Appendix B. Meanwhile, what follows is an attempt to highlight what are considered the most significant observations from the collective reviews. The approach is to integrate the important results of the IERT review by topic rather than by individual RAI response as several RAIs are often involved for a single topic. The relevant RAI responses are noted in the topical discussions below. The RAIs are identified by an NRC RAI number and a subject, a list of which is provided in Appendix C. The full RAIs and DOE responses are documented elsewhere.<sup>1,2,3,4</sup>

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<sup>1</sup> Letter, Dr. Keith I. McConnell to Bryan C. Bower, "Requests for Additional Information on Phase 1 Decommissioning Plan for the West Valley Demonstration Project," dated May 15, 2009.

<sup>2</sup> Letter, Bryan C. Bower to Dr. Keith I. McConnell, "Submission of U.S. Department of Energy (DOE) Responses to Requests for Additional Information (MI) for the Phase 1 Decommissioning Plan for the West Valley Demonstration Project for U.S. Nuclear Regulatory Commission Review," dated August 13, 2009.

<sup>3</sup> Letter, Bryan C. Bower to Dr. Keith I. McConnell, "Submission of Additional U.S. Department of Energy Responses to Requests for Additional Information for the Phase 1 Decommissioning Plan for the West Valley Demonstration Project from U.S. Nuclear Regulatory Commission Review," dated September 16, 2009.

<sup>4</sup> Letter, Bryan C. Bower to Dr. Keith I. McConnell, "Submission of Updated U.S. Department of Energy (DOE) Responses to Requests for Additional Information (RAIs) for the Phase 1 Decommissioning Plan for the West Valley Demonstration Project from U.S. Nuclear Regulatory Commission Review," dated November 5, 2009.

## SECTION 2

### MAJOR OBSERVATIONS OF THE REVIEWS

#### EXPOSURE SCENARIOS, DCGLs, AND DOSE CALCULATIONS

The consideration of multiple exposure scenarios in the DP has been expanded, but as a scenario set may still fall short of providing high confidence in the results. The DOE overall approach to the determination of cleanup goals involves the selection of adjusted minimum DCGL values from a complex array of analyses based on various scenarios and combinations of scenarios. Also, selected deterministic and probabilistic assessments were performed, including various sensitivity and other analyses. The issue is not just the consideration of multiple exposure scenarios, but making sure that the scenario set includes those that are the most plausible and challenging. In this regard, sensitivity analysis can be effective in obtaining clear resolution of the impact of the different scenarios, particularly those scenarios considered the most challenging. Multiple exposure scenarios that clearly include those most challenging to remediation are key to having greater confidence in the dose calculations.

The IERT remains convinced that for a complex site such as West Valley, the best approach is to evaluate a range of exposure scenarios that are clearly plausible and challenging. For example, the DOE response to the RAIs included a new resident gardener/cistern scenario, which resulted in reduced DCGL values for subsurface soils. This occurred because reduced well pumping rates for irrigation resulted in reduced dilution of infiltrating water containing radionuclides, higher concentrations of radionuclides in the well water, and higher doses from ingestion of well water and harvested produce using well water for irrigation. The tradeoff between low pumping rates and low dilution versus higher rates is an example where the sensitivities are not obvious and where they haven't been adequately explored. This result raises the question whether other possible scenarios involving reduced well water pumping rates might result in further DCGL value reductions. Examples of other scenarios are to include the case of advective flow of contaminants (see below) and a resident using well water, but not for irrigation of crops for consumption.

There are issues having to do with the selection of parameter values. In responding to several of the RAIs pertaining to the selection of dose impacting parameter values (see 5C15 and 5C16), DOE fails to make a convincing argument that parameter values used to calculate doses are conservative. For example, for the radionuclides  $^{14}\text{C}$  and  $^{99}\text{Tc}$ , distribution coefficient ranges employed in DOE's RESRAD model exceed the RESRAD default values. In the case of uranium, the lower end of the distribution coefficient range was set at the measured value, instead of adequately bounding the measured value with a lower, more conservative value. Similarly, RESRAD  $K_{ds}$  for actinium, lead, protactinium, and radium selected by DOE were much higher than the RESRAD default values. All of these examples bring into question whether DOE's selection of dose impacting parameters is indeed conservative.

Relevant response reviews on exposure scenarios, DCGLs, and dose calculations are of RAI responses 5C6, 5C7, 5C15, and 5C16.

## **SUBSURFACE CONTAMINANT RELEASE AND TRANSPORT MODELING**

Despite additional groundwater modeling by DOE in response to NRC RAIs, IERT considers the conceptual framework underlying the DOE revised calculations of contaminant transport to be fundamentally flawed and non-conservative. In particular, a well that is pumping water from the saturated part of excavation backfill would cause groundwater flow, and hence advective transport in the underlying Unweathered Lavery Till (ULT) to reverse course upward, through the contaminated bottom of the excavation into the overlying uncontaminated saturated backfill, followed by lateral flow and contaminant advection toward the well. Advective transport, if significant, could reduce DCGL values for subsurface soils. DOE only considered diffusive transport, which is believed to be far too limiting in terms of mechanisms for transporting contaminants.

Relevant response reviews on subsurface modeling and contaminant release are of RAI responses 5C3, 5C6, 5C9 and 5C10.

## **WORK SEQUENCING ISSUES**

DCGL values, work plans, and engineered barrier designs are often based on preliminary information or assumptions to be confirmed later. For example, engineering details of the close-in-place alternative have not been specified in sufficient detail. The phased alternative seems to be equivalent to saying that we will figure it out later. It is anticipated that a Site Characterization Program, to be conducted later, will provide support for some assumptions included in the bases for the DP. (In simpler situations, site characterization typically is performed before development of the DP.) One example of the consequences of delayed characterization is evident in RAI 5C13, where DOE responds that it cannot currently compare sediment concentrations with sediment DCGLs. It is not always clear that sufficient conservatism has been incorporated in those assumptions to minimize the risk of necessary re-evaluation and rework in the future. Some requirements for reconsideration of the bases for DCGL values considering the outcome of future work are not clearly stated in the DP. A clear statement of these requirements is necessary to assure that they are not overlooked in the implementation of the DP.

Relevant response reviews on work sequencing issues are of RAI responses 5C13, 6C3, DC3, and DC6-8.

## **EROSION**

Gully erosion is the principal threat to the long term retention of residual radionuclides. While the change from the SIBERIA model to the CHILD model is a major improvement, there remain issues, some of which may be related to the limitations of erosion science. There is great uncertainty on the rates at which gully erosion occurs at critical locations within the site. The result is very little confidence in the timeline for gullies breaching soils bearing radionuclides. There appears to be considerable discrepancy between the DOE calculated gully erosion migration rates and the observed migration rates of advancing gullies at the West Valley site.

Short term erosion rates have not been developed by a model in which there is high confidence. Besides inadequate modeling and the lack of site-specific input to the analyses performed, important phenomena were not taken into account. For example, the DOE analysis does not take into account the role of seepage on gully erosion initiation and upstream migration as a potential mechanism of contaminant transport.

Relevant response reviews on erosion are of RAI responses 5C4, 5C6, and 5C7.

## **STRATEGIC OVERVIEW**

The complexity of the West Valley site and the plan for its decommissioning make it very difficult to construct mentally a complete and coherent strategic overview of the DP. Such an overview is necessary to determine how all the elements are integrated and whether all significant gaps have been identified. In the absence of such an overview as part of the DP, the reviewers must provide their own interpretation of the integrated plan from descriptions of individual plan elements. A narrative or graphic that would aid in this effort would make the entire plan much more transparent.

### **SECTION 3**

#### **COMPOSITION OF THE INDEPENDENT EXPERT REVIEW TEAM**

The members of the Independent Expert Review Team are all distinguished in the disciplines important to the purpose and scope of this review. The disciplines included geoscience, nuclear science and engineering, risk assessment, and environmental science and engineering. The IERT members are listed below and their qualification summaries are presented in Appendix A.

B. John Garrick, Ph.D., Chairman, U.S. Nuclear Waste Technical Review Board, Arlington, Virginia, and Independent Consultant, Laguna Beach, California

Sean J. Bennett, Ph.D., Professor, State University of New York at Buffalo, Buffalo, New York

Shlomo P. Neuman, Ph.D., Regents' Professor, University of Arizona, Tucson, Arizona

Chris G. Whipple, Ph.D., Principal, ENVIRON International Corporation, Emeryville, California

Thomas E. Potter, M.S., Independent Consultant and Consultant to IERT, Washington, DC

## APPENDIX A

### QUALIFICATION SUMMARIES OF THE MEMBERS OF THE INDEPENDENT EXPERT REVIEW TEAM

**Dr. B. John Garrick - Chairperson of the Independent Expert Review Team** – Dr. Garrick has a Ph.D. in Engineering and Applied Science and an M.S. in Nuclear Engineering from the University of California, Los Angeles; graduate from the Oak Ridge School of Reactor Technology; and a B.S. in Physics from Brigham Young University. He is an executive consultant on the application of the risk sciences to complex technological systems in the space, defense, chemical, marine, transportation, and nuclear fields. He was appointed as Chairman of the U.S. Nuclear Waste Technical Review Board on September 10, 2004, by President George W. Bush. He served for 10 years (1994-2004), 4 years as chair, on the U.S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste. His areas of expertise include risk assessment and nuclear science and engineering. A founder of the firm PLG, Inc., Dr. Garrick retired as President, Chairman, and Chief Executive Officer in 1997. Before PLG's acquisition and integration into a new firm, it was an international engineering, applied science, and management consulting firm.

Dr. Garrick was elected to the National Academy of Engineering in 1993, President of the Society for Risk Analysis 1989-90, and recipient of that Society's most prestigious award, the Distinguished Achievement Award, in 1994. He has been a member and chair of several National Research Council committees, having served as vice chair of the Academies' Board on Radioactive Waste Management and as a member of the Commission on Geosciences, Environment, and Resources. He is a member of the first class of lifetime national associates of the National Academies.

Dr. Garrick has published more than 250 papers and reports on risk, reliability, engineering, and technology, author of the book “Quantifying and Controlling Catastrophic Risks” (September 2008), written several book chapters, and was editor of the book, *The Analysis, Communication, and Perception of Risk*.

**Dr. Sean J. Bennett** - Dr. Bennett is a Professor in the Geography Department at the State University of New York at Buffalo. He holds a Ph.D., M.A., and B.S. in Geology. Dr. Bennett has extensive experience in physical and numerical modeling of gully erosion and river processes. His current research interests seek to quantify flow and sediment transport processes in watersheds and to determine the impact of these processes on soil losses, river form and function, water quality and ecology, landscape evolution, and watershed infrastructure and integrity. Prior to joining the State University of New York, he served as a Research Geologist with the U.S. Department of Agriculture, Agricultural Research Service, National Sedimentation Laboratory in Oxford, MS, and was a Research Fellow in the School of Earth Sciences at the University of Leeds.

Dr. Bennett has served as Guest Editor for the International Journal of Sediment Research (WASER), Assistant Editor for The Professional Geographer (AAG), Associate Editor for Water Resources Research (AGU), Associate Editor for the Journal of Hydraulic Engineering (ASCE),

and Co-editor for Sedimentology (IAS). Dr. Bennett has published two edited books and authored over 100 journal publications, conference proceeding papers, and technical reports.

**Dr. Shlomo P. Neuman** - Dr. Neuman is Regents Professor in the Department of Hydrology and Water Resources at the University of Arizona in Tucson. He holds a Ph.D. and a M.S. in Engineering Science, and a B.S. in Geology. Dr. Neuman's fields of specialization are subsurface hydrology and contaminant transport. He has made seminal contributions to the areas of pumping test design and analysis, flow in multilayered geologic media, finite element simulation of subsurface flow and transport, estimation of aquifer parameters, fractured rock hydrology, peat hydrology, geostatistics, hydrologic scaling and stochastic analysis of heterogeneous geologic media. He is a Member of the National Academy of Engineering, a Fellow of the American Geophysical Union, and a Fellow of the Geological Society of America. He holds honorary professorships at the University of Nanjing and the Hydraulic Research Institute in China.

Dr. Neuman has received numerous awards and citations during his career, including the 2003 Robert E. Horton Medal of the American Geophysical Union, and is a former Birdsall Distinguished Lecturer of the GSA and Langbein Lecturer of the AGU. Dr. Neuman has served on various national and international advisory panels including the Scientific Review Group for high-level nuclear waste disposal in Canada. Dr. Neuman is Associate Editor of Water Resources Research and a member of the Editorial Board of Stochastic Hydrology and Hydraulics. He is the author of over 310 publications, and has served on the 2005-2006 West Valley EIS Performance Assessment Peer Review Group.

**Dr. Chris G. Whipple** - Dr. Whipple is a Principal with ENVIRON International Corporation in Emeryville, CA. He holds a Ph.D., M.S., and B.S. in Engineering Science. He is a Member of the National Academy of Engineering and is a Designated National Associate of the National Academies. He chaired and served on the National Academy of Sciences Board on Radioactive Waste Management, and he chaired the Peer Review of the Yucca Mountain Total System Performance Assessment. He has been a consultant to the U.S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste, to the U.S. Nuclear Waste Technical Review Board, and to the Swedish Radiation Protection Institute. He is a Member of the National Council on Radiation Protection, and a Charter Member, Fellow, and Former President of the Society for Risk Analysis.

Dr. Whipple has served on a number of national and international review boards and oversight committees, and he is the author of numerous publications on risk assessment, risk management, and risk communication. Dr. Whipple chaired the 2005-2006 West Valley EIS Performance Assessment Peer Review Group.

**Thomas E. Potter (Consultant to IERT)** – Mr. Potter holds a Master of Science degree in environmental science (emphasis in radiation protection) from the University of Michigan, and a Bachelor of Science degree in chemistry from the University of Pittsburgh. He is an independent radiation protection consultant. His consulting experience exceeds 30 years and is pre-dated by 7 years of experience in nuclear materials processing, operational health physics, and nuclear materials licensing. His consulting work has included a broad range of radiation protection

matters, mostly for private U.S. Nuclear Regulatory Commission licensees. Projects included environmental radiation dose assessments of operations, accidents, and decommissioning actions; assistance in formulation of licensee positions and comments on developing regulations; design of radiation protection programs and environmental radiation monitoring programs; audits and management reviews of radiation protection programs; and litigation support. Mr. Potter lectured and conducted computer workshops in Cairo as part of a course on environmental radiation dose assessment sponsored by the International Atomic Energy Agency for the Egyptian government. As a consultant at Pickard, Lowe and Garrick, Mr. Potter participated in the design and development of the CRACIT code for the assessment of consequences from severe power reactor accidents, and participated in the consequence assessment portions of a number of full-scope probabilistic risk assessments for power reactors. He also participated in a comprehensive assessment of offsite radiation from the Three Mile Island accident.

## **APPENDIX B**

### **FULL IERT REVIEWS OF DOE RESPONSES**

#### **3C1 – NUMERICAL ANALYSIS TECHNIQUES**

##### **Shlomo P. Neuman**

NRC has asked for clarification as to the specific purpose and results of numerical modeling conducted to investigate groundwater flow and transport at the site as described in Section 3.7.7 of the DP.

The DOE response provides a cursory description of codes (FEHM and STOMP) used for this purpose, FEHM site model boundaries, gridding and calibration; a paragraph is used to describe near field modeling using STOMP, the reader being referred to Appendix D of the DP for results.

The response is much too brief to provide the reader with a clear understanding of how groundwater flow and transport have been modeled at the site for purposes of DP. The response does not address the NRC request for modeling results, though it does note that such results are available in Appendix D of the DP. The response does not provide a detailed answer to the NRC request for an explanation of how the results are used in decommissioning planning.

#### **4C1 – SOIL CONCENTRATIONS AND DCGL**

##### **Shlomo P. Neuman**

NRC has asked for additional information regarding lateral and vertical distribution of contaminants across the site and in saturated sediments, how soil concentrations will be estimated and compared to surface DCGLs, and criteria to determine the applicability of such DCGLs should the DP be revised as indicated on p. 5-4 to support remediation of surface soil.

The DOE response includes an important clarification that surface soil DCGLs apply only to areas of the project premises where there is no subsurface soil contamination and the subsurface soil DCGLs apply only to the bottoms and lower sides (extending from a depth of three feet and greater) of the large excavations in Waste Management Area (WMA) 1 and WMA2. The same applies to cleanup goals.

#### **5C1 – PRESERVING DECOMMISSIONING OPTIONS**

##### **Shlomo P. Neuman**

NRC has requested the DOE to indicate how its Phase 1 activities preserve all decommissioning options when a final decision is made on decommissioning the site. The limited site-wide dose

assessment does not presently address the possibility that a receptor may be exposed from multiple sources at a single location. A combined dose assessment should consider both the cumulative impacts of multiple receptor locations and those of multiple source areas at a single receptor location in deriving DCGLs for a single source area.

According to the DOE the long-term performance assessment in the Draft Environmental Impact Statement (DEIS) evaluated potential exposures to both offsite and onsite receptors from multiple source areas within the project premises for the site-wide close-in-place and no action alternatives. Since the Phase 1 decommissioning will remove much of the contamination from the North Plateau, SDA and NDA will continue to be the largest dose contributors to potential offsite and onsite receptors after Phase 1 decommissioning activities have been completed. Hence Phase 1 activities will not preclude these Phase 2 alternatives; the argument appears to be convincing.

**Thomas E. Potter**

The RAI does not reflect a specific IERT comment, although a number of IERT comments note potential problems associated with the complexity of site conditions and the DOE-proposed work phasing. The DOE response appears to reflect a reasonable interpretation of the RAI. The DOE discussion in this response is a plausible response to the NRC RAI and the bases for the RAI. It appears that the DOE response discussion supplements the discussion in DP Section 5.3, but it is not clear that any DP change to reflect this response is contemplated. The DP should explicitly identify the RAI issue and address it by including the response to the RAI.

**5C2 – SCREENING APPROACH**

**Chris G. Whipple**

Not clear why Ra-226 and Th-229 are on the list of 30 radionuclides analyzed while Th-230 is not. Also, justification for screening Cs-135 is that it is always several orders of magnitude less than Cs-137. But Cs-135 has a 2.3 million year half-life, versus 30 years for Cs-137. How far into the future does one need to calculate before the curves cross?

**Thomas E. Potter**

RAI reflects IERT additional observation 12. The DOE response explaining the screening process appears to reflect reasonable interpretation of the RAI and the response appears to be complete and reasonable. Inclusion in the DP of a brief summary of the RAI response would be useful.

**5C3 – FLOW FIELD IMPACT ON DCGLS (GROUP 2)**

**Shlomo P. Neuman**

NRC has expressed concern about the impact of the permanent hydraulic barriers on the flow field and on DCGLs derived using the surface and subsurface soil models. Echoing IERT

concerns and suggestions, NRC believes that DOE could use the three-dimensional STOMP model discussed in Appendix D to evaluate these impacts.

The DOE has done so as described in a document titled West Valley EIS/DPlan Calculation Package, Investigation of Dilution at Well Intakes and Influence of Engineered Barriers on Pressure Distribution for the Phased Decommissioning Alternative, found on the Group 2 CD. According to this document, the analyses have not considered subsurface contamination, a major shortcoming. It considered lateral groundwater flow to be uniform rather than converging toward a well; it is thus unclear how the effects of a pumping well, hydraulic barrier walls and the French drain were incorporated in the analysis (all would cause flow to be three-dimensional rather than uniform). Nothing is said in the document about how the flow rates  $Q$  were obtained: what boundary conditions and source terms were used to obtain them, and what material properties were assigned throughout the flow domain? On what basis? Dilution factors were computed on a crude grid on the non-conservative assumption that contaminants mix fully and instantaneously within each grid cell. Why were transport, and dilution, not analyzed using the transport capabilities of STOMP (being instead computed by hand based on a crude mixing cell idea)? Results of the analyses are presented along a northeast transect through the French drain, which maintains constant head and thus minimizes spatial variations in hydraulic gradient; these variations are much more pronounced along a north-south direction perpendicular to the hydraulic barrier wall, raising a question about the validity of DOE's conclusion that the impact of the hydraulic barrier walls on gradients is minimal.

Given the crude and non-conservative nature of the computational methodology employed, and its lack of transparency, I remain unconvinced by DOE's conclusion that groundwater flow patterns with the hydraulic barriers in place would not be inconsistent with the RESRAD model and would therefore not impact the calculated DCGLs.

### **Chris G. Whipple**

The NRC is concerned that the effect of engineered barriers on flow has not been analyzed:

RAI: The impact on the flow field of construction of permanent hydraulic barriers as part of Phase 1 activities should be considered in deriving DCGLs. (Section 5.2.1, Page 5-23 and 5-27)

Basis: The results of the flow and transport modeling in Appendix D indicate that the hydraulic barriers will have a significant impact on the flow field (i.e., reduced natural flow downgradient of the barriers and diverted flow upgradient of the barriers); however, consideration of the presence of these hydraulic barriers was neglected when calculating the surface and subsurface DCGLs (see page 5-23 and 5-27).

Because the impact of the hydraulic barriers on the flow field was not considered, it is not clear that RESRAD calculations are consistent with the amount of clean water that may actually be pumped from the aquifer. Additionally, DOE did not consider how contaminated water from other source areas might be drawn to a

well at the given pumping rates and assuming the presence of the hydraulic barriers (e.g., extraction of contaminated groundwater from other source areas or contamination from the bottom of the excavation in the Lavery Till). Application of the RESRAD conceptual model for surficially deposited materials without consideration of actual site conditions (e.g., flow field and multiple sources of contamination) could lead to a significant underprediction of the risk from groundwater dependent pathways if greater dilution in clean water is assumed than what could actually be supported in the real system.

The DOE response notes that if the site-wide removal alternative is selected in Phase 2, then none of the engineered barriers would be needed and their effect on flow would not be an issue. DOE then compares well dilution factors for contaminated areas ranging from 92 m<sup>2</sup> to 9,900 m<sup>2</sup> using STOMP and RESRAD and asserts that they compare reasonably well. Whether the differences in these values are small enough to be ignored is not clear to me, absent some analysis of how the various models affect the estimated dose rates or the subsurface DCGLs. Although the term “DCGL” appears in the title of the RAI, DOE does not address how DCGLs might be affected. Since I am not familiar with the STOMP model, I hope that Shlomo will offer more detailed comments on this issue.

What comes across to me is that the response was written by someone cranking out model results; the basic conceptual model underlying the analysis and its reflection of likely future conditions is not addressed.

#### **5C4 – BASIS FOR NO EROSION ASSUMPTION**

##### **Sean J. Bennett**

RAI and DOE Response: NRC asked for the technical basis for the assumption that no surface erosion occurs, and to further justify that this approach is conservative. DOE defends this approach by noting: (1) the no erosion assumption avoided depletion of the source, and (2) the rate of rill and sheet erosion as suggested by the modeling results from Appendix F is small, and expected to be on the order of inches over a 1000-yr period. DOE, however, does recognize the potential threat of gully erosion, and considered as a plausible exposure a recreational hiker spending time in a gully that is deep enough to expose the buried contaminants as well as a resident farmer whose garden receives water and sediment washed from the gully.

This risk assessment to the recreational hiker and a resident farmer with a garden is conducted by assuming a gully 2-m wide and 100-m long has developed. The recreational hiker then walks across or through the gully for discrete periods of time each year, whereas the garden receives water and soil washed from the gully. A qualitative comparison is made between these two scenarios, and DOE concludes that the risk of exposure to the resident farmer is much greater than the risk to the recreational hiker due to (1) source dilution, (2) spending less time in the contaminated area, and (3) exposure through fewer pathways. This conceptual model of the recreational hiker is presented in RAI 5C6 (11) (see below), and quantified using RESRAD with

the following assumptions (1) gully erosion of the WMA2 excavation in the area of Lagoons 1 and 2 in 200 years, (2) one or more gullies extending through the contamination zone, which is made up of 1-m of Unweathered Lavery Till, (3) gully is 2-m wide and 100-m long, and (4) the recreationist walks at a pace of 0.8 km/hr with 28 hr per year of total exposure.

There is an additional risk due to the transport of contaminated water and sediment from the gully to downstream environments. These transport rates are determined using the WEPP model and show that the exposure risk to a receptor located at the confluence of Cattaraugus and Buttermilk Creek is significantly less than the exposure risk to the resident farmer.

Comment: DOE and its cooperators correctly recognize that gully erosion remains the principal threat to the site and the primary surface erosion mechanism to expose the buried waste. The following critical comments are offered on the above risk assessment.

1. It is not clear when the gully breaches the buried waste. One assumption presented above is that a gully will breach the WMA2 location 200 years into the future. While more than 20 major and moderate-sized gullies have been identified at the site, few rates of gully migration have been determined. Three active gullies are identified and their migration rates determined: 0.4 m/yr for the SDA gully on Erdman Brook, 0.7 m/yr for the NP-3 gully on Frank's Creek, and 0.7 m/yr for the 006 gully on Frank's Creek (Appendix F, DEIS), yet gully advance rates could be an order of magnitude higher. The gully advance rate simulated by the CHILD model in Appendix H (Table H-26) of the DEIS is about 0.026 m/yr (and 0.012 for Lagoon 1 and 0.0035 m/yr for Lagoon 3; see RAI 5C6 below). This rate of advance is about one order of magnitude lower than the onsite advance rates reported and much lower than gully advance rates reported in the literature. Since contaminant concentration is time-dependent, and the gully advance rates appear to be low, the time to exposure may occur much sooner than predicted and the concentration of the contaminant may be much higher than predicted, the latter conditioned by the material's decay rate.
2. Short-term erosion rates determined using WEPP are not considered useful in the broad context of the present and future integrity of the West Valley Site. This is because no onsite verification or validation of the hydrologic and geomorphic input parameters used in this model is conducted, and WEPP is incapable of predicting the development, growth, and upstream migration of and soil losses due to gullies.

### **Thomas E. Potter**

This RAI reflects a number of IERT comments. Evaluation of the DOE response is beyond the expertise of this reviewer.

### **5C5 – WELL DRILLER ACUTE DOSE**

### **Chris G. Whipple**

DOE's response in the 2<sup>nd</sup> bullet on page 50 is that the contaminated zone is 9 square meters in area and 0.33 meters thick. This seems to be based on the cistern scenario, where only the

bottom foot of the excavation was contaminated. This seems reasonable given that the topic is acute doses to a well driller.

**Thomas E. Potter**

This RAI is not reflective of any IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI, and the response incorporating a drilling scenario appears to be complete and reasonable.

**5C6 – SHOW CISTERN SCENARIO BOUNDING\* AND\*\***

**Sean J. Bennett**

RAI and DOE Response: NRC asked for the technical basis as to why the cistern drilling scenario is bounding, given that actively eroding gullies could intercept the lagoon areas and produce greater exposure of the buried waste to onsite and offsite receptors. As noted above in RAI 5C4, DOE recognizes the potential threat of gully erosion, and considered as a plausible exposure a recreational hiker spending time in a gully that is deep enough to expose the buried contaminants as well as a resident farmer cistern drilling scenario.

This new conceptual model and the assumptions made to construct it are shown in Figure 5C6-1 and on pp. 8-9, respectively. Employing RESRAD, DOE states that for the 18 radionuclides of interest, the onsite receptor (cistern drilling resident farmer) is shown to be at a much greater risk than the recreational hiker using two exposure time periods (100 and 500 years from present).

An additional risk analysis is performed to assess the offsite impacts of gully erosion. Using the results from Appendix F of the DEIS, it is assumed that peak rates of gully erosion into the Lagoon 1 and 3 areas is 0.012 and 0.0035 m/yr, respectively. This mobilized contaminated material then is transported downstream to the confluence of Buttermilk and Cattaraugus Creek using the WEPP model, where the receptor would ingest both water and fish and use the water to irrigate a garden. The results from RESRAD again suggest that the onsite receptor (cistern drilling scenario) is shown to be at a much greater risk than the offsite receptor located downstream.

Comment: DOE and its cooperators correctly recognize that gully erosion remains the principal threat to the site and the primary surface erosion mechanism to expose the buried waste. The following critical comments are offered on the above risk assessment.

1. It is not clear when the gully breaches the buried waste. As noted above, the gully advance rate simulated by the CHILD model in Appendix H (Table H-26) of the DEIS is about 0.026 m/yr, and the rates reported herein in the DP are 0.012 and 0.0035 m/yr. These rates are significantly lower than both onsite observations (one to two orders of magnitude; 0.4 to 0.7 m/yr) and rates reported in the literature (one to several orders of magnitude higher). If this gully advance rate is underpredicted as suggested here, then the buried waste would be breached by a gully much sooner in time than predicted (potentially sooner than the 100 and 500 year periods chosen here), and the concentration

of the contaminant exposed at the surface may be much higher than predicted assuming a given decay rate.

2. The results using the WEPP model cannot be ratified or accepted here because no onsite verification or validation of the hydrologic and geomorphic input parameters is conducted.
3. The authors do not recognize the role of seepage (exfiltration) on gully erosion initiation and upstream migration and as a potential mechanism of contaminant transport. Evidence of surface seepage processes at the West Valley Site is pervasive, and this exfiltration process has been shown to cause, catalyze, and significantly enhance headcut erosion and gully development in cohesive materials. It is highly likely that rates of gully erosion at the West Valley Site would be greatly enhanced because of the pervasive seepage that occurs. In addition, the pore waters emerging from these developing gullies could be transporting contaminants to the ground surface before the gully exposes the contaminated layers.

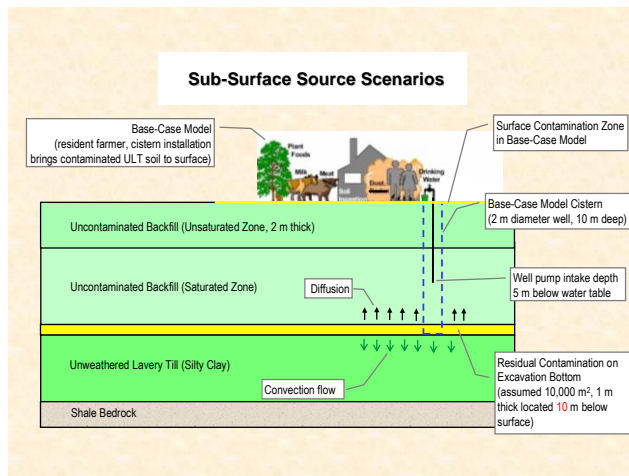
### **Shlomo P. Neuman**

NRC has asked for results of a quantitative analysis to support its assumption that subsurface DCGLs calculated assuming a cistern driller scenario bound the potential impact from erosion. According to the DOE, additional groundwater modeling using the STOMP code has shown that diffusion of radioactivity from the bottom of the deep excavations must be taken into account in establishing the subsurface soil DCGLs and cleanup goals. The updated response to RAI 5C9 describes the additional modeling and the reduced DCGLs and cleanup goals that take the results of this analysis into account. This updated response includes a new DP Subsection 5.2.6 that describes the modified conceptual model used, the mathematical models used, and the results of the analysis. The updated response to RAI 5C15 includes revised tables for Section 5 of the DP such as Table 5-14 that specifies the cleanup goals to be used in soil and sediment remediation associated with Phase 1 of the decommissioning.

It is the understanding of this reviewer, based on the above, that DOE's response to RAI 5C6 relies on groundwater modeling which considers potential release of radionuclides from the bottom of a remediated excavation by diffusion. As noted in the second paragraph of my original comments on DOE Group 2 responses below, I consider such modeling inadequate. Instead, I expect contaminants from the bottom of each excavation to be drawn toward a pumping well completed within the backfill of the excavation not by a slow process of diffusion but much more rapidly by advection. Ignoring advection would underestimate the rate at which contaminants from the bottom of an excavation reach the well, thereby overestimating dilution and the derived DCGLs.

That such advection is disregarded is made clear by the recently submitted West Valley EIS/DPlan Calculation Package, Estimates of Human Health Impacts Due to a Sub-surface Source in the Vicinity of the Excavation at WMA1. As illustrated without ambiguity in Figure 1 of this package (reproduced below), (a) contaminants are taken to be released from the bottom of the excavation into the saturated zone of the backfill purely by diffusion, and (b) advective flow in Unweathered Lavery Till beneath the backfill is taken to continue being directed downward. In reality, a well pumping water from the saturated part of the backfill (pictured in Figure 1)

would cause groundwater flow, and hence advective transport, in the underlying shallow ULT to reverse course upward, through the contaminated bottom of the excavation (yellow in Figure 1), into the overlying (originally) uncontaminated saturated backfill, followed by lateral flow and contaminant advection toward the well.



**Figure 1. Schematic for Exposure Scenarios Initiated by a Sub-Surface Source**

The conceptual framework underlying the DOE revised calculations of contaminant transport from the contaminated bottom of a remediated excavation, through the originally uncontaminated saturated backfill, toward a well pumping water from the latter is fundamentally flawed and not conservative.

**Chris G. Whipple**

DOE comments that the cistern scenario was more limiting than the onsite receptor scenario. It isn't clear whether water pathways were considered in these scenarios, such that contamination at depth could affect drinking water, irrigation, etc.

It appears that this question may have been overtaken by 5C9, which remains a work in progress, and 5C10, which was addressed in the slides discussed on September 2. The slides indicated that diffusive transport from the deep contaminated layer is the dominant exposure source, and will control subsurface DCGLs. My guess is that at the time this RAI was written, the revised analysis of doses from contaminants at depth had not been done. Need to cross-check with 5C3 as well.

**Thomas E. Potter**

This RAI is reflective of a number of major IERT comments. The DOE response appears to reflect reasonable interpretation of the RAI. DOE demonstrates that the dose to a farmer with a cistern is limiting with respect to exposure scenarios involving gully erosion. It should be noted, however, that the offsite exposure scenario assumed for this evaluation was a resident gardener/fisherman on Cattaraugus Creek. Although this receptor is assumed to ingest stream water, which would be unlikely and conservative, other aspects of the assumption may not be

conservative. There is now a resident farmer on the banks of Buttermilk Creek just upstream of the confluence with Cattaraugus Creek where nuclide concentrations in stream water are approximately an order of magnitude higher than in Cattaraugus Creek. DOE work involving assessment of radionuclide transport from residual subsurface materials as related to this matter is continuing and the results could be important to this RAI.

## **5C7 – SUBSURFACE DCGL APPROACH NOT LIMITING**

**Sean J. Bennett**

RAI and DOE Response: NRC noted that subsurface DCGLs may not be limiting for all contamination sources given that erosion of the cover could convert a subsurface water source into a surface water source. NRC therefore asked for the technical basis for this limiting scenario given the known surface erosion processes. As noted above in RAI 5C4, DOE recognizes the potential threat of gully erosion, and considered as plausible the exposure to a recreational hiker spending time in a gully that is deep enough to expose the buried contaminants in comparison to an onsite receptor (cistern drilling scenario) and an offsite receptor (at the confluence of Buttermilk and Cattaraugus Creek). These scenarios and their risks are presented and discussed in RAI 5C4 and RAI 5C6, and employed the use of RESRAD. In summary, DOE notes that the cistern drilling scenario poses a greater risk to radioactive exposure than both the recreational hiker and the receptor located at the downstream confluence.

Comment: DOE and its cooperators correctly recognize that gully erosion remains the principal threat to the site and the primary surface erosion mechanism to expose the buried waste. This RAI further considers the effect of erosion on the exposing contaminants to the environment. The critical comments offered in response to RAI 5C4 and 5C6 are reiterated briefly below.

1. It is not clear when the gully breaches the buried waste. As noted above, the gully advance rate simulated by the CHILD model (0.012 and 0.0035 m/yr) are significantly lower than both onsite observations (one to two orders of magnitude; 0.4 to 0.7 m/yr) and rates reported in the literature (one to several orders of magnitude higher). If this gully advance rate is underpredicted, then the buried waste would be breached by a gully much sooner in time than predicted and the concentration of the contaminant exposed at the surface may be much higher than predicted.
2. The results using the WEPP cannot be ratified or accepted here because no onsite verification or validation of the hydrologic and geomorphic input parameters is conducted.
3. The authors do not recognize the role of seepage (exfiltration) on gully erosion initiation and a potential mechanism of contaminant transport. Evidence of surface seepage processes at the West Valley Site is pervasive, and it is highly likely that rates of gully erosion would be greatly enhanced, and the pore waters emerging these seeps and developing gullies could be transporting contaminants to the ground surface in advance of exposure of the contaminated layer itself.

## **Shlomo P. Neuman**

NRC has asked for additional information about the potential for groundwater contamination by buried sources and erosion of cover material that might convert a subsurface source to a surface source, rendering an excavation scenario applicable. NRC has requested a technical basis for the assertion that subsurface DCGLs developed by DOE are limiting when groundwater transport and erosion are considered.

The DOE response states, among others, that monitoring results indicate a low potential for contamination of the remediation WMA1 excavation from upgradient sources. What about the potential for contamination from sources that would not be strictly upgradient when a farmer activates a well at the site? Has the DOE considered the possibility that such a well could cause local gradient reversals which might potentially draw contamination from directions other than those that are currently upgradient of WMA1?

The same question applies to the DOE argument that since the area of buried contamination in the old sewage treatment plant drainage is not hydraulically upgradient of WMA1 and WMA2, the potential for any impact on those areas by groundwater transport is low. Has the potential for gradient reversal by pumping been considered in addressing this issue?

If the answer to either of these two questions is negative, then the DOE may need to reconsider its summary conclusion that there is no significant potential for groundwater contamination from outside buried sources impacting either WMA1 or WMA2.

The above questions have not been addressed in the November 2009 revision.

Instead, the DOE restates that additional groundwater modeling using the STOMP code has shown that diffusion of radioactivity from the bottom of the deep excavations must be taken into account in establishing the subsurface soil DCGLs and cleanup goals. The updated response to RAI 5C9 describes the additional modeling and the reduced DCGLs and cleanup goals that take the results of this analysis into account. This updated response included a new DP Subsection 5.2.6 that describes the modified conceptual model used, the mathematical models used, and the results of the analysis. The updated response to RAI 5C15 includes revised tables for Section 5 of the DP such as Table 5-14 that specifies the cleanup goals to be used in soil and sediment remediation associated with Phase 1 of the decommissioning.

For reasons I have enumerated under RAI 5C6, the conceptual framework underlying the DOE revised calculations of contaminant transport from the contaminated bottom of a remediated excavation, through the originally uncontaminated saturated backfill, toward a well pumping water from the latter is fundamentally flawed and not conservative.

## **Chris G. Whipple**

NRC asks about the potential for groundwater contamination; DOE's response is that "Additional evaluation has confirmed that the approach used to develop subsurface DCGLs is limiting when groundwater transport and erosion processes are considered." I take this to mean

that at the time this RAI was prepared, it appeared that the cistern scenario was still the scenario with the most restrictive DCGLs. As with RAI 5C6, it isn't clear that the additional analysis presented in the Powerpoint slides was available.

See comments re 5C6 and 5C9.

**Thomas E. Potter**

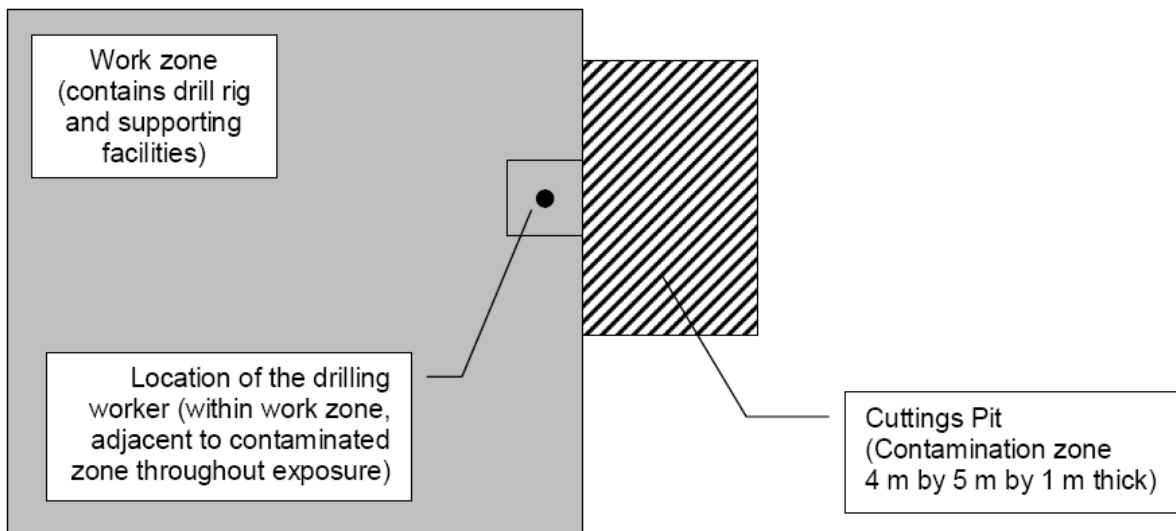
This RAI is reflective of a number of major IERT comments. The DOE response appears to reflect reasonable interpretation of the RAI. DOE demonstrates that the dose to a farmer with a cistern is limiting with respect to alternate exposure scenarios involving gully erosion. The DOE response appears to address the NRC concerns laid out in the NRC basis statement. DOE work involving assessment of radionuclide transport from residual subsurface materials as related to this matter is continuing and the results could be important to this RAI.

**5C8 – MODEL GAS AND OIL WELLS**

**Chris G. Whipple**

The RAI asked for a comparison of DCGLs for drilling a natural gas well with those for the cistern scenario. As the figure in the response shows (pasted below), the gas well was not drilled through contamination, so contaminated cuttings were not brought to the surface. It is not surprising that doses were low. The RESRAD files associated with this analysis were included in a zipped file. Since this analysis involves low doses from a borehole through uncontaminated soil, it is both uninteresting and not surprising.

I would not expect this scenario to be limiting, given that the total time spent on the site by the well driller is 50 days.



**Thomas E. Potter**

This RAI is not reflective of any IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response incorporating a drilling scenario appears to be complete and reasonable.

**5C9 – CONSIDERATION OF SUBSURFACE CONTAMINATION (GROUPS 2 AND 3)**

**Shlomo P. Neuman**

NRC has expressed concern about lack of consideration of subsurface contamination at the bottom of WMA1 and WMA2 excavations when deriving subsurface DCGLs. The same concern was previously voiced by the IERT.

DOE response to this RAI in round 2 (i.e., September) was that they are awaiting further computations. As mentioned in their letter of submission (discussed earlier), the modeling assumes that releases of residual radioactivity from the bottom of the two deep excavations take place by diffusion. I have pointed out earlier why, in my estimation, this modeling approach may not be adequate.

As I have noted in the context of RAI 5C6, the November 2009 revision (including the revised response to RAI 5C9, most notably Figure 5-10) makes clear that (a) contaminants are taken to be released from the bottom of the excavation into the saturated zone of the backfill purely by diffusion and (b) advective flow in Unweathered Lavery Till beneath the backfill is taken to continue being directed downward. In reality, a well that is pumping water from the saturated part of the backfill would cause groundwater flow, and hence advective transport, in the underlying shallow ULT to reverse course upward, through the contaminated bottom of the excavation, into the overlying (originally) uncontaminated saturated backfill, followed by lateral flow and contaminant advection toward the well.

It follows that the conceptual framework underlying the DOE most recent calculations of contaminant transport from the contaminated bottom of a remediated excavation, through the originally uncontaminated saturated backfill, toward a well that is pumping water from the latter is fundamentally flawed and not conservative.

In their revised responses the DOE demonstrates that most of the subsurface soil cleanup goals were reduced after taking into account the impacts of continuing releases of residual radioactivity from the bottom of the deep excavations by diffusion. Lack of conservatism behind their calculations suggests that the goals would have been reduced further had due consideration been given to advective transport.

**Chris G. Whipple**

This RAI addresses a concern that was a key focus of the previous IERT review – that the cistern scenario should probably not be the driver for subsurface DCGLs, but that a more detailed analysis of the effect of residual contamination at depth on DCGLs was required.

The NRC captures the basis for our concerns well. I quote the entire NRC comment because it has several aspects:

RAI: DOE has not provided sufficient information to justify lack of consideration of subsurface contamination at the bottom of WMA1 and WMA2 excavations when deriving subsurface soil DCGLs. Additional data collected on the extent of Lavery Till contamination as remediation proceeds may show greater extent of contamination than originally assumed, additional transport pathways not considered in the subsurface DCGL calculations (e.g., contamination of Lavery Till sand or along H-piles in the Lavery Till), or greater accessibility of contamination at depth than what is expected. (Section 5.2.1, Page 5-23)

Basis: DOE presented several qualitative arguments (page 5-41) to justify lack of consideration of subsurface contamination at depth after contaminated subsurface soils are excavated from WMA1 and WMA2. While some of the qualitative arguments regarding the relative inaccessibility of contamination in the Lavery Till to a potential receptor are compelling, additional data and calculations are needed to fully support the arguments presented. Because only one scenario is evaluated in deriving subsurface DCGLs (i.e., construction of a cistern), this scenario must be demonstrably conservative when considering other scenarios that may be just as, or more, likely. The amount of contamination assumed to be brought to the surface from construction of a cistern is relatively small and dilute<sup>5</sup> and may not be limiting for those radionuclides where water-dependent pathways may dominate the dose (e.g., existing contamination present in the saturated zone may be drawn from a well leading to water-dependent exposure pathways).

Additional information may be needed to support the hydrogeological conceptual model for contamination assumed to be present underneath WMA1 and WMA2 used to derive subsurface DCGLs. Previous geologic interpretations showed contamination of a significant portion of the Lavery Till and Lavery Till sand underneath the Main Plant Process building that could lead to pathways of exposure not considered in the current analysis. DOE should indicate how it plans to manage the risk associated with significantly greater contamination levels at depth along H-piles or within the Lavery Till then were assumed in the DCGL calculations.

Additional calculations or modeling should be performed to support the assumption regarding the expected lower relative risk of residual contamination at depth versus the risk associated with contamination assumed to be brought to the surface due to a cistern drilling scenario. This would include a quantitative evaluation of the potential for Lavery Till contamination to be transported to the

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<sup>5</sup> Only one tenth of the soil column is assumed to be contaminated resulting from assumptions regarding the thickness of contamination in the Lavery Till at the bottom of the excavation and the amount of clean soil used to back-fill the excavation.

Kent Recessional Sequence (KRS). DOE should present information on the relative risk of the cistern versus a ground/surface water transport scenario. DOE should also quantitatively evaluate the impact of pumping and the presence of hydraulic barriers on the potential migration of contamination from the top of the Lavery Till to a well located in the sand and gravel unit and present the relative risks associated with a cistern versus groundwater well scenario.

DOE should clarify how the residual risk from contaminated soil located just below 1 m (e.g., on the sides of the excavations) is appropriately accounted for when comparing residual concentrations to subsurface DCGLs which assume the contamination is mixed with clean soil at a ratio of one to ten (i.e., dilution factor of ten). DOE indicates in a footnote on page 5-4 that contamination on the sides of the excavation up- and cross-gradient from the source area is not expected to be contaminated. This expectation should be confirmed in the field or enough data collected to evaluate the impact of contamination at intermediate depths on the dose calculations.

DOE's response addresses several issues. On the question of where and how much residual activity would remain following excavation of WMA1 and WMA2, DOE notes that there are large uncertainties regarding locations and concentrations, and comments that "It is not known whether the radioactivity in the shallow Lavery Till soil samples is an artifact of the Geoprobe® sampling method or the result of migration from contaminated groundwater from the source area of the north plateau groundwater plume (Hemann and Steiner 1999)." It is noted that deeper samples from the Lavery Till have not been collected.

The emphasis on the uncertainties seems to have not been included when the cistern scenario was described and the associated DCGLs derived.

In the discussion of the potential for residual contamination at the top of the Lavery Till to contaminate groundwater, the September response is:

The response to RAI 5C3 describes the results of additional groundwater modeling using the STOMP code and other models used in the Environmental Impact Statement (EIS) to evaluate the potential impacts of changes in flow fields associated with installation of the hydraulic barriers on the DCGLs. As explained in the response to that RAI, this impact is expected to be negligible.

The potential impact of movement of residual contamination from the upper layer of the Lavery Till into groundwater of the backfilled excavations has been evaluated using a combination of flow modeling performed using the three-dimensional STOMP model and transport and dose modeling using the FEIS finite difference rectangular source model. The STOMP modeling determined the influence of pumping of a well on the direction and magnitude of groundwater flow at the backfill soil-Lavery Till interface and established the magnitude and direction of flow of groundwater towards and around the well in the volume above the contaminated till.

This modeling showed that some residual radioactivity at the bottom of the deep excavations will diffuse upwards into the uncontaminated fill placed in the excavation and contaminate the groundwater in the backfilled excavation, resulting in contaminated water potentially being drawn into the hypothetical well included in the base-case conceptual model used to develop the subsurface soil DCGLs. This will result in increased predicted doses from water dependent pathways, especially from drinking water.

The Final Environmental Impact Statement (FEIS) transport-dose model established the time-dependent rate of diffusion of contamination upward into the uncontaminated backfill volume and using the STOMP groundwater and well flow rates calculated the dose due to consumption of drinking water produced from the well. Drinking water doses calculated using this approach will be combined with dose-to-source ratios calculated using RESRAD to establish subsurface soil DCGLs for the combined pathways.

Table 5C-9-2 shows the changes necessary to the subsurface soil DCGLs and cleanup goals to take into account releases of radioactivity from the bottoms of the remediated WMA1 and WMA2 excavations.

In the November update, the response more clearly establishes that the scenario where diffusive transport of contaminants from the Lavery Till is more constraining than the cistern scenario. However, the above discussion that references RESRAD analyses and RAI 5C3 seems not to connect with the comments here about diffusive transport of contaminants from the Lavery Till into clean fill. As far as I know, RESRAD cannot model such a process. The intention to use STOMP to calculate concentrations which are then converted to doses based on RESRAD ratios makes sense, but whether and how this was done is not adequately explained. As with my comments on 5C3, the question of whether the correct conceptual model is being used is central to this issue. Specifically, the basis for assuming that advective transport would not occur is not explained. Were such transport to occur, it seems almost certain that dose rates would be higher than for the diffusive transport case. The discussion here does address what is known about contaminant locations and concentrations and possible mechanisms for transport in a way that is clearer than in 5C3.

**Thomas E. Potter**

This RAI reflects one of the major IERT comments. The DOE response appears to reflect reasonable interpretation of the RAI. As noted in the excerpt provided at the outset, the DOE cover letter states that new consideration of the potential for diffusive transport of radionuclides in soils at the bottom of the excavation would require revision of this response. The DOE response to RAI 5C15 (20) includes a note indicating that additional STOMP calculations showing that transport of nuclides from soils at the base of the excavated area to a well could be significant from the standpoint of subsurface soil DCGL calculation, and would require modification of responses to this RAI and others. The DOE response to this RAI provides additional information:

The response to RAI 5C3 describes the results of additional groundwater modeling using the STOMP code and other models used in the EIS to evaluate the potential impacts of changes in flow fields associated with installation of the hydraulic barriers on the DCGLs. As explained in the response to that RAI, this impact is expected to be negligible.

The potential impact of movement of residual contamination from the upper layer of the Lavery Till into groundwater of the backfilled excavations has been evaluated using a combination of flow modeling performed using the three-dimensional STOMP model and transport and dose modeling using the FEIS finite difference rectangular source model. The STOMP modeling determined the influence of pumping of a well on the direction and magnitude of groundwater flow at the backfill soil-Lavery Till interface and established the magnitude and direction of flow of groundwater towards and around the well in the volume above the contaminated till.

This modeling showed that some residual radioactivity at the bottom of the deep excavations will diffuse upwards into the uncontaminated fill placed in the excavation and contaminate the groundwater in the backfilled excavation, resulting in contaminated water potentially being drawn into the hypothetical well included in the base-case conceptual model used to develop the subsurface soil DCGLs. This will result in increased predicted doses from water dependent pathways, especially from drinking water.

The FEIS transport-dose model established the time-dependent rate of diffusion of contamination upward into the uncontaminated backfill volume and using the STOMP groundwater and well flow rates calculated the dose due to consumption of drinking water produced from the well. Drinking water doses calculated using this approach will be combined with dose-to-source ratios calculated using RESRAD to establish subsurface soil DCGLs for the combined pathways.

## **5C10 – SUBSURFACE MODEL CONTAMINATED AREA**

### **Shlomo P. Neuman**

NRC was concerned that for certain pathways and radionuclides, the assumption that contamination is distributed over a larger area (e.g., 1000 m<sup>2</sup>) rather than 100 m<sup>2</sup> would lead to more restrictive DCGLs.

The DOE continues to maintain that the assumed 100 m<sup>2</sup> area of the contamination zone is reasonable; the size of this area in the model is limited by the relatively small volume of material brought to the surface during construction of the hypothetical cistern, which is approximately 30 m<sup>3</sup>. A sensitivity analysis was performed to address this. However, the multi-source conceptual model described in the revised response to RAI 5C9 is said to have effectively superseded the original base-case conceptual model for subsurface soil DCGL development. The multi-source

model accounts for continuing release by diffusion of residual radioactivity from the bottom of the deep excavation as a secondary source of contamination.

The modified model makes use of larger contamination zone areas of 2000 m<sup>2</sup> for the residential gardener scenario and 10,000 m<sup>2</sup> for the resident farmer scenario. The updated response to RAI 5C9 provides the reduced DCGLs and cleanup goals that take the results of this analysis into account. This updated response includes a new DP subsection 5.2.6 that describes the modified conceptual model, the mathematical models used, and the results of the analysis. The updated response to RAI 5C15 includes revised tables for section 5 of the DP such as Table 5-14 that specifies the cleanup goals to be used in soil and sediment remediation associated with Phase 1 of the decommissioning.

The DOE found that DCGLs for I-129, Np-237, U-233, U-234 and U-238 decreased significantly with a smaller thickness / larger area contamination zone geometry. The DCGLs for most radionuclides increased with a larger thickness / smaller area contamination zone geometry, with only C-14 exhibiting a significant decrease.

As I have noted earlier, the conceptual framework underlying the DOE most recent calculations of contaminant transport from the contaminated bottom of a remediated excavation, through the originally uncontaminated saturated backfill, toward a well pumping water from the latter is fundamentally flawed and not conservative due to its over-reliance on diffusion and disregard of advection. Lack of conservatism behind these calculations suggests that DCGLs would have been reduced with an increase in contaminated zone area of a given thickness had due consideration been given to advective transport.

### **Chris G. Whipple**

The issue raised in the RAI concerns the lack of sensitivity analysis of the effect of the assumed area of contamination on the DCGLs. The NRC asserts that “For certain pathways and radionuclides, the assumption that contamination is distributed over a larger area (e.g., 1000 m<sup>2</sup>) rather than 100 m<sup>2</sup> would lead to more restrictive DCGLs.”

DOE’s response is that (1) the assumption of a 100 m<sup>2</sup> contaminated zone is reasonable and (2) the volume of material removed by digging a cistern is so small – 30 m<sup>3</sup> – that it probably would not matter. This argument seems simple to test, at least in principle, using RESRAD. The DOE scenario would produce a 1/3 meter thick layer of dirt over an area of 100 m<sup>2</sup>; the NRC asks what the dose would be if the dirt were spread over a 1000 m<sup>2</sup> area to a depth of 1/30 of a meter.

The RAI document provides a sensitivity analysis that it includes 18 radionuclides and looks at dose rates at the time of peak dose. Dose rates for a 300 m<sup>2</sup> area with 0.1 m of contaminated dirt and a 50 m<sup>2</sup> area with 0.6 m deep contamination were compared with the nominal 100 m<sup>2</sup> case. This analysis showed that for about 5 radionuclides – I-129, Np-237, and 3 uranium isotopes – the DCGLs would be reduced by more than half for a 300 m<sup>2</sup> contaminated area, relative to the 100 m<sup>2</sup> DCGLs. These 5 radionuclides are not significant contributors to external dose, and the DOE response notes that in general, a larger area leads to more external dose but that for migration to groundwater, the larger area experiences more dilution.

The only significant decrease in a DCGL for a smaller contaminated zone was for C-14, which was 33% lower for a 50 m<sup>2</sup> area than for the 100 m<sup>2</sup> base case. This seems likely to be due to the dilution of groundwater noted above.

For the 5 radionuclides that do not have strong external dose rates, my best guess is that the larger surface area led to higher exposures via dust inhalation and soil ingestion.

Although the title of this RAI concerns subsurface DCGLs, the question of the sensitivity of the surface DCGLs to the assumed area of contamination also seems to be worth looking at. I plugged the numbers into RESRAD to see how external doses would be affected by the area and thickness of contamination, using all the RESRAD default values. For a contaminated zone of 100 m<sup>2</sup> with 100 pCi/g of Cs-137 in a layer 0.33 m thick, the dose rate at time = 0 was 159 mrem/year. For the same concentration and isotope spread over 1000 m<sup>2</sup> and a depth of 0.033 meters, the dose rate was 73 mrem/year. If, however, one uses a 1000 m<sup>2</sup> area and 0.33 m depth, then the dose rate is 183 mrem/year.

So it appears that the NRC's assertion that increasing the area of contamination would decrease the DCGLs is not correct for radionuclides with significant external dose rates when the amount of contaminated dirt is held constant.

However, revised 5C9 results indicate that the cistern scenario is not the limiting case for derived DCGLs. If this scenario is not the limiting case, doing sensitivity analysis on this result is of little value. It appears that this RAI has been overtaken by other changes to the analysis.

### **Thomas E. Potter**

This RAI is not reflective of any IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response confirms the NRC concern and addresses it by including sensitivity analyses, the results of which are to be included in the ultimate cleanup goal selection. (See 5C15 (20).)

## **5C11 – STREAMBED DCGL MODEL ADEQUACY**

### **Chris G. Whipple**

The NRC's comment is clear: "DOE has not provided adequate information on the conceptual model related to exposure of a potential receptor from streambed contamination and the adequacy of the mathematical model, RESRAD, to represent this conceptual model."

DOE's response is that most releases to the streams were historical releases from the lagoons, and that their conceptual model is one in which contaminated sediments exist at the bottom of the streams. RESRAD cannot analyze this conceptual model, so what was analyzed was the case where contaminated sediments are found next to the stream. In addition direct exposures from the sediments, exposure pathways include fish consumption and sediment-to-forage-to-deer-to human deer hunters and their families. In considering plausible land use scenarios, DOE observed "Long-term erosion may result in downcutting and rim widening of the streams, as

discussed in Section 5.1.4. Considering this factor and the present steep banks, future land use in the area of the streams would be unlikely to include farming or home construction. A residential farmer scenario would therefore not be plausible.”

My impression is that it would be difficult to develop a plausible scenario in which the streambed DCGLs have any effect on how the site is remediated. However, if current concentrations exceed DCGLs due to historical releases from the lagoons, some remediation of the sediments would make sense. It isn't clear to me (or to NRC – see RAI 5C13) whether this is the case.

**Thomas E. Potter**

This RAI is not reflective of any IERT comment. The basis for the NRC RAI is complex:

**Basis:** Complex subsurface and surface water interactions are operable at the West Valley site (e.g., stream widening, gully formation, seasonal fluctuations in water-levels, flooding, groundwater seepage/discharge, and surface water runoff). However, the approach used to derive streambed DCGLs through use of the RESRAD code, which is first and foremost a code that models leaching processes from surface soils to groundwater, considerably simplifies the more complex processes occurring in the real system. DOE has not addressed the limitations of the RESRAD code in modeling ground and surface water interactions or the more complex processes occurring in the real system. Key processes significantly impacting the dose calculations for streambeds should be identified and evaluated to ensure that the DCGLs appropriately bound the exposures to a potential receptor.

The NRC-proposed path forward is also complex:

**NRC Path Forward:** For the purposes of Phase 1 DCGL calculations, DOE should evaluate the adequacy of the adaptation of the conceptual model in RESRAD for calculation of streambed DCGLs. DOE should clarify that the streambed DCGLs only consider *existing* contamination and that future release and transport to streambeds from upgradient sources is considered separately in a combined dose assessment, if DOE performs such a combined dose assessment to address NRC comments (see RAI 5C1 above).

To guide final decisions on decontamination and decommissioning of the site, DOE should consider interactions between contaminated groundwater and surface water in estimating future risks including seepage/discharge concentrations from upgradient sources, and potential accumulation of residual contamination on streambeds from erosion, flooding, seasonal water fluctuations, and other processes.

The DOE response appears to reflect reasonable interpretation of the RAI. But it is not clear that the DOE response is complete. The purpose of the streambed scenario is to compute DCGL values for streambed sediments, assuming existing radionuclide status. This purpose may require evaluation of not just exposure of a receptor to these sediments in place, but also

evaluation of the impact of transport of these sediments and radionuclides contained in them or leached from them over time to other locations and other receptors downstream. Questions about future transport of radionuclides to streambed sediments should be part of the computation of DCGL values for materials constituting the potential radionuclide sources feeding the streams.

## **5C12 – STREAMBED MODEL INHALATION PATHWAY**

### **Shlomo P. Neuman**

This RAI concerns inhalation pathway in streambed sediments.

The DOE response includes a revised Appendix C with revisions indicated in red. Not all of these revisions pertain to inhalation pathway in streambed sediments and some concern items related to groundwater. The DOE response does not make clear what the source and/or motivation for these revisions might be.

In addition to considering acute dose from subsurface material to a well driller during cistern installation, dose from subsurface material during installation of a natural gas well, and dose from surface and subsurface material to a resident gardener, the revised version includes a separate multisource evaluation to assess the impact of the bottoms of the deep excavations as a continuing source to groundwater.

As noted earlier this multisource evaluation relies entirely on diffusive transport from contaminated excavation bottoms, ignores advection and is therefore not conservative.

### **Chris G. Whipple**

The NRC comment indicates that they think that the inhalation pathway was omitted from the streambed DCGL analysis; DOE's reply is that the sediments are wet and unlikely to generate dust. I would not expect this pathway to make a significant contribution to dose or to affect the DCGLs. This impression is supported by the sensitivity analysis provided by DOE in Table 5C12-1, in which DCGLs are derived with the inhalation pathway on and off, and where the DCGLs are insensitive to the change. Nonetheless, DOE has now included an inhalation pathway.

### **Thomas E. Potter**

This RAI is not reflective of any IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response incorporates conservative assumptions related to the inhalation pathway and appears to be complete and reasonable.

## 5C12 - APPENDIX C, DETAILS OF DCGL DEVELOPMENT AND THE INTEGRATED DOSE ASSESSMENT

### Chris G. Whipple

Comments on the parameters used in the deterministic analysis appear in this Appendix. It is not clear to me whether this Appendix is meant to be part of RAI 5C12 or that it is simply included in the November 6 responses following the responses to RAI 5C13. These responses apply to issues raised by the NRC in RAI 5C15 in NRC's numbering. DOE's actual response in RAI 5C15 is to provide a probabilistic uncertainty analysis and to compare the results of this analysis with those of the deterministic approach. Appendix C discusses the parameters used in the deterministic analysis.

Table C-1 lists the input parameters to the model, with changes shown in a different color. This table does not do what NRC asked, that is, to "provide sufficient support that the selection of parameter values in the deterministic analysis is sufficiently conservative to demonstrate compliance with License Termination Rule (LTR) criteria." The changes do not appear to be particularly important; they include performing a sensitivity analysis on the areal extent and thickness of the contaminated layer from the cistern cuttings, the use of a slightly higher evapotranspiration factor, minor changes to hydraulic parameters, the use of a significantly lower dust loading factor, and an increase in the assumed fraction of locally grown food that is contaminated.

Table C-2 describes the central estimate and range of  $K_d$  values used; one set of values applies to the surface soil DCGL contaminated zone, the unsaturated zone, and the saturated zone, and for many radionuclides, a higher central estimate and range of possible  $K_d$  values applies to the subsurface soil DCGL contaminated zone and the sediment DCGL contaminated zone. The basis for using different values in different calculations is that apparently the latter two zones reflect the properties of the Lavery Till, while the first three reflect sand and gravel or loam.

The remainder of Appendix C includes tables that describe the radionuclide data for the Lavery Till, summarize the sensitivity analysis cases and results, and identify the primary dose pathways for the three cases analyzed: surface soil, subsurface soil, and sediments. Perhaps not surprisingly, the water-dependent pathways were the main dose contributors for the low  $K_d$  radionuclides, e.g., I-129, Tc-99, and uranium, with the water-independent pathways more important for the less mobile radionuclides.

RAI 5C12 and Appendix C provide a summary of parameters used in the analysis, but they do not make a technical case that such values are conservative. In particular, several of the  $K_d$  values in Table C-2 are higher than the default values used by RESRAD, and even the lowest end of the range over which sensitivities were analyzed exceed the RESRAD default values. For example, the default  $K_d$ s in RESRAD for C-14 and Tc-99 are both 0 mL/g. But in the derivation of DCGLs, a  $K_d$  of 5 or 7 mL/g, with a range of 0.7 to 12, was used for C-14. A value of 0.1 (range 0.01 to 4.1) or 4.1 (range 1 to 10) mL/g was used for Tc-99.

The  $K_d$  for uranium was measured as 10 mL/g in the Lavery Till. The NRC questioned why the analysis assumed a  $K_d$  of 35 for the sand and gravel fill (see RIA 5C16). In cases where a value of 35 mL/g was used, the associated range for the sensitivity analysis was 10-350. It makes no sense to set the lower end of the range to the site-specific value that was actually measured.

Table C-2 indicates that the default RESRAD  $K_d$ s for actinium, lead, protactinium, and radium range from 20 to 100 mL/g. The values used in the analysis ranged from 1740 to 3550 mL/g. It is difficult to see how these values can be defended as being conservative.  $K_d$ s are also discussed in the comments concerning RAI 5C16.

Finally, comments have been added to Appendix C to indicate that the subsurface soil analysis does not consider releases from the bottoms of the deep excavations as a continuing source. As discussed in RAI 5C9, contaminants at the exposed surfaces of the excavations (technically, the tops of the excavations rather than the bottoms) were analyzed using the STOMP model. This analysis is apparently beyond the capabilities of RESRAD.

### **5C13 – STREAM SEDIMENT, MODEL-ACTUAL COMPARISON**

#### **Chris G. Whipple**

[Note: this item is listed as “Stream sediment, actual-model comparison” on the RAI Review Assignments table]

The NRC comment is “The assumed distribution of contamination for development of the streambed sediment DCGLs should be compared to observed contamination.”

DOE’s response is that “Available data on contamination associated with the sediment in Erdman Brook and the portions of Frank’s Creek on the project premises and on the banks of those streams are limited as explained in Section 4.2 of the DP. Consequently, the comparison requested cannot be made at this time.”

As noted in the discussion of RAI 5C11 above, if current concentrations exceed DCGLs due to historical releases from the lagoons, some remediation of the sediments would make sense. DOE should collect sediment data as needed to determine whether this is the case.

Taking the questions and answers in 5C12 and 5C13 together, it seems likely that historical releases from the lagoons have produced sediment concentrations that are unlikely to be exceeded by future site releases. If this is the case, then the question of whether streambed sediments need to be remediated can be answered by measuring current concentrations, and the decision about what to do about sediments can be made without consideration of how the site will be decommissioned.

#### **Thomas E. Potter**

The RAI does not reflect any specific IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI, but the DOE response does not appear consistent with an

optimally logical approach to site closure. To evaluate this, examination of the basis for the NRC RAI, the NRC-identified path forward, and the DOE response all need to be considered, so they are reproduced below:

**NRC Basis:** The contaminated zone of interest is located on the streambed and is assumed to be 3 meters (10 feet) wide and 333 meters (1093 feet) long, with a total area of 1000 square meters (approximately ¼ acre). Figure 2-7 on page 2-38 shows how natural redistribution processes can result in contamination over a much broader area than would be expected based solely on the geometry of the stream channels. For remediation of onsite streams, a technical basis should be provided to support the assumption that the assumed extent of contamination is consistent with or more limiting than expected to result from observed redistribution processes.

**NRC Path Forward:** Provide a comparison of the assumed size of the contaminated zone to the observed contamination of streambed sediment.

**DOE Response:** Available data on contamination associated with the sediment in Erdman Brook and the portions of Frank's Creek on the project premises and on the banks of those streams are limited as explained in Section 4.2 of the DP. Consequently, the comparison requested cannot be made at this time.

The Characterization Sample and Analysis Plan will provide for gamma walkover surveys of the banks of the streams and biased sampling of sediment in the streambeds and on the banks of the streams. These characterization data will be compared to the contamination zone geometry specified in the conceptual model for streambed sediment DCGLs and the model refined accordingly.

**Changes to the Plan:** None. Refining the source geometry in the conceptual models based on characterization data is required by the text and footnote on page 5-18.

First, it is important to consider the language in the footnote on page 5-18:

The characterization to be performed early in Phase 1, which is described in Section 9, would provide data that may be useful in better defining source geometry in the conceptual model. For example, if the depth of surface soil contamination were to be found to typically be about six inches, rather than three feet (one meter) as used in the conceptual model, then the conceptual model thickness would be changed and the DCGLs recalculated. While DCGLs are developed for 18 radionuclides, characterization data may indicate that some radionuclides may be dropped from further consideration. This could be the case, for example, if one or more of the 18 radionuclides do not show up above the minimum detectable concentration in any of the soil or sediment samples.

Contrary to the DOE response statement, the footnote does not appear to state a clear requirement to reconsider validity of DCGL assumptions based on the outcomes of the Characterization Sample and Analysis Plan. Such a potentially important requirement should not

be relegated to a footnote in the plan. In fact, similar language appears in DP Section 5.4.2, which, if properly clarified could serve the purpose.

Second, the DOE approach reverses the conventional approach to site closure, which places site characterization before DCGL calculation. Complexities associated with this site compromises having a solid technical basis for calculating DCGL values. DCGL values calculated without adequate site characterization, such as source geometry characterization, must be considered provisional and of questionable utility. DOE could improve its responsiveness in this particular instance by calculating DCGL values based on conservative assumptions regarding source geometry.

#### **5C14 – SOURCE FOR TRANSFER FACTORS**

##### **Chris G. Whipple**

The NRC comments that transfer factors for game were not provided. DOE's response is that RESRAD default factors for meat and milk were used. DOE does not comment on what transfer factors were used for migration from sediments to forage. My sense is that if DOE stuck pretty close to the RESRAD default values for these transfer factors, the analysis will be adequate for its intended purpose.

##### **Thomas E. Potter**

The RAI does not reflect an IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response provides information inadvertently omitted from the tabulation. RESRAD default values used for the transfer factors are appropriate.

#### **5C15 – CONSERVATISM IN MODEL INPUT PARAMETERS (September and November Responses)**

##### **Shlomo P. Neuman**

DOE response to this RAI is prefaced by a note indicating that a revised response is being prepared using the above diffusive modeling approach. Considering my earlier critique of this approach I expect the revised response to be deficient.

The revised modeling is indeed deficient for the reasons mentioned, lacking conservatism.

The DOE notes that the multi-source evaluation for subsurface soil DCGLs described in the updated response to RAI 5C9 produced generally lower DCGLs. Lack of conservatism suggests that the goals would have been reduced further had due consideration been given to advective transport.

NRC has expressed a need to demonstrate that model parameters used in the deterministic analysis are uniformly conservative.

DOE has responded by conducting a probabilistic analysis using the corresponding capabilities of RESRAD. This is a welcome development, demonstrating that the deterministic analysis has indeed not been conservative except in a few cases. The probabilistic analysis is presented as a supplement to the deterministic analysis; I recommend eliminating the latter and replacing it by the former in the revised DP.

The choice of probability distribution functions and statistical parameters in the probabilistic analysis need detailed justification. For example, hydraulic conductivities, assumed by the DOE to have triangular distributions, tend instead to exhibit lognormal distributions.

DOE asserts that probabilistic evaluation of the multi-source model was not practical due to the complexities of such an analysis considering the need to integrate the probabilistic analytic capabilities of RESRAD with the FORTRAN program used to develop the DCGLs. It is unclear why such integration would not have been practical. As noted on p. 106, this lack of integration caused a lack of direct correspondence between subsurface soil peak-of-the-mean DCGLs and multi-source deterministic DCGLs, releases from the bottom of deep excavations having remained unaccounted for in the probabilistic RESRAD analysis.

### **Chris G. Whipple**

The NRC clearly describes their concern:

**RAI:** DOE did not provide sufficient support that the selection of parameter values in the deterministic analysis is sufficiently conservative to demonstrate compliance with LTR criteria. (Section 5.2.4)

**Basis:** When performing deterministic analysis to demonstrate compliance with radiological criteria for license termination it is important to demonstrate that the selection of parameter values does not lead to a significant underprediction of the potential risk to the average member of the critical group for a 1000 year compliance period. Due to the large number of radionuclides and limited characterization, it is difficult to select a global parameter set that is demonstrably conservative for the actual mix of radionuclides expected to remain at the site following remediation. For example, if water-dependent pathways dominate the dose, then distribution coefficients ( $K_{ds}$ ) on the low end of the distribution (lower quartile) may be conservative. But, if water-independent pathways dominate the dose, then  $K_{ds}$  on the high end of the distribution (upper quartile) may be conservative. Several important parameter values were identified in the sensitivity analysis (e.g., distribution coefficients, various parameters/model affecting groundwater dilution, bioaccumulation factors); however, DOE did not evaluate the sensitivity of the results to all parameter values and it is not clear how DOE made changes to its selection of parameter values to ensure that the deterministic analysis is sufficiently conservative.

**Path Forward:** DOE should provide support that the selection of parameter values in the deterministic analysis does not significantly underpredict the

potential risk associated with residual material remaining at the site following remediation. Using the limited characterization data available, DOE should identify the key risk drivers and indicate how the parameter selection is conservative for these radionuclides. In the absence of sufficient information on radionuclide distributions, DOE should consider use of pathway- or radionuclide-dependent parameter sets that would tend to overestimate rather than underestimate the potential dose when considering the potential uncertainty associated with the dose calculations.

Although this issue and DOE's response are listed as RAI 5C15, the main discussion of the parameters used in the deterministic analysis appears in the revised version of Appendix C that appears after RAI 5C12 in the November 6, 2009, responses. RAI 5C15 describes DOE's probabilistic analysis. Appendix C (beginning on page 60 of the November 2009 RAI response) includes discussion of the surface soil DCGLs and the subsurface DCGLs as well as those for sediments. This section has been updated to reflect the inclusion of consideration of contamination at the bottom of the excavated areas in the DCGLs. In the DP, the pathway that determined the subsurface DCGLs was the cistern scenario, and our comments questioned whether the remaining contamination under the fill would contaminate groundwater. RAI 5C9 considered this and this pathway led to the reduction of concentrations in the DCGLs for about half the radionuclides considered. This revised analysis in RAI 5C9, while an improvement over the previous version in which the cistern scenario determined the DCGLs, only considers diffusive transport of radionuclides, so it is likely to underestimate doses. Consequently, DCGLs derived in RAI 5C9 are overestimated.

DOE presents the results of its probabilistic uncertainty analysis in this section. Table 5-11a reports the DCGLs for 18 different radionuclides for the three cases, i.e., surface soil, subsurface soil, and streambed sediments. For each case, the deterministic DCGL is listed along with the peak-of-the-mean from the probabilistic analysis. Peak-of-the-mean refers to the mean dose rate observed at the time of peak dose. For surface soils, the peak-of-the-mean DCGL was lower than the deterministic DCGL for every radionuclide except Np-237. For subsurface soils, the peak-of-the-mean DCGLs were lower than the deterministic DCGLs for 12 of the 18 radionuclides. Recall however, the subsurface DCGLs were initially derived based on the cistern scenario, which we have argued is inappropriate in comparison to the analysis of exposures to residual contamination at depth. For sediments, all 18 DCGLs were lower for the probabilistic analysis than for the deterministic.

This response also addresses subsurface soil DCGLs that would be based on continuing releases from the contaminants left behind under the fill. The comment appears "For subsurface soil, the limiting deterministic analysis results from the residential gardener alternative scenario described above are more limiting than the peak-of-the-mean DCGLs for 10 of the 18 radionuclides. (However, the additional deterministic multi-source analysis that includes continuing releases from the bottoms of the remediated deep excavations as discussed in Section 5.2.6 results in even lower DCGLs from many of the radionuclides of interest.)" No explanation was offered for why a residential gardener scenario was considered plausible while a residential farmer was not.

Appendix E provides additional details regarding the probabilistic uncertainty analysis.

## Discussion of RAI 5C15 and Appendix E

Tables E-1, E-2, and E-3 describe the parameter input distributions for inputs other than distribution coefficients. These inputs are mostly represented by triangular distributions, with the peak equal to what is judged to be the most likely value. Default distributions recommended by RESRAD appear to be used in most cases. Truncated normal distributions were also used.

The probabilistic analysis assumed that the probability density functions for  $K_d$ s are truncated lognormals. No  $K_d$  values are allowed to include zero in their distribution, because the log  $K_d$  value would need to extend to negative infinity. So even though RESRAD's default  $K_d$  values for Tc-99 and C-14 is zero, the range of plausible values for these radionuclides and for I-129 do not extend down to zero.

As noted in the comments on RAI 5C12, the treatment of the uranium  $K_d$  is intuitively unsatisfying. It does not make physical sense that the  $K_d$  would be 10 mL/g in the Lavery Till and 35 in the sand and gravel layer. In the probabilistic analysis, the truncated lognormal range used for the uranium  $K_d$  is from 0.03 to 2,200 mL/g. In contrast, a range of 1 to 100 mL/g is used for the subsurface to represent the Lavery Till. No explanation is given regarding why the upper end of the distribution for the  $K_d$  is sand and is so much higher than the top of the range for the Lavery Till. This could reflect what has been referred to as risk dilution, defined as "...a situation in which an increase in the uncertainty in the values of input parameters to a model leads to a decrease in calculated risk."<sup>6</sup>

Additional tables in Appendix E compare the deterministic DCGLs with both the peak-of-the-mean values and with the 95<sup>th</sup> percentile values of the probabilistic analysis. These results indicate the deterministic analysis, using parameter values meant to be conservative, was less conservative than the mean value of the probabilistic analysis. This may be due to the use of the deterministic parameter values as the most likely value in the probabilistic analysis input distributions.

### Thomas E. Potter

The RAI reflects a number of IERT comments related to uncertainty in parameter values and the desirability of probabilistic analysis. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response, which includes probabilistic analysis, appears to respond to the RAI appropriately. The DOE response includes a note indicating that additional STOMP calculations showing that transport of nuclides from soils at the base of the excavated area to a well could be significant and would require modification of responses to this RAI and others.

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<sup>6</sup> The term risk dilution was used in the IAEA and NEA International Peer Review of the Yucca Mountain Project TSPA-SR in 2002. It is further discussed in an article "The Issue of Risk Dilution in Risk Assessments" by R. Wilmot and P. Robinson in an OECD Nuclear Energy Agency (NEA) workshop proceedings on the "Management of Uncertainty in Safety Cases and the Role of Risk" Stockholm, Sweden, on 2-4 February 2004.

The DOE overall approach to the determination of cleanup goals results in selection of adjusted minima DCGL values from a complex array of results computed for various scenarios, combinations of scenarios (computed deterministically and probabilistically), various sensitivity analyses, etc. Once the details regarding individual scenarios, etc., are worked out, the overall approach should be workable.

## **5C16 – CONSERVATISM IN $K_d$ s (GROUP 2)\*\***

### **Chris G. Whipple**

#### **NRC Concerns**

The NRC comments that DOE did not adequately support its claim that the selection of parameter values in the deterministic analysis was conservative. Specifically, the NRC notes that there appear to be some inconsistencies in particular  $K_d$  values, depending on whether site-specific or literature values are used.

The NRC observed that  $K_d$  values measured in the Lavery Till were also used for sand and gravel fill, which NRC expects to have lower  $K_d$ s than those for the Lavery Till. DOE also used the Lavery Till values for sediments without justification.

NRC notes that the  $K_d$  for uranium based on site-specific data for the Lavery Till is 10 L/kg. However, DOE used a value of 35 L/kg for sand and gravel fill for the excavated North Plateau. The NRC also notes that “A footnote to Table C-2 indicates that the uncertainty in  $K_d$ s for progeny was not evaluated in the sensitivity analysis and RESRAD default values were used in all cases. As the risk from ingrowth of daughter products in many cases dominates the risk from the parent radionuclides, the sensitivity of results to daughter product  $K_d$ s should be evaluated and uncertainty appropriately managed with parameter values that tend to overestimate rather than underestimate the potential dose in the deterministic analysis.”

#### **DOE Response**

DOE’s response is that the  $K_d$  values they used were evaluated and found to be reasonable. No specific details or discussion of the basis for deciding that they used reasonable values is provided. DOE did change the  $K_d$  values used for curium and for progeny to those in NUREG/CR-5512. Regarding the use of Lavery Till values for fill and sediments, the DOE response is “As noted in the basis for this RAI,  $K_d$  values for Lavery till soil were used for the contamination zone in the subsurface soil and streambed sediment models. In the case of the subsurface soil model, Lavery Till material is brought to the surface and mixed into the hypothetical garden. In the case of the streambed sediment model, the streambeds of interest lie within the Lavery Till layer.”

“To evaluate the impacts of use of the Lavery Till  $K_d$  values in calculating the subsurface soil DCGLs, the deterministic model was run using sand and gravel layer  $K_d$  values for the contamination zone. The revised model did not produce significantly different results, with DCGLs that were similar to the DCGLs with the base-case model in most cases; somewhat lower

DCGLs for I-129, U-232, and Np-237; and somewhat higher DCGLs for Tc-99, U-233, U-234, and U-238.”

“In the probabilistic uncertainty analyses described in the response to RAI 5C15, the  $K_d$  values for the 18 radionuclides of interest were treated as probabilistic parameters. A range of potential values was established for each  $K_d$  based on site-specific data and literature values and bounded lognormal distributions were assigned consistent with NRC guidance.”

## Discussion

DOE justifies the use of Lavery Till  $K_d$  values as representative of the excavation fill on the North Plateau on the grounds that “Lavery Till material is brought to the surface and mixed into the hypothetical garden.” However, the Decommissioning Plan (at page 7-27) indicates that “After the verification survey is completed and regulatory approval is received, the area would be backfilled with uncontaminated earth and graded as necessary to restore to it a near natural appearance. The backfill material would be obtained from similar offsite geologic deposits. The properties of this material (especially the texture, hydraulic conductivity, and distribution coefficients) would be similar to those of the sand and gravel layer on the project premises as described in Section 3.” Figure 7-7 illustrates that the excavation, which reaches 40 feet in depth at some locations, involves removal of perhaps one foot of Lavery Till. Elsewhere, the DP indicates that the excavated material in excess of cleanup goals would be treated as radioactive waste and disposed of offsite, and contaminated soil below cleanup goal concentrations would be removed where practical, consistent with As Low As Reasonably Achievable (ALARA).<sup>7</sup>

DOE’s statement above is “The revised model did not produce significantly different results, with DCGLs that were similar to the DCGLs with the base-case model in most cases; somewhat lower DCGLs for I-129, U-232, and Np-237; and somewhat higher DCGLs for Tc-99, U-233, U-234, and U-238.” It is difficult to understand how revisions to  $K_d$  values led the DCGL for U-232 to decrease while the DCGL for other uranium isotopes increased. It could be due to the fact that the half-life of U-232 is 72 years, while the other uranium isotopes have much longer half-lives. This is not explained.

DOE’s probabilistic uncertainty analyses are discussed under RAI 5C15. However, the questions that NRC asks here regarding RAI 5C16 is how one can be confident that the values DOE selected for its deterministic case are conservative. NRC was not asking about an uncertainty analysis; they were looking for evidence concerning why the deterministic analysis is at least conservative. A complicating factor is that when exposures are primarily through water-based pathways, lower  $K_d$  values typically lead to higher dose rates and to lower DCGLs. Conversely, for exposure pathways that do not involve groundwater use, higher  $K_d$  values typically lead to higher dose rates and lower DCGLs. Without understanding the mix of water-based and non-water-based pathways, one cannot confidently assert that literature values such as those from NUREG/CR-5512 are conservative or not. An additional source of complexity is that lower  $K_d$ s can be associated with more rapid migration of radionuclides away from onsite

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<sup>7</sup> The use of cleanup goals derived specifically for the West Valley site as a basis to determine whether wastes are radioactive may not match the license conditions and waste acceptance criteria of the disposal facility. This is not noted in the DP.

locations with high dose rates. For these reasons, in discussing whether and why  $K_d$  values are conservative, it is often not obvious whether doses increase or decrease with increases and decreases in  $K_d$ s.

**Thomas E. Potter**

The RAI does reflect a number of IERT comments related to  $K_d$  uncertainty. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response, in conjunction with probabilistic analyses conducted in response to RAI 5C15 (20), appears to respond to the RAI appropriately.

**5C17 – GAMMA SHIELDING FACTOR (GROUP 2)**

**Thomas E. Potter**

The RAI does not reflect an IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response described recomputed the shielding factor, resulting in a substantially higher value (lower DCGL for nuclides for which external exposure is the dominant pathway). The DOE approach appears to be sound and results in a shielding factor not greatly lower than the default RESRAD value.

**5C18 – PUMPING, IRRIGATION RATE CONSERVATISM**

**Chris G. Whipple**

The NRC comment is “DOE did not provide sufficient support that the selection of parameter values in the deterministic analysis is sufficiently conservative to demonstrate compliance with LTR criteria. This specific comment is related to DOE's selection of pumping and irrigation rates.” NRC continues “Irrigation and pumping rates can have a significant impact on the expected risk associated with residual contamination remaining at the site following remediation. While higher pumping and irrigation rates would be more conservative for some radionuclides in certain situations, the assumed pumping and irrigation rates may not be conservative for other radionuclides. Therefore, the conservatism of the set of parameter values selected for the DCGL calculations becomes a function of the scenario and radionuclide being evaluated making it difficult to select a global parameter set that is demonstrably conservative for the entire site.”

- Surface soil DCGLs

For the surface soil DCGLs, the DOE response compares DCGLs for the resident farmer scenario with those for a residential gardener. In comparison to the farmer, the gardener uses less land (2,000 m<sup>2</sup> versus 10,000 m<sup>2</sup>), a well pumping rate that is scaled down by a factor of 5 (1140 m<sup>3</sup>/yr versus 5720 m<sup>3</sup>/yr), a lower fraction of time spent outdoors (12% versus 25%), and no production of meat or milk. The same dilution factor of 0.2 was used for both cases; the RESRAD Manual defines the dilution factor as “The dilution factor is the steady-state ratio of the concentration a radionuclide at the point of withdrawal or use to the concentration of the same radionuclide in infiltrating water as it leaves the contaminated zone.”

In essence, the gardener differs from the farmer by using one fifth as much land and water (where the water has equal radionuclide concentrations), by not producing meat or milk, and by staying indoors more. It is pretty obvious that such assumption would not lead to more restrictive DCGLs. However, the question that NRC raises, whether a scenario in which less water is used could result in water with higher radionuclide concentrations and consequently higher doses, was not considered by DOE.

- Subsurface soil DCGLs

The subsurface soil DCGLs are addressed using a sensitivity analysis as in RAI 5C10, that is, calculation of DCGLs for 50 m<sup>2</sup> and 300 m<sup>2</sup> for comparison with the base case 100 m<sup>2</sup>. As with RAI 5C10, the contaminated zone is created by the excavation of 30 m<sup>3</sup> of soil for a cistern. As with the surface soil DCGLs, a resident farmer and residential gardener are compared. Unlike the surface soil case, the relatively small contaminated area coupled with the lower water use by the residential farmer results, in some cases (see Table 5C-18-3) in lower DCGLs than for the resident farmer.

DOE has indicated that it will use either the resident farmer or residential gardener DCGL, whichever is lower. But this scenario still is derived from the questionable cistern scenario. When an improved subsurface scenario is analyzed, I expect that the cistern case will go away.

### **Thomas E. Potter**

The RAI reflects a number of IERT comments oriented toward evaluation of multiple exposure scenarios. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response is oriented more toward a single exposure scenario with broadly varying parameter values—varying broadly enough to effectively include multiple scenarios, i.e., farming and gardening. Although the DOE approach is different, it leads to the appropriate outcome for the cistern scenario, as defined.

## **5C19 – CONTAMINATED PLANT FRACTION**

### **Chris G. Whipple**

The NRC comment is “DOE should justify use of a contaminated plant fraction of -1 in RESRAD.” The NRC recommendation is that DOE should use a contaminated plant fraction of 1, but adjust intake rates based on expected yields. As with some other RAIs, this one is driven by the cistern scenario and the associated assumption that the contaminated soil covers only 100 m<sup>2</sup>.

The contaminated fraction refers to parameters to account for the ratio of contaminated foods to clean imported foods. The value of -1 for a plant contamination fraction has no physical meaning; it functions as a switch, as described in the relevant section of the RESRAD Manual:

The area factor (plant,  $FA3$ ; meat,  $FA4$ ; and milk,  $FA5$ ) is used to account for the fraction of consumption that is obtained from the contaminated site. If the input value of the “contamination fraction” is -1, then the area factors will be calculated by using Equation D.5. Otherwise, the input value will be assigned to the area factor:

$$\begin{aligned} FA3 &= A/2,000 \text{ when } 0 < A < 1,000 \text{ m}^2, \\ &= 0.5 \text{ when } A > 1,000 \text{ m}^2, \text{ and} \end{aligned} \quad (D.5)$$

$$\begin{aligned} FA4 = FA5 &= A/20,000 \text{ when } 0 < A < 20,000 \text{ m}^2, \\ &= 1 \text{ when } A > 20,000 \text{ m}^2, \end{aligned}$$

where  $A$  = area of contaminated zone (10,000 m<sup>2</sup>).

As the NRC correctly notes, the use of a -1 value for the plant fraction causes RESRAD to use a plant fraction of 0.5 for a farmed area of 1,000 m<sup>2</sup> or more, and a proportionally lower value for farmed areas below 1,000 m<sup>2</sup>. For the assumed 100 m<sup>2</sup> area contaminated by excavation of the cistern, the calculated value of  $FA3$  is  $100/2,000 = 1/20$  of the normal consumption rate.

DOE agreed to use a plant fraction of 1 and to adjust the consumption rates as requested by NRC. In theory, if the consumption rates for plants grown onsite were lowered by a significant amount, one could get the same exposure and risk estimate as the previous method. But in this case, DOE did not change the food consumption estimates significantly. The estimate for fruits, vegetables, and grain consumption was lowered from 160 to 112 kg/year, and the estimate for leafy vegetables was increased from 14 to 21 kg/year.

With a revised analysis in which water contaminated by residual subsurface contamination is used for irrigation and as drinking water, this cistern scenario with its 100 m<sup>2</sup> contaminated zone may go away.

This RAI does not reflect an IERT comment.

**Thomas E. Potter**

The RAI does not reflect an IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI. The DOE response appears to be appropriate.

**5C20 – CONSIDER BARRIERS IN HYDRAULIC PARAMETERS**

**Shlomo P. Neuman**

NRC noted that DOE should consider the impact of hydraulic barriers on the flow field when selecting parameter values for use in RESRAD or show how its selection of parameter values is reasonable or conservative.

Both the RAI and the DOE response focus on hydraulic gradient as the parameter of interest. Since flow depends not only on gradients but also on hydraulic conductivities, which is not discussed, I find both the RAI and the DOE response to be (in this sense) inadequate and misleading.

The DOE seems to be arguing that the impact of hydraulic barriers on flow is not relevant to the derivation of DCGLs. I find the argument to be unclear and unconvincing: as pointed out by IERT comments on the DP, DCGLs associated with contaminated subsurface soils should be (though in the original DP they have not been) derived upon considering the flow and transport of water and contaminants to a well pumping water from the subsurface.

## **5C21 – I-129 SENSITIVITY TO CONDUCTIVITY CHANGES**

### **Shlomo P. Neuman**

NRC noted that since I-129 is very long lived, one should not expect the corresponding DCGL derived from the surface soil model to depend on soil hydraulic conductivity and/or travel time to the well; yet sensitivity analyses by the DOE suggest such dependence.

The DOE suggests that such unexpected sensitivity is an artifact (so I understand) of an inconsistency in the manner that RESRAD computes dilution factors for high and low soil hydraulic conductivities. Discussions between NRC and DOE are said to have resulted in agreement about how to circumvent this inconsistency using a three-dimensional site model in a way that I find difficult to understand. Though the DOE provides a description of how this was done, I find their description difficult to follow. The one impression I am left with is that consistency between the three-dimensional model and RESRAD is tenuous and must be imposed through model and/or parameter manipulations by the user. This does not imbue me with confidence that RESRAD reflects groundwater flow and transport conditions in a manner adequate for its purpose.

### **Chris G. Whipple**

The NRC comments “The sensitivity analysis of the surface soil model indicated that decreasing the hydraulic conductivity increased the DCGL for I-129 due to increasing the travel time to the well. It is not clear why this result was obtained (see bullet on page 5-37)...I-129 is very long-lived, and therefore the travel time to the well should have little impact on the estimated DCGL instead of resulting in a 1873% change.” The NRC thinks that DOE’s reference to travel time is an indication that decay was occurring. But for I-129 with a half-life in excess of 15 million years, this makes no sense.

The DOE response notes that the change in travel time associated with the change in hydraulic conductivity resulted in significant changes to the dilution factor: “In the specific case of I-129, the dilution factor is reduced from 0.2 to 0.026 when reducing the hydraulic conductivity from 140 m/y to 1 m/y. For the high conductivity case, the dilution factor is calculated based on the depth of contamination in the aquifer relative to the depth of well intake. For the low

conductivity case, the dilution factor is calculated as a ratio of infiltrating recharge to aquifer pumping rate.”

This RAI does not reflect an IERT comment.

**Thomas E. Potter**

The RAI does not reflect an IERT comment. The DOE response appears to reflect reasonable interpretation of the RAI. The underlying problem identified in the NRC RAI ultimately relates to computation of dilution of infiltration water bearing radionuclides (from flow through cistern cuttings) in the process of transport to the well. The DOE response appears to be appropriate for the cistern scenario as defined, assuming validity of the hydrological interpretation.

**6C1 – ALARA, GOOD PRACTICES**

**Chris G. Whipple**

The NRC identifies two aspects of an ALARA program. The first is the use of good practice or good housekeeping efforts, such as floor and wall washing (for buildings that will remain) and removal of readily removable radioactivity in both buildings and soil areas. Such practices should be part of normal operations and training and do not require formal ALARA analyses to be performed. The second aspect concerns actions supported by a cost-benefit analysis. NRC’s observation is that the DOE is apparently more focused on the latter, that is, on ALARA justified by a cost-benefit analysis.

DOE apparently agrees and has added a “Good Practices” section with ten bullet points to the decommissioning plan.

This RAI does not reflect an IERT comment.

**6C2 – ALARA, INTERGENERATIONAL CONCERNS**

**Chris G. Whipple**

The NRC requested that a sensitivity analysis be performed regarding the long-term discount rate used in the intergenerational equity analysis, and that this sensitivity analysis includes the case where a 0% discount rate was used. NRC also looked for but did not find any discussion of intergenerational equity issues.

DOE provides the requested analysis, and also notes that under the site-wide removal alternative, the majority of the doses are not so far in the future. DOE also notes that the OMB recommends that real discount rates of 3% and 7% be used in such analyses.

This RAI does not reflect an IERT comment.

## **6C3 – ALARA, EXPLAIN TWO-STEP APPROACH**

### **Chris G. Whipple**

The NRC asks DOE why to “Provide reasons for why DOE has presented a simple, preliminary ALARA analysis in the DP and proposes an additional, complete ALARA analysis during Phase 1.... Add a discussion that explains why the two-step approach is consistent with NRC's guidance (2006) and why it is a reasonable approach for the nature of Phase 1 decommissioning at this site. Also explain why a preliminary analysis is reasonable for the DP.”

DOE’s response is to add the following note:

DOE has performed a preliminary ALARA analysis and provided for a later, more detailed ALARA analysis that will be performed during the remediation work. This approach is appropriate for Phase 1 of the decommissioning since information used in the analyses may change between the time of Decommissioning Plan issue and the time when remediation of the large excavations – the activity for which the analyses are most important – takes place. For example, waste disposal costs could increase significantly and possibly change the outcome of the analyses.

The results of the preliminary analysis provide useful information for planning purposes, even though it is possible that the later, more detailed analysis will produce different results. This two-step approach is consistent with guidance in Appendix N of NUREG-1757, Volume 2 (NRC 2006).

Comment: This statement asserts that DOE’s approach of using a preliminary and then refined analysis is consistent with guidance, but no specific aspects of the guidance are cited that would demonstrate that this is the case. DOE additionally argues that it will be better able to do a refined ALARA analysis once it gets into the Phase 1 remediation. This is likely to be true, but it isn’t clear whether some fundamental aspect of the remediation plan would change if a refined analysis were available before the work began. Once remediation begins, the basic plan is unlikely change significantly.

## **7C1 – EXCAVATED GROUNDWATER MANAGEMENT**

### **Shlomo P. Neuman**

This RAI concerns groundwater management during excavation: NRC has asked for an estimate or design of the dewatering schemes to be used during the excavation of WMA1 and WMA2 as well as the sequencing of these excavations.

According to the DOE, the final design for the dewatering system will be prepared by the site decommissioning contractor following the collection of additional data; DOE will change the conceptual schedule to provide for installation of the WMA1 hydraulic barrier before starting the WMA2 large excavation. This response seems rational.

## **DC1 – RECONTAMINATION POTENTIAL, SHEET PILINGS**

**Shlomo P. Neuman**

NRC has asked for a more detailed discussion of the impact of excavations on water flow patterns and a summary of experience with interlocking sheet piling. NRC was concerned with the recontamination potential of the WMA1 excavation.

According to the DOE the final design of the temporary interlocking sheet piling system as well as of permanent hydraulic barrier walls and a French drain will be prepared by the site decommissioning contractor after 2011. Past experience with sheet piling is summarized with the aid of photographs, providing a reason to believe that the planned system would function adequately at the site.

## **DC2 – GROUNDWATER FLOW CHANGE IMPACTS**

**Shlomo P. Neuman**

NRC has asked for an assessment of impacts that Phase 1 alterations of the hydrologic system would have on Phase 2 decisions, or a description of how those impacts could be mitigated. Key questions concerned future options regarding HLW tank closure and decreased dilution of the Sr-90 plume.

According to the DOE, groundwater modeling in Appendix D of the DP demonstrates that planned hydraulic barriers and French drain could achieve groundwater levels and hydraulic gradients within the backfilled WMA1 and WMA2 excavations that would result in groundwater flow outward from both WMA1 and WMA2 to downgradient areas. It is not clear to me how this would jive with the idea behind both the surface and subsurface soil DCGL models, that wells operating at these sites are able to draw indefinitely uncontaminated water from the saturated zone to help dilute contaminated water from surface and/or subsurface sources: this would require groundwater to flow into rather than out of the backfilled WMA1 and WMA2 excavations. Which of these situations, if any, does the three-dimensional modeling results in Appendix D support?

Though the DOE may be right that Phase 1 hydraulic barrier walls will not limit potential Phase 2 decisions on the North Plateau, they will certainly impact these decisions: for example, the DOE suggests that Phase 2 decisions may require designing and constructing additional hydraulic barriers to keep the HLW tanks dry.

## **DC3 – ENGINEERED BARRIER PERFORMANCE**

**Chris G. Whipple**

The NRC asks some very good questions regarding DOE's claims for engineered barrier performance:

Additional information is needed to support the assumption that the performance goals (e.g., hydraulic conductivity, mechanical strength or durability) of the slurry wall trenching technology and other engineered barriers are likely to be achieved. (Appendix D).

Basis: The slurry wall technology is stated as having a long history of successful usage, however this usage is not summarized. An initial maximum design hydraulic conductivity of  $6E-06$  cm/s is provided, which is approximately 200 cm/y. It is not clear at a moderately high conductivity for a hydraulic engineered barrier that the objectives of the barrier will be achieved. The DP states that the upper three feet of the barrier wall would be clean backfill to allow vehicular traffic over the wall without damaging it; however no basis is provided for this statement. The French drain system will contain perforated pipe and the trench will be backfilled with permeable granular materials. The DP states the French drain trench backfill will be designed to minimize silting, but no technical basis is provided on how it will be designed. In addition, the DP states the French drain will be monitored but includes no description of how the monitoring will be completed and what performance metrics will be used.

The durability of the engineered barriers projected to be used is discussed briefly on page D-8; however, a comparison of the required performance period to the experience base is not provided. The DP states that sodium bentonite would be added at a rate to achieve  $1E-8$  to  $1E-6^*$  cm/s hydraulic conductivity, but no information is provided as to how it will be determined that those hydraulic conductivity values have been achieved.

\*The actual RAI says  $1E8$  to  $1E6$ , but the  $1E6$  is apparently a typo.

The DOE response is “The proposed WMA1 and WMA2 hydraulic barrier walls and French drain described in the DP are conceptual designs that were developed to constrain the EIS analysis for the phased decision-making alternative. If the phased decision-making alternative is selected in the Record of Decision for the Decommissioning EIS, the final design for the barrier walls, French drain, and their monitoring program will be prepared by the site decommissioning contractor after Phase 1 decommissioning activities start in 2011. It is premature to present final performance goals in this revision of the DP as the final design of these hydraulic barriers has not been prepared.”

Comments: This approach is basically that DOE will come up with a final design later and will provide support for how this design will work at that time. This seems to be a risky approach, because once Phase 1 is initiated, it will likely be difficult to make major changes to the plan without undesirable delays. The phased approach does not include safe and stable stopping points at which major redesign could occur. DOE should make a better case that its design will perform as required before remediation is undertaken.

**Thomas E. Potter**

This RAI reflects a number of IERT comments. Evaluation of the DOE response is beyond the expertise of this reviewer.

**DC6 – BARRIER PERFORMANCE MONITORING**

**Shlomo P. Neuman**

NRC has requested that the DOE provide additional monitoring locations at the western end of the WMA1 barrier wall both pre- and post-installation of the barrier and specify monitoring schedules for monitoring wells and piezometers. Measurement of water levels with adequate frequency from the upgradient and downgradient piezometers is essential to ensure the integrity of the hydraulic barrier.

According to the DOE a post-installation monitoring system will be designed by the site decommissioning contractor after Phase 1 decommissioning activities begin in 2011.

**DC7 – BARRIER WALL STABILITY**

**Shlomo P. Neuman**

NRC has requested design and analysis details to demonstrate that the hydraulic barrier walls will be stable during excavations prior to backfilling under reasonably foreseeable loadings and scenarios.

According to the DOE the final design will be provided by the site decommissioning contractor after Phase 1 decommissioning activities begin in 2011 based on subsurface soil geotechnical data and a newly installed groundwater monitoring system.

**DC8 – INTERACTIONS WITH PERMEABLE REACTIVE BARRIER AND PERMEABLE TREATMENT WALL**

**Shlomo P. Neuman**

NRC has expressed concern that the proposed hydraulic barrier walls in WMA 1 and WMA 2 may impact the effectiveness of the Ditch Permeable Reactive Barrier and a full-scale Permeable treatment wall by reducing groundwater flow toward and through them.

The DOE states that it is no longer considering the installation of a Permeable Reactive Barrier in the area of the Swamp Ditch. The Permeable Treatment Wall is currently being designed and is scheduled to be installed in 2010. The contractor responsible for the design is modeling the potential effects that the proposed WMA 1 and WMA 2 hydraulic barrier walls and French drain may have on groundwater flow directions, gradients, and velocities in the non-source area of the North Plateau Plume.

I sense a certain inconsistency between DOE responses to some of the previous RAIs according to which the final design of the hydraulic barriers and French drain will be conducted no sooner than 2011 and their response to this RAI according to which the Permeable Treatment Wall is being designed based on current modeling of the effects that these structures may have on groundwater flow patterns. Why would one design the PTW on the basis of preliminary rather than final hydraulic barrier wall and French drain designs? If these preliminary designs are deemed sufficiently accurate for purposes of designing the PTW, why are they not sufficient to provide detailed responses to corresponding NRC RAIs?

## **DC9 – GROUNDWATER FLOW CHANGES AND WASTE**

### **Shlomo P. Neuman**

NRC has expressed concern about the impact of hydraulic barriers at WMA1 and WMA2 on the dewatering system currently operating in the Waste Tank Farm area (WMA3). They have asked the DOE to analyze the potential implications of increased groundwater flow towards the waste tank farm and ability of the tank and vault drying system to maintain the waste tanks/vaults in a safe configuration during the ongoing assessment period.

According to the DOE such an analysis cannot be conducted at this time because the proposed Tank and Vault Drying System is currently being designed by the WVDP site operations contractor and is not expected to be completed and in operation until 2010. Once again the DOE quotes results of three-dimensional groundwater modeling in Appendix D of the DP to the effect that the hydraulic barrier wall and French drain could achieve groundwater levels and associated hydraulic gradients within the backfilled WMA1 and WMA2 excavations that would result in groundwater flow from these excavations outward to downgradient areas, thereby severely limiting the potential for recontamination of the backfilled excavations by SR-90 contaminated groundwater from the non-source area of the north plateau plume or from potential releases from the Waste Tank Farm in WMA3. Once again I need to point out that this appears to contradict the idea behind both the surface and the subsurface soil DCGL models according to which a well could pump uncontaminated water from the saturated zone in each excavation laterally and indefinitely, thereby diluting contaminated water drawn by the same well. Where would this uncontaminated water come from if flow is directed outward rather into these excavations?

## APPENDIX C

### LIST OF RAIs BY NRC NUMBER AND SUBJECT\*

NRC RAI NUMBER	SUBJECT	NRC RAI NUMBER	SUBJECT
ESC1	Underground lines	5C18	Pumping, etc., rate conservatism
1C1	Phase 2 studies	5C19	Contaminated plant fraction
3C1	Numerical analysis	5C20	Barriers in hydraulic parameters
4C1	Soil concentrations and DCGLs	5C21	<sup>129</sup> I sensitivity
4C2	Process building releases	6C1	ALARA, good practices
5C1	Decommissioning options	6C2	ALARA, intergenerational
5C2	Screening approach	6C3	ALARA, two-step approach
5C3	Impact on DCGLs	7C1	Excavated groundwater mgmt
5C4	No erosion assumption	7C2	Excavated soil mgmt
5C5	Well driller dose	9C1	Characterization surveys
5C6	Cistern scenario	9C2	Field survey detection limits
5C7	Subsurface DCGL approach	9C3	Soil background data
5C8	Model gas and oil wells	9C4	Final status survey plan details
5C9	Subsurface contamination	DC1	Recontamination potential
5C10	Subsurface contaminated area	DC2	Groundwater flow impacts
5C11	Streambed DCGL model	DC3	Engineered barrier performance
5C12	Streambed inhalation pathway	DC4	Barrier corrective action program
5C13	Streambed model comparison	DC5	Missing text
5C14	Source for transfer factors	DC6	Barrier performance monitoring
5C15	Conservatism in parameters	DC7	Barrier wall stability
5C16	Conservatism in K <sub>ds</sub>	DC8	Interactions with PRB and PTW
5C17	Gamma shielding factor	DC9	Groundwater flow changes

\*Some of the subjects are shortened or abbreviated.

## APPENDIX D

### ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
Codes	CHILD, FEHM, RESRAD, SIBERIA, STOMP, WEPP
DCGL	Derived Concentration Guideline Level
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
DP	Phase 1 Decommissioning Plan for the West Valley Demonstration Project
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
IERT	Independent Expert Review Team
KRS	Kent Recessional Sequence
LTR	License Termination Rule
NDA	NRC-Licensed Disposal Area
NRC	U.S. Nuclear Regulatory Commission
NYSERDA	New York State Energy Research and Development Authority
PDEIS	Preliminary Draft of the West Valley Decommissioning Environmental Impact Statement
RAI	Request for Additional Information
SDA	State-Licensed Disposal Area
ULT	Unweathered Lavery Till
WMA	Waste Management Area