National Nuclear Security Administration
Sandia Site Office
P.O. Box 5400
Albuquerque, New Mexico 87185-5400

JAN 1 9 2007

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. James Bearzi, Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Road, East, Bldg. 1
Santa Fe, NM 87505

Dear Mr. Bearzi,

On behalf of the Department of Energy (DOE) and Sandia Corporation (Sandia), DOE is submitting the second response to the Notice of Disapproval (NOD): Mixed Waste Landfill Corrective Measures Implementation Work Plan, November 2005 and Requirements for Soil-Vapor Sampling and Analysis Plan, Sandia National Laboratories, EPA ID NM5890110518, HWB-SNL-05-025. In a letter dated December 21, 2006, we submitted responses to Part 1 comments and the required Soil Vapor Sampling and Analysis Plan.

Enclosed with this letter is an Errata sheet correcting a typographical error in the response to Part 1 Comment Number 15. In addition, the enclosure contains responses that address Part 2 comments.

As part of this response submittal, DOE and Sandia are presenting additional information on the monitoring trigger evaluation process. This information provides the basis for requirements to be established under the Long Term Monitoring and Maintenance Plan (LTMMP). Accordingly, this information is preliminary and will be finalized in the LTMMP which is required for submittal to the New Mexico Environment Department and subject to a public review and comment period.

If you have any questions regarding this submittal, please contact me at (505) 845-6036 or Joe Estrada of my staff at (505) 845-5326.

Sincerely,

Kimberly A Davis for

Patty Wagner
Manager

Enclosures (2)

JAN 1 9 2007

cc w/enclosures:
W. Moats, NMED (via Certified Mail)
J. Kieling, NMED, Santa Fe
L. King, USEPA, Region VI (via Certified Mail)
T. Skibitski, NMED-OB
T. Longo, NNSA/NA-56/HQ, GTN
UNM Zimmerman Library

cc w/o enclosure:
M. Reynolds, NNSA/SSO, MS-0184
J. Gould, NNSA/SSO, MS-0184
A. Blumberg, SNL/NM, Org. 11100, MS- 0141
P. Freshour, SNL/NM, Org. 6765, MS-1089
D. Miller, SNL/NM, Org. 6765, MS -0718
C. Ho, SNL/NM, Org. 6313, MS- 0735
T. Goering, SNL/NM, Org. 6765, MS -1089
S. Griffith, SNL/NM, Org. 6765, MS-1089
M. J. Davis, SNL/NM, Org. 6765, MS-1089
Records, Center, SNL/NM, Org. 6765, MS-1089

CERTIFICATION STATEMENT FOR APPROVAL AND FINAL RELEASE OF DOCUMENTS

Document title: **DOE/Sandia Response to NMED's "Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Work Plan, November 2005" (Comment Set 2), January 2007**

Document authors: **Tim Goering, 6765 and Cliff Ho, 6313**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.

Signature: [signature] 1/15/07

Peter B. Davies
Director
Nuclear Energy & Global Security Technologies
Division 6700
Sandia National Laboratories/New Mexico
Albuquerque, New Mexico 87185
Operator

Date

and

Signature: [signature] for 1/19/07

Patty Wagner
Manager
U.S. Department of Energy
National Nuclear Security Administration
Sandia Site Office
Owner and Co-Operator

Date

ERRATA SHEET

Part 1, Comments on Landfill Construction Plans and Performance Modeling

Revised Response to Comment No. 15, Comment Set 1 (SNL December 2006):

15. Appendix B, Construction Quality Assurance Plan, Section 8.7 -- The Final Report must be submitted to the NMED as part of the CMI Report. The Final Report must include copies of all quality control data generated by the construction contractor as well as the quality assurance data generated by the CQA contractor.

Response: The Construction Quality Assurance **Report** will include all quality control data generated by the construction contractor as well as quality insurance data generated by the CQA contractor. The Construction Quality Assurance **Report** will be submitted to the NMED as part of the CMI Report.

Note: The original response incorrectly referred to the document as a Construction Quality Assurance Plan, rather than a Construction Quality Assurance Report.

Sandia Corporation
Albuquerque, New Mexico
January 15, 2007

DOE/Sandia Responses to NMED's "Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Work Plan, November 2005"

Comment Set 2

INTRODUCTION

This document responds to the second set of comments received in a letter from the New Mexico Environment Department (NMED) to the U.S. Department of Energy (DOE) and Sandia Corporation (Sandia) on November 24th, 2006 regarding the Mixed Waste Landfill (MWL) Corrective Measures Implementation (CMI) Plan for Sandia National Laboratories (SNL). The letter is entitled "Notice of Disapproval: Mixed Waste Landfill Corrective Measures Implementation Work Plan, November 2005, and Requirement for Soil-Vapor Sampling and Analysis Plan, Sandia National Laboratories" [EPA ID NM5890110518, HWB-SNL-05-025].

The NMED letter contains two sets of comments, divided based on subject. The first set is entitled, "Part 1, Comments on Landfill Construction Plans and Performance Modeling". A response to the first set of comments was submitted by DOE/Sandia to NMED on December 21, 2006 (SNL December 2006). This document provides a correction for the response to Comment No. 15 in Comment Set 1 along with the DOE/Sandia response to the second set of comments, which are entitled, "Part 2, Comments on the MWL Fate and Transport Model (Appendix E)".

This document lists each NMED comment, and DOE/Sandia's response to that comment. The NMED comment is listed in boldface, followed by the DOE/Sandia response, written in normal font under "Response".

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94AL85000.

Part 2. Comments on the MWL Fate and Transport Model (Appendix E)

1. Section 2.1.2.2 -- The last paragraph of Section 2.1.2.2 states, "Present conditions were simulated by modeling infiltration through various thicknesses of an engineered cover, while future conditions were simulated by modeling infiltration through various thicknesses of soil under natural conditions (i.e., the 'natural analog')." This description implies that present and future conditions are simulated using different designs (in the near term an engineered cover which in the future eventually degrades to the conditions of natural soil). Section 3.4.2 states that the engineered soil cover reverts to the natural soil conditions around the landfill. Provide clarification in Section 2.1.2.2 regarding the evolving soil conditions within the cover. Explain what soil conditions are expected to evolve, why and when they will evolve, and what will they will evolve to.

Response: Cover performance modeling was conducted in 2003 and 2004 using site-specific climate, hydrologic, and vegetation input parameters, and is discussed in depth the document entitled, "Calculation Set for Design and Optimization of Vegetative Soil Covers" (Peace and Goering 2005). This modeling effort simulated cover performance under present and future conditions using the same design, but slightly different soil hydraulic properties. A complete copy of this report is included on the CD as Attachment 1, under the subdirectory, "Supporting Documentation".

Soil hydraulic properties for modeling present conditions were determined by measuring soil hydraulic properties of an engineered cover test plot, while soil hydraulic properties for modeling future conditions were determined by measuring soil hydraulic properties of the natural analogue. Additional information on measurement of the soil hydraulic properties for both modeling scenarios is presented below.

Present Conditions – Engineered Cover Properties

Soil hydraulic properties for the engineered vegetative cover were determined by field and laboratory measurements conducted on an engineered cover test plot constructed at the IP Test Site west of the MWL. The engineered cover test plot was constructed to the same bulk density and initial moisture contents specified in the current MWL cover design. The test plot consisted of 6 feet of compacted native soil overlain by 9 inches of uncompacted native topsoil. The native soil layer was placed in 8-inch loose lifts to attain maximum 6-inch compacted lift thickness. The native soil was compacted to not less than 90% maximum dry density at -3 to +2 percentage points of optimum moisture content, as determined by ASTM D698 (Standard Proctor testing). A total of 13 lifts, excluding subgrade, were placed to complete construction of the engineered cover test plot. Additional details on the construction of the engineered cover test plot and the measurement of the soil hydraulic properties are presented in Section 4.2 of the document, "Calculation Set for Design and Optimization of Vegetative Soil Covers, Sandia National Laboratories, Albuquerque, New Mexico" (Peace and Goering 2005).

Field and laboratory tests were conducted on the soils of the engineered cover test plot to measure the soil hydraulic and geotechnical properties used for performance modeling of the engineered cover. Because the engineered cover test plot was constructed to the same specifications as the proposed MWL cover using the same soil type, the soil hydraulic properties of the engineered test plot were considered representative of the proposed MWL cover. Thus, the modeling results from the engineered cover represent present conditions for the proposed MWL cover.

Future Conditions – Natural Analogue Properties

The soil hydraulic properties for the natural analogue were determined by field and laboratory measurements conducted on undisturbed soils near the IP test site west of the MWL. The soil hydraulic properties of the natural analogue are discussed in Section 6.5.3 of Peace and Goering (2005). The soil hydraulic properties of the natural analogue were considered representative of future conditions for reasons presented below.

Evolution of Soil Conditions within the Cover:

The MWL engineered cover will gradually evolve over time to a more natural system (i.e. the natural analogue) as vegetation is established, and natural processes gradually affect the properties of the cover. Pedogenic processes (i.e., soil evolution) will change soil physical and hydraulic properties that are fundamental to the performance of the engineered cover. Pedogenesis includes processes such as 1) hydraulic and mechanical redistribution of soil particles, affecting soil hydrologic properties (i.e. bulk density, porosity, and hydraulic conductivity); 2) formation of macropores for preferential flow associated with root growth, animal intrusion, and soil structural development; 3) secondary mineralization, deposition, and illuviation of fines, colloids, soluble salts, and oxides that can alter water storage and infiltration; and 4) soil mixing caused by freeze-thaw activity, animal burrows, and the shrink-swell action of expansive clays (Chadwick and Graham 2000).

Although vegetation will be established on the MWL cover within three to five years, the pedogenic processes discussed above will take many years for the engineered cover to evolve to, and perform like the natural analogue. Pedogenic processes are driven by climate, organisms, topographic relief, parent material, and time. Many interactions occur between water, air, temperature, microorganisms, plants, animals, and their residues, affecting the mineral material of the original soil and its position in the landscape. During its evolution, the soil profile slowly expands and deepens, developing characteristic discrete soil layers called horizons, while a steady-state balance is approached. One cannot predict when steady state (i.e. the natural analogue) is attained. For this reason, the soil properties of the natural analogue were considered, and used as modeling input parameters to assess the future performance of the MWL cover.

Cover Performance Modeling of Present Conditions versus Future Conditions

Cover performance modeling of both the engineered cover and the natural analogue was conducted using input parameters measured on the engineered cover and the natural analogue, as described above. Present conditions were simulated by modeling cover performance assuming soil properties of the engineered cover. Future conditions were simulated by modeling cover performance assuming soil properties of the natural analogue. Table 1 presents the model input parameters for both the engineered cover and the natural analogue.

The modeling results confirm that under both current and future scenarios, the MWL cover will meet the EPA-prescribed technical equivalency criteria for RCRA landfills. These criteria are a net annual infiltration of 31.5 millimeter/yr, and an average infiltration rate of 1 X 10^{-7} cm/s or less (Peace and Goering 2005).

Table 1. UNSAT-H Code Input Parameters

Parameter	Natural Analogue		Engineered Cover		Source
	Input value	Unit(s)	Input value	Unit(s)	
Initial Head	17,200	cm	5620	cm	RETC Code
θ_s	0.39	Percent	0.35	Percent	RETC Code
θ_r	0.001	Percent	0.001	Percent	RETC Code
α	0.0309	cm^{-1}	0.022	cm^{-1}	RETC Code
n	1.19	(-)	1.26	(-)	RETC Code
ℓ	0.5	(-)	0.5	(-)	a
K_s	4.05×10^{-4}	cm/s	3.46×10^{-4}	cm/s	Field
Root Depth	80	cm	80	cm	Field
LAI Historical Precipitation	0.8 max	(-)	0.8 max	(-)	b, c, d
LAI Maximum Precipitation	1.2 max		1.2 max		
Growing Season	2–364	Julian Day	2–364	Julian Day	b, c, d
Percent Bare Area	81	Percent	81	Percent	Field
RLD coefficient *a*	0.5090	(-)	0.5090	(-)	Field
RLD coefficient *b*	-0.0630	(-)	-0.0630	(-)	Field
RLD coefficient *c*	0.0262	(-)	0.0262	(-)	Field
Ψ_w	30,000	cm	30,000	cm	e, f, g
Ψ_d	3000	cm	3000	cm	h, i
Ψ_n	30	cm	30	cm	h, i
PET coefficient *a*	0	(-)	0	(-)	j
PET coefficient *b*	0.52	(-)	0.52	(-)	j
PET coefficient *c*	0.5	(-)	0.5	(-)	j
PET lower limit *d*	0.0	(-)	0.0	(-)	j
PET upper limit *e*	3.7	(-)	3.7	(-)	j

[a]Maulem (1976)
[b]NMED (1998)
[c]Scurlock et al. (2001)
[d]Munk (2004)
[e]HDR Engineering (2000)
[f]ITRC (2003)
[g]Hillel (1998)
[h]Fayer (2000)
[i]Feddes et al. (1978)
[j]Ritchie and Burnett (1971)

α Air entry parameter
θ_r Residual moisture content
θ_s Saturated moisture content
Ψ_w Wilting point
Ψ_d Limiting point
Ψ_n Anaerobic
cm Centimeter(s)
K_s Saturated hydraulic conductivity
ℓ Mualem numerical parameter
LAI Leaf area index
max Maximum
n van Genuchten curve-fitting parameter
PET Potential evapotranspiration
RDL Root length density

2. The first paragraph of Section 3.2.1 states that lead, cadmium, and radionuclides (except radon) were modeled using the Framework for Risk Analysis in Multimedia Environmental Systems (FRAMES) and Multimedia Environmental Pollutant Assessment System (MEPAS) simulation tools. Section 3.2.2 states, "A separate model was used to model the transient transport of tritium at the MWL". The reader, however, does not learn until Section 3.7.1 that tritium was also modeled using FRAMES and MEPAS. Revise the text of Section 3.2.1 to indicate tritium was modeled using FRAMES and MEPAS, as well as the separate transient transport model.

The second paragraph of Section 3.2.1 indicates MEPAS is capable of computing contaminant fluxes for multiple routes, including radioactive decay and contaminant degradation. The paragraph states further that MEPAS was used only for the source-term and vadose-zone models, suggesting MEPAS was not used to model radioactive decay. In contrast, Section 3.2.2 indicates that the transient model for tritium and perchloroethene (PCE) accounts for contaminant decay. Clarify whether the modeling of radionuclide transport through the vadose zone at the MWL accounts for contaminant decay.

Response: The text in Sections 3.2.1 and 3.2.2 has been clarified to indicate that FRAMES/MEPAS can only simulate liquid-phase transport of constituents such as tritium. A separate analytical model was used to simulate the gas and liquid-phase transport of tritium.

The use of source-term and vadose-zone models in MEPAS does not preclude radioactive decay. Constituent decay can occur in both the source-term and vadose-zone transport models. Text has been added to Section 3.2.1 to clarify this. The revised Probabilistic Performance Assessment Modeling Report is included in Appendix A.

3. The first paragraph of Section 3.3 references Table E-2, which provides a summary of input parameters and distributions of constituents used in the modeling. Footnotes "b" and "d' reference an EPA fact sheet for tetrachloroethene; the fact sheet was reportedly accessed on the U.S. EPA website at www.epa./WGWDW/dwh/t-voc/tetrachl.html, but it is not referenced in Section 6, References, of the report. The fact sheet was not available at the web address provided, so the input parameters could not be verified. Provide the fact sheet as an attachment to the report and update the website address, if available, for the fact sheet. Also, revise Section 6 to include this fact sheet among the references. In addition, provide all other internet-referenced data as attachments to the report and cite these sources in Section 6.

Response: There was a typo in the URL address for the PCE fact sheet. This has been corrected and all online references have been added to Section 6. PDF versions of these web pages are included in the attached CD (Attachment 1). The online references are listed in Section 6 as follows:

- U.S. EPA, Tetrachloroethylene (PCE) Online Fact Sheet: www.epa.gov/OGWDW/dwh/t-voc/tetrachl.html

- U.S. EPA, Cadmium Online Fact Sheet: www.epa.gov/safewater/dwh/t-ioc/cadmium.html

- U.S. EPA, Lead Online Fact Sheet: www.epa.gov/safewater/dwh/t-ioc/lead.html

- U.S. EPA, Henry's Constant Online Calculator: www.epa.gov/athens/learn2model/part-two/onsite/esthenry.htm)

4. Section 3.4.2, page E-35, 2nd paragraph -- Explain why future infiltration rates would be less than current rates.

Response: The cover performance modeling predicted the average infiltration rate through the engineered cover (representing present conditions) to be 1.18 X 10^{-9} cm/s for historical precipitation, and 5.34 X 10^{-9} cm/s for the maximum precipitation scenario (Peace and Goering 2005). The modeling predicted the average infiltration rate for the natural analogue (representing future conditions) to be 2.44 X 10^{-10} cm/s for the historical precipitation scenario, and 1.04 X 10^{-9} cm/s for the maximum precipitation scenario.

The difference in modeling results between the engineered cover (representing present conditions) and the natural analogue (representing future conditions) reflect variations in soil properties between the engineered cover and the natural analogue, as shown in Table 1. These include minor differences in saturated hydraulic conductivity (4.05 X 10^{-4} cm/s for the natural analogue, versus 3.46 X 10^{-4} cm/s for the engineered cover) and porosity, as indicated by the saturated moisture content (θ_s) of 0.39 for the natural analogue versus 0.35 for the engineered cover. These variations in soil properties are a result of the pedogenic processes discussed above (see Response to Comment No. 1), and result in a net increase in porosity and hydraulic conductivity. The increased porosity and hydraulic conductivity of the natural analogue facilitate evapotranspiration, resulting in a net decrease in infiltration rate for the natural analogue (i.e. future conditions).

***5.* Section 3.6, Fate and Transport of Radon -- Radon was modeled as originating from radium-226 sources. Explain why radon originating from the decay of depleted uranium was not incorporated into the radon fate and transport model.**

Response: Radon was included as a daughter product of uranium-238 in the FRAMES/MEPAS simulations, as discussed in Section 3.6.2.2 and 3.7.2.2. However, U-238 was not included as a source of radon for the gas-transport model detailed in Section 3.6.2.2 because the activity of Ra-226 (parent of Rn-222) resulting from the decay of uranium-238 is negligible (15 microCuries after the first 1,000 years) relative to the activity of Ra-226 assumed in the model (6-12 Curies). This has been clarified in the text.

6. Section 4, Pages E-59 and E-59a -- Revise the trigger evaluation process to follow the corrective action process described in the Consent Order (April 29, 2004) if a trigger level is exceeded (step 3A), provided the Consent Order is still in force at the time the trigger level is exceeded. If the Consent Order has terminated, the trigger evaluation process

should follow the standard RCRA corrective action process.

Response: To be consistent with the Compliance Order on Consent (NMED April 2004) between the NMED, the DOE, and Sandia Corporation, hereinafter referred to as the Consent Order, several minor modifications were made to the trigger evaluation process figure on Pages E-59 and E-59a. The Consent Order requires notification of the NMED in writing within 15 days after the discovery of any previously unknown release of a Contaminant from a SWMU or Area of Concern. For consistency with the Consent Order, Step 3B on Figure E-25 has been revised to state, "If verified, notify NMED ***in writing within 15 days*** and increase sampling frequency as negotiated with NMED".

In addition, the following line was added to Item 5 on Page E-59a, which explains the trigger evaluation process, ***"If the NMED determines that further investigation of the trigger exceedance is needed, NMED may require corrective action based on a finding that releases of contaminants have occurred, are occurring, or are likely to occur."***

The revised Trigger Evaluation Process is shown in Figure 1 below. All proposed monitoring triggers are considered preliminary at this point, and provide the basis for requirements to be established under the Long Term Monitoring and Maintenance Plan (LTMMP). Accordingly, this information is preliminary and will be finalized in the LTMMP which is required for submittal to NMED and subject to a public review and comment period.

7. Section 3.3 -- The fourth paragraph of Section 3.3 discusses the dose via inhalation and dermal adsorption for gas-phase tritium, but a similar discussion is not presented for radon gas or gas-phase PCE. Clarify whether this dose discussion is applicable to all gas-phase constituents considered in the Report. If the dose discussion is only applicable to gas-phase tritium, then explain why this is the case. Alternatively, discuss inhalation and dermal adsorption doses for radon gas and gas-phase PCE.

Response: Inhalation and dermal adsorption of gas-phase radon and PCE were not used as performance metrics in this analysis. Table 1 in Section 3.1 of the Performance Assessment Modeling Report summarizes the performance metrics that were used for these constituents. Text has been added to clarify this in the report. The inhalation dose is only applicable to gas-phase tritium because the enforceable regulatory metrics pertaining to radon and PCE do not use dose (surface flux is used for radon and groundwater concentration is used for PCE).

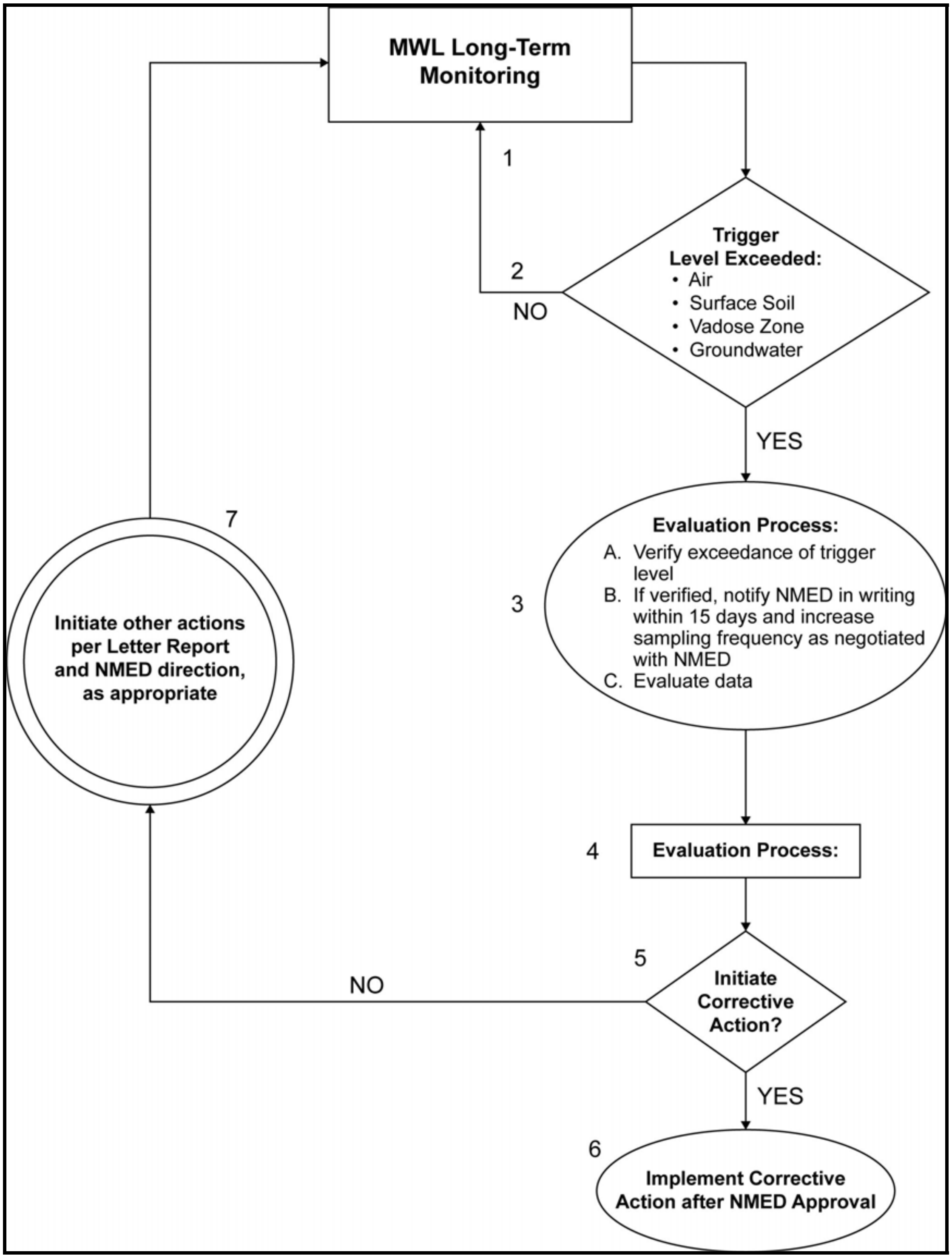

Figure 1. Trigger evaluation process for the Mixed Waste Landfill (revised)

8. Section 3.4.1 --The first paragraph of Section 3.4.1 states the modeling study of water infiltration through the cover was "discretized by placing computational nodes at predetermined vertical spacing in a conceptual soil profile to evaluate the performance of a cover 3 ft in thickness." The model evaluated a soil profile that was actually 6 feet thick in order to avoid impacts due to boundary conditions, but these impacts and boundary conditions are not discussed. Thirty nodes were located within this 6-foot-thick soil profile. However, the discussion does not describe how or why the 30 node locations were predetermined within this soil profile. Explain the specific impacts caused by boundary conditions. Clarify how and why the computational node locations were predetermined.

The conceptual soil profile for the infiltration model, as discussed in Section 3.4.1, is presented side-by-side in Figure E-3 with nodal discretization used in the UNSAT-H model. As illustrated, the conceptual soil profile does not correspond to the components of the MWL soil cover cross-section. The soil profile illustration is dimensionless; i.e., it is not clear whether the soil profile is 6 feet thick. Also, only 23 of the 30 computational nodes within the cross-section are shown. In addition, the nodal depth locations cannot be determined from the illustration. Revise the Figure E-3 conceptual model to clearly indicate the components of the MWL soil cover (i.e., subgrade layer, biointrusion barrier, native soil layer, topsoil layer, and vegetation) and their location relative to the MWL waste zone. Revise Figure E-3 to include a vertical scale for depth (i.e., inches or feet below the cover surface) and the locations of all 30 computational nodes. Clarify the soil type specified for each component of the soil cover.

Response: Section 3.4.1 presents only a conceptualization of the model used to predict water percolation through the cover. A detailed description of the model and extensive discussion of the input parameters, boundary conditions, and results are discussed in the document, "Calculation Set for Design and Optimization of Vegetative Soil Covers, Sandia National Laboratories, Albuquerque, New Mexico" (Peace and Goering, 2005). Additional information from this report is included below.

Node Locations:

The 30 node locations within this soil profile were carefully selected to minimize modeling computational requirements, yet yield accurate numerical results. Node spacing is very fine near the ground surface and becomes progressively larger with increased depth through the soil profile. The fine node spacing near the surface is necessary for an accurate numerical solution because very large and rapid changes in suction head occur as the surface dries and wets in response to evaporation and precipitation. Deeper in the soil profile, suction head changes are less dramatic and node spacing is increased. This spacing was selected to minimize numerical errors while maintaining reasonable execution times.

By code convention, nodal depths in the soil profile were assigned metric values. The node locations were "predetermined" within the soil profile to facilitate interpretation of modeling results. Node numbers 10, 14, 19, 22, and 26 were assigned depths of 30, 61, 91, 122 and 152 cm, respectively, to represent the lower boundary of covers 1,2,3,4 and 5 ft in thickness. Model output included flux across each nodal boundary; hence, the results could be used to optimize cover thickness for the remedy design.

Boundary Conditions:

Boundary conditions were selected to be conservative with regards to prediction of net percolation through the cover. Hence, predicted percolation values may be higher than actual percolation values. The water flow for the upper boundary (i.e., through the surface of the soil profile), is specified as an evaporation flux boundary and an infiltration boundary equivalent to hourly precipitation over a 24-hr period. The water flow for the lower boundary or the base of the soil profile at 6 ft is specified as a unit downward gradient —flow is always directed downward. A lower boundary specified as a unit gradient is conservative because in nature, movement of water is either upward or downward as the soil profile responds to precipitation, evaporation, and transpiration. Since hourly precipitation is designated and the model regards daily precipitation as occurring over a 24-hr period, all flow is directed downward through the soil profile.

Nodal Discretization versus Conceptual Soil Profile (Figure E-3):

The MWL cover was modeled as a lithologic monolayer to be conservative. A soil profile with uniform soil and hydrologic properties translates into a significant conservative estimate of liquid water flow, i.e. water flow is increased. If multiple layers are simulated, the water potential in the underlying layer must equal the water potential in the overlying layer before flow into the lower layer occurs. Multiple layering in performance modeling as well as multiple layers in nature attenuate the downward flow of liquid water (e.g., yielding multiple capillary barriers that slow water flow).

Figure E-3 does not show the actual components of the MWL soil cover (i.e., subgrade layer, biointrusion barrier, native soil layer, topsoil layer, and vegetation), because the model did not model each of these as individual components of the cover. Figure E-3 represents a conservative 3-ft thick, monolithic cover (i.e., the native soil layer, the topsoil layer, and the vegetation). The subgrade layer adds additional thickness to the lithologic monolayer represented by the modeled thicknesses of 4 and 5 ft. Although the biointrusion barrier was not modeled, its inclusion in the design does not adversely affect cover performance. In fact, the biointrusion barrier serves as a capillary break, further reducing the downward flow of water and adding additional conservatism to the estimate of net percolation by the model.

The figure has been revised to include a vertical scale for depth (i.e., feet below the cover surface) and the locations of all 30 computational nodes. However, to be true to the infiltration model, the biointrusion barrier, subgrade layer, and underlying wastes are not shown on the revised figure. The revised figure is shown below.

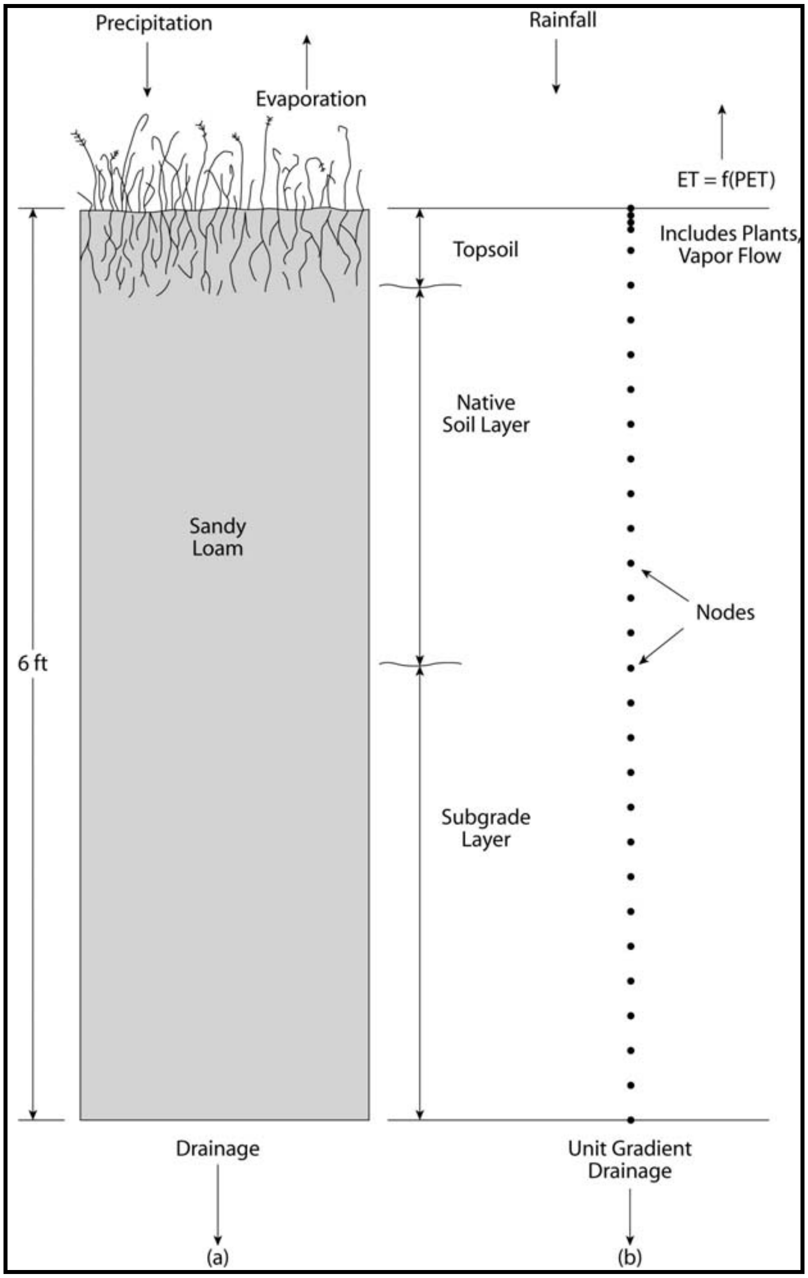

Figure 2. (a) Conceptual model for infiltration model. (b) Nodal discretization in UNSAT-H.

Soil Type Modeled:

The soil type modeled for the cover is a sandy loam.

9. Section 4.2.2 -- Section 4.2.2 discusses the proposed neutron probe system for monitoring moisture content beneath the MWL. However, for the neutron probes to detect percolation through the soil cover, water will have to move through the bio-

intrusion barrier, the waste zone, and a portion of the vadose zone prior to detection, which would be expected to require a considerable amount of time. The neutron probe system is thus more reliably a vadose-zone monitoring system rather than a tool to determine loss of integrity of the soil cover. If the Permittees want to monitor the cover for performance, the neutron probes should be placed just below the cover in the subgrade.

Response: Neutron probes installed immediately below the cover in the subgrade could be used to detect changes in moisture content as a result of infiltration through the cover. However, installation of horizontal neutron access tubes beneath the MWL to monitor moisture would yield limited additional monitoring benefits. The behavior of the cover design was evaluated at the engineered cover test plot constructed at the IP Test Site west of the MWL and is well understood. It is of more interest to monitor the vadose zone beneath the landfill to monitor potential migration of contaminants from the landfill. The proposed neutron probe system is suggested as part of the vadose zone monitoring system to be utilized for long-term monitoring of the landfill.

Installation of vertical neutron probe access holes through the MWL cover to monitor the subgrade is also not recommended. Access holes installed directly through the cover would increase the potential for preferential flow down the boreholes, and into the underlying wastes. In addition, increased vehicular traffic on the cover during monitoring activities could damage the vegetation growing on the cover, and would negatively affect bulk density and porosity of the cover. Increased traffic on the cover may also cause rutting and potential erosion of the cover itself.

The current neutron moisture monitoring system, consisting of three boreholes angled 30 degrees from vertical beneath the MWL, will be used to monitor the vadose zone beneath the landfill, and to indirectly monitor the cover performance. If infiltration through the cover were to significantly increase, the resulting percolation through the disposal cell would be detected by neutron moisture logging in the underlying vadose zone. The angled boreholes extend well beneath the lateral extent of the cover with depth, as shown in Plate 4 of the MWL CMI Plan, and will intercept any increased percolation through the cover. Additional details on use of the current neutron moisture monitoring system to monitor cover performance are included in the response to Comment No. 16, below.

10. Figures -- Figures E-13, E-15, E-19, and E-24 present a graphical illustration of the sensitivity analyses performed for some of the constituents. The figures present histograms to compare ΔR^2 for constituent concentration and dose. Clarify why actual concentrations and doses were not presented in the sensitivity analyses.

Response: Section 2.2.1 describes the stepwise linear rank-regression sensitivity analysis that was used in this study. In this approach, the actual concentrations and doses *are* used as performance metrics in the sensitivity analyses. The impact of the uncertainty of the input parameters on the simulated performance metrics (e.g., concentration, dose) is evaluated, and the relative impact is presented as ΔR^2 in Figures E-13, E-15, E-19, and E-24 Those parameters with a large ΔR^2 have a greater correlation to the simulated performance metric; in other words, the simulated performance metric (e.g., concentration, dose) has a greater sensitivity to those parameters. Additional text has been added to Section 3.5.2.3 to clarify this.

11. General Comment on the Fate and Transport Model -- Compared to typical reports for modeling studies, the report as presented is brief, particularly when considering the complexity of using a Monte Carlo approach with multiple models, scenarios, and constituents of concern. In general, the report provides a narrative of a probabilistic model that is presented as a "black box." The report discusses the input parameters and selectively presents output results, but there is not adequate information to assess whether the "black box" is operating satisfactorily. The report does not present a discussion regarding software quality assurance -- it is not known how well the various models work separately or together. Also, the report does not provide a critique of the modeling runs, except for an occasional qualitative statement In contrast, a typical modeling report is a detailed and exhaustive presentation that addresses the conceptual development and construction of the model (e.g., the data quality objectives, the software code), the software quality assurance performed (including software validation and verification) to assess model performance both separately and when working together, the details regarding specific inputs and outputs for all runs of every scenario, and a quantitative analysis of the sensitivities of the input parameters, including an assessment of the bias of the model toward specific outputs. The report, however, does not provide this level of information. The Permittees must provide additional information to address the deficiencies mentioned above.

Response: The software and models that are used in this report are taken from widely used packages (e.g., FRAMES/MEPAS) or peer-reviewed journal articles. The report provides references for each model and software that is used (the gas-phase radon-transport model is derived in an appendix). These references contain the full description of each mathematical model and associated validation studies, and the report qualitatively summarizes the relevant features and processes that are utilized in the analysis. We felt that this was the best approach for this report; inclusion of this material in the report would have made the report extremely large and cumbersome to read.

We agree, however, that additional work and materials are needed to provide quality assurance for the models and software used in this particular study. With regard to model and software validation and verification, we have added additional documentation of tests that demonstrate the models and software were working properly and as intended (see "Model_Supplement_12-7-06.doc," included on the CD in Attachment 1). This supplement includes additional details regarding each of the models and software that were used in the analyses, and tests are performed to demonstrate the performance of each model. Links are provided to the Mathcad models (written in plain English and symbolic text) for the radon, tritium, and PCE transport models. In addition, all of the model input and output files have been made available on the CD.

With regard to "details regarding specific inputs and outputs for all runs of every scenario," the CD contains Excel files that contain the inputs and outputs for every realization that was simulated for each constituent. This information is summarized in the cumulative distribution functions and plots presented in the report. We believe that presenting the input and output data for every realization in the report would be excessive, so we have included it on the CD instead.

Finally, with regard to "a quantitative analysis of the sensitivities of the input parameters," this has been done and is described in the sensitivity-analysis sections throughout the report for each constituent (see Sections 3.5.2.3, 3.6.2.3, 3.7.2.3, and 3.9.2.3).

12. Provide information evaluating the risk to ecological receptors for tritium, radon, and radon daughter products, which are expected to be released to surface soil and the atmosphere.

Response: Risk to ecological receptors from tritium, radon, and radon daughter products that would be expected to be released to surface soil and the atmosphere is anticipated to be negligible, and is typically not evaluated for ecological risk. The primary components of ecological risk from these radionuclides are due to ingestion and external exposure.

SNL current ecological risk assessment methodology, as agreed upon by NMED, does not account for inhalation as a primary pathway. Within the current SNL ecological risk assessment methodology, the inhalation pathway is considered to be a minor pathway in the overall contribution to ecological risk. Furthermore, ecological risks due to radiological contaminants have been minimal at other SNL sites when compared to human health radiological risk assessment concerns (i.e., the allowable dose is significantly higher for ecological receptors when compared to human receptors), and are anticipated to be negligible at the MWL as well. For this reason, evaluation of risk to ecological receptors was not included in the report.

13. Provide information evaluating the risk to human receptors for tritium, radon, and radon daughter products that would be expected to be released to surface soil and the atmosphere. Include external exposures.

Response: For tritium, calculation of risk to human receptors can be estimated from dose which was calculated in the fate and transport (F&T) modeling report. The maximum dose from tritium calculated in the F&T realizations was 18 mrem/year, while the average dose was 1.7 mrem/year. The risk from these tritium doses ranges from 1E-5 to 1E-6.

Regulatory-based metrics (e.g., dose, groundwater concentrations, and surface flux rate for radon) provide a more rigorous basis for performance-assessment calculations than risk. For this reason, risk from tritium to human receptors was not calculated in the F&T report.

Risk from radon and radon daughter products is implicit in the airborne concentrations provided in the EPA guidelines. Dose/risk from radon and radon daughter products are considered as one. The majority of dose/risk from exposure to radon and its daughter products comes from the daughter products, which are solids that may be deposited in lung tissue.

The estimate of risk from radon is subject to considerable uncertainty, and depends on a myriad of variables affecting dose for a given exposure scenario. For example, risk from radon (and its daughter products) is a function of age, gender and whether or not one currently smokes, has smoked in the past, or has never smoked. Additional information on the risk to human receptors from radon (and radon daughter products) is presented in the document, "EPA Assessment of Risks from Radon in Homes", US EPA 2003 (*http://www.epa.gov/radon/images/402-r-03-003.pdf*). A copy of this document is included on the attached CD (Attachment 1) under the subdirectory, "Supporting Documentation".

14. The NMED expects surface soil surrounding animal borrows (including ant nests) to be monitored for radionuclides and metals. Develop triggers that are protective of both human health and the environment for radionuclides and metals in soil.

Response: Surface soil surrounding select animal burrows and ant nests was sampled prior to clearing and grubbing the site in order to obtain baseline environmental monitoring data. The data are being evaluated, and will be presented in a report to NMED on baseline environmental monitoring data for the MWL that is currently being drafted.

During long-term monitoring at the MWL, DOE/Sandia will monitor animal burrows and ant nests (ant hills). Current plans are to survey locations of animal burrows and ant hills by GPS on an annual basis, and to collect surface soil samples from animal burrows and ant hills every five years to ensure that contaminants have not been mobilized by biota. The soil samples will be analyzed for RCRA metals, gamma-emitting radionuclides, and gross alpha and gross beta activity.

Triggers proposed for RCRA metals concentrations in the surface soil samples are the NMED Industrial/Occupational Soil Screening Levels (NMED 2006). Triggers proposed for gamma-emitting radionuclides are the NMED-HWB Approved Background Values (Dinwiddie 1997).

A table summarizing all proposed monitoring triggers is included in the DOE/Sandia response to Comment No. 20, below.

Please note that the Consent Order includes the corrective action requirements for the MWL but contains no requirements for radionuclides or the radioactive portion of mixed waste. Thus, any triggers proposed for radionuclides are provided voluntarily, pursuant to the Consent Order. The voluntary inclusion of such radionuclide information shall not be enforceable and shall not constitute the basis for any enforcement because such information falls wholly outside the requirements of the Consent Order. Additional information on radionuclides and the scope of the Consent Order is available in Section III.A of the Consent Order. Throughout the remainder of this submittal, this paragraph will be referred to as the Consent Order note.

15. Develop triggers for tritium, radon, PCE and total VOCs as soil vapor. The NMED expects soil-gas in the vadose zone to be monitored for these constituents.

Response: In order to monitor soil vapor for contaminants, DOE/Sandia is proposing installation of a robust monitoring system for sampling soil gas within the vadose zone at the MWL. The proposed vadose zone monitoring system would serve as an early warning system to protect groundwater, and would allow early detection of contaminants migrating through the vadose zone, before they impact groundwater quality. Soil gas samples would be analyzed for VOCs, but not for tritium or radon for reasons described below.

During the Phase 2 RCRA Facility Investigation (RFI) in the mid 1990s, extensive soil gas data were collected to determine the nature and extent of VOC contamination in near-surface soils at the site (SNL/NM 1996) with most of the samples collected from depths of 10 ft and 30 ft below ground surface. Although low concentrations of VOCs are present in the vadose zone at the MWL, they have not impacted groundwater quality based on sixteen years of groundwater monitoring data collected since 1990.

The proposed vadose zone monitoring system will provide updated data regarding VOC profiles with depth, and is proposed to consist of three Flexible Liner Underground Technologies (FLUTe™) sampling wells. The FLUTes™ are proposed to be constructed in vertical boreholes located immediately outside the perimeter of the MWL cover with the locations selected near areas where the highest concentrations of VOCs were detected during earlier studies at the MWL. Actual locations of the FLUTe™ boreholes will be selected in conjunction with NMED. Soil gas sampling ports are proposed to be installed in each FLUTe™ at depths of 50 ft, 100 ft, 200 ft, 300 ft, and 400 ft below ground surface.

Soil gas data collected from the FLUTes™ will be used to assess current VOC distributions with depth, and to monitor VOC concentrations over time, allowing early identification of any potential threats to groundwater. The VOC data from the FLUTes™ will also be used to update the MWL fate and transport model every five years, as required in the NMED Final Order (NMED 2005).

Triggers for Tritium and Radon

Analysis of FLUTe™ soil gas samples for tritium and radon is not recommended, as these are not routine analyses, and would yield data of limited value. Tritium and radon can be more directly monitored at ground surface, as described in Section 4.2.1 of the Performance Assessment Modeling Report. Because of tritium's high mobility, any significant releases of tritium would be readily detected in surface soils adjacent to the landfill, eliminating the need to sample tritium in soil gas. As discussed in the Performance Assessment Modeling Report, the proposed trigger for tritium in surface soils along the MWL perimeter is 20,000 pCi/L in soil moisture. Tritium concentrations measured in soil samples collected with depth during the Phase 2 RFI were relatively low below depths of 26 feet, pose minimal risk to human health, and have not impacted groundwater quality.

Radon will be monitored above ground surface along the MWL perimeter using track etch monitors (Section 4.2.1), with a proposed trigger value of 4 pCi/L in air. This technique is superior for analysis of radon flux over time, and will provide more useful information than time-discrete samples collected from the FLUTes™. Radon has not been detected above background levels in soils at the MWL, and any significant releases of radon in the near future are unlikely, due to the nature of the sealed sources containing radium-226, from which the radon would emanate.

Please see Consent Order note provided in response to Comment No. 14.

Triggers for VOCs in the Vadose Zone

Triggers are proposed for PCE, TCE, and total VOCs in soil gas at the MWL. TCE has been detected in groundwater at other locations across SNL and Kirtland Air Force Base, and for this reason, a trigger is proposed for TCE, as well as PCE.

There are no regulatory limits for individual concentrations of volatile organic compounds in the vadose zone. DOE/Sandia propose trigger levels for TCE and PCE in soil gas based on a similar trigger proposed for the Chemical Waste Landfill (CWL). In the Post-Closure Care Plan for the CWL, a trigger of 20 ppmv was proposed for TCE in soil vapor samples collected from the deepest sampling ports (SNL September 2005). The CWL is located only 1.3 miles to the southeast of the MWL, and overlies similar hydrogeologic conditions, with similar depths to groundwater. Triggers protective of groundwater at the CWL should also be protective of groundwater at the MWL because of the similar hydrogeologic conditions at both sites.

DOE/Sandia propose triggers of 20 parts per million by volume (ppmv) for TCE and 20 ppmv for PCE for soil gas samples at the MWL. In addition, DOE/Sandia propose a trigger of 25 ppmv for total VOCs in soil gas samples at the MWL. These triggers, although not based on risk or regulatory limits, are sufficiently low to protect groundwater quality of the aquifer. All triggers would apply to samples collected from the deepest sampling port in each FLUTe™. Triggers would not apply to samples collected from shallower ports.

16. Table E-6 -- The proposed trigger value for "infiltration" is *25%* by volume. Specify whether "infiltration" means moisture content. Also, the proposed trigger is too high, as it likely represents conditions whereby there is near complete saturation of the soil.

Response: The trigger parameter actually applies to "moisture content" rather than "infiltration". The moisture content of the subsurface soil provides an indirect indication of the infiltration through the cover. The EPA-prescribed technical equivalence criteria for RCRA landfills is an average infiltration rate of 10^{-7} cm/s through the landfill cover, equivalent to a net annual infiltration of 31.5 mm of water per year through the cover. Assuming an average vertical hydraulic gradient of unity, an infiltration rate of 10^{-7} cm/s would result in an underlying moisture content of the soils to be approximately 23 percent by volume. A 23 percent volumetric moisture content is equal to 59 percent saturation, assuming an average soil porosity of 39 percent.

Figure 3 shows the relationship between unsaturated hydraulic conductivity and volumetric moisture content for 18 subsurface soil samples collected from the IP Test Site, located 500 ft west of the MWL. Assuming a vertical hydraulic gradient of unity, the infiltration rate through soil at a given moisture content is equal to the unsaturated hydraulic conductivity at that moisture content. Thus, by drawing a horizontal line across the graph at the EPA-prescribed infiltration rate of 10^{-7} cm/s through the cover, one can estimate the volumetric moisture content of the underlying soils, based on their soil moisture characteristic curves. This moisture content is equivalent to the extrapolated moisture content at the x-intercept along the graph where the horizontal line meets the soil moisture characteristic curve.

Based on soil moisture characteristic data for MWL soils shown in Figure 3, moisture contents in underlying soils would range from approximately 18 percent by volume up to 28 percent by volume, and would average approximately 23 percent by volume, if infiltration through the MWL cover averaged the EPA-prescribed equivalence criterion of 10^{-7} cm/s.

For this reason, DOE/Sandia recommend using the average 23 percent volumetric moisture content of underlying soils as the trigger to indicate that the MWL cover is meeting the EPA-prescribed technical equivalency criteria for RCRA landfills. This 23 percent volumetric moisture content has a regulatory basis, and is considered a reasonable value for a trigger to indicate cover performance. Because the accuracy of the neutron logging tool is ± 2 percent volumetric moisture content, a 2 percent delta was originally added to the 23 percent value to ensure that readings at this level are not false positive interpretations, and the trigger was initially proposed at 25 percent by volume in the original Performance Assessment Modeling Report (Appendix E in SNL November 2005). However, because NMED considers the initially-proposed 25 percent moisture content value to be too high, DOE/Sandia suggest eliminating the 2 percent delta, with the final moisture content trigger set at 23 percent by volume. The proposed trigger of 23 percent by volume would apply to linear depths of 10 ft to 100 ft (vertical depths of 8.7 ft to 86.6 ft) along the neutron probe access holes in the vadose zone beneath the MWL. This interval is proposed as the "regulated interval" because it lies beneath the root zone, and yet is shallow enough that a response would be readily detected if there is a significant increase in infiltration through the cover.

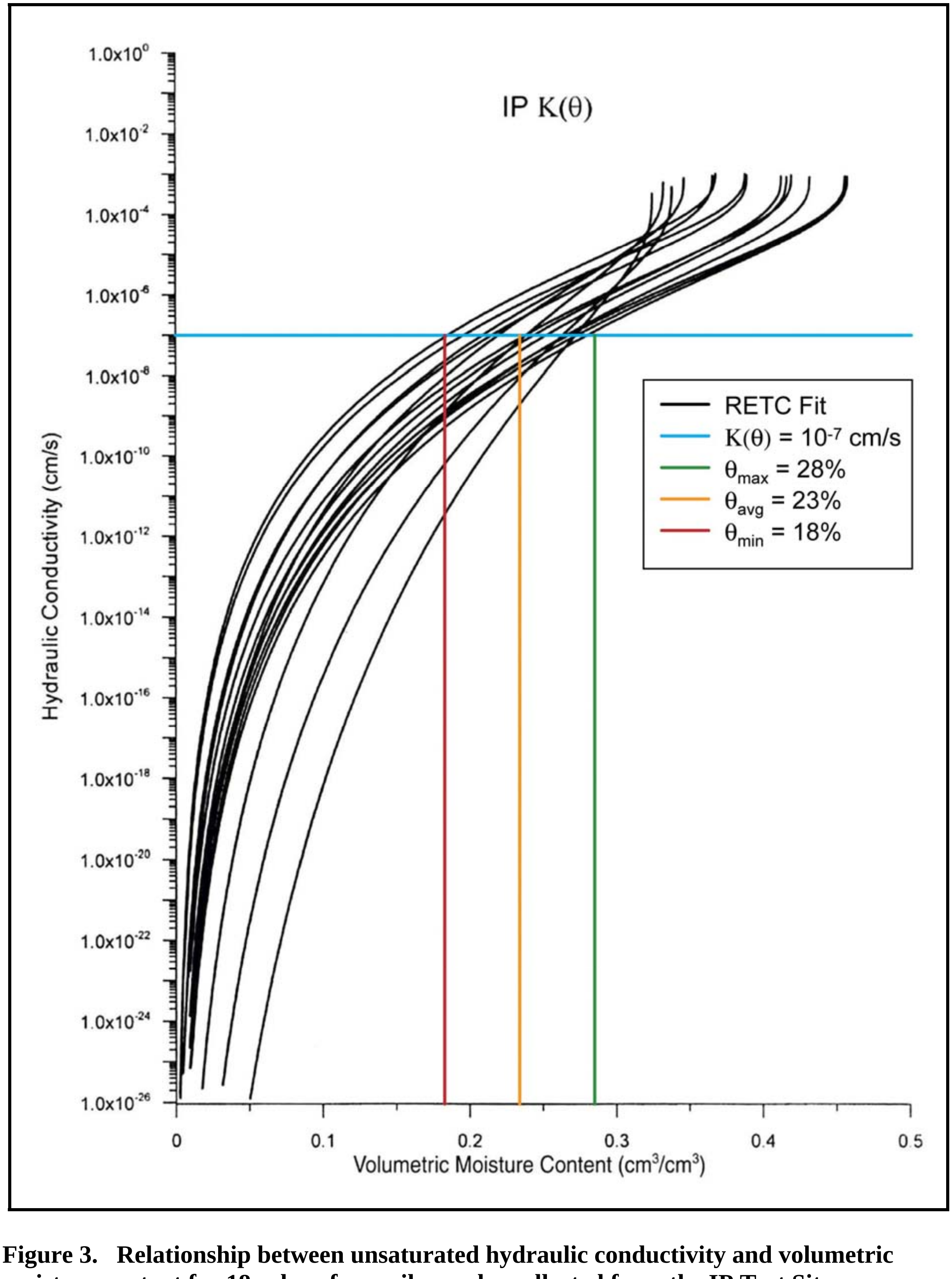

Figure 3. Relationship between unsaturated hydraulic conductivity and volumetric moisture content for 18 subsurface soil samples collected from the IP Test Site

17. Provide NMED a copy of the reference: Johnson et al (1995), *A Human Health Risk Assessment for the Mixed Waste Landfill, Sandia National Laboratories, Albuquerque, New Mexico,* Argonne National Laboratories, Argonne, IL.

Response: This document is actually entitled, "A Preliminary Human Health Risk Assessment for the Mixed Waste Landfill, Sandia National Laboratories, Albuquerque, New Mexico" by Johnson et al., 1995. A copy of this report is included on the attached CD, under the subdirectory "Preliminary Risk Assessment by Johnson et al".

18. Table E-6, the proposed trigger levels for 1,1,1-TCA, ethylbenzene, styrene, toluene, and total xylenes in groundwater are set too high. For these unnatural constituents, the levels of detection normally achieved by laboratories are much lower than groundwater standards set by the New Mexico Water Quality Control Commission (WQCC). The trigger levels can be set to much lower levels, and still allow for a given trigger level to be sufficiently above the limit of detection such that the constituent can be readily quantified with a high degree of confidence. Additionally, trigger levels should be set well below WQCC standards or below U. S. Environmental Protection Agency Maximum Contaminant Levels so that there will be time to react to prevent unacceptable levels of contamination should any trigger levels be exceeded.

Response: The proposed trigger levels for 1,1,1-TCA, ethylbenzene, styrene, toluene, and total xylenes in groundwater are regulatory-based, and are set at a value of one-half the EPA Primary Drinking Water Standard (MCL) (EPA 2003a) for each constituent. There is no technical or regulatory basis for further reducing these trigger levels (with respect to risk and human health), and DOE/Sandia are concerned that reductions in these triggers to even lower concentrations will result in more false positive detections for these constituents. There are often analytical difficulties with measuring extremely low concentrations of VOCs in groundwater.

Rather than lowering the trigger levels for VOCs in groundwater and increasing the risk of false positive detections, DOE/Sandia recommend installation of a robust vadose-zone monitoring system to allow early detection of any potential migration of VOCs through the vadose zone, well before they reach groundwater (see response to Comment No. 16). DOE/Sandia recommend keeping trigger levels for VOCs in groundwater at one-half the EPA Primary Drinking Water Standard, as proposed originally in Table E-6. DOE/Sandia also recommend expanding the list of triggers for VOC in groundwater to include triggers for all Target Compound List (TCL) VOCs analyzed using EPA Method 8260. See response to Comment No. 20, below.

19. Propose some additional monitoring to be conducted at locations within the landfill where contaminants were detected at their highest levels during the RFI. These locations should be subject to the same triggers as those proposed as points of compliance in Table E-6.

Response: Additional monitoring at locations within the landfill using intrusive techniques is not recommended, and could compromise the integrity of the cover. However, Appendix A to the first NOD Comment Set (SNL December 2006) presented a sampling and analysis plan

(SAP) for soil-gas volatile organic compounds, tritium, and radon at the Mixed Waste Landfill. Sampling locations were selected based on maximum concentrations of VOC contaminants detected during the Phase 2 RFI in the mid 1990s (SNL 1996). VOC concentrations will be measured at depths of 10 ft and 30 ft in a total of six boreholes in and around the MWL, and two background boreholes. The boreholes will be advanced using a GeoProbe in the same manner as was done during the Phase 2 RFI. Soil samples will also be collected at depths of 10 ft and 30 ft in each borehole for analysis of tritium concentrations in soil moisture. All sampling will be conducted prior to construction of the MWL cover.

If the upcoming sampling program within the MWL shows concentrations of VOC contaminants significantly elevated above concentrations detected during the Phase 2 RFI study, DOE/Sandia will open discussions with NMED on the potential need for additional intrusive monitoring activities within the landfill. However, at this time, DOE/Sandia suggest approaching this issue in a phased manner; if the data show no significant increases in contaminant concentrations, additional intrusive monitoring within the landfill is not recommended.

Additional monitoring for VOCs in soil gas is proposed using FLUTes™ installed around the perimeter of the MWL. The FLUTes™ are proposed to be located near areas of the landfill where contaminants were detected at their highest levels during the Phase 2 RFI. In order to protect the integrity of the cover and to minimize the potential for preferential flow down boreholes, the FLUTes™ are not planned to be installed directly through the cover of the landfill.

Monitoring of animal burrows and ant nests is also proposed for the MWL cover (see response to Comment No. 14). Samples of soil from the vicinity of animal burrows and ant nests on the MWL cover will be collected on a five-year basis and analyzed for RCRA metals, gross alpha and beta activity, and gamma-emitting radionuclides. Additional details on future monitoring activities will be included in the MWL Long Term Monitoring and Maintenance Plan.

20. Expand the proposed monitoring triggers in Table E-6, giving consideration of the following table:

Environmental Medium	Monitoring Parameters	Main Potential Receptors	Sampling Points
Air	**radon, tritium**	**humans**	**landfill perimeter and interior stations**
Surface Soil	**radon, tritium, other radionuclides, metals**	**humans and ecological receptors**	**landfill perimeter, interior stations, and animal burrows located on cover**
Subsurface Soil	**moisture**	**humans via groundwater**	**neutron probe monitoring wells**
Subsurface Soil Gas	**radon, tritium, VOCs**	**humans via groundwater**	**beneath landfill**
Groundwater	**tritium, radon, isotopic uranium, VOCs**	**humans**	**down gradient groundwater monitoring wells**

Radionuclides (other than radon and tritium) and metals should be the same as those listed in Table E-2. VOCs should include PCE, all organic constituents listed in Table E-6, and all other organic constituents normally detected by method 8260. NMED reserves the right to require additional monitoring pending review of the long-term monitoring and maintenance plan to be submitted later by the Permittees and pending receipt and review of public input of this latter mentioned plan.

Response: The proposed monitoring triggers in Table E-6 have been revised, based on NMED's requests presented in Comments No. 14, 15, 16, 18, and 20. The updated monitoring triggers are shown in Table 2. Based on NMED's recommendations, modifications to the proposed monitoring discussed in Appendix E (SNL November 2005) include the addition of the following:

- Collection of surface soil samples near animal burrows and ant nests, and analysis for RCRA metals, gamma-emitting radionuclides, gross alpha activity, and gross beta activity. Additional triggers are proposed for RCRA metals and gamma-emitting radionuclides. Please see Consent Order note provided response to Comment No. 14.

- Installation of a robust multi-level vadose zone sampling system for VOCs using FLUTe™ technology. This system will be used as an early-warning system to protect groundwater.

- Monitoring of the vadose zone to assess VOC profiles with depth. Triggers are proposed for TCE, PCE, and Total VOCs in soil vapor.

- Additional triggers are proposed for VOCs in groundwater. Triggers are proposed for all Target Compound List (EPA Method 8260) VOCs.

Table 2. Proposed Monitoring Triggers for the Mixed Waste Landfill.

Environmental Medium	Monitoring Parameter	Main Potential Receptors	Proposed Trigger Value	Sampling Points	Performance Objective	Applicable Guideline or Regulation
Air	Radon	Humans	4 pCi/L (measured by Track-Etch radon detectors)	MWL Perimeter	Average flux of radon-222 gas shall be less than 20 $pCi/m^2/s$ at the landfill surface (design standard)	EPA Action Threshold for radon in air (U.S. EPA 2005)
Surface Soil	Tritium	Humans and ecological receptors	20,000 pCi/L tritium in soil moisture	MWL Perimeter	Dose to the public via the air pathway shall be less than 10 mrem/yr	DOE Order 5400.5, 10 CFR 61 Subpart H, 40 CFR 141.66
Surface Soil	Cs-137	Humans and ecological receptors	0.664 pCi/g	Animal burrows & ant nests on the cover	Radionuclide concentrations in soil shall not exceed NMED-Approved Maximum Background Concentrations	NMED-Approved Maximum Background Concentrations (Dinwiddie 1997)
Surface Soil	Ra-226	Humans and ecological receptors	2.30 pCi/g	Animal burrows & ant nests on the cover	Radionuclide concentrations in soil shall not exceed NMED-Approved Maximum Background Concentrations	NMED-Approved Maximum Background Concentrations (Dinwiddie 1997)
Surface Soil	Th-232	Humans and ecological receptors	1.01 pCi/g	Animal burrows & ant nests on the cover	Radionuclide concentrations in soil shall not exceed NMED-Approved Maximum Background Concentrations	NMED-Approved Maximum Background Concentrations (Dinwiddie 1997)
Surface Soil	U-235	Humans and ecological receptors	0.16 pCi/g	Animal burrows & ant nests on the cover	Radionuclide concentrations in soil shall not exceed NMED-Approved Maximum Background Concentrations	NMED-Approved Maximum Background Concentrations (Dinwiddie 1997)
Surface Soil	U-238	Humans and ecological receptors	1.4 pCi/g	Animal burrows & ant nests on the cover	Radionuclide concentrations in soil shall not exceed NMED-Approved Maximum Background Concentrations	NMED-Approved Maximum Background Concentrations (Dinwiddie 1997)

Table 2 (continued)

Environmental Medium	Monitoring Parameter	Main Potential Receptors	Proposed Trigger Value	Sampling Points	Performance Objective	Applicable Guideline or Regulation
Surface Soil	Arsenic	Humans and ecological receptors	17.7 mg/kg	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)
Surface Soil	Barium	Humans and ecological receptors	100,000 mg/kg	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)
Surface Soil	Cadmium	Humans and ecological receptors	56.4	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)
Surface Soil	Chromium	Humans and ecological receptors	3400 mg/kg	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)
Surface Soil	Lead	Humans and ecological receptors	800 mg/kg	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)
Surface Soil	Mercury	Humans and ecological receptors	100,000 mg/kg	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)
Surface Soil	Selenium	Humans and ecological receptors	5680 mg/kg	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)

Table 2 (continued)

Environmental Medium	Monitoring Parameter	Main Potential Receptors	Proposed Trigger Value	Sampling Points	Performance Objective	Applicable Guideline or Regulation
Surface Soil	Silver	Humans and ecological receptors	5680 mg/kg	Animal burrows & ant nests on the cover	RCRA metal concentrations in soil shall not exceed NMED Industrial/Occupational Soil Screening Levels	NMED Industrial/Occupational Soil Screening Levels (NMED 2006)
Subsurface Soil	Moisture Content	Humans via groundwater	23 percent by volume	Linear depths of 10 ft to 100 ft along neutron probe access holes beneath the MWL	Infiltration through the cover shall be less than the EPA-prescribed technical equivalence criterion of 31.5 mm/yr [10E-7 cm/s]	RCRA 40 CFR Part 264.301
Subsurface Soil Gas	PCE	Humans via groundwater	20 ppmv	Deepest FLUTe Sampling Port	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Subsurface Soil Gas	TCE	Humans via groundwater	20 ppmv	Deepest FLUTe Sampling Port	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Subsurface Soil Gas	Total Volatile Organic Compounds	Humans via groundwater	25 ppmv	Deepest FLUTe Sampling Port	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Uranium	Humans via groundwater	15 µg/L	Downgradient monitoring well locations	Uranium concentrations in groundwater shall not exceed the EPA MCL of 30 µg/L	EPA Primary Drinking Water Standard
Groundwater	1,1,1-Trichloroethane (1,1,1-TCA)	Humans via groundwater	100 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	1,1,2-Trichloroethane	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	1,1-Dichloroethene	Humans via groundwater	3.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard

Table 2 (continued)

Environmental Medium	Monitoring Parameter	Main Potential Receptors	Proposed Trigger Value	Sampling Points	Performance Objective	Applicable Guideline or Regulation
Groundwater	1,2-Dichloroethane	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	1,2-Dichloropropane	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Benzene	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Carbon tetrachloride	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Chlorobenzene	Humans via groundwater	50 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Ethyl benzene	Humans via groundwater	350 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Methylene chloride	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Styrene	Humans via groundwater	50 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Tetrachloroethene (PCE)	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Toluene	Humans via groundwater	500 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Trichloroethene (TCE)	Humans via groundwater	2.5 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard

Table 2 (continued)

Environmental Medium	Monitoring Parameter	Main Potential Receptors	Proposed Trigger Value	Sampling Points	Performance Objective	Applicable Guideline or Regulation
Groundwater	Vinyl Chloride	Humans via groundwater	1.0 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Xylenes (Total)	Humans via groundwater	5,000 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	cis-1,2-Dichloroethene	Humans via groundwater	35 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Trans-1,2-Dichloroethene	Humans via groundwater	50 µg/L	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA MCLs	EPA Primary Drinking Water Standard
Groundwater	Method 8260 VOCs with no MCLs	Humans via groundwater	EPA Region 6 Human Health Medium-Specific Screening Levels	Downgradient monitoring well locations	VOC concentrations in groundwater shall not exceed EPA Region 6 Human Health Medium-Specific Screening Levels	EPA Region 6 Human Health Medium-Specific Screening Levels

CFR = Code of Federal Regulations.
cm = Centimeter(s).
DOE = U.S. Department of Energy.
EPA = U.S. Environmental Protection Agency.
ft = Foot (feet).
L = Liter(s).
m = Meter(s).
m^2 = Square meter(s).
µg = Microgram(s).
MCL = Maximum contaminant level.
mm = Millimeter(s).
mrem = Millirem.
MWL = Mixed Waste Landfill.
pCi = Picocurie(s).
RCRA = Resource Conservation and Recovery Act.
s = Second(s).
TCA = Trichloroethane.
VOC = Volatile organic compound.
yr = Year(s).

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