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January 31, 2006

Mr. David Cobrain
State of New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building One
Santa Fe, New Mexico 87505-6303

Reference: Work Assignment No 06110.310; State of New Mexico Environment Department, Santa Fe, New Mexico; General Permit Support Contract; Sandia National Laboratories; Technical review of the *Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories*, presented in Appendix E of the Sandia National Laboratories (SNL) *Mixed Waste Landfill Corrective Measures Implementation Plan* (the CMI Plan), dated November 2005; Task 2 Deliverable

Dear Mr. Cobrain:

Enclosed please find the deliverable for the above-referenced work assignment. This deliverable consists of comments developed during a technical review of the *Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories* (the Assessment), which is presented in Appendix E of the Sandia National Laboratories (SNL) *Mixed Waste Landfill Corrective Measures Implementation Plan* (the CMI Plan), dated November 2005. The selected remedy for the Mixed Waste Landfill (MWL) is a 3-foot-thick soil cover, with an underlying biointrusion barrier, which is considered by the Assessment.

The deliverable presents numerous comments that request further clarification in the Assessment. The following points are significant issues discussed in the deliverable:

- Section 3.3 indicates the minimum thickness of the cover is set equal to zero as a bounding value to account for a worst case scenario in which complete erosion of the cover occurs at some point during the 1,000-year performance period. Although this scenario is for modeling purposes only, if the scenario runs indicate the potential for erosion of the soil cover, then design modifications may be necessary to demonstrate ongoing integrity during the performance period. These modifications may include additional run-on/run-off controls, which would not directly impact the actual cap design. Also, Section 3.3 states that the cover integrity will be maintained, however, it appears unlikely that the United States federal government can or will be able to maintain the integrity of the cover for the entire 1,000-year performance period. Consequently, the cap should be designed to require little maintenance and preferably none at all.

- Tables E-3 and E-4 indicate that the waste zone thickness and vadose zone thickness were modified to accommodate the modeling of cadmium beneath the MWL waste zone. This is a significant deviation from the input parameters for other constituent modeling. Table E-3 explains that the cadmium waste zone was increased to simulate the maximum penetration depth of the coolant water that *may* have carried cadmium. Correspondingly, Table E-4 indicates a decreased thickness for the vadose zone for cadmium modeling. These modifications were not discussed in Section 3.3, nor were they justified in the Assessment. The Assessment should be clarified to explain why the maximum depth of contamination was used as the waste zone thickness for cadmium, yet the maximum depth of contamination was not used for any of the other constituents considered by the performance assessment modeling.

- 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. A similar discussion for inhalation and dermal adsorption doses for radon gas and gas-phase PCE should be presented in the Assessment.

- Section 4.2.2 discusses the proposed neutron probe system for monitoring moisture content beneath the MWL. In order, however, for the neutron probes to detect a potential, but not determinate, issue with infiltration through the soil cover, the water will move through the biointrusion barrier, the waste zone, and then the vadose zone prior to detection, which will require a considerable length of time. More importantly, the percolation of water through the waste zone will leach waste constituents, thus increasing contaminant transport from the MWL. The neutron probe system is more reliably a vadose zone monitoring system for the waste zone, rather than a tool to determine loss of integrity in the soil cover. Moisture detection within the biointrusion barrier is a more reliable location for detection of infiltration through the overlying soil cover.

- The NMED should consider the Assessment's language regarding trigger level exceedance. TechLaw prepared a comment regarding the trigger discussion in Section 4.1 of the Assessment. Of particular concern, however, is the discussion in Paragraph 3 on page E-59a, which indicates that SNL will negotiate the use of trend analysis to determine action following an exceedance. Paragraph 3 states, "The length of this period [for sampling after an exceedance] and the increased sampling frequency will be negotiated with the NMED. Once the increased sampling data have been collected, the data and any resulting trends will be evaluated to determine the significance of the exceedance...." The use of data trends for trigger evaluation is not typically performed and not usually negotiated as an option to determining the statistical significance of each exceedance. The transition from compliance monitoring to detection monitoring can be based on a single exceedance, according to regulations and federal EPA guidance. In addition, a single exceedance can be used to initiate an interim corrective action. SNL, however, proposes waiting for an indeterminate time prior to determining that an exceedance requires initiation of further action. TechLaw is concerned that this may be a *de facto* assumption of regulatory authority.

TechLaw reviewed the probabilistic performance-assessment model as requested; however, we have reservations regarding the level of detail presented in the Assessment. Compared to typical reports for modeling studies, the Assessment is very brief, particularly when considering the complexity of using a Monte Carlo approach with multiple models, scenarios, and constituents of concern. In general, the Assessment provides a narrative report of a probabilistic model that is presented as a "black box." The Assessment discusses the input parameters and selectively presents output results, but we do not have adequate information to assess that the "black box" is operating satisfactorily. The Assessment does not present a discussion regarding software quality assurance – we do not know how well the various models work separately or together. Also, the Assessment 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 (i.e., the data quality objectives, the software code, etc.), 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 Assessment, however, does not provide this level of information and we caution its acceptance without a full understanding of the "black box."

The draft of the deliverable was e-mailed to you on January 31, 2006, at david.cobrain@state.nm.us. The deliverable is formatted in Microsoft Word 2000. If you have any questions, please feel free to contact me at (303) 763-7188, Ms. Paige Walton at (801) 451-2978, or Mr. Gary Walvatne at (503) 557-9698.

Sincerely,

June K Dreith

June K. Dreith
Program Manager

Enclosure: Technical Review of *Probabilistic Performance-Assessment of the Mixed Waste Landfill at Sandia National Laboratories*

cc: Mr. John Young, NMED
Mr. Will Moats, NMED
Mr. Gary Walvatne, TechLaw
Mr. Jim Ashworth, TechLaw
Ms. Paige Walton, TechLaw

TASK 2 DELIVERABLE

SANDIA NATIONAL LABORATORIES
ALBUQUERQUE, NEW MEXICO

TECHNICAL REVIEW OF APPENDIX E, PROBABILISTIC PERFORMANCE-ASSESSMENT MODELING OF THE MIXED WASTE LANDFILL AT SANDIA NATIONAL LABORATORIES,

OF THE

MIXED WASTE LANDFILL CORRECTIVE MEASURES IMPLEMENTATION PLAN

Dated November 2005

Submitted by:

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Submitted to:

Mr. David Cobrain
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In response to:

Work Assignment No. 06110.310

January 31, 2006

Sandia National Laboratories
Albuquerque, New Mexico

Technical Review of Appendix E,
Probabilistic Performance-Assessment Modeling of the
Mixed Waste Landfill at Sandia National Laboratories,
of the
Mixed Waste Landfill Corrective Measures Implementation Plan

Dated November 2005

The following comments were developed during a technical review of the *Probabilistic Performance-Assessment Modeling of the Mixed Waste Landfill at Sandia National Laboratories* (the Assessment), which is presented in Appendix E of the Sandia National Laboratories (SNL) *Mixed Waste Landfill Corrective Measures Implementation Plan* (the CMI Plan), dated November 2005. The selected remedy for the Mixed Waste Landfill (MWL) is a 3-foot-thick soil cover, with an underlying biointrusion barrier, which is considered by the Assessment.

2. MODELING APPROACH

2.1.2.2 Recent Cover Performance Modeling (pages E-19 through E-20)

1. 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 (engineered cover vs. natural conditions, respectively), however, Section 3.4.2 clarifies that the engineered soil cover reverts to the natural soil conditions around the landfill. Provide a brief clarification in Section 2.1.2.2 regarding the evolving soil conditions within the cover.

3. PERFORMANCE-ASSESSMENT MODELING OF THE MIXED WASTE LANDFILL

3.1 Scenarios and Performance Objectives (page E-23; Table E-1, page E-24)

2. Section 3.1 references Table E-1, which presents a summary of scenarios and performance objectives. The performance objective for Scenario 1 references 40 CFR 264.301 for the performance objective for water percolating through the landfill cover. Although the performance objective value for hydraulic conductivity of 10^{-7} centimeter/second (cm/s) is correct, the reference is incomplete. The maximum landfill liner hydraulic conductivity value is provided at 40 CFR 264.301, but this specifically addresses the bottom liner system. The hydraulic conductivity requirement for the landfill cover is promulgated at 40 CFR 264.310(a)(5), which in turn refers back to §264.301. Revise the citation to also include the reference to 264.310(a)(5).

3.2 Performance-Assessment Models

3.2.1 FRAMES/MEPAS (pages E-23 and E-25)

3. 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. The paragraph states further that MEPAS was used only for the source-term and vadose-zone models and not 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 why the modeling of radionuclide transport through the vadose zone does not incorporate radioactive decay, particularly since this is a feature of MEPAS.

3.3 Input Parameters and Distributions (pages E-26, E-31, and E-32; Tables E-2 through E-5, pages E-27 through E-31)

4. 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.gov/WGWDW/dwh/t-voc/tetrachl.html, but it is not referenced in Section 6, References, of the Assessment. The fact sheet was not available at the web address provided and the input parameters, therefore, could not be verified. Provide the fact sheet as an attachment to the Assessment and update the website address for the fact sheet, if available. Also, revise Section 6 to include this fact sheet among the references. In addition, provide all other internet-referenced data as attachments to the Assessment and cite these sources in Section 6.

5. The second paragraph of Section 3.3 states: "The minimum thickness of the cover is set equal to zero as a bounding value to account for the possibility that complete erosion of the cover may occur in the future. This is a conservative bounding assumption since the intent is to maintain the integrity of the cover at the MWL." The reasoning behind the minimum bounding value for the cover thickness is logical and allows modeling of a worst-case scenario (i.e., no cover). As the selected final remedy for closure of the MWL, however, the 3-foot-thick vegetated soil cover (with an underlying biointrusion barrier) should demonstrate ongoing integrity during the 1,000-year performance period. If there is a possibility for complete erosion of the cover during the performance period,

then the cover design may require modification to mitigate the potential for erosion. Further, it is unlikely that the United States federal government can or will maintain the integrity of the cover, as stated, for the entire 1,000-year performance period. Since the performance assessment, as defined in DOE Order 435.1, is required to "demonstrate there is a reasonable expectation that performance objectives established for the long-term protection of the public and the environment <u>will not be exceeded following closure of the facility</u>," then the cover design should mitigate the potential for a reduction in cover thickness due to soil erosion or other causes. If the full design thickness of the cover can not be reasonably assumed for the 1,000-year performance period, then evaluate additional run-on/run-off controls for the soil cover and the area surrounding the MWL, as necessary, to mitigate any reasonably anticipated damage to the cover during the performance period.

6. Section 3.3 does not discuss the modification of the waste zone thickness and vadose zone thickness to accommodate the modeling of cadmium beneath the MWL waste zone, even though it is a significant deviation from the input parameters for other constituent modeling. Table E-3 indicates that the cadmium waste zone thickness extends 93 feet below the maximum depth (thickness) of the MWL waste zone. Table E-3 explains that the cadmium waste zone was increased to simulate the maximum penetration depth of the coolant water that *may* have carried cadmium. Correspondingly, Table E-4 indicates a decreased thickness for the vadose zone for cadmium modeling. Clarify why the maximum depth of contamination was used as the waste zone thickness for cadmium, yet the maximum depth of contamination was not used for any of the other constituents considered by the performance assessment modeling.

7. 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 Assessment and, if so, revise the discussion accordingly. If the dose discussion is only applicable to gas-phase tritium, then revise Section 3.3 to discuss inhalation and dermal adsorption doses for radon gas and gas-phase PCE.

3.4 Water Infiltration through the Cover
3.4.1 Model Description (pages E-32 and E-34; Figure E-3, page E-33)

8. 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 can not be determined from the illustration. Figure E-3 indicates sandy loam is used throughout the entire thickness of the soil profile; although sandy loam is a good soil for growing vegetation, it is not satisfactory for the construction of a landfill cap with a performance objective value for hydraulic conductivity of 10^{-7} cm/s. 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 ground surface) and the locations of all 30 computational nodes. Clarify the soil type specified for each component of the soil cover.

4.1 Trigger Evaluation Process (page E-58)

9. The second paragraph of Section 4.1 states "...any recommendations for corrective action because of trigger exceedances will be based upon data trends rather than upon single detection values above the trigger level." This discussion regarding data trends does not present any timeframe for trend analysis (e.g., length of time or number of data points in exceedance of a limit) nor does it describe what constitutes a trend. Data trends may be useful for long-term assessment of constituent releases and corrective action effectiveness; however, triggers are typically evaluated based upon the statistical significance of each exceedance. For example, a spike in a constituent's concentration in groundwater samples collected around the MWL requires a move from compliance monitoring to detection monitoring. This spike may also indicate the development of a plume requiring an interim corrective action, rather than possibly waiting for several years to determine whether a trend is present in the data prior to acting. Revise the trigger evaluation process to determine the statistical significance of each exceedance of the groundwater protection standard for the MWL.

4.2 Proposed Triggers
4.2.2 Vadose Zone Monitoring Triggers
4.2.2.1 Moisture Content (pages E-64 to E-65)

10. The first paragraph of Section 4.2.2.1 states, "A significant increase in moisture content beneath the landfill may indicate that the disposal cell cover may not be performing as originally designed, and that infiltration through the cover is greater than originally predicted." Section 4.2.2 discusses the proposed neutron probe system for monitoring moisture content beneath the MWL; however, the three probe holes (200 feet in length at a 30-degree angle from the surface, or 173 feet of total depth) should not be relied upon

to measure significant increases in moisture content due to infiltration through the cover. In order for the neutron probes to detect a potential, but not determinate, issue with infiltration through the soil cover, the water will move through the biointrusion barrier, the waste zone, and then the vadose zone prior to detection, which will require a considerable length of time. More importantly, the percolation of water through the waste zone will potentially leach waste constituents, thus increasing contaminant transport from the MWL. The neutron probe system is more reliably a vadose zone monitoring system for the waste zone, rather than a tool to determine loss of integrity in the soil cover. Moisture detection within the biointrusion barrier is a more reliable location for detection of infiltration through the overlying soil cover. Consider revising the proposed trigger for detection of infiltration through the cover to include measurement of moisture directly beneath the 3-foot-thick soil cover. Also, the biointrusion barrier may be designed with geosynthetic drains to carry any moisture within the cover system out and away from the soil cover and the underlying waste zone.

FIGURES

11. Figures E-13, E-15, E-19, and E-24 present a graphical illustration of the sensitivity analyses performed for some of the constituents addressed by the Assessment. 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.