UTAH DIVISION OF RADIATION CONTROL: ENERGY*SOLUTIONS'* CLIVE LLRW DISPOSAL FACILITY;

LICENSE AMENDMENT REQUEST; CLASS A WEST EMBANKMENT

ROUND 2A INTERROGATORIES

TABLE OF CONTENTS
(Highlighted items continued to Round 2)

Section **Page**

Interrogatory CAW R313-25-6(3)-01/2A: Description of Facility i
Interrogatory CAWR313-25-7(1)-02/1: Specific Technical Information – Groundwater Elevation Value(s) Used in Analyses ii
Interrogatory CAW R313-25-7(2)-03/2A: Specific Technical Information – Buffer Zone ii
Interrogatory CAW R313-25-7(3)-04/2A: Specific Technical Information – Design Criterion for Distortion of Liner and Clay Cover Components ..... **Error! Bookmark not defined.**
Interrogatory CAW R313-25-7(7)-05/1: Specific Technical Information -- Closure Plan vii
Interrogatory CAW R313-25-7(9)-06/2B: Specific Technical Information – Quantities of Radioactive Materials vii
Interrogatory CAW R313-25-7(10)-07/1: Specific Technical Information – Construction Quality Assurance/Quality Control Manual viii
Interrogatory CAW R313-25-8(1)-08/2B: Technical Analyses; Releases of Radioactivity viii
Interrogatory CAW R313-25-8(2)-09/2B: Technical Analyses; Protection of Inadvertent Intruders viii
Interrogatory CAW R313-25-8(4)-10/1: Technical Analysis – Design Safety Factors viii
Interrogatory CAW R313-25-8(4)-11/2B: Technical Analysis - Rock Cover Design And Rock Cover Design Calculations/ Analyses viii
Interrogatory CAW R313-25-8(4)-12/2B: Technical Analysis - Filter Stability/ Filter Permeability Criteria viii
Interrogatory CAW R313-25-8(4)-13/2B: Technical Analyses-Perimeter Drainage Ditch Calculations viii
Interrogatory Caw R313-25-8(4)-14/2B: Technical Analyses – Infiltration and Transport Modeling: Climate Conditions, Engineered Barrier Conditions, and Vertical Transport Distance ix
Interrogatory CAW R313-25-8(4)-15/1: Technical Analyses – Groundwater Depth in Geotechnical Stability Analysis ix
Interrogatory CAW R313-25-8(4)-16/2A: Seismic Hazard Evaluation / Seismic Stability Analysis Update ix
Interrogatory CAW R313-25-24(1 through 3)-17/1: Disposal Site Design for Near-Surface Disposal - Liner Design and Construction x
Interrogatory CAW R313-25-24(5)-18/2B: Disposal Site Design for Near-Surface Disposal - Drainage Juncture and Drainage Outlet Design for Perimeter Drainage Ditch System xi

Interrogatory CAW R313-25-25(6)-19/2A: Radiation Dose Rate at the Surface of the Cover xi
Interrogatory CAW R313-25-26(1)-20/2A: Environmental Monitoring xii
Interrogatory CAW R313-25-26 (2 and 3)-21/2B: Technical Analyses - Horizontal Transport and Well Spacing Analysis Input Parameters xiii
Interrogatory CAW R313-25-33(1)-22/1: Records xiii
Interrogatory CAW R317-6-6.4-23/2A: Issuance of Discharge Permit: Best Available Technologies - Monitoring Wells Requiring Abandonment and Decommissioning and Lysimeters Proposed for Abandonment xiii

ABBREVIATIONS AND ACRONYMS

CAW LAR	Class A West Embankment License Amendment Request
ft	foot
km	kilometer
LLRW	low-level radioactive waste
M	magnitude
PSHA	Probabilistic Seismic Hazard Analysis
UAC	Utah Code Annotated
US	United States
USBR	US Bureau of Reclamation

INTERROGATORY CAW R313-25-6(3)-01/2A: DESCRIPTION OF FACILITY

PRELIMINARY FINDING:

Refer to R313-25-6(3). ...Provide a description of:

(a) the location of the proposed disposal site;
(b) the general character of the proposed activities;
(c) the types and quantities of waste to be received, possessed, and disposed of;
(d) plans for use of the land disposal facility for purposes other than disposal of wastes;
(e) the proposed facilities and equipment

INTERROGATORY STATEMENT:

Refer to Sections1.2.2.12 and 1.2.3 of the Class A West (CAW) Embankment License Amendment Request (LAR):

1. *Provide a revised description in Section 1.2.2.12 indicating that, contrary to the statement made that "No existing facilities will be impacted by the CAW embankment", a number of "facilities" will be affected by the proposed CAW Embankment (e.g., the Class A and Class A North Embankments, groundwater monitoring wells, and selected lysimeters [as described in Section 1.2.3]).*

BASIS FOR INTERROGATORY:

The statement "No existing facilities will be impacted by the CAW embankment" is not strictly correct. The Class A and CAN embankments are both affected, as are groundwater monitoring wells located between the two existing embankments. A number of lysimeters will also be affected. They will be removed from service. These are stated in Section 1.2.3 of the CAW LAR to be CL-W3, CL-W4, and CL-N5. If the statement means that "facilities" are only structures such as the rotary dump facility and the shredder facility then please change the sentence in Section 1.2.2.12.

REFERENCES:

Energy*Solutions, LLC 2011. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.*

EnergySolutions, LLC 2011. "License and Modification Request – Class A West Embankment: Round 1 Interrogatory Response" and cover letter (CD11-0295) to Mr. Rusty Lundberg at Utah Division of Radiation Control dated October 31, 2011.

EnergySolutions, LLC 2011. "License and Modification Request – Class A West Embankment: Response to Interrogatory CAW R313-25-8(1)-08/1"and cover letter (CD11-0327)to Mr. Rusty Lundberg at Utah Division of Radiation Control dated November 29, 2011.

INTERROGATORY CAWR313-25-7(1)-02/1: SPECIFIC TECHNICAL INFORMATION – GROUNDWATER ELEVATION VALUE(S) USED IN ANALYSES

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-7(2)-03/2A: SPECIFIC TECHNICAL INFORMATION – BUFFER ZONE

PRELIMINARY FINDING:

Refer to R313-25-25(8). A buffer zone of land shall be maintained between any buried waste and the disposal site boundary and beneath the disposed waste. The buffer zone shall be of adequate dimensions to carry out environmental monitoring activities specified in R313-25-26(4) and take mitigative measures if needed.

INTERROGATORY STATEMENT:

NOTE: The following comments apply to revisions of drawings issued prior to issuance of revisions submitted to the Division with Revision 1 of the License Amendment Request on October 31, 2011. These comments apply to the revisions transmitted on November 29, 2011 to the extent that they have not been addressed by the latest revisions.

Please revise Drawing 10014 C01 as follows:

1. *Correctly show the "CAW Waste Break Line" in the drawing (presently, the line style for CAW Waste Limit appears to be used to denote the CAW Waste Break Line).*
2. *Use a line style for Class A and Class A North Embankments that is easily distinguishable from that used to denote the CAW Waste Break Lines.*
3. *Provide coordinate sets that define the end points of the heavy dashed line. Label these coordinate sets so that it is clear what they represent. Explicitly state that the heavy dashed line defines the eastern extreme of waste placement and that no waste will be placed east of that line from its north end to its south end. NOTE: The line is presently labeled as representing an "area".*
4. *Revise the legend label from "Waste Restricted Area" to "Eastern extreme of CAW waste placement" or similar. Maintain consistency between terminology used in the entire drawing set.*
5. *Revise references to the "Waste Restricted Area" so that it refers to a line, limit, or boundary.*

Please revise Drawing 10014 C02 as follows:

6. *Identify the location of the "Eastern extreme of CAW waste placement" in Cross Section A.*

7. *Maintain consistency between terminology used in this drawing (that for "Shoulder") and in Drawing 10014 C05 [that for "CAW Break Line (Typical)"].*

Please revise Drawing10014 C03 as follows:

8. *Revise the term "Toe of Waste (Actual)" to "Eastern extreme of CAW waste placement" or otherwise maintain consistency between terminology used throughout this drawing set.*
9. *Revise the term "Waste Limits" to be "Authorized CAW Waste Limits".*

Please revise Drawing 10014 C05 as follows:

10. *Maintain consistency between terminology used in this drawing [that for "CAW Break Line (Typical)"] and in Drawing 10014 C03 (that for "Shoulder").*

***Note**: Additional suggested changes/corrections to drawings will be provided in Round 2b Interrogatories, as necessary.*

BASIS FOR INTERROGATORY:

The Round 1 responses adequately resolve the buffer zone matter. However, ambiguities and seemingly conflicting or confusing information exist in the drawings. These need to be resolved.

REFERENCES:

EnergySolutions, LLC 2011. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.

EnergySolutions, LLC 2011. "License and Modification Request – Class A West Embankment: Round 1 Interrogatory Response" and cover letter (CD11-0295) to Mr. Rusty Lundberg at Utah Division of Radiation Control dated October 31, 2011.

EnergySolutions, LLC 2011. "License and Modification Request – Class A West Embankment: Response to Interrogatory CAW R313-25-8(1)-08/1"and cover letter (CD11-0327) to Mr. Rusty Lundberg at Utah Division of Radiation Control dated November 29, 2011.

INTERROGATORY CAW R313-25-7(3)-04/2A: SPECIFIC TECHNICAL INFORMATION – DESIGN CRITERION FOR DISTORTION OF LINER AND CLAY COVER COMPONENTS

PRELIMINARY FINDING:

Refer to R313-25-7. The application shall include certain technical information….
(3) Descriptions of the principal design criteria and their relationship to the performance objectives.

INTERROGATORY STATEMENT:

1. *Please demonstrate that the maximum tensile strain associated with an angular distortion of 0.02 ft/ft is sufficiently less than the strain which causes a compacted clay liner (CCL) to crack, considering the properties of the soil(s) in question. As part of this demonstration, please integrate results/findings from more recent investigations of compacted clay layer deformation behavior with prior investigation/testing results. The demonstration should consider both axial and bending strains when relating maximum tensile strain to angular distortion. The demonstration should also address the potential role of soil creep and/or moisture changes over time in determining the maximum allowable tensile strain.*
2. *In Table 1, page 8, of the Response to Round 1 Interrogatories (EnergySolutions 2011), please revise entries in the last column is titled "Maximum Tensile Strain (%") to list the correct parameter reported for each cited case study, or delete the row summarizing results for the study if the listed value is not tensile strain. For example, the study by Le et al. 2009 measured maximum tensile strength which is not the same as maximum tensile strain as listed in the table.*

BASIS FOR INTERROGATORY

EnergySolutions' response to Interrogatory CAW R313-25-7(3)-04/1 does not sufficiently demonstrate the adequacy of the 0.02 value for the maximum allowable angular distortion used as a design criterion for the liner and clay components of the CAW Embankment cover. In its response, the Licensee attempts to demonstrate adequacy of the 0.02 distortion value by first establishing with a literature review the maximum tensile strain of clay before cracking; then correlating that strain to a corresponding angular distortion, and finally comparing that angular distortion with the design criterion. However, some deficiencies trouble the development of the justification.

The literature review presented by the Licensee consists of references to seven publications (some of which appear to be derived from the others) published since 2002. In focusing on more recent literature, the Licensee has not integrated the results obtained from more recent investigations and laboratory testing with results from its previous work (AMEC 2000). A partial list of previous work includes reports by Tschebotarioff et al. (1953), Leonards and Narain (1963), Marsal and De Arellano (1967), Al Hussaina and Townsend (1971), Covarrubias

(1971), Krishnayya et al. (1974), Ajaz and Parry (1975a, 1976b, 1976), Wilson and Marsal (1979), Gaind and Char (1983), Chandhari and Char (1985), Gilbert and Murphy (1987), Scherbeck et al. (1991), Jessberger and Stone (1991), Scherbeck and Jessberger (1993), Claire et al. (1994), and Lozano and Aughenbaugh (1995).

Several of the references listed above were considered and referenced in AMEC 2000; however, a comprehensive assessment that more wholly reflects the current state of knowledge has not been provided in response to Interrogatory CAW R313-25-7(3)-04/1. Several of these references also indicate that the maximum tensile strain before cracking occurs in a CCL (compacted clay liner) may be as low as 0.1%, which is less than the 0.2% value that the Licensee has declared to be "a very conservative lower bound." Of course, maximum tensile stain before cracking does depend upon the specific properties (particularly the plasticity index) of the soil(s) in question. Thus, 0.2% may yet be shown to be appropriate for this project. More work is, however, needed to fully demonstrate the validity of the Licensee's conclusion.

More recent investigation results reported in the literature should be integrated with results the Licensee has reported earlier (AMEC 2000). For example, the more recent study by Rajesh and Viswanadham (2010,) cited by in the Licensee's response features numerical- and measurement-based subsidence profiles, together with axial and bending strains. The results of Rajesh and Viswanadham (2010) suggest higher localized strain levels for a given angular distortion than does the simple model of LaGatta et al. 1997. In AMEC 2000, as well as in its response to Interrogatory CAW R313-25-7(3)-04/1, the Licensee relies upon a simple mathematical model presented in LaGatta et al. (1997) to relate maximum tensile strain to displacement ratio. The model is a linearized representation of a settlement/subsidence profile and accounts only for the axial lengthening of the clay liner. Consequently, the strain provided by LaGatta et al.'s model is an <u>average</u> of only axial strain that does not account for bending-induced strains away from the neutral axis. The strain-distortion relationship presented graphically in Gilbert and Murphy (1987) also seems to be based on average tensile strain without consideration of potential bending.

If the Licensee seeks to clearly and transparently justify the angular distortion criterion by relating it to the maximum tensile strain (strength) in the clay liner, these more recent and realistic relationships should be considered.

Additionally, the maximum tensile strains cited in the Licensee's response from Viswanadham and Mahesh's study (2002) are not explicitly stated in that study, and the maximum tensile strains reported by the Licensee from the study by Rajesh and Viswanadham (2010) appear to be for a fiber-reinforced clay liner (FRCL), not for a plain CCL which seems to have cracked at lower strain.

The Licensee has not stated whether results from these controlled, short-term laboratory tests are directly transferable to the long-term performance of clayey soils where soil creep and/or moisture changes can affect the soil behavior. On Table 1, page 8, of the Response to Round 1 Interrogatories, the last column is titled: Maximum Tensile Strain (%). However, the values in the column are not all tensile strain values. For example, the study by Le (2009) measured maximum tensile strength, not maximum tensile strain as listed in the table. The table needs to be corrected and the correct parameters listed as stated in each reference.

REFERENCES

Ajaz, A. and Parry, R.H.G. (1975a). "Stress-Strain Behavior of Two Compacted Clays in Tension and Compression," Geotechnique, Vol. 25, No. 3, pp. 495-512.

Ajaz, A. and Parry, R.H.G. (1975b). "Analysis of Bending Stresses in Soil Beams," Geotechnique, Vol. 25, No. 3, pp. 586-591.

Ajaz, A. and Parry, R.H.G. (1976). "Bending Test for Compacted Clays," ASCE Journal of the Geotechnical Engineering Division, Vol. 102, No. 9, pp. 929-943.

Al-Hussaina, M.M. and Townsend, T.C. (1971). "Investigation of Tensile Testing of Compacted Soils," Miscellaneous Paper S-74-10, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi, June.

AMEC 2000, "Letter; Allowable Differential Settlement and Distortion of Liner and Cover Materials; New LARW and Proposed LLRW Embankments; Clive, Utah", from Pilz and White of AMEC to Alkema of Envirocare of Utah, October 4, 2000.

Chandhari, A.P. and Char, A.N.R. (1985). "Flexural Behavior of Reinforced Beams," ASCE Journal of Geotechnical Engineering, Vol. 111, No. 11, pp. 1328-1333.

Claire, R.F., Kuo, J.C., and Wanket, D.R. (1994). "Evaluation of the Cover Cracking Potential Due to Ground Subsidence at UMTRA Project Disposal Cells." Morrison Knudsen Corporation, Boise, Idaho.

Covarrubias, S.W. (1971). "Cracking of Earth and Rock Dams – Comparison of Observed and Theoretical Tensile Strains in the Crests of Two Earth and Rock Dams," Contract Report S-71-11, U.S. Waterways and Experiment Station, Vicksburg, Mississippi. April.

EnergySolutions, LLC 2011. "License and Modification Request – Class A West Embankment: Round 1 Interrogatory Response" and cover letter (CD11-0295) to Mr. Rusty Lundberg at Utah Division of Radiation Control dated October 31, 2011. Gaind, K.J. and Char, A.N.R. (1983). "Reinforced Soil Beams," ASCE Journal of Geotechnical Engineering, Vol. 109, No. 7, pp. 977-982.

Gilbert, P.A. and Murphy, W.L. (1987). "Prediction/Mitigation of Subsidence Damage to Hazardous Water Landfill Covers." Report EPA/600/2-87/025, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi.

Jessberger, H.L. and Stone, K. (1991). "Subsidence Effects on Clay Barriers," Geotechnique, Vol. 41, No. 2, pp. 185-194.

Krishnayya, A.V.G., Eisenstein, Z., and Morgenstern, N.R. (1974). "Behavior of Compacted Soil in Tension," ASCE Journal of the Geotechnical Engineering Division,Vol.100, GT-9, pp. 1051-1061.

LaGatta, M.D., Boardman, B.T., Cooley, B.H., and Daniel, D.E. (1997). "Geosynthetic Clay Liners Subjected to Differential Settlement," Journal of Geotechnical and Geoenvironmental Engineering, Vol. 123, No. 5, pp. 402-410.

Le, TNH, et al. 2009. "Discrete Analysis of Clay Liner Tensile Strength", in Powders and Grains 2009, Proceedings of the the 6th International Conference on Micromechanics of Granular Media, 970-0-7354-0682-7.

Leonards, G.A. and Narain, J. (1963). "Flexibility of Clay and Cracking of Earth Dams," ASCE Journal of the Soil Mechanics and Foundations Division, Vol. 89, No. 2, pp. 47-98.

Lozano, N. and Aughenbaugh, N.R. (1995). "Flexibility of Fine-Grained Soils," Geoenvironment 2000, Geotechnical Special Publication No. 46, D.E. Daniel and Y.B. Acar (eds.), ASCE, New York, NY, Vol. 1, pp. 844-858.

Marsal, R.J. and De Arellano, L.R. (1967). "Performance of El Infiernillo Dam 1963 -1966," ASCE Journal of the Soil Mechanics and Foundations Division, Vol. 93, SM4, pp. 265-298.

Rajesh, S. and Viswanadham, B.V.S. (2010). "Performance Assessment of Deformation Behavior of Landfill Barriers at the Onset of Differential Settlement," International Journal of Environmental Engineering, Vol. 2.1, pp. 269-289.

Scherbeck, R. and Jessberger, H.J. (1993). "Assessment of Deformed Mineral Sealing Layers." Proceedings, Green '93, Bolton University, Manchester England.

Scherbeck, R., Jessberger, H.J., and Stone, K. (1991). "Mineral Liner Reaction from Settlement Induced Deformation." Centrifuge 1991. Ko, H.Y., and McLean, F.G., Eds. A.A. Balkema, Rotterdam, Netherlands, pp. 121-128.

Tschebotarioff, G.P., Ward, E.R., and Dephilippe. A.A. (1953). "The Tensile Strength of Disturbed and Recompacted Soils," Proc. Third International Conference on Soil Mechanics and Foundation Engineering, Vol.1, Session2/28, pp. 207-210.

Wilson, S.D. and Marsal, R.J. (1979). "Current Trends in Design and Construction of Embankment Dams," ICOLD Committee on International Relations and Geotechnical Division, ASCE, New York, NY.

Viswanadham, B.V.S. and Mahesh, K.V. (2002). "Modeling Deformation Behavior of Clay Liners in a Small Centrifuge," Canadian Geotechnical Journal, Vol. 39, pp. 1406-1418.

INTERROGATORY CAW R313-25-7(7)-05/1: SPECIFIC TECHNICAL INFORMATION -- CLOSURE PLAN

Follow –up issues will be included in the Round 2B Interrogatories

INTERROGATORY CAW R313-25-7(9)-06/2B: SPECIFIC TECHNICAL INFORMATION – QUANTITIES OF RADIOACTIVE MATERIALS

Follow-up issues, if any, will be included in Round 2B Interrogatories.

INTERROGATORY CAW R313-25-7(10)-07/1: SPECIFIC TECHNICAL INFORMATION – CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL MANUAL

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(1)-08/2B: TECHNICAL ANALYSES; RELEASES OF RADIOACTIVITY

Follow-up issues, if any, will be included in Round 2B Interrogatories.

INTERROGATORY CAW R313-25-8(2)-09/2B: TECHNICAL ANALYSES; PROTECTION OF INADVERTENT INTRUDERS

A performance assessment to be completed in 2012, will address dose limits for disposal.

INTERROGATORY CAW R313-25-8(4)-10/1: TECHNICAL ANALYSIS – DESIGN SAFETY FACTORS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-11/2B: TECHNICAL ANALYSIS - ROCK COVER DESIGN AND ROCK COVER DESIGN CALCULATIONS/ ANALYSES

Follow-up issues, if any, will be included in Round 2B Interrogatories

INTERROGATORY CAW R313-25-8(4)-12/2B: TECHNICAL ANALYSIS - FILTER STABILITY/ FILTER PERMEABILITY CRITERIA

Follow-up issues, if any, will be included in Round 2B Interrogatories.

INTERROGATORY CAW R313-25-8(4)-13/2B: TECHNICAL ANALYSES-PERIMETER DRAINAGE DITCH CALCULATIONS

Follow-up issues, if any, will be included in Round 2B Interrogatories.

INTERROGATORY CAW R313-25-8(4)-14/2B: TECHNICAL ANALYSES – INFILTRATION AND TRANSPORT MODELING: CLIMATE CONDITIONS, ENGINEERED BARRIER CONDITIONS, AND VERTICAL TRANSPORT DISTANCE

Follow-up issues, if any, will be included in Round 2B Interrogatories.

INTERROGATORY CAW R313-25-8(4)-15/1: TECHNICAL ANALYSES – GROUNDWATER DEPTH IN GEOTECHNICAL STABILITY ANALYSIS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-16/2A: SEISMIC HAZARD EVALUATION / SEISMIC STABILITY ANALYSIS UPDATE

PRELIMINARY FINDING:
Refer to R313-25-8(5). Analyses of the long-term stability of the disposal site shall be based upon analyses of active natural processes including erosion, mass wasting, slope failure, settlement of wastes and backfill, infiltration through covers over disposal areas and adjacent soils, and surface drainage of the disposal site. The analyses shall provide reasonable assurance that there will not be a need for ongoing active maintenance of the disposal site following closure.

INTERROGATORY STATEMENT:

Justify using the outdated "semi-probabilistic" approach reported in the response or preferably perform a probabilistic seismic hazard analysis (PSHA). In addition,

a. *If an attempt is made to justify the semi-probabilistic, explain and justify the basis for using the radius of the circular area of 18.74 km in the deterministic calculations.*
b. *Decluster the earthquake catalog as is done in standard probabilistic approaches and as was done by Pechmann and Arabasz (1995) and use that catalog in any ground motion calculations.*
c. *Correctly label the vertical axis in Figure 3 and correctly interpret the information presented in Figure 3 (cumulative frequency plot).*

BASIS FOR INTERROGATORY:

In lieu of performing a PSHA to assess the ground motions from background earthquakes as they had previously done for this site, AMEC has attempted to take what they call a "semi-probabilistic" approach. The justification for taking such an approach is however unstated. Semi-probabilistic approaches are not standard practice and have been abandoned since the late 1990's.

In some aspects, the "semi-probabilistic" approach has similarities with the methodology used by the U.S. Bureau of Reclamation (USBR) since the early 1980's but long since abandoned since the late 1990's. As pointed out by Pechmann and Arabasz (1995) for the Wasatch Front region, this approach which they call "semi-deterministic" yields peak horizontal accelerations

that are a factor of 1.5 to 5.7 lower than values obtained by a more complete PSHA. The USBR performs a PSHA to address the hazard from background earthquakes.

Even given these observations, the approach appears flawed as follows:

1. *The statement is made on page 4 of the AMEC report that the "resulting earthquake activity rate curve is conservative and exceeds the Pechmann and Arabasz (1995) rate of earthquakes < 5." This difference may have resulted because AMEC did not decluster their earthquake catalog as is done in standard probabilistic approaches and as was done by Pechmann and Arabasz (1995). At the magnitude range of importance M > 5, the rate of activity is lower than Pechmann and Arabasz (1995) which may be appropriate for this area west of the Wasatch Front.*
2. *For a 1000 km^2 area, the radius of 17.84 km is used. The recurrence interval of an earthquake of M 6.5 and greater from the AMEC analysis is 9950 years but that earthquake can occur anywhere within the 1000 km^2 area. Specifying the earthquake occurs at 17.84 km effectively places the event at the further distance from the site for that probability. Note the vertical axis on Figure 3 is mislabeled. It is "Recurrence Interval" not "Return Period".*
3. *The recurrence curves shown on Figure 3 are cumulative frequency plots. AMEC is interpreting earthquake magnitudes from these plots but is ignoring the fact that these magnitudes represent events that have the specified magnitude value and larger. As stated above, the magnitude on Curve B that has a recurrence interval of 9950 years is a M 6.5 and greater.*

Note: *An additional interrogatory item related to the topic addressed in this interrogatory may be provided in the Round 2B Interrogatories.*

REFERENCES:

AMEC Earth & Environmental, Inc., "Response to Interrogatory CAW R313-25-8(4)-16/1: Seismic Hazard Analysis", Job Number 10-817-05290, October 25, 2011.

Pechmann, J.C. and Arabasz, W.J., 1995, The problem of the random earthquake in seismic hazard analysis: Wasatch Front region, Utah in W.R. Lund (ed), Environmental and Engineering Geology of the Wasatch Front Region, 1995 Symposium and Field Conference: Utah Geological Association Publication 24, p. 77-93.

INTERROGATORY CAW R313-25-24(1 THROUGH 3)-17/1: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - LINER DESIGN AND CONSTRUCTION

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-24(5)-18/2B: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - DRAINAGE JUNCTURE AND DRAINAGE OUTLET DESIGN FOR PERIMETER DRAINAGE DITCH SYSTEM

Follow-up issues, if any, will be included in Round 2B Interrogatories.

INTERROGATORY CAW R313-25-25(6)-19/2A: RADIATION DOSE RATE AT THE SURFACE OF THE COVER

PRELIMINARY FINDING:

Refer to R313-25-25(6). Waste shall be placed and covered in a manner that limits the radiation dose rate at the surface of the cover to levels that at a minimum will permit the licensee to comply with all provisions of R313-15-105 at the time the license is transferred pursuant to R313-25-16.

INTERROGATORY STATEMENT:

Refer to Section 3.1.9 of the Class A West (CAW) Embankment License Amendment Request (LAR):

Please submit a Microshield output showing the dose rate at the surface of the cover, taking into account the revised cover design described in the November 29, 2011 response to Interrogatory CAW R313-25-8(1)-08/1.

BASIS FOR INTERROGATORY:

Since the cover design and thickness have been revised, the previous Microshield analysis is no longer valid.

REFERENCES

Energy*Solutions, LLC 2011. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.*

Energy*Solutions*, LLC 2011. *Responses to Round 1 Interrogatories: License Amendment Request (UT2300249) for the Class A West Embankment and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control, dated October 28, 2011.*

EnergySolutions, LLC 2011. "License and Modification Request – Class A West Embankment: Response to Interrogatory CAW R313-25-8(1)-08/1"and cover letter (CD11-0327)to Mr. Rusty Lundberg at Utah Division of Radiation Control dated November 29, 2011.

INTERROGATORY CAW R313-25-26(1)-20/2A: ENVIRONMENTAL MONITORING

PRELIMINARY FINDING:

Refer to R313-25-26(1). During the land disposal facility site construction and operation, the licensee shall maintain an environmental monitoring program. Measurements and observations shall be made and recorded to provide data to evaluate the potential health and environmental impacts during both the construction and the operation of the facility and to enable the evaluation of long-term effects and need for mitigative measures. The monitoring system shall be capable of providing early warning of releases of waste from the disposal site before they leave the site boundary.

INTERROGATORY STATEMENT:

Please revise the Environmental Monitoring Plan to include installation and operation of at least 2 additional air monitoring stations on the east side of the proposed CAW disposal embankment and west of the Vitro disposal area.

BASIS FOR INTERROGATORY:

Although access to the Vitro disposal area is restricted, no means presently exists to monitor how much particulate matter is release from the proposed CAW embankment to the Vitro disposal area – not within EnergySolutions' controlled area. EnergySolutions and the Division are both responsible to ensure that these possible releases are monitored and to demonstrate that LLRW disposal operations are not causing contamination to adjacent and downwind properties.

The air monitoring stations located south of the 11e.(2) embankment perform this function for potential releases to unrestricted areas south of the 11e.(2) embankment.

REFERENCES:

Energy Solutions, LLC 2011. License Amendment Request: Class A West Embankment, with Attachments 1 through 7 and Cover Letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.

INTERROGATORY CAW R313-25-26 (2 AND 3)-21/2B: TECHNICAL ANALYSES - HORIZONTAL TRANSPORT AND WELL SPACING ANALYSIS INPUT PARAMETERS

Follow-up issues, if any, will be included in Round 2B Interrogatories.

INTERROGATORY CAW R313-25-33(1)-22/1: RECORDS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R317-6-6.4-23/2A: ISSUANCE OF DISCHARGE PERMIT: BEST AVAILABLE TECHNOLOGIES - MONITORING WELLS REQUIRING ABANDONMENT AND DECOMMISSIONING AND LYSIMETERS PROPOSED FOR ABANDONMENT

PRELIMINARY FINDING:

Refer to R317-6-6.4(A). The Executive Secretary may issue a ground water discharge permit for a new facility if the Executive Secretary determines, after reviewing the information provided under R317-6-6.3, that: …2. the monitoring plan, sampling and reporting requirements are adequate to determine compliance with applicable requirements; 3. the applicant is using best available technology to minimize the discharge of any pollutant;…".

INTERROGATORY STATEMENT:

Refer to Section 1.2.3 of the Class A West (CAW) Embankment License Amendment Request (LAR) and Drawing 10014 C01 in Attachment 2 to the Round 1 Interrogatory Response submitted in support of the CAW Embankment LAR:

1. *Please provide additional information regarding feasible systems and/or means that will be implemented for ensuring that there will be a reliable means for acquiring data on vadose zone conditions (soil moisture, pore-water chemistry) underlying the southeastern portion of the proposed CAW Embankment. Drawing 10014 C01 indicates that two existing or currently planned lysimeters (CL-W3 and CL-W4) located beneath the southeastern portion (southeastern "quadrant") of the CAW Embankment footprint are proposed to be abandoned. However, no new lysimeters or other types of vadose zone monitoring devices are proposed to be installed beneath this CAW Embankment "quadrant" area (the eastern part of the existing Class A Embankment).*

2. *Please provide information and details to demonstrate that the system and/or measures* Energy*Solutions proposes to implement will provide reliable data to aid in early warning detection of potential releases from this portion of the proposed CAW Embankment, and include means for obtaining pore-water chemistry data (e.g., to help confirm and/or characterize constituents in leachate associated with a potential release). Identify and evaluate available monitoring technologies that could be feasibly employed and used to acquire such data, including, but not limited to: (1) suction lysimeters (e.g., SoilMoisture Equipment Corporation Model 1940 Hi-Pressure/Vacuum soil water sampler)*

constructed and installed in angled boreholes; (2) neutron probe access tubes, possibly combined with a means of obtaining a sample of accumulated liquid present, if any, from beneath the eastern portion of the current Class A Embankment footprint portion of the CAW Embankment within the vadose zone monitored interval; or (3) other technologies, to the extent that they may be available and feasible. Demonstrate that the system and/or measures to be employed, if different than the current or planned vadose zone monitoring method, satisfy criteria for best available technologies for this type of monitoring.

BASIS FOR INTERROGATORY:

The total number of existing and proposed lysimeters originally proposed for installation under the Class A Embankment area was 8, and was subsequently reduced to 7 with the Division's approval. The total number of lysimeters currently proposed for this same area is 5, according to the information included in the CAW Embankment LAR (Section 1.2.3 and Drawing 10014 C01). The total surface area of coverage per lysimeter for the Class A Embankment area, as proposed in the CAW Embankment LAR, would be 10 acres. By comparison, the total surface area of coverage per lysimeter for the Class A North Embankment area, according to the CAW Embankment LAR, would be 8 acres. Additionally, given the prevailing groundwater flow direction in the area (northeastward); the relative proximity of the Vitro Embankment northeast (in the downgradient groundwater flow direction from) of the CAW Embankment area and the consequent need to respond quickly to potential releases of constituents from the CAW Embankment to soil and/or groundwater reliable early detection of releases from the proposed embankment be ensured);, and the proposed removal of lysimeters CL-W4 and CL-W3 located in the Class A Embankment area, a "gap" would occur in the vadose zone monitoring system coverage underlying the eastern part of the area now occupied by the Class A Embankment, especially from the perspective of the monitoring system needing to provide a reliable early warning detection capability to facilitate timely response/corrective actions to any such releases. EnergySolutions needs to provide information regarding how this vadose zone monitoring gap will be filled, or, alternatively, provide detailed justification as to why the currently proposed lysimeter monitoring plan would be adequate and reliable.

REFERENCES:

Energy*Solutions, LLC 2011. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.*

"Ground Water Discharge Permit UGW450005", Department of Environmental Quality, Utah Water Quality Board, held by Energy*Solutions, LLC, July 29, 2010.*

Utah Department of Environmental Quality 2011. Request for Modification to Appendix C. "Construction Quality Assurance Plan for Collection Lysimeter Construction" and Collection Lysimeter Operation, Maintenance and Closure Plan" Groundwater Quality Discharge Permit No. UGW450005: Approval. June 27, 2011.

UTAH DIVISION OF RADIATION CONTROL: ENERGY*SOLUTIONS'* CLIVE LLRW DISPOSAL FACILITY;

LICENSE AMENDMENT REQUEST; CLASS A WEST EMBANKMENT

ROUND 2B INTERROGATORIES

TABLE OF CONTENTS

(Highlighted items either addressed in these Round 2B interrogatories or deferred to Round 2C as indicated)

Section **Page**

Interrogatory CAW R313-25-6(3)-01/2A: Description of Facility ii
Interrogatory CAWR313-25-7(1)-02/1: Specific Technical Information – Groundwater Elevation Value(s) Used in Analyses ii
Interrogatory CAW R313-25-7(2)-03/2A: Specific Technical Information – Buffer Zone ii
Interrogatory CAW R313-25-7(3)-04/2A: Specific Technical Information – Design Criterion for Distortion of Liner and Clay Cover Components ii
Interrogatory CAW R313-25-7(7)-05/2B: Specific Technical Information -- Closure Plan ii
Interrogatory CAW R313-25-7(9)-06/1: Specific Technical Information – Quantities of Radioactive Materials iv
Interrogatory CAW R313-25-7(10)-07/1: Specific Technical Information – Construction Quality Assurance/Quality Control Manual iv
Interrogatory CAW R313-25-8(1)-08/1: Technical Analyses; Releases of Radioactivity iv
Interrogatory CAW R313-25-8(2)-09/2B: Technical Analyses; Protection of Inadvertent Intruders iv
Interrogatory CAW R313-25-8(4)-10/1: Technical Analysis – Design Safety Factors iv
Interrogatory CAW R313-25-8(4)-11/2B: Technical Analysis - Rock Cover Design And Rock Cover Design Calculations/ Analyses iv
Interrogatory CAW R313-25-8(4)-12/2B: Technical Analysis - Filter Stability/ Filter Permeability Criteria vii
Interrogatory CAW R313-25-8(4)-13/1: Technical Analyses-Perimeter Drainage Ditch Calculations vii
Interrogatory Caw R313-25-8(4)-14/2B: Technical Analyses – Infiltration and Transport Modeling: Climate Conditions, Engineered Barrier Conditions, and Vertical Transport Distance vii
Interrogatory CAW R313-25-8(4)-15/1: Technical Analyses – Groundwater Depth in Geotechnical Stability Analysis xiii
Interrogatory CAW R313-25-8(4)-16/2B/2C: Seismic Hazard Evaluation / Seismic Stability Analysis Update xiii
Interrogatory CAW R313-25-24(1 through 3)-17/1: Disposal Site Design for Near-Surface Disposal - Liner Design and Construction xiv
Interrogatory CAW R313-25-24(5)-18/1: Disposal Site Design for Near-Surface Disposal - Drainage Juncture and Drainage Outlet Design for Perimeter Drainage Ditch System xiv

Interrogatory CAW R313-25-25(6)-19/2A: Radiation Dose Rate at the Surface of the Cover xiv
Interrogatory CAW R313-25-26(1)-20/2A: Environmental Monitoring xiv
Interrogatory CAW R313-25-26 (2 and 3)-21/2B: Technical Analyses - Horizontal Transport and Well Spacing Analysis Input Parameters .....
Interrogatory CAW R313-25-33(1)-22/1: Records xviii
Interrogatory CAW R317-6-6.4-23/2A: Issuance of Discharge Permit: Best Available Technologies - Monitoring Wells Requiring Abandonment and Decommissioning and Lysimeters Proposed for Abandonment xviii

ABBREVIATIONS AND ACRONYMS

CAW LAR	Class A West Embankment License Amendment Request
cm	centimeter
ft	foot
HELP	Hydrologic Evaluation of Landfill Performance Model
kg	kilogram
L	liter
LLW	low-level waste
UAC	Utah Code Annotated
US	United States

INTERROGATORY CAW R313-25-6(3)-01/2A: DESCRIPTION OF FACILITY

Refer to Interrogatory Round 2A

INTERROGATORY CAWR313-25-7(1)-02/1: SPECIFIC TECHNICAL INFORMATION – GROUNDWATER ELEVATION VALUE(S) USED IN ANALYSES

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-7(2)-03/2A: SPECIFIC TECHNICAL INFORMATION – BUFFER ZONE

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-7(3)-04/2A: SPECIFIC TECHNICAL INFORMATION – DESIGN CRITERION FOR DISTORTION OF LINER AND CLAY COVER COMPONENTS

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-7(7)-05/2B: SPECIFIC TECHNICAL INFORMATION -- CLOSURE PLAN

PRELIMINARY FINDING:

Refer to R313-25-7. The application shall include certain technical information….
(7) A description of the disposal site closure plan, including those design features which are intended to facilitate disposal site closures and to eliminate the need for active maintenance after closure.

INTERROGATORY STATEMENT:

1. *Please revise Attachment 9 to the CAW LAR to address and justify the increased demand for clay and rock, as stated in Attachment 5 to ES letter CD11-0327.*
2. *Please demonstrate quantitatively that the amount of rock available for constructing the revised CAW cover system is adequate to meet the need for rock stated in the Round 1 Response to this interrogatory in Section 2.5.4 of CAW LAR, rev. 2.*

3. *Provide evidence that EnergySolutions has valid claims to rock in any of the "adjoining pit areas [that] contain several hundred thousand additional cubic yards of material." State and justify the total amount of rock to which EnergySolutions has valid claims.*
4. *Demonstrate that rock from these adjoining pits to which EnergySolutions has valid claims and has included in the total amount stated in Item 3 above is of adequate quality under NUREG-1623 for use in constructing the CAW cover system.*

BASIS FOR INTERROGATORY:

1. *The amounts of clay and rock needed to construct the revised CAW cover system are not justified by revisions to the Attachment 9, provided to quantify the need for clay and rock before the CAW cover design change was proposed.*
2. *The revised CAW LAR pages provided in Attachment 5 to ES letter CD11-0327 states the demand for rock material to total more than 1.7 million cubic yards of rock. The associated justification that adequate supplies of rock are actually available is provided in the statements that "This is one of several pits in the region; and EnergySolutions contract area alone provides approximately 1.1 million cubic yards of proven rock material. The adjoining pit areas contain several hundred thousand additional cubic yards of material." This qualitative assessment is inadequate and must be supplemented by quantitative estimates based on verifiable information about each adjoining pit.*
3. *The Division requires assurance that EnergySolutions will indeed be able to extract the rock from its various natural locations. Without such assurance, confidence that the proposed facility can be appropriately closed cannot exist.*
4. *The Division requires assurance that rock available from adjoining pits is of adequate quality to be acceptable under NUREG-1623 for use in constructing the proposed revised CAW cover system. Without such assurance, confidence that the proposed facility can be appropriately closed cannot exist.*

REFERENCES:

EnergySolutions, LLC. 2011a. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg of Utah Division of Radiation Control dated May 2, 2011.

EnergySolutions, LLC. 2011b. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011, including Attachment 1 – "RML Revisions".

EnergySolutions, LLC. 2011c. Radioactive Materials License #UT2300249 and Groundwater Quality Discharge Permit No UGW450005. Amendment and Modification Request – Class A West Embankment: Response to Interrogatory CAW R313-25-8(1)-08/1; Letter from Sean McCandless of EnergySolutions to Mr. Rusty Lundberg of Utah Division of Radiation Control

dated November 29, 2011, including Attachment 5 – "CAW LAR redline/strikeout pages from the text based on the attached Groundwater Modeling".

INTERROGATORY CAW R313-25-7(9)-06/1: SPECIFIC TECHNICAL INFORMATION – QUANTITIES OF RADIOACTIVE MATERIALS

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-7(10)-07/1: SPECIFIC TECHNICAL INFORMATION – CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL MANUAL

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(1)-08/1: TECHNICAL ANALYSES; RELEASES OF RADIOACTIVITY

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-8(2)-09/2B: TECHNICAL ANALYSES; PROTECTION OF INADVERTENT INTRUDERS

XXX A performance assessment to be completed in 2012 will address dose limits for disposal.

INTERROGATORY CAW R313-25-8(4)-10/1: TECHNICAL ANALYSIS – DESIGN SAFETY FACTORS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-11/2B: TECHNICAL ANALYSIS - ROCK COVER DESIGN AND ROCK COVER DESIGN CALCULATIONS/ ANALYSES

PRELIMINARY FINDING:

Refer to R313-25-8(4). Analyses of the long-term stability of the disposal site shall be based upon analyses of active natural processes including erosion, mass wasting, slope failure,

settlement of wastes and backfill, infiltration through covers over disposal areas and adjacent soils, and surface drainage of the disposal site. The analyses shall provide reasonable assurance that there will not be a need for ongoing active maintenance of the disposal site following closure.

INTERROGATORY STATEMENT:

1. **Refer to Drawing 10014 C04 of Energy*Solutions* 2011a; and 2011b and Drawing 10014 C04, Rev. 2 of Energy*Solutions* 2011c:** *To further justify and corroborate the expected hydraulic performance of the Type A Filter Zone/bedding layer and further evaluate its ability to accommodate the proposed change in riprap layer design (EnergySolutions 2011c), please provide the following:*

    1. *Calculations/estimates of expected interstitial flow velocities within the Type A Filter Zone Layer on the topslope and sideslope areas, derived using alternative analysis methods, including, but not necessarily limited to: (a) Abt et al. 1991/Abt et al. 1988, Section 5.3; and (b) Codell et al. 1990;*

    2. *Evaluation of the potential impact of results of additional infiltration analyses conducted in response to Interrogatory CAW R313-25-8(4)-14/2B: "Technical Analysis - Infiltration and Transport Modeling: Climate Conditions, Engineered Barrier Conditions, and Vertical Transport Distance" below on the projected performance of, and technical adequacy of, the various cover layers in proposed CAW Embankment cover, including but not limited to, the riprap layer, Type A Filter Zone layer, and the underlying Sacrificial Soil layer.*

    3. *Other additional information to fully justify the selection of a thickness of 6 inches for the Type A Filter Zone layer, which appears to be contrary to the following published guidance:*

        - *Nelson et al. 1986, Section 4.4, which indicates that a filter/bedding layer thickness of one-half the riprap layer thickness, but not less than 6 to 9 inches, depending on the riprap thickness and riprap design procedure, is recommended; and*
        - *Abt et el. 1988, Section 7.1, which highly recommends the use of a filter/bedding layer greater than 6 inches thick (to ensure stability of the riprap, prevent migration of particles beneath the filter/bedding layer, and reduce any pressure gradient that may exist from seepage).*

BASIS FOR INTERROGATORY:

Applicable published guidance documents, cited in the interrogatory above, recommend that granular filter/bedding layers installed beneath rock riprap layers either have a thickness at least one-half of the riprap layer thickness (Nelson et al. 1986) or have a minimum thickness

greater than 6 inches (Abt et al. 1988). The referenced documents discuss certain performance characteristics/performance issues that NRC considered when developing these minimum thickness recommendations. The Type A Filter Zone layer in the proposed CAW Embankment cover has a thickness of 6 inches, while the proposed thickness of the overlying riprap layer has been increased from 18 inches (EnergySolutions 2011a; 2011b) to 24 inches (Energy Solutions 2011c).

EnergySolutions has not provided information to justify the proposed thickness of 6 inches for the Type A Filter Zone layer, which is a departure from the above-described published recommendations, especially given the recent proposed increase in the riprap layer thiockness, and has not discussed, considered, and evaluated how use of a 6-inch thick filter/bedding layer in the CAW Embankment would impact cover performance with respect to the potential long-term performance issues described by the NRC in the cited references. Additional information and analysis results need to be provided to justify the proposed Type A Filter Zone layer design, or alternatively, a thicker and /or otherwise modified (as needed, based on analyses done in response to other interrogatories) Type A Filter Zone layer design should be proposed and justified.

REFERENCES:

Abt, S.R, Whittler, R.J., Ruff, J.F., LaGrone, D.l., Khattak, M.S., Nelson, J.D. 1988. Development of Riprap Design Criteria by Riprap Testing in Flumes: Phase II, Followup Investigations. NUREG/CR-4651, ORNL/TM-10100/V2, Vol. 2. 1988.

Abt, S.R, Ruff, J.F., and Whittler, R.J. 1991."Estimating Flow through Riprap", Journal of Hydraulic Engineering, Vol. 117, No. 5.

Codell, R.B., Abt, S.R., Johnson, T., and Ruff, J. 1990. "Estimation of Flow Through and Over Armored Slopes", in Journal of Hydraulic Engineering, Vol. 116, No. 10, October 1990. Pp. 1252-1269.

EnergySolutions, LLC. 2011a. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.

EnergySolutions, LLC. 2011b. Responses to Round 1 Interrogatories: License Amendment Request (UT2300249) for the Class A West Embankment and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control, October 28, 2011.

EnergySolutions, LLC. 2011c. Drawing 10014 C04, Rev. 2. Class A West Embankment Sections and Details, 2 of 2, November 3, 2011.

Nelson, J.D., Abt, S.R., Volpe, R.L., van Zyl, D., Hinkle, N.E., and Staub, W.P. 1986. Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments. NUREG/CR-4620. June 1986.

INTERROGATORY CAW R313-25-8(4)-12/2B: TECHNICAL ANALYSIS - FILTER STABILITY/ FILTER PERMEABILITY CRITERIA

Round 1 Interrogatory response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-13/1: TECHNICAL ANALYSES-PERIMETER DRAINAGE DITCH CALCULATIONS

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-8(4)-14/2B: TECHNICAL ANALYSES – INFILTRATION AND TRANSPORT MODELING: CLIMATE CONDITIONS, ENGINEERED BARRIER CONDITIONS, AND VERTICAL TRANSPORT DISTANCE

PRELIMINARY FINDING:

Refer to R313-25-8(5). Analyses of the long-term stability of the disposal site shall be based upon analyses of active natural processes including erosion, mass wasting, slope failure, settlement of wastes and backfill, infiltration through covers over disposal areas and adjacent soils, and surface drainage of the disposal site. The analyses shall provide reasonable assurance that there will not be a need for ongoing active maintenance of the disposal site following closure.

INTERROGATORY STATEMENT:

Reference the November 28, 2011 (Whetstone Associates 2011c) CAW Cell Infiltration and Transport Modeling Report, Drawing 10014 C04 of Energy*Solutions* 2011a; and 2011b, and Drawing 10014 C04, Rev. 2 of Energy*Solutions* 2011c: *Please provide the following:*

1. *Provide an analysis, using an appropriate 2-D or 3-D modeling simulation tool other than the HELP Model (e.g., HYDRUS 2D or other appropriate modeling tool), to assess predicted peak moisture conditions and peak flow behavior within various layers of the cover system over different time spans (hours to several years) during the CAW Embankment's required performance period. Provide sensitivity analyses that consider peak precipitation conditions, including extreme, short-duration (e.g., on the order of*

hours) precipitation events, minimum and/or maximum evapotranspiration conditions, and degraded conditions within the various cover layers. Provide analysis results demonstrating that excessive seepage pressure gradients will not occur within the specific layers of the cover system (e.g., within the Type A Filter Zone layer) during the CAW Embankment's performance period, considering both as-built and degraded conditions. Demonstrate that all cover layers in both the topslope and sideslope areas have sufficient capacity to safely convey lateral flows that may occur within such layers under peak flow conditions, if they occur, and that cover system stability would not be compromised under such conditions. Demonstrate that the expected range of residence times for water accumulating within the riprap and Type A Filter Zone layers on the topslope would not be sufficiently long to allow freezing conditions (e.g., ice bridging) to occur during times of freezing temperatures, possibly resulting in blocking of flow at certain times (e.g., during meltwater flow episodes) within the riprap or Type A Filter Zone layer.

2. *Provide information supporting the range of climate conditions, including peak precipitation events and durations, and/or periods of assumed higher average precipitation rates, and minimum and/or maximum evapotranspiration rates used in the simulations, and demonstrate that the climatic regime(s) used for modeling infiltration through the cover system bounds the range of uncertainties associated with potential climatic conditions that may occur over the CAW Embankment's performance period. Provide results of infiltration performance analyses incorporating such peak/higher precipitation and/or minimum evapotranspiration conditions into the modeling simulations. Alternatively, provide detailed justification why consideration of such climatic conditions in the infiltration simulations is not required.*

3. *Provide rationale to support the selection of degraded conditions in the cover system layers that may affect the long-term performance of the CAW Embankment cover, including conditions developed as a result of environmental influences such as bioturbation, burrowing animals, and plant root development. Provide results of infiltration performance analyses incorporating such degraded conditions into the modeling simulations, or, alternatively, provide detailed justification why consideration of such degraded engineered barrier conditions in the infiltration simulations is not required.*

4. *For the top slope PATHRAE analysis, please correct discrepancies between the fractional release rates in Table 24 of the November Infiltration and Transport Modeling Report (Whetstone 2011) and the values used in the PATHRAE modeling for the Class A West top slope analysis. State the values of all the input parameters used in the release rate equation in Section 5.1.5 of the report.*

5. *For the side slope PATHRAE analysis, please correct discrepancies between the fractional release rates in Table 25 of the November Infiltration and Transport Modeling Report (Whetstone 2011) and the values used in the PATHRAE modeling for the Class A West side slope analysis. State the values of all input parameters used in the release rate equation in Section 5.1.5 of the report.*

6. *Please correct the values for "Soil Retardation Factors" shown in Table 24 and ensure that the correct values are used in the PATHRAE top slope analysis.*

7. *Please provide information on transverse and longitudinal dispersivity values used in the horizontal transport component of the modeling done by Whetstone. Provide information justifying the selection of the parameter values used in modeling, including information demonstrating that the range of potential dispersivity values considered reasonably bounds the range of values that could be appropriate for the site conditions and scale of the investigation. Provide sensitivity values as appropriate for different assumed dispersivity values demonstrating the sensitivity of model results to changes in dispersivity values. Provide rationale to support use of dispersivity values in the horizontal transport simulations that are different from those used in MEMO Model simulations, or, alternatively, use the same assumed values for both simulations.*

BASIS FOR INTERROGATORY:

The information provided by EnergySolutions regarding the expected infiltration and runoff performance characteristics of the proposed CAW Embankment cover system does not adequately investigate the dynamics (pressure head distributions, flashy flow behavior/velocity surging, down dip loading, etc…) of percolating water flow within individual layers of the proposed cover system, including the dynamics of flow within the cover layers following extreme precipitation events. EnergySolutions' Response to the Round 1 interrogatory on this topic (EnergySolutions 2001a) indicating that additional infiltration sensitivity analyses are not needed for the CAW Embankment because previous infiltration sensitivity analyses completed for other disposal embankments at the Clive Facility are adequate does not address the potential differences in 2-D/3-D flow behavior within the CAW Embankment cover system compared to the other embankment covers owing to the larger size and longer slope lengths of the CAW Embankment compared to existing disposal embankments at the Clive Facility. Previous infiltration model sensitivity analyses also do not address the potential effects of the recently proposed increase in thickness of the riprap layer for the CAW Embankment. Additionally, with one exception -- a report by The Mines Group, Inc. (2000) which included use of alternative infiltration models for the Mixed Waste Cell cover) -- all previous sensitivity analyses performed for disposal embankment covers at the Clive Facility were performed using the HELP® Model, which is a quasi-2-D model.

Given the proposed longer topslope and longer sideslope lengths of the CAW Embankment, and also given the proposed recent increase in the riprap layer thickness in the cover (EnergySolutions2011c), while retaining the proposed Type A Filter Zone layer thickness at 6 inches, additional analysis/modeling should be completed, using an alternative 2-D or 3-D modeling tool, to provide additional information to gain further insight into the specific hydraulic performance of the individual cover layers, including both lateral subsurface and vertical fluxes, and pressure head distributions and lateral flow velocities and velocity profiles within the different cover layers. Additional assessment of the potential consequences of such layer-specific, transient flow conditions, including potential head buildup in one or more layers

in the cover system and down dip loading effects in individual layers including the Type A Filter Zone layer and the Sacrificial Soil layer, on cover system stability is needed.

The Whetstone Associates (2011a and 2011b) Infiltration and Transport Modeling Reports use the HELP® Model (Version 3.06) to simulate infiltration behavior and predict infiltration rates through the proposed CAW Embankment cover system. This modeling approach does not investigate the characteristics of dynamic, transient (e.g., "flashy") flow behavior, including potential for velocity "surges" at certain locations, that may occur within the CAW Embankment cover system layers in response to shorter-term, high-intensity precipitation events. Likewise, the current modeling approach does not provide means of assessing, in a 2-D or 3-D manner, mechanisms that could lead to the build up of heads in individual layers. Minimizing buildup of head in the upper layers of the cover system will improve long-term stability of the upper part of the cover system.

The HELP® Model "spreads out" daily rainfall uniformly over 24 hour-periods, which decreases precipitation intensity compared to actual intensities that occur during certain shorter periods of time, thereby increasing infiltration and decreasing runoff during these events. This may result in underestimation of the maximum heads that may develop with different layers at certain times. In addition, the HELP® Model treats the Type A Filter Zone layer as a vertical percolation layer instead of a lateral drainage layer. While this approach may be conservative from the standpoint of estimating the maximum total water flux rates out of the base of the cover system, it does not provide insights or understanding of the internal flow dynamics within the upper parts of the cover system (e.g., riprap layer, Type A Filter Zone layer, and Sacrificial Soil layer, etc…) on the topslope and sideslope areas at times of interest that need to be considered in the performance assessment. In contrast to the HELP® Model, other, 2-D or 3-D simulation models, such as HYDRUS 2D®, allow a 2-D analysis of water flow behavior within the individual cover system layers. Alternative models such as HYDRUS 2D® also allow the user to use smaller time intervals to discretize precipitation, which better reflects the actual precipitation intensities, because the duration of most storms is significantly less than 24 hours.

Additionally, comparison study of four different modeling tools – two of which included HELP® and HYDRUS 2D® - by Albright et al. (2002) indicated the following observations with respect to sensitivity analyses that were completed for certain parameters and variables relative to the performance of multilayer cover systems designed for arid site conditions:

Cover Parameter or Variable	***HELP® Model Sensitivity Analysis Result***	***HYDRUS 2D® Model Sensitivity Analysis Result***
Available water content (AWC) = field capacity minus wilting point	*Sensitive to AWC but unrealistic response pattern observed*	*Sensitive to AWC and realistic response pattern observed*
Cover thickness response	*Low sensitivity and unrealistic response pattern observed*	*Highest sensitivity and realistic response*
Saturated hydraulic conductivity (K_s) of drainage	*Sensitive to K_s with realistic*	*Sensitive to K_s with realistic*

layer and barrier layers	*response patterns observed*	*response patterns observed*

Although the cover systems evaluated by Albright et al. (2002) (a barrier layer and drainage layer overlain by a vegetative soil layer) differ from the proposed CAW Embankment cover system, the results of the above study are informative and may be relevant to simulation approaches that should be considered and used for assessing the performance of the CAW Embankment cover, e.g., the noted superior performance of the HYDRUS 2D compared to HELP with regard to model reliability in assessing impacts of changes in cover thickness).

Figure 3 and Table 4 of the November 2011 Whetstone Associates Infiltration and Transport Modeling Report (2011b) indicate that significantly higher precipitation levels have occurred during some years relative to others (e.g., 1997 and 1998 [136 % and 160 % , respectively, of the 17-year annual average precipitation for the 1992-2009 period]) and significant fluctuations in monthly precipitation have also occurred during several months during a 17-year-long period (1992 through 2009) at Clive. Figure 4 indicates that, for the 17-year period between 1992 and 2009, the average monthly precipitation level at Clive exceeded, in some cases (January, February, March, April, June) and was lower, in some cases, than at Dugway, Utah, where a considerably longer (60-year) climate record exists.

Sections 1.2 and 3.2.1 of NUREG-1573 (NRC 2000) specifies that weather conditions should be taken into consideration in performance assessments for low level radioactive waste disposal facilities. In particular, Section 3.2.1indicates that "a key aspect of an LLW performance assessment is determining how variations in precipitation result in varying rates of percolation into disposal units and of recharge to the water table. The NRC's Performance Assessment Working Group recommends using historical and current weather data, and other site information (e.g., field tests) to establish a broad range of infiltration rates that may be used to simulate both wetter and drier conditions than the current average. Sensitivity analyses performed as part of the LLW performance assessment will provide some insight into the effects that such variations could have on the dose calculations…"

Sections 3.2.2 and 3.3.4 of NUREG-1573 (NRC 2000) indicate that potentially degraded conditions in engineered barrier components of the closure cover system should be declared and taken into account when estimating the long-term performance of a reclaimed facility such as the closed CAW Embankment. Section 3.2.2 of NUREG-1573 indicates that " given natural forces likely to cause unavoidable and unpredictable deterioration of physical barriers, no compelling evidence was found [by NRC's Performance Assessment Working Group] to suggest that physical barriers, such as natural covers and reinforced concrete vaults, will perform at anticipated design levels, indefinitely." That section further recommends that an applicant assign and justify the credit given to engineered barrier performance, and indicates that "in the degraded condition, at the end of its intended service life, an engineered barrier (e.g., reinforced concrete vault, engineered subsurface drainage system, etc.) can still perform a function, but the (diminished) function would be established by the applicant based on the assumed properties of its constituent materials…In general, the parameter values for hydraulic conductivity and other physicochemical properties of [each] engineered barrier used in the performance assessment should represent its changed/degraded condition."

For the top slope transport analysis there are differences between the fractional release rates stated in Table 24 of the Infiltration and Transport report (Whetstone 2011) and the values used in the top slope PATHRAE files. For example, Table 24 states a Cl-36 fractional release rate of 3.85E-02 yr^{-1}, but the value used in the PATHRAE file "09Wa OUT.docx" (Attachment 3 of the Whetstone report) is 1.65E-02 yr^{-1}. This means that the top slope PATHRAE simulation used a Cl-36 release rate that was only about half of the release rate stated in Table 24. Other radionuclides (e.g., H-3, C-14) in Table 24 showed the same disagreement when compared to the PATHRAE computer file. Please correct the discrepancy and justify the correct values for the fractional release rates.

For the side slope transport analyses there are differences between the fractional release rate values stated in Table 25 of the Infiltration and Transport report and the values used in the side slope PATHRAE files. For example, Table 25 states a Cl-36 fractional release rate of 5.50E-02 yr^{-1}, but the value used in the side slope PATHRAE file "168Wa OUT.docx" (Attachment 3 of the Whetstone report) is 2.86E-02 yr^{-1}. The side slope PATHRAE analysis therefore used a Cl-36 release rate that was about half of the release rate stated in Table 25. Other radionuclides (e.g., H-3, C-14) in Table 25 showed the same disagreement when compared to the PATHRAE computer file. Please correct the discrepancy and justify the correct values for the fractional release rates.

Table 24 shows "Soil Retardation Factors" that appear different than the values calculated using the data at the top of Table 24. For example, the Cl-36 retardation factor in Table 24 is 1.039. Using the data at the top of Table 24, a different value is calculated:

*R = 1 + (soil density * Kd/soil moisture) = 1.042*

where,

Soil density = 1.8 g/cm3
Kd = 0.0025 ml/g
Soil moisture = 0.093

The error appears to be caused by using moisture contents from the side slope to calculate retardation factors for the top slope. The incorrect values were also used in the top slope PATHRAE analysis. Please correct the error in Table 24 and in the PATHRAE files.

The Infiltration and Transport Model Reports (Whetstone Associates 2011a and 2011b) used a (vertical) dispersivity value of 0.1 m (0.3ft) for the vertical transport portion of the model, but did not cite dispersivity values used for the horizontal transport portion of the model. This information should be provided for clarity and for completeness and to allow these input values to be reviewed for appropriateness.

REFERENCES:

Albright, W.H., Gee, G.W., Wilson, G.V., and Fayer, M.J. 2002. Alternative Cover Assessment Report Project, Phase 1 Report. Desert Research Institute. Publication No. 41183, October 2002.

EnergySolutions, LLC. 2011a. License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.

EnergySolutions, LLC. 2011b. Responses to Round 1 Interrogatories: License Amendment Request (UT2300249) for the Class A West Embankment and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control, October 28, 2011.

EnergySolutions, LLC. 2011c. Drawing 10014 C04, Rev. 2. Class A West Embankment Sections and Details, 2 of 2, November 3, 2011.

NRC (US NUCLEAR REGUALTORY COMMISSION) 2000. NUREG-1573. A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities - Recommendations of NRC's Performance Assessment Working Group. Division of Waste Management Office of Nuclear Material Safety and Safeguards. U.S. Nuclear Regulatory Commission, Washington, DC. October 2000.

The Mines Group, Inc. 2000. Technical Report for the Mixed Waste Facility Cover Design, Clive, Utah. November 14, 2000.

Whetstone Associates 2011a. EnergySolutions Class A West Disposal Cell Infiltration and Transport Modeling Report, April 19, 2011.

Whetstone Associates 2011b. EnergySolutions Class A West Disposal Cell Infiltration and Transport Modeling Report, November 28, 2011.

INTERROGATORY CAW R313-25-8(4)-15/1: TECHNICAL ANALYSES – GROUNDWATER DEPTH IN GEOTECHNICAL STABILITY ANALYSIS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-16/2B/2C: SEISMIC HAZARD EVALUATION / SEISMIC STABILITY ANALYSIS UPDATE

PRELIMINARY FINDING:

Follow-up issues, if any, will be included in Round 2C Interrogatories.

INTERROGATORY CAW R313-25-24(1 THROUGH 3)-17/1: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - LINER DESIGN AND CONSTRUCTION

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-24(5)-18/1: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - DRAINAGE JUNCTURE AND DRAINAGE OUTLET DESIGN FOR PERIMETER DRAINAGE DITCH SYSTEM

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-25(6)-19/2A: RADIATION DOSE RATE AT THE SURFACE OF THE COVER

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-26(1)-20/2A: ENVIRONMENTAL MONITORING

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-26 (2 AND 3)-21/B: TECHNICAL ANALYSES - HORIZONTAL TRANSPORT AND WELL SPACING ANALYSIS INPUT PARAMETERS

PRELIMINARY FINDING:

Refer to R313-25-26(2). During the land disposal facility site construction and operation, the licensee shall maintain an environmental monitoring program. Measurements and observations shall be made and recorded to provide data to evaluate the potential health and environmental impacts during both the construction and the operation of the facility and to enable the evaluation of long-term effects and need for mitigative measures. The monitoring system shall be capable of providing early warning of releases of waste from the disposal site before they leave the site boundary.

Refer to R313-25-26(3). After the disposal site is closed, the licensee responsible for post-operational surveillance of the disposal site shall maintain a monitoring system based on the operating history and the closure and stabilization of the disposal site. The monitoring system shall be capable of providing early warning of releases of waste from the disposal site before they leave the site boundary.

INTERROGATORY STATEMENT:

Refer to Attachment 6 (Clive Facility Well Spacing Evaluation Class A West Embankment, April 28, 2011) to the CAW LAR (Energy*Solutions* 2011a) and EnergySolutions' Response to this Round 1 Interrogatory (Energy*Solutions* 2011b):

1. *Please provide additional information to further support selection of appropriate dispersivity values, particularly longitudinal dispersivity (α_x) values, for use in the well spacing evaluation for the CAW Embankment (and for transport modeling). Evaluate, compare, and use, as appropriate, one or more other alternative methodologies, for estimating dispersivity values that may be appropriate for this well spacing evaluation, considering the scale of the distances involved in the well spacing evaluation and site-specific subsurface conditions. Estimate or otherwise justify that the full range of dispersivity values that may be appropriate for this evaluation have been considered. Demonstrate that the identified range of dispersivity values used bounds the uncertainties associated with available methodologies for estimating dispersivity parameters. Provide MEMO Model sensitivity analyses that incorporate the full range of inferred possible α_x and transverse dispersivity values to demonstrate that the effects of possible changes in dispersivity values on the well spacing evaluation conclusions have been characterized. Provide and compare model-predicted results including and comparing breakthrough curves for various representative radionuclides based on modeled longitudinal dispersivity values, as appropriate, to demonstrate sensitivity of model results to changes in the input dispersivity values.*

2. *Please provide additional rationale for why the Xu and Eckstein (1995) method is defensible for use as a "check" of calculated dispersivity values, despite its use of low and moderate reliability data in development of the methodology.*

3. *Provide revised Transport Model results, as required, that either (i) reflect the use of dispersivity values that are consistent with those used in the final well spacing evaluation or (ii) further justify use of different dispersivity values in these different models.*

4. *Provide information demonstrating that the retardation factor (R) values calculated for all constituents and used in MEMO Model simulations were calculated correctly. In Section of 3.2.4 the Clive Facility Well Spacing Evaluation (Attachment 6 to EnergySolutions 2011a [April 28, 2011 MEMO Model Evaluation Report]), provide a corrected version of the retardation equation that specifies the correct set of units for all variables included in the equation.*

5. *Please provide a summary of all input parameters and copies of output from any MEMO Model simulations performed.*

BASIS FOR INTERROGATORY:

EnergySolutions, in their response to the Round 1 Interrogatory item regarding dispersivity (EnergySolutions 2011b), used an alternative method for estimating dispersivity values for use in the well spacing evaluation. Specifically, they used a method developed by Xu and Eckstein (1995) to independently calculate dispersivity values. Xu and Eckstein's approach involved using all calculated dispersivity values available, including those considered to have lower reliability, to create a statistical correlation model for model dispersity values based on scale length. They proposed some weighting schemes, but the weights chosen for reliability (e.g., 3, 2 and 1) appear to be somewhat arbitrary, with limited scientifically based justification provided for their selection. Work done by Gelhar et al. (1992) and summarized by Fitts (2002) indicates that certain published longitudinal dispersivity "data" that are considered to be less reliable are reported to have come from sources of information where there were apparent problems associated with a particular investigation or analysis. Such problems might be, for example, mismatches between the dimensionality of a model (e.g., a 1-D model) and field conditions (e.g., radial flow in 2-D), which tends to artificially inflate reported dispersivity values. Gelhar et al. 1992 indicate that for nearly all cases where the reported data on longitudinal dispersivity data were considered to be highly reliable, regardless of the model scale length examined, use of a value for longitudinal dispersivity on the order of one meter was considered to be most reliable.

Depending on the analysis, EnergySolutions has chosen or used values of longtitudinal dispersivity for horizontal flow and transport of radionuclides from the proposed CAW Embankment in different models that are up to two to three orders of magnitude greater than one meter. Moreover, the values used are inconsistent for the same disposal cells, depending on the type of model used. For example, in Attachment 6 of the initially submitted CAW License Amendment Request (EnergySolutions 2011a), the longitudinal dispersivity (αx) was set at 129.1 ft in the MEMO Model simulation, which is equal to one tenth the average distance from the center of the top slope to the line of compliance wells. In the Response to the Round 1 version of this Interrogatory, an α_x value of 27.1 ft was derived and used in a second MEMO Model simulation. Results from that second simulation indicated that, in order to retain at least a 95 % level of confidence that the well spacing interval would ensure reliable detection of potential releases from the CAW Embankment, the geometry of the source term at the Embankment needed to be modified somewhat compared to the initial assumed source term geometry.

The Infiltration and Transport Model Reports (Whetstone Associates 2011a and 2011b) used a (vertical) dispersivity value of 0.1 m (0.3ft) for the vertical transport portion of the model, but did not cite dispersivity values used for the horizontal transport portion of the model. This information should be provided to allow these input values to be compared to the values used in the MEMO Model simulations.

In Section 3.2.4 of the "Clive Facility Well Spacing Evaluation, dated April 28, 2011, an equation for calculating the Retardation Factor(R) is presented where the set of units specified for certain variables are inconsistent/ incompatible with each other, as follows:

$$R = 1 + (\rho * K_d/\text{soil moisture})$$

where,

ρ = *Soil density (in kilograms per cubic meter)*
K_d = *Soil-water distribution coefficient (in L per kg); and*
Soil moisture is effective porosity (dimensionless units)

The correct set of units would be either:

ρ = *Soil density (in grams per cubic centimeter)*
K_d = *Soil-water distribution coefficient (in L per kg); and*
Soil moisture is effective porosity (dimensionless units)

or:

ρ = *Soil density (in kilograms per cubic meter)*
K_d = *Soil-water distribution coefficient (in L per kg) x (1 m^3/1000 L); and*
Soil moisture is effective porosity (dimensionless units)

It needs to be demonstrated/verified that the calculated R values that were used in the MEMO Model simulations are correct in all cases, given this error in descriptions of units for variables in the formula as presented. The description of units in the Retardation equation should also be corrected for accurateness.

REFERENCES:

Energy*Solutions, LLC. 2011a. Clive Facility, Well Spacing Evaluation, Class A West Embankment, dated April 28, 2011: Attachment 6 to the License Amendment Request: Class A West Embankment, with Attachments 1 Through 7 and cover letter to Mr. Rusty Lundberg at Utah Division of Radiation Control dated May 2, 2011.*

Fitts, C. 2002. Groundwater Science. Academic Press.

Gelhar, L. W., C. Welty, and K. R. Rehfeldt. 1992. A critical review of data on field-scale dispersion in aquifers. Water Resources Research, 28:1955-1974.

Whetstone Associates 2011a. EnergySolutions Class A West Disposal Cell Infiltration and Transport Modeling Report, April 19, 2011.

Whetstone Associates 2011b. EnergySolutions Class A West Disposal Cell Infiltration and Transport Modeling Report, November 28, 2011.

Zu, M. and Eckstein, Y. 1995. "Use of Weighted Least-Squares Method in Evaluation of the Relationship Between Dispersivity and Field Scale". Ground Water, Vol. 33, No. 6, pp. 905-908.

INTERROGATORY CAW R313-25-33(1)-22/1: RECORDS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R317-6-6.4-23/2A: ISSUANCE OF DISCHARGE PERMIT: BEST AVAILABLE TECHNOLOGIES - MONITORING WELLS REQUIRING ABANDONMENT AND DECOMMISSIONING AND LYSIMETERS PROPOSED FOR ABANDONMENT

Refer to Interrogatory Round 2A

UTAH DIVISION OF RADIATION CONTROL: ENERGY*SOLUTIONS'* CLIVE LLRW DISPOSAL FACILITY;

LICENSE AMENDMENT REQUEST; CLASS A WEST EMBANKMENT

ROUND 2C INTERROGATORIES

TABLE OF CONTENTS

(Highlighted items addressed in these Round 2C)

Section **Page**

Interrogatory CAW R313-25-6(3)-01/2A: Description of Facility 4
Interrogatory CAWR313-25-7(1)-02/1: Specific Technical Information – Groundwater Elevation Value(s) Used in Analyses 4
Interrogatory CAW R313-25-7(2)-03/2A: Specific Technical Information – Buffer Zone 4
Interrogatory CAW R313-25-7(3)-04/2A: Specific Technical Information – Design Criterion for Distortion of Liner and Clay Cover Components 4
Interrogatory CAW R313-25-7(7)-05/2B: Specific Technical Information -- Closure Plan 4
Interrogatory CAW R313-25-7(9)-06/1: Specific Technical Information – Quantities of Radioactive Materials 4
Interrogatory CAW R313-25-7(10)-07/1: Specific Technical Information – Construction Quality Assurance/Quality Control Manual 5
Interrogatory CAW R313-25-8(1)-08/1: Technical Analyses; Releases of Radioactivity 5
Interrogatory CAW R313-25-8(2)-09/2B: Technical Analyses; Protection of Inadvertent Intruders 5
Interrogatory CAW R313-25-8(4)-10/1: Technical Analysis – Design Safety Factors 5
Interrogatory CAW R313-25-8(4)-11/2B: Technical Analysis - Rock Cover Design And Rock Cover Design Calculations/ Analyses 5
Interrogatory CAW R313-25-8(4)-12/1: Technical Analysis - Filter Stability/ Filter Permeability Criteria 5
Interrogatory CAW R313-25-8(4)-13/1: Technical Analyses-Perimeter Drainage Ditch Calculations 5
Interrogatory Caw R313-25-8(4)-14/2B: Technical Analyses – Infiltration and Transport Modeling: Climate Conditions, Engineered Barrier Conditions, and Vertical Transport Distance 6
Interrogatory CAW R313-25-8(4)-15/1: Technical Analyses – Groundwater Depth in Geotechnical Stability Analysis 6
Interrogatory CAW R313-25-8(4)-16/2B: Seismic Hazard Evaluation / Seismic Stability Analysis Update 6
Interrogatory CAW R313-25-8(4)-16/2C: Potential Effects Of Liquefaction In Native Soils At The Clive Site 6
Interrogatory CAW R313-25-24(1 through 3)-17/1: Disposal Site Design for Near-Surface Disposal - Liner Design and Construction 9
Interrogatory CAW R313-25-24(5)-18/1: Disposal Site Design for Near-Surface Disposal - Drainage Juncture and Drainage Outlet Design for Perimeter Drainage Ditch System 9
Interrogatory CAW R313-25-25(6)-19/2A: Radiation Dose Rate at the Surface of the Cover 9

Interrogatory CAW R313-25-26(1)-20/2A: Environmental Monitoring 9
Interrogatory CAW R313-25-26 (2 and 3)-21/B: Technical Analyses - Horizontal Transport and Well Spacing Analysis Input Parameters 10
Interrogatory CAW R313-25-33(1)-22/1: Records 10
Interrogatory CAW R317-6-6.4-23/2A: Issuance of Discharge Permit: Best Available Technologies - Monitoring Wells Requiring Abandonment and Decommissioning and Lysimeters Proposed for Abandonment 10

ABBREVIATIONS AND ACRONYMS

CAW LAR	Class A West Embankment License Amendment Request
cm	centimeter
ft	foot
HELP	Hydrologic Evaluation of Landfill Performance Model
kg	kilogram
L	liter
LLW	low-level waste
UAC	Utah Code Annotated
US	United States

INTERROGATORY CAW R313-25-6(3)-01/2A: DESCRIPTION OF FACILITY

Refer to Interrogatory Round 2A

INTERROGATORY CAWR313-25-7(1)-02/1: SPECIFIC TECHNICAL INFORMATION – GROUNDWATER ELEVATION VALUE(S) USED IN ANALYSES

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-7(2)-03/2A: SPECIFIC TECHNICAL INFORMATION – BUFFER ZONE

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-7(3)-04/2A: SPECIFIC TECHNICAL INFORMATION – DESIGN CRITERION FOR DISTORTION OF LINER AND CLAY COVER COMPONENTS

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-7(7)-05/2B: SPECIFIC TECHNICAL INFORMATION -- CLOSURE PLAN

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-7(9)-06/1: SPECIFIC TECHNICAL INFORMATION – QUANTITIES OF RADIOACTIVE MATERIALS

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-7(10)-07/1: SPECIFIC TECHNICAL INFORMATION – CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL MANUAL

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(1)-08/1: TECHNICAL ANALYSES; RELEASES OF RADIOACTIVITY

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-8(2)-09/2B: TECHNICAL ANALYSES; PROTECTION OF INADVERTENT INTRUDERS

A performance assessment to be completed in 2012 will address dose limits for disposal.

INTERROGATORY CAW R313-25-8(4)-10/1: TECHNICAL ANALYSIS – DESIGN SAFETY FACTORS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-11/2B: TECHNICAL ANALYSIS - ROCK COVER DESIGN AND ROCK COVER DESIGN CALCULATIONS/ ANALYSES

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-8(4)-12/1: TECHNICAL ANALYSIS - FILTER STABILITY/ FILTER PERMEABILITY CRITERIA

Round 1 Interrogatory response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-13/1: TECHNICAL ANALYSES-PERIMETER DRAINAGE DITCH CALCULATIONS

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-8(4)-14/2B: TECHNICAL ANALYSES – INFILTRATION AND TRANSPORT MODELING: CLIMATE CONDITIONS, ENGINEERED BARRIER CONDITIONS, AND VERTICAL TRANSPORT DISTANCE

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-8(4)-15/1: TECHNICAL ANALYSES – GROUNDWATER DEPTH IN GEOTECHNICAL STABILITY ANALYSIS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-8(4)-16/2B: SEISMIC HAZARD EVALUATION / SEISMIC STABILITY ANALYSIS UPDATE

PRELIMINARY FINDING:

Refer to Interrogatory Round 2B.

INTERROGATORY CAW R313-25-8(4)-16/2C: POTENTIAL EFFECTS OF LIQUEFACTION IN NATIVE SOILS AT THE CLIVE SITE

PRELIMINARY FINDING:

Refer to R313-25-8(5). Analyses of the long-term stability of the disposal site shall be based upon analyses of active natural processes including erosion, mass wasting, slope failure, settlement of wastes and backfill, infiltration through covers over disposal areas and adjacent soils, and surface drainage of the disposal site. The analyses shall provide reasonable assurance that there will not be a need for ongoing active maintenance of the disposal site following closure.

INTERROGATORY STATEMENT

Please demonstrate that the potential effects of soil liquefaction and/or cyclic softening phenomena in native soils at the Clive Facility have been adequately accounted for in the geotechnical analyses supporting the design of the proposed CAW Embankment. In doing so, clearly justify the selection of soil parameters and any design assumptions by comparison of such with correlations, field test results, and/or laboratory test results (including cyclic shear

testing) consistent with the guidance given by developers of current, published analytical methods.

BASIS FOR INTERROGATORY

In recent years, the geotechnical engineering profession's understanding of, and analysis methods for, liquefaction-related phenomena have evolved. In the past, liquefaction was treated as a phenomenon largely associated with the seismic loading of loose, clean sands which could result in significant loss of strength and large deformations. However, the 1999 earthquakes in Kocaeli, Turkey and Chi-Chi, Taiwan both highlighted the potential for significant strength loss and deformation of finer-grained soils – soils previously considered "non-liquefiable." Subsequent research (e.g., Andrews and Martin, 2000; Seed et al., 2003; Boulanger and Idriss, 2004, 2005, and 2006; Bray and Sancio, 2006; and Youd et al., 2009) has generally led to a distinction between "sand-like" soils which undergo liquefaction and "clay-like" soils which undergo cyclic-softening. Both phenomena are generally associated with generation of high pore pressures and strains during shear; however, the distinction between liquefaction and cyclic softening is important in that the methods of analysis and assessment are different for the different types of soil. Also important is that the resulting behaviors can vary.

In previous reports as well as "Geotechnical Update Report" dated February 15, 2011 (Attachment 5 to EnergySolutions, 2011), the Licensee addressed liquefaction susceptibility using site specific data and analyses (see Section 4.5.2, page 19, of referenced document). However, rather than presenting quantitative factors of safety and/or cyclic resistance and cyclic stress ratios, the Licensee qualitatively summarized the results of the analyses thusly:

> *"The 2005 study determined that for the design event, the majority of the soils in the upper 30 to 60 feet of the soil profile consist of cohesive deposits, which have a low probability of liquefaction due to their high clay content. It was also found that the interbedded cohesionless silt and silty sand deposits would also be unlikely to liquefy under the design seismic event."*

A close reading of this statement reveals that the susceptibility of non-silty or "clean" sands (those which, if loose, are most prone to liquefaction) which may be at the site has not been addressed. Also, from the information provided, it is not clear how the finer-grained soils were treated in the analyses. Similarly, with respect to slope stability and other deformation-related assessments, it is unclear how the shear strengths of finer-grained soils subject to seismic loading conditions were assessed and quantified. Reported fines content, moisture content, and Atterberg limit data suggest that some of the loose/soft soils at the site are "marginal" soils which may or may not experience liquefaction and/or cyclic softening. Published guidance and criteria (e.g., Youd et al., 2001; Boulanger and Idriss, 2008, Bray and Sancio, 2008, Boulanger and Idriss, 2011) currently referenced in the geotechnical engineering profession typically recommend that such soils be examined in greater detail and potentially be subjected to cyclic shear testing.

Stability and deformation calculations for existing embankments may be affected by the particular issues described in this interrogatory. Stability and deformations associated with the

proposed CAW Embankment, particularly given the increase in embankment height and longer slopes of this embankment relative to other embankments at the Clive Facility, need to be assessed with consideration given to these issues.

Also, it should be noted that other current/recent interrogatories submitted for the proposed CAW Embankment License Amendment Request focus on further verifying the level of ground acceleration expected at the site. The effect of any revision to that parameter on previous liquefaction and embankment stability assessments needs to evaluated and documented.

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INTERROGATORY CAW R313-25-24(1 THROUGH 3)-17/1: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - LINER DESIGN AND CONSTRUCTION

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R313-25-24(5)-18/1: DISPOSAL SITE DESIGN FOR NEAR-SURFACE DISPOSAL - DRAINAGE JUNCTURE AND DRAINAGE OUTLET DESIGN FOR PERIMETER DRAINAGE DITCH SYSTEM

Round 1 Interrogatory revised response (based on revised CAW cover design) is satisfactory.

INTERROGATORY CAW R313-25-25(6)-19/2A: RADIATION DOSE RATE AT THE SURFACE OF THE COVER

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-26(1)-20/2A: ENVIRONMENTAL MONITORING

Refer to Interrogatory Round 2A

INTERROGATORY CAW R313-25-26 (2 AND 3)-21/2B: TECHNICAL ANALYSES - HORIZONTAL TRANSPORT AND WELL SPACING ANALYSIS INPUT PARAMETERS

Refer to Interrogatory Round 2B

INTERROGATORY CAW R313-25-33(1)-22/1: RECORDS

Round 1 Interrogatory Response is satisfactory.

INTERROGATORY CAW R317-6-6.4-23/2A: ISSUANCE OF DISCHARGE PERMIT: BEST AVAILABLE TECHNOLOGIES - MONITORING WELLS REQUIRING ABANDONMENT AND DECOMMISSIONING AND LYSIMETERS PROPOSED FOR ABANDONMENT

Refer to Interrogatory Round 2A