SEQUOYAH FUELS
A GENERAL ATOMICS COMPANY

RE: **0637-N**

October 10, 2006

Certified Mail – Return Receipt Requested
Receipt # 7006 0100 0006 7846 9804

U.S. Nuclear Regulatory Commission
ATTN: Mr. Myron Fliegel, Senior Project Manager
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
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Subject: Sequoyah Fuels Corporation, Docket – 40-8027
Response to OIs on the Final Safety Evaluation Report – Reclamation Plan (TAC L52511)

Dear Mike:

In a telephone conference dated September 25, 2006, SFC discussed an open issue (OI) on the Reclamation Plan concerning desiccation cracking in the disposal cell cap (OI.16). We identified a possible resolution to close this open issue. Please find enclosed with this letter SFC's response to the OI discussed in that telephone conference.

If you have any questions, don't hesitate to call me at (918) 489-5511, ext. 13.

Sincerely,

John H. Ellis

John H. Ellis
President

Enclosure (1)

XC: Alvin Gutterman, MLB
Rita Ware, EPA
Clint Strachen, MFG
Jeanine Hale, CN
Trevor Hammons, OAG

Sequoyah Fuels Corporation
Draft Safety Evaluation Report (DSER)
Remaining Open Issues as of September 2006

DSER OI.16

The hydraulic conductivity value used to represent the cell cover top soil and subsoil zone can be considered conservative. The issue of representing flow in fissures and desiccation cracks in the infiltration model is yet to be resolved. The licensee approach of using conservative hydraulic conductivity values to incorporate the complex flow processes in a heterogeneous (potential for preferential flow) subsoil zone is not adequate and, therefore, is an open issue.

Response:

The updated infiltration modeling for the current, multilayered cover design (presented in Appendix E of Reclamation Plan Attachment E) includes a subsoil zone in the cover system designed to retain meteoric water until vegetation can extract the water for evapotranspiration. At the base of the cover system (8 to 10 feet beneath the surface of the cover) is a two-foot thick layer of compacted clay. Desiccation cracking of the clay layer at this depth in the climate of eastern Oklahoma is not expected.

Desiccation cracks are formed from tensile strain in soil due to a decrease in volume from drying. The change in soil volume with drying is represented by the shrinkage limit, and this change is more pronounced in high-plasticity clays (Holtz and Kovacs, 1981). This is affirmed in Albrecht and Benson (1991), where soils with high clay content and high plasticity are more susceptible to desiccation cracking and associated increase in hydraulic conductivity. The soils planned for use in the clay layer of the disposal cell cover system are low-plasticity clays that have a relatively low potential for shrinkage with drying. As outlined in Albrecht and Benson (1991), the best method of protection of a clay layer from desiccation cracking is (1) by compaction with high compaction energy at optimum moisture content, (2) covering the layer with a geomembrane, and (3) surcharging the layer with overlying cover soils. These protective steps are planned for the clay layer in the cover system, and are outlined in the Technical Specifications (Reclamation Plan Attachment A).

Infiltration modeling of the multilayered disposal cell cover system was conducted with the TerreSIM model, with the results presented in the January 2006 Disposal Cell Construction Plan (Reclamation Plan Attachment E). The TerreSIM model is a plant growth-based model that is structured to estimate evapotranspiration from specific plant species. The model incorporates root depth, root density, and above-ground canopy. Cover soil properties are represented by water-holding capacities of the soil types in the cover. The model cannot directly simulate the effects of desiccation cracks in the cover. The daily precipitation record used in the TerreSIM model was obtained from Sallisaw, Oklahoma (approximately 20 miles east of the site), with an average annual total of approximately 45 inches. The model was run for a simulation period of 200 years.

The model calculated downward percolation of meteoric water below the root zone depth (essentially above the clay layer). The average infiltration rate over this 200-year period was approximately 5.1 in/yr, or 11.3 percent of average annual precipitation. The average rate is higher during the first 50 years (6.5 in/yr) while vegetation species are becoming established, and is lower (4.6 in/yr) after 50 years.

This indicates that on average, approximately 10 percent of annual precipitation percolates downward through the cover past the root zone depth. Due to the lower saturated hydraulic conductivity of the clay layer, this percolating water would become perched within the drainage sand above the clay layer and migrate laterally along the top of the clay layer. If this perched zone of saturated sand is 6 inches thick, the gradient for flow across the 24-inch thick clay layer would be 0.25 (6/24). For a saturated hydraulic conductivity of 10^{-7} cm/sec (1.2 in/yr) in the clay layer, the downward migration of water through a unit area of the clay layer would be 0.3 in/yr. For a saturated hydraulic conductivity of 10^{-6} cm/sec (12 in/yr) in the clay layer, the downward migration of water through a unit area of the clay layer would be 3.0 in/yr.

The HELP model (Schroeder and others, 1997) was used track moisture movement in the cover system and to provide a rough comparison of estimated infiltration with the TerreSIM model. The daily precipitation record in the HELP model data base was Tulsa, Oklahoma (approximately 70 miles northwest of the site), with an average annual total of approximately 39 inches. The model was run for a simulation period of 100 years. A grass cover (fair quality) with a root depth of seven feet was used in the model. A provision for lateral drainage was included in the model at the top of the clay layer, as summarized with key input values in the table below.

Cover Layer	Layer Thickness (in)	Saturated Hydraulic Conductivity (cm/sec)	Flow Direction
Topsoil	18	3.7×10^{-4}	Vertical only
Subsoil	60	3.3×10^{-5}	Vertical only
Drainage layer	18	5.8×10^{-3}	Vertical and lateral
Clay layer	24	1.0×10^{-7}	Vertical only

The HELP modeling results are summarized in the table below.

Flow Component	Fraction of Average Annual Precipitation (%)	Average Value (in/yr)	Standard Deviation (in/yr)
Precipitation	100.00	38.70	7.401
Runoff	2.77	1.075	0.823
Evapotranspiration	90.31	34.95	4.85
Lateral drainage	3.07	1.19	0.745
Percolation (through base of clay layer)	3.85	1.49	0.487

Several conclusions can be drawn from the HELP model results, as outlined below.

First, the average rate of downward meteoric water flow below the root zone is the sum of lateral drainage and percolation in the table above, or 2.7 in/yr (6.9 percent of average annual precipitation). This average value is lower than that calculated with the TerreSIM model (approximately 10 percent of average annual precipitation).

Second, the modeling results show that a saturated zone would form on top of the clay liner. Due to the one percent slope of the cover, lateral drainage along the top of the clay layer removes approximately 1.2 in/yr of the downward-migrating water. The HELP model calculated the height of the saturated zone on top of the clay liner, averaging 5.6 inches, with a standard deviation of 4.0 inches. This indicates that the saturated zone is present on top of the clay liner through most of the model simulation period.

Third, the downward percolation rate over this period through the base of the cover (below the clay layer) averaged approximately 1.5 in/yr, or 3.9 percent of average annual precipitation. These results indicate that with a saturated hydraulic conductivity of 10^{-7} cm/sec in the clay layer, there is sufficient downward moving meteoric water that percolates below the root zone to perch on top of the clay layer, creating a zone of saturation that would prevent desiccation cracking of the clay layer. This is consistent with the TerreSIM modeling results discussed above.

The HELP model was also run with a saturated hydraulic conductivity of the clay layer of 10^{-6} cm/sec. The model results were similar to those presented above, with percolation through the base of the clay layer averaging approximately 3.3 in/yr, or 8.5 percent of average annual precipitation. With the clay layer conductivity of 10^{-6} cm/sec, the saturated zone of meteoric water perched on top of the clay layer was not as thick or consistent as with the 10^{-7} cm/sec case (an average thickness of 0.39 inches and a standard deviation of 0.57 inches).

The disposal cell design consists of a clay liner at the base of the cell that is three feet thick, and a clay layer in the cover that is two feet thick. Although both zones have a synthetic liner on top of the clay, the synthetic liners cannot be considered in the long-term design life of the disposal cell. In order to prevent the long-term "bathtub" effect caused by a more permeable cover than the underlying liner, a leachate collection system has been incorporated into the cell design, where fluids that accumulate on top of the liner at the base of the cell are collected in a sand and drainage pipe network and conveyed by gravity to ponds outside the perimeter of the cell. This collection system is designed primarily for fluid removal during and immediately after cell construction, but the system also provides a secondary method of preventing the long-term "bathtub" effect.

REFERENCES

Albrecht, B.A., and C.H. Benson, 2001. "Effect of Desiccation of Compacted Natural Clays," *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 127, No. 1, pp 67-75.

Holtz, R., and Kovacs, W., 1981. *An Introduction to Geotechnical Engineering*, Prentice-Hall.

Schroeder, P.R, C.M.Lloyd, and P.A. Zappi, 1997. "Hydrologic Evaluation of Landfill Performance," *HELP Model Version 3.07*, developed by USAE Waterways Experiment Station for for USEPA Risk Reduction Engineering Laboratory, November 1.