State of Utah

Department of Environmental Quality

Dianne R. Nielson, Ph.D.
Executive Director

DIVISION OF RADIATION CONTROL
Dane L. Finerfrock
Director

JON M. HUNTSMAN, JR.
Governor

GARY HERBERT
Lieutenant Governor

September 18, 2007

Mr. Harold R. Roberts
Executive Vice President – U.S. Operations
Denison Mines (USA) Corporation (DUSA)
1050 Seventeenth Street
Denver, CO 80265

Dear Mr. Roberts:

Subject: June 25, 2007 Division of Radiation Control, DUSA Cell 4A Relining Project Design Approval; August 31, 2007 Geosyntec Consultants, *GCL Liner Hydration Demonstration Letter Report* with proposed GCL Hydration Plan Modifications
Request for Additional Information

On September 5, 2007 we received the subject letter report from Geosyntec Consultants. The original goal of the hydration project was to determine the duration needed by a flexible membrane liner (FML) covered geosynthetic clay liner (GCL) in contact with the subgrade on-site, to attain a moisture content (MC) of 140%. Original estimates were that this MC would be reached between 2 and 6-weeks. This hydration did not occur during the recent demonstration project.

As a result, additional testing was done in a laboratory, using freshwater pre-hyrated GCLs. Four MCs (50%, 75%, 100% and 140%) of the specified GCL were tested. Permeabilities (K) were determined after passage of various pore discharge volumes from each GCL MC condition. The permeability tests used hydrochloric acid.

Of these, K was lowest using a pre-hyration condition of 50% MC (yielding $K = 2 \times 10^{-9}$ cm/sec) after one-half pore volume. However, K increased to 3.0×10^{-8} cm/sec after 2 pore volumes. Of all the pre-hydration cases tested, the 75% MC appeared to produce the lowest K (2.5×10^{-8} cm/sec) after 2 or more pore volumes. The 100% and 140% MC cases yielded K values of 3.5×10^{-8} and 4.5×10^{-8} cm/sec, respectively. Thereafter, the GCL at 75% MC appears to yield the lowest permeabilities. We note that all the MCs yielded permeability results that were fairly close in magnitude for each pore discharge volume studied.

Via the subject letter report, Geosyntec recommends that the specified Cetco Bentomat ST geosynthetic clay liner (GCL), be hydrated to a minimum of 50% moisture content (MC), prior to covering with the flexible membrane liner (FML). However, we note that the 75% MC, rather than the 50% MC recommended by the consultant, appears to be the most desirable for longest term lowest permeability for

the maximum tested number of pore volumes (7). In the report, the graph in Attachment C, Figure 4 shows that after numerous (18) tests, the permeability at 7-pore volumes appears to be stabilized at roughly 1.5 X 10^{-8} cm/sec for the 75% MC GCL, the lowest permeability for all the MCs tested.

Why this MC appears to be the most robust, having the lowest permeability performance than the originally specified 140% MC is unknown. However, the actual specified Cetco GCL material was not experimented with in the literature used by DRC and URS to specify the requirement of 140% MC. From the results of the field test FD-3, we also have concerns in the ability of the GCL to attain this MC, simply by applying only the balance of water needed (as if the GCL will absorb it all), to attain the target MC.

Therefore, we request that:

1. The specifications be revised for wetting and covering the GCL with the FML expeditiously to avoid evaporation losses.
2. Consideration be given to adjusting the amount of water to be used to hydrate the GCL and subgrade, considering evaporation as noted above, as well as subgrade soil suction, per the enclosed article by Daniel, Shan and Anderson.[1] In the FD-3 demonstration, water losses (using the direct watering method to the GCL) appear to have been experienced, i.e. the hydration may have been lower than anticipated, from the amount of water added. Also, in the FD-3 field test, the subgrade appears it may have been pre-hydrated as well, from the effects of pre-hydrating the subgrade in the FD-2 field test.
3. As per item 7 of our email to Greg Corcoran of Geosyntec from Loren Morton of DRC dated September 4, 2007, please provide the lab data used in making the permeability vs. time and pore volume graphs for the four MCs tested. Any additional completed lab data since the report submission is also requested.

Please review the above comments, and submit a written response. If you have any questions on the above, please contact me.

Sincerely,

David A. Rupp, P.E.
Geotechnical Services Section

LBM/DAR: dr

Enclosure: Copy of Email Exchange (dated 4 and 6 Sept. 2007)
Footnoted Article

Cc: Greg Cocoran, P.E., Geosyntec Consulting Engineers
Britt Quinby, P.E., URS Corp.

[1] Daniel, Shan, and Anderson (1993). "Effects of Partial Wetting on the Performance of the Bentonite Component of a Geosynthetic Clay Liner." Industrial Fabrics Association International, Vol. 3, pp. 1483-1496.