M/047/0103
cc: Leslie Tom

State of Utah
GARY R. HERBERT
Governor

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Department of
Environmental Quality

Amanda Smith
Executive Director

DIVISION OF WATER QUALITY
Walter L. Baker, P.E.
Director

Rec'd 2/13/2012

February 10, 2012

Mr. Robert J. Bayer, P.G.
JBR Environmental Consultants, Inc.
8160 Highland Drive
Sandy, Utah 84093

Dear Mr. Bayer:

Subject: Completeness Review Comments and Request for Information
Red Leaf Resources, Inc. Ground Water Discharge Permit Application

The Division of Water Quality (DWQ) has completed a review of the Ground Water Discharge Permit Application for the Red Leaf Resources (Red Leaf) Southwest #1 Project, which we received on December 21, 2011. The application is for a proposed oil shale mining and hydrocarbon extraction project at the Red Leaf SITLA lease site located approximately 55 miles south of Vernal in Uintah County, Utah. The proposal involves mining and crushing oil shale, and constructing "capsules" using the crushed shale and overburden, along with bentonite-amended shale (BAS) liners, to provide an in-situ no-discharge structure for thermal hydrocarbon extraction, and subsequent in-place reclamation. Based on our review, we have the following comments.

Spent Shale Management

Analysis of spent shale from a pilot test of Red Leaf's capsule retort technology using the Synthetic Precipitation Leaching Procedure (SPLP) suggests that natural precipitation coming into contact with the spent shale would dissolve minimal amounts of contaminants at concentrations below Utah ground water quality standards. One exception is antimony, which was slightly above the ground water quality standard. The SPLP results indicated a pH of 10, which suggests that water from precipitation exposed to the spent shale could generate leachate with high pH. Red Leaf has not provided information to indicate that the potential for the spent shale to generate high-pH leachate will diminish over time. Because high-pH leachate has the potential to harm beneficial uses of surface and ground water, the spent shale must be managed in a way to prevent the potential release of high pH leachate to surface or ground water.

Under Red Leaf's plans for mining and reclamation, it would take a considerable amount of time for precipitation to accumulate and react with buried spent shale in quantities large enough to affect ground water resources. Therefore, DWQ's concerns are related to long-term management of the spent shale. Following are several deficiencies we have identified in the Red Leaf ground water discharge permit application dated December 20, 2011.

Comment 1: Red Leaf asserts that the upper layer of BAS to be installed on top of the stacked shale and an insulating layer in a capsule will retain a 1 x 10^{-7} cm/sec saturated hydraulic conductivity after the shale is heated and undergoes compaction of nearly 40 feet in the capsule. Red Leaf should either provide a field demonstration that the hydraulic conductivity will not be adversely affected by capsule compaction, or provide additional modeling results using higher hydraulic conductivity values that might be expected post-compaction to show that surface and ground water quality will be protected after reclamation.

Comment 2: The application should provide a more complete justification for the input parameters and climate data used in the HELP model to assure that the values chosen are appropriate for this site. In particular, the justification should address the values chosen for hydraulic conductivity of the upper BAS layer, as mentioned above, the initial moisture content of the various model layers, and the climate data chosen for the growing season and precipitation. There should also be a statement of limitations inherent to the HELP model. Also, Red Leaf only ran the model for thirty years, while DWQ is interested in long-term performance of the waste containment. In particular, Red Leaf should estimate the time it would take for the spent shale in an upper, "Tier 2" capsule to reach field capacity, at which point it could possibly discharge leachate. The estimate should be done for two scenarios, one in which the upper BAS layer and capping materials are intact; and another scenario where they have been removed by erosion. Model input parameters and limitations should be explained as with the HELP modeling described above.

Comment 3: Surface drainage off of the reclaimed capsules could potentially come into contact with the spent shale as the upper cap and BAS layer erode over time. Red Leaf's plans for reclamation include collecting some of this water in ponds within the mine pit, and other streams would discharge to the regional surface drainage. Red leaf should demonstrate how this planned drainage will be protective of surface and ground water resources in the long term, in case the water becomes alkaline due to contact with the spent shale.

Capsule Engineering Comments

Comment 1: The second to last sentence at the bottom of page 5 states: *The permeability of the BAS layer will be 10 x 10^{-07} cm/sec or less.* This is incorrect and should be 1.0 x 10^{-07} cm/sec or less.

Comment 2: Sheets 1 and 2 of Figure 7 (Capsule Life Cycle Sections) are drawn to scale and show the knuckles and sides of the capsules. However, it would be appreciated if dimensions were placed on the drawings for the knuckles (slope, thickness of ore, thickness of overburden, etc.).

Comment 3: The following statement is made in Section 11.6 (Process Wall Penetrations): *Proprietary fabrications have been designed and will be installed to enable BAS protection from heating.* Although these fabrications may be proprietary, the information is still required for our engineering review and can be marked "confidential" to ensure that DWQ does not make the proprietary information available to the public.

Comment 4: The following statement is made in Section 11.13.2.1. (Shale): *The ANSYS "multi-linear elasticity" model was used to approximate consolidation properties of rubblized shale at varying temperatures.* Please provide the entire report and model with all input parameters so we can review them.

Comment 5: Sections 11.13.2.2. (Gravel) and11.13.2.3 (BAS) reference a Drucker-Prager plasticity model. Please provide the entire report and model with all input parameters so we can review them.

Comment 6: Section 12.2. (Bottom Liner Fill) of the Construction Quality Control Plan states that BAS will be placed and bladed to a maximum loose lift thickness of 18 inches. Although 20 feet by 40 feet test pads will be constructed using BAS manufactured on site, we have never seen a clay liner constructed with an 18-inch loose lift thickness. Typically, the loose lift thickness is between 8 and 12 inches.

Comment 7: Section 12.3. (Side Liner) indicates that the test pad will be constructed without the gravel side liner. However, a test pad should be built just as it would be with the actual construction, which would mean construction of the BAS with the gravel side liner.

Comment 8: Based on the SPLP results, potential leachate generated by percolation of precipitation through the spent shale could have a high pH. Please provide information that addresses potential adverse effects of high pH leachate on the BAS bottom liner.

We realize that some of the information we are requesting may be proprietary or business confidential. Please indicate when requested information is proprietary or business confidential so we can keep this information separate from the publicly accessed files.

If you have any questions about the Spent Shale Management comments, please contact Mark Novak at (801) 536-4358 or mnovak@utah.gov. For questions on the Capsule Engineering comments, please contact Woodrow Campbell at (801) 536-4353 or wwcampbell@utah.gov.

Sincerely,

Robert J. Herbert

Rob Herbert, P.G., Manager
Ground Water Protection Section

RFH/WWC/MTN:

cc: Laura Nelson, Red Leaf Resources
Paul Baker, DOGM
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