Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

Matthew H. Mead, Governor

John Corra, Director

November 2, 2011

Mr. Ken Garoutte
Manager, Safety, Health, Environment & Quality
Cameco Resources
P.O. Box 1210
Glenrock, WY 82637

RE: TFN 5 1/119 & 5 3/121, Draft Review of Revised Restoration Water Balance Permits 603 & 633, Cameco Resources

Dear Mr. Garoutte:

The Land Quality Division (LQD) is providing a courtesy review of the draft water balance that was discussed during the November 10, 2011 LQD Inspection and during a subsequent meeting on November 14, 2011 at the LQD office. In addition, Mr. Steve Ingle, LQD hydrologist, has reviewed the merits of groundwater sweep as was used during the Highland Pilot ISR Restoration Project and summarized the restoration project in the enclosed review.

It is of significant importance to resolve the groundwater restoration TFNs (5 1/119 & 5 3/121) for approval very soon. Resolving the restoration schedule is part of the Commitments/Deadlines agenda items related to the list of compliance items noted by LQD during meetings with CR late last summer. Ongoing discussions with LQD in recent months have provided clear expectations for resolving the restoration schedule issue. Therefore, it is expected that the proposal to be presented in the meeting scheduled for December 6, 2011 will be specific to the discussions and not include unexpected changes that have not been discussed. It is my expectation that CR will provide the necessary information and that LQD will not have exception to any part of the proposal allowing approval of the TFNs before the end of the year. The LQD appreciates your cooperation in meeting this goal.

If you have any questions, please contact me at prothw@wyo.gov or 307-777-7048.

Sincerely,

Pam Rothwell

Pam Rothwell
Permit Coordinator/District I Assistant Supervisor
Land Quality Division

Enclosures
Cc: Doug Mandeville, NRC

TFNS 5 3/121 & 5 1/119, RESTORATION PLAN REVISIONS, DRAFT WATER BALANCE

PERMITS 603 & 633, CAMECO RESOURCES (CR)

INTRODUCTION

The Land Quality Division (LQD) and the DEQ Director met with CR staff on July 26, 2011 to discuss unresolved compliance issues that had potential for violation. Of primary concern was the delay in approving an updated restoration schedule for the permits. It was determined that CR was not conducting restoration according to the approved permit (one pore volume of groundwater sweep (GWS)) and would need to revert to the approved methodology with an updated schedule to reflect the correct water balance. Changes to methodologies would need to be reviewed under a separate and subsequent review proposal. CR has continued to struggle with developing a modified schedule using the full pore volume of GWS due to the large consumption of groundwater. During the November 10, 2011 inspection, CR provided draft changes to the water balance which included the full pore volume of GWS.

LQD, hydrologist Steve Ingle has reviewed the draft water balance to assist in the final submittal of the proposal. The review is found in the comments below. In addition, LQD discussed a strategy during the inspection and a subsequent meeting on November 14, 2011 to expedite the restoration schedule approvals which would be followed by the review of the Permit Combination/Reynolds Ranch Amendment review (TFN 5 6/100).

- CR will evaluate and remove previous proposed changes to the permit (under TFNs 5 3/121 & 5 1/119) which resulted in additional comments to the review.
- CR will provide an updated water balance showing a full pore volume of groundwater sweep
- LQD agreed that CR could include text changes which would allow LQD to review water quality data when CR has determined that less than a pore volume of GWS is no longer effective in treating the wellfield thus allowing the use of RO and reductants. The review of the data will need to be submitted to LQD for formal approval.

COMMENTS

1. For several of the mine units the pore volumes with flare on the water balance worksheet do not match the pore volumes on the Pore Volume worksheet. **(SI)**

2. The Pore Volume worksheet shows a Mine Unit 8, but this mine unit is not included in the water balance. **(SI)**

4. The water balance includes production flows at Reynolds. Inclusion of production flows from Reynolds Ranch should be included after approval of the amendment. **(SI)**

5. At Highland the restoration startup date for Mine Units F and J is three years sooner for restoration with groundwater sweep and for Mine Unit K the restoration startup is five years sooner for restoration with groundwater sweep than in the restoration without sweep scenario. With production ending at HUP in 2019, it appears that the K-Wellfield will be idling until 2025 in the no GWS scenario and idling until 2020 for the scenario with GWS. I'm not sure if the F and J wellfields will be idling or production will be slowed in these wellfields to extend the production to compensate for the lag between production and restoration. **(SI)**

6. The restoration times for Wellfield 2 and 3 seem excessive. For Wellfield 2 with GWS it will take 20 years and without GWS it'll take 14 years. For Wellfield 3 with GWS it will take 17 years and without GWS it'll take six years. Also for Mine Unit 3 the restoration with GWS begins 10 years before the restoration without GWS. LQD's understanding is that the start of restoration after production should be closer to a two year time period. **(SI)**

7. In the without groundwater sweep scenario it appears that restoration activities will cease in Mine Unit 2 for two years. Please explain the gap in time. **(SI)**

ADDITIONAL INFORMATION

In addition to the review of the draft water balance, Mr. Ingle evaluated the *Highland Pilot ISR Restoration Project*. The summary provides the restoration sequence used to restor the Highland Pilot project carried out under the Exxon Permit 218C. The Everest Minerals discussion of the results from each phase is also included.

Phase 1

Restoration:

The initial phase consisted of IX treatment and reinjection for the first eight months. This resulted in what they called 0.7 pore volumes of groundwater sweep.

Results:

Many parameters other than uranium dropped to less than half of their levels at the start of restoration.

Discussion:

- Groundwater sweep was most effective at the start of restoration, because the contaminants were displaced with natural groundwater.
- The decrease in oxidation potential due to termination of oxidant (lixiviant) introduction caused reprecipitation of some of the mobilized species. However, the effectiveness of

reprecipitation was reduced by the reinjection of water that had been aerated during the IX process.

- Other cations in addition to uranium were removed by the IX treatment.
- Cation adsorption onto clays was thought to be occurring.
- The IX phase was terminated when the RO became operational.

Phase 2

Restoration:

The second phase consisted of RO and IX. The IX was only being used for uranium removal. The RO had a 20% bleed and only operated about half of this phase.

RO Discussion:

- The text provides a theoretical estimate of how far the parameter concentrations should be reduced by the RO for each pore volume removed. The performance was far short of the estimate.
- Although native groundwater was drawn in to the wellfield, the preferential flow followed the maximum gradient which would be a direct line between the injection and production wells.
- Very clean oxygenated RO water was reinjected and oxygen which reinitiated the leaching process.
- There were operational problems with the RO operation. It was not functional for about half of the time.

Phase 3

Groundwater Sweep was initiated for the following reasons:

- The RO had left a bubble of very clean water between the injection and production wells where the flow was concentrated. Groundwater sweep would draw water uniformly from the ore zone around the pumped wells, which would remove the "bubble" and sweep the unswept portions of the wellfield.
- Terminating the injection would allow the natural reductant in the groundwater to help reverse the leaching process.
- There was an expected initial increase in parameter values due to mixing, as the clean water bubble was pulled into other areas of the wellfield. After the increase the parameter values began a gradual decline. At this point Exxon made a claim of restoration success, which was rejected.

Phase 4

Revised Restoration Program:

- The entire field would be treated with RO using potable make up water.
- RO plus a chemical reductant (H2S). Prior to the addition of hydrogen sulfide all steel piping, etc. was replaced with pvc to prevent corrosion.
- As part of the hydrogen sulfide addition process the stream was analyzed for bacteria. At the production wellhead there was a high concentration of desulfovibria (anaerobic

bacteria). The concentration gradually decreased and the concentration of aerobic bacteria increased through the system to the injection well, probably due to exposure to air.

Summary of Groundwater Sweep in Restoration

Groundwater sweep is an effective method for groundwater restoration for three reasons:

1. Groundwater sweep removes contaminants without the reinjection of oxygenated water.
2. Groundwater sweep reintroduces native groundwater which stimulates the reducing bacteria present in the formation.
3. Groundwater sweep removes water more uniformly within the wellfield.