HOMESTAKE

GRANTS OFFICE

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U.S. Nuclear Regulatory Commission
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Attn: Mr. John T. Buckley, Senior Project Manager

RE: Homestake Mining Company – **License SUA-1471**
Docket 40-8903 (TAC LU0134)
Grants Reclamation Project
Treatment Alternatives Testing in the Large Tailings Pile

Dear Mr. Buckley:

Homestake Mining Company of California (HMC) is committed to addressing impacted groundwater at the Grants, New Mexico uranium mill site. The current strategy combines flushing of the Large Tailings Pile (LTP) with extraction and treatment of groundwater through a combination of evapo-concentration and reverse osmosis. In addition, alluvial aquifer hydraulic barriers are established through injection wells to limit and control the overall footprint of the uranium at concentrations above 0.16 mg/L. With the full implementation of the current strategy, HMC expects to continue to make significant progress toward achieving the remediation targets and associated milestones in 2012 through 2017. Despite the significant success with the current strategy, HMC plans to proactively explore and evaluate additional alternatives to address groundwater. Alternative strategies that would be most appropriate as focused treatment options for groundwater at specific areas of the site include the following:

- removal of uranium from groundwater through adsorption onto zeolite
- removal of uranium from groundwater through in situ precipitation in the following low solubility chemical forms:
  - uranium phosphates [(UO_2HPO_4) or $Ca(UO_2)_2(PO_4)_2$]
  - uranium oxide (UO_2 (uraninite))

In order to evaluate the effectiveness of these approaches as applied to groundwater remediation, HMC will perform testing in the LTP and will use to the greatest extent possible the existing infrastructure. Pilot tests will be performed within the LTP in areas selected through evaluation of geochemical characteristics and uranium concentrations (with areas selected specifically to allow extrapolation to alluvial groundwater conditions). HMC plans the following pilot areas:

- Zeolite testing using one of the 4 water supply wells used for tailings flushing

- Supply well flow will be directed over zeolite beds, followed by discharge of treated groundwater into an existing injection well within the tailings

- Phosphate testing using 2 or 3 locations to evaluate *in situ* precipitation in areas of the LTP with differing geochemical and physical characteristics
  - Soluble sodium tripolyphosphate or other source of phosphate will be added to supply well injection water (using an existing injection well); in situ uranium phosphate precipitation will be monitored using existing well networks augmented with new wells as appropriate.
  - A radial distance of approximately 50 – 100 feet will be monitored by the well network to evaluate uranium phosphate precipitation from tailings water.

- Sulfide testing in 2 or 3 locations within the LTP.
  - Soluble sodium polysulfide or other source of sulfide will be added to supply well injection water and *in situ* uranium precipitation will be monitored using a well network (augmented as necessary with new wells).

The technical basis for these alternatives remediation strategies are as follows:

- The surface chemical characteristics of zeolite are optimal for the retention of soluble uranium, transforming dissolved uranium into a surface chemical precipitate on the zeolite.
  - Zeolite has a specific capacity to remove and retain uranium; once this capacity is expended the material is regenerated by stripping the uranium from the zeolite using the appropriate chemistry.

- The addition of soluble sodium tripolyphosphate to tailings water will provide a soluble form of phosphate to enable injection and distribution of the phosphate within an area of the LTP local to the injection well.
  - The sodium tripolyphosphate will gradually transform to phosphate (HPO_4^{2-}) and this will then rapidly react with calcium and uranium.
  - Phosphate will combine with uranium to form a solid uranium phosphate mineral precipitate or calcium uranium phosphate (autinite).
  - Both possess very low solubility and can effectively reduce uranium concentrations in groundwater.
  - Calcium phosphate (apatite) precipitate may also form within the phosphate injection zone; apatite can sorb uranium and retain uranium in the solid phase through incorporation with this mineral.

- The addition of soluble sulfide results in groundwater with a low oxidation-reduction (redox) potential.
  - Under these conditions soluble uranium in the +6 oxidation state is transformed to uranium in the +4 oxidation state.

- Uranium in the +4 oxidation state exist as a solid uranium oxide mineral precipitate (UO_2 (uraninite)); initially this mineral will precipitate as an amorphous hydrated form ($UO_2 \cdot H_2O$(am)) but over time will become more crystalline.
- Both the amorphous and crystalline forms of uraninite have very low solubility and can effectively reduce uranium concentrations in groundwater.
- Iron sulfide may also form within the sulfide injection zone; iron sulfide can sorb uranium and retain uranium in the solid phase through incorporation with this mineral.

Through testing under the controlled conditions of the LTP, HMC will evaluate the ease of implementation of each of these approaches and will develop procedures for their application to the alluvial groundwater system. HMC will closely monitor and control injected amendments, and the movement of these amendments through the tailings water through the use of performance monitoring wells (using the existing well network or new wells installed as appropriate). Tailings water will be evaluated for field parameters (pH, redox potential, conductivity) during injection and will be sampled and analyzed for phosphate, sulfide, uranium, molybdenum, selenium and calcium. Nontoxic conservative tracers will be deployed within each of the pilot test areas, and in other locations of the LTP, and may include fluorescent dyes (e.g., fluorescein, Rhodamine WT), deuterium, or dissolved gases sulfur hexafluoride or helium. The tracers will travel through tailings water in a conservative manner (they will not react or sorb to the tailings) and will therefore provide a means to closely track injected water. By comparing tracer movement to movement of the injected amendments, reaction rates and extent will be quantified. Tracers will also be employed in assessing the overall performance and optimization of the flushing process. In summary, all of the pilot testing planned in the LTP will be closely monitored and controlled with the goal of providing as complete an understanding of the efficacy of these alternative treatment approaches and their potential for broader use in the alluvial groundwater and LTP. Testing in the LTP will provide the necessary controls on amended injection fluid movement, with pilots performed over a limited footprint within the confines of the LTP.

HMC plans to begin testing the zeolite and amendments as soon as possible, and this testing will continue over an appropriate time period to allow for adjustments and refinements of the approaches. Information about the progress of testing will be available as requested. If you have any questions, please contact me at your earliest convenience.

Sincerely yours,

HOMESTAKE MINING COMPANY
OF CALIFORNIA

Alan D. Cox
Project Manager

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