Homestake Mining Company of California
P.O. Box 98
Grants, NM 87020

Tel +1 505 287 4456
Fax +1 505 287 4457

November 13, 2020

Mr. Ron Linton, Project Manager
U.S. Nuclear Regulatory Commission
Materials Decommissioning Branch
Decommissioning, Uranium Recovery & Waste Programs
Office of Nuclear Materials Safety and Safeguards
MS T-5A10, 11545 Rockville Pike
Rockville, MD 20852

Director, Office of Enforcement
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

RE: Homestake Mining Company of California – Responses to NRC's "Request for Supplement Information, Groundwater Corrective Action Program," Docket No. 040-08903, License No. SUA-14-71

Dear Mr. Linton,

On June 18, 2020, the Homestake Mining Company of California (HMC) received the above referenced Request for Supplemental Information (RSI) (ADAMS Accession No. ML20142A195) from the Nuclear Regulatory Commission (NRC) regarding HMC's December 19, 2019 submission of the Groundwater Corrective Action Program (GCAP) (ML19354B960) and February 28, 2020 submission of the Environmental Report (ML20080M078). This submittal provides responses to NRC's June 18, 2020 RSIs as well as the revised Groundwater Corrective Action Program (GCAP) report and associated Environmental Report.

The revised assessment in the GCAP shows that none of the range of proposed reasonable alternatives provide assurance of long-term compliance with the current groundwater protection standards. The revised assessment and the results of over 40 years of groundwater corrective action support the need for Alternative Concentration Limits to comply with the requirements of 10 CFR 40 Appendix A Criterion 5B(5). The GCAP proposes continued groundwater collection, treatment and injection within the alluvial and Chinle aquifers using the existing infrastructure while an ACL application is prepared, reviewed, and approved. The ACL Application is currently in development and submittal of the report to NRC is proposed for the second quarter of 2021.

Thank you for your time and attention on this matter. If you have any questions, please contact me via e-mail at bbingham@homestakeminingcoca.com or via phone at 505.290.8019.

Respectfully,

Brad R. Bingham
Closure Manager
Homestake Mining Company, Grants, New Mexico
Office: 505.287.4456 x35 | Cell: 505.290.8019

cc: Document Control Desk, NRC, Washington, DC (electronic copy)
A. Winton, NMED, Santa Fe, New Mexico (electronic copy)
M. Purcell, Region VI EPA, Dallas, Texas (electronic copy)
B. Tsosie, DOE, Grand Junction, Colorado (electronic copy)
D. Lattin, HMC, Elko, Nevada (electronic copy)
M. McCarthy, HMC, Salt Lake City, Utah (electronic copy)

Attachment 1: HMC's Responses to NRC's Request for Supplemental Information
Attachment 2: Groundwater Corrective Action Program
Attachment 3: Environmental Report for the Groundwater Correction Action Plan

HMC's Responses to
NRC's Request for Supplemental Information
Homestake Mining Company of California
Groundwater Corrective Action Program
Docket Number: 040-08903
License Number: SUA-1471

NRC RSI 7-1 *- Provide the following supporting documentation that was referenced in the application but was missing and is not otherwise available to NRC for its review:*

a) Frenzel, P.F. 1992. Simulation of ground-water flow in the San Andres-Glorieta aquifer in the Acoma embayment and eastern Zuni uplift, west-central New Mexico: U.S. Geological Survey Water-Resources Investigations Report 91-4099, 381 pp;
b) HDR 2016. Draft Remedial Investigation Report. Homestake Mining Company Superfund Site. June 21, 2016;
c) Hydro-Engineering, LLC (HE). 2019. Memorandum – Drain Down Model Modifications and Predictions;
d) For Appendix B, Attachment 2 "Tailings and Alluvial Water Quality Data" is missing;
e) For Appendix B, Attachment 4 "Humidity Cell Testing Results" is missing; and
f) For Appendix B, Attachment 5 "LTP [Large Tailings Pile] Static Column Testing Results" is missing.

HMC Response: The above referenced supporting documents can be accessed as follows:

a) Frenzel (1992) can be found at: https://pubs.er.usgs.gov/publication/wri914099;
b) HDR (2016) can be accessed at: https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.scs&id=0600816&doc=Y&colid=32174&region=06&type=SC;
c) Hydro-Engineering (2019) is included as an appendix to the Groundwater Flow and Transport Model Report that is included as Appendix F of the revised GCAP;
d) Included as Attachment 2 in Appendix B to the revised GCAP;
e) Included as Attachment 4 in Appendix B to the revised GCAP; and
f) Included as Attachment 5 in Appendix B to the revised GCAP.

NRC RSI 7-2 *- Provide the laboratory data (cation exchange capacity, selective chemical extraction samples) used for the design of the models but not included with the application.*

HMC Response: The cation exchange capacity (Section 2.2.3 and Table 8) and selective chemical extraction (Section 2.2.4) results used for the design of the transport model is included in Appendix B to the revised GCAP.

NRC RSI 7-3 *- Provide the elevation data for the WME wells used for the design of the models but not included with the application.*

HMC Response: Well data tables, including the elevation data, are provided in Appendix E to the revised GCAP.

NRC RSI 7-4 *- Provide the historical remedial system collection and injection rates used for the design of the models.*

HMC Response: The historical remedial system collection and injection rates used in the design of the revised groundwater flow and transport models are provided in Appendix F to the revised GCAP.

NRC RSI 7-5 *- Provide electronic versions for the numerical groundwater flow and fate and transport model predictive simulations.*

HMC Response: Electronic versions of the revised numerical groundwater flow and transport models are provided as attachments to Appendix F to the revised GCAP.

NRC RSI 7-6 *- Provide a table summarizing pertinent well data. The data should include; well name, coordinates, reference and ground elevations, completion interval and aquifer, depths to subsurface geologic contacts, installation date, and abandonment date.*

HMC Response: Tables summarizing pertinent well data are provided in Appendix E to the revised GCAP.

NRC RSI 7-7 *- Verify that the following information submitted as part of the application is true and accurate (e.g., final and not draft):*

a) Appendix B Second Interim Draft Geochemical Characterization of Tailings, Alluvial Solids, and Groundwater (HMC noted in Section 1.0 of the GCAP Appendix that a final report will be submitted in September of 2020).
b) Previously submitted electronic groundwater flow and fate and transport model files.

HMC Response: Updates to the above referenced supporting documents can be found as attachments to the revised GCAP.

a) The final version of the "*Geochemical Characterization of Tailings, Alluvial Solids, and Groundwater Report" is included as Appendix B* to the revised GCAP submitted to the NRC on November 14, 2020.
b) Electronic versions of the revised numerical groundwater flow and transport models are provided as attachments to Appendix F to the revised GCAP submitted to the NRC on November 14, 2020.

NRC RSI 7-8 *- Provide a sensitivity analysis on the impact of an alternate conceptual model that includes low permeability layers in the Alluvial Aquifer on the restoration timeline.*

HMC Response: The revised groundwater flow and transport model includes a sensitivity analysis addressing dual porosity domains within the Alluvial Aquifer. These sensitivity runs illustrate the impacts of these hydrogeologic characteristics and features on aquifer restoration timeframes. Details regarding the sensitivity analyses are provided in the revised "Groundwater Flow and Transport Model Report" in Appendix F to the revised GCAP.

NRC RSI 7-9 *- Provide clarification and support for the assumed concentrations of uranium and molybdenum in the re-injection water or revise the modeling to be consistent with observed treatment effectiveness. If the actual concentrations of the re-injection water are higher than assumed in the GCAP, it could result in an unrealistic groundwater restoration timeline.*

HMC Response: The previous groundwater flow and transport model has been updated. Re-injection concentrations associated with GRP Site remedial activities were set equal to 0.04 mg/L for uranium and 0.074 mg/L for molybdenum. These values were based on analytical sampling data of effluent from the reverse osmosis (RO) treatment system that supplies the water to be injected, averaged over the model calibration period of 2002-2017. Constituent concentrations associated with direct re-injection of collected groundwater were based on analytical sampling data and pumping estimates for the collection wells, which were used to calculate annual flow-weighted average concentrations. Rationale for the assumed concentrations of uranium and molybdenum in the re-injection water used in the revised groundwater flow and transport model is discussed in Appendix F to the revised GCAP.

NRC RSI 7-10 *- Provide a more robust sensitivity analysis for the fate and transport model parameters on the predictive simulations.*

HMC Response: The updated groundwater flow and transport model includes more robust sensitivity simulations in which different types of input parameters were adjusted using the predictive natural attenuation scenario as a base case. These parameters include dual-domain mass transfer rate coefficient, dual-domain mobile/immobile domain porosity ratio, retardation factors resulting from Freundlich non-linear sorption isotherm parameters, and groundwater recharge. Sensitivity analyses are provided in the revised Groundwater Flow and Transport Model Report in Appendix F to the revised GCAP.

NRC RSI 8-1 *- Clarify if Permeable Reactive Barriers (PRBs) are needed for HMC to meet the Groundwater Protection Standards (GWPSs).*

HMC Response: Installation of PRBs as presented in Remedial Alternative 3 are not expected to restore the entire aquifer to the GWPS. Following revisions to the groundwater model that added dual-domain fate and transport of solutes, model simulations (Groundwater Flow and Transport Model Report in Appendix F of the revised GCAP) predict that groundwater protection standards will not be met in the entire aquifer by any of the remedial alternatives presented in the revised GCAP submitted to the NRC on November 14, 2020. The model simulations show that the uranium mass stored in the immobile fraction of porosity acts as a long-term source of uranium in mobile groundwater that is as much or more of a source to long-term exceedance of the GWPS than seepage from the LTP.

NRC RSI 8-2 *- If PRBs may be needed to meet the groundwater restoration timeline proposed in Alternative 3, provide the following additional information on the environmental impacts of:*

a) the installation of injection wells,
b) injection of sodium phosphate and calcium citrate into the Alluvial and Upper Chinle Aquifers,
c) the potential change in groundwater flow directions, and
d) the potential for release of other COCs, such as arsenic displacement that was observed with the tripolyphosphate injections.

HMC Response: Although PRBs proposed and evaluated in Alternative 3 are not expected to restore groundwater to the GWPS, the following additional information on potential environmental impacts of PRBs are summarized here and detailed in the Permeable Reactive Barrier Assessment Technical Memorandum, Appendix G of the Groundwater Flow and Transport Model Report included as Appendix F of the revised GCAP.

a) Approximately 138 injection wells would be installed to create the PRB (2,750 ft PRB with 20-ft spacing per the tech memo). Potential environmental impacts are:
    - Generation of solid and liquid waste from well installation that would require management and disposal,
    - Exposure of drilling staff to health and safety concerns (physical and chemical risks) related to well drilling,
    - Exposure of the community to increased traffic from required equipment and staff to install the wells over a period of several months, and
    - Increased use of local resources to support drilling operations.
b) The injection of sodium phosphate and calcium citrate would increase the risk of exposure of staff and the community to these chemicals during transport, storage, and injection.
c) The formation of hydroxyapatite would be expected to occur on the surfaces of mineral grains in the pore structure and would not be expected to affect porosity, permeability, and the direction of saturated groundwater flow.
d) Although arsenic is more strongly adsorbed to alluvial soil compared to phosphate, arsenic can be displaced during sodium phosphate injection because of the mass-action effect of high phosphate concentrations. At the Site, previous studies showed that increases in arsenic and other COCs caused by desorption from injections are minor, temporary, and limited only to areas immediately proximal to the injection wells.

NRC RSI 8-3 *- Provide the following additional information for NRC to evaluate the effectiveness of the PRBs:*

a) Provide information regarding the concentrations and quantities of COCs that are anticipated to be released from the LTP over time.
b) Provide information regarding the assumed natural attenuation from the LTP to the proposed PRBs for each COC that could exceed the GWPS beneath the LTP.
c) Provide information regarding the projected performance of the PRBs with respect to each COC that could exceed the GWPS (i.e., magnitude of reduction of COCs,

longevity of COC sorption/precipitation, solubility/stability of hydroxyapatite under reasonably anticipated environmental conditions). This information should include hydroxyapatite PRB performance observed at other sites, comparison of tripolyphosphate PRB performance at the GRP with proposed hydroxyapatite PRB, potential for well fouling, variable PRB performance due to stratigraphic and structural variability (e.g., interbedding layers, fractures)

d) Provide information regarding the potential for contaminated groundwater to bypass the PRBs due to a reduction in permeability within the PRBs.

HMC Response: Although PRBs proposed and evaluated in Alternative 3 are not expected to restore groundwater to GWPS, the following additional information on the effectiveness of PRBs is summarized here.

a) Seepage from the LTP represents a continuing but gradually diminishing source of both recharge and chemical mass loading to groundwater. In the groundwater model, a Brooks-Corey-based drain down model (DDM) was developed and used to estimate future seepage and mass loading rates. A description of the DDM including the concentrations and quantities of COCs anticipated to be released from the LTP over time is provided in Appendix I (Numerical Modeling Files) of the Groundwater Flow and Transport Model Report included as Appendix F of the revised GCAP.

b) Natural attenuation of COCs from the LTP to the proposed PRBs is summarized in the Conceptual Geochemical Model (Section 5.3) of the Groundwater Flow and Transport Model Report and Appendix D of the revised GCAP. In summary, COCs in tailings seepage are partially diluted during mixing with alluvial groundwater from upgradient. As the tailings-influenced groundwater moves downgradient in the Alluvial Aquifer, the primary attenuation mechanisms for the COCs in the alluvial aquifer are dilution and dispersion, even though mineral precipitation, adsorption by various clay minerals, and adsorption by amorphous iron hydroxide (ferrihydrite) are other potential attenuation mechanisms. Thus, natural attenuation of COCs between the LTP and proposed PRBs is controlled by mixing and dispersion in the groundwater flow and transport model and not by a specified attenuation rate.

c) A review of previously demonstrated hydroxyapatite treatability studies, the expected performance (effectiveness and capacity) of a PRB, and long-term geochemical stability of a PRB are discussed in the Permeable Reactive Barrier Assessment Technical Memorandum in Appendix G of the Groundwater Flow and Transport Model Report submitted as Appendix F of the revised GCAP.

   In summary,

   - Results from small- and large-scale tests indicate that under optimal hydraulic and chemical conditions, the U treatment efficiency of an injected PO_4 PRB is approximately 75%.
   - Estimates of U removal capacity indicate the lifetime of the PRB ranges from 38 to 55 years when using the minimum and maximum U removal capacities.
   - The PRB is expected to remain stable up to 1,000 years with no significant loss of functionality due to dissolution of the hydroxyapatite by groundwater or secondary mineral precipitation.

d) As discussed in the response to *NRC RSI 8-2c*, the formation of hydroxyapatite would be expected to occur on the surfaces of mineral grains in the pore structure and would not be expected to affect permeability and cause contaminated groundwater to bypass the PRB.

NRC RSI 8-4 *- Provide projections of cost estimates for restoration that are based on reasonable and defensible assumptions.*

HMC Response: Cost estimates in the GCAP were prepared for the purpose of comparing the proposed corrective action alternatives. The cost estimates are considered to be “order-of-magnitude” with an expected level of accuracy ranging from minus 30 percent to plus 50 percent. In addition, a real discount rate of 5% was used and limits the contribution of future costs to their net present value. Thus, in order to provide a basis of comparison, cost projections are estimated through year 50 for each alternative because annual costs beyond 50 years do not significantly change the net present value. Costs were revised in the GCAP based largely on timing revisions to the corrective action alternatives predicted by the revised groundwater flow and transport model (Appendix F of the GCAP). Because the revised groundwater model indicates that groundwater cannot be restored by any of the corrective action alternatives, the cost estimates for the alternatives are not for purposes of evaluating ultimate restoration costs and are only intended to be used for comparison of the alternatives.

NRC RSI 9-1 *- Provide realistic projections of flowrates for groundwater treatment systems. This information should include the following:*

a) If the capacity of the Reverse Osmosis (RO) and zeolite systems are not increased, provide realistic projections of groundwater treatment rates based on past operating experience.
b) If the evaporative capacity is not increased, provide realistic projections of future performance based on evaporative capacity.

HMC Response: Expected flowrate projections for the groundwater treatment systems are provided in the “Groundwater Flow and Transport Model Report” in Appendix F to the revised GCAP.

a) Volumes, rates, and locations of injection and extraction have varied over time to optimize system performance. Maintenance of the hydraulic barrier is re-assessed and modified on roughly an annual basis. In addition, groundwater extraction volumes from wells are measured on an aggregate basis for the Alluvial Aquifer, Upper and Middle Chinle aquifers, and off-site areas. Similarly, injection rates within specific aquifer units and areas of the GRP Site are also measured collectively and not for individual wells. Therefore, past collection and injection rates at specific locations were approximated for years 2002 through 2017 and compiled and were then simulated in the GRP Model using the MODFLOW Well (WEL) package. Treatment flowrate projections for the reverse osmosis (RO) and zeolite systems are provided in the “Groundwater Flow and Transport Model Report” in Appendix F to the revised GCAP.
b) Groundwater extraction, treatment (including evaporation) and injection rates have been revised to be consistent with current site capacity. An increase of the evaporative capacity for non-compliant extracted groundwater and non-compliant

treatment effluents is not planned. In 2017, average evaporation from the ponds was approximately 225 gallons per minute (gpm), while the ponds were receiving an average of 222 gpm from the tailings extraction wells, brine from the RO treatment plant, precipitation, the zeolite treatment systems, and collection ponds. Treatment rates based upon the site's evaporative capacity are provided in Appendix F "Groundwater Flow and Transport Model Report" of the revised GCAP.

NRC RSI 9-2 *- Provide additional information on specific metrics that can be used to evaluate the performance of the groundwater corrective actions.*

HMC Response: Metrics to be used to evaluate the performance of the groundwater corrective actions are provided in Section 10 the revised GCAP.

NRC RSI ER-1 *- Provide additional/revised information in the Environmental Report, Section 2.1.1 regarding the no-action alternative using the definition in NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs," for the purpose of establishing a baseline for comparing alternative*

HMC Response: The Environmental Report (ER) associated with the revised GCAP has also been updated. The GCAP and ER sections addressing the No Action alternative have been revised to identify that the No Action Alternative postulates that the ACL application is denied and that the current corrective action continues for 50 more years. The No-Action Alternative establishes a baseline for comparing alternatives and is further described in the revised ER and the revised GCAP.