SAFETY EVALUATION REPORT

DATE:	February 3, 2020
DOCKET:	040-08903
LICENSEE:	Homestake Mining Company of California
SITE:	Grants Reclamation Project
PROJECT MANAGER:	Ron Linton
TECHNICAL REVIEWERS:	George Alexander, Robert Nelson
SUBJECT:	Zeolite Water Treatment Systems License Amendment Request

SUMMARY

By letter dated December 11, 2017,[1] as supplemented by letter dated February 22, 2018,[2] the Homestake Mining Company of California (HMC) submitted a license amendment request (LAR) to the U.S. Nuclear Regulatory Commission (NRC) for review and approval. In its letter, HMC proposed to amend License Condition 35 to include the 300 gallons per minute (gpm) and 1,200 gpm zeolite water treatment systems as a method to be used for groundwater restoration, and specifically, for removal of uranium in groundwater at the Grants Reclamation Project (Grants) site. Contaminated influent water from off-site wells is pumped to the zeolite systems. The treated effluent water from the zeolite systems is then injected into the site aquifers as part of the contaminant plume control efforts of the Grants groundwater corrective action program (GCAP). An environmental review was performed for the proposed license amendment request that resulted in the publication of an environmental assessment.[3] The NRC staff has determined that HMC's proposed request to amend the License Condition 35 to include the 300 gpm and 1,200 gpm zeolite systems is acceptable. The NRC staff review of this license amendment request is documented in this Safety Evaluation Report (SER).

BACKGROUND

The Grants site is in Cibola County, New Mexico, approximately 5.5 miles north of the city of Grants and the village of Milan. Uranium milling began at the site in 1958 and continued until 1990. A total of 22 million tons of ore were milled at the site using an alkaline leach process. From 1993 to 1995, the mill was decommissioned and demolished. The site has two tailings piles, the Large Tailings Pile (LTP) and Small Tailings Pile (STP), and three evaporation ponds. Five residential areas are located within 2 miles of the site with the nearest (i.e., Murray Acres) located approximately one-half mile downgradient from the LTP and STP.

Groundwater restoration activities began in 1977 to mitigate the impacts of seepage from the unlined tailings impoundments into the underlying aquifer. The current license includes

[1] Agencywide Documents Access and Management System (ADAMS) Package Accession No. ML17361A006.
[2] ADAMS Accession No. ML18066A583.
[3] ADAMS Accession No. ML19263C623.

approval for use of the Reverse Osmosis (RO) system under License Condition 35C, which states:

> *Implement the corrective action program described in the September 15, 1989 submittal, as modified by the reverse osmosis system described in the January 15, 1998 submittal, excluding all sampling and reporting requirements for Sample Point 1, with the objective of achieving the concentrations of all constituents listed in License Condition 35B. Composite samples from Sample Point 2 (SP2) will be taken monthly and analyzed for the constituents listed in License Condition 35B; the results of these analyses will be reported in the semi-annual and annual reports required by License Conditions 15 and 42.*

The licensee discontinued the use of groundwater injection into the LTP and the land application of groundwater. To expand its treatment capacity, reduce treatment power requirements, and reduce waste stream volume per unit volume of water treatment, HMC began pilot testing zeolite treatment systems for removal of uranium. The zeolite systems were designed in stages, progressing from bench scale, to a 50 gpm field pilot test, through a 300 gpm mid-scale pilot test, and, finally, a full-scale 1,200 gpm field test. The LAR submitted on December 11, 2017, requests NRC review and approve the 300 gpm and 1,200 gpm zeolite systems and add them into HMC's license SUA-1471, Condition 35. The zeolite system passes uranium-contaminated groundwater through a sequence of lined ponds that contain zeolite crystals, which sorb the dissolved uranium onto the zeolite crystals through an ion exchange reaction with other cations (e.g., sodium, calcium, or hydrogen). The zeolite system can only remove uranium from the groundwater. Therefore, these systems are designed to treat groundwater from off-site locations where uranium is the only constituent of concern that does not exceed the groundwater protection standards, as described by License Condition 35B. Because almost all of the off-site groundwater only contains uranium above the GWPS, the zeolite system is well-suited for treating off-site groundwater.

Both the 300 gpm and 1,200 gpm zeolite systems consist of a series of three successive high-density polyethylene lined cells containing crystalline zeolite granules on top of the LTP. The 300 gpm zeolite system consists of a single set or train of three cells. The 1,200 gpm system consists of four parallel and independent trains of three cells each. Each of the four trains is designed to treat up to 300 gpm. Influent treatment water from off-site wells is pumped from the well field to the LTP zeolite systems. In its LAR, HMC also discussed that pumping from on-site wells where impacted groundwater exceeds only the uranium groundwater protection standards may be proposed in the future. The influent stream is treated with minor amounts of sulfuric acid to reduce the pH to approximately 5.6 to 5.8. The treatment of sulfuric acid facilitates uranyl ion disassociation from bicarbonate ions and subsequently uranyl ion exchange and sorption onto the zeolite crystals. The uranium-impacted groundwater is then pumped into the bottom of the first cell and percolates up through the overlying zeolite. The groundwater then flows by gravity from the top of the first cell into the bottom of the second cell, which is then repeated with the third cell. The treated groundwater stream is then transferred to the post-treatment plant discharge tank and mixed with the effluent from the RO system. These two effluent streams, in combination with fresh water from the San Andres-Glorieta (SAG) aquifer, are then injected into the impacted aquifers as part of the contaminant plume control efforts of the GCAP.

Water quality of the groundwater influent and effluent streams is monitored weekly for the parameters listed in Table 2-1 of the LAR and reproduced in Appendix A of this report. The samples are sent to a certified laboratory for analysis, according to the methods identified in

Table 2-1. This allows HMC to assess when the zeolite system is approaching capacity (i.e., become effectively loaded with uranium) and requires regeneration, described below. Water quality is also measured prior to injection into the aquifers at SP-2, as described in License Condition 35C (see above).

When the zeolites reach capacity and they are no longer capable of removing uranium from the influent stream to less than 0.16 mg/L, the zeolite beds undergo regeneration. For the regeneration process, the influent stream is stopped, the zeolite cells are drained of treatment water, and a regeneration solution containing sulfuric acid with a pH of around 1.5 is added. The regeneration solution is sequentially passed through each of the three cells, similar to the uranium removal process. However, the regeneration solution is cycled back from the third cell to the first cell in a closed loop until the system pH is reduced to 1.5 or below and the measured dissolved uranium concentrations have stabilized. Then the regeneration solution is drained to Evaporation Pond 2 or other ponds and the process is repeated until the dissolved uranium concentrations are less than the target value of 0.01 mg/L in the regeneration solution. Once this target value is achieved, the final regeneration solution is pumped to one of the ponds and the cells are flushed with impacted groundwater until the cell solution pH reaches approximately 5. All of the flushing water below a pH of 5 is also pumped to one of the ponds. Once the flushing water reaches a target pH of 5.6 to 5.8 and the third cell is confirmed to have a dissolved uranium concentration of less than 0.16 mg/L, the third cell effluent discharge is switched to the RO post treatment tank, where it is mixed with the RO effluent.

NRC STAFF EVALUATION

The NRC staff approves HMC's proposed LAR to add the 300 gpm and 1,200 gpm zeolite treatment systems as a groundwater restoration method in HMC's license. Performance monitoring data demonstrates that the zeolite system can remove uranium from off-site groundwater. The NRC staff determined that the zeolite system does not pose a significant risk to workers, members of the public, or groundwater restoration activities, as described below in more detail. The NRC staff will continue to review HMC Annual Reports and Semi-Annual Reports to determine the effectiveness of the zeolite system to treat off-site impacted groundwater. The NRC staff will review the effectiveness of the zeolite system with respect to meeting HMC's restoration timeline as part of NRC staff's review of the upcoming revised GCAP.

By letter dated February 22, 2018, HMC provided pilot zeolite system performance data. This data, in combination with Section 2 of the 2018 Annual Monitoring Report/Performance Review for HMC's Grants Project,[4] demonstrates that the zeolite system can remove uranium from the off-site groundwater wells. As noted above, the zeolite system is only designed to remove uranium from the groundwater and is not able to treat groundwater from on-site wells that contain other constituents of concern exceeding the groundwater protection standards. The performance data indicate that effluent leaving the zeolite systems has occasionally been greater than the groundwater protection standards. However, as discussed in more detail below, the water leaving the zeolite systems that is greater than the groundwater protection standards is mixed with other treated water and fresh water and has not resulted in exceedances at SP2. The NRC staff will review the effectiveness of the zeolite system with respect to its potential to cause exceedances at SP2 during inspections and in review of Annual Reports and Semi-Annual Reports. Also, although the performance data demonstrate the ability of the zeolite system to remove uranium, the zeolite systems, as reported in NRC inspection

[4] ADAMS Package Accession No. ML19101A370.

reports,[5] has operated significantly below the designed flowrate. This is due, in part, to operational challenges (e.g., algae growth) for the zeolite system and relining of Evaporation Pond 1, which has limited the flowrate of the RO and zeolite systems. The relining of Evaporation Pond 1 has reduced the site evaporative capacity from three ponds to two ponds, which has reduced the amount of regeneration solution that can be put into the Evaporation Ponds. The NRC staff will review the operational effectiveness of the zeolite system and the RO treatment system for HMC meeting its restoration timeline as part of NRC's review of HMC's revised GCAP, which was submitted to the NRC dated December 18, 2019.[6]

By letter dated January 24, 2019,[7] the NRC staff requested additional information (RAI), including comments related to: (1) impacts due to potential leakage from the lined ponds; (2) reported zeolite effluent exceedances (zeolite effluent that is greater than the groundwater protection standards); and (3) any changes to the zeolite system. By letter dated May 17, 2018,[8] HMC responded to NRC RAI comments. With respect to impacts due to potential leakage of restoration solution from the lined ponds into the tailings, HMC provided several reasons for limited potential impacts to the tailings and the alluvial aquifer. HMC evaluated the impact of a hypothetical leak through the liner but first noted that there has been no indication of leakage based, in part, on tailings water levels that are routinely measured and which have continued to decline since 2015. For a postulated leak of 5 gpm, which corresponds to a composite leakage rate of 0.5 gpm, HMC discussed that the impacts would be limited due to the leakage of acidic regeneration solution being neutralized by the tailings, which were produced by an alkaline leach milling process. HMC then discussed that the leakage would then be mixed with the LTP tailings pore solution and that the regeneration solution would likely contain concentrations of uranium, sulfate, and total dissolved solids that are similar to that of the tailings pore solution. With respect to flow rates, HMC discussed that the postulated 0.5 gpm leakage rate is small in comparison to the rate of seepage from the LTP in 2018 of 28.8 gpm. Based on this reasoning, the NRC staff determined that HMC's assessment of impacts to the tailings and alluvial aquifer due to potential leakage from the zeolite system are not risk significant.

With respect to the zeolite effluent exceedances, HMC discussed that none of these zeolite effluent exceedances resulted in any exceedances at SP2 (i.e., prior to injection into the aquifers). HMC provided several reasons why the zeolite effluent exceedances did not result in exceedances at SP2, including:

1. Exceedances of the groundwater protection standards in the zeolite effluent would be mitigated by the mixing of RO product water and fresh water from SAG aquifer in the post treatment tank.

2. Many of the zeolite effluent exceedances occurred after regeneration of a train or disruption of normal operation of the zeolite system (e.g., after zeolite system repairs). HMC has refined regeneration procedures and implemented additional field water quality measurements after operational changes to reduce the likelihood of a future site exceedance. These frequent measurements allow for adjustments to be made if early-detection measurements provide an indication of exceedance.

[5] ADAMS Accession No. ML19129A405 and ML18303A199.
[6] ADAMS Package Accession No. ML19354B960.
[7] ADAMS Accession No. ML18218A560.
[8] ADAMS Accession No. ML19149A366.

The NRC staff determined that the zeolite effluent exceedances that were reported are not risk significant because the concentrations of contaminants at SP2, after zeolite effluent water is mixed with RO water and fresh water, did not exceed the groundwater protection standards. Further, the additional field measurements will reduce the likelihood of future exceedances, because HMC will be able to more quickly adjust operations.

In an RAI comment, the NRC staff requested additional information regarding changes that were made to the zeolite system since the submittal of the LAR. In response, HMC discussed the following series of changes to the zeolite systems:

1. A layer of cobble-sized zeolite material was added to reduce the wind-blown removal of the underlying granular zeolite material.

2. The piping was modified in the 1,200 gpm zeolite system to allow for individual discharge from each train so that each train could be operated independently. This enables one train to be regenerated while the other trains are operating.

3. The single-walled tanks holding the regeneration fluid for both the 300 gpm and 1,200 gpm zeolite systems were replaced with double-walled tanks.

4. Wooden-access walkways/platforms were added to both the 300 gpm and 1,200 gpm zeolite systems to improve worker safety.

5. A direct acid injection port into the feed piping was installed for the 1,200 gpm zeolite system.

The NRC staff determined that these changes to the zeolite system are reasonable as they will improve safety or operations.

HMC discussed that algae growth has plugged the grates in the transfer piping and continued to interrupt system operation. HMC has tested natural suppressants (e.g., barley straw) and ultrasonic instruments, but is currently physically removing the algae from the zeolite system. HMC discussed that they will continue to review and possibly test or implement algae-mitigation approaches that do not adversely affect treated water quality or zeolite system operation. The NRC staff determined that this approach to algae mitigation is reasonable.

The NRC staff performed a health physics review of the radiation exposure dose from the zeolite system and determined that worker and public dose impacts are not significant. In the Occupational Dose/Toxicity Assessment for Zeolite Facility Operations, shown in Exhibit D of the LAR, the licensee determined the potential occupational exposures from zeolite facility operations will not result in significant radiological doses or intakes from ingestion and inhalation pathways. The NRC staff performed a health physics review of the licensee's calculated dose assessments and reviewed operational procedures and agrees that occupational exposures from the zeolite facility operations will result in no significant radiation worker dose. All estimated occupational radiation doses are below regulatory limits. In LAR Section 3.1, Public and Occupational Health, the licensee indicated that public dose and occupational health is assessed regularly, and all monitoring data are reported to NRC in the Semi-Annual Report and Annual Environmental Report. The licensee stated that data have consistently demonstrated that occupational and public exposures remain below regulatory limits. The NRC staff agrees that worker dose and public dose impacts from the zeolite system is not risk significant.

The zeolite system has been included as a line item in the HMC financial surety as a long-term care and maintenance cost and has been reviewed and approved by the NRC staff in license amendment 53 dated April 2, 2019.[9] The zeolite system long-term care and maintenance costs will continue to be reviewed by the NRC staff in subsequent financial surety reviews.

RECOMMENDED LICENSE CHANGES

The licensee has requested that the authorization to operate the zeolite system be included as condition 35E and that former condition 35E be renamed 35F. The NRC staff finds this acceptable. The license will be amended as follows to include the LAR, supplemental information provided by the licensee, and RAI responses:

> 35. The licensee shall implement a groundwater compliance monitoring program to assess the performance of the groundwater restoration program. This program is separate from the requirements in License Condition 15. The Licensee shall:
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> A. Unchanged
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> B. Unchanged
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> C. Unchanged
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> D. Unchanged
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> E. Operate the zeolite water treatment systems located on the Large Tailings Pile as described in the December 11, 2017 (ML17361A006), February 22, 2018 (ML18066A583), and May 17, 2019 (ML19149A366), submittals, including all monitoring and mitigation requirements specified therein.
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> F. Submit by March 31 of each year, a performance review of the corrective action program that details the progress towards attaining groundwater protection standards.

The licensee agreed to these changes to Material License SUA-1471, condition 35 in correspondence dated January 28 and 30, 2020.[10]

ENVIRONMENTAL REVIEW

The NRC staff published an environmental assessment related to this review[11] and a Finding of No Significant Impact in the *Federal Register*.[12]

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[9] ADAMS Package Accession No. ML18323A179.
[10] ADAMS Package Accession No. ML20031D507.
[11] ADAMS Accession No. ML19263C623.
[12] 84 FR 67480; ADAMS Accession No. ML19263B857.

Appendix A

Parameter	Analytical Method	LLD	Units
pH	A4500-H B	0.01	s.u.
TDS	A2540 C	20	mg/L
SO_4	E300.0	4	mg/L
NO_3+NO_2-N	E353.2	0.1	mg/L
Cl	E300.0	1	mg/L
CO_3	A2320 B	5	mg/L
HCO_3	A2320 B	5	mg/L
Ca	200.7	0.5	mg/L
K	200.7	0.5	mg/L
Mg	200.7	0.5	mg/L
Na	200.7	0.5	mg/L
Mo	200.8	0.03	mg/L
Se	200.8	0.005	mg/L
U	200.8	0.0003	mg/L
V	200.8	0.01	mg/L
Ra-226	E903.0	0.2	pCi/L
Ra-228	RA-05	1.5	pCi/L
Th-230	E908.0	0.1	pCi/L
LLD = Lower Limit of Detection			