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

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

February 2, 2024

Document Control Desk
U.S. Nuclear Regulatory Commission Washington, DC 20555–0001

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

RE: Homestake Mining Company of California – Grants Reclamation Project – Response to NRC's Staff Acceptance Review of the HMC Request for Amendment to License SUA-1471 for Alternate Concentration Limits

Mr. Linton,

On May 17, 2023, Homestake Mining Company of California (HMC) received NRC's letter declining to accept for technical review HMC's license amendment request (LAR) for alternate concentrations limits (ACL) for the Grants Reclamation Project. In this letter and its Attachments 1-5, HMC is responding to the NRC's acceptance denial letter and associated information, providing the NRC with information it has requested, and requesting that the NRC resume its review of the ACL LAR.

In summary, HMC respectfully disagrees with the NRC's original decision to deny acceptance of the ACL LAR for detailed technical review. As detailed in this letter and its Attachments, HMC believes that the NRC staff did not have a sufficient justification to decline to accept the LAR for detailed technical review. In our view, many of the NRC's comments on the ACL LAR, based on past NRC decisions, are more appropriately suited for the detailed technical review process rather than the acceptance review. We have reviewed the administrative record for the 10 previous Title II sites that have been granted ACLs. In those cases, NRC began its review of the LARs and even granted ACLs on submittals comparable to or less detailed than the HMC submittal.

While HMC respectfully disagrees with the NRC's initial acceptance denial, and in the interests of moving the ACL process forward as expeditiously as practicable, HMC is providing in this letter and its Attachments a substantial amount of detailed information responding to the NRC's bases for declining to accept the ACL LAR. HMC is committed to working with the NRC staff, in a collaborative way, to complete the ACL process as expeditiously as practicable.

HMC would like to provide a brief overview of the information in this package that we firmly believe address the NRC concerns that resulted in its prior decision to decline the acceptance of the ACL LAR.

The NRC's May 17, 2023 letter declining to accept the ACL LAR provided three generic comments as the bases for not accepting the LAR application. From HMC's perspective, these three comments did not provide sufficient detail to support the NRC's conclusion or provide HMC with sufficient information to adequately address any perceived shortcomings in the LAR. HMC respectfully submits that the NRC's three comments also do not provide a sufficient justification for declining to accept the ACL LAR for technical review. Despite the areas of disagreement here, in **Attachment 1**, HMC is providing detailed responses to these three generic comments. In addition, **Attachment 2** provides a listing of the administrative record references in the license and decision-making documents referenced in Attachment 1.

In **Attachment 3**, HMC identifies the ACL LAR's detailed responses corresponding to each of NRC's comments in the May 5, 2022 pre-submission audit meeting summary notes (ML22131A272). Based on our review of those responses and the comments provided by the NRC in that audit meeting, we cannot identify any indication in the NRC's comments that HMC was failing to provide the necessary information for application completeness. At most, it appears, based upon NRC's comments, that requests for additional information during the normal, detailed technical review process would be needed for progress on the detailed technical review of the application.

Indeed, following its May 17, 2023 acceptance denial letter, the NRC Staff provided HMC with 20 pages of detailed comments on the ACL LAR for discussion at the June 15, 2023 public meeting. HMC respectfully submits that these comments should have formed the basis for Requests for Additional Information (RAIs) during the detailed technical review process, rather than becoming a basis for declining to accept the LAR for technical review. Nonetheless, in the spirit of moving the process forward, HMC has conducted a detailed review of these comments and developed responses to them, which are provided in **Attachment 4**. We note that many of the NRC's comments do not provide a basis in applicable regulations or guidance for the RAIs. Despite this concern, HMC is providing the requested information where feasible and appropriate to do so, but we would respectfully request that future RAIs, if any, be accompanied by a basis for the question in applicable regulations or guidance. We believe this reasonable request is consistent with the NRC Principles of Good Regulation and is needed to provide the most efficient means for HMC to provide a sufficient and acceptable response.

In the interest of thoroughness, responses to NRC's comments in the April 30, 2021 acceptance review of the 2020 Groundwater Corrective Action Program (GCAP) LAR submission have also been provided in **Attachment 5**.

From HMC's perspective, it appears that the staff's decision to not accept the ACL LAR for technical review was influenced in part by an attempt to comply with perceived obligations under the Nuclear Energy Innovation and Modernization Act (NEIMA) to complete an application review in two years. The NRC staff comments in the pre-submission audit meeting effectively confirmed HMC's impression, which is documented in the formal audit meeting summary notes (ML22131A272). HMC understands that a LAR with this level of complexity may well take longer than the two years identified by the "milestone schedules" developed by NRC in accordance with NEIMA. However, nothing in NEIMA suggests it should be used as a pretext for not accepting an application for technical review. To the contrary, the entire purpose of NEIMA was to ensure that NRC's review processes consistently advance in a timely manner. Accordingly, NRC's NEIMA obligation is not to complete its review and Safety Evaluation Report in the two-year period, but to establish reasonable timelines and report to Congress if the milestone schedules are not met. HMC believes that changing the standards of the LAR acceptance process, as we believe was done in this case, in order to meet newly imposed legislative milestones, is contrary to Congressional intent.

In summary, HMC respectfully requests that the NRC staff resume and expeditiously conclude its acceptance review of the ACL LAR submitted on August 8, 2022 including the supplemental information provided with this submittal. With this additional information, the NRC staff should have all the information that it needs to docket and commence the detailed technical review on HMC's ACL LAR as soon as practicable.

Thank you for your time and attention to 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

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

cc:
B. Von Till, NRC, Rockville, Maryland (electronic copy)
J. Marshall, NRC, Rockville, Maryland (electronic copy)
J. Lubinski, NRC, Rockville, Maryland (electronic copy)
M. Lemoncelli, NRC, Rockville, Maryland (electronic copy)
S. Appaji, EPA, Dallas, Texas (electronic copy)
A. Maurer, NMED, Santa Fe, New Mexico (electronic copy)
N. Olin, DOE, Grand Junction, Colorado (electronic copy)
M. McCarthy, Barrick, Salt Lake City, Utah (electronic copy)
D. Lattin, Barrick, Elko, Nevada (electronic copy)

Attachments: Attachment 1: Response to NRC Comments in May 17, 2023 letter of nonacceptance of the ACL application for technical review

Attachment 2: Administrative Record for Referenced ACL Applications

Attachment 3: Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting

Attachment 4: Response to Agency Talking Points from June 15, 2023 Public Meeting

Attachment 5: Response to Review Comments from NRC's April 30, 2021 Acceptance Review of the 2020 GCAP LAR

Attachment 1. Response to NRC comments in May 17, 2023 letter of nonacceptance of the ACL Application for technical review

Comment		**HMC Response to Comment**
1	The LAR has not detailed whether the pertinent estates within the proposed control boundary have been acquired and does not describe the efforts and timelines for these acquisitions. With these uncertainties, the NRC staff is unable to undertake a detailed review of the LAR.	Respectfully, in HMC's opinion, this information concerning pertinent estates within the proposed boundary is not required by NRC regulation, or suggested by NRC guidance, or are otherwise a requirement for the NRC staff to accept the ACL license amendment request (LAR) for detailed technical review. Consequently, the perceived lack of detail does not provide a sufficient basis for the NRC staff to assert that the LAR is incomplete, or to decline to accept the LAR for a detailed technical review. Further, review of the administrative records for uranium mill sites regulated under Title II of UMTRCA previously granted ACLs by NRC identifies that applications for ACLs at four Title II uranium mill sites were accepted for detailed technical review that did not have full fee title ownership to all lands within the proposed control boundary at the time of application (Ambrosia Lake, Bear Creek, L-Bar, Split Rock). In addition, review of the administrative records for Title II of UMTRCA previously granted ACLs by the NRC identifies that detailed technical review and approval of all ACL applications submitted since 2001 have taken between three years (Lisbon Valley) and five years (Ambrosia Lake). This is ample time for HMC to resolve and document for NRC the ownership status of the minority amount of remaining lands within the proposed control boundary while the lengthy detailed technical review proceeds. Furthermore, it appears to HMC that, during NRC's completeness review, the NRC may have overlooked information provided to NRC in the 2022 ACL application related to this subject. HMC addressed the status of the land ownership, HMC's efforts to acquire fee title to all lands within the proposed control boundary not yet owned, and the timelines for acquisition of those parcels. This topic was addressed in general terms in the Executive Summary (p.1-4), Section 1.2.2.9.3 (Groundwater Use, p. 1-30); Section 5.0 (Alternate Concentration Limits, p. 5-1). This topic was addressed in specific terms in Section 1.5.2 (Proposed Points of Compliance and Points of Exposure, p. 1-60) and Section 5.1.5 (Controls for long-Term Protection, p. 5-9). The ACL Application further explained that "*HMC is documenting its effort to acquire the remaining parcels and to* [and will] *provide documentation of property ownership within the proposed control boundary in a subsequent submittal prior to final approval of this ACL Application.*" (Section 1.5.2, Section 5.1.5). Moreover, land ownership status is primarily relevant for license termination, not for the ACL license amendment request. Correspondingly, the status of or schedule for acquiring property is also not required at this stage. Irrespective of the status of and schedule for property acquisition, there are no current or reasonably likely future risks of public exposure to impacted groundwater. Properties have been provided an alternate water supply (as documented in Appendix E of the 2022 Annual Performance Report (ML23095A165)). All well owners have been informed by the State and EPA of potential groundwater quality impacts, and there are State prohibitions on establishing any new access to potentially impacted groundwater in the area. For all the forementioned reasons, while HMC continues it serious and good faith efforts to purchase all of the properties within the proposed control boundary, the fact this has not been fully accomplished is not a legitimate justification under the NRC rules for denial of the ACL Application. Although NRC has not identified particular status and schedule information that it claims is necessary, HMC is providing extensive additional information that should address any potentially relevant questions that NRC may have with respect to the property acquisition process.
2	While the application addressed several of the NRC staff comments from the pre-submission audit and summary dated May 17, 2022, several significant comments previously discussed with the applicant were either not fully addressed or the assumptions made were not supported.	For convenience, HMC has attached its Responses to NRC Staff pre-submission audit comments (Attachment 3), which were addressed in the 2022 ACL Application submittal. HMC respectfully submits that the NRC's comments (and letter of May 17, 2023 (ML23119A006)) provides an insufficient basis for its general assertion that HMC had failed to sufficiently address several unidentified staff significant comments, or failed to support unidentified assumptions for those unidentified comments. The NRC could have and should have identified any shortcomings in its specific requests for supplemental information (RSIs) to which HMC could have responded to facilitate the staff's acceptance review. Going forward, each RSI should be supported by a regulatory basis for the information requested. As such, HMC formally requests NRC provide specific explanation in the future, with citations to regulation and/or NRC guidance, as to why the NRC believes the application is lacking information, or that certain information is not adequately supported for detailed technical review.
3	Information from the ongoing groundwater pumping indicates	Again, HMC respectfully submits that the NRC's letter of May 17, 2023 (ML23119A006) fails to specify what information it believes to be missing. As detailed below, HMC believes that it closely followed applicable NRC guidance when detailing that the proposed ACLs are ALARA. First, HMC acknowledges that ongoing groundwater pumping continues to remove site contaminants from

Attachment 1. Response to NRC comments in May 17, 2023 letter of nonacceptance of the ACL Application for technical review		
Comment		**HMC Response to Comment**
	that the GCAP continues to remove site contaminants from the groundwater notwithstanding claims that contaminants have been removed to a level that is as low as is reasonably achievable. Without explanation of how these data are consistent with HMC's claims, the NRC staff is unable to undertake a detailed review of the LAR.	the groundwater. This was the case for most of the 10 Uranium Mill Sites regulated under Title II of the Uranium Mill Tailings Radiation Control Act (UMTRCA) for which NRC has previously granted ACLs. The fact that treatment continues to remove contaminants cannot alone justify rejecting an application for detailed technical review. Further, HMC respectfully disagrees with NRC's assertion that HMC did not give an "explanation" of how those reductions co-exist with HMC's ALARA claims. HMC has demonstrated across multiple sections of the application that the 45 years of groundwater corrective actions at the HMC GRP, the largest and longest running groundwater corrective action program of any Title I or Title II site in the U.S., have reduced groundwater concentrations to levels that are ALARA. This information is clearly presented in Section 4.3 (Analysis and Comparison of Corrective Action Alternatives), Section 4.4 (Costs and Benefits of Corrective Action Alternatives), and Section 4.5 (ALARA Demonstration). This information was also supported by numerous detailed appendices (e.g., Appendix 4.3-A Assessment of Groundwater Corrective Action Alternatives; Appendix 4.3-B Cost Bases of Corrective Action Alternatives; Appendix 4.4-A Projected Water Use Demand Basis of Estimate; Appendix 4.4-B Technical Memorandum: Calculation of Present Worth of Averted Dose from Corrective Action Alternatives). The ACL application HMC submitted to NRC on 8/8/2022 adhered with section 4.3.3.3 of NUREG-1620 (Corrective Action Assessment), which states: "A *ground-water corrective action assessment typically (a) identifies several practicable corrective action alternatives; (b) assesses the technical feasibility, costs, and benefits of each alternative; and (c) selects an appropriate corrective action for achieving compliance with the ground-water protection standards established at the site.*" Regarding the assessment of past and current groundwater corrective actions, section 4.3.3.3(1) of NUREG-1620 goes on to state: "*For past and current corrective actions, site-specific operational and monitoring data should be included to show the effectiveness of those measures. The evaluation may include information from literature sources or documented experience from other sites for those corrective actions that have not been implemented at the site but appear to be practicable. The evaluation should also include projections of the hazardous constituent concentration that each corrective action would likely produce at specific times at the point of compliance and the point of exposure.*" The site-specific monitoring data has been provided to NRC annually in its reporting per License Conditions 15 and 35, was included by reference in the 2022 ACL application, and supported by the data provided by HMC in Sections 1.2.2 and Appendix 1.2-A (2020 Annual Monitoring Report/Performance Review); Appendix 4.1-A (Additional Groundwater Corrective Action Program History); and Appendix 4.1-C (Technical Memorandum: Grants Reclamation Project Cessation of Corrective Action Program). In accordance with NUREG-1620, Section 4.3.3.3(1), the ACL application provides evaluations and projections of the hazardous constituent concentration that each corrective action would likely produce at specific times at the point of compliance and the point of exposure in Section 4.3 of the ACL application and supported by Appendix 4.2-A (Detailed Screening of Technologies and Process Options); Appendix 4.2-B (Predictive Modeling Report); and Appendix 4.3-A (Assessment of Groundwater Corrective Action Alternatives). Sections 4.3.3.3(2) through 4.3.3.3(4) of NUREG-1620 then directs that the costs and benefits of each alternative be identified, quantified where practicable, and compared, including the "No Action" alternative which is continuation of the currently approved groundwater CAP. Section 4.3.3.3(4) of NUREG-1620 states: "*The "as low as is reasonably achievable" analysis typically considers (a) the direct and indirect benefits of implementing each corrective action to achieve the target concentration levels; (b) the costs of performing the corrective action to achieve the target concentrations; and (c) a determination whether any of the evaluated corrective action alternatives will reduce contaminant levels below the proposed alternate concentration limit, considering the benefits and costs of implementing the alternative.*" Section 4.4 of the 2022 ACL application, supported by Appendix 4.3-B (Cost Bases of Corrective Action Alternatives); Appendix 4.4-A (Projected Water Use Demand Basis of Estimate); and Appendix 4.4-B (Technical Memorandum: Calculation of Present Worth of Averted Dose from Corrective Action Alternatives) details the identification, quantification where practicable, and evaluation of benefits of groundwater restoration as identified in Section 4.3.3.3(2) of NUREG-1620 as well as the costs , as identified in NUREG-1620 Section 4.3.3.3(3). Finally, NUREG-1620, Section 4.3.3.3(4) states:

Attachment 1. Response to NRC comments in May 17, 2023 letter of nonacceptance of the ACL Application for technical review		
Comment		**HMC Response to Comment**
		"A proposed alternate concentration limit is considered as low as is reasonably achievable if the comparison of the costs to achieve the target concentrations lower than the alternate concentration limit are far in excess of the value of the resource and the benefits associated with performing the corrective action alternative." This process of assessment and comparison applies to all alternatives in the corrective action alternatives assessment, including the No Action Alternative of continuing the current groundwater correction action. The analysis presented in Section 4.4 and 4.5 of the 2022 ACL application identify that the monetized costs of complete and permanent groundwater restoration are between 37 to 102 times all monetized benefits (including the value of the groundwater resource, not just the value of collective averted dose from groundwater restoration). This result is then compared to NRC guidance in Appendix N.6 of NUREG-1757, Vol. 2, Rev. 2 (NRC, 2020), which states: "*For a "prohibitively expense" assessment, this value* [value of averted dose] *should be multiplied times 10 prior to being used as* V_{AD} *in the analysis. This increased value of averted dose reflects the statement in the final rule on radiological criteria for license termination that the NRC considers it appropriate that a remediation would be prohibitively expensive if the cost to avert dose were an order of magnitude more expensive than the cost recommended by the NRC for an ALARA analysis (see 62 FR 39058, p. 39071, July 21, 1997)*". HMC has followed the analysis described in NUREG-1620 Section 4.3.3.3 and has shown that the proposed ACLs are ALARA. HMC can find no requirement in regulation or guidance that requires or prescribes a threshold level of groundwater restoration or groundwater corrective action performance that must be achieved prior to acceptance of an ACL application and the associated assessment of a range of corrective action alternatives for detailed technical review. Nor has the NRC identified any such regulation or guidance. From HMC's perspective, the NRC has offered no reasonable basis for considering the application incomplete for detailed technical review based on continued recovery of contaminant mass. Indeed, the NRC's position of denying the ACL application for detailed technical review in part on ALARA concerns appears to be inconsistent with the NRC's own guidance in NUREG-1757, which specifically states in Vol. 2, Rev. 2, Section 6.1.2.1 that *"The NRC staff should review the ALARA portion of the DP* ***without assessing the technical accuracy or completeness*** *of the information contained therein, which it should determine during the detailed technical review".* [emphasis added] HMC formally requests NRC provide specific explanation, with citations to regulation and/or NRC guidance, as to why the NRC believes that the ACL application is not complete and sufficient for detailed technical review. This requested information will ensure that the issue in question will be appropriately addressed in subsequent submittals. Finally, in light of the consequences of global climate change and the impacts on water availability in areas such as Grants, continuing to utilize this precious asset for pump and treat purposes when the law of diminishing returns has been met is arguably environmentally irresponsible. Clearly, the groundwater resources in this region are a precious resource for agricultural and residential purposes and should not be utilized in a manner that could be deleterious to the needs of the local community and for which a higher and better use is clearly apparent. This is certainly a changed circumstance from the situation that was present when pump and treat operations began 45 years ago, and HMC believes that the NRC should recognize this changed condition as it evaluates the ACL application.

Attachment 2. Administrative Record for Referenced ACL Applications

Site	ACL Licensing Submittals
Ambrosia Lake	2/15/2000 Bedrock ACL application (ML003687843) 7/21/2000 Modeling & Feasibility (ML003737960) Supplements: 5/21/2001 Alluvial ACL application (ML011690068) 4/11/2003 RAI Responses (ML031080523) 8/12/2003 (not on ADAMS) 7/29/2004 meeting Notes BMH025509 (ML060040250, ML041950418) 7/7/2005 (ML051990088) 12/7/2005 (ML053480214) 2/24/2006 Approval, TER (ML060590024)
Bear Creek	2/28/1997 CAP & ACL Application, not on ADAMS 6/30/1997 ACL and CAP Approval, not on ADAMS 10/28/2011 ACL update new model (ML12046A858) 2/1/2013 Revised Final EA (ML12145A264) 2/27/2013 ACL approval (ML12145A471)
Bluewater	5/10/1989 CAP & ACL Application (ML20247R810) 8/9/1989 Revised CAP & ACL Application (ML20247R803) 6/20/1990 ACL Application approval (ML20055F398, ML20055F402) 8/27/1991 ACL Application (ML200082T159) 4/25/1995 ACL Application. supersedes previous (ML20100H916, ML20083A017, ML20092C121) 2/22/1996 ACL Approval/TER (ML20100H916)
L-Bar	8/24/1998 ACL application (ML20151S129) Supplements: 10/26/1998 RAI Responses (ML20155A295) 11/25/1998, RAI Responses (ML20155A295) 3/2/1999 RAI Responses, (ML20207E60) 3/3/1999 GW Report (ML20207G935) 5/21/1999 NRC Approval and TER (ML092400289)
Lisbon Valley	3/31/1989 GW CAP 5/22/2002 ACL application 10/10/2003 RAI responses 1/20/2004 supplement 2/19/2004 Exposure Assessment 4/20/2004 ACL Approval, Amendment 66, NRC EA 4/23/2004 EA- FONSI in FR
Lucky MC	12/21/2000 ACL application (ML010250146) 10/26/2001 ACL RAI (ML023510318) 1/11/2002 ACL Revision, (ML023510318, ML023510605) 11/4/2002 ACL revision (ML023160530) 12/20/2002 NRC Approval/TER (ML023570130)

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting

Comment		HMC Response to Comment
General Comments		
1	This U.S. Nuclear Regulatory Commission (NRC) staff pre-submission audit of the Homestake Mining Company of California (HMC) alternate concentration limit (ACL) application is not to make conclusions or findings. The NRC staff reviewed the ACL application for completeness and will d**iscuss items that may be questionable in a formal review**. The items noted and comments are not to be considered inclusive and complete at this stage. A formal acceptance review may result in additional comments and questions.	Noted.
2	The application generally follows the content and format for ACL applications in NUREG-1620, Appendix K, and in general touches on the contents outlined in Section 4.3 of NUREG-1620, "Protecting Water Resources, Hazard Assessment, Exposure Assessment, Corrective Action Assessment, and Compliance Monitoring for ACL's." HMC provided a crosswalk for NUREG-1620, Chapter 4, and Criterion 5.	Noted.
3	NRC comments were presented in the following general categories: • ACL Values and Groundwater Modeling • As Low as is Reasonably Achievable (ALARA) Analysis • Corrective Actions • Compliance Monitoring • Institutional Controls • Miscellaneous	Noted.
ACL Values and Groundwater Modeling Comments		
4	The NRC staff has several concerns with the method for calculation of ACL values. The method of using attenuation and scaling factors may be acceptable but then using maximum observed values rather than model values, applying a factor of safety from one aquifer to another, and the effect of an assumed background value may introduce uncertainty, or possibly over-estimate the ACL values.	HMC respectfully submits that the methodology for the calculation of ACLs is not a question of application completeness. NUREG-1757 states *"The NRC staff should review the ALARA portion of the DP* ***without assessing the technical accuracy or completeness*** *of the information contained therein, which it should determine during the detailed technical review".* However, in response to NRC's feedback, HMC revised the method of development for ACLs and used a more simple and direct approach (see Application Section 1.5, Section 5.1). Rather than using maximum observed values, maximum predicted POC values were utilized instead. These proposed ACLs are then demonstrated to remain protective at the POE based on conservative bounding- case model and conservative assumptions of constituent transport. The use of a bounding case model run was intended to decrease uncertainty associated with calibrated model results.

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting		
Comment		**HMC Response to Comment**
4.a	The NRC staff is concerned that this approach obscures the risk significance of natural barriers that result in attenuation of contaminants by processes such as sorption, dilution, and precipitation reactions. The use of a more simple and direct approach to the ACL calculation would allow for a better understanding of site performance and risk. Realistic or conservative projections of attenuation from point of compliance (POC) wells to point of exposure (POE) wells would represent the physical system, which would help facilitate: (1) understanding of the amount of site characterization needed, (2) understanding of site performance and model validation, (3) understanding of risk in the future, and (4) stakeholder communication. The approach is not consistent with ALARA. For the uranium ACL, HMC selected the well with the highest concentration. This is an alluvial well, T23, located beneath the tailings pile, and its concentration was not used in the model. This well has anomalously high uranium concentrations. Although selection of a well with the highest uranium concentration decreases the likelihood of an ACL exceedance, this approach is inconsistent with ALARA. Section 4.3 of NUREG 1620 on ACLs states, "…and that the proposed alternate concentration limit is as low ALARA, considering practicable corrective actions."	HMC used an approach that conservatively overestimates transport and potential future peak exposure conditions to minimize uncertainty associated with future climate and transport conditions: a) The bounding-case model was used to conservatively predict hydrologic and transport conditions and conservative predictions of peak POC and POE future concentrations (adjusted calibrated model major input parameters to reflect the most conservative end of their reasonable ranges) b) Attenuation mechanisms have been accounted for via model-calibrated non-linear Freundlich isotherms for Uranium and Molybdenum. Uranium transport has clearly bounded that of Molybdenum. Therefore, using the calibrated model uranium Attenuation Factor for Molybdenum transport will overpredict Mo transport and peak POE Molybdenum concentrations. This is simply the relationship observed between the predicted peak POC and POE conditions considering the calibrated bulk effect of all attenuation mechanisms. c) All other analytes have ACLs based on conservative (non-retarded) transport and attenuation factors. This approach overpredicts transport and peak POE concentrations and obviates the need to address any uncertainties about attenuation mechanisms. The background values were not assumed, they are the values in the License, and the proposed ACLs are not estimated. They are calculated and proposed for approval as sufficiently protective. The approach used to calculate ACLs has precedent for other Title II sites. NRC has approved ACLs based on maximum predicted POC concentrations in 4 previous ACL applications (Ambrosia Lake, Bear Creek, L-Bar, Lucky MC). NRC has approved ACLs developed using the Attenuation Factor approach at 2 previous sites (Ambrosia Lake, Bluewater). See attachment 2 for reference to relevant documentation.
4.b	c. An ACL is proposed for chloride, a non-hazardous constituent, which may be the first chloride ACL at a uranium recovery facility.	HMC understands that the NRC approved ACLs for chloride at Ambrosia Lake and L-Bar. See Attachment 2 for reference to relevant documentation.
5	The calculation and presentation of an ACL value based on a best estimate/core/calibrated model would be informative. The predictive simulations include a "core" natural attenuation (based on parameter values for the calibration simulation) and an assumed bounding case (i.e., using key input parameter values that are assumed to represent "worst case" impacts). It is difficult to understand what is a conservative or bounding assumption in a complex model. Presentation of a predictive simulation using the calibrated model parameter values would improve understanding of the model's predictive capabilities and help ensure that the assumptions used to estimate the ACLs are realistic or conservative. Alternatively, HMC could run the model with the proposed	HMC respectfully submits that providing the additional calculation suggested by this comment is not a basis for finding that the ACL application was not complete. In any event, the application as submitted uses proposed ACLs from the bounding-case model. Further, while the comparison may be informative, the comparison ultimately has no bearing on the appropriateness of the assumptions made in the bounding case analysis on which the ACLs were calculated.

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting		
Comment		**HMC Response to Comment**
	ACL bounding values and demonstrate that the model-predicted concentrations at the POE are protective.	
6	Without conducting a detailed technical review, it is difficult for the NRC staff to assess whether there are sufficient technical bases for key modeling assumptions. Additional site characterization data may be needed to demonstrate that the site is protective upon a detailed review of the model, including:	Noted. Please see responses to comments 6.a, 6.b, and 6.c, below.
6.a	Supporting evidence for future recharge rates. The maximum assumed precipitation in the model (i.e., approximately 12.8 in/yr) was slightly less than the average precipitation from 1986-2018 (i.e.,13.6 in/yr). The remainder of the assumed precipitation rates in the model were significantly less than the recent average. This appears to result in modeled cells becoming dry. The NRC staff is concerned that the modeled cell drying results in a significant risk reduction, because if the cells are predicted to be dry at a potential POE, then there is no assumed risk at that POE. There are a significant number of HMC's assumed points of exposure that were determined by the NRC staff to be dry. This is a risk significant conclusion that was not immediately clear in the draft ACL application. In its ACL application, HMC should clearly communicate this model result (e.g., a figure illustrating the location of dry cells versus POE boundary), communicate the risk significance of this result, and demonstrate that the level of model support is commensurate with the assumed risk reduction. This is a significant change from previous modeling and appears to be due, in part, to changes in the assumed precipitation and recharge. The NRC staff is concerned about the risk significance of cell drying and the uncertainty in climatic conditions.	While the staff's concerns with the implications of the precipitation and recharge are noted, HMC respectfully submits that the basis for the assumptions are well-documented in the reports. Further HMC believes that any concerns about these assumptions should be addressed in the detailed technical review and are not a basis to find the application is incomplete. HMC provides the following additional information. HMC believes that the NRC has provided no basis for its position that the modeling assumptions are inappropriate. NRC staff cited an average yearly precipitation of 13.6 inches from a Remote Automatic Weather Station (RAWS) as representative of Grants, New Mexico. However, the referenced station coordinates are 35°14'30", 107°40'12" at an elevation of approximately 8250 ft. Thus, the cited data makes for an inappropriate comparison to model inputs. Additional information on the RAWS data can be found at the link below. https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?nmXGRA The PRISM method interpolates a database of climate records onto a spatial grid covering the coterminous United States (Daly et al., 2008). PRISM calculates a climate-elevation regression for each gridded spatial location based on data from nearby climate stations where long-term records are available, a digital elevation model (DEM), and other spatial datasets. Stations entering the regression are assigned weights based upon location, elevation, coastal proximity, topographic facet orientation, vertical atmospheric layer, topographic position, and orographic effectiveness of the terrain. The PRISM precipitation product was obtained for each month of the calibration period (2002 through 2019), averaged over each model stress period, interpolated to each MODFLOW-USG model node, and then scaled to develop groundwater recharge rates. Thus, recharge in the model varies both spatially and temporally within the calibration period. The figure included with Attachment 4 as Exhibit C shows the spatial variability of recharge over the model domain for reference. The figure included with Attachment 4 as Exhibit D shows the annual average, maximum, and minimum precipitation values for the calibration period for the entire model domain. It also includes the annual precipitation amounts measured at the Grants, New Mexico, airport for the period of 1985 through 2017 (note: it appears that NOAA is currently not providing access to data from recent years). Also, the PRISM minimum precipitation estimate coincides well with the Grants Airport data as would be expected given the geography of the general San Mateo Creek basin area. The risk significance was addressed with use of bounding case model assumptions which included increased precipitation and recharge as discussed in Section 4.4 of the Predictive Modeling Report located in Appendix 4.2-B of the ACL Application. While the staff's concerns with the implications of the precipitation and recharge are noted, the basis for the assumptions are well documented in the reports. Further, any concerns about these assumptions are not a question of completeness but rather one of technical review. NRC has provided no defensible basis for its position that the modeling assumptions are inappropriate.
6.b	Longer-term monitoring of the tailings to demonstrate that rebound will not occur.	In response to NRC's comment, the monitoring of the Large Tailings Pile sumps was proposed to be included in the groundwater monitoring program to address concerns for rebound potential. In addition, multiple lines of evidence were provided to demonstrate that rebound of tailings seepage concentrations is not reasonably likely as presented in the Worthington Miller Environmental Geochemical Characterization of Tailings, Alluvial solids, and Groundwater, May 2020 and in the Annual Performance Report submitted each March.

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting

Comment		HMC Response to Comment
6.c	Characterization of the low permeability zones to quantify contaminant concentrations and mass in the low permeability zones and mass flux rates from low permeability zones to high permeability zones.	The basis for the estimation of mass resides in the low permeability zones is provided within the ACL Application. Section 5.5.2 of the Groundwater Flow and Transport Calibration Report presents the basis for the contaminant mass (and concentrations), and the mass flux rate from the low permeability zone. Two separate approaches were used to estimate the mass present in the low permeability zones (the approach specified in Section 5.5.2 of the Calibration Report and the approach articulated in Appendix G of the Calibration Report, both found in Appendix 3.1-A of the ACL Application) and the difference between the two approaches yield only 6% difference in estimated mass. The mass flux rate was taken from literature for calcium-uranium complexations as specified in Appendix 3.1-A and in the Groundwater Flow and Transport Predictive Period Report (Appendix 4.2-B), and the value was evaluated in the sensitivity analysis. The results of the sensitivity analyses showed that adjusting the value by an order of magnitude showed little change to overall model behavior.
7	The NRC staff is not making any determination on the proposed control boundary. It is the NRC staff understanding that the selection of POEs is based on proximity of the plume to the control boundary and that the precise location of a specific POE along the control boundary is not critical. However, the NRC staff will need to evaluate the locations. The application needs to include discussion that the control boundary is ALARA (e.g., the long-term surveillance boundary may ultimately be only the current NRC-licensed boundary and thus the control boundary may be reduced).	The boundary proposed conservatively bounds predicted future contaminant transport and POE concentrations with the objective of providing reasonable assurance of long-term protection. The proposed boundary itself is not subject to an ALARA analysis or minimization. Rather, the ALARA analysis is focused on the costs and benefits of concentration reduction at the POE. HMC cannot identify in regulation or guidance basis for NRC's position on this matter. The ALARA analysis presented in the ACL applications clearly demonstrates that the entire monetized benefit from restoration of all aquifers in perpetuity (Table 4.4-6) is less than one year cost of operating the current groundwater corrective action program (approx. $8MM/yr). Consequently, substantive reduction of the POE concentrations from additional corrective action is not within in the limits of what is considered by NRC guidance as practicable or reasonably achievable, considering the costs and benefits. Therefore, HMC's request for approval of ACLs and termination of the groundwater corrective action at this time is well justified.
ALARA Analysis		
8	HMC discusses the first significant water treatment effort for collected groundwater occurred with the operation of the Reverse Osmosis (RO) Treatment Plant in 1999. The RO Treatment Plant was significantly modified and expanded in 2014 and 2015 to improve treatment and increase capacity. The NRC staff notes contaminants are still being removed by the current active treatment system at similar rates as in the past several years. For example, the cumulative uranium removed continues to increase in a linear fashion, which brings into question that the ongoing corrective actions are ALARA.	Please see response to Comment 10 regarding the diminishing returns of mass removal over the last 30 years at the site. Please also see response to ACL Application General Comment #3 in Attachment 1 for a complete discussion of how ALARA was addressed in the Application.
9	The cost benefit analysis and associated technical memo was not reviewed in detail. The cost per person rem avoided appear to be calculated over the lifespan of the groundwater corrective action program in the alternatives evaluated. There did not appear to be any cost analysis for corrective actions occurring for shorter time periods.	Homestake's analysis in Section 4 of the ACL application shows that the cost of continuing groundwater corrective action for ***a single year*** is greater than the value of the collective dose that would be averted even if treatment continued for ***a thousand years*** and the total monetized benefit of aquifer restoration. The calculated maximum monetary value of the collective averted dose resulting from 1,000 years of corrective action ($711,648, see Table 4.4-6 and Appendix 4.4-B) is an order of magnitude below the cost of performing corrective action for one year (approx. $8MM). Further, the high-end monetized present worth benefit of complete and permanent aquifer restoration is still less than one-year operating cost for the current groundwater corrective action program ($7,454,330, see Table 4.4-6 and Appendix 4.4-B). Thus, even if one additional year of treatment were as effective as 1,000 years of treatment, that one additional year would not meet NRC's standards for reasonably achievable or practicability. Accordingly, current groundwater concentrations constitute ALARA.

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting		
Comment		**HMC Response to Comment**
Corrective Action		
10	The application stresses that 45 years of investigation and corrective actions have effectively reduced the contaminant levels in the Alluvial Aquifer. The most effective period for corrective actions was from 2000 to present.	First, HMC respectfully disagrees with this comment. The assertion that the most effective period for corrective action was from 2000 to present is entirely unsupported by site data. Prior to the use of the RO Treatment plant in 1999, corrective action had already been ongoing for 22 years. The uranium concentration graphs presented in Appendix 4.1-C of the ACL Application show that more progress was made in reducing dissolved concentrations in groundwater prior to the commissioning of the RO Plant in 1999, than afterwards. Since the mid-2000's, groundwater concentrations have, overall, shown small amounts of change (decrease) and generally become somewhat stable, although there is variability in the monitoring data. This is further supported by Table 2.1-1 from the Annual Performance Report. The average mass removed from 1993 through 1998 (6 years) was 20,555 pounds versus 14,906 pounds from 2016-2022 (7 years). The average collection rate was 194 gpm from 1993-1998 and was 458 gpm from 2016-2022 (increased pumping rate of 236%). Thus, on a mass removal per gallon collected basis, the mid-1990s were over three times as effective in mass removal than post-expansion of the RO Plant and post-cessation of the tailings flushing program. HMC believes that in light of the consequences of global climate change and the impacts on water availability in areas such as Grants, continuing to utilize this precious asset for pump and treat purposes when the law of diminishing returns has clearly been met is neither appropriate nor environmentally beneficial. Any outstanding questions on these issues should be addressed as part of technical review and are not a valid basis for declining to accept an application for detailed technical review.
11	The licensee's evaluation of alternatives based on impacts to the designated POEs indicate a greater impact associated with the alternatives that include continuing or enhanced corrective actions and a lesser impact associated with the ACL alternative which has no corrective actions. This appears counterintuitive to the NRC staff.	While counterintuitive at first glance, the reasoning behind this observed phenomenon is reasonable given what each of these alternatives entails. Alternatives 1 & 2 implement active treatment, while alternative 3 does not. The continued pump and treat present in the first two alternatives sustains the level of alluvial aquifer saturation for a longer duration than alternative 3 does, allowing for extended groundwater transport that does not occur under the drier, less saturated groundwater conditions in alternative 3 with commensurately less groundwater transport. In addition, the corrective actions target only uranium above the site standard of 0.16 mg/L. As a result, concentrations below 0.16 mg/L migrate further downgradient as a result of the saturation in alternatives 1 & 2 than in alternative 3.

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting		
Comment		**HMC Response to Comment**
Compliance Monitoring		
12	A long-term groundwater monitoring program for determining if the predicted modeling results are being observed at the Grants Reclamation Project (GRP) appears to be minimal. There is minimal discussion of monitoring of the aquifers return to steady-state conditions after years of groundwater corrective actions. A robust monitoring program with performance standards may be required prior to termination. The NRC staff notes that only three POC wells are identified. Additional POC wells may be needed for a site as complex as the GRP. The NRC staff would have to evaluate POC or intermediate wells to determine that the site is protective of public health, safety, and the environment.	The ACL Application was revised to include six POC wells as well as continuing monitoring of the entire monitoring program specified in License Condition 35A with minor modifications specified in Section 5.2.1. The monitoring program specified in Section 5.2.1 includes 96 wells distributed spatially across the alluvial, Upper Chinle, Middle Chinle, Lower Chinle, and San Andres.
Institutional Controls		
13	The NRC staff did not review in detail any institutional controls noted in the application, such as the New Mexico Office of the State Engineer prohibition on new wells in the Alluvial or Chinle Aquifers. The adequacy of this institutional controls will need further legal evaluation in a more detailed review.	The application proposes to use full fee title ownership as the basis for control and title transfer of all lands necessary to long-term custodian to the extent possible based on Homestake's good faith efforts to acquire properties within the proposed Long Term Care Boundary. *See also* Homestake's Response to Staff Talking Points in Attachment 4.
14	The NRC staff notes that there are still many privately owned groundwater wells in the Alluvial & Chinle aquifers that are within the proposed control boundary. Institutional controls (IC's) or disposition of these wells did not appear to be discussed in detail.	The disposition of privately owned groundwater wells is discussed in Section 1.2.2.9.3 (Groundwater Use) Also see Table 4-4-1, Figure 1.2-57. "*Based on the results of the 2020 annual survey, all water users in the area of concern are supplied by the Village of Milan water supply.*" No use of groundwater from these wells is identified in the Annual Monitoring Report. These wells will be abandoned when fee title to these parcels are acquired, the acquisition of all properties is in process. *See also* Attachment 4 to this submittal, Homestake's Response to Staff Talking Points.
15	It appears the NRC staff that IC's may not be complete, or nearly complete, at this time as there is very little information or details on IC's. For example, water rights, subsurface rights, mineral rights do not appear to be discussed.	The Issues of water rights, subsurface rights, mineral rights are made moot by the acquisition of full fee title to the surface and subsurface estates and title transfer of all lands necessary to long-term custodian, this process is ongoing. *See also* Attachment 4 to this submittal, Homestake's Response to Staff Talking Points. Any outstanding questions on these issues should be addressed as part of technical review and are not a valid basis for declining to accept an application for detailed technical review.
16	The NRC staff notes that based on the complexity of the GRP, previous ACL reviews might not serve as precedent for a GRP ACL application being acceptable for review for the NRC staff.	HMC understands that the GRP may have different complexities compared to other sites that have undergone ACL review. NRC, however, identifies no such "complexities" in its comments and questions and offers no explanation of how any specific circumstances at the GRP require more or different information on particular subjects to satisfy the staff's acceptance review. A general reference to "complexity" is not sufficient to support reversal of agency practice, especially across the entirety of the ACL application.

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting

Comment		HMC Response to Comment
17	The NRC staff questions if an ACL application could be acceptable for review under the 2019 Nuclear Energy Innovation and Modernization Act (NEIMA) requirements, prior to all IC's being in place. NEIMA requires that the NRC staff review period, from acceptance to Safety Evaluation Report, be completed within two years.	HMC respectfully submits that NEIMA does not require that the NRC review be completed in two years. NEIMA required that the NRC develop "milestone schedules" that it would commit to meet. Moreover, if schedules are not kept, the consequence is that reports must be made, internally within NRC, and, eventually, as part of Congressional Reports, where required. Nothing in NEIMA suggests it should be used as a pretext for delaying the acceptance of an application for technical review and effectively elongating NRC's review process. Quite to the contrary, Congress's intent in NEIMA was to ensure that NRC's review processes consistently advance in a timely manner.
18	The application does not appear to have a commitment from the Federal or State government to take the land proposed in the ACL application.	HMC respectfully submits that such commitment is not a prerequisite for the staff to undertake detailed technical review. NUREG-1620 States: "*The* ***NRC and the applicant*** *must verify whether the state or the federal government will be the long-term site custodian, after the license is terminated. The applicant must then secure a commitment from that party to take custody of the site. The applicant* ***or*** *the NRC must then secure written assurance that the appropriate federal or state agency will accept the transfer of the specific property, including land in excess of that needed for tailings disposal. Alternate concentration limits may not be established at sites involving a distant point of exposure until the licensee agrees to transfer the title to the land, and the appropriate federal or state government commits to take such land, including the land between the point of compliance and point of exposure that is in excess of the land used for disposal of byproduct material.*" As specified in the excerpt above, the alternate concentration limits may not be established prior to the commitment, but it gives no indication that it is a requirement for acceptance for technical review of the application for ACLs. The language is included to ensure the reviewer verifies that the long-term custodian is aware of the full extent of the required land trans prior to termination of the specific license. The intent is to avoid delays in license termination due to a lack of mutual understanding on the extent of the land transfer. NRC shares the responsibility with the licensee to verify who the long-term custodian will be. In essence, the commitment is not a requirement for completeness review because neither license termination nor transfer of land title is being requested as part of this license amendment request. *See also* Attachment 4 to this submittal, Homestake's Response to Staff Talking Points.
19	License termination is not part of the ACL application. HMC stated that license termination would be addressed after ACL was approved and any monitoring required was completed.	Noted.
Miscellaneous		
20	The NRC staff had two comments related to the assumed background values.	Please see responses to Comments 20.a and 20.b below.
20.a	A review being conducted by the U.S. Environmental Protection Agency and the New Mexico Environment Department may provide additional information regarding the background values at the GRP. Under HMC's proposed ACL approach, the ACL values would not be affected by a change in the assumed uranium background values for the Alluvial Aquifer. However, a more typical approach to the calculation of ACL values (e.g., attenuation of contaminants from the POC to the POE wells to protective values in the respective aquifers), could be affected by a change in the assumed background concentrations.	HMC has applied for an amendment based on its current license and site conditions. The background values were approved by all three agencies (NRC, EPA, and NMED) and NRC has not initiated any license actions that indicates these values (groundwater protection standards) are not appropriate or protective.

Attachment 3. HMC Response to NRC Staff Comments from May 5, 2022 Pre-Submission Audit Public Meeting		
Comment		**HMC Response to Comment**
20.b	The NRC-approved background values were determined for the current licensed boundary of the HMC GRP site. If the control boundary expands beyond the licensed boundary, then the POE may have different background values than the current licensed boundary.	It appears to HMC that the NRC has not adequately reviewed the spatial extent of the wells utilized in the NRC-approved background values noted in this response. While the alluvial standards approved by NRC, EPA, and NMED are representative of the water quality directly upgradient of the large tailings pile, the Chinle standards set for the mixing zone, Upper Chinle non-mixing zone, Middle Chinle non-mixing zone, and Lower Chinle non-mixing zone all encompassed wells located far beyond the footprint of the current licensed boundary. The footprint of the wells considered in the background assessment encompasses approximately 4,000 acres and thus an area four times larger than the current HMC control boundary. The hypothetical that NRC offers (“*If the control boundary expands beyond the licensed boundary, then the POE* ***may*** *have different background values than the current licensed boundary*.”) is not a basis for rejection for detailed technical review supported by guidance or regulation but a condition that is to be assessed in the detailed technical review.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
1-1	The LAR does not provide information regarding the transfer of property and structures within the proposed control boundary including:	The long-term disposition of infrastructure within the proposed boundary is a subject to be addressed at license termination and does not relate to the completeness of the LAR for detailed technical review. Nonetheless, HMC is providing below as much information as is reasonably practicable at this time to address the NRC staff's comments here. Respectfully, in HMC's opinion, none of the items in Comments 1-1 and 1-(a) through -(h) concerning property and structures within the proposed control area boundary are required by NRC regulation, or suggested by NRC guidance, or are a requirement for the NRC staff to accept the license amendment request (LAR) for detailed technical review. Consequently, the perceived lack of these items does not provide a sufficient basis for the NRC staff to assert that the LAR is incomplete, or to decline to accept the LAR for a detailed technical review. Indeed, HMC's review of the administrative record for other uranium mill facilities regulated under Title II of the Uranium Mill Tailings Radiation Control Act demonstrates that the NRC staff has previously accepted ACL applications for detailed technical review before all land ownership, long-term disposition of structures, and access control issues for groundwater use issues are resolved.
1-1a	The status and schedule for acquisition of the 166 parcels out of the 522 that have not been acquired.	As detailed in the LAR (Section 1.1; 1.2.2; etc.), HMC is in the process of acquiring title to all remaining parcels within the proposed boundary and intends to comply with regulatory requirements governing acquisition and transfer of property within the control boundary. HMC intends to demonstrate its efforts to acquire the land ownership to NRC **prior to final approval** of this amendment request. HMC's view is consistent with applicable statutes, as well as NRC regulations, guidance, and prior practices, and no other schedule would be appropriate for the matter of addressing acquisition and transfer matters. Nonetheless, HMC is providing the following updated information to the NRC Staff. The proposed long-term control boundary contains approximately 5,968 acres and approximately 522 different parcels of property. There are a number of subdivisions within the proposed long-term control boundary, which make up the largest number of total individual parcels (but a small share of total acreage). However, most of the proposed long-term control boundary is covered by a relatively small number of very large parcels that are owned by HMC. To date, HMC controls approximately 83% of the total parcels in the LTCB and 91% of the total area. It is difficult to project a schedule to acquire the remaining parcels, in particular a schedule for making a second attempt at a purchase or negotiated institutional controls for landowners who rejected initial attempts to negotiate a purchase. However, HMC's goal is to make a good faith offer for the remaining parcels by the end of 2024 to achieve the ultimate objective of acquiring all remaining parcels. With respect to the landowners who have rejected good faith offers made, HMC is currently reviewing those rejections and providing additional information and/or appraisals. The reasons for rejections are unique for each property owner. Commonly, the rejections are due to personal attachment to the home and property, financial concerns, timing issues, and age or health related reasons. These are personal decisions which frequently go beyond monetary considerations and while HMC can make a best faith effort, the company does not possess eminent domain authority to force the sale by an unwilling owner. Despite these circumstances, HMC is carefully reviewing the circumstances surrounding each of these rejections and developing tailored follow-up and support in an effort to assist potential sellers and accommodate their needs and concerns. Such arrangements could include, but are not limited to, sale-leaseback transactions, making information on alternative properties available, providing other information or identifying potential resources to address particular landowner concerns, property exchanges, or other contractual arrangements to facilitate the transition properties. If a sale cannot be negotiated, then HMC will seek alternative arrangements to impose institutional controls that will prohibit long-term drilling of ground water or other wells on the parcel and will attempt to provide reasonable accommodations of resident concerns. HMC has acquired parcels through a form warranty deed which transfers all property, water rights, water wells (if any) and mineral rights. The form warranty deed is subject to all patent reservations, restrictions, easements and rights-of-way of record, as well as taxes for the current year and all subsequent years. HMC has obtained title insurance on all purchased parcels. As discussed below, HMC has also engaged a well-regarded landman brokerage to conduct a full title examination of county records to identify any potential split estate mineral

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
		interests and third-party water rights within the long-term control (LTC) boundary. HMC also has plans, as the date for license termination and land transfer nears, to complete a full survey of all parcels within the boundary. A few subdivisions have recorded subdivision covenants that will be terminated if and when HMC acquires all lots within each subdivision. If a holdout landowner remains in a subdivision, HMC will seek to negotiate a termination of subdivision covenants with the landowner.
1-1b	The disposition of above ground structures, such as existing single-family homes, ancillary structures, and additional onsite materials.	HMC will remove all above ground structures, infrastructure, and additional on-site materials from properties it owns as required by regulation or statute within the proposed long-term control boundary prior to license termination land transfer to the long-term custodian. If property surface estates are not owned by HMC at the time of license termination and land transfer due to the application of approved institutional controls, above ground structures, infrastructure, and additional on-site materials would remain in-place at the discretion of the land surface owner.
1-1c	The disposition of below ground existing infrastructure on individual parcels, for example, septic tanks, drain fields, and groundwater wells.	HMC has made and continues to make good faith efforts to purchase all water rights within the LTC boundary. As part of that effort, HMC has also purchased some groundwater wells and will make a good faith effort to purchase wells, if any, that may be located on future acquired lands. Prior to license termination and land transfer to the DOE, HMC intends to plug and abandon all groundwater wells not required by the NRC License in accordance with state law. HMC has already plugged and abandoned multiple wells within the prospective LTCB area.
1-1d	A discussion and plan for existing roads, road maintenance, or road removal, if required, and discussions with the governmental agency that controls existing roads.	The major existing public roads that cross the lands within the proposed long-term control boundary and are used by the public to cross to and from neighboring lands (e.g., State Highway 605; County Road 334-Anaconda Road) will remain and will be maintained by the applicable state or local agencies. For public roads, such as subdivision roads, that only serve as an access from a larger public road to parcels purchased by HMC, the ultimate objective is to commence proceedings to abandon those roads such that title will pass to the adjoining lot owner (being HMC). For example, once HMC has purchased all lots in a subdivision, it will abandon those subdivision roads. While the objective is to acquire all lots and parcels within the LTC boundary, if there is a holdout parcel in a subdivision, for example, that refuses to sell, then HMC will seek to obtain mutual institutional controls with that holdout landowner regarding the road. In connection with such negotiations, HMC's preference and approach will be to abandon the road as to the public (with the cooperation of such holdout landowner) and then grant a permanent easement for the existing road across HMC land to a remaining public road. There may be private roads that were granted by one neighboring landowner to another for a private access road (although to HMC's knowledge, it has yet to come across private roads). If HMC acquires both the burdened and the beneficiary parcel, all those rights, including the private access road, will pass at the time of the License termination and land transfer to the long-term custodian. If one of the two parcels is a holdout landowner, HMC will seek institutional controls that include covenants addressing future use of the road. HMC owns several road easements within the proposed long-term control boundary from third parties, which will be terminated or conveyed to the DOE if required. If HMC discovers any roads that are not covered by a recorded easement, it will conduct an analysis for any prescriptive rights (but at this point, HMC is not aware of any potential prescriptive rights roads). For all public roads that are abandoned (or private roads if applicable), HMC will make a case-by-case decision, with input from the DOE, whether certain roads should remain for the future access, use and maintenance of the DOE for the long-term objectives of the transition. Those necessary roads will remain, whether paved or otherwise. HMC would prefer to leave all roads, paved or otherwise, in place, but will remediate and restore roads that could present a risk for nuisance trespassers.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
1-1e	A discussion and plan for any public water lines that exist within the proposed control boundary and discussions with the governmental agency that controls existing public water lines.	For any public water lines and the underlying easements that only serve lots or parcels acquired by HMC, HMC will terminate water service, cap and seal water pipelines, and bury any surface access points so that any underground facilities of value (such as copper pipes) will not be visible or disturbed by trespassers. For any larger water pipelines that cross the LTC boundary to service lands outside the boundary, those pipelines and underlying easements will remain. HMC intends to notify any water pipeline operators of the pending transition and, unless waived by the DOE, seek to obtain some form of institutional controls in writing that will set forth procedures for accessing, maintaining, fixing, or replacing such water pipelines and related facilities. While an easement owner, such as a water pipeline owner, is not typically an owner or operator under CERCLA, an easement owner can incur operator liability if the use, modification, or maintenance of the easement facilities results in a hazardous materials release. See Redevelopment Agency v. BNSF Ry., 643 F.3d 668, 680 (9th. Cir. 2011) (citing Long Beach Unified Sch. Dist. v. Dorothy B. Godwin Living Trust, 32 F.3d 1364, 1367-68 (9th Cir. 1994)). Thus, it will be in the interest of the water pipeline operator to establish institutional controls that will inform and protect all parties with respect to the long-term operation of the water pipelines and the long-term objectives of DOE's ownership and care of the property.
1-1f	A discussion and plan for any electric utilities that exist within the proposed control boundary and discussions with the utility that controls existing electric lines.	The response to this question is essentially the same as for water pipelines above. All electric utilities that only serve HMC-purchased lots or parcels will be terminated, and all surface access points will be buried so as to be undetectable from the surface (unless the utility or other laws or ordinances require full removal of electric lines, in which case HMC will remove those lines as directed). All electric utility lines and facilities that must remain because they cross the property to serve neighboring lands will be notified and institutional controls will be sought and negotiated (similar to water utilities, as discussed above).
1-1g	A discussion and plan for any rights-of-way, public land or additional infrastructure that may exist in the proposed control boundary.	For any other right-of-way, such as a fiber optic line or other similar above or below ground facilities, the same standards and approach detailed in subparagraphs (e) and (f) above will be followed. With respect to "public land," there are two parcels in the LTC boundary that are owned by the State of New Mexico. HMC has reached out to the New Mexico State Land Office ("SLO"), and a preliminary legal review has been completed. The next step in those negotiations is for HMC to prepare a presentation to the SLO and arrange for a meeting. If allowed under state law and if the agency is amenable, HMC will seek to purchase those parcels in fee simple. If a sale is not permitted or the agency rejects a purchase, then another option would be to engage with the DOE and the BLM to explore a land exchange between New Mexico and the BLM to transfer the LTC boundary parcels to the long-term ownership of the United States. A third option could be to implement some form of institutional controls that allow the state to retain ownership. In at least one other instance in another state, the state lands agency placed a permanent hold on contaminated state lands to prohibit activities that might disturb the contamination (e.g. mineral leasing and development, drilling of water wells or other similar development) but left the land open for grazing. If transfer in fee simple is not possible, a similar approach could be utilized for the lands owned by New Mexico. There are also a few parcels where HMC owns or hopes to acquire the surface estate, but the underlying mineral estate is owned by the United States and administered by the BLM. Those parcels should pass to the DOE for long term care and administration. While not mentioned in any of NRC's questions, HMC is in the process of identifying any split estate mineral interests. The title examination is substantially complete and shows that Homestake owns the majority of the mineral rights within the Long-Term Care Boundary. It also shows that three other parties own split estate mineral interests underneath HMC surface parcels (other than the BLM). Two of those parties are sophisticated mineral owners. HMC will seek to purchase those minerals. If a purchase cannot be negotiated, then HMC will seek institutional controls consistent with DOE guidelines. However, based on our research, there has been virtually no successful mineral development within the proposed long-term control boundary and the DOE's institutional control guidelines will highly discourage any efforts

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		HMC Response to Comment
		to develop the mineral estate. Thus, we anticipate that split estate mineral owners will be amenable to a negotiated sale on reasonable terms. There may be one outstanding grazing lease from HMC to a private party that covers portions of HMC's land in the proposed long-term control boundary which expires in 2026. If a License termination and land transfer would occur before that date, and upon demand of the DOE, HMC would seek to terminate that grazing lease early, as to the portions that apply to the proposed long-term control boundary.
1-1h	A discussion of the durability and enforceability of the 2018 State of New Mexico Order that restricts the permitting and drilling of wells for new appropriations, or replacement or supplemental wells, and restricts the permitting of any change to the point of diversion of any existing wells within the boundaries defined and as shown in ACL application Figure 1.2-56.	HMC anticipates that drilling of groundwater wells within the proposed long-term control boundary will be durably and enforceably barred by HMC's acquisition of property and placement of restrictive covenants. Accordingly, the 2018 State of New Mexico Order ("Order") will be largely or entirely unnecessary to prevent drilling of groundwater wells. Even if this were not the case, the Order would be effective in preventing such drilling. In 2018, the New Mexico Office of the State Engineer ("State Engineer" or "OSE") enacted an Order ("Order") prohibiting the permitting of new appropriations, drilling of new or supplemental wells, and transfer of groundwater wells within the boundaries identified in Attachments A and B, respectively, to the Order. See May 3, 2018, State Engineer Order, at pg. 1; see also id. at Attachments A, B. The State Engineer has broad legal and technical authority to administer declared ground and surface water basins in New Mexico, such as the Bluewater Basin, which was declared in 1966. See State v. Myers, 1958-NMSC-059, ¶10, 64 N.M. 186, 326 P. 2d 1075. Under this authority, the State Engineer can enact moratoria, such as the one at Grants, addressing permitting, drilling, and transfers in a given area. See id. New Mexico statutes also provide for enforceability of the Order. Specifically, the OSE can issue a compliance order against a person who violates the Order pursuant to N.M. Stat. Ann. § 72-2-18. The OSE will first provide the person an opportunity for a hearing, but the order will then become final. If the person does not comply with a final compliance order, the OSE may file a civil action to enforce the compliance order and receive any remedies provided in the section, including civil monetary penalties or injunctive relief. N.M. Stat. Ann. § 72-2-18. The Order also provides for durability, stating that it will remain in place for perpetuity or until such time as the groundwater concentrations have decreased to levels less than the WQCC standards set forth in 20.6.2.3103 NMAC. The fact that the Order indicates that it is to remain in place in perpetuity makes it unlikely that the OSE will terminate the Order. OSE has implemented similar orders for other Superfund areas in New Mexico. These orders have not been repealed since their adoption. In addition, the text and substance of the Order in effect serves as an additional institutional control and renders it highly unlikely that the Order would be repealed. Public records providing notice of contamination can serve as effective Institutional Controls by identifying the contaminated areas as unfit for use. Here, the Order explains that it is being issued because groundwater in the site area is contaminated. This provides an additional public notice that groundwater at the site is unsuitable for use. Accordingly, it greatly diminishes the likelihood that anyone would seek to access groundwater in the first place, that anyone would press OSE to rescind the Order, or that OSE would decide to rescind the Order. Express restrictions in deeds can further serve as a mechanism to ensure durability. Such restrictions involve a (1) deed notation and recording in the County real property records where the real property lies and (2) a notation in the OSE file for the water rights upon filing of a change of ownership form (COO) at the OSE. Both processes are described below.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		HMC Response to Comment
		Regarding the deed notation and recording, before transfer of the real property to the long-term custodian, a notation regarding the OSE Order can be included on the deed and a copy of the Order can be recorded in the county real property records where the real property lies. Regarding COOs with the OSE, upon transfer of any water rights from HMC to the long-term custodian, a COO will need to be filed with the OSE Water Rights Division (OSE-WRD). A copy of the deed must be provided with the COO. The moratorium-notated deed can be included with the COO form. A request also can be made to the OSE-WRD to annotate the COO form itself explaining that the respective water right is subject to an OSE moratorium. Annotating (1) the real property deed to be recorded in the county records and the (2) COO form with the OSE-WRD provides additional controls to ensure durable institutional controls.
1-1i	A discussion of the use of groundwater from the San Andres-Glorieta aquifer (SAG) within the proposed control boundary and if use of groundwater from the SAG within the control boundary can be fully restricted based on HMC's effort to acquire land ownership.	HMC is requesting approval of ACLs based on the reasonable presumption that access to and use of ALL groundwater (including the SAG aquifer) will be fully restricted within the proposed control boundary via ownership of all land interests (other than land or subsurface rights owned by the United States). HMC intends to record restrictive covenants prohibiting drilling of any water wells on all lands owned by HMC within the proposed long-term control boundary, including the lands overlying and controlling access to the SAG aquifer. For any properties that HMC is unable to acquire through good faith efforts, HMC will seek to negotiate similar institutional controls that will prohibit drilling of water wells on those properties.
1-1 Discussion-A	The proposed control boundary for this ACL application increases the total acreage of the boundary from approximately 1,200 acres to over 6,000 acres. There are currently 522 parcels in this expanded area, and HMC currently owns 356 of these parcels, which is about 84 percent of the land area. This area has a variety of owners including residential, commercial, and other government entities. Based upon the application, additional information will be required to assess the ownership interests HMC is obtaining (surface versus subsurface, quit claim deed versus warranty deed, restrictions, and other potential leases and licenses) from these various owners. HMC should provide information on the protectiveness, durability, viability, and liabilities attendant to the overall land ownership by HMC within the proposed control boundary and how that could and will be managed in the long-term.	As previously stated, this level of detail is not required under NRC regulations or suggested by NRC guidance for the NRC staff to accept the LAR for detailed technical review. Nonetheless, with the additional information provided above, HMC has provided substantially more information and in greater detail than required of any other licensee previously granted ACLs, and has certainly provided sufficient information for NRC staff to proceed with a detailed technical review. Further, HMC provides the following additional information. License termination and land transfer are not within the scope of the proposed action (i.e., establishing ACLs). Therefore, the detail and specificity of the information provided on this subject are focused on demonstrating that there is adequate control over access and use of groundwater for the period during which HMC is the Licensee (prior to license termination), while identifying that HMC has fulfilled the requisite serious and good faith efforts to acquire the appropriate and necessary controls over the long-term. HMC has already acquired surface and mineral estates in a large majority of the parcels and is in the process of negotiating the purchase of certain reserved mineral estates in some parcels, as discussed in more detail above. Should HMC's ongoing serious and good faith efforts to acquire fee title to the lands and all interests therein not be completely successful prior to approval of the proposed action, HMC will document and demonstrate its good faith efforts to acquire durable and enforceable institutional controls identical to or substantially the same as institutional controls that have previously been accepted by NRC (i.e., Split Rock Site); such as restrictive covenants that run with the land title, title to the subsurface estates only), in conformance with the requirements of 10 C.F.R. Part 40 Appendix A Criterion 11c. In the potential but unlikely event that not all land interests can be acquired, HMC would comply with the requirements identified in Criterion 11.c, provide notification in local public land records of the fact that the land is being used for the disposal of radioactive material and is subject to either an NRC general or specific license prohibiting the disruption and disturbance.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		HMC Response to Comment
		Control of access to and use of groundwater within the proposed boundary, while HMC is the Licensee, addresses the area of affected groundwater and not the entire area within the proposed boundary. During this period while HMC is the Licensee, the controls that ensure protection are identified in the response to Comment 1-1h, above. Long-term control of access to and use of groundwater within the proposed boundary after the HMC license is terminated and the land interests are transferred to the long-term custodian addresses the entire area within the proposed boundary. During this period after the HMC license is terminated, the controls that ensure protection are identified in response to Comment 1-1h. In addition, the protectiveness, durability, enforceability and viability of the identified institutional controls are de facto sufficient as demonstrated by their prior NRC approval.
1-1 Discussion-B	HMC states it will not allow use of groundwater on any land it owns within the control boundary for any purpose and HMC intends to provide demonstration of this effort to acquire the land ownership to NRC prior to final approval of this amendment request. If ownership cannot be obtained, it is unclear how access to groundwater can or will be restricted. The 2018 State of New Mexico Order is only intended to restrict groundwater use from the alluvial and Chinle aquifers and considering that New Mexico could rescind the order at any time, its durability is uncertain. There is little discussion of control and restriction of SAG water use within the proposed control boundary.	Access to and use of all groundwater (including the SAG aquifer) will be fully restricted within the proposed control boundary primarily through property ownership. For any properties for which full fee title cannot be acquired through good faith efforts, HMC will seek to acquire subsurface rights, water rights, and/or restrictive covenants to prevent access to groundwater. HMC has made serious good faith efforts to acquire nearly all properties within the proposed Long-Term Care Boundary and anticipates completing that effort during 2024. For any properties that cannot be obtained through good faith efforts, appropriate durable and enforceable institutional controls will be demonstrated.
1-2	The LAR does not contain a commitment from the proposed long-term care custodian to take land within the proposed control boundary, including the land between the point of compliance (POC) and distant point of exposure (POE) that is in excess of the land used for disposal of byproduct material.	Such commitment from the proposed long-term care custodian is not required under NRC regulations or suggested by NRC guidance for the NRC staff to accept the LAR for detailed technical review. Consequently, the perceived lack of this item does not provide a sufficient basis for the NRC staff to assert that the LAR is incomplete, or to decline to accept the LAR for a detailed technical review. Indeed, review of the administrative record for other uranium mill facilities regulated under Title II of the Uranium Mill Tailings Radiation Control Act demonstrates that NRC has accepted ACL applications for detailed technical review before acquiring a commitment from the proposed long-term care custodian to take land within the proposed control boundary. Notwithstanding the foregoing, HMC provides the following information. LAR Section 1.5.2 addresses this issue and states in relevant part, "*NRC and HMC have not yet verified whether the state or the federal government will be the long-term site custodian upon License termination. However, HMC discussions with DOE to date have confirmed that such a commitment is premature at this point, which is consistent with NRC guidance in NUREG-1620 and the requirements of Appendix A to 10 CFR Part 40. It is anticipated that, once this ACL Application is nearing acceptance, that commitment will be sought and presented to NRC in a subsequent submittal.*" NUREG-1620, Section 4.3.3.2(5) states: "*The **NRC and** the applicant must verify whether the state or the federal government will be the long-term site custodian, after the license is terminated. The applicant must **then** secure a commitment from that party to take custody of the site. The applicant **or the NRC** must then secure written assurance that the appropriate federal or state agency will accept the transfer of the specific property, including land in excess of that needed for tailings disposal.*" [emphasis added] NUREG-1620 states that ACLs involving a distant Point of Exposure (POE) may not be established (approved) before such a commitment is received. A distant POE is not proposed for the Grants site. Further, HMC has corresponded with DOE, which has stated that it is premature to make such a commitment at this time. DOE's position is logical given that the final limits of the boundary are subject to change as a result of NRC detailed technical review. In addition, this obligation is shared with NRC. NRC and HMC have not yet verified whether the state or the federal government will be the long-term site custodian. HMC believes it is unlikely that the State of New Mexico will take custody (and the US DOE/Office of Legacy

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
		Management will) because no State has taken custody of a Title II uranium mill site after all reclamation is complete for long-term custodial care.
1-2 Discussion-A	Due to the complexities of the number of properties in the proposed control boundary, a general statement that an applicant will acquire control on all properties or provide a demonstration of the effort to acquire land ownership, is insufficient and the NRC staff needs to treat the proposed POE(s) as a “distant” POE(s).	HMC respectfully suggests that NRC may not arbitrarily change its definition of a “distant POE” or the standards for accepting an application for technical review based on a generalized reference to “complexities.” NRC offers no substantive basis for any such changes. NRC does not state how this undefined “complexity” affects the viability of the proposed action nor does it provide any reference to what criteria, standard, or metric is insufficiently met by the information provided, and unfortunately provides no explanation nor justification in regulation or guidance as to why this issue renders the LAR unsuitable for detailed technical review. As stated previously, HMC does not believe such a regulatory basis exists.
1-2 Discussion-B	Written assurance is needed stating that the appropriate Federal or State agency will accept the transfer of the proposed property, including land in excess of what is needed for the tailings disposal (see NUREG 1620 Section 4.3.3.2 (5)). Alternate concentration limits may not be established at sites involving a distant POE until the licensee agrees to transfer the title to the land, and the appropriate Federal or State government commits to take such land, including the land between the POC and POE that is in excess of the land used for disposal of byproduct material. In this ACL application, HMC uses the control boundary to represent the groundwater POE (see ACL Section 4.2.4.3 and 4.3.2.1.1). Assurances are needed from the long-term care custodian to accept the nearly 6,000 acres of land contained within the proposed control boundary. Because of the complexity of the site (e.g., widespread contamination across multiple aquifers, multiple regulatory agencies), the risk significance of the site (e.g., proximity of contamination to potential receptors), and the uncertainty of modeling of the site (e.g., limited support for key modeling assumptions such as precipitation, recharge, contaminant transport), an agreement with the appropriate agency may require a significant amount of time.	See above response to Comment 1-2, above. Written assurance from the long-term custodian at this point in the License Amendment process is not required or should be reasonably expected. Given that the scope of the long-term boundary and the areas to be transferred have not been determined, such written assurances would be premature. This is not a sufficient basis for determining the application is incomplete and rejecting the application for detailed technical review. That said, HMC is eager to begin discussions with appropriate State and Federal officials on how to efficiently and promptly move toward transfer to a long-term custodian and we believe acceptance of the LAR ACL application for detailed technical review will enable such productive discussions.
1-3	The assumed precipitation rates do not appear to be consistent with historical precipitation rates and provide for uncertainty when associated with climate change projections.	This NRC comment reflects detailed technical review issues and should be addressed during that process. It does not provide a sufficient basis in the NRC regulations and guidance for declining to accept the application is for technical review. HMC believes this discussion is mixing the historical calibration period and the predictive period recharge assumptions. It also fails to recognize the recent study by New Mexico Bureau of Geology and Mineral Resources (NMBGMR) indicating that a significant decrease in basin recharge over the next 50 years is expected. This decrease will have the commensurate effect of significantly lowering the baseline for recharge in the basin. The NMBGMR’ (NMBGMR; Dunbar et al., 2022) recent report on climate change and associated impacts on water resources stresses the role that increased temperature will have on future reduction of groundwater recharge. *“[H]igher temperature will lead to more evaporation, and therefore less recharge of aquifers. Associated longer growing seasons and higher temperatures increase stress on aquifers by further increasing the water demand of vegetation. All of these interrelated factors will lead to lower water availability.*” Please see response to Comment 1-3 Discussion-B below for additional detail.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
1-3 Discussion-A	NRC staff is concerned with the significant discrepancy between the reported precipitation from the Grants-Milan Municipal Airport and HMC's GRP meteorological data (i.e., 44% higher annual precipitation at Grants-Milan Municipal Airport than GRP), which are located approximately 5 miles apart. Several factors (e.g., exposure and wind, rain gauge design and evaporation) could be biasing HMC's meteorological data low.	Please see the detailed response for Comment 1-3 Discussion-B on the inappropriateness of NRC's cited meteorological data. The detailed discussion below also provides a comparison between the NOAA data taken at the Grants-Milan Municipal Airport and the Grants Reclamation Project data.
1-3 Discussion-B	The NRC staff reviewed the Western Regional Climate Center (WRCC) data for Grants, NM, which HMC also relied upon. For the period from 1986 to 2022, annual precipitation averaged 13.5 in/year with a maximum annual value of 19.0 in/year (https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?nmXGRA), as shown in Figure 2. These precipitation rates from the Grants-Milan Municipal Airport are plotted against HMC's projected precipitation rates for the proposed base case, bounding case, and decreased precipitation case in Figure 3 below.	NRC staff cited an average yearly precipitation of 13.6 inches from a Remote Automatic Weather Station (RAWS) as representative of Grants, New Mexico. However, the referenced station coordinates are 35°14'30", 107°40'12" at an elevation of approximately 8,250 ft. Thus, the cited data is not representative of the conditions within the Licensed area or the proposed long-term control boundary. Consequently, we believe the NRC is utilizing an inapplicable location for comparison to model inputs. Additional information on the RAWS data can be found at the link below: https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?nmXGRA. Table 1.2-5 of the August 2022 ACL application was developed from Table 2-2 of the Draft Remedial Investigation Report (HDR, 2020), which incorrectly used the cited WRCC precipitation data. A revised Table 1.2-5 is attached as Exhibit A to this Attachment, which identifies the mean annual precipitation at the Grants Milan airport from 1953 to 2017 to be 10.23 inches, not 13.5 inches as indicated in NRC's comment. The PRISM method interpolates a database of climate records onto a spatial grid covering the coterminous United States (Daly et al., 2008). PRISM calculates a climate-elevation regression for each gridded spatial location based on data from nearby climate stations where long-term records are available, a digital elevation model (DEM), and other spatial datasets. Stations entering the regression are assigned weights based upon location, elevation, coastal proximity, topographic facet orientation, vertical atmospheric layer, topographic position, and orographic effectiveness of the terrain. The PRISM precipitation product was obtained for each month of the calibration period (2002 through 2019), averaged over each model stress period, interpolated to each MODFLOW-USG model node, and then scaled to develop groundwater recharge rates. Thus, recharge in the model varies both spatially and temporally within the calibration period. The attached Figure in Exhibit B shows the spatial variability of recharge for predictive modeling over the model domain for reference. The attached Figure in Exhibit C shows the annual average, maximum, and minimum precipitation values for the calibration period for the entire model domain. It also includes the annual precipitation amounts measured at the Grants, New Mexico, airport for the period of 1985 through 2017 (note: it appears that NOAA is currently not providing access to data from recent years). Note the PRISM minimum precipitation estimate coincides with the Grants Airport data as would be expected given the geography of the general San Mateo Creek basin area. Also, note the PRISM average precipitation rates very well model the measured data for the period of overlapping data and consistently over-estimate measured precipitation rates.
1-3 Discussion-C	The NRC staff is concerned that HMC selected a range of precipitation rates for the base case and bounding case conditions that was generally less than the recent precipitation rates from 1986 to 2022. Because of the uncertainty in climate projections, the level of support required for the assumption that future precipitation rates will be below the historical average for very long	Please see detailed response to Comment 1-3 Discussion-B for additional information on the inapplicability of NRC's cited data for comparison. As noted in that response, the range of precipitation rates for the base-case are the same as or greater than the recent precipitation rates from 1986 to 2022. Nonetheless, we appreciate the NRC bringing to our attention that Table 1.2-5 of the ACL application contains an error that is HMC's fault. Based on further review, Table 1.2-5 inadvertently provided data that is not representative of the Grants-Milan airport meteorological station

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
	periods of time (e.g., up to 1,000 years) would be exceptionally high. In addition, the assumed below-historical-average precipitation rates appear to be very risk significant as they contribute to a model-projected drying of the alluvial aquifer. This drying of the alluvial aquifer essentially cuts off the plume in the alluvial aquifer from migrating toward the subcrop area with the SAG aquifer. This SAG subcrop area is located near to Milan Municipal wells.	but is rather from a monitoring station on Mt Taylor at an elevation of over 8,200 feet above mean sea level. HMC regrets the error. A corrected Table 1.2-5 is provided in Exhibit A. These data indicate that the 60-year median precipitation rate at the Grants Milan airport is 9.93 inches per year while the 60-year mean precipitation rate is 10.22 inches per year. Figure 15 from the 2023 GRP ET Cover Design Report (ML23222A192) presents WRCC precipitation data at the Grants-Milan airport for the period 1954-2013 and the 2014-2020 precipitation data from the HMC Grants Reclamation Project (see Exhibit D to this Attachment). In addition, Table 10 of the ET Cover Design Report presents summary statistics for precipitation stations in the region, which show that the measured precipitation at both the site and the Grants-Milan Airport are consistent with precipitation in the region, as shown in Figure 16 (see Exhibit D to this Attachment). For comparison, Figure 4-9 from the Appendix 4.2-B of the August 2022 ACL Application illustrates the precipitation profile used for the base-case predictive model and the bounding-case predictive model (see Exhibit D to this Attachment). In addition, the subsequent Figure 4-10 compares the volumetric recharge for the predicted future precipitation profiles for both the base-case and bounding-case simulations, illustrating the magnitude of additional groundwater recharge assumed in the bounding-case model over the base-case model (see Exhibit D to this Attachment). These data indicate the base-case model used a precipitation profile representative of measured current conditions and the bounding-case model use a precipitation profile that results in future precipitation and recharge substantially above those anticipated form current conditions. The corrected data, with no new modeling, shows that NRC's concern is not warranted: the model indicates that episodic decreased alluvial aquifer saturation is likely to occur even with precipitation rates higher than current conditions. In addition, since the reduction of SAG aquifer usage in reinjection with treated water to 500 ac-ft per year in 2016, the water levels in the alluvial aquifer at the site have steadily declined at a rate of approximately 1.5 feet per year (HMC&HE, 2023). Prior to that reduction, water levels at the site had steadily risen from the early 1980s through the mid-2010s. This indicates that the levels of saturation observed over the last 30 years at the site are a result of a positive water balance at the site (i.e. injecting more water than collecting), and that a significant amount of desaturation is consistent with a conceptual understanding of the hydrology. Further, data for New Mexico Climate Division 4 from the National Oceanic and Atmospheric Association (NOAA) demonstrates a clear and significant upward trend in temperature within the Grants region beginning in the mid-1970s. Over the same period, NOAA documented precipitation trends have remained relatively stable (similar to the Grants-Milan airport data) or have shown a slightly decreasing trend. In combination, drought conditions as measured by the Palmer Hydrologic Frequency Index have become increasingly common in the basin since the mid-1990s. (NMBGMR; Dunbar et al., 2022) It follows, that with increasing drought conditions, groundwater recharge rates would not be a constant function of precipitation but instead exhibit a decreasing trend. The increased temperature and associated evapotranspiration means less precipitation is available to recharge shallow groundwater. Recent trends in climatic conditions show a clear increase in drought, which indicates a commensurate decrease in recharge in the basin over the last 25 years. This trend is expected to continue into the future as stated by the NMBGMR in their recent climatic report for the state of New Mexico (NMBGMR; Dunbar et al., 2022). HMC is not aware of any reliable data to indicate that the basin will either experience higher future recharge based on historical averages, or that trends will reverse and recharge will increase relative to historical averages in the basin.
1-3 Discussion-D	The groundwater model appears to be very sensitive to the assumed precipitation. A comparison of the base case figures (i.e., Figure 4 and Figure 5) with Figure 6 and Figure 7, shows the impact of a slightly higher recharge rate on the drying of the alluvial aquifer. In the base case with natural attenuation, the plume is shown below in Figure 5 as being effectively cut off before 1,000 years as the leading edge of the plume migrates toward the confluence with the Rio San Jose, just upgradient from the subcrop area. However, in the higher recharge sensitivity analysis, the alluvial aquifer remains hydraulically connected to the SAG subcrop area. The NRC staff further notes that HMC's higher	See response to Comment 1-3 Discussion-C, above

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
	recharge rate, which is based in part of the annual precipitation, does not appear to capture the historic average precipitation, as observed at the Grants-Milan Municipal Airport. Figure 7 shows that the leading edge of the plume under HMC's preferred Alternative 3 (i.e., ACLs) could result in impacts to the area where the SAG is in hydraulic communication with the alluvial aquifer. Also, HMC's bounding case, which also does not adequately capture historical precipitation rates at the Grants-Milan Municipal Airport, results in a cutting off of the plume prior to the plume reaching the subcrop area, as shown in Figure 8 and Figure 9 below. Accordingly, the NRC staff is concerned that actual precipitation rates could result in substantially greater impacts than assumed in HMC's ACL application, including impacts to the regional drinking water supply aquifer.	The ACL application specifically models and addresses SAG aquifer water quality at the POE under bounding case assumptions and demonstrates that it remains protective for 1,000 years (See ACL application Section 5).
1-4	The precipitation rate implemented in the groundwater model is unclear.	See responses below as well as the response to Comment 1-3 on the use of PRISM data both spatially and temporally. Even if Homestake had not fully explained precipitation rates used in its groundwater modeling, we believe this comment would have been more appropriate to address as part of the detailed technical review process and as written does not provide a sufficient basis in regulation and guidance for declining to accept the application for review.
1-4 Discussion	It is not clear in the ACL application how the annual precipitation rates are applied in the groundwater model. If the precipitation is temporally averaged (i.e., applied at an annual rate or averaged monthly or daily), then recharge could be underestimated. Even though annual pan evaporation may exceed annual precipitation, episodic events and snowmelt could still result in precipitation percolating into the groundwater. Figure 10 shows the monthly precipitation rates relative to the range of modeled precipitation if the annual precipitation was evenly divided across 12 months. Daily precipitation versus an average annual precipitation would illustrate an even greater disparity. To avoid potentially underestimating recharge, there needs to be some accounting and discussion of how episodic events are addressed within the model. [emphasis added]	Please refer to Section 3.4.1 of the historical calibration model report (ACL application Appendix 3.1-A) and Sections 2 and 5 of the predictive transport modeling report (ACL application Appendix 4.2-B). These sections identify how precipitation and recharge are handled in the model. In addition, as the NRC is already in possession of the actual modeling files, it can review the precipitation and recharge components of the model on its own. Recharge from snowmelt is represented in the PRISM data used for both the historical calibration and predictive simulations. Also, recharge in ephemeral channels, which is a more significant spatial consideration, is incorporated in both the calibration and predictive models. Inclusion and processing of daily climatic data and short-term/episodic events is not a standard of practice for long-term predictive groundwater model simulations. Model timesteps are not of the scale for such a long model simulation period to allow such inputs on an extremely short temporal scale. Modeling of short-term episodic precipitation events is not practicable for this model due to the annual time steps and long period of prediction (1,000 years). However, it is reasonably expected that the net effect of such randomly occurring high and low intensity precipitation events within a given year would average out over the long-term period of prediction and would not be expected to have a substantive bias in predictive results.
1-5	The assumed recharge rate in the groundwater model for years with above-average precipitation is not well supported in the LAR.	As stated previously, HMC believes that the NRC request for additional information on recharge rates is not a sufficient basis in regulation or guidance for declining to accept the ACL LAR for detailed technical review. Please see detailed response below for further discussion.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
1-5 Discussion	As discussed in Comment 1-3, the assumed precipitation and recharge rates are risk significant because of the potential for modeled drying of the cells representing the alluvial aquifer. In Section 1.2.2.3.3 of the ACL application, HMC discussed that the annual precipitation in 2020 was 7.55 inches and the average pan evaporation is approximately 63 inches/year, resulting in an annual moisture deficit for the region. Further, in Section 4.4 of the Groundwater Flow and Transport Modeling – Predictive Period Report, HMC discussed that projected increases in temperatures will significantly reduce groundwater recharge. The NRC staff note that recharge can still occur in areas where pan evaporation rates exceed precipitation rates because of temporal variability and averaging. The pan evaporation is an annual average. However, precipitation is episodic and not temporally distributed evenly throughout the year, so precipitation events can exceed average evaporation rates. During these events, precipitation can result in recharge before evapotranspiration can remove all of the moisture, especially during short, intense rainfall events. Also, the evaporation rate can vary significantly throughout the year. Accordingly, precipitation in colder periods could exceed evaporation rates, which can include snow melt. Lastly, higher temperatures can result in more evaporation, but the likelihood and magnitude of significant precipitation events also increases with the increased energy and increased air moisture holding capacity associated with those higher temperatures, as discussed in Section 10 of NUREG/KM-0015.	Ongoing trends in climatic conditions show a clear increase in drought from which we can infer a commensurate decrease in recharge in the basin over the last 25 years. This trend is expected to continue and accelerate into the future as stated by the NMBGMR in their recent climatic report for the state of New Mexico (NMBGMR; Dunbar et al., 2022). HMC is not aware of any reliable data that would refute this trend or indicate that the basin will either experience higher future recharge based on historical averages or that trends will reverse and recharge will increase relative to historical averages in the basin.
1-5 Discussion	In Section 4.4 of the Groundwater Flow and Transport Modeling – Predictive Period Report, HMC discussed that base case recharge rates were assumed to be 2 percent for precipitation rates less than 8 inches/year, 4 percent for 11 to 12 inches/year, and 5 percent for greater than 12 inches/year. These recharge rates are slightly higher than assumed by Maxey and Eaken (1949), which was cited by HMC, for precipitation rates of less than 12 inches/year. However, for precipitation rates of 12 to 15 inches/year, Maxey and Eaken assumed 7 percent recharge rather than 5 percent recharge. Most significantly, Maxey and Eaken assumed for precipitation rates of 15 to 20 inches/year that 15 percent would be recharge. The NRC staff review found that 14 of the last 33 years had precipitation rates exceeding 15 inches/year, based on the nearby Grants-Milan Municipal Airport.	Please see detailed response to Comment 1-3 on the inapplicability of NRC's cited precipitation data. In the NOAA data set from the Grants-Milan Airport, there are 3 years in total where the annual precipitation exceeded 15 inches/year from 1953 through 2017. Nonetheless, in Maxey-Eakin (1949), recharge rates for 8-12 inches/year of annual precipitation are scaled by 3% to estimate groundwater recharge. This is the approach used in the predictive period model for precipitation values less than 11 inches/year. As referenced in the Predictive Report, in areas with 11 or 12 inches/year of precipitation, the Wilson & Guan (2004) method was used, which is a modified Maxey-Eakin method that interpolates percentages for each precipitation increment of an inch. So, for 11 inches, Wilson & Guan (2004) used 4% scaling factor and for 12 inches they use 5%, 13 inches uses 6%, 14 inches uses 7%, and so on. The methodology used by HMC is conservative because the Wilson & Guan method increases the recharge rates at higher precipitation values relative to what would otherwise occur using the tradition Maxey-Eakin (1949) approach. Figure 4-10 of the Predictive Period report graphically illustrated the significant increase in recharge as a result of the higher precipitation rates assumed for the bounding case model run. As shown in the figure the volumetric recharge for the increased recharge rate is over 20% higher than that of the base case for over half of the model duration.
1-5 Discussion	Uncertainty in the recharge rate has a significant impact on the model results because potential plume migration towards the POE, and, in association with the uncertainty of other model input parameters, may lead to non-compliance with Criterion 5B(6). The NRC staff is concerned that recharge could be underestimated by	An appropriate predictive sensitivity analysis was performed to increase future recharge where the total volume and volumetric rates of recharge applied over the entire 1,000-year predictive period were significantly increased relative to the base case. Please see detailed responses above to questions on precipitation rate and recharge rates bases.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		HMC Response to Comment
	assuming below-average precipitation and excluding higher precipitation years. Accordingly, the groundwater model could underestimate plume migration and risk.	
1-6	The assumed percolation rate through the LTP is not well supported in the LAR, considering events such as episodic events and snowmelt.	The specificity discussed herein relates to detailed technical review questions and does not provide a defensible basis for determining the application is incomplete and rejecting the application. The estimated percolation rates assumed in the ACL Application are conservative in comparison to the modeled percolation rates done in support of the LTP ET Cover Design (ML23222A171). The base case modeling expected percolation through the cover to be less than 0.01 inches/year. In addition, the modeling included an evaluation of expected percolation over wettest periods of 10 and 100 years for both annual and winter precipitation. Even in a century-long period with wetter than average winter or annual precipitation, the anticipated percolation is less than 1mm/year. In comparison, the bounding case model assumed approximately 11mm of infiltration which is an order of magnitude higher than predicted. The bounding case rate is also more than double that of the highest estimated recharge value presented for sites in New Mexico identified by Caldwell and others in the “Evapotranspiration cover at Uranium Mill Tailings Sites” paper published in the Vadose Zone Journal 2022.
1-6 Discussion	In the ACL application, HMC appears to have assumed a percolation rate of 1.5 mm/year and 6 mm/year for the base case and bounding case conditions, respectively. By letter dated September 28, 2022,[5] the NRC staff provided comments on HMC’s License Amendment Request for an evapotranspiration cover. In the letter dated September 28, 2022, the NRC staff requested additional information related to percolation through the cover. Support could include lysimeter data from a test cover, lysimeter data from the actual cover with a monitoring period sufficient to capture at least the near-term percolation and pedogenic processes, and/or data from similar covers in similar climates.	Please see detailed discussion for Comment 1-6 above.
2-1	The assumed contaminant flux from the Drain Down Model for the LTP needs additional support with longer-term monitoring results.	This NRC comment reflects detailed technical review issues and should more appropriately be addressed during the technical review process. It does not provide a sufficient basis in regulation or guidance for declining to accept the application is for technical review.. For the detailed discussion of the conservative percolation rate assumption, please see the discussion for Comment 1-6. In terms of estimated concentrations for purposes of predicting future contaminant flux, Section 2.1.1.2 of the ACL Application provides detailed geochemical characterization of the current tailings porewater. In addition, the bounding case model run assumed a concentration of 45 mg/L uranium, which was representative of pre-flushing concentrations in the tailings sumps. In spite of no evidence to support a rebound to those concentrations, this conservative assumption was utilized in to adequately bound contaminant flux conservatively.
2-1 Discussion	In Section 4.5.1 of Appendix 4.2-B, HMC discussed that the baseline Drain Down Model seepage rates were not predicted to be a significant contributor of uranium mass to the alluvial aquifer in the future. However, it is plausible that the flux from the LTP could be greater than assumed in the ACL application. For example, it took approximately 10 years for several contaminant concentrations to reach steady-state conditions during the LTP flushing program. Because the flushing program ended less than 10 years ago, steady-state conditions may not have been achieved at this time and tailings concentrations could still	It appears to HMC that the NRC has not recognized that the bounding-case source terms for the predictive model (See Section 5.1.3) utilized highly conservative values for the tailings source term. To illustrate the conservatism applied for the source term inputs in the bounding case for the predictive model runs, the following data (below) identifies the characterization data for the measured pre- and post-tailings flushing concentrations and then identifies the long-term source conditions assumed for the bounding-case predictive models. Section 2.1.12 identifies the representative Large Tailings Pile concentration data, both from 1987 NRC sampling of the tailings and from calculation of average seepage concentrations since 2006 based on HMC sampling. The 1987 NRC sampling data identify dissolved uranium concentrations ranging from 9.5 mg/L to 22.1 mg/L and dissolved molybdenum concentrations ranging from 39 mg/L to 58 mg/L.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
	rebound. Additional data may be needed to demonstrate that LTP seepage rates have stabilized and rebound will not occur.	Figure 2.1-3 identifies the average pre-flushing (pre-2000) tailings well dissolved uranium concentrations ranged from approximately 40 mg/L to 45 mg/L and post-flushing (post-2015) dissolved uranium concentrations range from approximately 5 mg/L to 6 mg/L. Figure 2.1-4 identifies the average pre-flushing (pre-2000) tailings sump dissolved molybdenum concentrations ranged from approximately 95 mg/L to 115 mg/L and post-flushing (post-2016) dissolved molybdenum concentrations range from 15 mg/L to 17 mg/L. Figure 2.1-5 identifies the individual pre-flushing (pre-2000) tailings sump dissolved uranium concentrations ranged from 30 mg/L to 130 mg/L with the majority of pre-flushing tailings sump uranium concentrations ranging from 30 mg/L to 50 mg/L). The 2020 post-flushing dissolved uranium sump concentrations range from 8 mg/L to 20 mg/L. Section 2.1.1.4 presents the evaluation of potential future rebound in tailings porewater concentrations from current relatively lower concentrations to potentially higher future concentrations. This evaluation identifies the following, which does not support the presumption of substantial future tailings concentrations rebound to pre-flushing levels. "*Results from the supplemental Large Tailings Pile rebound investigation indicated that a few select tailings sumps and former Arcadis rebound monitoring wells have demonstrated increasing constituent concentrations since flushing ceased but the increases are minor compared to pre-flushing concentrations and none have returned to pre-flushing concentration (WME, 2020a; also see Figures 2.1-3 through 2.1-8 of this ACL Application). However, monitoring results from the short-screen wells indicate either decreasing or overall stable concentrations of constituents in Large Tailings Pile pore water (Figure 2.1-9). In addition, results from the controlled static column study provided no indication of diffusive rebound over a one-year test period (Figure 2.1-10 and Figure 2.1-11). The volume-weighted concentrations of uranium, molybdenum, and selenium in the Large Tailings Pile have also been decreasing since flushing ceased, providing no indication of diffusive concentration rebound in the Large Tailings Pile as a whole (WME, 2020a).*" Section 2.1.1.5 develops a reasonable upper bound for future tailings seepage concentrations (Table 2.1-1). However, the potential future concentrations at the POE are evaluated using a bounding-case predictive model run, as developed in Section 5.1.3 with the inputs presented in Table 5.1-1. For the long-term bounding case tailings seepage inputs, a uranium concentration of 45 mg/L was used, commensurate with the average pre-flushing tailings uranium concentrations. Tailings seepage rates were assumed to be 4 times higher than predicted base-case steady state long-term steady state seepage rates. The bounding-case long-term seepage rate (2.4 gpm) is higher than the range of seepage rates calculated using the data presented in Caldwell et al., 2022.
3-1	The low-permeability zones, which appear to control the long-term uranium groundwater concentrations, are not adequately characterized in the LAR.	The issues discussed herein are appropriate for a detailed technical review and should be addressed during that process. They do not provide a sufficient basis in regulation or guidance for declining to accept the application for detailed technical review. The basis for the estimation of mass resides in the low permeability zones is provided within the ACL Application. Section 5.5.2 of the Groundwater Flow and Transport Calibration Report presents the basis for the contaminant mass (and concentrations), and the mass flux rate from the low permeability zone. Two separate approaches were used to estimate the mass present in the low permeability zones (the approach specified in Section 5.5.2 of the Calibration Report and the approach articulated in Appendix G of the Calibration Report, both found in Appendix 3.1-A of the ACL Application) and the difference between the two approaches yield only 6% difference in estimated mass. The mass flux rate was taken from literature for calcium-uranium complexations as specified in Appendix 3.1-A and in the Groundwater Flow and Transport Predictive Period Report (Appendix 4.2-B), and the value was evaluated in the sensitivity analysis. The results of the sensitivity analyses showed that adjusting the value by an order of magnitude showed little change to overall model behavior.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
3-1 Discussion	The low-permeability zones in the alluvial aquifer appear to control the long-term uranium groundwater concentrations based on a comparison of the base case (Figure 4), Back-Diffusion Only Source (from the low-permeability zones) Sensitivity Analysis (Figure 11), and the LTP Seepage Source Sensitivity Analysis (Figure 12). HMC discussed that sensitivity analyses indicated that model results were not sensitive to model parameters related to low-permeability zones. However, several model assumptions (e.g., alluvial cell drying) appear to obscure results from these sensitivity analyses. In other words, if parts of the alluvial aquifer are assumed to dry out and plume migration is effectively cut off, then the assumptions related to contaminant transport would not impact the model results. Because the NRC staff has concerns regarding HMC's assumptions that result in cell drying (see Comment 1-3, Comment 1-4, and Comment 1-5) and the low-permeability zones appear to control long-term uranium groundwater concentrations, the licensee will likely need additional characterization information regarding the low-permeability zones, such as: • Characterization of the presence and distribution of low-permeability zones and high permeability zones; • Characterization of the uranium mass and concentration in low-permeability zones; • Characterization of the uranium concentration gradients in the high permeability zones leading to or from the low-permeability zones; • Characterization of the physical and hydraulic properties of the high and low-permeability zones; and • Characterization of the mass transfer rates into and out of the low-permeability zones.	Please see detailed responses above. The issues discussed herein are more appropriately addressed during the detailed technical review issues and should be addressed during that process. They are not a sufficient basis in regulation or guidance for declining to accept the application for detailed technical review.
3-2	The methodology used for calculation of the proposed values for the ACLs may require additional basis and discussion, which may include:	The specificity discussed herein relates to detailed technical review questions and should be addressed during that process. This is not a sufficient basis in regulation and guidance for finding the application is incomplete and declining to accept the application for detailed technical review. Nonetheless, in the spirit of moving the process forward, HMC is providing the following information in response to the NRC staff's individual comments:
3-2a	The corresponding model-predicted impacts at the POE's may need to be adjusted, if the maximum observed value is used as the ACL which is greater than the impacts predicted by the model;	Potential adjustment of model-predicted impacts at the POE's may or may not be required but should be considered within the context of the modeling issue addressed elsewhere in the responses to NRC's comments. HMC proposes to defer addressing this issue once consensus regarding the calibration and input parameters of the groundwater flow and contaminant transport modeling are resolved as part of the detailed technical review process.
3-2b	The possible analysis error resulting from using background in the attenuation factor analyses that will ***likely be conservative as proffered by the applicant*** (i.e., the calculated attenuation factor is lower than the actual attenuation factor) will need further discussion; [emphasis added]	No detailed response is needed as HMC recognizes that the analysis is understood to be conservative.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
3-2c	Further explanation is required as to why POEs are located “along principal transport paths at points where predicted solute isoconcentration contours were the closest to the control boundary” and why POE concentrations were not evaluated in the centerline of the plume;	NRC is not accurately characterizing and perhaps doesn’t understand the description of the POE locations. The full text from the ACL application Section 4.3.2.1.1 (Points of Exposure) states: “*To assess representative **maximum** predicted groundwater concentrations along the control boundary, observation points were placed in the predictive model at 12 key points along the boundary to report predicted groundwater concentrations over the next 1,000 years (Figure 1.5-1). Observation points were placed in each hydrostratigraphic unit at downgradient edges of the control boundary along the principal transport paths **and** at points where predicted solute isoconcentration contours were closest to the control boundary.*” [emphasis added] The intent of the text in the ACL application was to say the POE are located where maximum predicted groundwater concentrations would be expected (i.e., at the centerline of the groundwater plumes). The point that POE were **also** located “***and** at points where predicted solute isoconcentration contours were closest to the control boundary*” was to demonstrate to NRC that concentrations at the proposed boundary was also protective where the lateral margins of the plume were close to the boundary, although maximum concentrations would not be expected at these locations. HMC proposes to defer addressing this detailed technical review issue further until consensus between HMC and the NRC regarding the calibration and input parameters of the groundwater flow and contaminant transport modeling is achieved as part of the detailed technical review process.
3-2d	The possible bias in the maximum POE concentration due to the POE location becoming dry during the simulation or the intervening alluvial aquifer becoming dry during the simulation impeding the horizontal plume migration will need further discussion; and	See responses to Comments 1-3, 1-4 and 1-5. Drying (desaturation) of the alluvial aquifer over time is a natural condition predicted to occur even under bounding case assumptions that conservatively overestimate groundwater recharge and other transport inputs. This is the same drying methodology with which the NRC concurred in approval of the Ambrosia Lake ACL Application directly up basin from the HMC Grants Site (See Attachment 2- Administrative Record for Referenced ACL Applications). This result is due to a) primarily a response to the cessation of water injected as part of the groundwater corrective action program and b) secondarily predicted long-term fluctuation of precipitation and recharge. The bounding case model input assumptions do not bias the predicted result toward drying but rather provide additional natural recharge above the current precipitation and recharge conditions.
3-2e	The applicant will need to demonstrate that well SZ is representative of groundwater flow through the alluvial aquifer at the proposed POC.	The issues discussed herein are detailed technical review issues and should be addressed during that process. They do not provide a sufficient basis in regulation or guidance for declining to accept the application for detailed technical review. Nonetheless, please see detailed response below for further discussion. HMC does not assert Well SZ is representative of **all** groundwater flow through the alluvial aquifer. However, HMC does assert location SZ is an actual groundwater monitoring well in the uppermost aquifer at a downgradient margin of the waste management facility (tailings cell). This well is proposed as one of many POC wells precisely because it has the highest real measured concentrations of some, but not all, of the identified hazardous constituents. Criterion 5B.1 requires “*Hazardous constituents entering the groundwater from a licensed site must not exceed the specified concentration limits in the uppermost aquifer beyond the point of compliance during the compliance period*“. For this License amendment application, the “*specified concentration limits*” are the proposed ACLs. For this application to comply with Criterion 5B.1, HMC must address the data in Well SZ, even if it is not a POC well or even if it not representative of the overall groundwater system. The maximum value at any site is never representative of the overall system, as discussed further below. However, well SZ does represent a real, measured groundwater concentration that must be addressed and encompassed by the proposed ACLs under the Criteria in Appendix A to 10 CFR 40. Seepage from tailings piles is never uniform or homogeneous and the alluvial aquifer into which the tailings seepage enters does not transport that seepage in a homogeneous manner. Therefore, it would be expected that there be a range of hydrologic conditions and water quality conditions across the groundwater flow system assessed by each well in that aquifer. Some wells will monitor groundwater representative of aquifer areas with relatively lower tailings seepage input concentrations and/or seepage rates while some wells will monitor groundwater representative of aquifer areas with relatively higher tailings seepage input concentrations and/or seepage rates. Similarly, some wells will monitor groundwater representative of aquifer areas with relatively lower permeabilities (silty and clayey zones) while some wells will monitor groundwater representative of aquifer areas with relatively higher permeabilities (sandy or gravely zones).

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
		Each of these locations would be representative of the specific location it monitors and be representative of the range of conditions occurring at a site but each would invariably **not** be representative of **overall** groundwater flow through the alluvial aquifer.
3-2 Discussion f	The attenuation factor analyses presented in the application appear to employ a sizable number of errors. First, if the maximum observed value is used as the ACL, which is greater than the impacts predicted by the model at the POC, then the corresponding model-predicted impacts at the POE's should be adjusted accordingly. For example, if corrected by simple scaling, the maximum uranium concentration at POE-9 would be 0.0445 mg/L (0.0225 X 1.976) rather than the model-predicted concentration (i.e., 0.0225 mg/L) using a scaling factor of 1.976 ((57.7 mg/L (Proposed ACL) / 29.2 mg/L (maximum model-predicted concentration)). Such a POE concentration exceeds the uranium Maximum Contaminant Limit (MCL) of 0.03 mg/L, which would be the appropriate standard for uranium at the proposed POE location.[6] ([6]The applicant uses a background value of 0.16 mg/L for the POE locations. However, that background value was approved for the tailings impoundment location. The POE locations are several miles from the tailings and the background value for the tailings pile location is not appropriate.)	HMC appreciates NRC's point and proposes to defer addressing this issue further until consensus between NRC an HMC regarding the calibration and input parameters of the groundwater flow and contaminant transport modeling is achieved as part of the detailed technical review process. HMC looks forward to a productive dialog with the NRC on this matter after the LAR is accepted.
3-2 Discussion g	Second, the attenuation factor values are based on POE concentrations of +/- 0.02 mg/L. However, those values are likely the model-assumed background of 0.02 mg/L with a variation due to numerical dispersion (inherent in modeling software) or mixing with recharge with a model-assumed concentration of 0.01 mg/L rather than due to the plume migration. While using background in the attenuation factor analyses will likely be conservative as proffered by the applicant (i.e., the calculated attenuation factor is lower than the actual attenuation factor), the analysis is in error and should be discussed.	Respectfully, HMC does not agree that considering predicted maximum groundwater concentrations at exposure points, rather than exposures above background, is an erroneous analysis. Exposure assessment (Section 3.5) is based on total exposure concentration, not exposure above background. As the NRC acknowledges, HMC recognizes that this is a conservative approach. HMC proposes to defer addressing this issue further until consensus regarding the calibration and input parameters of the groundwater flow and contaminant transport modeling is achieved as part of the detailed technical review process. HMC looks forward to a productive dialog with the NRC on this matter after the LAR is accepted. `
3-2 Discussion h	Third, the attenuation factor methodology is most appropriate when the POC and POE are on the centerline of plume migration and both have been affected by the plume major attenuation processes. Away from the centerline, the attenuation factor may be more of a factor of transverse dispersion rather than the primary advective process of adsorption. For example, if the POE location is not affected by the plume, then a calculated attenuation factor value would approach infinity as the impacted concentration at the POE is zero (the attenuation factor is the concentration at the POC divided by the concentration at the POE). The application states that the POE are located "along principal transport paths at points where predicted solute isoconcentration contours were the	See response to Comment 3-2c, above. The groundwater plume isocontours above the License protective limits do not cross the proposed long-term control boundary, if they did the boundary would not provide reasonable assurance of protection. Response to Comment 3-2c identifies that the POE locations are appropriately placed to identify maximum predicted concentrations at the proposed long-term control boundary. HMC has intentionally proposed a control boundary that does not have any groundwater contaminant plumes with concentrations **above** the proposed *specified concentration limits* in order to provide the requisite reasonable assurance of protection and to comply with the requirements of Appendix A.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
	closest to the control boundary." The applicant should have considered the concentrations in the centerline. Unfortunately, based on the model-predicted water table contours, the NRC staff **anticipates** that no plume centerline crosses the long-term control boundary. As such, any elevated concentration in the source area would be acceptable even without any corrective actions which is contrary to the requirements for an ACL to be as low as is reasonably achievable (ALARA). [emphasis added]	
3-2 Discussion i	Fourth, the maximum POE concentration may be biased because the POE location becomes dry during the simulation or the intervening alluvial aquifer becomes dry during the simulation impeding the horizontal plume migration. For example, the maximum model-predicted concentration in Layer 1 (alluvium) at the POE-11 location is 0.014365 mg/L. However, that concentration is observed during the 5th stress period (5th year after cessation of the corrective actions) and the cell, which is alluvium, becomes dry thereafter. The NRC staff does not expect that the plume would reach the location of POE-11 within 5 years and such a comparison is not technically appropriate.	See responses to Comments 1-3, 1-4, 1-5, and 3-2d. The calculation of ACLs within the LAR utilizes the maximum concentration predicted at any POE in any water-yielding layer. The proposed LTCB encompasses all points that may exceed the specific standard at any time during the 1000-year predictive period, and thus is conservative. Constraining the calculation of ACLs to only periods of "appropriateness" inserts an unnecessary level of subjectivity and would not make the ACLs more protective.
3-2 Discussion j	Fifth, a constituent concentration based on the current observed maximum levels at well SZ is not likely representative of groundwater flow through the alluvial aquifer at the proposed POC. Historically, the concentrations of all constituents at well SZ have been elevated and more consistent with the 1980's tailings liquid quality rather than that of the alluvial aquifer. The NRC staff **assumes** this concentration is a relict when tailings fluid spilled into the aquifer and, at this location, the strata had a high affinity to sorb the constituents. If correct, such strata would not yield sufficient flux to the aquifer to significantly contribute to the plume quality downgradient of the POC. The applicant has not provided a boring log for this well or other tests to better define its role as a POC well. It should be noted that a conclusion similar to staff's assumption that well SZ is not representative of the aquifer was reached by the licensee in evaluating water levels during aquifer testing/monitoring. [emphasis added]	See response to Comment 3-2e, above. The boring log from Well SZ is provided in Exhibit E. As shown in the drilling log, the screened interval is within the saturated alluvial material. In contrast to NRC's speculation, the drilling log indicates the well had an estimated yield of 15 gpm, which is well within the observed ranges of well yields in the vicinity of the site. The staff is correct that an HMC report in the early 1980s indicated that the water level in the well may have not been representative of groundwater in the early 1980s after less than a decade of data (the well was drilled in 1977). However, the last two decades of monitoring demonstrate the well acts consistently with other wells in the general vicinity as shown by the areal map and hydrograph included in Exhibit E with the boring log. See response to Comment 3-2e, above.
3-3	The model appears to artificially isolate the SAG aquifer from the alluvium that will require further explanation in the LAR.	This NRC comment reflects detailed technical review issues and should be addressed during that process. It does not provide a sufficient basis in regulation or guidance for declining to accept the application for detailed technical review. Please see a detailed response below.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
3-3 Discussion A	The model appears to artificially isolate the SAG aquifer from the alluvium by: 1. Assigning a low hydraulic conductivity to the top 20 feet of the SAG. A low conductivity to the uppermost limestone (San Andres Formation) would limit the infiltration to the underlying portion of the SAG (Glorieta Sandstone). On the other hand, data from two irrigation wells within the control boundary suggest the upper limestone (San Andres Formation) is highly permeable with driller yield estimates of 1000 gallons per minute. In addition, the Hydrogeologic Conceptual Site Model Report (Appendix A of the ACL Model Calibration Report) list the San Andres Formation as highly permeable.	The NRC appears to infer that the San Andres Glorieta aquifer is homogenous in the vertical distribution of hydraulic conductivity. HMC is unaware of any study other than its 2021 study that evaluated the SAG in high enough resolution to identify specific flow zones within the limestone and sandstone. The low hydraulic conductivity of the upper portion is based upon site-specific data collected in the 2021 study. The 8 samples taken of the limestone in the top 20 feet of the formation had an average porosity of 5.1%, with a range from 3.7% to 6.6%. Neither the FLUTE transmissivity profiles nor the heat pulse flowmeter measures indicate that the upper 20 feet of the limestone contribute to the overall high hydraulic conductivity of the regional aquifer. The profiles and measurements instead indicate that the significant flow zones within the SAG are closer to the contact of the San Andres limestone and Glorieta sandstone. In the absence of the NRC providing more detail on the data from two irrigation wells in the vicinity, HMC can only assume the staff is referring to wells 907 and 911, the closest SAG wells to the study area. HMC concurs with the agency that these wells can yield a substantial rate, however, the agency appears to have failed to consider the length of well completion. Well 907 identified the top of the SAG at 260' and was originally drilled to a depth of 315': not until it was deepened to 360' was the discharge noted at 1400gpm. While the original yield of the well isn't noted on the log, it was low enough that the well owner felt the need to deepen it in order to generate a sufficient yield for irrigation, thus providing an anecdotal data point supporting the conceptualization of a competent layer of limestone at the top of the formation. Well 911 identified the top of the SAG at 130' and was also deepened to 200', after its initial drilling to 188', in order to increase its yield. Thus, while the wells do support the conceptualization of a highly prolific aquifer, they do not provide any useful data to contradict the site-specific and much more detailed analysis and conceptualization of the SAG incorporated in the ACL application. .
3-3 Discussion B	2. Assigning a General Head Boundary (GHB) in the southeastern corner of Layer 2 that effectively lowers the potentiometric surfaces for layers 3 through 9 (Chinle) but not in layers 10 and 11 (SAG). The reference head in a GHB in Layer 2 is 6019.6 ft-MSL. For comparison, the reference head in the GHB in Layer 11 at the same location is 6379.95 ft-MSL. The GHBs in Layer 2 may be artificial.	The Layer 2 GHB head elevations in the SE corner of the model are set slightly higher than the Layer 2 hydrostratigraphic unit bottom elevations. This approach conceptualizes saturated but unconfined conditions within this unit and groundwater exiting the domain through the boundary in Layer 2. SAG groundwater head elevations (Layer 11) are higher than Layer 2 GHBs based on observed groundwater elevations and gradients indicating that this portion of SAG is likely highly confined. Furthermore, there are no GHBs in Layers 3 through 9 and it is unlikely that a GHB with a higher head elevation (i.e., that in Layer 2) than these deeper layers would "effectively lower potentiometric surfaces for layers 3 through 9," as NRC suggests. Additionally, there is approximately 790 feet of thickness (Bottom of Layer 2 to Bottom of Layer 9), including low permeability shales, separating any hydraulic influence that Layer 2 GHB head elevations may have on simulated SAG groundwater conditions. HMC believes it is unlikely that Layer 2 GHBs in the SE corner model would have any influence on model calibration or predictive results. HMC further believes that basic sensitivity analyses can be performed during the course of the detailed technical review to confirm whether or not this is the case. Domenico, P.A., and F.W. Schwartz. 1998. Physical and Chemical Hydrogeology. John Wiley & Sons, New York, 506 p. Woessner, W.W., and E.P. Poeter. 2020. Hydrogeologic Properties of Earth Materials and Principles of Groundwater Flow. Available online at Hydrogeologic Properties of Earth Materials and Principles of Groundwater Flow - The Groundwater Project (gw-project.org). 205 p.
3-3 Discussion C	3. Assigning an extremely low hydraulic conductivity to the Chinle shales. The hydraulic conductivities assigned to the Chinle shales (layers 3, 5, 7, and 9) are from 2.5e-4 to 1.0e-3 feet per day. Within the control boundary, even at the assigned low hydraulic conductivities, some impacts are reaching the SAG. In the southern area of the alluvium where the alluvium directly overlies the San Andres, the impact to the SAG would be more significant due to the lack of an intervening Chinle Formation if the plume migrated into this area.	Domenico and Schwartz (1998) estimate that horizontal conductivities for shales range from 2.8x10-9 to 2.8 x 10-7 feet/day in the horizontal and 2.8x10-10 to 2.8 x 10-8 feet/day in the vertical directions. Woessner and Poeter (2020) do not distinguish between horizontal and vertical values but provide typical hydraulic conductivities for shales ranging from 2.8x10-8 to 2.8x10-4 feet/day. All shale values in the model are isotropic. Across the 4 shale units, the total range in hydraulic conductivities range from 2.5x10-4 to 1x10-3 feet per day. The slightly higher values used in the model relative to those described in typical hydrogeology textbooks account for the fractured nature of the shales in the vicinity of the GRP. These values are consistent with the typical high-end of the hydraulic conductivity value range for this rock type.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		HMC Response to Comment
		The only simulation performed where mass reached the SAG occurred within the subcrop area for a highly conservative unit concentration (no contaminant retardation in transport) bounding-case analyses (increased precipitation and recharge assumptions) which resulted in a 1/100 concentration value relative to source term concentration beneath the LTP. Figure 5.1-3 of the ACL Application illustrates the predicted unit concentrations at POE 9 and POE 10 from bounding-case predictive model runs, the POE most relevant to SAG aquifer flows from the subcrop under the Rio San Jose alluvial aquifer.. This figure , along with the calculations presented in Table 5.1-7, demonstrate that the SAG aquifer concentrations remain protective of all beneficial uses for the entire 1,000-year compliance period under conservative bounding-case source and transport conditions at the proposed long term control boundary. None of the base-case or bounding-case model runs show hazardous constituent concentrations above the MCL in the SAG reaching the POE. Given the high values of shale hydraulic conductivity used in the model, the potential for mass passing directly through the shales is accounted for yet it does not occur in any predictive simulation for either the unit concentration or uranium models.
3-4	The model predicts the SAG aquifer is dry in the area west of Route 122 that appears to be contrary to the conceptual model of recharge to the SAG along the northwestern flanks of the Zuni Mountain.	This comment reflects detailed technical review issues and should be addressed during that process. It does not provide a sufficient basis in regulation or guidance for declining to accept the application for detailed technical review.
3-4 Discussion	The model predicts the SAG aquifer is dry in the area west of Route 122. This prediction is based on a thickness of the SAG of 350 feet and may or may not be correct. The prediction, however, is contrary to the conceptual model of recharge to the SAG along the northwestern flanks of the Zuni Mountain (see Figures 23 and 24 in the Licensee's San Mateo Creek Basin and HMC Hydrogeologic Site Conceptual Model). It is possible that lowering of the SAG potentiometric surface by 40 feet during the previous 30 years may have resulted in drying of the recharge area. However, the New Mexico State Engineer database lists a well (B-01898) completed in 2015 near the location of the southwestern boundary of the modeled area. The well has a depth to water of 300 feet and a depth of 400 feet, which the driller described as limestone and sandstone. The surface elevation at this location is estimated by staff at 7000 ft-MSL. This information can be interpreted that the Glorieta is partially saturated though the potentiometric head is significantly higher than that measured in the Rio San Jose valley.	Estimating ground surface elevation at well B-01898 from Google Earth yields an approximate value of 6,707 feet. Subtracting 300 feet from ground surface, yields an approximate groundwater elevation in this well of 6,407 feet. The screen shot provided in Exhibit F for the end of the historical calibration period shows the well location and the simulated dry cells in purple and, where the aquifer is saturated is colored white. The well is simulated as being saturated by the model. The simulated heads versus the observed value provided in Exhibit F shows the model slightly overestimates groundwater elevations close to the mountain front contrary to NRC's assertion. Therefore, the model is not in conflict with the conceptual model of recharge along the Zuni Mountains.
3-5	The assumptions and parameters used for Layer 2 of the model are not well supported and will likely require additional basis	This NRC comment reflects detailed technical review issues and should be addressed during that process. It does not provide a sufficient basis in regulation or guidance for declining to accept the application for detailed technical review. Nonetheless, responsive information is provided in the responses to Comment 3-3 Discussion B and Comment 3-4 Discussion.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
3-5 Discussion A	The regional model may be unduly influenced by assumptions for input parameters needed for Layer 2. Layer 2 represents the undifferentiation of bedrock units younger than the Chinle Group. The units include the Jurassic- to Cretaceous-age Entrada Formation, Todilito Limestone, Summerville Formation, Bluff Formation, Morrison Formation, Dakota Sandstone, Mancos Shale, Gallup Formation, Crevasse Canyon Formation, and the Menefee Formation. The model assigns a single hydraulic conductivity of 0.1 feet per day except in the southeastern corner where the hydraulic conductivity is increased to 1.0 feet per day (this is the area with the GHB noted above). In addition to the boundary conditions noted above, this layer also has cells with substantial thicknesses (up to 6549.2 feet). There are no monitoring points nor targets in the model Layer 2.	Model layer 2 is only active far north and east of the GRP area and does not exert significant influence over the model calibration or predictions within the areas of active transport. These bedrock units above the Chinle Group are indeed combined into model layer 2 and are appropriately represented with generalized hydraulic parameter values that provide reasonable simulated groundwater head conditions beneath the overlying San Mateo alluvium. Because these bedrock units are consolidated, it would not be appropriate to include head targets from monitoring wells screened in individual bedrock units.
3-5 Discussion B	The application does not reference the source of information on Layer 2 hydraulic properties but states that the GHBs in Layer 2 were "developed using published groundwater-level contour maps" for several units "as presented and discussed in the Work Plan (HMC 2018 a)." The specific reference is a 60-page Groundwater Flow and Transport Modeling Work Plan which staff assumes is the Agencywide Documents Access and Management System document dated March 2018. The plan includes only one regional schematic map. Several published maps are included in the applicant's report entitled "San Mateo Creek Basin and HMC Hydrogeologic Site Conceptual Model" which would be a better reference.	As noted by NRC, HMC concurs that the Hydrogeologic Site Conceptual Model report would be an appropriate reference. It is incorporated by reference per the NRC's helpful suggestion.
3-5 Discussion C	By letter dated March 4, 2019, the licensee submitted a "Preliminary Groundwater Flow and Transport Model Status Report. In that report, the licensee stated that an initial attempt to produce an 18-layer model in which the various units within Layer 2 were segregated into individual layers proved to be difficult. As a result, that model presented in 2019 was reduced to 10 layers, in which Layer 2 represented the undifferentiated bedrock units above the Chinle Group similar to the current model in the 2022 ACL application. However, in the 2019 model, Layer 2 only had one hydraulic value of 0.04 ft/day and a reference head of 6320 ft-MSL for GHBs in the southwestern corner, both of which differ from those values in the current model. The licensee did not provide the rationale for the change in the application.	Again, the undifferentiated bedrock above the Chinle Group does not exert significant influence over the model calibration or predictions within the areas of active transport. The 2019 model's domain was also reduced laterally in the 2022 model to focus on the area around the GRP site rather than the entire San Mateo Basin. The hydraulic parameter values and boundary conditions assigned to layer 2 were developed through model calibration and differ between the models because of the lateral and vertical extents of layer 2 in each model domain. Note that the GHBs in the southeastern portions of each model domain are not in the same spatial locations and so should not be expected to have the same reference head values assigned. The 2019 model, which the NRC appears not to have reviewed in detail, is not relevant to the new application. HMC believes there is no unique or "correct" model of a hydrologic system. Instead, there are multiple reasonable, scientifically-based, valid, and representative approaches to simulate overall hydrogeologic conditions in a system. HMC further asserts that the rationalization of a basis for a change in a model does not provide a basis for declining to accept the ACL application for detailed technical review.
3-6	The LAR should include a buffer area outside of the proposed control boundary that may provide groundwater within the control boundary.	HMC can identify no basis supporting this request in applicable regulation (10 CFR 40 Appendix A), guidance (NUREG-1620), or the administrative record for the 10 previously approved ACL applications for Title II uranium Mill sites. Stated differently, NRC has no legal or regulatory basis to request that HMC establish a "buffer zone" or any other feature beyond the Long Term Care Boundary. To the extent that NRC may identify any appropriate questions within its regulatory scope that also relate to the availability of water supplies to be used within the Long Term Care Boundary, those questions should be addressed as part of the detailed technical review. This issue

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
		otherwise does not provide a sufficient basis in regulation or guidance for declining to accept the ACL application for detailed technical review.
3-6a	The groundwater wells within the buffer area should be identified.	For informational purposes, HMC has added a figure in Exhibit G showing all third-party permitted wells within the HMC proposed control boundary as well as all permitted wells for ¼ mile outside the proposed control boundary. Wells are distinguished by the aquifers in which they are completed.
3-6 Discussion	The applicant identified 23 non-HMC permits for private wells (Figure 1.2-57, Table 4.4-1 and Appendix 4.4-A). The NRC staff reviewed the New Mexico Office of the State Engineers Geographical Information Systems for the registered Points of Diversion and identified several registered diversions listed as active but not included in the 23 applicant identified wells. It is unknown if those wells did not meet other applicant search criteria (e.g., on land not controlled by HMC). Furthermore, a survey should include a buffer area as well outside of the proposed control boundary that may provide water at a point of use within the proposed control boundary. The licensee did not provide a full record of all active registered diversions within the control boundary (and buffer area), all active points of use within the control boundary, and those active permits owned by Homestake.	HMC believes that the NRC's assertion is incorrect. Appendix 4.4-A, Attachment A provided an electronic copy **of the entire SEO database query and the basis for the identification of 23 wells.** This spreadsheet provides the available information for the 54 well permits identified within the proposed control boundary.
4-1a	Assumptions in the ALARA analysis require additional support and basis, including: Impacts from contaminants at the POE that exceed the MCLs or background standards for contaminants based on the proposed control boundary;	This issue should be addressed as part of the detailed technical review. It does not provide a sufficient basis in regulation or guidance for declining to accept the application for detailed technical review. HMC proposes to defer addressing this issue further until consensus regarding the calibration and input parameters of the groundwater flow and contaminant transport modeling is achieved as part of the detailed technical review process. HMC looks forward to a productive dialog with the NRC on this matter after the LAR is accepted.
4-1b	A recalculation of the cost benefit analysis based on a revised groundwater model that considers the likelihood of the alluvial aquifer not drying out based on the effects of climate change that are highly uncertain;	HMC believes NRC does not fully understand the basis for recharge parameters in the model and the validity of the findings regarding the drying of the alluvial aquifer over time (see responses to comments 1-3, 1-4, 1-5, as well as others above) and their role in the cost—benefit analyses. The drying (desaturation) of the alluvial aquifer occurs even under the bounding-case model inputs. Those bounding-case model inputs include precipitation and recharge rates greater than current conditions. These inputs are contrary to current and anticipated future trends based on increased temperatures and lower precipitation rates (See response to Comment 1-5 Discussion), and are highly conservative The fact that using these conservative parameters still results in desaturation of the alluvial aquifer is consistent with recognition of the same phenomenon -- drying of the alluvial aquifer -- at the Ambrosia Lake Site, for which NRC approved ACLs. (see Attachment 2). Nonetheless, HMC believes that desaturation of the aquifer is not relevant to the ACL Application assessment of the benefits of restoring the aquifer. The benefit of restoring the aquifer to supply the entire projected future demand is not dependent on the actual status of the aquifer, drying or not drying. The NRC did not provide a rationale for why it believes that the projected future groundwater use demand is in any way limited by the actual amount of water available. The indirect benefit of averted dose, calculated in Appendix 4.4-B and summarized in Table 4.4-6, is at least an order of magnitude below the calculated direct benefit of the value of the water resource (Table 4.4-6) and many orders of magnitude below the cost of any alternative (see Table 4.4-6). HMC believes it is highly improbable that any

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		HMC Response to Comment
		uncertainty surrounding predicted exposures would surmount the large difference between these benefits and costs. As part of the detailed technical review, Homestake expects that clarification of any remaining questions about the calibration and input parameters of the groundwater flow and contaminant transport modeling are addressed, any additional clarification relating to these issues will be addressed in turn. HMC looks forward to a productive dialog with the NRC on this matter after the LAR is accepted for detailed technical review.
4-1c	Possible impact to the SAG aquifer that may affect a larger population than analyzed in the LAR;	Homestake has provided a conservative analysis of potential SAG impacts and has addressed increased SAG usage and population growth. The NRC has provided no specific comments regarding that analysis nor has it raised any specific questions that reflect its consideration of the information provided by Homestake. Homestake has provided more than sufficient basis to support a detailed technical review and should NRC identify specific concerns or questions with respect to that information they should be addressed within the context of a detailed technical review. The ACL application assessed SAG impacts by incorporating the RSI to the 2020 groundwater CAP (see Attachment 5), which used a conservative bounding-case model. The LAR incorporated the pumping from nearby municipal water supply wells in its predictive modeling and included an assumption that pumping would increase proportionally to population growth requiring additional extraction wells in the SAG. No impacts from the site were predicted at any of these municipal wells, nor in the SAG at the proposed long-term care boundary.
4-1d	Supplemental information regarding consequences to future generations, and	See responses to Comment 4-1a, b, and c above. Again, NRC identifies no particular critique or question derived from Homestake's analysis in the ACL application. Moreover, this comment is so general that HMC is at a loss on how it is expected to respond to the comment. Respectfully, in the view of HMC the question does not provide the level of transparency and clarity expected in the NRC Principles of Good Regulation. It is unclear to HMC how 1,000-year model runs evaluated at the POE do not incorporate consequences to future generations. If the proposed long-term control boundary is protective, there are no long-term consequences to future generations. Homestake has provided more than sufficient analysis of ACL consequences, including consequences to "future generations," to support a detailed technical review. As part of the detailed technical review, Homestake expects that clarification of any remaining questions about the calibration and input parameters for the groundwater flow and transport model will likely address whatever specific concerns NRC may identify with respect to future generations. In any event, any such questions should be addressed within the context of a detailed technical review.
4-1e	A demonstration that contaminant removal is ALARA considering practicable corrective actions.	HMC clearly establishes and presents its basis for the proposed ACLs being ALARA per the process and approach established in NUREG-1620. See Section 4.3, 4.4, 4.5, Appendix 4.3-B, 4.4-A, 4.4-B.
4-1 Discussion A	In Appendix 4.4-B, HMC discussed the potential radiological dose benefit from groundwater use at the GRP with respect to the approved groundwater protection standards and that no constituent concentrations exceed the groundwater protection standards beyond the points of compliance. The NRC staff notes that the groundwater protection standards are based on the approved background concentrations for the GRP. However, the NRC has not determined background conditions or established groundwater protection standards beyond HMC's licensed	It appears current NRC staff may not be familiar with the administrative history of the License groundwater protection standards and have not appropriately reviewed the spatial extent of the wells utilized in the NRC-approved background values noted in this response. While the alluvial standards approved by NRC are representative of the water quality directly upgradient of the large tailings pile, the Chinle standards set for the mixing zone, Upper Chinle non-mixing zone, Middle Chinle non-mixing zone, and Lower Chinle non-mixing zone all encompassed wells located beyond the footprint of the current licensed boundary (see the figure included in Exhibit H). The entirety of the subcrop and mixing zones of the Lower Chinle and the majority of the non-mixing zone affected by the groundwater transport are outside of the NRC Licensed boundary, as are the majority of the subcrop and mixing zones of the Middle Chinle Aquifer. The vast majority of the predicted contamination in the Upper Chinle is within the NRC licensed area. The footprint encompassed by the wells utilized used in establishing the approved groundwater protection standards in the License is approximately 4,000 acres and thus four times larger than the current NRC License area.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
	boundary. Accordingly, **HMC should evaluate impacts from any contaminants that exceed the MCLs.**	The License groundwater protection standards used in the ACL application were incorporated into the License in 2006 with concurrence of NRC, EPA and NMED and were explicitly intended as the protective cleanup standards for all groundwater (NRC-Amendment 39, EPA-9/7/2005). In 2006, groundwater contaminations above the License protection standards were known to be beyond the NRC license boundary as documented in the 2006 Annual Environmental Report (ML060950167).
4-1 Discussion B	In the ACL application, HMC referred to NUREG 1757 Vol.2, Rev.1, which discussed that an alternative is not reasonably achievable if its costs are more than one order of magnitude greater than the monetized benefits of additional reduction. HMC provided a cost benefit analysis in Appendix 4.1-A to address the direct and indirect costs and benefits of groundwater corrective action alternatives. HMC concluded that Alternative 1 (i.e., Removal and Containment or No Action) and Alternative 2 (i.e., Removal and Containment with a Permeable Reactive Barrier) were not reasonably achievable because the costs exceeded the benefits by more than one order of magnitude. The costs for Alternative 3 (i.e., ACLs) were less than one order of magnitude greater than the benefits. Accordingly, HMC proposed the use of ACLs with Alternative 3. The NRC staff has several concerns related to HMC's cost benefit analysis.	No response needed. HMC is pleased to discuss the concerns of the NRC after acceptance of the LAR for detailed technical review.
4-1 Discussion C	The NRC staff is concerned that HMC's cost benefit analysis relies on a groundwater model that may not be technically defensible. The NRC staff identified concerns with assumptions regarding precipitation, recharge, and drying of the alluvial aquifer (see Comment 1-3, 1-4, 1-5), as well as other assumptions related to the geochemical fate and transport modeling. Because assumptions within the groundwater model effectively preclude contamination from migrating toward the assumed points of exposure, the potential benefits of additional groundwater remediation are obscured.	See responses to Comments 1-3, 1-4, 1-5, and other responses above. These referenced responses identify that NRC's concerns regarding the model defensibility were based on erroneous data and mis-interpretation of the model. Regardless, NRC's concerns here are not a sufficient basis for declining to accept the application for detailed technical review.
4-1 Discussion D	For the calculation of benefits, HMC assumed that the affected population would be 57 people across an area of 9.7 square miles, based on institutional controls limiting access to potentially contaminated land and groundwater. However, HMCs ALARA analysis raises three key concerns that were not fully explained: (1) anticipated plume expansion and migration, including the plume in the alluvial aquifer (2) plume migration toward the area where the alluvial aquifer is hydraulically connected to SAG aquifer (observed as a depression in isopleth contours for the alluvial aquifer potentiometric surface in the vicinity of the southwestern corner of Township 12N, Range 10W Section 33 on ACL application Figure 1.2-29), and (3) the SAG being the drinking water resource for the region. The NRC staff is concerned because even a minor increase in contamination to the SAG aquifer could result in significant impacts due to the number of	HMC believes the NRC misunderstands the assumptions and analysis presented in Appendix 4.4-C of the ACL application. Given the responses to Comments 1-3, 1-4, 1-5 and others above, the predictions of the groundwater contaminant migration are reasonable. NRC's concerns regarding impacts to more receptors are without technical or regulatory basis. NRC's stated concerns do not dispute the methods used to evaluate ALARA but rather they generically question the correctness of the underlying assumptions relating to exposure, which were developed from modeling outputs. In fact, the ACL Application fully supported its conclusions on ALARA. More specifically, Homestake's assessment of indirect benefit from aquifer restoration and avoided dose did assess: • The anticipated plume expansion and migration, including the plume in the alluvial aquifer (see Sections 3 and 4 of the ACL application) • Plume migration toward the area where the alluvial aquifer is hydraulically connected to SAG aquifer (see Sections 3 and 4 of the ACL application), and • The SAG being the drinking water resource for the region-existing and potential future water supply wells pumping at rates above their historical maximums were modeled in the bounding case simulations, (see Section 4 of the ACL Application and Figure 2-4 of

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
	people potentially impacted. The number of affected people could increase by multiple orders of magnitude greater than assumed by HMC if the SAG becomes impacted. Accordingly, consideration of additional groundwater restoration could be cost effective depending on key assumptions and the validity of HMC's groundwater model.	Appendix 4.2-B). No adverse impacts to SAG aquifer at the POE are predicted under the proposed action for either base-case or bounding-case models. Therefore, HMC believes there is no rationale to assume a substantially greater population could reasonably be adversely impacted and the order of magnitude of the calculated benefit of avoided dose is appropriate.
4-1 Discussion E	In addition to potential contamination of the SAG and the associated health impacts, there could be environmental impacts. HMC calculated the costs of an alternative water supply. However, there is no known alternative water supply for the SAG. HMC qualitatively discussed land value depreciation based on the three alternatives. However, HMC did not include loss of land value due to potential impacts to the SAG with the consideration that the SAG is the regional drinking water resource. The NRC staff will need to have confidence that milling activities at the GRP will not impact the SAG aquifer. The determination of the practicability of corrective actions requires a defensible groundwater model.	See responses to Comments 1-3, 1-4, 1-5 and others above. If the groundwater at and beyond the proposed long-term control boundary in all aquifers is demonstrated to be protective, then HMC believes there is no quantitative basis for assessing land value depreciation outside the proposed boundary. To the extent that this comment is premised on questions about the model, HMC further believes the NRC's concerns have been addressed in previous comments. No impacts to the SAG beyond the POE are predicted with either base-case-or bounding case models. Therefore, HMC believes there is no reasonable basis to assume or calculate adverse impacts to public or environmental health or land/property values outside the POE.
4-1 Discussion F	The NRC staff appreciates that there are diminishing returns over time with continuing groundwater restoration corrective action. However, HMC's ACL application shows that a significant amount of uranium continues to be removed from the groundwater at nearly a linear rate, as shown by the green line in Figure 13 below. Furthermore, the onsite groundwater collection rate, which is shown by the gray line in Figure 13 below, has been operated at or below 300 gpm on an annualized average rate for approximately 11 years between 2005 and 2015. During that time, the Reverse Osmosis (RO) capacity was 600 gpm as stated in Section 4.1.3.2 of the LAR. In 2015, the RO system was upgraded and reached a design capacity of 1,200 gpm, however, after a rapid collection rate increase in 2016 to nearly 600 gpm, the collection rate again has rapidly declined to approximately 300 gpm in 2019, as shown in Figure 13. Operating the RO system corrective action at approximately one-half of its capacity for an extended period of time from 2005 to 2015 would have likely hindered removing uranium and other contaminations to the extent practicable and to ALARA. Operational declines after the RO system capacity peaked in 2016 does not support that the RO plant corrective action was operating to remove contaminants at the extent practicable and to ALARA. A defensible groundwater model could indicate that additional groundwater corrective actions are cost effective.	NRC continues to assert that there is a basis for assessment of the groundwater CAP other than that presented in 10 CFR Part 40 Appendix A and described in the NUREG-1620, Section 4.3.3.3 process. NRC appeals to the concept of ALARA but fails to acknowledge that ALARA is a cost-benefit analysis based on a threshold level of protection at the POE. The ALARA demonstration presented in the LAR conforms to the process and addresses the acceptance criteria presented in NUREG-1620. The historical efficacy of the groundwater CAP is not the relevant criteria in the ALARA analysis and NRC's focus on CAP performance from over a decade ago ignores the established ALARA process and criteria. The issue of model defensibility has been addressed in comments above and the issues are of a detailed technical nature, not one of completeness of this application. Modeling clearly demonstrated that aquifer restoration cannot return the aquifer to current groundwater protection standards, even with continued and increased pumping. HMC is pleased to discuss this matter with the NRC after acceptance of the LAR for detailed technical review.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting

Comment		**HMC Response to Comment**
4-1 Discussion G	In Appendix N of NUREG 1757 Rev. 2, Vol. 2,[1] the NRC staff stated that *"…if licensees anticipate important intergenerational consequences, such as for cases with radionuclides with half-lives of decades or longer, licensees should consider supplementing the analysis with an explicit discussion of the intergenerational concerns, such as how future generations will be affected by the regulatory decisions*."	The application, and all ACLs, are predicated on the presumption of meeting protective standards at the POE and restricting exposures within the control boundary (all points upgradient of the POE) for all POE (all aquifers). This precludes any long-term risk to the public or any inter-generational consequences.
4-1 Discussion H	In Section E.2.5 of NUREG/BR-0058, Rev. 5 Appendix E,[2] the NRC staff states: *For certain regulatory actions, such as those involving decommissioning and waste disposal issues, the regulatory analysis may have to consider consequences that can occur over hundreds, or even thousands, of years. The Office of Management and Budget [OMB] recognizes that special considerations arise when comparing benefits and costs across generations. Under these circumstances, OMB continues to see value in applying discount rates of 3 and 7 percent. However, ethical and technical arguments can also support the use of lower discount rates. Thus, if a rule will have important intergenerational consequences, the analyst should consider supplementing the analysis with an explicit discussion of the intergenerational concerns such as how future generations will be affected by the regulatory decision. Additionally, supplemental information could include a presentation of the costs and benefits at the time in which they are incurred with no present-worth conversion (e.g., no discounting). In this case, no calculation of the resulting net cost should be made. Also, the analyst should consider a sensitivity analysis using a lower, but positive, discount rate.* Accordingly, the LAR should include information regarding consequences to future generations.	Sections 4 and 5 of the ACL Application clearly identify the fate and transport of the groundwater contaminants is assessed for 1,000 years and concentrations at the proposed long-term control boundary remain protective of public health, safety and the environment. Therefore, HMC believes there is no basis to assume or predict inter-generational consequences or exposures.
5-1	The LAR provides limited information regarding the monitoring of key performance indicators to provide model confidence and help ensure protection of public health and safety.	To the extent that there are any outstanding questions relating to this comment, they should be addressed as part of the detailed technical review. These questions do not provide a sufficient basis in regulation or guidance for declining to accept the ACL application for detailed technical review.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
		HMC does not understand the basis for this comment as a detailed monitoring plan is provided in the ACL application that addresses key performance indicators (See Section 5.2 and Appendix 2.2-A). This monitoring program essentially continues the vast majority of the current compliance monitoring program and includes data collection from over 100 locations for 20 parameters: • Tailings seepage conditions via measurement of water concentrations and seepage collection rates for six tailings sumps • Concentrations and water level measurement for six POC wells • Concentrations and water level measurement for two alluvial aquifer up-gradient wells • Concentrations and water level measurement for 88 wells in five hydrologic units. Table 5.2-2 summarizes the rationale for each set of monitoring wells. This monitoring program provides essentially all the data and performance indicators that can be collected to assess tailings seepage rates and concentrations as input to the aquifers, water levels to assess future groundwater flow conditions, concentrations throughout the current and potential future transport domain in all aquifers. Further, Appendix 5.1-C provided predicted groundwater concentration plots from conservative bounding case model predictions, upon which predicted long-term protective POE concentrations and proposed ACLs are based, for the next 1,000 years. These predicted concentrations plots allow for direct comparison of the modeled groundwater conditions with measured conditions, a direct and explicit means for assessing the performance of the groundwater model predictions. This amount of data collection and inclusion of well-specific predicted concentrations for direct comparison to future measured groundwater conditions is provided in unprecedented detail compared to all previous ACL application NRC has approved to date.
5-1 Discussion A	In the ACL application, HMC is relying on several mechanisms and assumptions to ensure protection to public health, safety and the environment. The NRC staff have several comments and concerns related to these mechanisms and assumptions, including institutional controls to limit potential receptors (Comment 1-1); precipitation and recharge (Comments 1-3, 1-4, and 1-5); groundwater modeling (Comments 3-2, 3-3, 3-4, 3-5), and characterization of the low-permeability zones (Comment 3-1). These mechanisms and assumptions are risk significant and uncertain.	This discussion point does not address monitoring or performance indicators but instead, simply references other individual comments. For this reason, no further response is provided.
5-1 Discussion B	As part of the GRP corrective action program, injection wells have been used to create a hydraulic barrier and to facilitate groundwater restoration. With the proposed cessation of corrective actions, this hydraulic barrier would subside, the hydraulic gradient would revert toward pre-milling conditions, and contaminants would be able to migrate downgradient.	This discussion point is a statement of conditions and does not address monitoring or performance indicators. This does not affect the results of Homestake's analyses. These conditions have been taken into account throughout the modeling and site evaluation processes.
5-1 Discussion C	In Section 5 of the ACL application, HMC discussed that a comparison of measured values to proposed ACLs and predicted maximum concentrations at intermediate monitoring locations will allow verification that groundwater constituent concentrations will remain protective at the POE. The NRC staff agrees that monitoring data can be used to provide model confidence, especially for risk significant sites and sites with significant uncertainty. However, the ACL application is not clear on what key performance indicators should be monitored, the period of	See response to Comment 5-1, above. NRC does not acknowledge the explicit language provided in the ACL Application. Section 5.2.1 (Proposed Groundwater Monitoring) clearly identifies the performance indicator for groundwater monitoring "*Measured groundwater constituent concentrations at each POC and intermediate monitoring well location will be compared to the predicted groundwater constituent concentrations from the bounding-case model to verify that groundwater conditions continue to remain within the predicted conditions for each monitoring location. Maximum predicted groundwater constituent concentrations at each downgradient monitoring well are presented in Table 3 of the proposed Groundwater Compliance Monitoring Plan, included as Appendix 5.2-A of this ACL Application. Predicted time-concentration data and time-concentration data plots for uranium and the bounding-case conservative solute model run for each well are provided in Appendix 5.2-B. Confirmed and verified exceedance of ACLs in the POC wells or maximum*".

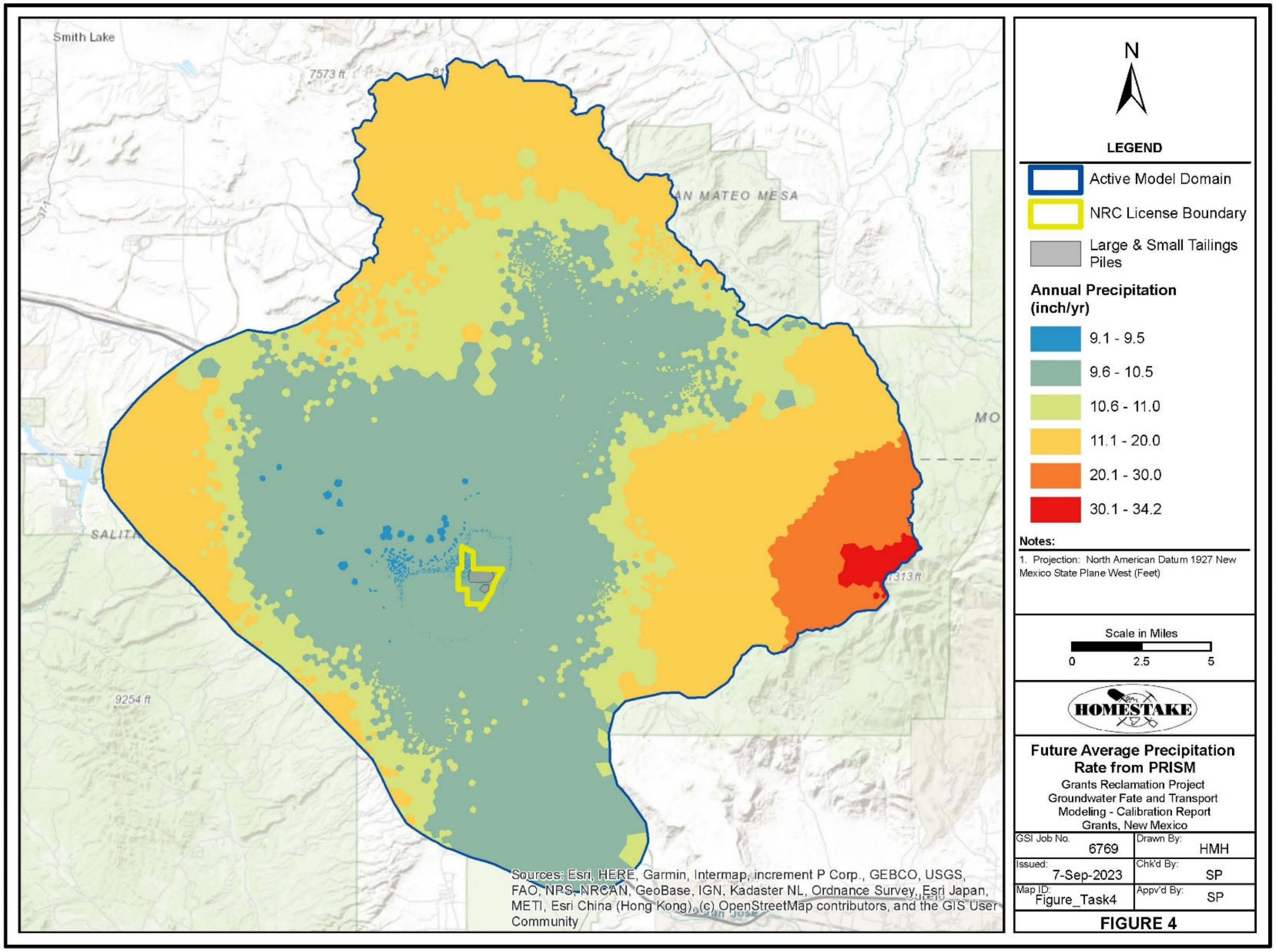
Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
	monitoring necessary to achieve confidence in the modeling results, and when the model should be revised.	Groundwater compliance and the potential need for corrective action (e.g., model revision or other actions) is based on comparison of groundwater concentrations to License groundwater protection standards. The proposed ACLs are based on the bounding case predictive model results. These results are clearly presented in the predicted groundwater concentrations provided in Appendix 5.1-C. Therefore, the performance indicator that is most explicitly relevant for determining if corrective action and/or revision of the model is necessary or appropriate is comparison of measured groundwater concentrations to the predicted conditions upon which the protective conditions are based. This performance indicator is also clearly identified in Appendix 5.2-A" *Any point of compliance monitoring result verified to be above respective License groundwater protection standard or downgradient monitoring result verified to be above Table 3 values as described above will be considered a potential exceedance of License conditions and may trigger appropriate notification and corrective action requirements.*" Hypothetically, if future measured tailings sump concentrations or volumetric flux rates or groundwater head conditions in the aquifers differ from predicted conditions, revision of the predictive model or other corrective actions would not be warranted as long as the site conceptual model was not substantially challenged by the measured data and the measured groundwater concentrations remained below predicted levels. Therefore, while other data (i.e., tailings sump flux and concentration data) are of relevance for understanding the site conditions, they are not appropriate performance indicators that warrant threshold criteria triggering potential model revision. Compliance and protection are fundamentally based on measured groundwater concentrations in the relevant aquifers, and therefore, the proposed monitoring and performance indicators that might trigger model revision are clearly identified in the text referenced above.
5-1 Discussion D	The NRC staff notes that the following key performance indicators would reduce uncertainty and provide additional model confidence: - Groundwater monitoring results during the near term to evaluate model assumptions, including sorption, dilution/dispersion, and effects from low-permeability zones	See response to Comment 5-1 Discussion C, above. Monitoring and reporting of water quality and hydrologic conditions are proposed in Section 5.2 of the ACL application and are an extension of the current compliance monitoring program. Therefore, these data would be available and used in the near term to assess evolution of groundwater conditions. Sorption, dilution, dispersion, and effects of low permeability zones are generally evaluated via direct groundwater monitoring and comparison to modeled conditions, as currently proposed.
5-1 Discussion E	- Lysimeter data from a test cover or emplaced cover to evaluate infiltration, percolation, evapotranspiration, and runoff	NRC has not indicated any reason in regulation or guidance why lysimeter data collected from a test cover for a period of several years to evaluate infiltration, percolation, evapotranspiration, and runoff would substantially increase certainty about long-term cover performance. More importantly, Homestake's bounding case model assumed more than 4 times the estimated cover long-term steady state infiltration/seepage rate, which provides more assurance that long-term protection at the POE will be maintained than measurement estimates of current and/or short-term cover conditions. Furthermore, HMC is not aware that such data has been required for any previous Title II uranium mill ACL applications. HMC believes the proposed cover should be evaluated in the same manner as in all other ACL applications.
5-1 Discussion F	- Longer-term tailings seepage monitoring to evaluate potential contaminant rebound and seepage rates	In the ACL application (Section 5.2) HMC proposed monitoring of tailings drainage collection system seepage rates until final tailings reclamation is completed. The bounding-case model runs, upon which the proposed ACLs and long term control boundary are based and include the highly conservative assumptions of pre-flushing tailings seepage concentrations (e.g., 45 mg/L uranium) and seepage rates 4 times those developed from cover infiltration modeling, provide the requisite reasonable assurance that the actual long-term tailings seepage will remain within the bounds of those modeled and diminish if not eliminate the need to verify tailings conditions with longer-term monitoring beyond that proposed. HMC is not aware of any specific requirement in regulation or specific guidance for Title II uranium mills specifying a period for long-term monitoring prior to license termination. Review of the administrative record for the previous ACL applications previously granted by NRC indicates that license termination has been completed in less than 10 years after ACL applications have been approved.

Attachment 4. HMC Response to NRC Staff Talking Points from June 15, 2023 Public Meeting		
Comment		**HMC Response to Comment**
		The proposed monitoring in this LAR is for the period HMC is the Licensee until License termination is approved or an amendment to this this monitoring program is approved. Longer term monitoring is the purview of the long-term custodian as documented in an NRC-approved Long term surveillance plan.
5-1 Discussion G	• Longer-term tailings elevation monitoring to evaluate potential subsidence as the tailings drain	As the NRC well knows, tailings settlement is monitored and reported annually (see Appendix D in Annual Monitoring Report/Performance Review, ML23095A168), 90% tailings consolidation was achieved several years ago. The approved cover design addresses deformation of the cover due to subsequent settlement via an analysis of potential radon barrier cracking from potential subsidence. Further, the updated cover design currently under review by NRC (ML23222A192, ML23222A193, ML23222A194, ML23222A195) includes proposed monitoring of cover settlement after construction. Following placement of the final radon barrier and overlying cover materials, a Construction Completion Report will document the as-built conditions of the cover. This is not an issue for groundwater remedy analysis, but for tailings closure. This site should not be assessed differently than other NRC ACL sites.

EXHIBIT A

Grants Milan Airport Met station USC00293682			
	Mean Total Precipitation	Average Temperature Maximum	Average Temperature Minimum
Month	**Inches**	**Degrees Fahrenheit**	**Degrees Fahrenheit**
January	0.51	46.7	14.6
February	0.41	52.3	19.1
March	0.47	59.4	24.0
April	0.43	67.8	30.5
May	0.51	76.6	39.0
June	0.53	87.3	47.8
July	1.76	88.8	55.4
August	2.06	85.7	53.2
September	1.27	80.3	44.9
October	1.05	70.0	32.8
November	0.57	57.0	22.3
December	0.66	47.5	14.8
Annual Averages, 1953-2017	**10.23**	**68.5**	**33.4**

EXHIBIT B



Notes:
1. Projection: North American Datum 1927 New Mexico State Plane West (Feet)

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Future Average Precipitation Rate from PRISM
Grants Reclamation Project
Groundwater Fate and Transport
Modeling - Calibration Report
Grants, New Mexico

GSI Job No. 6769	Drawn By: HMH
Issued: 7-Sep-2023	Chk'd By: SP
Map ID: Figure_Task4	Appv'd By: SP

FIGURE 4

EXHIBIT C

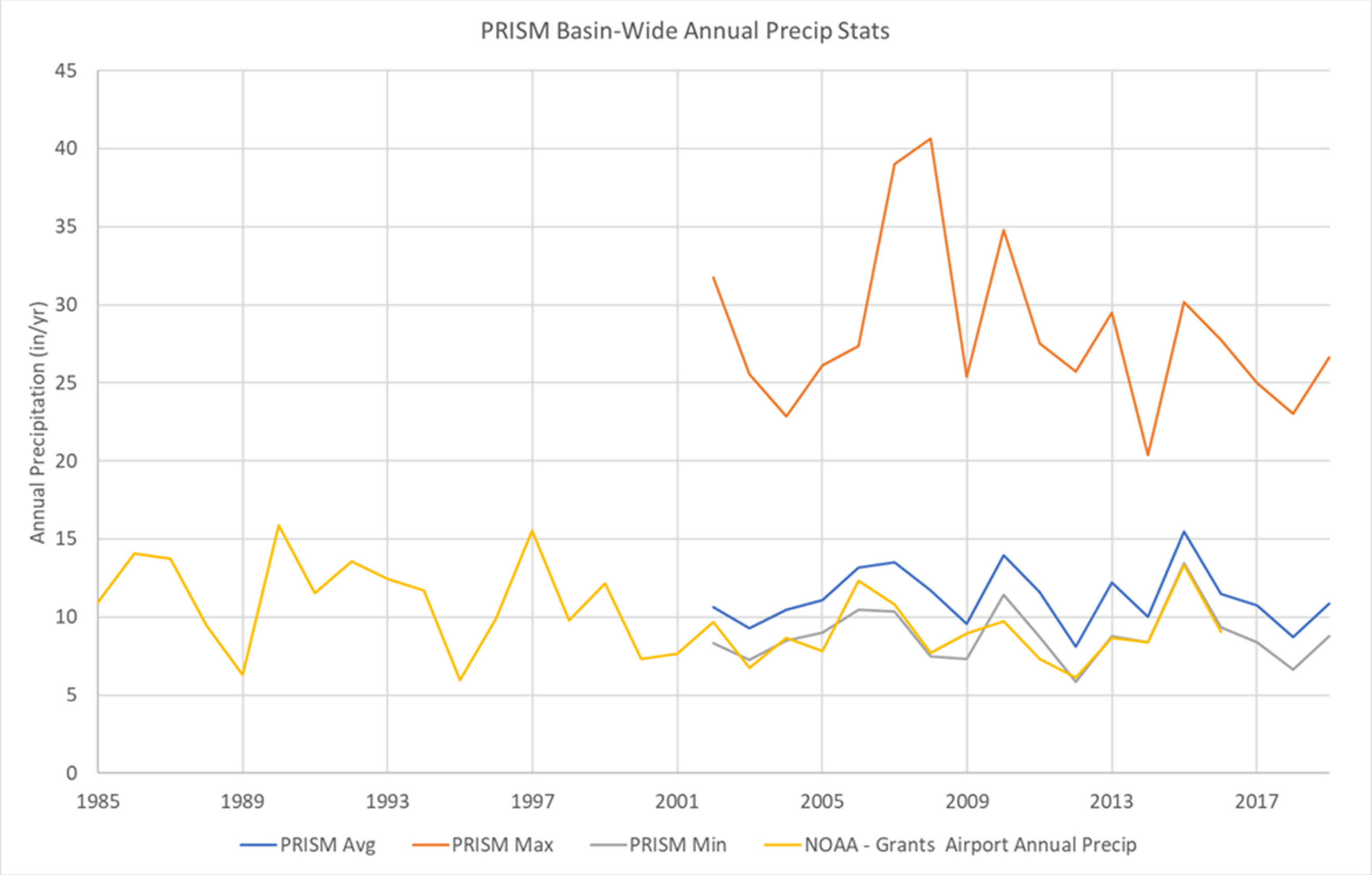

PRISM Basin-Wide Annual Precip Stats
Annual Precipitation (in/yr)
0
5
10
15
20
25
30
35
40
45
1985
1989
1993
1997
2001
2005
2009
2013
2017
PRISM Avg
PRISM Max
PRISM Min
NOAA - Grants Airport Annual Precip

EXHIBIT D

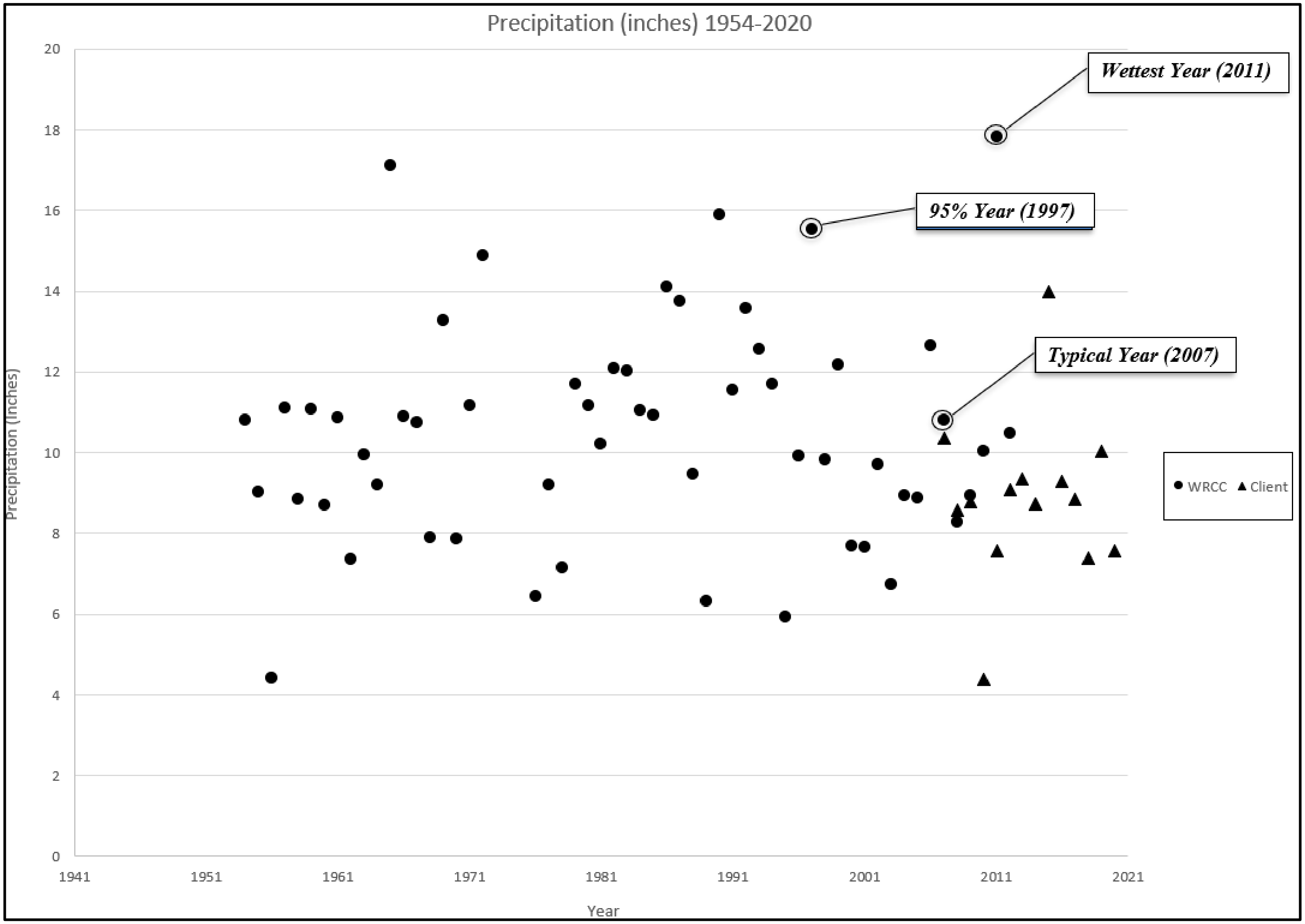

Precipitation (inches) 1954-2020
Wettest Year (2011)
95% Year (1997)
Typical Year (2007)
Precipitation (Inches)
20
18
16
14
12
10
8
6
4
2
0
1941
1951
1961
1971
1981
1991
2001
2011
2021
Year
● WRCC
▲ Client

EXHIBIT D

Location	Annual Precipitation Statistics										
	POR	Easting	Northing	Elevation	Minimum	Median	Mean	Maximum	Std Dev	Skew	SSM*
	years	ft	ft	ft amsl	in	in	in	in	in	-	-
Homestake, Synthetic	1000	788447	12808987	6601	4.40	10.26	10.32	19.33	2.09	0.41	3.46 to 4.31
Grants Milan Airport	60	774116	12779970	6520	4.41	9.93	10.22	17.11	2.60	0.38	2.65
Laguna	84	930137	12732131	5830	1.96	8.85	9.42	18.42	3.01	0.19	2.99
El Morro National Monument	85	2433782	12731201	7223	7.33	13.14	13.44	19.56	3.14	0.22	1.95
Zuni	72	2286942	13060808	6311	4.41	11.35	11.32	17.57	3.16	-0.08	1.98
Chaco Canyon National Monument	81	779968	13093966	6174	3.28	8.36	8.78	18.02	2.68	0.78	3.44
Johnson Ranch	73	1023354	13060808	7203	3.68	10.64	11.14	17.66	2.77	0.34	2.35
Cuba	70	1057712	13074804	6908	3.07	8.55	8.68	20.15	2.94	0.88	3.90
St Michaels, AZ +	19	2174927	12954419	7640	7.30	11.95	12.45	19.35	3.13	0.65	2.21
Keams Canyon, AZ +	62	1877523	13005075	6210	1.25	9.80	9.89	17.28	3.21	0.00	2.30
Holbrook, AZ +	107	1890111	12671490	5070	2.56	7.93	8.18	20.05	3.02	0.98	3.93
Chama +	114	1177696	13402064	7850	8.11	20.36	20.77	31.38	5.38	-0.02	1.97
Socorro +	113	1177696	12372749	4620	1.15	8.64	9.32	17.85	3.41	0.60	2.50
Whiteriver, AZ +	95	1954014	12283855	5280	8.69	16.97	17.61	33.15	4.88	0.84	3.19
Natural Bridge, AZ +	94	1504588	12458652	4610	10.41	22.70	23.13	50.17	7.26	0.75	3.73

From 2023 Evapotranspiration Cover Design Report by Stantec (ML23222A192)

EXHIBIT D

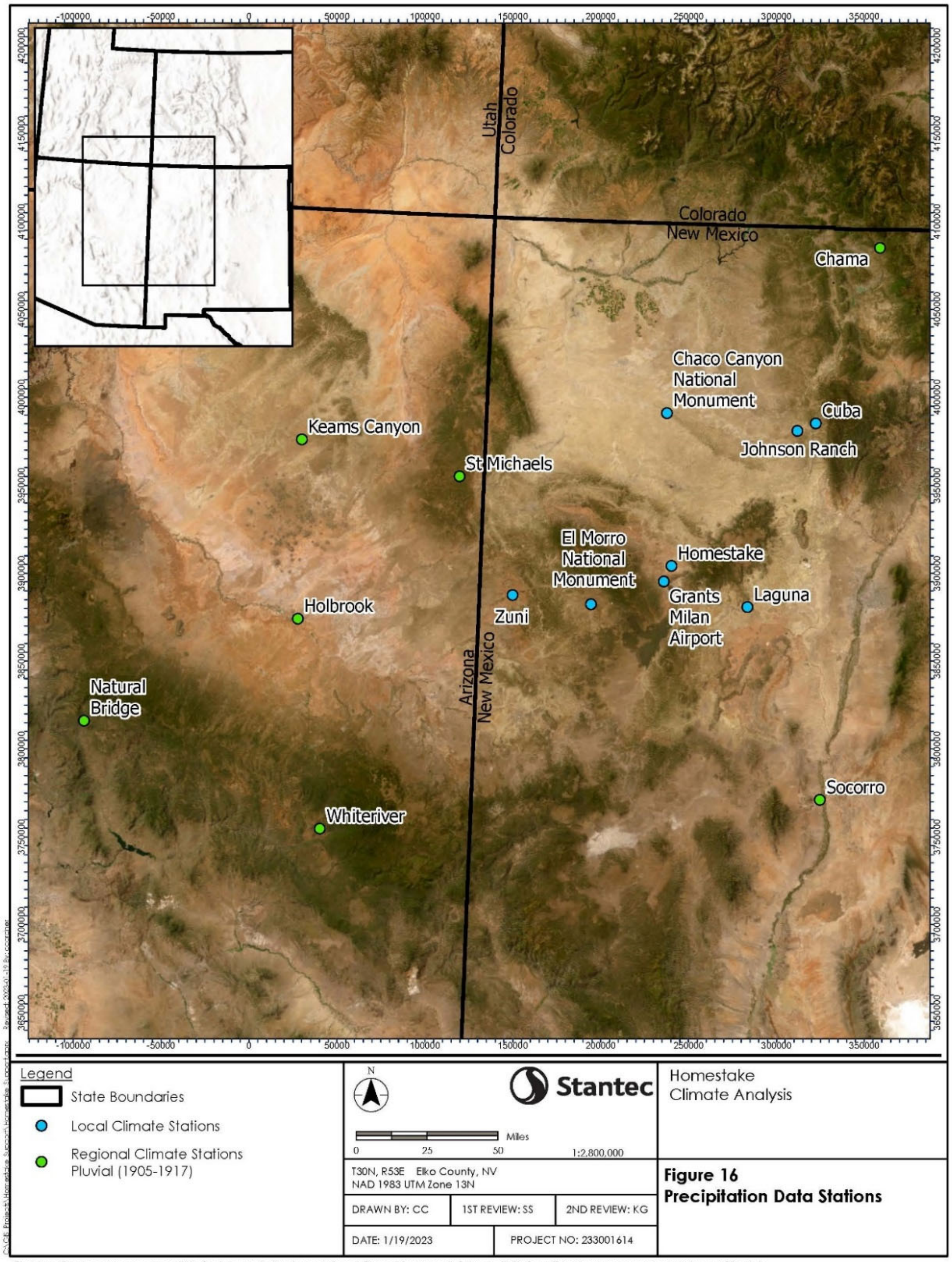
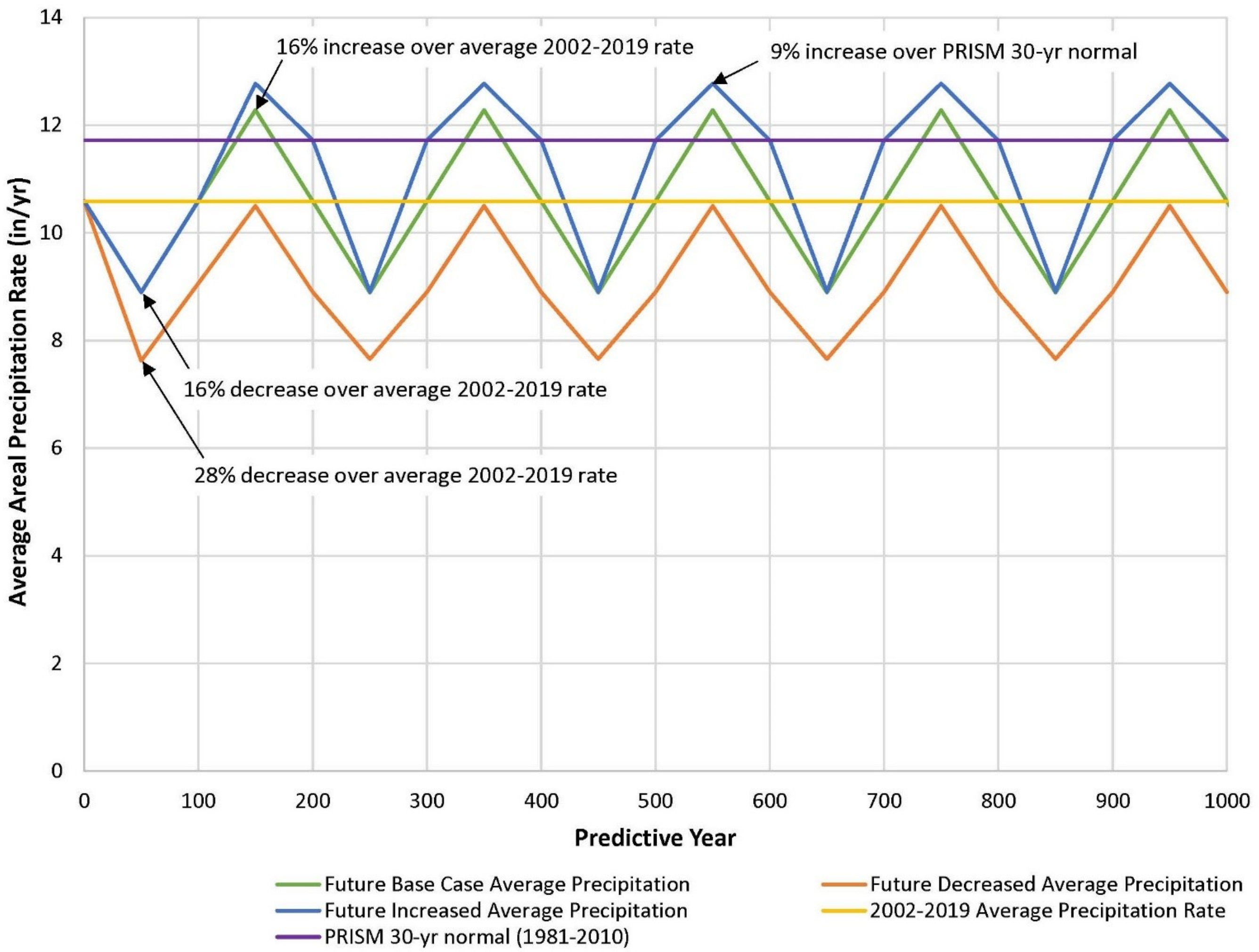


Figure 16
Precipitation Data Stations

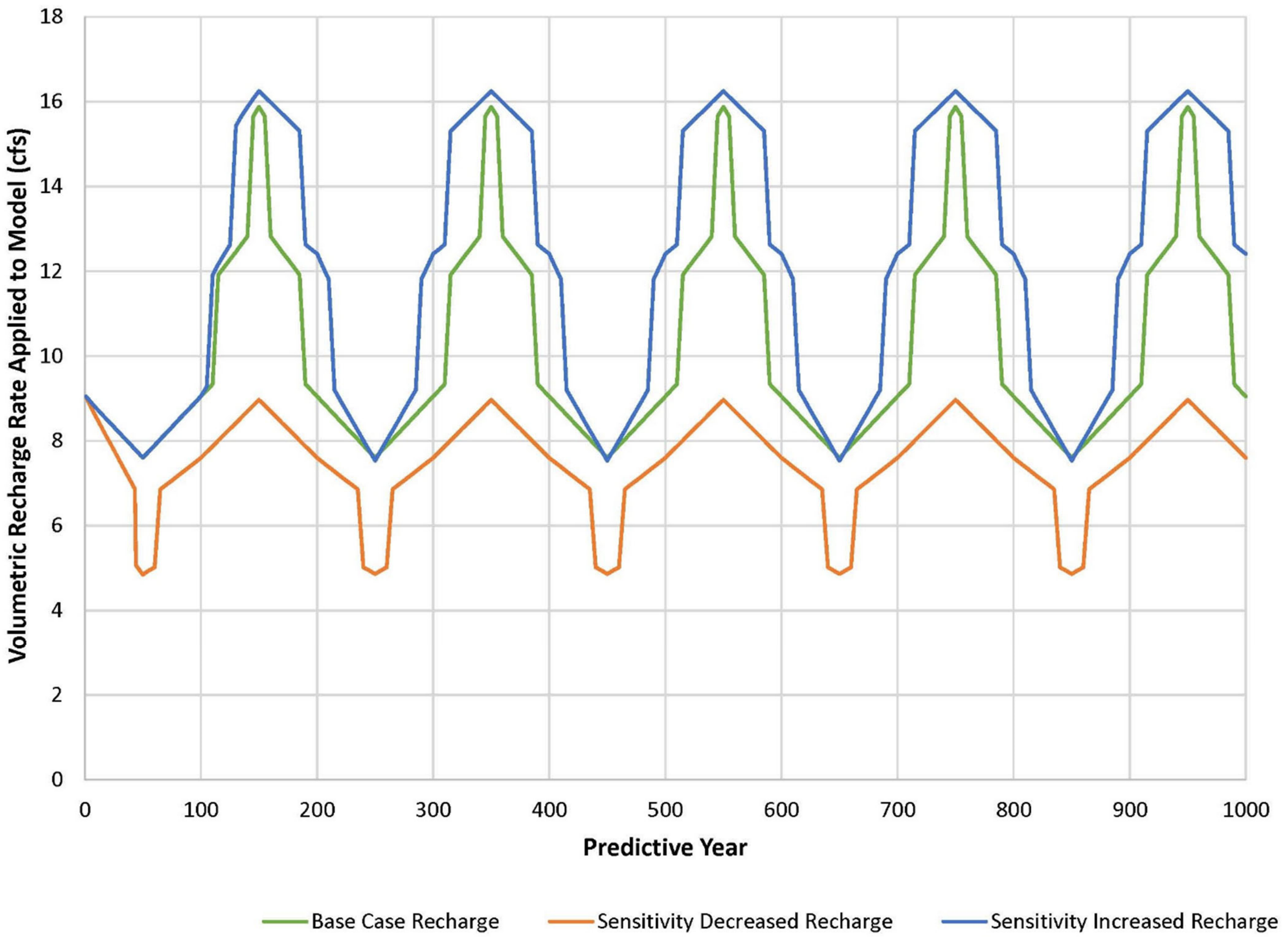
From 2023 Evapotranspiration Cover Design Report by Stantec (ML23222A192)

EXHIBIT D



GSI Job. No. 6023	Drawn By: RLW	Assumed Future Average Precipitation Rates to Develop Sensitivity Recharge Rates Grants Reclamation Project Groundwater Fate and Transport Modeling - Predictive Period Report Grants, New Mexico	Figure 4-9
Issued: 20-Jan-22	Checked By: KKZ		
Revised: 20-Jan-22			
Scale:			

EXHIBIT D



HOMESTAKE	GSI Job. No. 6023	Drawn By: RLW	Total Applied Base Case and Sensitivity Volumetric Recharge Rates Grants Reclamation Project Groundwater Fate and Transport Modeling - Predictive Period Report Grants, New Mexico	Figure 4-10
	Issued: 20-Jan-22	Checked By: KKZ		
	Revised: 20-Jan-22			
	Scale:			

EXHIBIT E

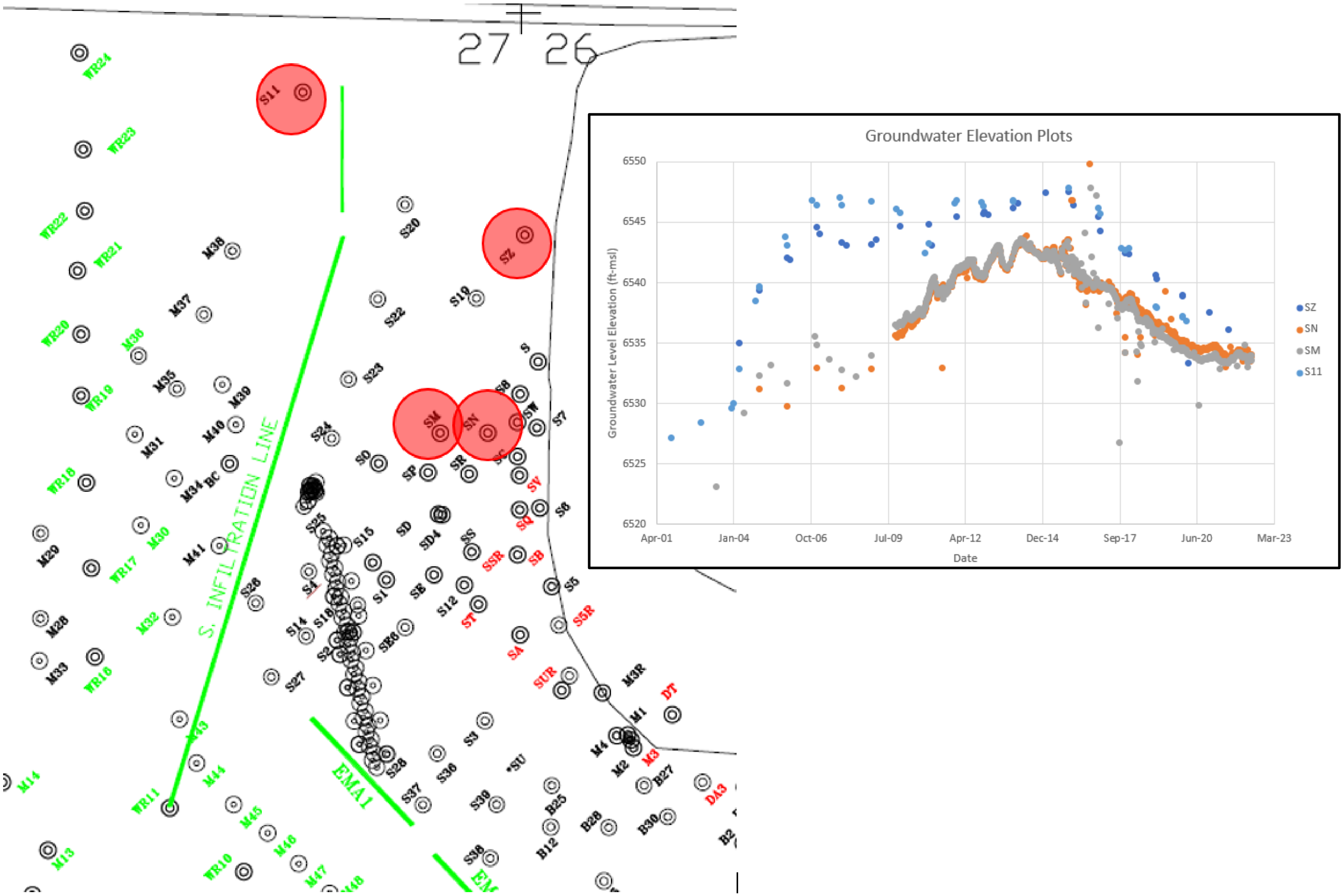
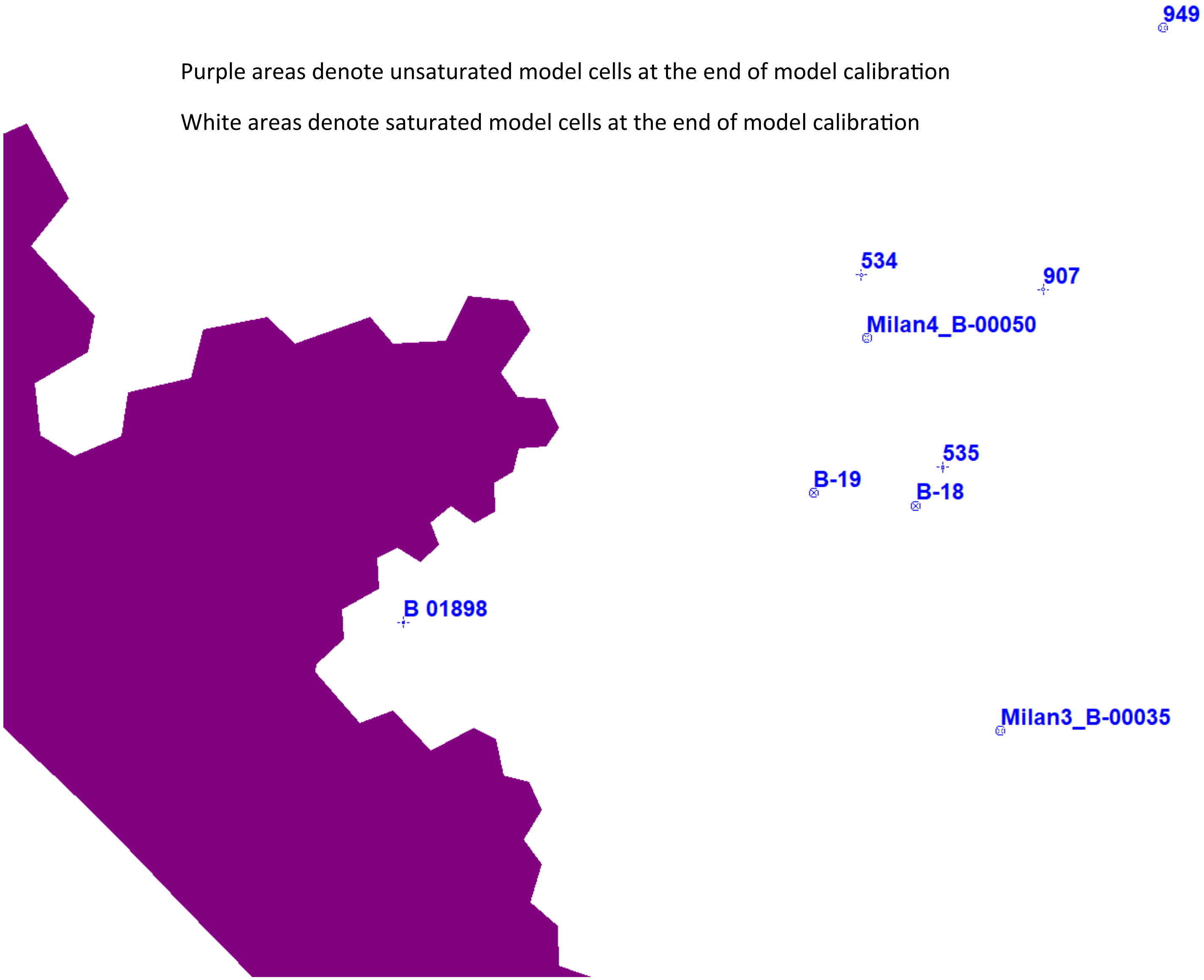

27
26
S11
SZ
SM
SN
S. INFILTRATION LINE
EMA1
Groundwater Elevation Plots
Groundwater Level Elevation (ft-msl)
6550
6545
6540
6535
6530
6525
6520
Apr-01
Jan-04
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Date
SZ
SN
SM
S11

EXHIBIT F


Purple areas denote unsaturated model cells at the end of model calibration

White areas denote saturated model cells at the end of model calibration

EXHIBIT F

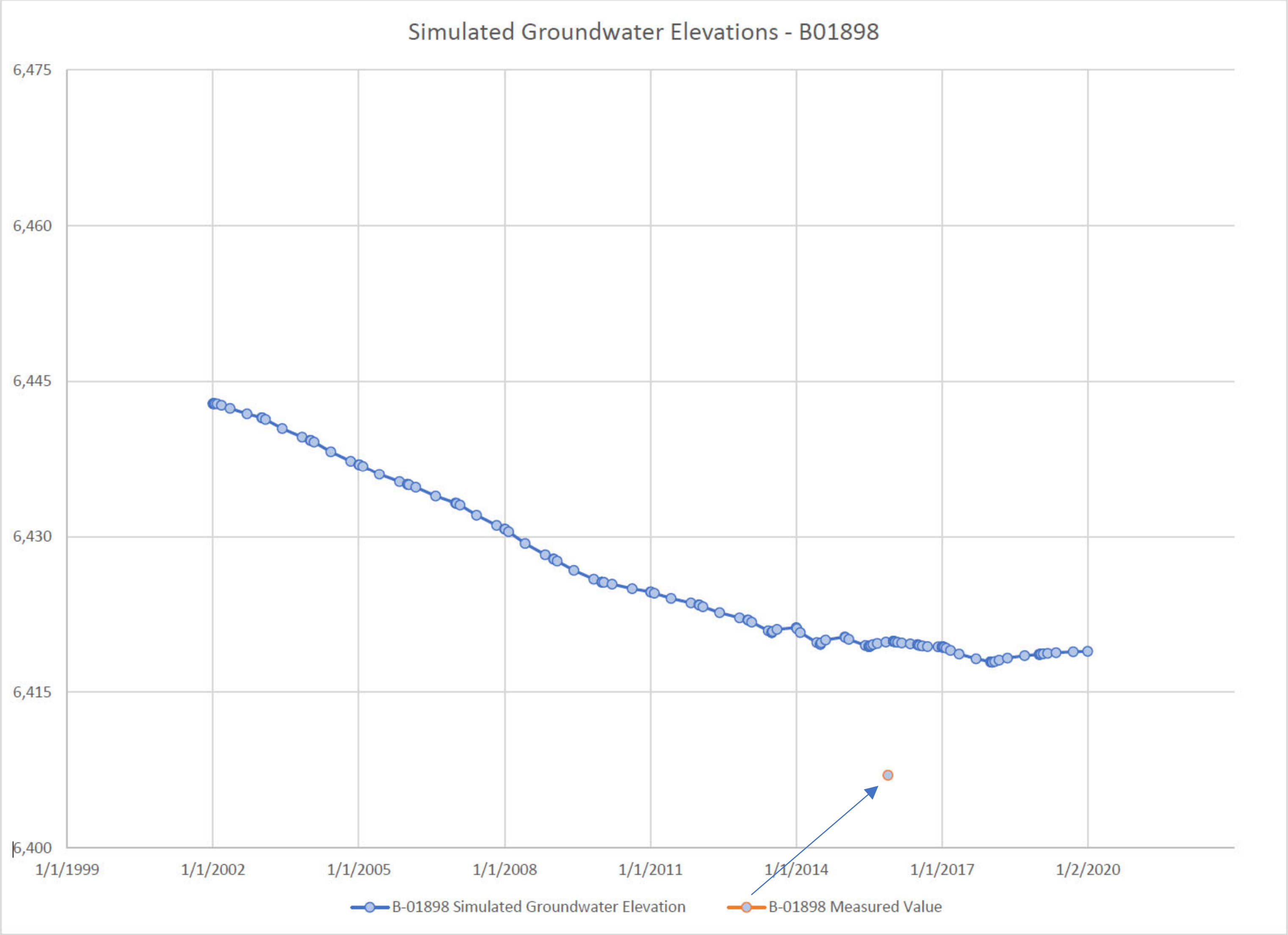
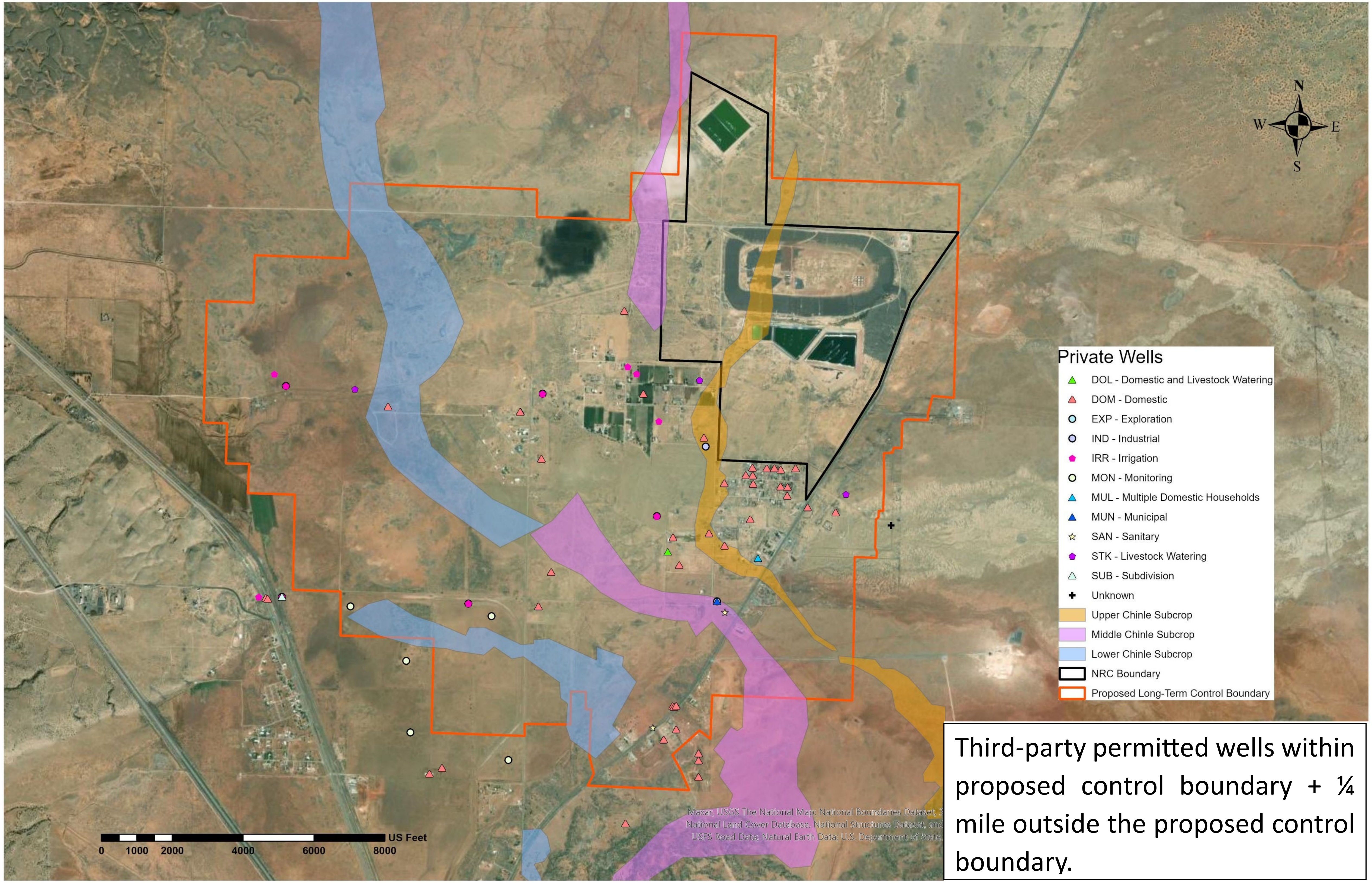
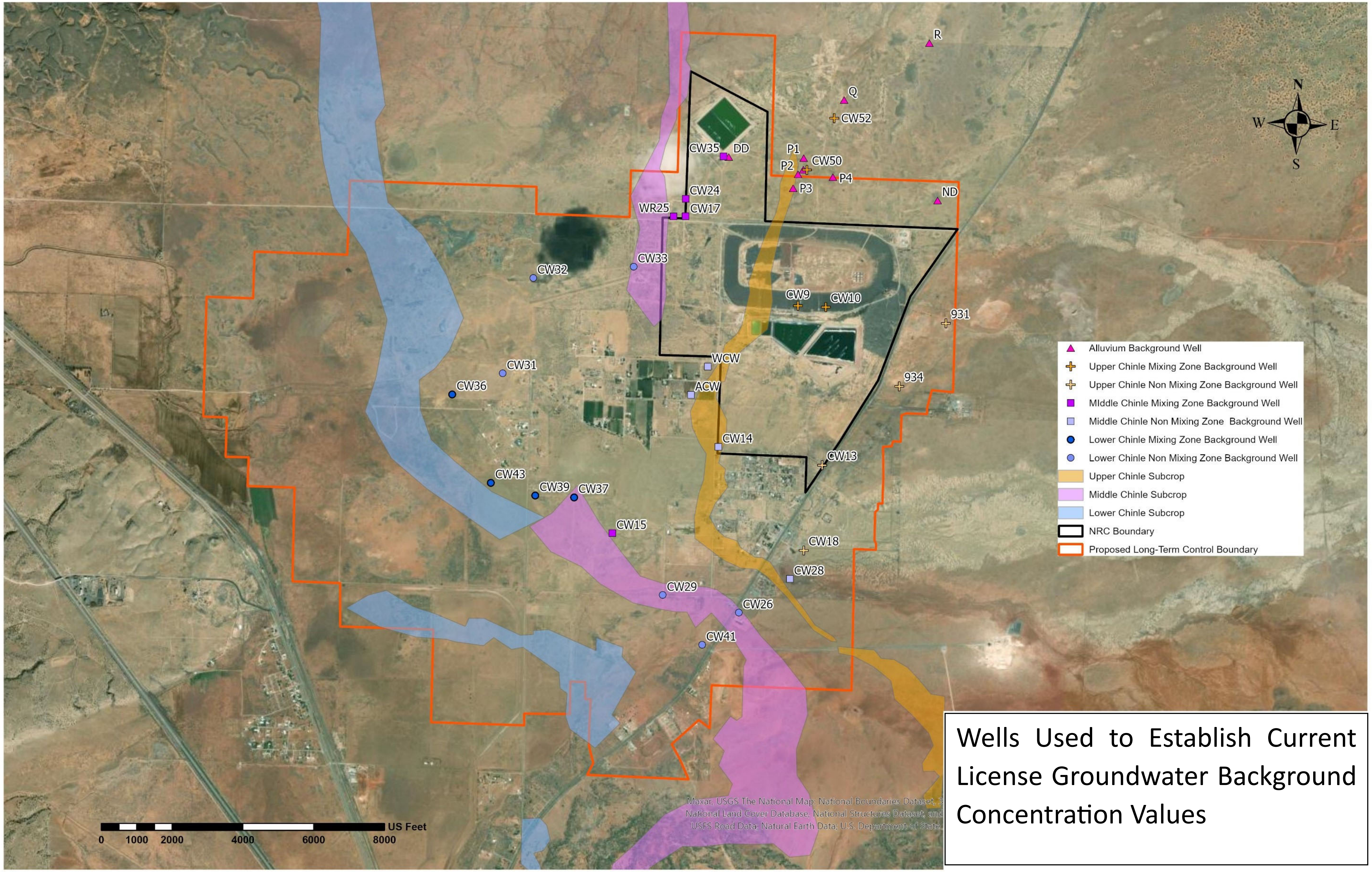

Simulated Groundwater Elevations - B01898
6,475
6,460
6,445
6,430
6,415
6,400
1/1/1999
1/1/2002
1/1/2005
1/1/2008
1/1/2011
1/1/2014
1/1/2017
1/2/2020
B-01898 Simulated Groundwater Elevation
B-01898 Measured Value

EXHIBIT G



Third-party permitted wells within proposed control boundary + ¼ mile outside the proposed control boundary.

EXHIBIT H



Maxar, USGS The National Map: National Boundaries Dataset, 3 National Land Cover Database, National Structures Dataset, and USFS Road Data; Natural Earth Data; U.S. Department of State

Wells Used to Establish Current License Groundwater Background Concentration Values

Attachment 5. HMC Response to Review Comments from NRC's April 30, 2021 Acceptance Review of the 2020 GCAP LAR

Comment		**HMC Response to Comment**
Comment-1	Document the methodology used for the seepage rates and correct inconsistencies in the translations of the seepage to the model inputs for the various simulations.	HMC respectfully submits that the specificity requested on these Comment 1 issues is best reserved for the detailed technical review process and is not a sufficient basis for declining to accept the application for detailed technical review. Nonetheless, in the interest of thoroughness, HMC is providing the below information to the NRC. See responses below.
1 Discussion-A	HMC predicts that the long-term seepage rate from the large tailings pile (LTP) is equivalent to 0.6 gallons per minute (gpm) and the long-term uranium concentration for the seepage will be 5.16 mg/L. The predicted long-term seepage rate and concentration may not be conservative. For example, the long-term seepage rate through a 215-acre impoundment is equivalent to infiltration of 0.05 inches per year or 0.5 percent of the average annual precipitation.3 Typically, the estimated infiltration through an impoundment without a synthetic liner cover would be higher than 0.5 percent, on the order of several percentage of the total precipitation. However, any of the reported infiltration rates are for sites in temperate climates rather than semi-arid climates as is the case for HMC and the low rate may be attributed to site conditions. It is unclear if HMC's drain down model (DDM) analysis evaluated the predicted seepage rate by comparing long-term percolation data (e.g., lysimeter studies) from sites with similar cover systems in areas with similar climates. The expected infiltration for the GRP should either be similar to the observations at other sites and provide for potential long-term degradation or HMC should discuss any disparities between observed infiltration for those similar systems with HMC's assumptions.	From Aug 2022 ACL Application, Section 2.1.1.3 (Large Tailings Pile Seepage Rates Characterization) "*A Large Tailings Pile seepage model (the reformulated mixing model [RMM]) was previously developed to assess drain-down and long-term changes in both tailings seepage flow rates and constituent mass loading (Hydro-Engineering, 2019). The reformulated mixing model assessments of past Large Tailings Pile seepage rates were developed based on vadose modeling using the VADOSE/W code. Development, calibration, and application of the VADOSE/W seepage model are described in Appendix G of the Draft RI (HDR, 2016). Subsequently, a drain-down model (DDM) was developed that incorporates the Brooks and Corey method (Brooks and Corey, 1964) to estimate past seepage rates and mass loading beginning in 2012 as well as future seepage and Large Tailings Pile toe drain rates and constituent concentrations (Hydro-Engineering, 2020a; Hydro-Engineering, 2020b). Seepage estimates developed from the reformulated mixing model for the period 2002 through 2011 and from the drain down model for the period 2012 through 2019 are used in the predictive groundwater flow and contaminant transport models, and discussed in Sections 3 and 4, to simulate flow from the Large Tailings Pile into the local groundwater system. Simulated Large Tailings Pile seepage rates for each model stress period in the base-case calibrated model are presented in Table 2.1-2. The calculated long-term seepage rate for the entire Large Tailings Pile footprint, equilibrated with long-term infiltration through the approved final reclamation cover (AK Geoconsult and Jenkins, 1993), is estimated to be 0.6 gallons per minute. A conservative bounding-case estimate for long-term tailings seepage was also developed to support conservative modeling of contaminant transport for calculation of ACLs. This bounding-case estimate assumes that the long-term infiltration rate through the final reclamation cover is four times base-case estimate, or 2.4 gallons per minute. This rate of infiltration is demonstrably conservative for an engineered tailings cover as this represents about four percent of an annual precipitation rate of 10 inches per year for the roughly 100-acre Large Tailings Pond top surface area, which is comparable to recharge rates for natural ground (see recharge discussion in Sections 3 and 4). The Large Tailings Pile seepage rates as modeled for future conditions are presented in further detail in Section 3.1.1.2 and Section 5.1 of this ACL Application.*" From Aug 2022 ACL Application, Section 3.1.1.2 Model Boundary Conditions: "*Seepage from the Large Tailings Pile represents another important source of both recharge and chemical mass loading to the local groundwater system. Historical Large Tailings Pile seepage rates were developed using a calibrated VADOSE/W seepage model (HDR, 2016). These seepage rates were then incorporated into a separate seepage model (the reformulated mixing model [RMM]) to assess long-term changes in both seepage flow rates and constituent mass loading beginning in 2000 (Hydro-Engineering, 2019). Subsequently, a drain down model (DDM) was developed that applies the Brooks and Corey method to estimate past seepage rates and mass loading beginning in 2012 based on historical site-specific data as well as future seepage and Large Tailings Pile seepage rates, toe drain collection rates, and constituent concentrations (Brooks and Corey, 1964; Hydro-Engineering, 2020a). Seepage estimates developed from the reformulated mixing model for the period 2002 through 2011 and from the drain down model for the period 2012 through 2019 (Hydro-Engineering, 2020a, 2020b) are used input for the groundwater model to simulate flow from the Large Tailings Pile into the local groundwater system. Figure 3.1-4 illustrates the modeled Large Tailings Pile seepage rates, which were as high as 200 gallons per minute in 2014 and are estimated to reach a long-term steady-state rate of 0.6 gallons per minute. Documentation and copies of the reformulated mixing model and drain down model are provided in Appendix 1.2-C.*" From Aug 2022 ACL Application, Appendix 4.2-B (Predictive Modeling Report): "*Seepage estimates developed from the Drain Down Model (DDM) were incorporated into these GRP predictive model simulations to simulate future seepage from the Large Tailings Pile (LTP) into the underlying local groundwater system. Except for the bounding case simulations, the baseline version of the DDM model was selected for these predictive simulations, which assumes a long-term seepage rate of 0.6 gallons per minute (gpm) (Hydro-Engineering [HE], 2020; Appendix A). For the bounding case simulations, the*

Attachment 5. HMC Response to Review Comments from NRC's April 30, 2021 Acceptance Review of the 2020 GCAP LAR		
Comment		**HMC Response to Comment**
		contingency version of the DDM model was selected for these predictive simulations, which assumes a long-term seepage rate of 2.4 gpm (HE, 2020; Appendix A)."
1 Discussion-B	Predicting infiltration rates and water quality through an impoundment may involve complex models. The NRC staff will accept the values predicted by a licensee provided a reasonable assurance can be made on the applicability of the methods used to establish those values. NRC staff's preliminary review suggests the GCAP provides a wealth of information on certain aspects of seepage but also contains gaps in the discussion of methods used to calculate the present-day seepage rates or the long-term seepage rate.	See response to Comment 1 Discussion-A, above. The modeling basis for the estimated base-case seepage rate is well documented and the bounding-case seepage is assumed to be 4 times the estimated base-case to encompass uncertainty in modeled conditions.
1 Discussion-C	NRC staff's understanding of the method is referred to by HMC as the "reformulated mixing model" in Appendix I of the GCAP. Appendix I contains a memorandum or writeup entitled Drain Down Model Predictions – Baseline and Contingency, which is dated September 1, 2020. The DDM provides results and some rudimentary calculations appearing that the method is based on changes in saturated thickness of the tailings pile during corrective actions. However, the exact methodology is not entirely documented. The September 2020 memorandum relies heavily on the methods referenced to an earlier March 26, 2020 Memorandum - Drain Down Model Modifications and Predictions (3/26/2020), which apparently has not been submitted to NRC. It should be noted that this earlier memorandum has the same title as the document NRC requested be submitted with HMC's response to NRC's request for supplemental information dated June 18, 2020.	The identified reference, Memorandum - Drain Down Model Modifications and Predictions (3/26/2020) is included with this Attachment as Exhibit A.
1 Discussion-D	Finally, the NRC staff notes problems with translation of the data estimated by this method into input for the numeric model. For example, the NRC staff compared the recharge rates simulating seepage from the landfill for the numeric model calibration simulation to the respective time equivalent results as reported in the DDM (Table 1). First, the DDM does not report values for the years 2001 through 2011 and no documentation exists on the source of this information. Conversely, the equivalent recharge rates for years 2012 through 2017 in the model input are equal to the seepage values as listed in the DDM (within rounding error). Second, the area in the model calibration simulation representing the LTP is 10.15x106 ft3 (233 acres; 1913 model cells) whereas the area simulating the LTP in the predictive simulations is 9.69x106 ft3 (222 acres; 1,826 model cells). A properly calibrated model would have similar areas in both the calibration and predictive simulations.	As noted in Appendix 3.1-A of the ACL Application LAR, the source of the LTP seepage and water quality is derived from the RMM from the period of 2001 through 2011, which is then superseded by the DDM predictions. The concern of a 5% difference in footprint between the calibration and predictive model runs has since been resolved in the updated model.

Attachment 5. HMC Response to Review Comments from NRC's April 30, 2021 Acceptance Review of the 2020 GCAP LAR

Comment		**HMC Response to Comment**
Comment-2	Provide more detailed evaluation of the long-term seepage quality from the LTP.	HMC respectfully submits that the specificity requested on these Comment 2 issues is best reserved for the detailed technical review process and is not a sufficient basis for declining to accept the application for detailed technical review. Nonetheless, in the interest of thoroughness, HMC is providing the below information to the NRC. See detailed discussion below.
2 Discussion-A	HMC estimates the long-term seepage uranium concentration from the recently measured tailings pore-water concentration. Under normal conditions, this is a reasonable method; however, the site conditions warrant additional characterization. The historical corrective action program included dewatering pore water in the tailings. The intent was to reduce (1) the volume of water in the tailings that may have facilitated historical seepage through the tailings impacting the alluvium and (2) the concentrations in the pore water thus removing the amount of soluble uranium that could be mobilized in the future. The dewatering program evolved over time. Importantly, HMC elected to inject groundwater into the tailings to facilitate "flushing" of uranium from the tailings. An effect from revising this program was that not all water injected into the tailings for flushing was pumped from the tailings. Consequently, the saturated thickness of the tailings increased as well as the seepage rate to the alluvial groundwater, which defeats one of the initial intents of the program.	Regardless of the intent of the dewatering program, currently measured conditions in the tailings, the relative stability of post-dewatering program tailings pore water concentrations identified (2015-2020), and assessment of the long-term geochemical stability of the tailings and potential for concentrations to rebound to pre-dewatering concentrations are clearly presented in the LAR. Further, uncertainty in long-term tailings seepage flux and concentrations are addressed in the bounding-case modeling conditions, summarized below: **Base Case:** • 0.6 gpm long-term seepage rate from Drain Down Model (DDM) • 5.16 mg/L Unat from DDM (consistent with tailings wells post-flushing conc., Figure 2.1-3) • 11.24 mg/L Mo from DDM (consistent with post-flushing tailings, Figure 2.1-4) **Bounding Case:** • 2.4 gpm (4x base case, conservative assumption) • 45 mg/L Unat (max pre-flushing Tailings well conc. Fig. 2.1-3, consistent with majority of pre-flushing toe drains (Figure 2.1-5), • Mo not modeled • Increased Initial Mobile Domain Mass: ○ increased initial Unat concentration in mobile domain under the LTP and STP footprints by 25% over those of calibrated model, initial concentrations at model cells containing alluvial wells within a 200-foot distance of the LTP and STP were increased to match uranium analytical results from sampling events closest to the end of 2019 (unless prior to 2015) if greater than the initial concentration produced in the previous step.
2 Discussion-B	The injection and retention of fluids may have resulted in an "apparent" lowering of concentrations by dilution rather than a reduction in the soluble fraction of the tailings as noted by the U.S. Army Corp of Engineers (ACOE) (2010)5.[5Focused Review of Specific Remediation Issues: An Addendum to the remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico Final Report, prepared by the U.S. Army Corps of Engineers for the U.S. Environmental Protection Agency Region 6, December 23, 2010, 98 pp.] The GCAP provides a wealth of information on the geochemistry of the tailings to refute the ACOE suggestion of the potential rebounding of pore-water concentrations after cessation of the flushing program. The NRC staff is not commenting on this information as an adequate technical review is not possible under the acceptance review parameters. However, the NRC staff will comment on the assumption that the pore-water concentrations are equivalent to the seepage concentrations. In brief, if the water captured by the "toe drains" is a portion of the seepage, would the toe drain concentrations, which are roughly twice the pore-water concentrations, not be more indicative of the seepage concentration?	This issue is addressed by the bounding case analyses, discussed in the ACL application and summarized above. ACL Section 2.1.1.2. provided detailed geochemical characterization of the current tailings pore water. Regardless of how or why these are the concentrations (dilution via flushing) this is what the pore water is now and there is no evidence to indicate that they will revert to pre flushing levels. "*Results from the supplemental Large Tailings Pile rebound investigation indicated that a few select tailings sumps and former Arcadis rebound monitoring wells have demonstrated increasing constituent concentrations since flushing ceased but the increases are minor compared to pre-flushing concentrations and none have returned to pre-flushing concentration (WME, 2020a; also see Figures 2.1-3 through 2.1-8 of this ACL Application). However, monitoring results from the short-screen wells indicate either decreasing or overall stable concentrations of constituents in Large Tailings Pile pore water (Figure 2.1-9). In addition, results from the controlled static column study provided no indication of diffusive rebound over a one-year test period (Figure 2.1-10 and Figure 2.1-11). The volume-weighted concentrations of uranium, molybdenum, and selenium in the Large Tailings Pile have also been decreasing since flushing ceased, providing no indication of diffusive concentration rebound in the Large Tailings Pile as a whole (WME, 2020a).*" "*• rinsing of soluble constituents, dissolution of calcite, and oxidation of sulfide minerals (primarily pyrite) are the primary mechanisms controlling the long-term chemistry of weathered tailings solids leachate* *• tailings contain an excess acid-neutralizing capacity and no significant residual sources of constituent release from the tailings upon future long-term weathering are indicated* *• no future significant diffusive mass transfer and subsequent rebound of constituents is expected to occur.*"

Attachment 5. HMC Response to Review Comments from NRC's April 30, 2021 Acceptance Review of the 2020 GCAP LAR		
Comment		**HMC Response to Comment**
2 Discussion-C	HMC has demonstrated through the monitoring program that a portion of the seepage is captured by the "toe drains" collection system surrounding the LTP. The exact methods of how and why are not discussed in detail in the GCAP. The GCAP states that the tailings are underlain by a perched zone, which is located generally 10 feet below the base of the tailings and is not naturally saturated. The GCAP also states that alluvial material in the perched [aquifer] contains higher fractions of soluble uranium and the uranium "*is not expected to be strongly retained by clays under site conditions.*" This statement may be true for the coarser alluvium but may not be true for the underlying confining unit upon which the perched aquifer lies. For example, the GCAP states *"… the leachable concentrations of COCs [contaminants of concern] are generally higher from samples below the LTP sands (WME-7) compared to samples below the LTP slimes (WME-8). This is consistent with lower clay contents and soluble COC concentrations observed in the LTP sands indicating a potentially higher degree of COC migration into the alluvium below the sands.*"	The NRC's articulation of the perched zone is accurate, that an area in the alluvium directly underneath the tailings pile is artificially saturated by seepage from the tailings pile. The toe drains and French drains installed along the toe of the pile are situated in this perched zone, and thus, capture water from both the tailings pile seepage and the perched water in the alluvial material underneath. As a source to groundwater, conceptually, this area is treated as part of the tailings pile. While the agency is correct that contaminants may adsorb onto and diffuse into the fine-grained material underneath the perched zones, the model makes the conservative assumption that any seepage from the tailings pile reports to directly to the saturated alluvium.
2 Discussion-D	The extent of the fine-grained underlying confining unit is not discussed in the GCAP. Based on the D'Appolonia 1980 Stability Assessment of the uranium tailings pond, the fine-grained material may be part of the impoundment design or naturally occurring.[6] [[6]Engineer's Report: Stability Assessment of the Uranium Mill Tailings Pond, United Nuclear-Homestake Partners, Grants, New Mexico, prepared by D'Appolonia Consulting Engineers, Inc, for UN-HP, November 1980, 59 pp ADAMS Accession No. ML20212B474]. The 1980 report further provides a conceptual flow regime for the tailings in which flow occurs both vertically and horizontally through the "interface layer". Similar to back diffusion in the alluvium, uranium adsorbed to the confining unit underlying the perched zone will contribute to the concentrations within the perched zone as well as fluids infiltrating through the unit to the underlying alluvial aquifer.	Please see responses to the Comment 2, Discussions-A, -B, and -C, above.
	Based on the historical data, the rate of collection of fluids from the toe drains correlates with the pore-water elevations. It is reasonable to assume that fluid collected from the toe drains is indeed representative of the seepage as it migrates from the impoundment. The higher concentrations at the toe drains may be due to a longer residence time for the pore solution than at the locations of the pore-water measurements, less impact from the flushing or represent the seepage concentration as it further migrates to the alluvial aquifer. The latter scenario is perhaps the more conservative assumption and should be evaluated.	This issue is addressed by the bounding case analyses, discussed in the ACL application and summarized above.
Comment-3	Provide and evaluate the effectiveness of the control of radiological hazards at the GRP for 1,000 years.	This issue was fully addressed in ACL Application See response below.

Attachment 5. HMC Response to Review Comments from NRC’s April 30, 2021 Acceptance Review of the 2020 GCAP LAR		
Comment		**HMC Response to Comment**
3 Discussion-A	In the GCAP, HMC conducted modeling and evaluation on the effectiveness of the control of radiological hazards out to 200 years in the future. However, the NRC staff will need information on radiological hazards out to 1,000 years in the future.	This issue was fully addressed in the 2022 ACL application. All alternatives were modeled for 1,000 years, please see Section 4.3.2.1 Predictive Modeling of Alternatives, Section 4.3.2.3 Analysis of Long-term Sources, and Appendix 4.2-B Predictive Modeling
Comment-4	Provide additional details on the method used to establish initial concentrations for the predictive simulations. The discussion should include rationale for assigning a high value for the initial concentrations at the start of the simulation (end of 2001), which was after 15 years of corrective actions if the concentrations in the immobile domain decreased during the recent 15 years of corrective actions.	HMC respectfully submits that the specificity requested on these Comment 4 issues is best reserved for the detailed technical review process and is not a sufficient basis for declining to accept the application for detailed technical review. Nonetheless, in the interest of thoroughness, HMC is providing the below information to the NRC.
4 Discussion-A	The GCAP states that for areas where a dual-domain groundwater regime is not defined, the model is assigned values for an effective porosity of 0.20 and bulk density 2.12 grams per cubic centimeter (g/cm3). For areas where the dual-domain was defined, the effective porosity for the mobile domain was assigned a value of 0.18 and that for the immobile domain porosity was assigned a value of 0.1275. The mass transfer rate between immobile and mobile domains was set to 2.94x10-5 days-1. The immobile domain was assigned the same Freundlich isotherm as the mobile domain. The initial concentrations for the immobile domain in the calibration simulation was set within the 10 milligram per liter (mg/L) isopleth (mobile domain) by professional judgment. This method was based on the assumption that a significant mass had diffused into the immobile phase during the historical conditions. The initial concentrations outside of the 10 mg/L isopleth was set equal to the mobile domain concentration.	HMC has no response as this appears to merely be a statement of conditions. If the NRC has some further basis it wants to provide to HMC for including this RAI, we would be pleased to address the matter.
4 Discussion-B	For the predictive simulations, the GCAP states: Initial immobile concentrations for the area of dual-domain transport were developed by obtaining the ratio of simulated immobile to mobile domain concentrations in each model node at the end of the 2017 model calibration period and multiplying each node’s predictive initial mobile domain concentration by the mobile/immobile concentration ratio. Rationale for modifying output from the calibration simulation for input to the predictive simulations was not provided. Furthermore, though professional judgment will ultimately have to be used in establishing the initial concentrations for the immobile domain, the NRC staff is concerned about a bias that may result from assigning initial concentrations for each simulation without adequate technical bases.	The basis for the estimation of mass residing in the low permeability zones is provided within the 2022 ACL Application LAR. Section 5.5.2 of the Groundwater Flow and Transport Calibration Report presents the basis for the contaminant mass (and concentrations), and the mass flux rate from the low permeability zone. Two separate approaches were used to estimate the mass present in the low permeability zones (the approach specified in Section 5.5.2 of the Calibration Report and the approach articulated in Appendix G of the Calibration Report, both found in Appendix 3.1-A of the ACL Application) and the difference between the two approaches yield only 6% difference in estimated mass. Please see Appendix 4.2-B of the 2022 ACL Application for the detailed discussion of the basis for the initial condition of the predictive model runs. In short, the initial conditions for predictive model runs were based upon the final output at the end of the 2019 model calibration for both the mobile and immobile domain, resolving any potential concerns of biasing the predictive model run outcomes.

Attachment 5. HMC Response to Review Comments from NRC's April 30, 2021 Acceptance Review of the 2020 GCAP LAR		
Comment		**HMC Response to Comment**
4 Discussion-C	For example, the NRC staff compared the distributions of initial concentrations for two predictive simulations (Figure 1) with the distributions of output for the calibration simulation (Figure 2). The distributions are not equivalent nor proportional as suggested by the licensee's writeup. Unfortunately, the above comparison did not evaluate the data on a cell-by-cell basis and a more detailed analysis of the change is needed. The NRC staff preliminarily reviewed the spatial distributions of initial concentrations with the final output for the calibration simulation shown in Figure 2. A review of Figure 3 through Figure 7 shows: * Figure 3: (1) The distribution of immobile domain initial higher concentrations does not correlate with the mobile domain initial higher concentrations. (2) During the 15-year calibration simulation, the distribution of initial higher concentrations for both domains was "smoothed" and the values generally decreased. * Figure 5: (1) The distribution of immobile domain initial lower concentrations does correlate with the mobile domain initial lower concentrations. (2) During the 15-year calibration simulation, the distribution of initial lower concentrations for both domains was "smoothed" and the values generally decreased. * Figure 5 and Figure 6: The uranium concentration isopleths for the immobile domain indicate elevated concentrations (132 mg/L) at localized areas and a general decrease of approximately 20 mg/L at the end of the 15-year calibration simulation. * Figure 7: The uranium concentration isopleths for the mobile domain contrast with the reported 2017 concentrations. The isopleths are consistent with those shown on Appendix F Figure 5-32 except isopleths greater than 10 mg/L are not displayed in the report's figures. The elevated concentrations are significantly higher than those reported in 2017. (Note, several wells did report higher values in 2017 which were apparently not included in the contouring. Those wells were eliminated in the subsequent reports.)	Please see response above.
Comment-5	Because of the numerous assumptions incorporated in establishing both sources, provide an evaluation of simulations to document the impacts (i.e., impacts due to seepage alone, impacts due to back diffusion at low levels, impacts due to back diffusion at high levels, etc.).	Addressed in ACL via sensitivity modeling of the two primary source terms. Section 4.3.2.3 Analysis of Long-Term Sources and Appendix 4.2-B. "*In order to assess if long-term groundwater restoration can be reasonably maintained without perpetual treatment, additional model sensitivity simulations were performed. Specifically, sensitivity simulations were performed to assess the potential impacts of a range of input values for sources of constituent mass in the predictive model using uranium as the characteristic constituent for these simulations. These sensitivity simulations were run to isolate the relative impact of these individual source-terms on groundwater quality and assess if long-term restoration is reasonably achievable by assigning ambient initial groundwater concentration conditions to the relevant water-yielding units.*" "*The two sensitivity simulations addressed herein include uranium mass in alluvial recharge from seepage from the Large Tailings*

Attachment 5. HMC Response to Review Comments from NRC’s April 30, 2021 Acceptance Review of the 2020 GCAP LAR		
Comment		**HMC Response to Comment**
		Pile and back-diffusion from the dual-porosity immobile domain. The simulations of only the Large Tailings Pile seepage recharge mass and only back-diffusion from the immobile domain can be interpreted as assessing the relative impacts of each as a mass source to the lithologic units and their relative significance on the long-term effectiveness of groundwater corrective action and restoration efforts. *A third sensitivity simulation of increasing the initial mass in the alluvial aquifer, presented in the Transport Modeling Report included as Appendix 4.2-B, can be interpreted as addressing potential uncertainties in characterizing the mass beneath the tailings pile but is not specifically summarized here.*"
5 Discussion-A	The GCAP states that 50 years of active corrective actions do not restore the groundwater quality to background. However, no simulation was performed to predict the length of time needed for the corrective actions to restore the groundwater quality to background. HMC did perform a 150-year simulation to test the impact of back diffusion from the immobile domain on future concentrations in the mobile domain. The stated purpose and /or rationale for this simulation was: (1) “[t]his scenario is conservative in that it underestimates the time and cost to approach full aquifer restoration, thereby making the cost benefit assessment of this alternative, to be presented in another submittal, appear more time and cost effective than it is likely to be.” (2) “[t]his result [of back diffusion from the immobile domain] indicates that the hazardous constituent mass already in the groundwater system is as much or more of a source to long-term plume migration than seepage from the LTP.” This simulation does provide some interesting results but the GCAP should be revised to clarify that this simulation was artificial. Unlike the 18- or 36-year corrective action simulations in which the post natural attenuation period was included in the simulation, a new simulation was performed after the 50-year corrective action simulation for which the initial uranium concentrations mobile domain were adjusted outside of the model. Such a distinction is not readily discerned from the titles or annotations on Figures 6-75 through 6-89 in Appendix F. The figures should be properly annotated clearly stating the assumptions used.	HMC proposes to defer addressing this issue once consensus regarding the calibration and input parameters of the groundwater flow and contaminant transport modeling are resolved as part of the detailed technical review process.
Comment-6	Provide an evaluation of the mixing model output to ensure the mixing model is consistent with site conditions.	HMC respectfully submits that the specificity requested on these Comment 6 issues is best reserved for the detailed technical review process and is not a sufficient basis for declining to accept the application for detailed technical review. Nonetheless, in the interest of thoroughness, HMC is providing the below information to the NRC.
6 Discussion-A	**Low-Permeability Zone Source Term:** For the detailed technical review, the NRC staff will likely need additional characterization of the source term in the immobile zones. As HMC has discussed in the GCAP, back diffusion from the low-permeability zones is as much or more of a source to long-term plume migration than seepage from the LTP. To reduce the uncertainty in this source term, soil samples could be collected from the alluvial aquifer and	As discussed in other response attachments (Attachment 3, Comment 6c), the mass residing the low permeability zone was estimated using two different methodologies.

Attachment 5. HMC Response to Review Comments from NRC's April 30, 2021 Acceptance Review of the 2020 GCAP LAR		
Comment		**HMC Response to Comment**
	the mass of contaminants could be quantified in the low-permeability zones.	
6 Discussion-B	**Freundlich Isotherm Parameters:** The isotherm used in the model is based on a geochemical mixing model. The NRC staff reviewed the mixing model by including all elements in the output. The levels of several elements were not consistent with the observed data and calls into question the validity of the mixing model. For example, the endpoint solutions used by the licensee for the mixing model are (1) tailings-impacted groundwater and (2) native groundwater. The pH for the endpoints was 7.4 and 8.47. However, the pH for all the mixtures was between 6.8 and 6.9, significantly below the two endpoints. Furthermore, the pE for all mixtures was 15.0, values which is higher than expected.	The two master variables controlling the distribution of uranium and other redox-sensitive elements are pE and pH. Mixing scenarios in PHREEQC generate a batch-reaction calculation which produces redox equilibrium. When solutions are mixed, all valence states of elements react to redox equilibrium, which can change the pe of the solution (Parkhurst and Appelo, 2013). It has been noted that when using PHREEQC, the reactions being simulated should determine the pe, just as the reactions should also the pH (USGS, 2021). The resulting equilibrium pE values remained consistent with oxidizing conditions and ranged from 15.07 to 15.30; these values are slightly higher compared to typical environments in contact with the atmosphere but remain below the upper limit of water stability (Langmuir, 1997). Mixing of the two end member solutions (pH 7.40 and 8.47) in PHREEQC produced equilibrium pH values ranging from 6.69 to 6.89. The lower pH values are a result of calcite dissolution which releases carbon dioxide and decreases the pH due to production of carbonic acid (Langmuir, 1997). The calculated pH values (±0.5 pH units) are well within the values reported for the alluvial aquifer at the GRP (HMC and HE, 2020). HMC and HE. 2020. Grants Reclamation Project, 2019 Annual Monitoring Report/Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200. Consulting Report for Homestake Mining Company of California. Langmuir, D. 1997. Aqueous Environmental Chemistry. Prentice Hall, NJ. 600 pp. United States Geological Survey (USGS). 2021. FAQ-Frequently Asked Questions About PHREEQC, Phreeqci, and Netpath.
Comment-7	The number of general head boundaries (GHB) in the model differs for various stress periods and/or simulations. Provide a rationale for changing the number of GHB. General head boundaries are used as model-perimeter boundary conditions. As a general rule, the number of boundary conditions should remain constant for all stress periods in the predictive and calibration simulations; however, the number of GHB in the various simulations and individual stress periods are not constant. For example, for the 200-year natural attenuation predictive simulations, the number of GHB varied from 1,880 to 1,836 for the 80 stress periods.	Please see discussion on general head boundaries in Section 3.4.3 of the Model Calibration Report in Appendix 3.1-A. As discussed in the report, GHBs are used along the extent of the model domain as well as in the first stress period to establish the initial condition for the simulation of the artificial recharge to the alluvium in the San Mateo Creek Basin from historic mining activities.
Comment-8	Provide an evaluation of the potential future impacts to the SAG aquifer and municipal well(s) screened in the aquifer if the model is to be used to support an ACL application. Discussion: The objective of the model is to access the recent, current and potential future changes to the groundwater regime. The GCAP states the model will be used to support a Feasibility Study, revised GCAP, and an ACL application. This version of the model, which the NRC staff recognizes was intended to support revisions to the GCAP, includes the SAG aquifer as the lowermost layer but no attempt was made to evaluate impacts to that aquifer. An ACL application needs to evaluate potential impacts to points of exposure. The closest potential point of exposure may be a Town of Milan municipal well in the SAG	This issue is addressed in the ACL application: The model was revised to address both groundwater flow and contaminant transport related to the SAG aquifer. Contaminant concentrations in the SAG aquifer were evaluated at the POE for both the base case and bounding case model simulations. Demonstration of the protectiveness at the POE in all aquifers including the SAG was evaluated using the highly conservative bounding case model, which included additional SAG wells in the area for municipal supply and higher than current groundwater with high groundwater withdrawal rates. Groundwater Flow: ACL Section 3.1.1; Section 3.1.2; Contaminant Transport: ACL Section 3.1.3, Section 3.2, Section 3.3, Section 4.3.2.1 Appendix 3.1-A (Model Calibration), Appendix 4.2-B (Predictive Modeling)

Attachment 5. HMC Response to Review Comments from NRC’s April 30, 2021 Acceptance Review of the 2020 GCAP LAR		
Comment		**HMC Response to Comment**
	aquifer if not the SAG aquifer itself. However, the model domain for the SAG aquifer does not extend to some of the municipal wells.	

EXHIBIT A

Memorandum - Drain Down Model Modifications and Predictions (3/26/2020)

3/26/2020

Memorandum – Drain Down Model Modifications and Predictions

Drain Down and Mixing Model Concept and Introduction

The Reformulated Mixing Model (RMM) was developed as a mechanism to estimate or forecast water and constituent of concern (COC) mass balance and exchange within the Large Tailings Pile (LTP) at the Grants Reclamation Project (GRP) site, and to estimate or forecast the rates and water quality for seepage from the LTP. The RMM name was assigned to distinguish the model structure from earlier versions as described in the attached memorandum, but the name Mixing Model (MM) is also used generically to describe the modeling approach. As described in the remainder of this memorandum, the MM has been replaced with a Drain Down Model (DDM) which incorporates the Brooks and Corey (1964) method to estimate seepage and toe drain rates. In conjunction with the updated method for estimating seepage and toe drain rates, the DDM also includes refined estimates of the long-term infiltration rate and an updated mass balance for predicting COC concentrations in the LTP.

Transition to Drain Down Model and Update

With the flushing program ending in 2015 and only limited future dewatering effort anticipated, the MM has been effectively replaced by the DDM to estimate future seepage and toe drain discharge rates from the LTP. Because the flushing injection has been discontinued, the features of the MM that were incorporated to empirically estimate the change in COC concentrations with flushing or mixing are not needed after mid-2015. However, some formatting and presentation features of the MM remain useful because they provide a convenient avenue for presentation of DDM results including prediction of future COC concentrations. The output of the DDM described in this memorandum is based on the Brooks and Corey (1964) method to estimate seepage and toe drain rates as the LTP drains at a diminishing rate. This DDM output also provides an estimate of COC concentrations in the seepage and remaining in the LTP, but changes after flushing are limited to a minor dilution by a relatively small rate of infiltration. There are approximately three years of available LTP drain down or water balance data after the end of the flushing program that is useful in estimating seepage rates from the tailings. The DDM spreadsheet effectively begins in 2015 to incorporate the drain down data occurring after flushing injection.

Seepage Rate Estimation

The primary modification of calculation methods in the DDM for this analysis was a change in estimation of seepage rates and toe drain discharge rates using the Brooks and Corey approach and the available data for years 2015 through 2018. Since the flushing program was discontinued in 2015, the water-level elevation in the LTP has dropped and the rate of seepage can be estimated using the change in LTP water storage and the measured toe drain discharge rates. With the exception of a small rate of infiltration into the LTP and a small rate of dewatering in 2016 and 2017, the seepage and toe drain discharge represent the only exchanges of water and COC mass between the LTP and the surrounding environment over the last three years. The available estimates of seepage using the water volume changes in the LTP were developed for six months intervals since 2015 by smoothing and interpolating the volume calculations performed on an annual basis with the results shown in the following graph. The smoothing was required because year to year volume changes were based on annual potentiometric surfaces for the LTP that had varying numbers of measured water-level elevations and varying resolution/accuracy. The data points were also offset six months in time so they represented seepage during the year and additional data points were interpolated at six month intervals.

The information on the Brooks and Corey approach was provided by Johnny Zhan and it uses a relationship for estimating hydraulic conductivity (K) for partially saturated conditions as shown below.

$$K(\theta) = K_s\left(\frac{\theta - \theta_r}{\theta_{sat} - \theta_r}\right)^{\gamma}$$

Where: θ is the volumetric moisture content
K_s is the saturated hydraulic conductivity
θ_r is the residual moisture content
θ_{sat} is the porosity or saturated moisture content
γ is an empirical parameter related to grain size distribution

Reference: Brooks, R.H. and Corey, A.T. (1964) Hydraulic Properties of Porous Media. Hydrology Papers 3, Colorado State University, Fort Collins, 27 p.

The Brooks and Corey approach can also be converted to a volumetric formulation to predict seepage rate (Q) based on the volume of water remaining in the LTP as shown below.

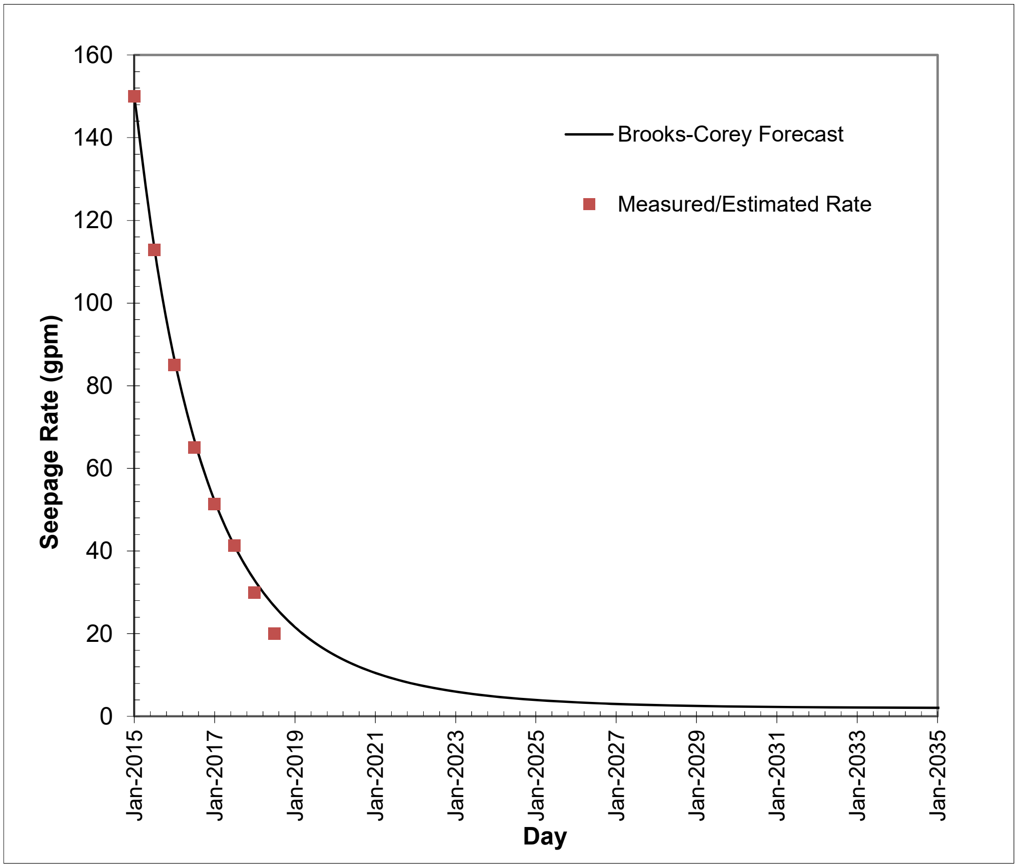
$$Q(V) = AK_s\left(\frac{V - V_r}{V_{sat} - V_r}\right)^{\gamma}$$

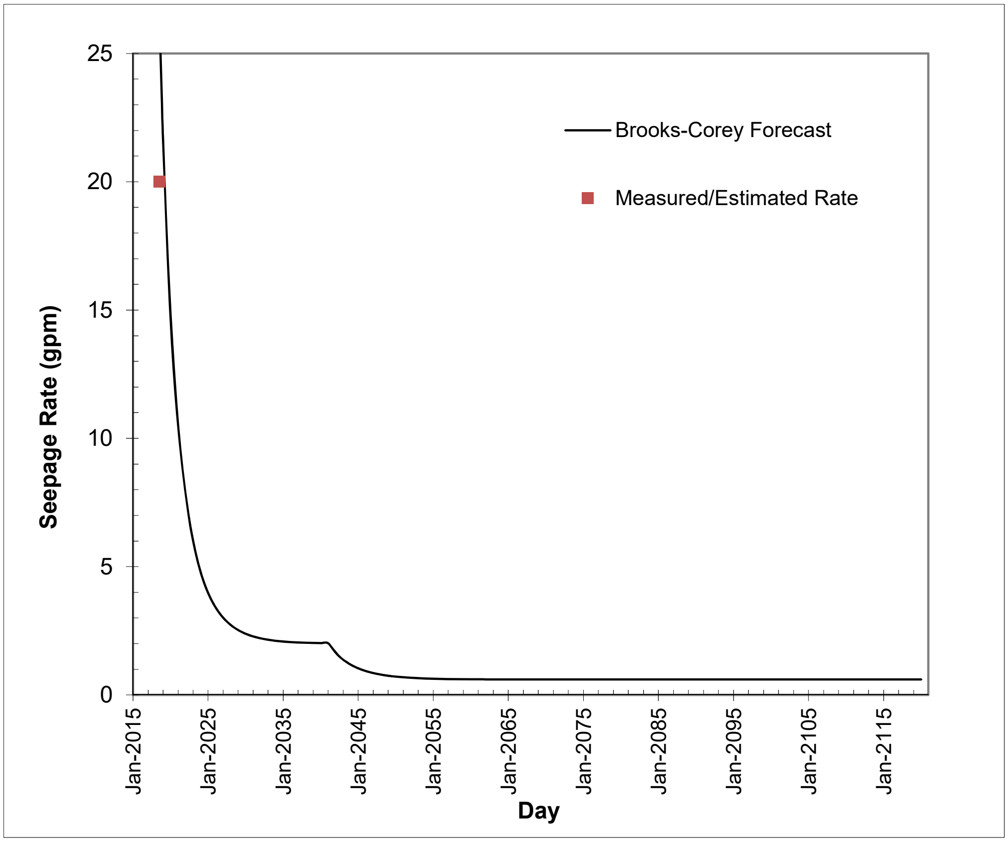
Where: V is the volume of water in the LTP
A is the area of the LTP
K_s is the saturated hydraulic conductivity
V_r is the residual water volume in the LTP
V_{sat} is the water volume in the LTP at saturation
γ is an empirical parameter related to grain size distribution

The implementation of the moisture content formulation of the Brooks and Corey in the DDM to estimate seepage is done by estimating the inputs of K_s, θ_r, θ_{sat}, γ and the moisture content θ in the LTP at the start of the simulation in 2015. The calculation of the seepage rate is performed on six month intervals with the calculated θ from the previous interval serving as the starting moisture content for the following time step. This formulation also allows incorporation of an infiltration rate as an input of water to the LTP. As seen in the volumetric formulation, the seepage rate can be calculated as the product of the partially saturated K and the area of the LTP. A preliminary estimate of K_s of 6E-06 cm/sec as a composite for the sand and slime tailings was made and the preliminary estimate of θ_{sat} was made by calculating the volume of sand and slime tailings in the LTP and then applying typical porosity estimates and retained water content estimates for the two different types of tailings. These estimates and the estimate of θ in 2015 were then refined by Johnny Zhan to achieve the best fit of the measured and smoothed seepage rates as shown in the following graphs.

Because the LTP is very heterogeneous with distinct sand and slime areas and tailings in various states of drainage, the estimate of starting θ in 2015 of approximately 0.2312 is a composite for a wide range of tailings conditions. In the Brooks and Corey method, this θ is then incrementally reduced by the rate of seepage over six month periods beginning in 2015 to produce a table of θ and predicted seepage rate through the end of the simulation. The seepage rate is calculated using the partially saturated K and the area of the tailings. The area of the LTP under which there is a measurable thickness of tailings or windblown tailings material is approximately 223 acres (902,459 square meters). After refinement of the Brooks and Corey variables to fit observed data by Johnny Zhan, the "composite" K_s was estimated at 5.5467E-06 cm/sec. The θ_r was estimated at 0.1907 and the θ_{sat} was estimated at 0.3579. The formulation is relatively sensitive to the exponent γ and the value was estimated at 1.174.

As shown in the following graphs, there was a relatively good fit of the Brooks and Corey prediction to the seepage rate estimated from the observed change in storage in the LTP. The Brooks and Corey prediction in the graph was extended through 2120, but it should be noted that the prediction includes two (2) gpm of infiltration through 2040 and 0.6 gpm of infiltration from 2041 through 2120 which slightly reduces the decay of the seepage rate.





In the preceding graphs, the rapid decay in seepage rate beginning at the start of 2015 reflects, in part, the operational conditions in 2014 and 2015. During 2014, the flushing injection rate was relatively high (308 gpm) with a modest dewatering rate (46 gpm) resulting in a rise in the potentiometric surface because of the excess injection. During 2015, flushing injection occurred for the first half of the year at a moderate rate and the decline in estimated seepage rate and the Brooks and Corey prediction reflects the declining water volume in the LTP after 2014. From 2016 through 2018, the continuing decay in seepage rate reflects the continuing reduction in estimated drainable water remaining in the tailings.

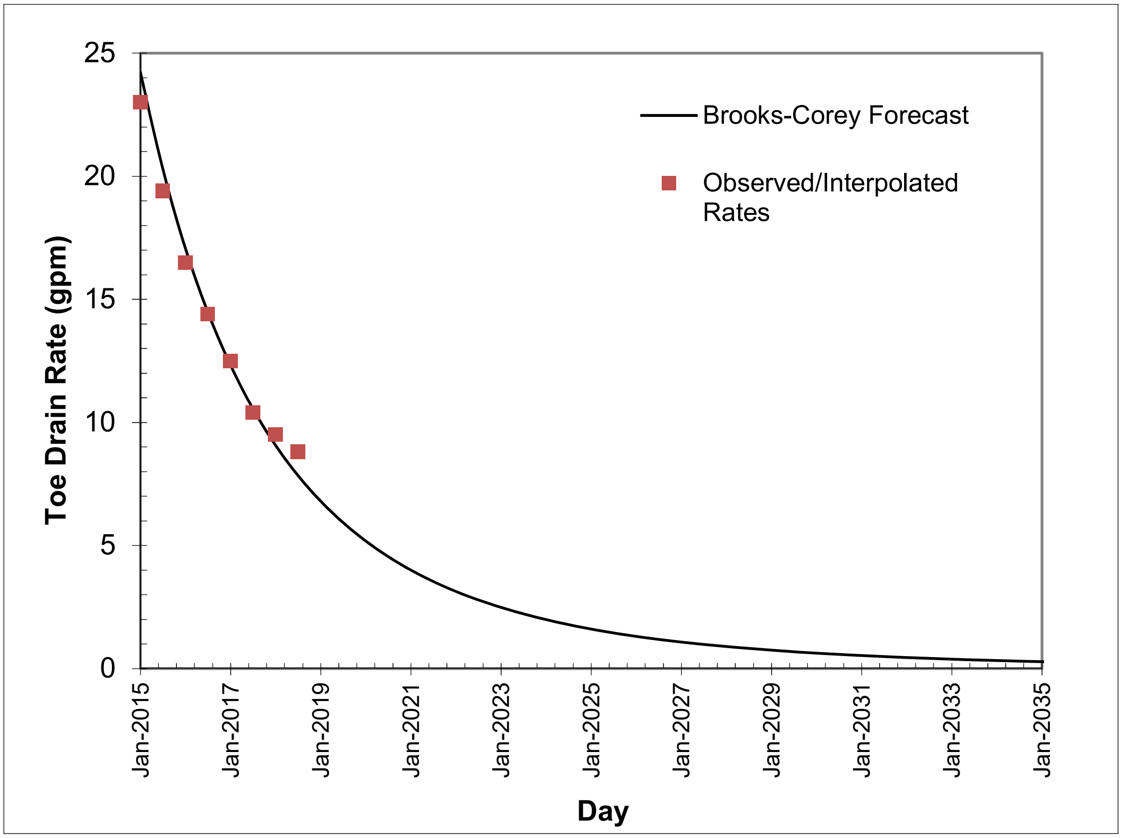
Toe Drain Rate Estimation

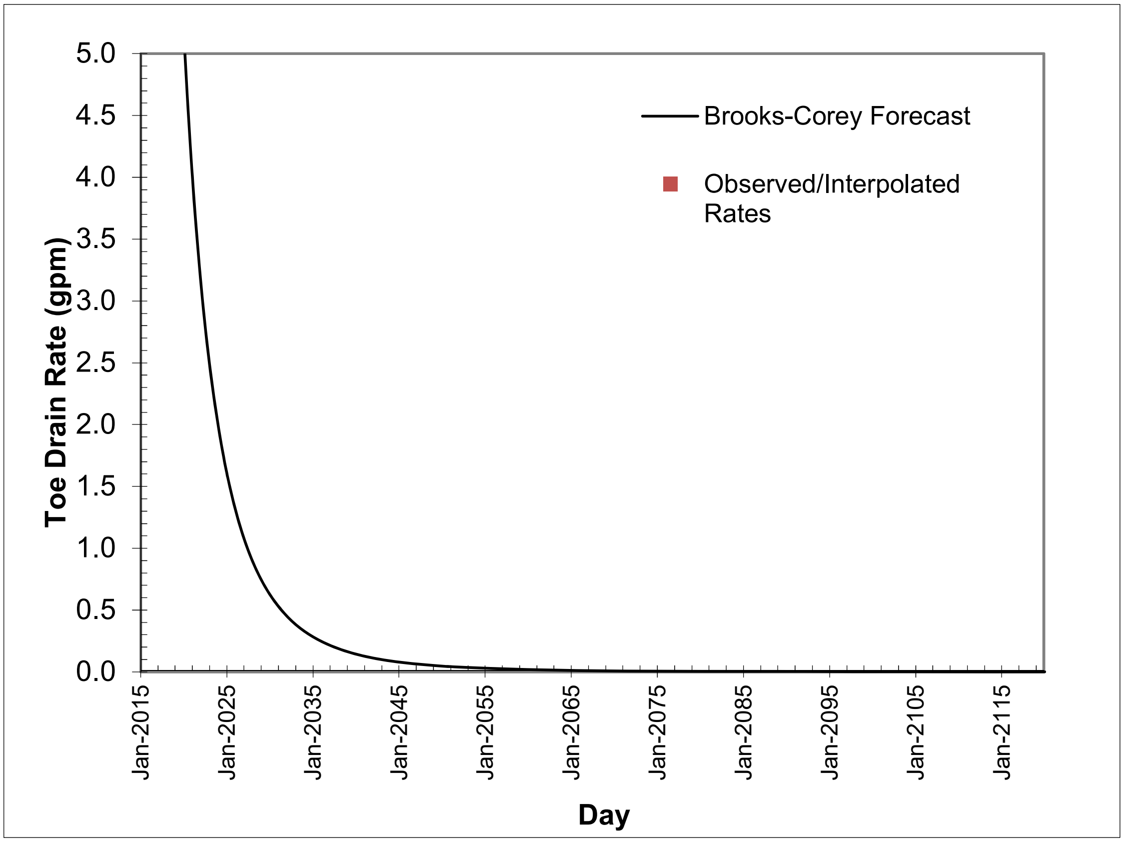
Like the predicted seepage rates, the DDM formulation estimates toe drain discharge rates as a function of moisture content in the tailings. The previous MM formulation used relationships between LTP water volume and toe drain rates developed from VADOSE/W modeling of the LTP by Johnny Zhan. This same VADOSE/W modeling indicated a highly correlated linear relationship between toe drain rates and seepage rates and this was supported by data prior to 2010. However, since approximately 2010, the toe drain rates declined significantly during a period when the LTP water volume and corresponding seepage rates remained relatively high. Because the toe drains are a perforated pipe, there is the potential for physical plugging or geochemical precipitation that restricts entry to the pipe, and this is a possible cause of the reduction. While the relationship between estimated seepage rate and observed toe drain rates may have changed since 2010, the toe drain discharge rates since 2015 have declined along with the declining water volume in the LTP. This consistent relationship between declining LTP water volume and declining toe drain rates allows the application of the Brooks and Corey method to the toe drains as discussed below. Also, the toe drain discharge is effectively additional seepage that is currently intercepted and pumped to the evaporation ponds. The maintenance of toe drain pumping systems will be increasingly difficult with declining rates, and for planning purposes it is assumed the toe drain sumps will no longer be pumped when discharge rates decline to two (2) to three (3) gpm. When the toe drain discharge reaches this rate, the discharge rate will be added to the seepage rate.

As mentioned above, the same methodology used for developing the Brooks and Corey prediction for the seepage rate is applicable for the toe drain discharge. While the physical processes for drainage from the LTP to the toe drains are analogous to those for seepage, the physical configuration for the toe drain does require some adaptation of the Brooks and Corey method. As an example, the area (A) variable in the Brooks and Corey volumetric formulation is not directly applicable for the toe drains because the LTP area is already represented in the seepage calculation. In order to apply the Brooks and Corey method to the toe drain discharge, the area term (A) was used as a variable to scale the predicted rates. A tabulation of observed toe drain rates with time allowed comparison with a Brooks and Corey prediction as shown in the following graphs. The measured toe drain discharge rates for each year were plotted as occurring in the middle of the year and intermediate points were interpolated for the beginning of each year as well as an extrapolated point for the beginning of 2015. The Brooks and Corey variables were then refined to give the best fit of these observed/interpolated toe drain rates.

The prediction of toe drain discharge using the Brooks and Corey method is independent of that for seepage, but the decline in rates occurs simultaneously as the LTP drains. After refinement of the Brooks and Corey variables to fit observed toe drain data by Johnny Zhan, K_s was estimated at 6.4057E-06 cm/sec and θ was estimated at 0.2724 at the start of 2015. The θ_r was estimated at 0.1344, θ_{sat} was estimated at 0.4740 and γ was estimated at 1.257. The effective area for the calculation of discharge from the partially saturated K was 18.28 acres (73,977 square meters).

The application of the Brooks and Corey method to the toe drain discharge as shown in the following graphs gives a reasonably good relationship between the predicted and observed rates. As noted previously, difficulty in continuing to pump the toe drain sumps at very low rates is likely to result in termination of the pumping from the sumps within a few years. Since the toe drain discharge will report to the alluvial aquifer as seepage once the pumping stops, the toe drain rate would then be directly added to the seepage estimate.


Toe Drain Rate (gpm)
25
20
15
10
5
0
Jan-2015
Jan-2017
Jan-2019
Jan-2021
Jan-2023
Jan-2025
Jan-2027
Jan-2029
Jan-2031
Jan-2033
Jan-2035
Day
Brooks-Corey Forecast
Observed/Interpolated Rates


Toe Drain Rate (gpm)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan-2015
Jan-2025
Jan-2035
Jan-2045
Jan-2055
Jan-2065
Jan-2075
Jan-2085
Jan-2095
Jan-2105
Jan-2115
Day
Brooks-Corey Forecast
Observed/Interpolated Rates

Estimation of Long-Term Infiltration

With the cessation of the flushing program and limited anticipated future dewatering, the future seepage rate from the LTP will continue to decline until it approaches the rate of infiltration into the tailings. The final tailings cover system includes a low permeability layer to limit infiltration through the cover to very small rates. The rate of infiltration through a low permeability cover is difficult to predict but past modeling has indicated an infiltration rate equivalent to a continuous rate of approximately 0.5 gpm over the area of the LTP. The following discussion describes the previous infiltration modeling and the features of the reclaimed LTP that will limit the future infiltration through the cover.

Previous Infiltration Modeling

The previous infiltration modeling was conducted with the Leaching Estimation and Chemistry Model (LEACHM), a one-dimensional model utilizing a numerical solution of Richards equation. The modeling separated the LTP into four areas based on slope, cover configuration, and measured cover soil properties, and the model results are summarized in Table 1.

Table 1. Summary of LEACHM Modeling

Layer and Model Property	LTP Top	East Side	North, West and South Sides	Apron
Rock Mulch Thickness (inch)	6	10	10	10
Rock Mulch Density (gm/cm^3)	1.46	1.46	1.46	1.46
Rock Mulch Hydraulic Cond. (cm/sec)	2.3E-06	2.3E-06	2.3E-06	2.3E-06
Filter Thickness (inch)	--	6	6	6
Filter Density (gm/cm^3)	--	1.46	1.46	1.46
Filter Hydraulic Cond. (cm/sec)	--	2.3E-06	2.3E-06	2.3E-06
Frost-Affected Barrier Thickness (inch)	18	18	18	18
Frost-Affected Barrier Density (gm/cm^3)	1.5	1.5	1.62	1.5
Frost-Affected Barrier Hyd. Cond. (cm/sec)	1.9E-06	1.9E-06	3.2E-07	1.9E-06
Thickness above barrier (inch)	24	34	34	24
Unaffected Barrier Thickness (inch)	26	6	28	6
Unaffected Barrier Density (gm/cm^3)	1.59	1.59	1.7	1.59
Unaffected Barrier Hyd. Cond. (cm/sec)	3.8E-07	3.8E-07	6.4E-08	3.8E-07
Precipitation Reduction	Minimal	Moderate	Moderate	Moderate
Modeled Area (acre)	100	40	66	18
Predicted Annual Infiltration (mm)	1.4	0.05	0.09	0.67
Predicted Infiltration Rate (gpm)	0.28	0.004	0.012	0.02

As indicated in Table 1 and the previous discussion, the prediction of composite long-term infiltration rate into the LTP is less than 0.5 gpm. The distinction in areas of the LTP is made because the cover configuration differs for the top and side slopes (also termed outslopes), and, more importantly, because the slope of the land surface will have a dramatic impact on the quantity of runoff and lateral flow through the rock cover on the LTP. When much of the precipitation is discharged off the pile as runoff or flows laterally through the rock and/or filter layers to beyond the footprint of the LTP, the quantity of infiltration is significantly reduced. The previous modeling used an LTP top area of 100 acres at milder slope where nearly 90% of the predicted infiltration occurred. It should also be noted that the previous modeling included the assumption of some degradation of the cover by pedogenic processes. Along with a reduction in soil density, a five-fold increase in permeability was assumed for the upper 18 inches of the compacted radon/infiltration barrier material as a result of freeze-thaw cycles or other pedogenic processes. Depending on the location, this gave a thickness of 24 to 34 inches of the total cover thickness above the radon/infiltration barrier that was assumed to be unaffected by freeze/thaw. The increased hydraulic conductivity included in the modeling was as great as 1.9E-06 cm/sec. This degradation of compacted clay and other covers has been observed and measured in studies (e.g. studies described in NUREG/CR-7028) with dramatic increases in permeability or hydraulic conductivity over time with pedogenic processes. There are numerous factors that affect the degree and depth of long-term barrier degradation making it difficult to predict. However, the infiltration depths or rates are also significantly affected by climatic and other factors so an increase in hydraulic conductivity does not necessarily translate to a significant increase in infiltration rate. Additionally, the design of the LTP reclamation surface reduces the potential for infiltration and other methods can be used to support the estimates of infiltration rate predicted by the previous modeling.

LTP Features and Expected Infiltration Estimation

The reclaimed LTP will have a top surface area of approximately 104 acres at relatively mild slope and a side slope area of 119 acres at moderate slopes. This compares favorably with a top surface area of 100 acres and an outslope/apron area of 124 acres used in the previous modeling. Nearly all of the future infiltration is expected to occur on the top of the reclaimed LTP because runoff and lateral flow through the rock and filter layers will occur quickly on the side slopes. However, an important component in the final reclamation of the LTP is the creation of positive drainage to prevent ponding of water on the top or side slope surfaces. The present top surface of the LTP has an interim cover layer and has generally been graded and shaped to create a typical outward slope of greater than 1% from the general east to west center line of the LTP. With the exception of minor residual depressions and those resulting from the infrastructure and access roads that are maintained on the top of the pile, there is generally a positive drainage system that reduces ponding. When the final LTP reclamation surface is completed, the surface will be graded to a typical land slope greater than 1% and the minor depressions will be eliminated. The final reclamation cover and rock erosion protection is completed on the side slopes of the LTP, so the expected infiltration on the side slopes is at very low levels.

The infiltration or recharge to the LTP can also be estimated by comparing with regional or local estimates of natural recharge. The GRP site is semi-arid with average annual precipitation of 10.48 inches as presented in the 2012 Corrective Action Plan. Numerous references present estimates of infiltration or recharge as a percentage of typical precipitation depths. When the climatic conditions, soil type, vegetation, topography and drainage conditions for these recharge estimates are considered, they can potentially be useful for estimating recharge at the GRP site. As an example, a United States Geological Survey (USGS) Open-File Report (OFR) 87-43 presents a "Summary of Infiltration Rates in Arid and Semiarid Regions of the World, with an Annotated Bibliography". While the data cited in USGS OFR 87-43 have a range of percentage of precipitation contributing to recharge from 0 to over 30%, the data for conditions which are more representative of those at the GRP site typically have small recharge rates. Many of the cited recharge rates for arid to semi-arid conditions are less than 1% of average precipitation depth with several values well below 0.5% of average annual precipitation depth. A study by Huntoon (1977) for an area in Arizona listed an infiltration depth of 2.5 mm or 0.9% of the annual precipitation of 280 mm (11.02 inches). As another example, Johnny Zhan supplied information indicating that eleven years of monitoring data for a heap leach pad in Nevada has indicated a percolation flux of 0.63% of the annual precipitation of approximately 13 inches.

Other methods are available for estimating infiltration or recharge as a percentage of annual precipitation. One such method is the Maxey-Eakin method which is described in Epstein et al. 2010. The method indicates that expected infiltration as a percentage of annual precipitation is; 0% for a precipitation depth of <8 inches, 3% for a precipitation depth of 8 to 12 inches, 7% for a precipitation depth of 12 to 15 inches, 15% for a precipitation depth of 15 to 20 inches, and 25% for a precipitation depth of >20 inches. Because this method is intended to estimate natural recharge for a wide range of soil and other conditions, a dramatic reduction is warranted for the LTP where the final reclamation cover and grading plan is designed to shed runoff from the pile. For the GRP site with an annual precipitation of approximately 10.5 inches, the Maxey-Eakin infiltration estimate of 3% of annual precipitation is likely a reasonable or somewhat conservative estimate of infiltration over the top of the LTP without the grading to create positive drainage and the construction of the final cover.

After the final cover is constructed, the expected infiltration rate as indicated by the previously cited modeling, data and studies is on the order of 0.5% to 1% of annual precipitation over the top of the pile. Because the final cover is not in place, the present infiltration rate over the top of the LTP may be greater than 1% of annual precipitation and an estimate of roughly 3% of annual precipitation as indicated above is likely a somewhat conservative estimate.

Effective Infiltration Rate Estimates

The DDM uses a composite infiltration rate that is converted to a long-term seepage discharge rate from the LTP. The previous modeling conducted in 1995 produced a somewhat conservative infiltration estimate of 0.5 gpm for the LTP with nearly 90% of the infiltration occurring on the top of the LTP. Because the contribution of the side slope area is expected to be a very small percentage of the total infiltration rate, the infiltration rates could be analyzed as occurring only on the top of the LTP. However, the use of the 223 acre LTP area in the Brooks and Corey method described previously makes it more straightforward to quantify the infiltration rate as being uniform over the effective LTP area. In the following forecasts of LTP seepage rates and drain down, total long-term infiltration rates equivalent to 0.6 gpm and 1.2 gpm are used. An infiltration rate of 0.6 gpm equates to a depth of infiltration over the 223 acre LTP of 0.052 inches or approximately 0.5% of average annual precipitation. Likewise, an infiltration rate of 1.2 gpm equates to a depth of infiltration over the 223 acre LTP of 0.104 inches or approximately 1.0% of average annual precipitation. If the infiltration is assumed to occur only on the top area of the LTP, the infiltration rates of 0.6 gpm and 1.2 gpm equate to approximately 1.07% and 2.1% of average annual precipitation, respectively.

The anticipated long-term infiltration rate is 0.6 gpm and a long-term infiltration rate of 1.2 gpm is considered in the drain down forecasting as a significantly more conservative infiltration estimate. During the interim period prior to construction of the final LTP top cover, the infiltration is estimated as 2.0 gpm which is approximately 1.7% of the annual precipitation over the LTP or 3.6% of the annual precipitation over the top of the LTP. This interim infiltration rate is applied through year 2040 in the DDM predictions, after which the infiltration rate is changed to the long-term infiltration rate. As a further measure of conservatism, a long-term infiltration rate of 2.4 gpm was considered in a modeling scenario for LTP drainage. In conjunction with the very conservative increase in estimated long-term infiltration rate, the interim infiltration rate was increased to 4.0 gpm to represent an expected worst-case DDM scenario.

Once the infiltration water enters the tailings, it will be in contact with the tailings solids and any residual water in the partially saturated tailings thickness. Hence the effective concentration of COCs in the water that is moving through the tailings is expected to increase through diffusive, exchange or displacement processes with the residual water in the tailings. The magnitude of this increase is difficult to predict, but several factors will likely affect the increase. Much of the tailings slimes have been flushed with large volumes of relatively fresh water and this should limit the COC mass available for exchange in much of the tailings. The more freely draining pore water in the LTP is continuing to report as seepage so future infiltration water will contact residual tailings water that is in smaller pore spaces where exchange and movement rates are slower. Additionally, as indicated by Worthington Miller Environmental, LLC (WME, 2018), no significant change in the geochemistry of the tailings is expected with the limited quantities of future infiltration, so significant mobilization of COCs presently in solid form is unlikely.

Estimated COC Concentrations in Infiltrate

While the increase in COC concentration in infiltrating water is not a new COC mass introduced to the LTP, the expected change in COC concentration by the time the water reports as seepage is incorporated in the DDM by assuming the water enters the LTP at a specified COC concentration. This introduction of infiltration at a specified COC concentration is not a major contribution to COC mass in the LTP, but it does have a noticeable impact on the estimate of long-term COC concentration in the seepage. Specifically, if the assumed COC concentration in the infiltration is less than the estimated average concentration in the LTP, the predicted COC concentration in the seepage will slightly decay over time. This is generally expected to be the case for the tailings as much of the tailings volume has already been flushed. The humidity cell testing conducted by Worthington Miller Environmental, LLC (WME, 2018) generally supports the limited increase in COC concentration for water passing through the tailings. The samples from the LTP subjected to humidity cell testing had a range of average effluent uranium concentrations from 0.11 to 1.26 mg/L and a range of average molybdenum concentrations from 0.087 to 0.28 mg/L. Although the humidity cell testing may not be a direct analogy to the expected mobilization of constituents as infiltrate passes through the tailings, it is likely a reasonable estimate of the range of COC concentrations in the infiltrate that will report as seepage. In the DDM, the range of uranium and molybdenum concentrations is incorporated in predictions for the expected infiltration rate of 0.6 gpm. For the remainder of the predictions, the upper concentration for the both the uranium and molybdenum is used.

DDM Seepage and Uranium Concentration Predictions

DDM predictions of uranium concentrations are presented in attached Figures 1 through 3 and in Figure 7 for the worst-case scenario. Each figure includes a tabulation of DDM predictions and three graphs that present combinations of model predictions of uranium concentration, measured uranium concentrations, and predicted seepage and toe drain rates. The average uranium concentration in the LTP is an input to the DDM model and the upper graph in each figure displays the measured average uranium concentration through 2018 along with the predicted concentration beginning in 2015. The observed concentrations shown in the upper plot in Figures 1 through 3 and in Figure 7 reflect a dramatic reduction in average concentration between 2010 and 2018 as a result of the flushing program. The unexpected temporary increase in observed average concentration in 2016 is likely a result of limitations of or anomalies in the available sample data used to estimate average concentration.

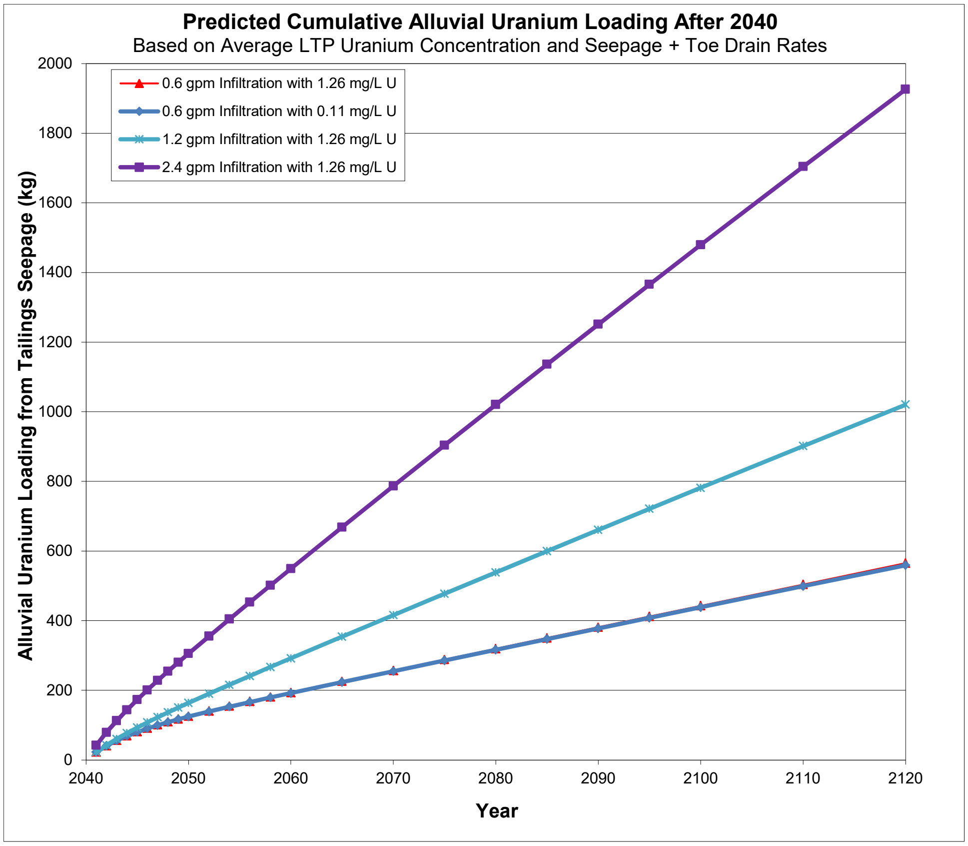
In all four figures, the graphs of seepage and toe drain rates indicate a dramatic decline in rates after 2015 followed by a gradual decay to approach the long-term infiltration rate for the particular simulation. Figure 1 presents the expected uranium concentrations and seepage rates for the condition where the long-term infiltration rate to the LTP is 0.6 gpm with the infiltrate having a uranium concentration of 1.26 mg/L after passing through the tailings. Figure 2 presents a similar simulation with the infiltrate uranium concentration reduced to 0.11 mg/L. In the graphs of seepage and toe drain rates for both figures, yellow shading is used to indicate toe drain rates where pumping of the toe drain discharge to the evaporation ponds may not be practical. When the pumping of the toe drain discharge is discontinued, the discharge simply reports to the alluvial aquifer as additional seepage. In comparing Figure 1 and Figure 2, there is a very slight reduction in predicted long-term uranium concentration in the LTP with the smaller uranium concentration in the infiltrate. For both simulations, the predicted long-term uranium concentration in the LTP is slightly greater than 5.0 mg/L and has a very gradual declining trend. For the simulation presented in Figure 3, the larger infiltrate uranium concentration is used for conservatism. Figure 3 presents a simulation where the long-term infiltration rate is doubled to 1.2 gpm over the baseline simulation rate of 0.6 gpm. The increased infiltration results in a slight decrease in predicted long-term LTP uranium concentration, but the uranium mass in seepage is increased because of the increased seepage rate after 2040. The doubling of the infiltration or seepage rates between the Figure 1 and Figure 3 simulations presented more than offsets the reduction in uranium concentration with a higher infiltration rate. Hence, the increasing infiltration rate increases the constituent loading to the alluvial aquifer. A similar dramatic increase in uranium mass in seepage occurs when both the interim and long-term infiltration rates are again doubled from those presented in Figure 3 to those presented in Figure 7. There is a relatively minor reduction in uranium concentration in seepage with the conservatively large infiltration rate estimate, but there is nearly a doubling of the estimated uranium mass in seepage.

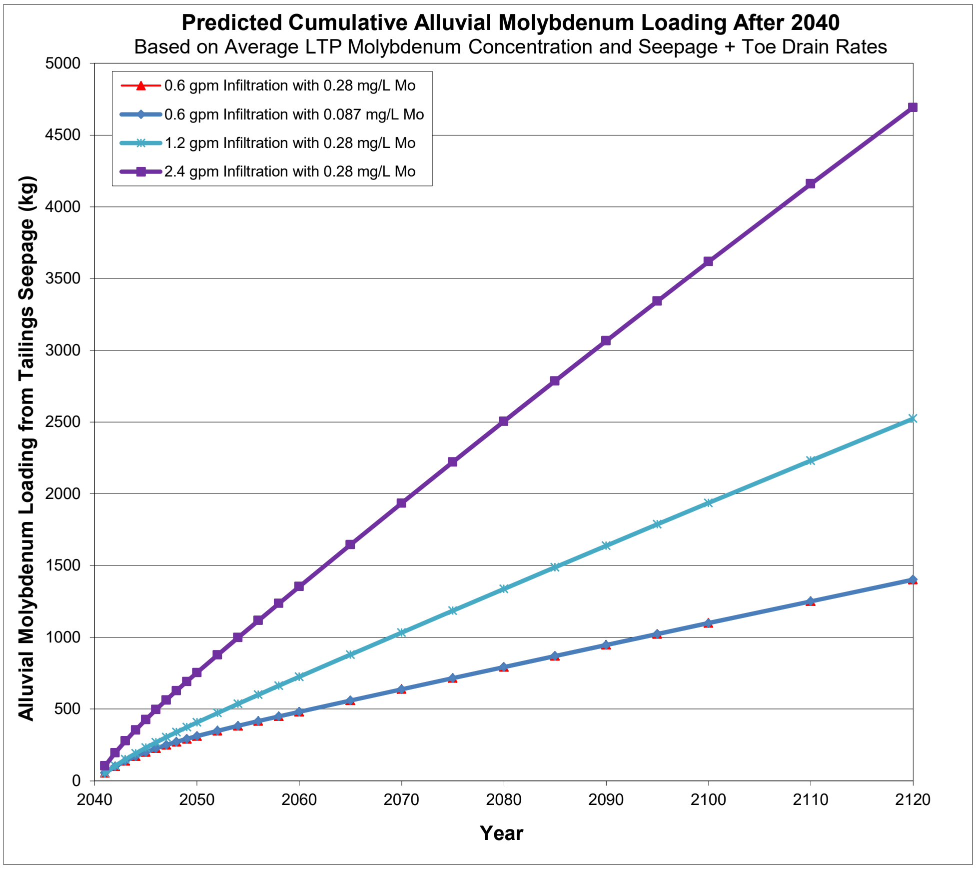
DDM Seepage and Molybdenum Concentration Predictions

DDM predictions of molybdenum concentrations are presented in attached Figures 4 through 6 and in Figure 8 for the worst-case scenario. Each figure includes a tabulation of DDM predictions and three graphs that present combinations of model predictions of molybdenum concentration, measured molybdenum concentrations, and predicted seepage and toe drain rates. The starting molybdenum concentration in 2015 for the simulation was set at 13.4 mg/L to produce a mid-2018 concentration of 13.35 mg/L which is consistent with observed concentrations. The observed concentrations shown in the upper plot in Figures 4 through 6 reflect a dramatic reduction in average concentration between 2010 and 2018 as a result of the flushing program. Like uranium, the temporary increase in average molybdenum concentration in 2016 is considered an anomaly. Figure 4 presents the expected molybdenum concentrations and seepage rates for the condition where the long-term infiltration rate to the LTP is 0.6 gpm with the infiltrate having a molybdenum concentration of 0.28 mg/L after passing through the tailings. Figure 5 presents a similar simulation with the infiltrate molybdenum concentration reduced to 0.087 mg/L. In comparing Figure 4 and Figure 5, there is a very slight reduction in predicted long-term molybdenum concentration in the LTP with the smaller molybdenum concentration in the infiltrate. For both simulations, the predicted long-term molybdenum concentration in the LTP ranges from greater than 12 mg/L to approximately 13 mg/L after 2040 and has a very gradual declining trend. For the remaining simulation presented in Figure 6, the larger infiltrate molybdenum concentration is used for conservatism. Figure 6 presents a simulation where the long-term infiltration rate is increased to 1.2 gpm. This condition results in a slight decrease in predicted long-term LTP molybdenum concentration, but the molybdenum mass in seepage is increased because of the increased seepage rate. Like uranium, the increase in long-term seepage rate more than offsets the reduction in molybdenum concentration and there is increased constituent loading to the alluvial aquifer. As occurred with uranium, a doubling of the interim and long-term infiltration rates over those in Figure 6 to the worst-case scenario results in a dramatic increase in molybdenum mass in seepage (see Figure 8).

Comparison of Drain Down Model Predictions

The range of infiltration rates and uranium or molybdenum concentrations used in the DDM predictions results in a range of predicted long-term seepage impacts to the alluvium. As indicated in the preceding discussions, the anticipated long-term infiltration rate is expected to be the most important factor in long-term seepage impacts, with significantly increased constituent (uranium or molybdenum) loading with increased infiltration. The following graphs illustrate the expected change in cumulative constituent loading to the alluvium with a range of infiltration rates and the range of constituent concentrations in the infiltrate for an infiltration rate of 0.6 gpm. In the graphs, the constituent loading in kilograms (kg) for each year is calculated using the product of the predicted average concentration in the LTP and the sum of the seepage and toe drain rates. The cumulative constituent loading calculation is started after year 2040 because the estimated long-term infiltration rate applies after 2040, and the seepage rates and constituent loading prior to 2040 are much greater and this would obscure the differences in projected loading with differing infiltration rates.


Predicted Cumulative Alluvial Uranium Loading After 2040
Based on Average LTP Uranium Concentration and Seepage + Toe Drain Rates
0.6 gpm Infiltration with 1.26 mg/L U
0.6 gpm Infiltration with 0.11 mg/L U
1.2 gpm Infiltration with 1.26 mg/L U
2.4 gpm Infiltration with 1.26 mg/L U
Alluvial Uranium Loading from Tailings Seepage (kg)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2040
2050
2060
2070
2080
2090
2100
2110
2120
Year


Predicted Cumulative Alluvial Molybdenum Loading After 2040
Based on Average LTP Molybdenum Concentration and Seepage + Toe Drain Rates
0.6 gpm Infiltration with 0.28 mg/L Mo
0.6 gpm Infiltration with 0.087 mg/L Mo
1.2 gpm Infiltration with 0.28 mg/L Mo
2.4 gpm Infiltration with 0.28 mg/L Mo
Alluvial Molybdenum Loading from Tailings Seepage (kg)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2040
2050
2060
2070
2080
2090
2100
2110
2120
Year

In the preceding graphs for uranium and molybdenum loading to the alluvium, the lowest predicted loading occurs for the modeled rate of infiltration of 0.6 gpm (dark blue line and symbols) with the lower uranium or molybdenum concentration in the infiltrate. With the uranium concentration in infiltrate increased to the upper humidity cell testing level with the infiltration rate of 0.6 gpm, there is a very slight increase in cumulative uranium loading to the alluvial aquifer. The molybdenum loading to the alluvium with model runs at 0.6 gpm of infiltration and molybdenum concentration in infiltrate of 0.087 mg/L and 0.28 mg/L is virtually the same. The DDM model runs (light blue line and symbols) at an infiltration rate of 1.2 gpm indicate a fairly dramatic increase in loading with the increased long-term seepage rate. As indicated in the preceding graphs, the constituent loading to the alluvium is increased by roughly 80% with a doubling of the infiltration rate from 0.6 to 1.2 gpm. A further doubling of the long-term infiltration rate to 2.4 gpm with an interim infiltration rate of 4.0 gpm results in a similarly dramatic increase in uranium and molybdenum loading to the alluvial aquifer (purple lines and symbols).

Summary of Model Predictions

The DDM predictions included in the attached figures are based on a more refined estimate of projected long-term seepage and toe drain discharge rates, an assumed long-term infiltration rate of approximately 0.5% and 1.0% of annual precipitation over the LTP, and an assumed increase in COC concentrations in the infiltrating water. Barring an artificial introduction of additional water into the LTP, the seepage and toe drain rates will continue to decline because there is a finite quantity of drainable water remaining in the LTP. The projected long-term infiltration rate does have a significant impact on future COC loading to the alluvium by seepage from the LTP. The expected rate of infiltration is approximately 0.6 gpm, and a more conservative rate of 1.2 gpm was also simulated. The assumed uranium concentration in infiltrate of 1.26 mg/L and assumed molybdenum concentration in infiltrate of 0.28 mg/L that are based on the humidity cell test results and observation of changes in COC concentration after cessation of flushing do result in a minor declining trend in predicted residual uranium and molybdenum concentration in the LTP.

References

Brooks, R. H. and A. T. Corey, 1964. Hydraulic Properties of Porous Media. Hydrology Papers 3, Colorado State University, Fort Collins, CO

Epstein, B. J., G. M. Pohll, J. Huntington and R. W. H. Carroll, 2010. Development and Uncertainty Analysis of an Empirical Recharge Prediction Model for Nevada's Desert Basins, in: Journal of the Nevada Water Resources Association, Summer 2010, Volume 5, No. 1.

Huntoon, P.W., 1977. Cambrian stratigraphic nomenclature and ground-water prospecting failures on the Hualapai Plateau, Arizona: Ground Water, v. 15, no. 6, p. 426-433

USGS, 1987. Summary of Infiltration Rates in Arid and Semiarid Regions of the World, with an Annotated Bibliography, Open File Report 87-43.

Worthington Miller Environmental, LLC (WME), 2018. Interim Draft – Geochemical Characterization of Tailings, Alluvial Solids and Groundwater – Grants Reclamation Project. Prepared for Homestake Mining Company of California.

Figure 1

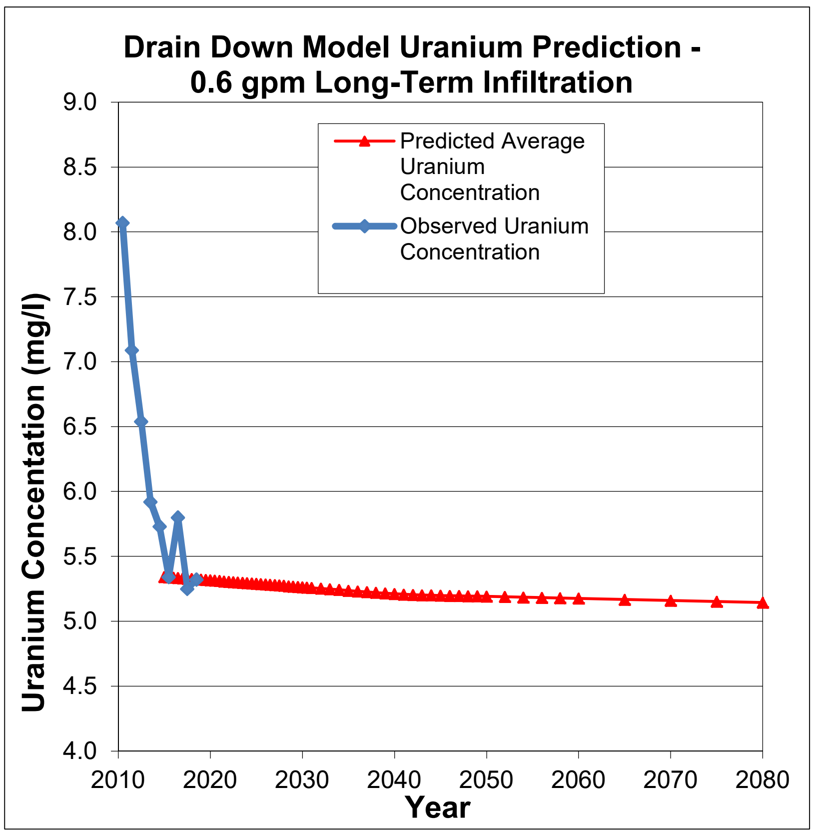
Drain Down Model Uranium Prediction with 0.6 gpm Long-Term Infiltration Rate and 1.26 mg/L Uranium Concentration in Infiltrate

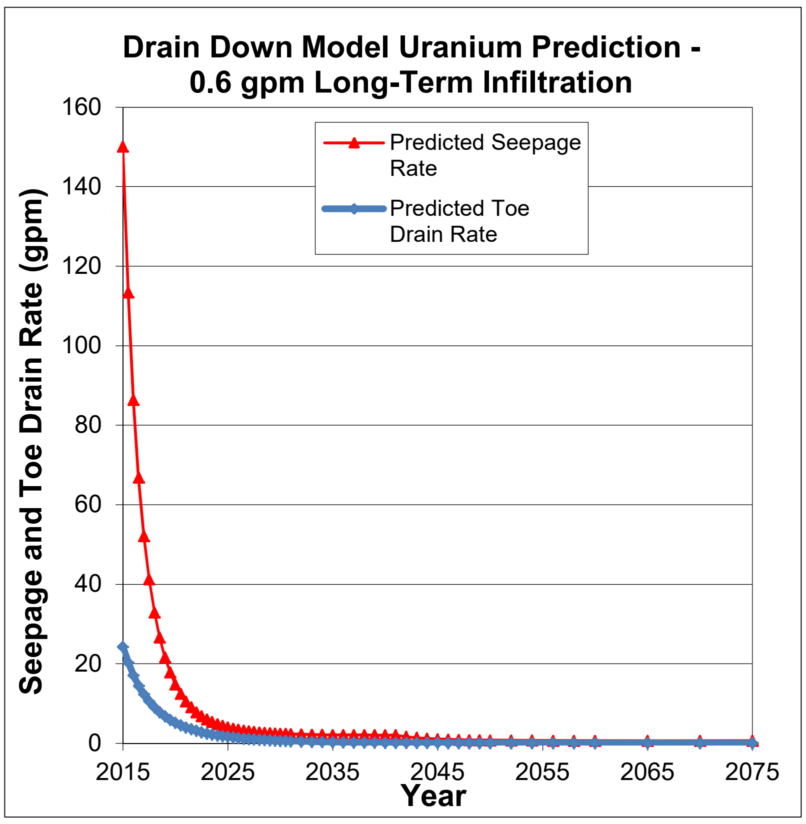
2015 Average U Concentration	5.34
Infiltration Water U Conc.	1.26
Humidity Cell Upper U Conc. (mg/L)	1.26
Humidity Cell Lower U Conc. (mg/L)	0.11

Estimated Drain Down and LTP Uranium Concentration

Year	Predicted Average Uranium Conc. (mg/l)	U Loading Seepage plus Toe Drain (kg/yr)	Infiltration Rate (gpm)	Seepage Rate (gpm)	Toe Drain Rate (gpm)
2012.5	6.54	2109.2	2.0	139.0	23.0
2013.5	5.92	2027.1	2.0	154.0	18.0
2014.5	5.73	2486.7	2.0	200.0	18.0
2015	5.34	1852.1	2.0	150.0	24.2
2015.5	5.34	1420.5	2.0	113.4	20.3
2016	5.34	1098.8	2.0	86.4	17.1
2016.5	5.33	862.7	2.0	66.8	14.5
2017	5.33	683.4	2.0	52.1	12.3
2017.5	5.33	549.4	2.0	41.2	10.6
2018	5.33	444.6	2.0	32.9	9.1
2018.5	5.32	364.7	2.0	26.6	7.8
2019	5.32	301.0	2.0	21.6	6.8
2019.5	5.32	251.5	2.0	17.8	5.9
2020	5.32	211.4	2.0	14.8	5.2
2020.5	5.31	179.5	2.0	12.4	4.6
2021	5.31	153.5	2.0	10.5	4.0
2021.5	5.31	132.7	2.0	9.0	3.5
2022	5.30	115.4	2.0	7.8	3.1
2022.5	5.30	101.3	2.0	6.8	2.8
2023	5.30	89.5	2.0	6.0	2.5
2023.5	5.30	79.8	2.0	5.3	2.2
2024	5.29	71.5	2.0	4.8	2.0
2024.5	5.29	64.6	2.0	4.3	1.8
2025	5.29	58.8	2.0	4.0	1.6
2025.5	5.29	53.9	2.0	3.7	1.5
2026	5.28	49.6	2.0	3.4	1.3
2026.5	5.28	46.1	2.0	3.2	1.2
2027	5.28	43.0	2.0	3.0	1.1
2027.5	5.28	40.4	2.0	2.9	1.0
2028	5.27	38.0	2.0	2.7	0.9
2028.5	5.27	36.1	2.0	2.6	0.8
2029	5.27	34.3	2.0	2.5	0.7
2029.5	5.27	32.9	2.0	2.5	0.7
2030	5.26	31.6	2.0	2.4	0.6
2030.5	5.26	30.4	2.0	2.3	0.6
2031	5.26	29.4	2.0	2.3	0.5
2032	5.25	27.8	2.0	2.2	0.4
2033	5.25	26.5	2.0	2.2	0.4
2034	5.24	25.5	2.0	2.1	0.3
2035	5.24	24.7	2.0	2.1	0.3
2036	5.23	24.0	2.0	2.1	0.2
2037	5.23	23.5	2.0	2.0	0.2
2038	5.22	23.1	2.0	2.0	0.2
2039	5.21	22.7	2.0	2.0	0.2
2040	5.21	22.4	2.0	2.0	0.1
2041	5.20	22.2	0.6	2.0	0.1
2042	5.20	18.2	0.6	1.6	0.1
2043	5.20	15.3	0.6	1.4	0.1
2044	5.20	13.2	0.6	1.2	0.1
2045	5.20	11.6	0.6	1.0	0.1
2046	5.20	10.4	0.6	0.9	0.1
2047	5.19	9.5	0.6	0.9	0.1
2048	5.19	8.8	0.6	0.8	0.1
2049	5.19	8.3	0.6	0.7	0.1
2050	5.19	7.9	0.6	0.7	0.0
2052	5.19	7.3	0.6	0.7	0.0
2054	5.18	7.0	0.6	0.6	0.0
2056	5.18	6.7	0.6	0.6	0.0
2058	5.18	6.6	0.6	0.6	0.0
2060	5.17	6.5	0.6	0.6	0.0
2065	5.17	6.4	0.6	0.6	0.0
2070	5.16	6.3	0.6	0.6	0.0
2075	5.15	6.3	0.6	0.6	0.0
2080	5.14	6.2	0.6	0.6	0.0
2085	5.14	6.2	0.6	0.6	0.0
2090	5.13	6.2	0.6	0.6	0.0
2095	5.12	6.2	0.6	0.6	0.0
2100	5.11	6.2	0.6	0.6	0.0
2110	5.10	6.1	0.6	0.6	0.0
2120	5.08	6.1	0.6	0.6	0.0

Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and uranium concentration.


Drain Down Model Uranium Prediction - 0.6 gpm Long-Term Infiltration


Drain Down Model Uranium Prediction - 0.6 gpm Long-Term Infiltration

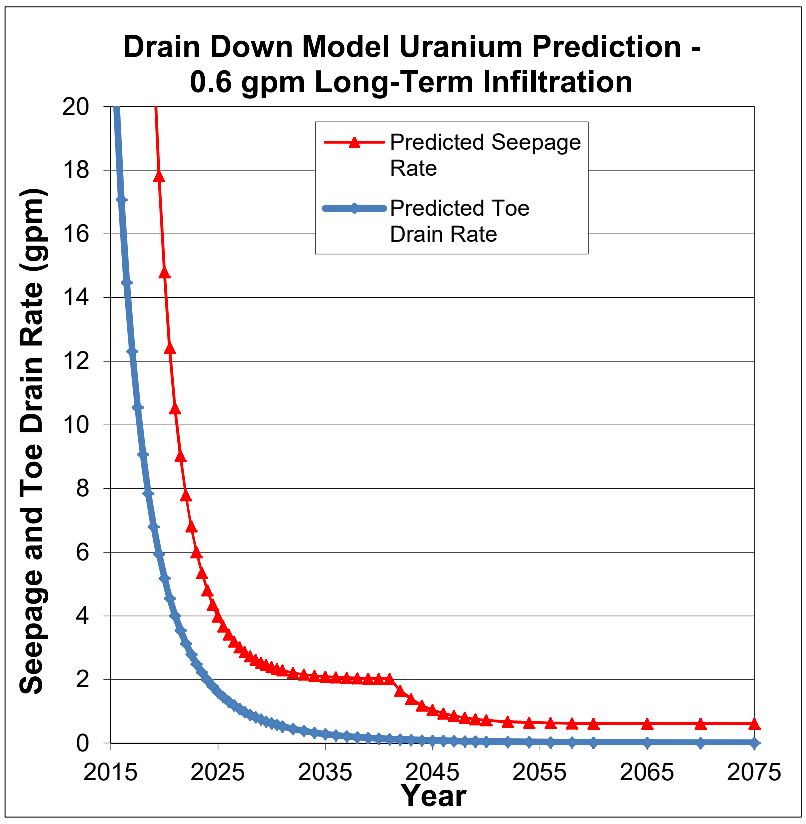

Drain Down Model Uranium Prediction - 0.6 gpm Long-Term Infiltration

Figure 2

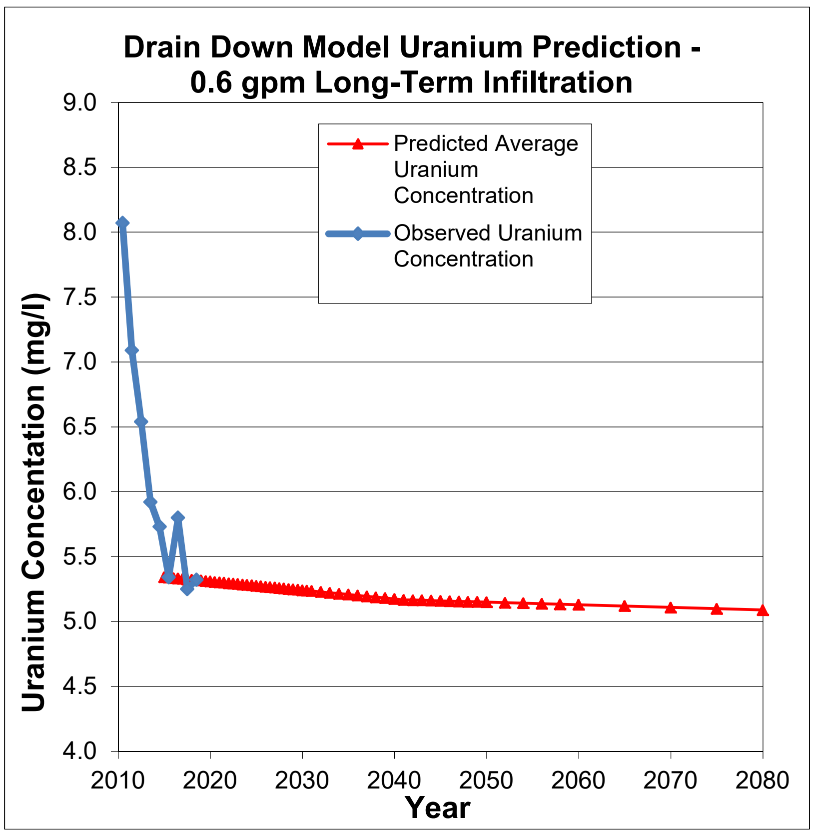
Drain Down Model Uranium Prediction with 0.6 gpm Long-Term Infiltration Rate and 0.11 mg/L Uranium Concentration in Infiltrate

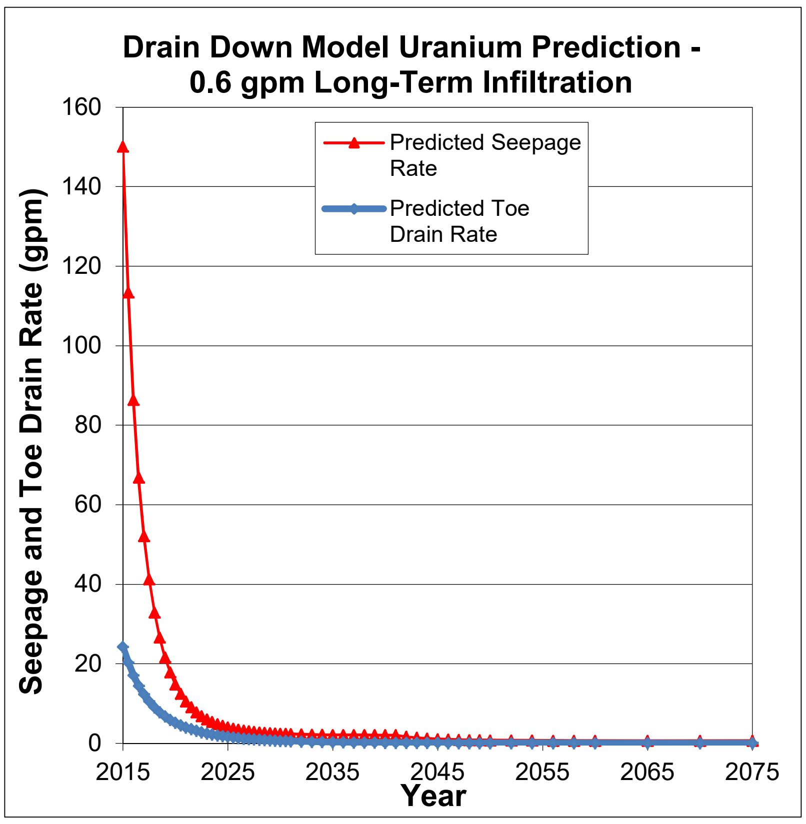
2015 Average U Concentration	5.34
Infiltration Water U Conc.	0.11
Humidity Cell Upper U Conc. (mg/L)	1.26
Humidity Cell Lower U Conc. (mg/L)	0.11

Estimated Drain Down and LTP Uranium Concentration

Year	**Predicted Average Uranium Conc. (mg/l)**	**U Loading Seepage plus Toe Drain (kg/yr)**	**Infiltration Rate (gpm)**	**Seepage Rate (gpm)**	**Toe Drain Rate (gpm)**
2012.5	6.54	2109.2	2.0	139.0	23.0
2013.5	5.92	2027.1	2.0	154.0	18.0
2014.5	5.73	2486.7	2.0	200.0	18.0
2015	5.34	1852.1	2.0	150.0	24.2
2015.5	5.34	1420.3	2.0	113.4	20.3
2016	5.33	1098.5	2.0	86.4	17.1
2016.5	5.33	862.4	2.0	66.8	14.5
2017	5.33	683.1	2.0	52.1	12.3
2017.5	5.32	549.0	2.0	41.2	10.6
2018	5.32	444.3	2.0	32.9	9.1
2018.5	5.32	364.3	2.0	26.6	7.8
2019	5.31	300.7	2.0	21.6	6.8
2019.5	5.31	251.2	2.0	17.8	5.9
2020	5.31	211.1	2.0	14.8	5.2
2020.5	5.30	179.3	2.0	12.4	4.6
2021	5.30	153.3	2.0	10.5	4.0
2021.5	5.30	132.5	2.0	9.0	3.5
2022	5.29	115.2	2.0	7.8	3.1
2022.5	5.29	101.1	2.0	6.8	2.8
2023	5.29	89.3	2.0	6.0	2.5
2023.5	5.28	79.6	2.0	5.3	2.2
2024	5.28	71.3	2.0	4.8	2.0
2024.5	5.28	64.5	2.0	4.3	1.8
2025	5.27	58.6	2.0	4.0	1.6
2025.5	5.27	53.7	2.0	3.7	1.5
2026	5.27	49.5	2.0	3.4	1.3
2026.5	5.26	45.9	2.0	3.2	1.2
2027	5.26	42.8	2.0	3.0	1.1
2027.5	5.26	40.2	2.0	2.9	1.0
2028	5.25	37.9	2.0	2.7	0.9
2028.5	5.25	35.9	2.0	2.6	0.8
2029	5.25	34.2	2.0	2.5	0.7
2029.5	5.24	32.7	2.0	2.5	0.7
2030	5.24	31.4	2.0	2.4	0.6
2030.5	5.24	30.3	2.0	2.3	0.6
2031	5.23	29.3	2.0	2.3	0.5
2032	5.23	27.6	2.0	2.2	0.4
2033	5.22	26.3	2.0	2.2	0.4
2034	5.21	25.3	2.0	2.1	0.3
2035	5.21	24.5	2.0	2.1	0.3
2036	5.20	23.9	2.0	2.1	0.2
2037	5.19	23.4	2.0	2.0	0.2
2038	5.19	22.9	2.0	2.0	0.2
2039	5.18	22.6	2.0	2.0	0.2
2040	5.17	22.3	2.0	2.0	0.1
2041	5.17	22.0	0.6	2.0	0.1
2042	5.16	18.1	0.6	1.6	0.1
2043	5.16	15.2	0.6	1.4	0.1
2044	5.16	13.1	0.6	1.2	0.1
2045	5.16	11.5	0.6	1.0	0.1
2046	5.16	10.3	0.6	0.9	0.1
2047	5.15	9.4	0.6	0.9	0.1
2048	5.15	8.7	0.6	0.8	0.1
2049	5.15	8.2	0.6	0.7	0.1
2050	5.15	7.8	0.6	0.7	0.0
2052	5.14	7.2	0.6	0.7	0.0
2054	5.14	6.9	0.6	0.6	0.0
2056	5.14	6.7	0.6	0.6	0.0
2058	5.13	6.5	0.6	0.6	0.0
2060	5.13	6.4	0.6	0.6	0.0
2065	5.12	6.3	0.6	0.6	0.0
2070	5.11	6.2	0.6	0.6	0.0
2075	5.10	6.2	0.6	0.6	0.0
2080	5.09	6.2	0.6	0.6	0.0
2085	5.08	6.1	0.6	0.6	0.0
2090	5.07	6.1	0.6	0.6	0.0
2095	5.06	6.1	0.6	0.6	0.0
2100	5.05	6.1	0.6	0.6	0.0
2110	5.03	6.0	0.6	0.6	0.0
2120	5.01	6.0	0.6	0.6	0.0

Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and uranium concentration.


Drain Down Model Uranium Prediction - 0.6 gpm Long-Term Infiltration


Drain Down Model Uranium Prediction - 0.6 gpm Long-Term Infiltration

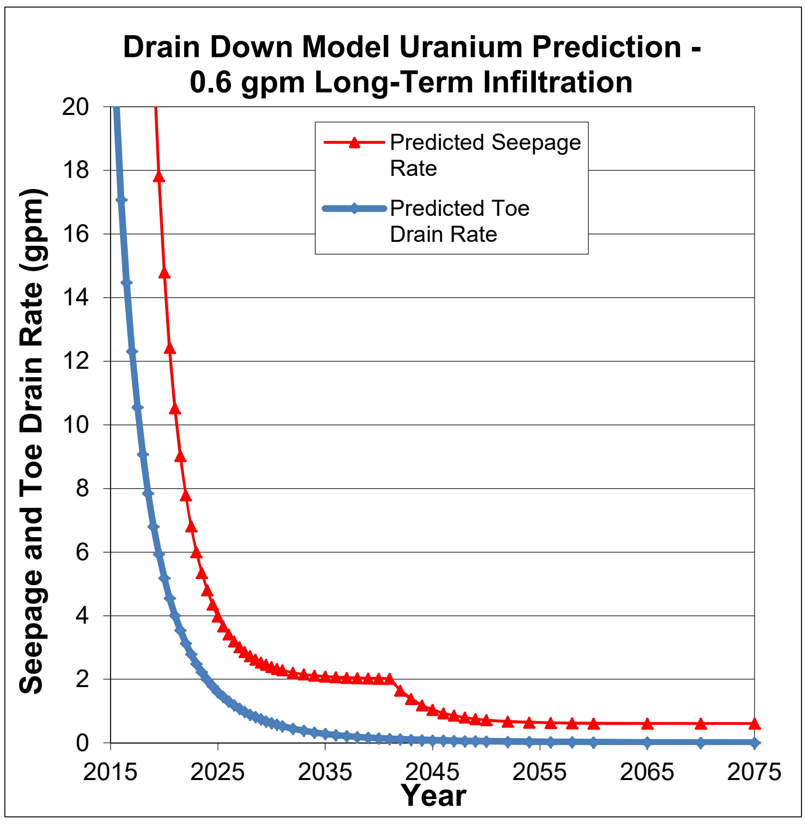

Drain Down Model Uranium Prediction - 0.6 gpm Long-Term Infiltration

Figure 3

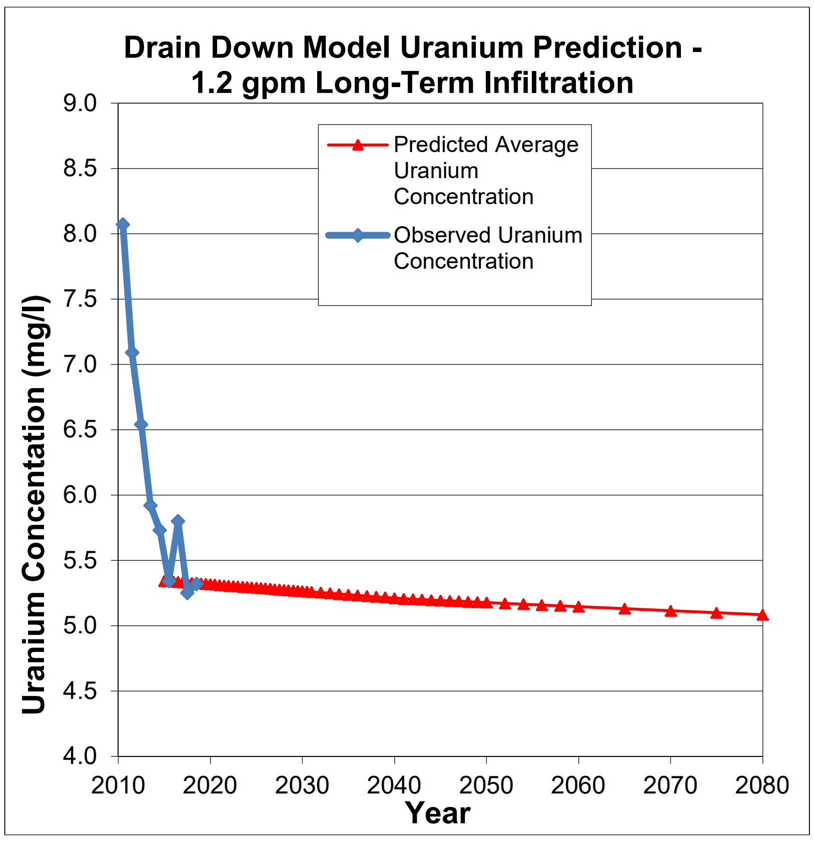
Drain Down Model Uranium Prediction with 1.2 gpm Long-Term Infiltration Rate and 1.26 mg/L Uranium Concentration in Infiltrate

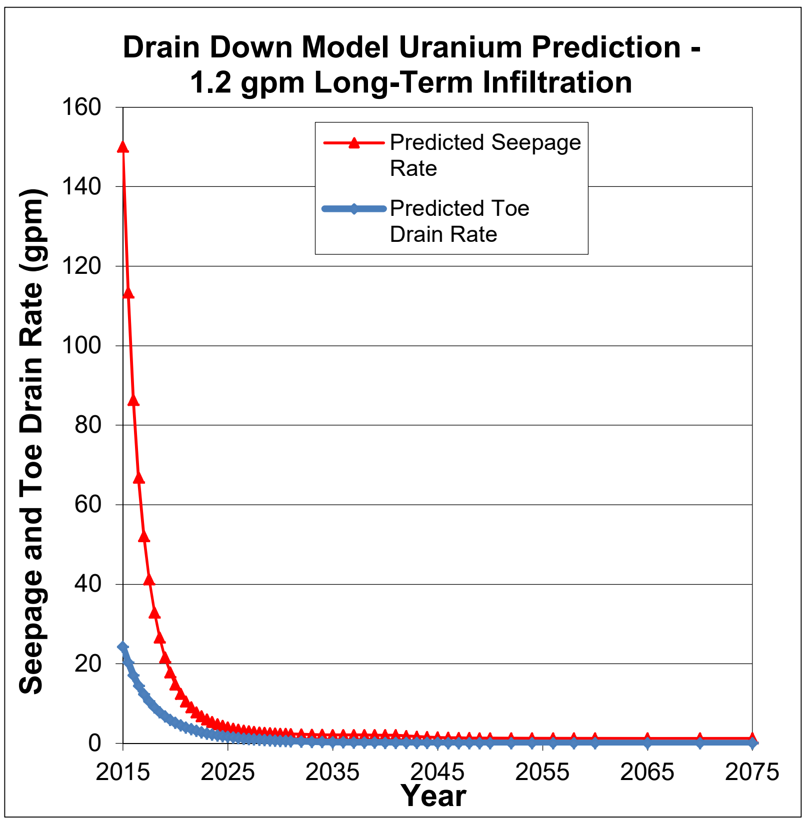
2015 Average U Concentration	5.34
Infiltration Water U Conc.	1.26
Humidity Cell Upper U Conc. (mg/L)	1.26
Humidity Cell Lower U Conc. (mg/L)	0.11

Estimated Drain Down and LTP Uranium Concentration

Year	Predicted Average Uranium Conc. (mg/l)	U Loading Seepage plus Toe Drain (kg/yr)	Infiltration Rate (gpm)	Seepage Rate (gpm)	Toe Drain Rate (gpm)
2012.5	6.54	2109.2	2.0	139.0	23.0
2013.5	5.92	2027.1	2.0	154.0	18.0
2014.5	5.73	2486.7	2.0	200.0	18.0
2015	5.34	1852.1	2.0	150.0	24.2
2015.5	5.34	1420.5	2.0	113.4	20.3
2016	5.34	1098.8	2.0	86.4	17.1
2016.5	5.33	862.7	2.0	66.8	14.5
2017	5.33	683.4	2.0	52.1	12.3
2017.5	5.33	549.4	2.0	41.2	10.6
2018	5.33	444.6	2.0	32.9	9.1
2018.5	5.32	364.7	2.0	26.6	7.8
2019	5.32	301.0	2.0	21.6	6.8
2019.5	5.32	251.5	2.0	17.8	5.9
2020	5.32	211.4	2.0	14.8	5.2
2020.5	5.31	179.5	2.0	12.4	4.6
2021	5.31	153.5	2.0	10.5	4.0
2021.5	5.31	132.7	2.0	9.0	3.5
2022	5.30	115.4	2.0	7.8	3.1
2022.5	5.30	101.3	2.0	6.8	2.8
2023	5.30	89.5	2.0	6.0	2.5
2023.5	5.30	79.8	2.0	5.3	2.2
2024	5.29	71.5	2.0	4.8	2.0
2024.5	5.29	64.6	2.0	4.3	1.8
2025	5.29	58.8	2.0	4.0	1.6
2025.5	5.29	53.9	2.0	3.7	1.5
2026	5.28	49.6	2.0	3.4	1.3
2026.5	5.28	46.1	2.0	3.2	1.2
2027	5.28	43.0	2.0	3.0	1.1
2027.5	5.28	40.4	2.0	2.9	1.0
2028	5.27	38.0	2.0	2.7	0.9
2028.5	5.27	36.1	2.0	2.6	0.8
2029	5.27	34.3	2.0	2.5	0.7
2029.5	5.27	32.9	2.0	2.5	0.7
2030	5.26	31.6	2.0	2.4	0.6
2030.5	5.26	30.4	2.0	2.3	0.6
2031	5.26	29.4	2.0	2.3	0.5
2032	5.25	27.8	2.0	2.2	0.4
2033	5.25	26.5	2.0	2.2	0.4
2034	5.24	25.5	2.0	2.1	0.3
2035	5.24	24.7	2.0	2.1	0.3
2036	5.23	24.0	2.0	2.1	0.2
2037	5.23	23.5	2.0	2.0	0.2
2038	5.22	23.1	2.0	2.0	0.2
2039	5.21	22.7	2.0	2.0	0.2
2040	5.21	22.4	2.0	2.0	0.1
2041	5.20	22.2	1.2	2.0	0.1
2042	5.20	19.8	1.2	1.8	0.1
2043	5.20	18.1	1.2	1.6	0.1
2044	5.19	16.8	1.2	1.5	0.1
2045	5.19	15.8	1.2	1.4	0.1
2046	5.19	15.1	1.2	1.4	0.1
2047	5.19	14.5	1.2	1.3	0.1
2048	5.18	14.1	1.2	1.3	0.1
2049	5.18	13.7	1.2	1.3	0.1
2050	5.18	13.5	1.2	1.3	0.0
2052	5.17	13.1	1.2	1.2	0.0
2054	5.16	12.9	1.2	1.2	0.0
2056	5.16	12.8	1.2	1.2	0.0
2058	5.15	12.7	1.2	1.2	0.0
2060	5.14	12.6	1.2	1.2	0.0
2065	5.13	12.5	1.2	1.2	0.0
2070	5.11	12.4	1.2	1.2	0.0
2075	5.10	12.3	1.2	1.2	0.0
2080	5.08	12.3	1.2	1.2	0.0
2085	5.07	12.2	1.2	1.2	0.0
2090	5.05	12.2	1.2	1.2	0.0
2095	5.04	12.1	1.2	1.2	0.0
2100	5.02	12.1	1.2	1.2	0.0
2110	4.99	12.0	1.2	1.2	0.0
2120	4.96	11.9	1.2	1.2	0.0

Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and uranium concentration.


Drain Down Model Uranium Prediction - 1.2 gpm Long-Term Infiltration


Drain Down Model Uranium Prediction - 1.2 gpm Long-Term Infiltration

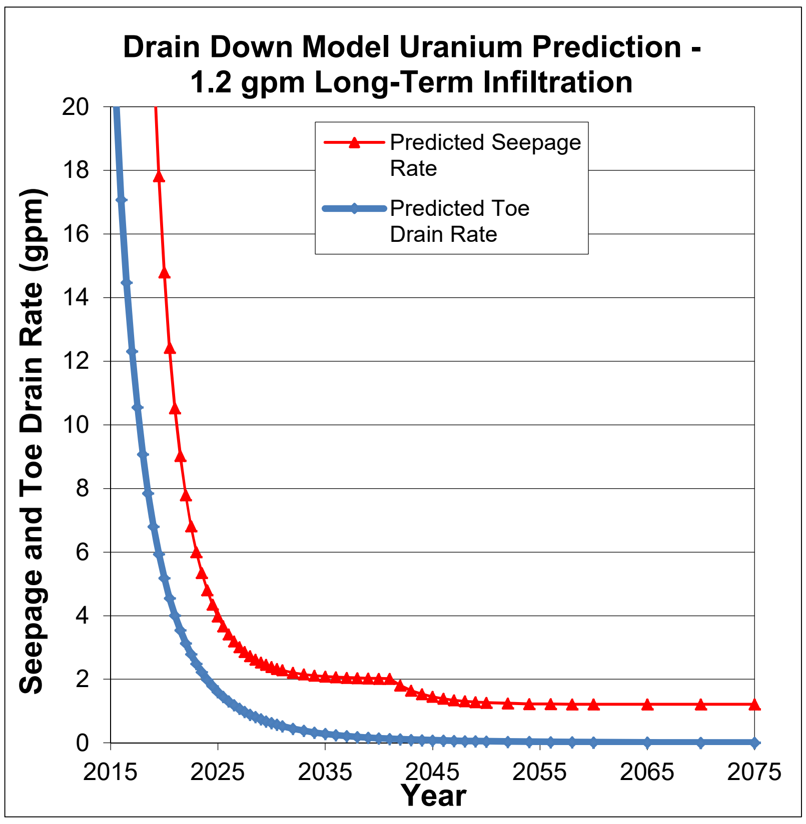

Drain Down Model Uranium Prediction - 1.2 gpm Long-Term Infiltration

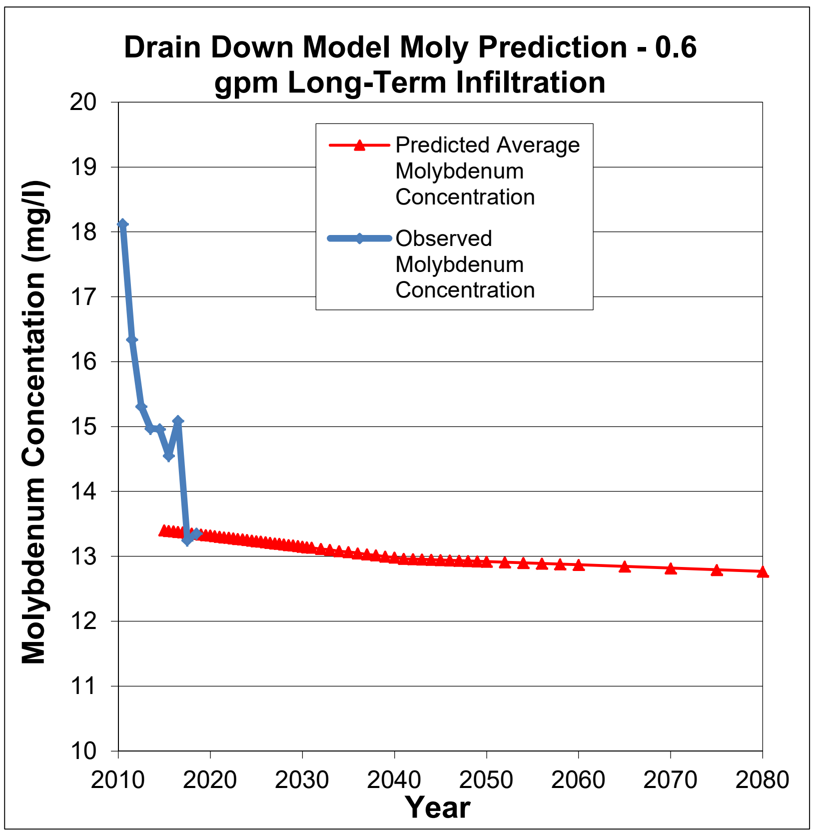
Figure 4

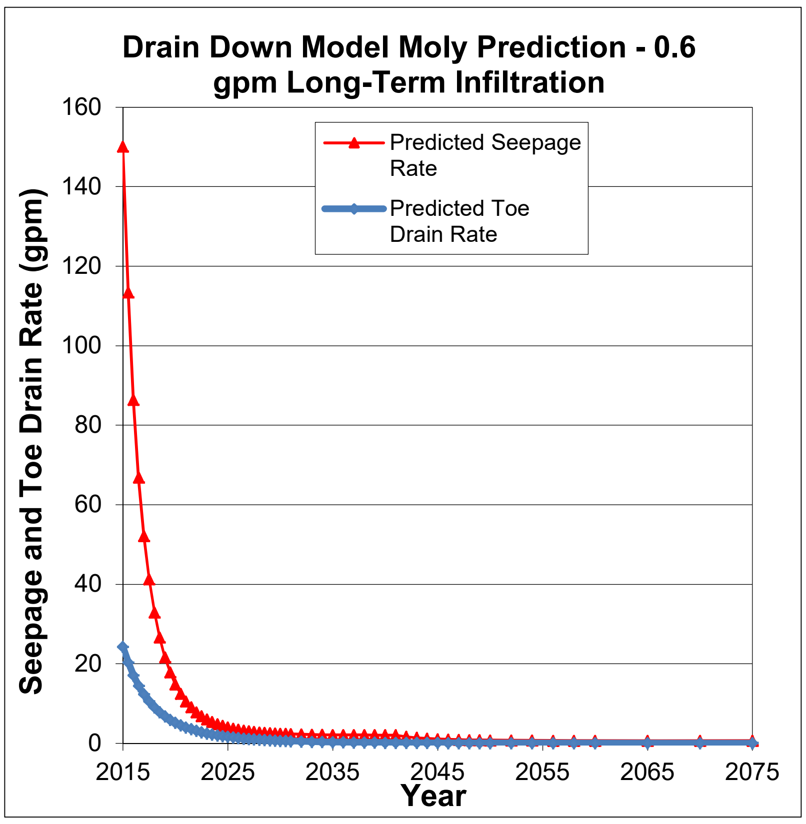
Drain Down Model Molybdenum Prediction with 0.6 gpm Long-Term Infiltration Rate and 0.28 mg/L Molybdenum Concentration in Infiltrate

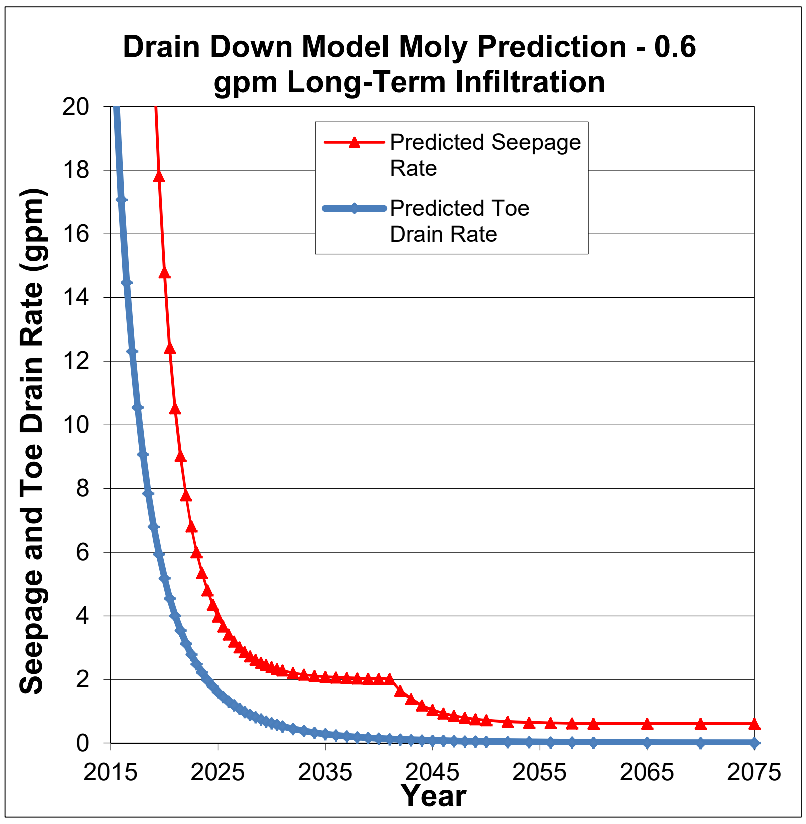
2015 Starting Mo Concentration	13.40
Infiltration Water Mo Conc.	0.28
Humidity Cell Upper Mo Conc. (mg/L)	0.28
Humidity Cell Lower Mo Conc. (mg/L)	0.087

Estimated Drain Down and LTP Molybdenum Concentration

Year	Predicted Average Mo Conc. (mg/l)	Mo Loading Seepage plus Toe Drain (kg/yr)	Infiltration Rate (gpm)	Seepage Rate (gpm)	Toe Drain Rate (gpm)
2012.5	15.31	4937.5	2.0	139.0	23.0
2013.5	14.97	5125.9	2.0	154.0	18.0
2014.5	14.96	6492.4	2.0	200.0	18.0
2015	13.40	4647.7	2.0	150.0	24.2
2015.5	13.39	3564.2	2.0	113.4	20.3
2016	13.39	2756.5	2.0	86.4	17.1
2016.5	13.38	2164.0	2.0	66.8	14.5
2017	13.37	1714.1	2.0	52.1	12.3
2017.5	13.36	1377.7	2.0	41.2	10.6
2018	13.35	1114.9	2.0	32.9	9.1
2018.5	13.35	914.2	2.0	26.6	7.8
2019	13.34	754.5	2.0	21.6	6.8
2019.5	13.33	630.3	2.0	17.8	5.9
2020	13.32	529.7	2.0	14.8	5.2
2020.5	13.31	449.9	2.0	12.4	4.6
2021	13.30	384.7	2.0	10.5	4.0
2021.5	13.30	332.5	2.0	9.0	3.5
2022	13.29	289.0	2.0	7.8	3.1
2022.5	13.28	253.7	2.0	6.8	2.8
2023	13.27	224.0	2.0	6.0	2.5
2023.5	13.26	199.7	2.0	5.3	2.2
2024	13.25	179.0	2.0	4.8	2.0
2024.5	13.24	161.8	2.0	4.3	1.8
2025	13.24	147.1	2.0	4.0	1.6
2025.5	13.23	134.8	2.0	3.7	1.5
2026	13.22	124.2	2.0	3.4	1.3
2026.5	13.21	115.3	2.0	3.2	1.2
2027	13.20	107.5	2.0	3.0	1.1
2027.5	13.19	100.9	2.0	2.9	1.0
2028	13.18	95.1	2.0	2.7	0.9
2028.5	13.18	90.2	2.0	2.6	0.8
2029	13.17	85.9	2.0	2.5	0.7
2029.5	13.16	82.1	2.0	2.5	0.7
2030	13.15	78.9	2.0	2.4	0.6
2030.5	13.14	76.0	2.0	2.3	0.6
2031	13.13	73.5	2.0	2.3	0.5
2032	13.12	69.4	2.0	2.2	0.4
2033	13.10	66.1	2.0	2.2	0.4
2034	13.08	63.6	2.0	2.1	0.3
2035	13.07	61.6	2.0	2.1	0.3
2036	13.05	59.9	2.0	2.1	0.2
2037	13.03	58.6	2.0	2.0	0.2
2038	13.01	57.5	2.0	2.0	0.2
2039	13.00	56.7	2.0	2.0	0.2
2040	12.98	55.9	2.0	2.0	0.1
2041	12.96	55.3	0.6	2.0	0.1
2042	12.96	45.3	0.6	1.6	0.1
2043	12.95	38.1	0.6	1.4	0.1
2044	12.95	32.8	0.6	1.2	0.1
2045	12.94	28.8	0.6	1.0	0.1
2046	12.94	25.9	0.6	0.9	0.1
2047	12.93	23.6	0.6	0.9	0.1
2048	12.93	21.9	0.6	0.8	0.1
2049	12.92	20.6	0.6	0.7	0.1
2050	12.92	19.6	0.6	0.7	0.0
2052	12.91	18.2	0.6	0.7	0.0
2054	12.90	17.3	0.6	0.6	0.0
2056	12.89	16.7	0.6	0.6	0.0
2058	12.88	16.4	0.6	0.6	0.0
2060	12.87	16.1	0.6	0.6	0.0
2065	12.84	15.8	0.6	0.6	0.0
2070	12.82	15.6	0.6	0.6	0.0
2075	12.79	15.5	0.6	0.6	0.0
2080	12.77	15.4	0.6	0.6	0.0
2085	12.74	15.4	0.6	0.6	0.0
2090	12.72	15.3	0.6	0.6	0.0
2095	12.69	15.3	0.6	0.6	0.0
2100	12.67	15.2	0.6	0.6	0.0
2110	12.62	15.2	0.6	0.6	0.0
2120	12.57	15.1	0.6	0.6	0.0







Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and molybdenum concentration.

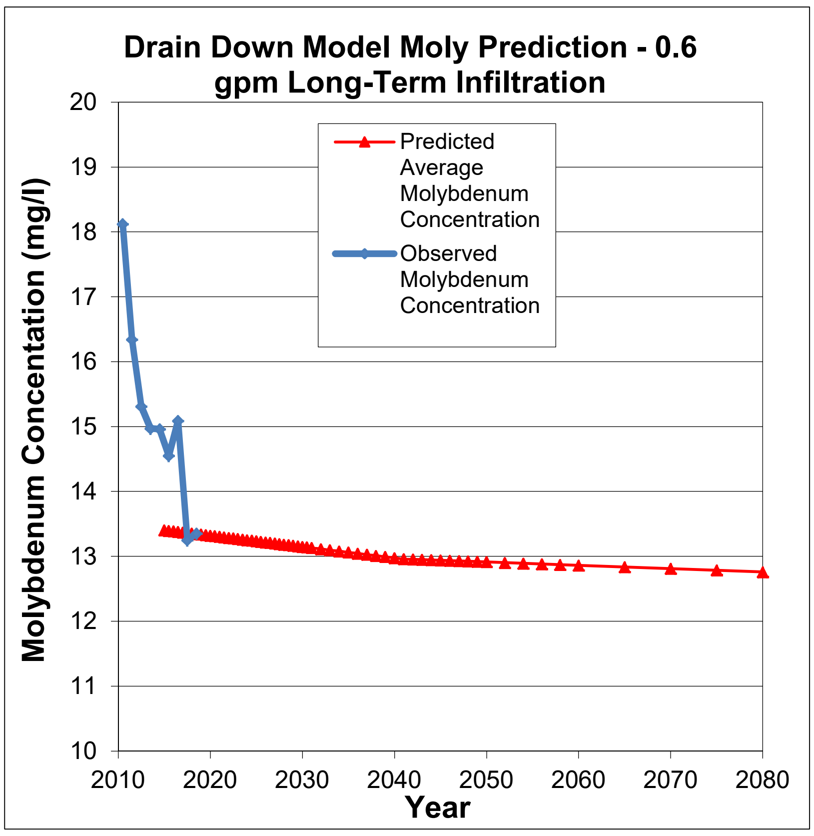
Figure 5

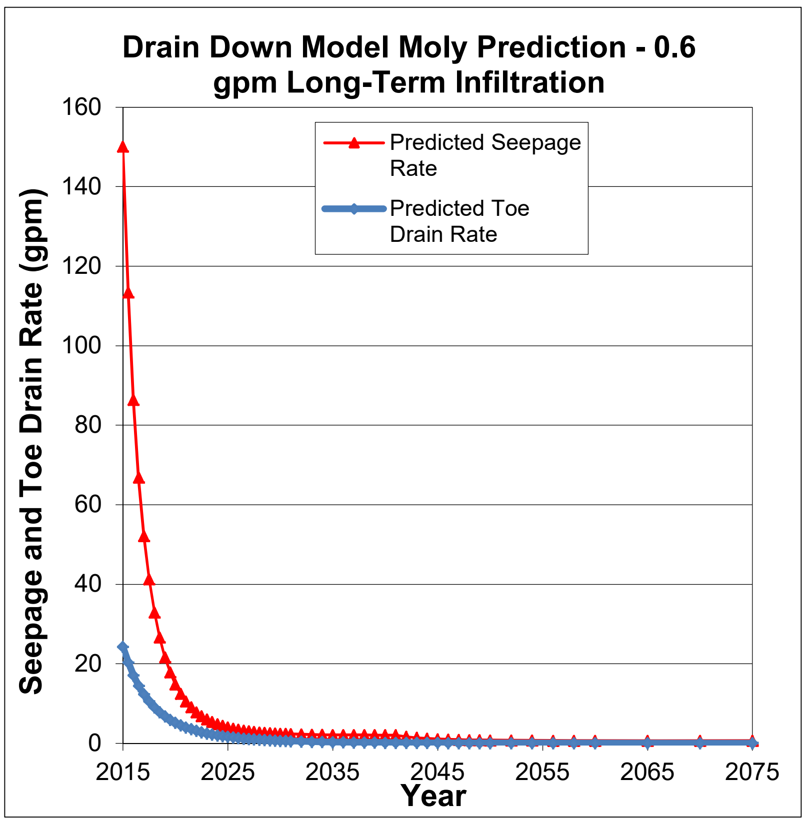
Drain Down Model Molybdenum Prediction with 0.6 gpm Long-Term Infiltration Rate and 0.087 mg/L Molybdenum Concentration in Infiltrate

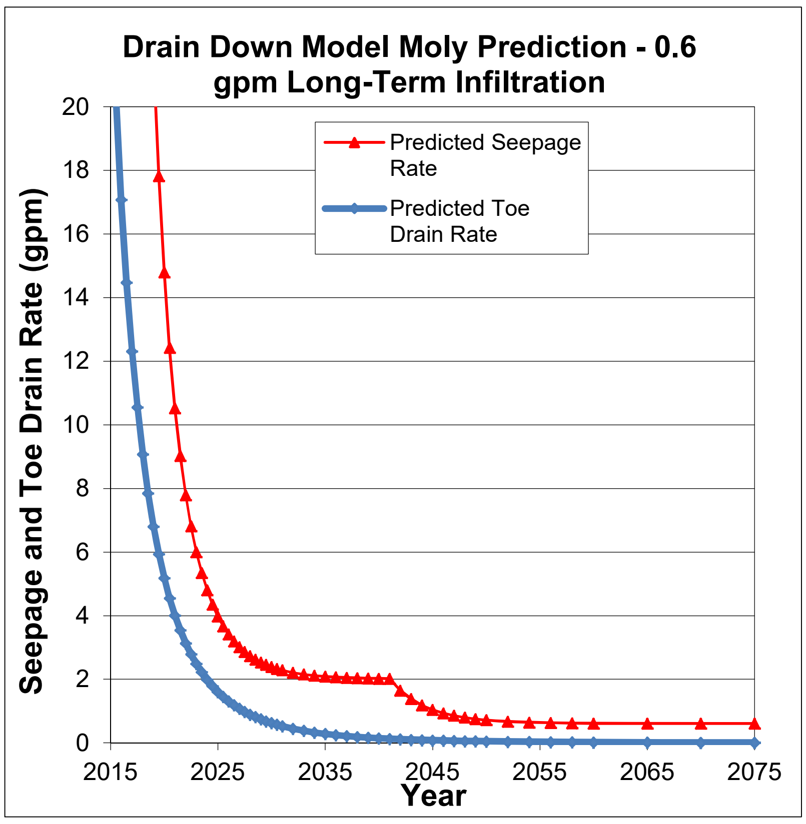
2015 Starting Mo Concentration	13.40
Infiltration Water Mo Conc.	0.087
Humidity Cell Upper Mo Conc. (mg/L)	0.28
Humidity Cell Lower Mo Conc. (mg/L)	0.087

Estimated Drain Down and LTP Molybdenum Concentration

Year	Predicted Average Mo Conc. (mg/l)	Mo Loading Seepage plus Toe Drain (kg/yr)	Infiltration Rate (gpm)	Seepage Rate (gpm)	Toe Drain Rate (gpm)
2012.5	15.31	4937.5	2.0	139.0	23.0
2013.5	14.97	5125.9	2.0	154.0	18.0
2014.5	14.96	6492.4	2.0	200.0	18.0
2015	13.40	4647.7	2.0	150.0	24.2
2015.5	13.39	3564.1	2.0	113.4	20.3
2016	13.39	2756.5	2.0	86.4	17.1
2016.5	13.38	2163.9	2.0	66.8	14.5
2017	13.37	1714.1	2.0	52.1	12.3
2017.5	13.36	1377.6	2.0	41.2	10.6
2018	13.35	1114.8	2.0	32.9	9.1
2018.5	13.34	914.2	2.0	26.6	7.8
2019	13.34	754.4	2.0	21.6	6.8
2019.5	13.33	630.2	2.0	17.8	5.9
2020	13.32	529.6	2.0	14.8	5.2
2020.5	13.31	449.8	2.0	12.4	4.6
2021	13.30	384.6	2.0	10.5	4.0
2021.5	13.29	332.4	2.0	9.0	3.5
2022	13.29	288.9	2.0	7.8	3.1
2022.5	13.28	253.7	2.0	6.8	2.8
2023	13.27	224.0	2.0	6.0	2.5
2023.5	13.26	199.7	2.0	5.3	2.2
2024	13.25	179.0	2.0	4.8	2.0
2024.5	13.24	161.8	2.0	4.3	1.8
2025	13.23	147.1	2.0	4.0	1.6
2025.5	13.22	134.8	2.0	3.7	1.5
2026	13.22	124.2	2.0	3.4	1.3
2026.5	13.21	115.3	2.0	3.2	1.2
2027	13.20	107.5	2.0	3.0	1.1
2027.5	13.19	100.9	2.0	2.9	1.0
2028	13.18	95.1	2.0	2.7	0.9
2028.5	13.17	90.2	2.0	2.6	0.8
2029	13.16	85.8	2.0	2.5	0.7
2029.5	13.16	82.1	2.0	2.5	0.7
2030	13.15	78.8	2.0	2.4	0.6
2030.5	13.14	76.0	2.0	2.3	0.6
2031	13.13	73.5	2.0	2.3	0.5
2032	13.11	69.3	2.0	2.2	0.4
2033	13.09	66.1	2.0	2.2	0.4
2034	13.08	63.6	2.0	2.1	0.3
2035	13.06	61.5	2.0	2.1	0.3
2036	13.04	59.9	2.0	2.1	0.2
2037	13.03	58.6	2.0	2.0	0.2
2038	13.01	57.5	2.0	2.0	0.2
2039	12.99	56.6	2.0	2.0	0.2
2040	12.97	55.9	2.0	2.0	0.1
2041	12.96	55.3	0.6	2.0	0.1
2042	12.95	45.3	0.6	1.6	0.1
2043	12.95	38.1	0.6	1.4	0.1
2044	12.94	32.8	0.6	1.2	0.1
2045	12.94	28.8	0.6	1.0	0.1
2046	12.93	25.9	0.6	0.9	0.1
2047	12.93	23.6	0.6	0.9	0.1
2048	12.92	21.9	0.6	0.8	0.1
2049	12.92	20.6	0.6	0.7	0.1
2050	12.91	19.6	0.6	0.7	0.0
2052	12.90	18.2	0.6	0.7	0.0
2054	12.89	17.3	0.6	0.6	0.0
2056	12.88	16.7	0.6	0.6	0.0
2058	12.87	16.4	0.6	0.6	0.0
2060	12.86	16.1	0.6	0.6	0.0
2065	12.83	15.8	0.6	0.6	0.0
2070	12.81	15.6	0.6	0.6	0.0
2075	12.78	15.5	0.6	0.6	0.0
2080	12.76	15.4	0.6	0.6	0.0
2085	12.73	15.4	0.6	0.6	0.0
2090	12.71	15.3	0.6	0.6	0.0
2095	12.68	15.3	0.6	0.6	0.0
2100	12.66	15.2	0.6	0.6	0.0
2110	12.61	15.2	0.6	0.6	0.0
2120	12.56	15.1	0.6	0.6	0.0







Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and molybdenum concentration.

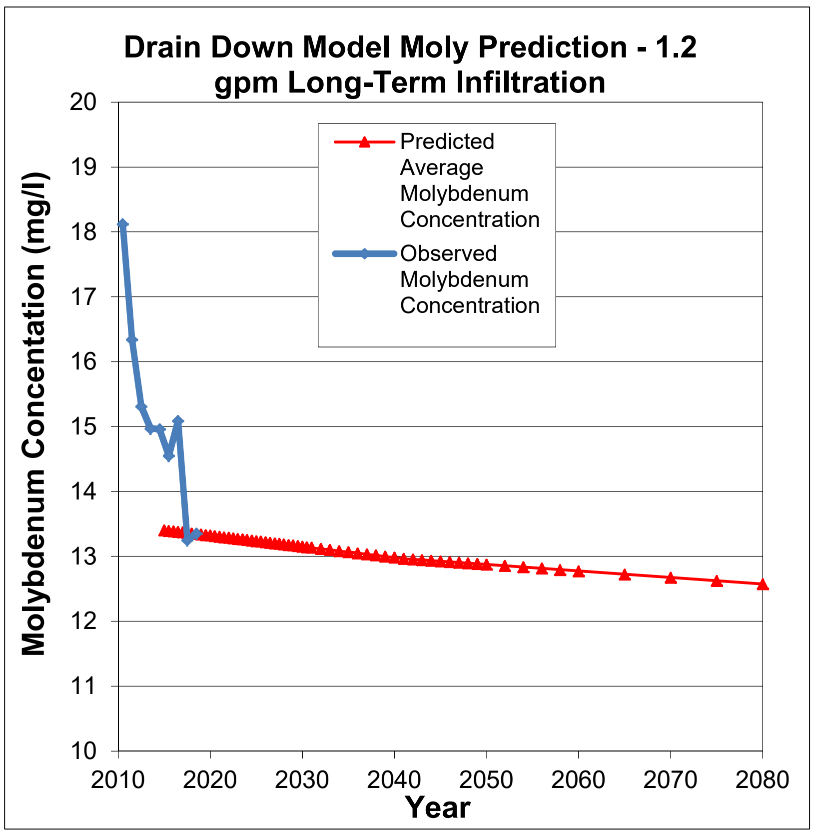
Figure 6

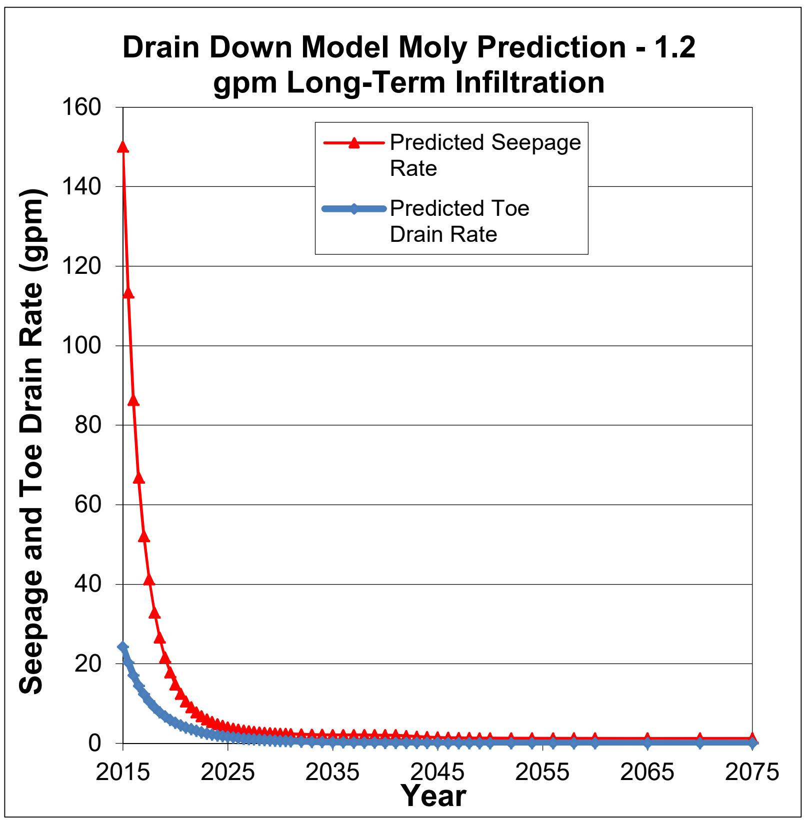
Drain Down Model Molybdenum Prediction with 1.2 gpm Long-Term Infiltration Rate and 0.28 mg/L Molybdenum Concentration in Infiltrate

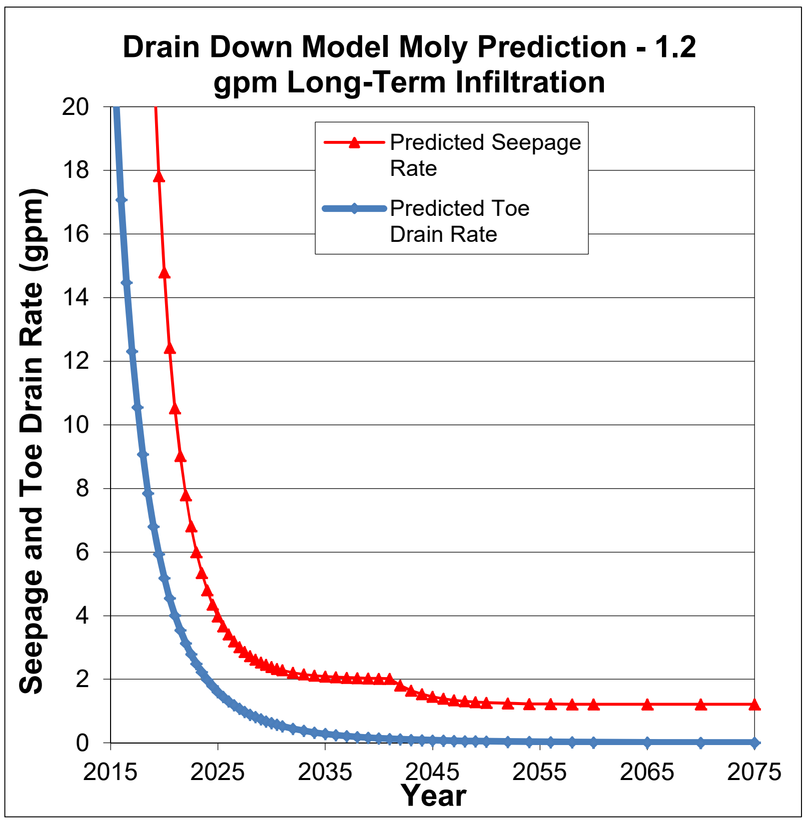
2015 Starting Mo Concentration	13.40
Infiltration Water Mo Conc.	0.28
Humidity Cell Upper Mo Conc. (mg/L)	0.28
Humidity Cell Lower Mo Conc. (mg/L)	0.087

Estimated Drain Down and LTP Molybdenum Concentration

Year	Predicted Average Mo Conc. (mg/l)	Mo Loading Seepage plus Toe Drain (kg/yr)	Infiltration Rate (gpm)	Seepage Rate (gpm)	Toe Drain Rate (gpm)
2012.5	15.31	4937.5	2.0	139.0	23.0
2013.5	14.97	5125.9	2.0	154.0	18.0
2014.5	14.96	6492.4	2.0	200.0	18.0
2015	13.40	4647.7	2.0	150.0	24.2
2015.5	13.39	3564.2	2.0	113.4	20.3
2016	13.39	2756.5	2.0	86.4	17.1
2016.5	13.38	2164.0	2.0	66.8	14.5
2017	13.37	1714.1	2.0	52.1	12.3
2017.5	13.36	1377.7	2.0	41.2	10.6
2018	13.35	1114.9	2.0	32.9	9.1
2018.5	13.35	914.2	2.0	26.6	7.8
2019	13.34	754.5	2.0	21.6	6.8
2019.5	13.33	630.3	2.0	17.8	5.9
2020	13.32	529.7	2.0	14.8	5.2
2020.5	13.31	449.9	2.0	12.4	4.6
2021	13.30	384.7	2.0	10.5	4.0
2021.5	13.30	332.5	2.0	9.0	3.5
2022	13.29	289.0	2.0	7.8	3.1
2022.5	13.28	253.7	2.0	6.8	2.8
2023	13.27	224.0	2.0	6.0	2.5
2023.5	13.26	199.7	2.0	5.3	2.2
2024	13.25	179.0	2.0	4.8	2.0
2024.5	13.24	161.8	2.0	4.3	1.8
2025	13.24	147.1	2.0	4.0	1.6
2025.5	13.23	134.8	2.0	3.7	1.5
2026	13.22	124.2	2.0	3.4	1.3
2026.5	13.21	115.3	2.0	3.2	1.2
2027	13.20	107.5	2.0	3.0	1.1
2027.5	13.19	100.9	2.0	2.9	1.0
2028	13.18	95.1	2.0	2.7	0.9
2028.5	13.18	90.2	2.0	2.6	0.8
2029	13.17	85.9	2.0	2.5	0.7
2029.5	13.16	82.1	2.0	2.5	0.7
2030	13.15	78.9	2.0	2.4	0.6
2030.5	13.14	76.0	2.0	2.3	0.6
2031	13.13	73.5	2.0	2.3	0.5
2032	13.12	69.4	2.0	2.2	0.4
2033	13.10	66.1	2.0	2.2	0.4
2034	13.08	63.6	2.0	2.1	0.3
2035	13.07	61.6	2.0	2.1	0.3
2036	13.05	59.9	2.0	2.1	0.2
2037	13.03	58.6	2.0	2.0	0.2
2038	13.01	57.5	2.0	2.0	0.2
2039	13.00	56.7	2.0	2.0	0.2
2040	12.98	55.9	2.0	2.0	0.1
2041	12.96	55.3	1.2	2.0	0.1
2042	12.95	49.4	1.2	1.8	0.1
2043	12.94	45.0	1.2	1.6	0.1
2044	12.93	41.7	1.2	1.5	0.1
2045	12.92	39.3	1.2	1.4	0.1
2046	12.91	37.5	1.2	1.4	0.1
2047	12.90	36.1	1.2	1.3	0.1
2048	12.89	35.0	1.2	1.3	0.1
2049	12.88	34.2	1.2	1.3	0.1
2050	12.87	33.6	1.2	1.3	0.0
2052	12.85	32.7	1.2	1.2	0.0
2054	12.83	32.1	1.2	1.2	0.0
2056	12.81	31.7	1.2	1.2	0.0
2058	12.79	31.4	1.2	1.2	0.0
2060	12.77	31.2	1.2	1.2	0.0
2065	12.72	30.9	1.2	1.2	0.0
2070	12.67	30.7	1.2	1.2	0.0
2075	12.62	30.5	1.2	1.2	0.0
2080	12.57	30.3	1.2	1.2	0.0
2085	12.52	30.2	1.2	1.2	0.0
2090	12.47	30.0	1.2	1.2	0.0
2095	12.43	29.9	1.2	1.2	0.0
2100	12.38	29.8	1.2	1.2	0.0
2110	12.28	29.5	1.2	1.2	0.0
2120	12.18	29.3	1.2	1.2	0.0







Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and molybdenum concentration.

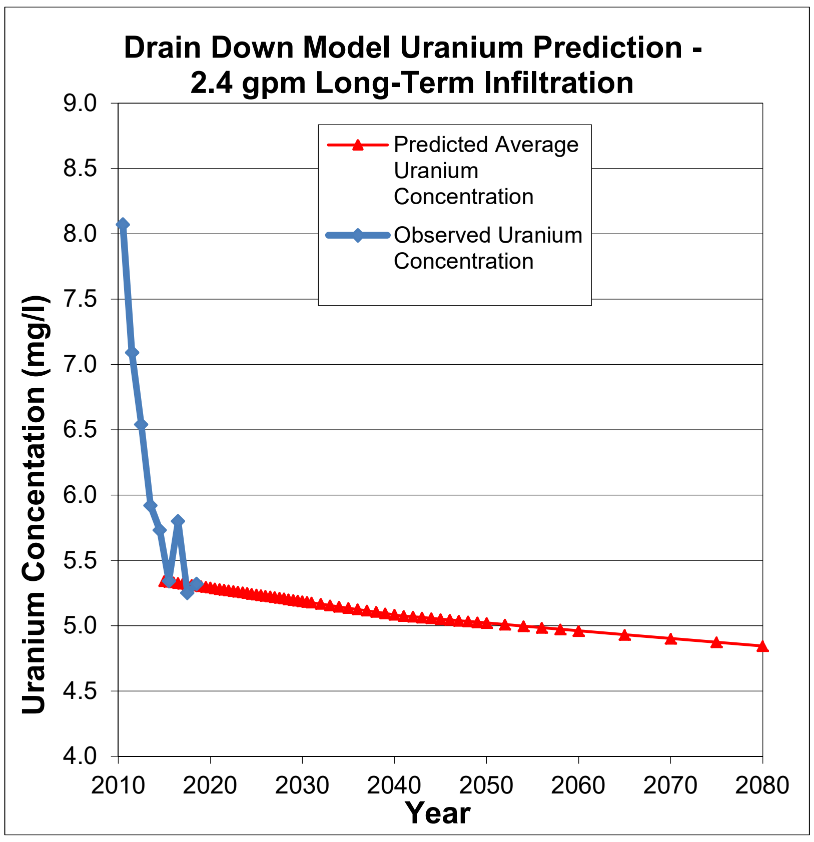
Figure 7

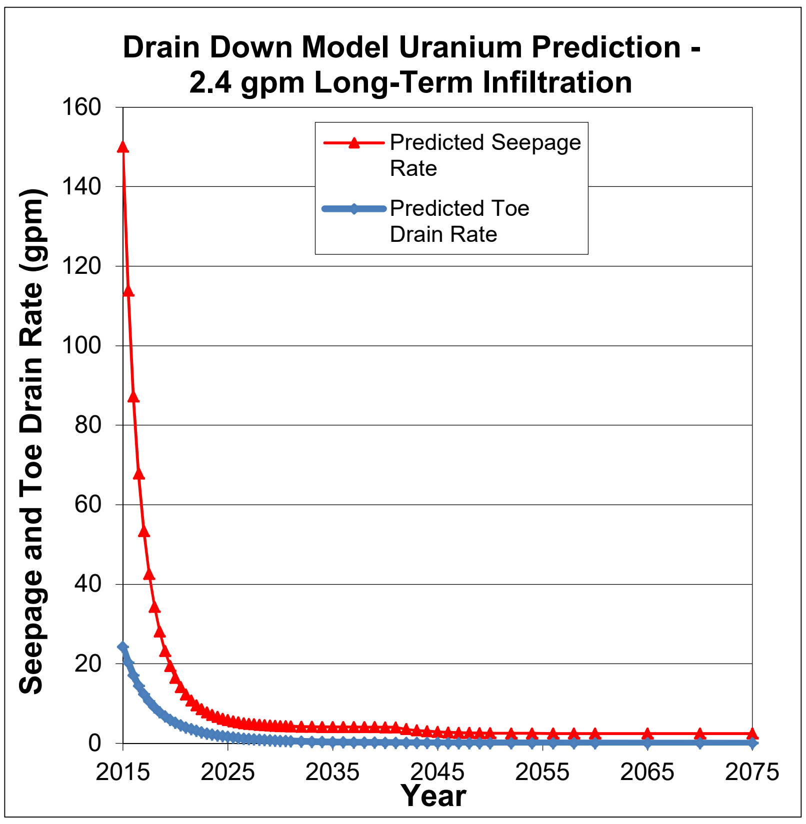
Drain Down Model Uranium Prediction with 4.0 gpm Short-Term Infiltration Rate, 2.4 gpm Long-Term Infiltration Rate and 1.26 mg/L Uranium Concentration in Infiltrate

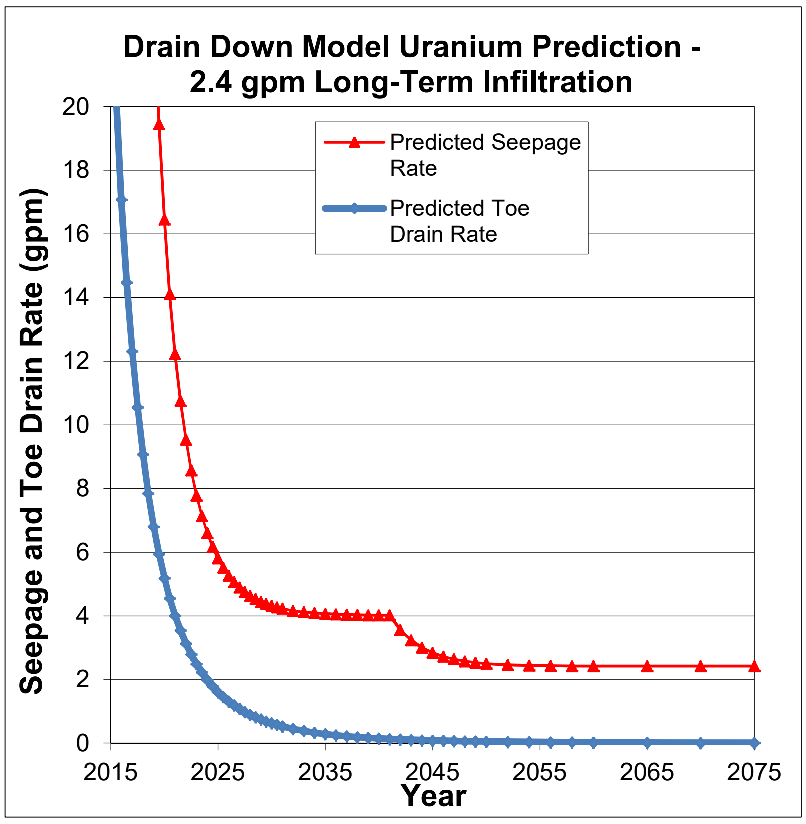
2015 Average U Concentration	5.34
Infiltration Water U Conc.	1.26
Humidity Cell Upper U Conc. (mg/L)	1.26
Humidity Cell Lower U Conc. (mg/L)	0.11

Estimated Drain Down and LTP Uranium Concentration

Year	Average Uranium Conc. (mg/l)	U Loading Seepage plus Toe Drain (kg/yr)	Infiltration Rate (gpm)	Seepage Rate (gpm)	Toe Drain Rate (gpm)
2012.5	6.54	2109.2	4.0	139.0	23.0
2013.5	5.92	2027.1	4.0	154.0	18.0
2014.5	5.73	2486.7	4.0	200.0	18.0
2015	5.34	1852.1	4.0	150.0	24.2
2015.5	5.34	1425.1	4.0	113.9	20.3
2016	5.33	1106.6	4.0	87.2	17.1
2016.5	5.33	872.9	4.0	67.9	14.5
2017	5.32	695.4	4.0	53.3	12.3
2017.5	5.32	562.6	4.0	42.6	10.6
2018	5.31	458.9	4.0	34.3	9.1
2018.5	5.31	379.7	4.0	28.1	7.8
2019	5.30	316.6	4.0	23.2	6.8
2019.5	5.30	267.6	4.0	19.4	5.9
2020	5.29	227.9	4.0	16.5	5.2
2020.5	5.29	196.4	4.0	14.1	4.6
2021	5.28	170.7	4.0	12.2	4.0
2021.5	5.28	150.1	4.0	10.8	3.5
2022	5.27	133.0	4.0	9.5	3.1
2022.5	5.26	119.1	4.0	8.6	2.8
2023	5.26	107.4	4.0	7.8	2.5
2023.5	5.25	97.9	4.0	7.1	2.2
2024	5.25	89.8	4.0	6.6	2.0
2024.5	5.24	83.0	4.0	6.2	1.8
2025	5.24	77.3	4.0	5.8	1.6
2025.5	5.23	72.5	4.0	5.5	1.5
2026	5.23	68.4	4.0	5.3	1.3
2026.5	5.22	65.0	4.0	5.1	1.2
2027	5.22	62.0	4.0	4.9	1.1
2027.5	5.21	59.4	4.0	4.7	1.0
2028	5.21	57.2	4.0	4.6	0.9
2028.5	5.20	55.3	4.0	4.5	0.8
2029	5.20	53.7	4.0	4.4	0.7
2029.5	5.19	52.3	4.0	4.4	0.7
2030	5.19	51.0	4.0	4.3	0.6
2030.5	5.18	49.9	4.0	4.3	0.6
2031	5.18	49.0	4.0	4.2	0.5
2032	5.17	47.4	4.0	4.2	0.4
2033	5.16	46.2	4.0	4.1	0.4
2034	5.15	45.2	4.0	4.1	0.3
2035	5.14	44.4	4.0	4.1	0.3
2036	5.12	43.8	4.0	4.0	0.2
2037	5.11	43.2	4.0	4.0	0.2
2038	5.10	42.8	4.0	4.0	0.2
2039	5.09	42.4	4.0	4.0	0.2
2040	5.08	42.1	4.0	4.0	0.1
2041	5.07	41.8	2.4	4.0	0.1
2042	5.07	37.0	2.4	3.6	0.1
2043	5.06	33.5	2.4	3.2	0.1
2044	5.06	31.1	2.4	3.0	0.1
2045	5.05	29.3	2.4	2.8	0.1
2046	5.04	28.0	2.4	2.7	0.1
2047	5.04	27.1	2.4	2.6	0.1
2048	5.03	26.3	2.4	2.6	0.1
2049	5.03	25.8	2.4	2.5	0.1
2050	5.02	25.4	2.4	2.5	0.0
2052	5.01	24.9	2.4	2.5	0.0
2054	5.00	24.5	2.4	2.4	0.0
2056	4.98	24.3	2.4	2.4	0.0
2058	4.97	24.2	2.4	2.4	0.0
2060	4.96	24.0	2.4	2.4	0.0
2065	4.93	23.8	2.4	2.4	0.0
2070	4.90	23.6	2.4	2.4	0.0
2075	4.87	23.5	2.4	2.4	0.0
2080	4.84	23.3	2.4	2.4	0.0
2085	4.81	23.2	2.4	2.4	0.0
2090	4.79	23.0	2.4	2.4	0.0
2095	4.76	22.9	2.4	2.4	0.0
2100	4.73	22.7	2.4	2.4	0.0
2110	4.67	22.5	2.4	2.4	0.0
2120	4.62	22.2	2.4	2.4	0.0







Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and uranium concentration.

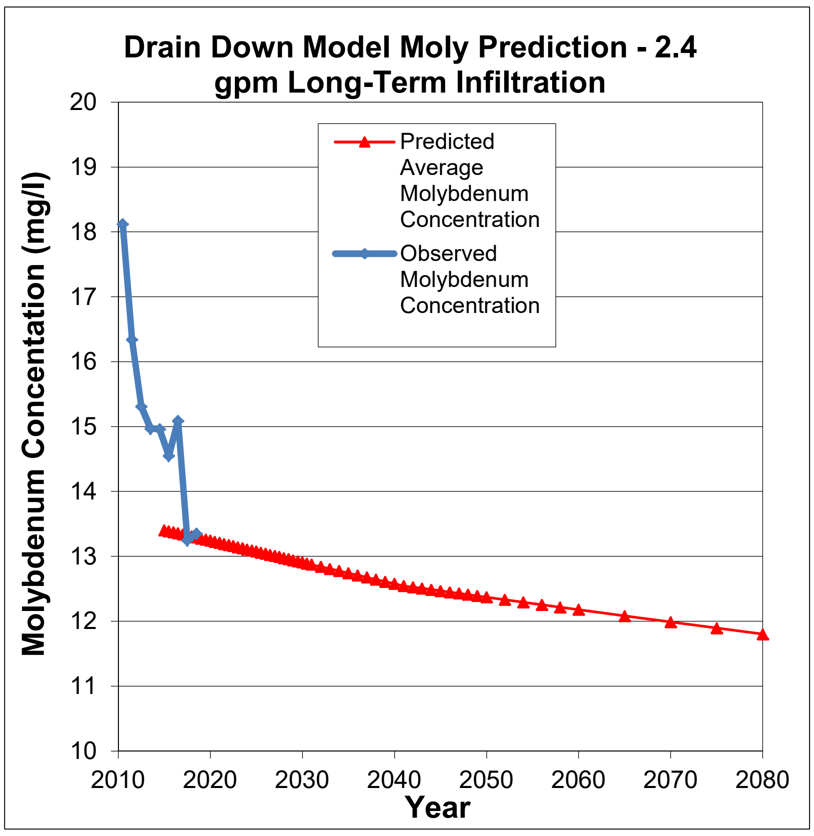
Figure 8

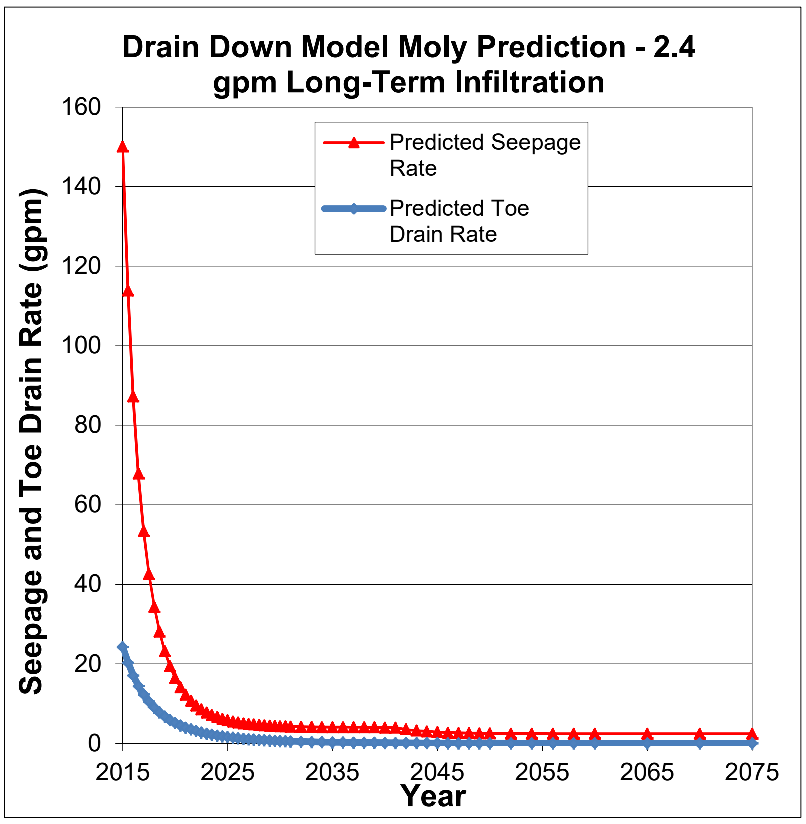
Drain Down Model Molybdenum Prediction with 4.0 gpm Short-Term Infiltration Rate, 2.4 gpm Long-Term Infiltration Rate and 0.28 mg/L Molybdenum Concentration in Infiltrate

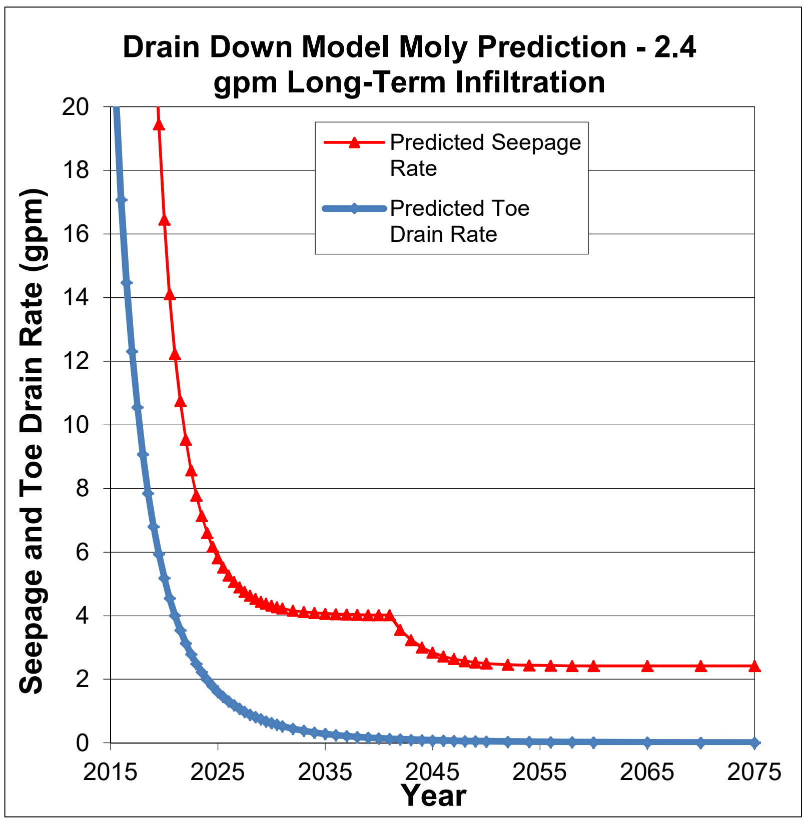
2015 Starting Mo Concentration	13.40
Infiltration Water Mo Conc.	0.28
Humidity Cell Upper Mo Conc. (mg/L)	0.28
Humidity Cell Lower Mo Conc. (mg/L)	0.087

Estimated Drain Down and LTP Molybdenum Concentration

Year	Average Moly Conc. (mg/l)	Mo Loading Seepage plus Toe Drain (kg/yr)	Infiltration Rate (gpm)	Seepage Rate (gpm)	Toe Drain Rate (gpm)
2012.5	15.31	4937.5	4.0	139.0	23.0
2013.5	14.97	5125.9	4.0	154.0	18.0
2014.5	14.96	6492.4	4.0	200.0	18.0
2015	13.40	4647.7	4.0	150.0	24.2
2015.5	13.39	3575.2	4.0	113.9	20.3
2016	13.37	2775.6	4.0	87.2	17.1
2016.5	13.36	2188.9	4.0	67.9	14.5
2017	13.34	1743.3	4.0	53.3	12.3
2017.5	13.32	1410.1	4.0	42.6	10.6
2018	13.31	1149.8	4.0	34.3	9.1
2018.5	13.29	951.1	4.0	28.1	7.8
2019	13.27	792.9	4.0	23.2	6.8
2019.5	13.26	669.9	4.0	19.4	5.9
2020	13.24	570.4	4.0	16.5	5.2
2020.5	13.23	491.4	4.0	14.1	4.6
2021	13.21	426.9	4.0	12.2	4.0
2021.5	13.19	375.3	4.0	10.8	3.5
2022	13.18	332.4	4.0	9.5	3.1
2022.5	13.16	297.6	4.0	8.6	2.8
2023	13.14	268.4	4.0	7.8	2.5
2023.5	13.12	244.5	4.0	7.1	2.2
2024	13.11	224.1	4.0	6.6	2.0
2024.5	13.09	207.3	4.0	6.2	1.8
2025	13.07	192.9	4.0	5.8	1.6
2025.5	13.06	181.0	4.0	5.5	1.5
2026	13.04	170.6	4.0	5.3	1.3
2026.5	13.02	162.0	4.0	5.1	1.2
2027	13.01	154.5	4.0	4.9	1.1
2027.5	12.99	148.1	4.0	4.7	1.0
2028	12.97	142.5	4.0	4.6	0.9
2028.5	12.96	137.8	4.0	4.5	0.8
2029	12.94	133.6	4.0	4.4	0.7
2029.5	12.92	130.1	4.0	4.4	0.7
2030	12.91	126.9	4.0	4.3	0.6
2030.5	12.89	124.2	4.0	4.3	0.6
2031	12.87	121.8	4.0	4.2	0.5
2032	12.84	117.8	4.0	4.2	0.4
2033	12.81	114.7	4.0	4.1	0.4
2034	12.77	112.2	4.0	4.1	0.3
2035	12.74	110.2	4.0	4.1	0.3
2036	12.71	108.5	4.0	4.0	0.2
2037	12.68	107.2	4.0	4.0	0.2
2038	12.64	106.0	4.0	4.0	0.2
2039	12.61	105.0	4.0	4.0	0.2
2040	12.58	104.1	4.0	4.0	0.1
2041	12.54	103.4	2.4	4.0	0.1
2042	12.53	91.4	2.4	3.6	0.1
2043	12.51	82.9	2.4	3.2	0.1
2044	12.49	76.8	2.4	3.0	0.1
2045	12.47	72.3	2.4	2.8	0.1
2046	12.45	69.1	2.4	2.7	0.1
2047	12.43	66.7	2.4	2.6	0.1
2048	12.41	65.0	2.4	2.6	0.1
2049	12.39	63.7	2.4	2.5	0.1
2050	12.37	62.6	2.4	2.5	0.0
2052	12.33	61.3	2.4	2.5	0.0
2054	12.29	60.4	2.4	2.4	0.0
2056	12.25	59.8	2.4	2.4	0.0
2058	12.22	59.4	2.4	2.4	0.0
2060	12.18	59.0	2.4	2.4	0.0
2065	12.08	58.4	2.4	2.4	0.0
2070	11.99	57.8	2.4	2.4	0.0
2075	11.89	57.3	2.4	2.4	0.0
2080	11.80	56.8	2.4	2.4	0.0
2085	11.71	56.3	2.4	2.4	0.0
2090	11.62	55.9	2.4	2.4	0.0
2095	11.53	55.4	2.4	2.4	0.0
2100	11.44	55.0	2.4	2.4	0.0
2110	11.26	54.1	2.4	2.4	0.0
2120	11.08	53.3	2.4	2.4	0.0


Drain Down Model Moly Prediction - 2.4 gpm Long-Term Infiltration


Drain Down Model Moly Prediction - 2.4 gpm Long-Term Infiltration


Drain Down Model Moly Prediction - 2.4 gpm Long-Term Infiltration

Note: Yellow shading indicates pumping from toe drain sumps will likely be discontinued at low rates.
Gray shading indicates values taken from measured/estimated water volume change and molybdenum concentration.