Comments on the
Grants Reclamation Project, Updated Corrective Action Program (CAP)
Homestake Mining Company of California, March 2012

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These comments are based on a review of *Grants Reclamation Project, Updated Corrective Action Program (CAP)*[1], and related documents. Notes on the requests for additional information (RAIs)[2] are included in attachment 1.

Comment 1: San Andres/Glorietta Aquifer

The San Andres/Glorietta Aquifer directly underlies (subcrops) the alluvial aquifer approximately 2.5 miles southwest of the Homestake Mining Company's (Homestake) tailings pile[3]. In the subcrop area, groundwater from the alluvial aquifer flows into the San Andres/Glorietta Aquifer[4]. Thus, contaminants in the alluvial aquifer may enter the San Andres/Glorietta Aquifer.

Samples collected in 1998 and 2010 show that contaminants emanating from the tailings pile have migrated through the alluvial aquifer to less than a half mile from the San Andres/Glorietta Aquifer subcrop[5]. Contaminants may have reached the subcrop, but this cannot be determined because no alluvial wells have been installed above the subcrop[6]. Only one San Andres/Glorietta well (0911) appears to have been installed in the in the subcrop area[7].

Conclusion: Homestake does not appear to have investigated the possibility that contaminants from the alluvial aquifer may have entered the San Andres/Glorietta Aquifer via the subcrop. Homestake should monitor the subcrop area of the San Andres/Glorietta Aquifer to determine whether it has been affected by contaminants emanating from the tailings pile.

[1] HMC, 2012a.
[2] HMC, 2012a, appendix A table A-2.
[3] HMC, 2012a, figure 3.2.4-3.
[4] HMC, 2012a, pages 3-13 and 3-14, and appendix J, attachment J-1, page 4-7.
[5] HMC, 2012a, figures 3.2.4-3, 4.2.3-1, and 4.2.3-4.
[6] HMC, 2012a, compare figures 3.2.4-3 and 5.2.3-1.
[7] HMC, 2012a, figure 3.2.4-3. No analyses of samples from well 0911 were found in the documents reviewed for these comments, i.e., HMC, 2012a; HMC and Hydro-Engineering, 2011; HMC and Hydro-Engineering, 2012; and USCOE, 2010a.

Comment 2: Flushing the large tailings pile

In 1995 Homestake began injecting water into the large tailings pile[8]. The purpose is to flush uranium and other contaminants from the pile[9]. In 2010 approximately 190 injection wells pumped a combined 193 gpm (approximately 300 ac-ft/yr) into the pile[10]. Most of the injected water is captured in either; 1) extraction wells installed in the pile, 2) extraction wells in the alluvium beneath the pile, or 3) toe drains installed along the perimeter of the pile. A portion of injected water remains, at least temporarily, in the pile[11].

Homestake plans to stop injecting water into the pile after 2014 because it predicts that by then, the vast majority of uranium will have been flushed from the pile[12]. However, this prediction is questionable for several reasons.

First, the permeability the slime[13] fraction of the tailings is probably much lower than that of the sand fraction. As a result, the injected water will tend to flow around rather than through the slimes. Thus, the slimes will, at best, be incompletely flushed and uranium in the pore water within the slimes will continue to be released after flushing ceases.

Second, the solid uranium in the tailings is likely to be mobilized as oxygen-rich precipitation percolates through the pile.

Third, Homestake used the model VADOSE/W to predict seepage rates through the large tailings pile. However, we cannot have confidence in the predictions produced by this model (see comment 4 below).

Finally, Homestake's predictions of uranium concentrations in the pile have not matched-up well with measured concentrations. This mismatch is illustrated in figure 1.

Conclusion: Although the injection of water has increased the rate at which uranium has been flushed from the pile, a significant reservoir of uranium will probably remain in the pile after injection is ceased. This uranium may continue to leach from the pile for many years or decades. Homestake should not rely on flushing to reduce this leaching to acceptable levels.

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[8] HMC, 2012a, page 5-5.
[9] HMC, 2012a, pages 5-5 and 5-6.
[10] HMC, 2012a, page 5-6.
[11] HMC, 2012a, page 5-6.
[12] HMC, 2012a, page 6-2; and HMC, 2012a, appendix G, attachment A, table A-3. According to the reformulated mixing model (RMM), the amount of uranium in the pile will have decreased from 105,600 pounds in 2003 to 1010 pounds in 2014.
[13] Slimes are the finer grained, clay to silt sized portion of the tailings. Water moves much slower through the slimes than it does through the sandy portion of the tailings. Thus, it takes longer for constituents to be flushed from the slimes.

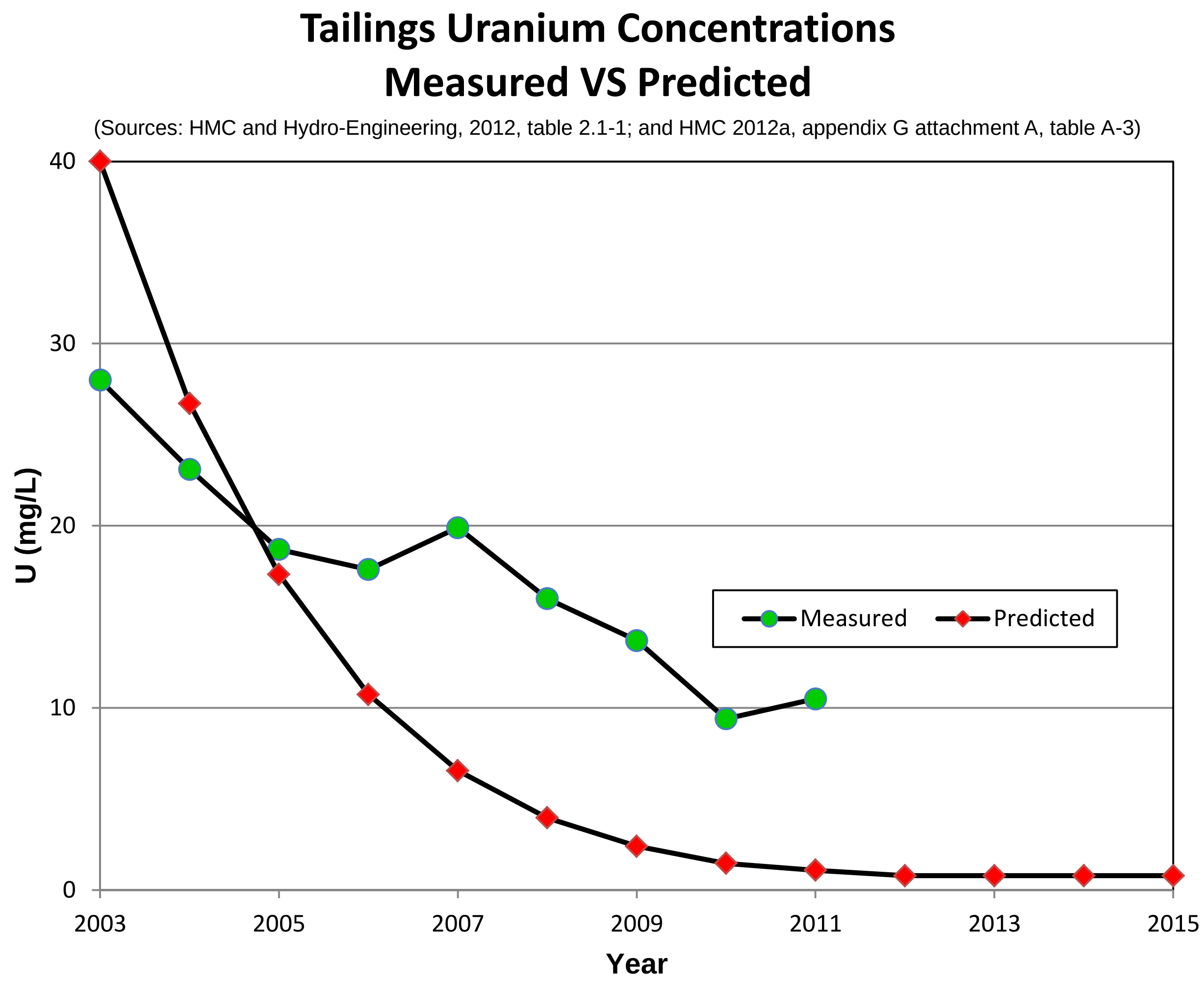

Figure 1

Comment 3: Model verification - groundwater flow and contaminant transport

Homestake used the coupled models MODFLOW and MT3DMS to simulate groundwater flow and contaminant transport[14]. The models were calibrated for the years 2000 through 2004[15]. In order to have confidence in model results, calibration is a necessary, but not a sufficient step. The models must also be verified[16]. Homestake does not appear to have verified the models.

Verification would involve performing model simulations for years not in the calibration period (e.g., 2005 - 2010) and comparing the model results with historical data (e.g., water levels, uranium concentrations). If the model is able to reproduce the historical

[14] HMC, 2012a, appendix G, page G-2.
[15] HMC, 2012a, appendix G, page G-9.
[16] Aka, history matching (Mandle, R.J., 2002, pages 18 and 19).

data, it is verified and we can have confidence in its ability to predict future conditions. Conversely, if the model is unable to reproduce the historical data, it is unverified and we cannot have confidence in its ability to predict future conditions.

Conclusion: Homestake should attempt to verify the groundwater flow and contaminant transport models. Until the models are verified, we cannot have confidence in their predictions of future conditions.

Comment 4: Model verification - tailings seepage rate

Homestake used the partially saturated flow model VADOSE/W to predict the rate of seepage from the large tailings pile. Seepage rates were predicted through the year 2050[17]. VADOSE/W was calibrated for the years 2000 through 2004[18]. However, Homestake does not appear to have verified VADOSE/W.

Conclusion: Homestake should attempt to verify the seepage rate model. Until the model is verified, we cannot have confidence in its predictions of seepage rates.

Comment 5: Land treatment

Homestake is treating contaminated water from the alluvial aquifer by using it to irrigate fields near the former uranium mill[19]. Contaminants (primarily selenium and uranium)[20] in the water are partially immobilized in the soil. The contaminated water is blended with uncontaminated water to keep contaminant concentrations below the land treatment standards established by the Nuclear Regulatory Commission (NRC) and the New Mexico Environmental Department (NMED)[21].

Four fields, ranging from 24 acres to 150 acres are irrigated[22]. Alfalfa, triticale, sorghum/sudan grass, canola, camelina, and winter wheat have been grown on the irrigated fields[23]. The amount of water applied to the fields from 2000 through 2010 ranged from 201 acre-feet to 1054 acre-feet. The average amount applied each year was 820 acre-feet (approximately 270 million gallons per year, or 500 gpm)[24].

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[17] HMC, 2012a, appendix G, attachment A, pages G.A-1 and table A-1.
[18] HMC, 2012a, appendix G, attachment A, page G.A-1.
[19] HMC, 2012a, pages 5-8 and 5-9.
[20] HMC, 2012a, appendix J, page J-1.
[21] HMC, 2012a, page 5-9.
[22] HMC, 2012a, page 5-9.
[23] HMC, 2012a, appendix J, pages J-4 and J-5.
[24] HMC, 2012a, appendix F, table F-5.

Modeling performed by Homestake predicts that the uranium in the irrigation water will never reach the groundwater beneath the irrigated fields[25]. The model used to make this prediction appears to be LEACHP[26]. However, the CAP[27] contains no description of LEACHP[28] or any indication that the model was calibrated or verified. Given this lack of information, it is not possible to have any confidence in the predictions produced by this model.

There is, however, evidence that contaminated water has moved a significant distance through the material beneath the irrigated fields. Samples collected from suction lysimeters show that contaminants have reached a depth of at least 15 feet in section 28[29], and a depth of at least 16 feet in section 33[30].

Homestake is monitoring wells near the irrigated fields to determine whether any contaminants have reached the underlying groundwater. However, many of the wells are not well-suited to this task. First, according to Homestake, contaminant concentrations in at least some of these wells may be affected by the groundwater restoration program[31]. Second, some of the monitor wells are also used as irrigation wells[32]. Thus, the water extracted from them is a mixture of water drawn from all directions around the well. Finally, the contaminant plume emanating from the large tailings pile passes directly beneath the irrigated area in section 28[33]. Contaminants in the plume could mask contaminants originating in the irrigation water.

Still, two monitor wells display increases in contaminants that could be caused by the irrigation. These wells are 844 (increases in uranium and selenium)[34] and 846 (increases in sulfate, chloride, total dissolved solids, and selenium)[35].

Conclusion: Homestake's contention that contaminants from the irrigated fields will not reach the underlying groundwater is not supported by the evidence. Lysimeter samples show that selenium and uranium from the irrigation water have already reached a depth of at least 15 feet. Two monitor wells contain elevated concentrations of contaminants that may have originated in the irrigation water. In addition, Homestake has not provided the information necessary to show that its LEACHP modeling is reliable.

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[25] HMC, 2012a, appendix J, attachment J-1, page ES-2.
[26] HMC, 2012a, page 3-4 and. appendix J, attachment J-1, page 3-62.
[27] HMC, 2012a.
[28] It is described only as a "partially saturated numerical model" (HMC, 2012a, appendix J, attachment J-1, page 3-62).
[29] Lysimeter LY28-1 (chloride, total dissolved solids, and uranium), (HMC, 2012a, appendix J, attachment J-1, figures 3-28 and 3-29).
[30] Lysimeter LY1 (chloride, sulfate, total dissolved solids, and selenium), (HMC, 2012a, appendix J, attachment J-1, figures 3-34 and 3-35).
[31] HMC, 2012a, appendix J, attachment J-1, pages 4-2, 4-3, and 4-5.
[32] Wells 649 and 881, see HMC, 2012a, appendix J, attachment J-1, figures 4-23, 4-24, 4-33, and 4-34. Note, figure 4-23 is mislabeled as 5-23.
[33] HMC, 2012a, appendix J, attachment J-1, page 4-5 and figure 4-21.
[34] HMC, 2012a, appendix J, attachment J-1, figures 4-8 and 4-10.
[35] HMC, 2012a, appendix J, attachment J-1, figures 4-2, 4-4, 4-6, and 4-10.

Comment 6: Site cleanup standards

The Nuclear Regulatory Commission (NRC), U.S. Environmental Protection Agency, and the New Mexico Environment Department have agreed on site standards (groundwater contaminant concentrations) that must be achieved by Homestake[36]. These standards must be met at five point-of-compliance (POC) wells[37]. Three of the POC wells are completed in the alluvial aquifer and two are completed in the Upper Chinle Aquifer[38]. All of the POC wells are within the NRC license boundary[39].

However, the groundwater contaminants emanating from the Homestake facility extend thousands of feet beyond the NRC license boundary[40]. It is not clear what groundwater cleanup standards apply beyond the license boundary.

Conclusion: Cleanup standards should be established for all groundwater that has been contaminated by the Homestake facility.

Comment 7: Windblown tailings and water quality

Homestake does not appear to have investigated surface water quality in the vicinity of its facility. Windblown contaminants from the tailings piles could be deposited in stream channels and subsequently entrained up by streamflows. This could affect both surface water quality and the quality of groundwater that receives recharge from an affected stream.

Conclusion: Homestake should determine whether windblown tailings have been deposited in stream channels near its facility. If they have, Homestake should determine whether they have affected water quality.

[36] HMC, 2012a, pages 1-11 and 1-12.
[37] HMC, 2012a, pages 7-10 and 7-11.
[38] HMC, 2012a, page 1-11.
[39] HMC, 2012a, figures 1.1-1 and 2.1-1.
[40] HMC, 2012a, figure 4.2.3-4.

References

HMC, 2012a, *Grants Reclamation Project, Updated Corrective Action Program (CAP)*, pursuant to NRC Radioactive Material License SUA-1471, March 2012.

HMC and Hydro-Engineering, 2011, *Grants Reclamation Project, 2010 Annual Monitoring Report/Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200*, March 2011.

HMC and Hydro-Engineering, 2012, Grants Reclamation Project, *2011 Annual Monitoring Report/Performance Review for Homestake's Grants Project Pursuant to NRC License SUA-1471 and Discharge Plan DP-200*, March 2012.

Mandle, R.J., 2002, Groundwater Modeling Guidance, Michigan Department of Environmental Quality.

US Army Corps of Engineers (USCOE), 2010a*, Focused Review of Specific Remediation Issues, An Addendum to the Remediation System Evaluation for the Homestake Mining Company (Grants) Superfund Site, New Mexico*, Final Report, December 23, 2010.

Attachment
Notes on RAIs

A listing of Homestake's responses to each RAI is given in table A-2 of appendix A of the CAP[41]. The list identifies the sections of the CAP that address each RAI.

RAI 2:

> *The collection for re-injection program should have its own section to describe well locations and water quality for each extraction well. The water quality of the reinjection area should be discussed including the effectiveness the program will have on the injection area.*

Homestake states that this RAI is addressed in section 5.3.2 of the CAP.

This section of the CAP contains no information regarding the … *water quality for each extraction well*. Nor does it discuss *The water quality of the reinjection area …* .

RAI 4:

> *Section 2.3, paragraph 1, page 9: The statement that "natural water quality was generally poor" is not supported with actual data.*
>
> *Provide water quality data from the Atomic Energy Commission's required monitoring program for groundwater protection that started in the 1950s (mentioned in paragraph 2 of this section). Also, include available water quality results from domestic wells that were installed in the 1960s and 1970s to justify your statement.*

Homestake states that this RAI is addressed in section 4.1 of the CAP.

This section of the CAP contains no information regarding … *the Atomic Energy Commission's required monitoring program for groundwater protection that started in the 1950s.* Nor does it … *include available water quality results from domestic wells that were installed in the 1960s and 1970s … .*

RAI 13:

> *Section 2.4.3, paragraph 1, page 17: The future impacts to the Middle Chinle aquifer need to be addressed in this section.*

Homestake states that this RAI is addressed in section 4.2 and appendix E of the CAP.

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[41] *Grants Reclamation Project, Updated Corrective Action Program (CAP)*, pursuant to NRC Radioactive Material License SUA-1471, Homestake Mining Company of California, March 2012.

These parts of the CAP contains no information regarding … *future impacts to the Middle Chinle aquifer … .*

RAI 15:

> *Section 2.4.4, paragraph 1, page 18: HMC needs to support the statement "natural water quality of the major constituents in the shaley Lower Chinle aquifer is poor".*

Homestake states that this RAI is addressed in section 3.2.3.3 of the CAP.

This section of the CAP contains only qualitative information[42] to … *support the statement "natural water quality of the major constituents in the shaley Lower Chinle aquifer is poor".* The statement is not supported by chemical analyses of water from the Lower Chinle Aquifer.

RAI 20:

> *Section 2.5, paragraph 2, pages 20 and 21: HMC should provide data to support its conclusion "… that baseline water quality in the Alluvial aquifer may change in the future. Discharge of groundwater from past mine dewatering in Ambrosia lake area (north and upgradient of the site) to San Mateo Alluvial aquifer had elevated levels of the same constituents as are elevated in the Grants tailings impoundments. Travel time calculations and preliminary information from far upgradient wells indicates selenium, uranium and other constituents from mine discharges to the Alluvial aquifer could reach the Grants site in the next 20 years." HMC should include a comparison of current discharges from the tailing piles into the Alluvial aquifer and the up-gradient groundwater quality of the Alluvial aquifer.*
>
> *Further, HMC should discuss how former up-gradient mine discharges to the Alluvial aquifer will impact efforts to remediate the effects of the tailing piles on the down-gradient groundwater in the Alluvial aquifer.*

Homestake states that this RAI is addressed in section 4.1 and appendix E of the CAP.

Neither part of the CAP contains data or analyses to support the statements that 1) *… baseline water quality in the Alluvial aquifer may change in the future*. 2) *Discharge of groundwater from past mine dewatering in Ambrosia lake area (north and upgradient of the site) to San Mateo Alluvial aquifer had elevated levels of the same constituents as are elevated in the Grants tailings impoundments.* Nor did they contain *Travel time calculations and preliminary information from far upgradient wells indicates selenium, uranium and other constituents from mine discharges to the Alluvial aquifer could reach the Grants site in the next 20 years.*

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[42] Homestake states: *The natural water quality of the aquifer is poor due to the low permeability of the shale and the associated long residence time for groundwater.* (HMC, 2012a, page 3-13).

These sections do not … *discuss how former up-gradient mine discharges to the Alluvial aquifer will impact efforts to remediate the effects of the tailing piles on the down-gradient groundwater in the Alluvial aquifer.*

RAI 23:

> *Sections 3.1 and 3.2, page 22, should be revised to include a discussion of the objectives of the tailings injection/extraction program. The discussion should include an explanation of how the final injection/extraction dates were determined. Provide a table with past injection/extraction rates compared to model predicted rates. Describe why past rates have been sufficient or insufficient to meet remediation goals and timelines. Explain how the seepage into the Alluvial aquifer is being contained and remediated since more water is being injected than extracted.*

Homestake states that this RAI is addressed in section 5.3.1 of the CAP.

This section of the CAP does not … *include an explanation of how the final injection/extraction dates were determined.* Nor does it *Describe why past rates have been sufficient or insufficient to meet remediation goals and timelines.*

RAI 24:

> *HMC needs a more thorough discussion of the tailing toe drain and the French drain. How do they differ? Are they interconnected?*

Homestake gives no information on where this RAI is addressed.

RAI 26:

> *Additional clarification is required on the effectiveness of extraction well P2 that pumps approximately 40 gpm of "clean groundwater" up-gradient from the Large Tailings Pile.*

Homestake states that this RAI is addressed in section 5.3.2 of the CAP.

This section of the CAP does not discuss … *the effectiveness of extraction well P2 that pumps approximately 40 gpm of "clean groundwater" up-gradient from the Large Tailings Pile.*

RAI 29:

> *Section 3.6, page 24 discusses the Upper Chinle extraction wells. However, the description does not provide enough detail for the staff to determine exactly where the 5 gpm is being injected and what is the concentration level of this water.*

> *Section 3.6, paragraph 1, page 24 should describe exactly where the 5 gpm is being injected and what the contaminate concentration level of this water is.*

Homestake states that this RAI is addressed in figure 5.2-1 of the CAP. This appears to be a typo. Pumping from the Upper Chinle is illustrated in figure 5.2.2.

However, neither figure contains … *enough detail for the staff to determine exactly where the 5 gpm is being injected and what is the concentration level of this water.*

RAI 30:

> *Sections 3.5, 3.7 and 3.9, pages 23-24, should provide the minimum injection rate needed in each well to create an effective hydraulic barrier and how these rates are achieved, as well as how these rates were determined to be effective.*

Homestake states that this RAI is addressed in section 5.3.2 of the CAP.

This section of the CAP refers to appendix M which lists pumping rates for wells at the Homestake facility. However, it does not 1) … *provide the minimum injection rate needed in each well to create an effective hydraulic barrier …* , or 2) explain *… how these rates are achieved,* or 3) explain *… how these rates were determined to be effective.*

RAI 31:

> *Please describe which San Andres wells are being pumped to supply the injection water for the Upper Chinle aquifer.*

Homestake states that this RAI is addressed in section 5.3.2 and appendix F of the CAP.

Neither section 5.3.2 or appendix F identify any … *San Andres wells* … *being pumped to supply the injection water for the Upper Chinle aquifer.*

RAI 32:

> *Please describe which San Andres wells are being pumped to supply the injection water for the Middle Chinle aquifer.*

Homestake states that this RAI is addressed in section 5.3.2 and appendix F of the CAP.

Neither section 5.3.2 or appendix F identify any … *San Andres wells* … *being pumped to supply the injection water for the Middle Chinle aquifer.*

RAI 33:

> *Section 3.12, paragraph 1, page 25: A discussion on past and future treatment rates for the RO plant and constituent levels for pre- and post-treated water needs to be included in this section. Provide a discussion on the RO systems optimum treatment rate for successful remediation. A comparison of actual rates to projected rates should be provided and discussed to determine if HMC is staying on track with the remediation timeline. Please explain why the RO treatment plant is running at 43% efficiency and include options to increase the capacity*.

Homestake states that this RAI is addressed in sections 5.3.3 and 5.5.3, and in appendices F and I of the CAP.

Section 5.5.3 indicates that some of the issues raised in this RAI will be addressed in the future. However, neither of the sections or appendices … *explain why the RO treatment plant is running at 43% efficiency …* .

RAI 36:

> *Section 3.14, page 25, states that clean groundwater is pumped from extraction wells screened in the San Andres formation (Figure 34) and in the un-impacted areas of the Alluvial aquifer and injected into the Alluvial, upper, and middle aquifers. However, the discussion does not identify here the extraction wells are located in the Alluvial aquifer, and what the contaminant concentrations are to justify the un-impacted area designation.*
>
> *Please identify where the extraction wells are located in the Alluvial aquifer, and what the contaminant concentrations are to justify the un-impacted area designation.*

Homestake states that this RAI is addressed in section 5.3.2 and appendix F of the CAP.

Neither section 5.3.2 or appendix F identify … *what the contaminant concentrations are to justify the un-impacted area designation.*

RAI 45:

> *HMC should provide the following items for the groundwater calibration: (1) a comparison of measured versus simulated groundwater levels or U concentrations and other chemicals of concern concentrations at wells or model nodes; (2) statistical analysis like the root-mean square approach; (3) information on the acceptable calibration criteria; and (4) more details on the calibration approach (trial and error changes, apparently a manual approach was used instead of a numerical approach).*

> *With regard to transport modeling, only U concentrations are compared in the discussion. HMC should provide comparisons of observed versus simulated concentrations of the other chemicals of concern at the site.*

Homestake states that this RAI is addressed in section 5.1 and appendix G of the CAP.

Neither section 5.1 or appendix G contains 1) … *statistical analysis like the root-mean square approach* …, 2) … *information on the acceptable calibration criteria …* or, 3) *comparisons of observed versus simulated concentrations of the other chemicals of concern at the site.*