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Technical Memorandum

To:	Kathy Arnold	From:	Michael Gabora, P.G.
Company:	Rosemont Copper Company	Date:	November 17, 2010
Re:	Responses to SRK's Technical Review Comments on Tetra Tech's Groundwater Flow Model Technical Memoranda	Doc #:	267/10-320874A-5.3
CC:	David R. Krizek, P.E. (Tetra Tech); Grady O'Brien (Engineering Analytics)		

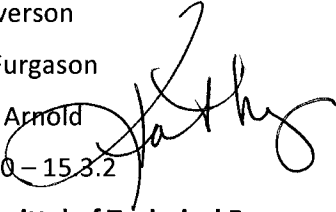
Tetra Tech completed several Technical Memoranda describing the development of regional groundwater flow models for the Rosemont Copper Project (Project). These individual memoranda were technically reviewed by SRK Consulting (SRK) on behalf of the Coronado National Forest Service (CNF). Technical Memoranda reviewed by SRK included the following:

- *Davidson Canyon Hydrogeologic Conceptual Model and Assessment of Spring Impacts Report* (Tetra Tech, 2010a);
- *Hydraulic-Property Estimates* (Tetra Tech, 2010b);
- *Hydrogeologic Framework Model* (Tetra Tech, 2010c);
- *Groundwater Flow Model Construction and Calibration* (Tetra Tech, 2010d);
- *Steady-State Sensitivity Analyses* (Tetra Tech, 2010e);
- *Predictive Groundwater Flow Modeling Results* (Tetra Tech, 2010f); and
- *Groundwater Flow Model Sensitivity Analyses* (Tetra Tech, 2010g).

This memorandum provides responses to SRK's review comments. Cross references between this memorandum and SRK's review memoranda were simplified by maintaining consistent section titles and reiterating SRK's comments, followed by Tetra Tech's responses. SRK's review comments are included in their entirety in Attachments 1 through 5.

The reviewed Tetra Tech memoranda have been compiled into a groundwater modeling report (Tetra Tech, 2010j), which documents the entire modeling process, groundwater-system predictions, and sensitivity analysis. Modifications indicated in the responses to comments were included in the groundwater modeling report. There are no plans to reissue the reviewed individual technical memoranda with modifications based on the review comments.

Memorandum

To: Bev Everson
Cc: Tom Furgason
From: Kathy Arnold 
Doc #: 045/10-15.3.2
Subject: **Transmittal of Technical Responses and Reports**
Date: November 18, 2010

Rosemont is pleased to transmit the following documents:

- *Response to SRK's Technical Review Comments to Tetra Tech's Groundwater Flow Model*, Technical Memorandum, Tetra Tech, November 17, 2010
- *Response to comments on February 2010 Geochemical Pit Lake Predictive Model Report*, Technical Memorandum, Tetra Tech, November 16, 2010
- *Geochemical Pit Lake Predictive Model – Revision 1 (includes DSM Input/Output Files in electronic format)*, Tetra Tech, November 2010

Rosemont is providing three hardcopies and two disk copies for the Forest and two hardcopies and one disk copy for SWCA of the technical memos. Copies of the reports are provided in a hardcopy format with the disk copies enclosed in the same number.

1.0 Response to Comments on “Davidson Canyon Hydrogeologic Conceptual Model and Assessment of Spring Impacts” (SRK, 2010a and 2010b)

The Davidson Canyon conceptual model was initially submitted in April 2010 and reissued in July 2010 (Tetra Tech, 2010a). Both of these documents were reviewed by SRK. Review of the April 2010 report was documented in the SRK memorandum dated May 11, 2010 (SRK, 2010a). These comments were incorporated into the July 2010 report. Review of the July 2010 report (Tetra Tech, 2010a) was documented in the SRK memorandum dated August 3, 2010 (SRK, 2010b; Attachment 1). The following responses address comments from both reviews by SRK, which are identified by the referenced review document. The indicated changes were incorporated into the July 2010 Davidson Canyon report (Tetra Tech, 2010a) and the groundwater modeling report (Tetra Tech, 2010j), as appropriate.

- **Comment (a):** SRK, 2010a – “*Figure 9: Local spring isolated from regional groundwater – groundwater flow lines are shown above the water table*”

Response: In the July 2010 report (Tetra Tech, 2010a), Figure 9 was modified to distinguish between “shallow localized water flow” and regional groundwater table.

- **Comment (b):** SRK, 2010a – “*Figure 15: Schematic cross section of Reach 2 spring development – what data are used for the unsaturated zone as shown between the alluvial and bedrock groundwater systems?*”

Response: In the July 2010 report (Tetra Tech, 2010a), the figure was modified to clearly illustrate surface water flows infiltrating into the unsaturated channel alluvium, which is above the regional groundwater table. The unsaturated zone was inferred from the geochemical data, geologic setting, ephemeral flow, and the nearby Pima County well that indicates hydraulically disconnected surface-water and groundwater systems. The Pima County well had the closest available groundwater-level data. These conditions also appear to be present in the Cienega Creek drainage based on several Pima Association of Governments (PAG) reports.

- **Comment (c):** SRK, 2010a – “*The water quality data described in Section 7.6 need to be added in the spring comparison table shown in Figure 8.*”

Response: In the July 2010 report (Tetra Tech, 2010a), Figure 18 was added to illustrate the general geochemistry via Stiff Diagrams, prepared by Montgomery & Associates (M&A) (M&A, 2009a), for each well and spring.

- **Comment (d):** SRK, 2010a – “*There is reference to Stiff diagrams prepared by others. It would be helpful to include these in this report.*”

Response: In the July 2010 report (Tetra Tech, 2010a), Figure 18 was added to illustrate the general geochemistry via Stiff Diagrams, prepared by M&A (2009a), for each well and spring.

- **Comment (e):** SRK, 2010a – “*A number of descriptors used in the report are relative but not quantified...*”

Response: In the July 2010 report (Tetra Tech, 2010a), an effort was made to quantify or provide data references and figures to support the relative comparison between data

at different locations. In some cases, however, data are not available for direct numerical comparison.

- **Comment (f):** SRK, 2010a – *“There are references to MC1 and MC2 differences being explained by the degree of rock alteration. Trace element characteristics could be included here as indicators. This would be a useful overall aspect to be added that could provide more in the geological context. A conclusions section should be included in the report.”*

Response: In the July 2010 report (Tetra Tech, 2010a), Figure 18 was added to illustrate the general geochemistry via Stiff Diagrams, prepared by M&A (2009a), for each well and spring, including MC1 and MC2. This figure illustrates the different geochemistry between these springs and presentation of trace elements was not needed to make this distinction.

Conclusions were added to the Executive Summary in a bulleted list to summarize the report’s (Tetra Tech, 2010a) primary findings.

- **Comment:** SRK, 2010a – *“Potential impacts to Davidson Canyon should be re-evaluated on the basis of the predictive simulations and sensitivity analyses of the 3-D numerical groundwater model currently being revised by M&A.”*

Response: The groundwater modeling report (Tetra Tech, 2010j), documenting Tetra Tech’s numerical regional groundwater flow model, discusses the potential impacts and sensitivity analyses in detail.

- **Comment:** SRK, 2010b – *“The M&A numerical groundwater flow model is being revised and Tetra Tech is currently developing a groundwater model. Once those works are complete and the final versions reviewed by SRK, the following will need to occur:*
 - *Re-evaluation of the impacts to Davidson Canyon from pit dewatering once the M&A and Tetra Tech models are reviewed and complete.*
 - *The Infiltration, Seepage, and Fate and Transport Modeling report (Tetra Tech, 2010c) was reviewed by SRK (2010c) and should be revised in light of the review comments.*
 - *Re-evaluation of the impacts of seepage from the TSF, waste rock, and heap on Davidson Canyon.*

Response: Tetra Tech’s groundwater flow models have been completed since the August 3rd review (SRK, 2010b). Impacts to Davidson Canyon and the larger regional area were subsequently evaluated in technical memoranda and in Section 8.0 of the comprehensive groundwater modeling report (Tetra Tech, 2010j).

Infiltration through and resulting seepage from the Waste Rock Storage Area and the Dry Stack Tailings Facility did not change in the updated report titled *“Infiltration, Seepage, and Fate and Transport Modeling, Revision 1”* (Tetra Tech, 2010h). There was no predicted infiltration through the Waste Rock Storage Area. The only infiltration through the Dry Stack Tailings Facility was the drain-down predicted by Amec Earth & Environmental (AMEC, 2009). Another report by Tetra Tech (2010i) documented the predicted infiltration due to the flow-through drains underneath the Dry Stack Tailings Facility. Flow-through drains pass stormwater from the up-gradient side of the Project facilities to the down-gradient side. The post-closure groundwater flow model simulations

incorporated recharge changes due to the tailings drain-down and flow-through drains (Section 5.6.3 of the comprehensive groundwater modeling report [Tetra Tech, 2010j]). In addition, a sensitivity simulation was completed using the unaltered, steady-state recharge distribution as shown in Section 9.5.8 of the comprehensive groundwater modeling report.

2.0 Response to Comments on “Hydraulic-Property Estimates” (SRK, 2010c)

Short-Term Aquifer Test Analysis

- **Comment:** *“To demonstrate that the re-analysis by Tetra Tech can be compared to the M&A analysis, SRK recommends that Attachment 1 include a column that refers the reader to the figures in the M&A report to show the particular analytical plots. Further, to make the comparisons fully defensible, it is recommended that the Tetra Tech analysis be provided as an additional attachment to the Technical Memorandum”.*

Response: References to the M&A (2009a) figures were originally included in Attachment 1 of the “Hydraulic-Property Estimates” Technical Memorandum (Tetra Tech, 2010b), but were more clearly identified and referenced in the groundwater modeling report (Tetra Tech, 2010j). The Tetra Tech short-term test analyses were added to the M&A figures for direct comparison and provided in Appendix B of the comprehensive groundwater modeling report.

Long-Term Pumping Test Analysis

- **Comment:** *“Though the configuration is implied in Attachment 1, SRK recommends that the text include a description of the configuration and some detail on how the isolation packers were deployed and monitored (given the 60 plus day deployment of the packer, if used)”.*

Response: Cross section figures (Figures 4-6, 4-7, 4-8, and 4-9) were added to the groundwater modeling report (Tetra Tech, 2010j) to illustrate the test and radial-model configurations (well completion and geologic units) for each radial-model analysis. The details of the screened intervals, hydrogeologic units, and formations are provided on these new figures. Details of the tests and procedures are provided in M&A (2009b). Isolation packers, however, were not used during the 30-day test.

- **Comment:** *“SRK would like to see a figure for that test cell similar to the Figure 2 cross section. The elevations of the screened intervals and piezometers, and the pumping rates should be listed in a text box on all plots. Tetra Tech should consider adding a right-hand Y-axis showing pumping rates over the duration of pumping. Also, the units on the time axis are not clear. They appear to be in units of “year decimal year,” which should be stated in the axis title. Actual dates may be a better presentation”.*

Response: Cross section figures (Figures 4-6, 4-7, 4-8, and 4-9) were added to the groundwater modeling report (Tetra Tech, 2010j) to illustrate the test and radial-model configurations (well completion and geologic units) for each radial-model analysis. The details of the screened intervals, hydrogeologic units, and formations are provided on these new figures. Pumping variations and average rates are discussed in the text of the

groundwater modeling report. Pump-discharge data and additional test background information are available in M&A (2009b). The time axis units on the graphs were converted to days, as suggested.

- **Comment:** *“To test the viability of the approach taken by Tetra Tech, SRK recommends a simplistic 3-D model (for the pumping area only) to re-evaluate the effects on the hydraulic parameters of the fault and truncated units for pumping test PC-5 and low permeable pre-Cambrian rock in pumping well HC-1B”.*

Response: A discussion was added to the groundwater modeling report (Tetra Tech, 2010j) on the benefits and drawbacks of alternative modeling approaches for analyzing the long-term tests (Section 4.3.4 of the report). A new model with a more refined 3D model grid could be used to overcome the limitations posed by the regional model's large cell sizes. Hydraulic properties from a refined model transient calibration, however, would ultimately have to be scaled to the same regional model grid. The additional detail and resolution required to match the test responses would be largely lost in the up-scaling process (effective hydraulic conductivity of the larger grid block), which would reduce the transient calibration's value.

Hydraulic Parameters Used In Regional Groundwater Flow Model

- **Comment:** *“It should be noted that no values for hydraulic conductivity were recommended as initial input to the regional groundwater model. Given that Tables 1 and 2 provide very different values for K_h and K_v , SRK is uncertain as to how the values will be applied. Part of our uncertainty comes from not clearly understanding the placement of the packer in PC-5, and the manner in which values for both the Concha Limestone and Scherrer Formation are provided in Table 1, even though they may have been producing at the same time from the same packer setting. Thus we are uncertain how vertical conductivities were calculated. Due to these uncertainties, SRK is not able to judge the applicability of a 2-D radial model to serve as input to, and provide transient calibration for a 3-D regional groundwater flow model.*

Response: As suggested, the initial, recommended hydraulic properties for the flow model were discussed in the Section 4.3.7 and provided in Table 4-6 of the groundwater modeling report (Tetra Tech, 2010j). Changes to these initial parameter values during model calibration were discussed in Section 6.2 and Table 6-3.

The well, test, and formation configurations for each analyzed long-term test were provided in Figures 4-6, 4-7, 4-8, and 4-9 (Tetra Tech, 2010j). Packers were not used during the long-term test and this was clarified in the report text.

3.0 Response to Comments on “Hydrogeologic Framework Model” (SRK, 2010d)

- **Comment:** *“The 10 hydrogeologic zones with individual sets of hydraulic parameters look reasonable. It should be noted that SRK did not find a description of these parameters in the reviewed document. But in as much as it presents a concept for*

modeling, we expect the parameters will be described and defended in subsequent documents.

Response: A full description of the hydrogeologic units was provided in Section 4.1 of the groundwater modeling report (Tetra Tech, 2010j). The two parameters added during model calibration are discussed in Section 6.2.1.

4.0 Response to Comments on “Groundwater Model Construction and Calibration” (SRK, 2010e)

Description of Groundwater Flow Model Setup

Comment: “...SRK did not find an explanation of modification of the western model boundary (assumed to be C-HEAD for the steady-state conditions) for transient mining and post-mining simulations.”

Response: The western model boundary was simulated as a constant-head boundary in the steady-state model and was not modified for transient mining and post-closure simulations. The flow-model boundaries were discussed in Section 5.10 “External Model Boundaries,” which is a subsection of 5.0 Groundwater Flow Model Construction in the groundwater modeling report (Tetra Tech, 2010j). Information in Section 5.0 of the report relates to all models unless specifically stated otherwise (e.g., post-closure recharge). Modification of the boundaries was discussed in Section 9.3 “Western Flow Model Boundary,” which is part of Section 9.0 “Sensitivity Analysis” in the groundwater modeling report (Tetra Tech, 2010j).

Simulation of Recharge

- **Comment:** *Recharge from precipitation was not applied into the pit area during transient mining simulations assuming that all water will be captured by drain cells and removed from the model. SRK agrees that this is a valid approach to simulate water levels in the vicinity of the proposed pit; however, it is our opinion that this method would underestimate dewatering requirements.*

Response: During the mining-phase simulation, the recharge distribution remained unchanged from the steady-state model. Recharge was applied to the pit area and it was removed by the drain cells and included in the pit dewatering estimates. However, recharge is less than direct precipitation and the simulated dewatering estimate does not account for this volume. Text in the groundwater modeling report (Tetra Tech, 2010j, Section 5.6.2) was modified for clarity.

- **Comment:** *Post-closure recharge from the waste rock storage area and the heap leach facility is assumed to be zero, based on the Tetra Tech (2010c) report, Infiltration, Seepage, and Fate and Transport Modeling Report. It should be noted that the review of that report by SRK (2010b) indicated that zero recharge is likely unrealistic. However, the zero value was also applied by Tetra Tech. SRK is of the opinion that recharge through the facilities should be revised or otherwise explained*

Response: Infiltration into and seepage from the Waste Rock Storage Area was re-evaluated by Tetra Tech (2010h) following SRK's review. After simulating different climate conditions as suggested, modeling resulted in the same conclusion of zero infiltration through the Waste Rock Storage Area. This finding was used in the groundwater flow models since it was considered the most reliable data available at the time the model was being constructed and calibrated.

Seepage due to heap leach drain-down after its operational period was estimated to be a maximum of 10 gpm, decreasing to 3 gpm after 10 years, and 0.5 gpm at 115 years (Tetra Tech, 2010h). At the end of operations, the drain-down seepage was predicted to be less than 5 ac-ft/yr. However, any recharge generated in the heap leach area is predicted to be within the capture zone of the Open Pit and will flow toward the pit/pit-lake. Due to the low potential seepage rate, and the short time period over which the seepage would occur, drain-down from the heap leach was not simulated in the flow models (Tetra Tech, 2010j).

Recharge was applied under the Dry Stack Tailings Facility to simulate drain-down seepage (AMEC, 2009). Recharge was also added to the areas underneath the Dry Stack Tailings Facility due to the flow-through drains (Tetra Tech, 2010i). This resulted in a net recharge increase in the Project facilities area. Sensitivity analyses were also performed on the recharge rate. Recharge rates used in the post-closure groundwater flow model is discussed in Section 5.6.3 of the groundwater modeling report (Tetra Tech, 2010j).

- **Comment:** *It is not clear from the reviewed Technical Memorandum why the recharge from the tailings is assumed to be a constant value for the entire duration of the post-closure simulation, given initial dewatering of the tailings following cessation of mining, followed by an asymptotic equilibration to average climatic conditions.*

Response: Recharge from the Dry Stack Tailings Facility varied over the post-closure period to account for the tailings drain-down as defined by AMEC (2009). The tailings will be dry stacked, so minimal drain-down was predicted. Text was added to the groundwater modeling report (Tetra Tech, 2010j) to make the recharge distribution and simulation set-up clear (see Section 5.6.3, Figures 5-5 and 5-6).

Simulation of Evapotranspiration

- **Comment:** *Assumption for extinction depth that was uniformly applied throughout the model domain (The Tetra Tech memorandum states that extinction depth varies with the types of the soil and vegetative cover, ranging from about 1.5 feet under bare conditions in sandy soil to about 27 feet under forest cover conditions in clayey soil). SRK requests an explanation of why a uniform extinction depth was applied.*

Response: In Section 5.7 of the groundwater modeling report (Tetra Tech, 2010j), the following text was added to describe the application of extinction depth: "A spatial distribution of extinction depths based on plant types was not available at the time of model construction, so the extinction depth was set uniformly to 16.4 feet (5 meters) below the land surface. This depth was a mid-range value that approximates an average extinction depth over the riparian areas." Simulated water levels in the riparian areas did

not substantially decrease, so the extinction depth did not strongly influence the simulated ET.

- **Comment:** *Distribution of maximum evapotranspiration rates along the reaches of Cienega Creek and Davidson Canyon. SRK suggests a better explanation for the basis in the data for the distribution.*

Response: As suggested, the availability of ET estimates is discussed in Section 2.6 of the groundwater modeling report (Tetra Tech, 2010j). Adoption of the M&A (2009c) ET estimates was selected as the best available ET distribution for the model domain at the time of model construction and calibration. ET is further discussed in Section 5.7 of the groundwater report.

Model Calibration and Simulated Groundwater Budget

- **Comment:** *It is not clear how the results of the interpretation of a 30-day pumping test by 2-D radial flow models (Tetra Tech, 2010d) were used for the model calibration. The comparison shown in Table 2 indicates that the hydraulic conductivity values calibrated and used in the model are less than those estimated from the 30-day pumping test data.*

Response: The hydraulic conductivity estimates from the 2D radial models and the other aquifer test analysis results were used to establish the initial model parameter values. The parameter values were subsequently modified during model calibration. The 2D model results and aquifer test data were not used explicitly due to the test limitations and scale issues, which were described in Sections 6.2 and 7.0 of the groundwater modeling report (Tetra Tech, 2010j).

- **Comment:** *Table 1 (in SRK memo) shows that the components of the groundwater budget simulated by the Tetra Tech (2010a) and M&A (2009b) numerical models both were calibrated to measured pre-mining water levels. Yet the components of the budget are substantially different. The differences in the components of the groundwater budget are as much as 2,900 ac-ft/yr for recharge and 8,800 ac-ft/yr in groundwater discharge into streams. Such differences indicate a non-unique calibration of the model to pre-mining only water levels.*

Response: The water budget differences between the M&A (2009c) and Tetra Tech models are largely explained by differences in modeling methods. Analyses to estimate the water budget components within the model domain were completed by M&A (2009c). Previous studies and M&A estimates were the best available data at the time of Tetra Tech's model construction, and they were used to the greatest extent possible. Even though similar estimates were initially used, water-budget differences remained and they were largely due to differences in model construction. The water-budget differences, however, were generally within the uncertainty of the original estimates.

SRK's calculation of water-budget differences did not consider the differences in simulation methods. Total recharge in the M&A model (2009c) was the sum of "recharge" and "groundwater recharge from streams", which was 9,182 ac-ft/yr. The difference in total recharge is only 727 ac-ft/yr or about 7 percent of Tetra Tech's simulated recharge. M&A's groundwater discharge to streams was 2,172 ac-ft/yr and Tetra Tech's net groundwater discharge to streams was 2,618 ac-ft/yr, which is a difference of 446 ac-ft/yr (10,962 ac-ft/yr – 8,344 ac-ft/yr) or 0.6 cfs. Additionally, M&A

(2009c) simulated stream flow gains and ET losses with constant-rate wells. This simulation approach did not allow the recharge and discharge rates to vary based on the simulated water levels. Tetra Tech used the SFR and EVT packages in MODFLOW which allowed the rates to vary based on the simulated water levels.

Although M&A subsequently revised their 2009 model, water-budget differences between it and the Tetra Tech model are still likely. Tetra Tech agrees with SRK that the simulated water-budget differences should be reasonable compared to the uncertainty in the water-budget component estimates. In the context of predicting impacts due to the Project, these water-balance differences appear to be acceptable since the model predictions are similar.

- **Comment:** *The Tetra Tech Technical Memorandum indicates that the streambed hydraulic conductivity of 3.28 ft/day was increased by a factor of 2 during the steady-state calibration to better match data from stream flow gauges. However, SRK was not able to find a comparison of simulated stream flows (shown in Figure 40) to measured values.*

Response: Measured flows at stream gages and simulated stream flows for each reach were presented on Figure 40 in the Technical Memorandum titled “Groundwater Flow Model Construction and Calibration” (Tetra Tech, 2010d). However, the font color was difficult to distinguish from the background. The presentation of the simulated steady-state stream flows were modified to make the results easier to see and read as illustrated on Figure 6-30 and similar figures in the groundwater modeling report (Tetra Tech, 2010j). These figures illustrate both the measured and simulated stream flows. The MODFLOW GAGE package was also used by Tetra Tech to obtain simulated flows in the model cells where the USGS gages were located. This provided a direct comparison of measured to simulated stream flow, as suggested.

- **Comment:** *Different pairs of values for recharge/vertical hydraulic conductivity can simulate the same distribution of the water levels, resulting in the same calibration to steady-state water levels. Calibrations of the model to steady-state fluxes (results have not been found) and transient conditions (not completed) are additionally required in SRK’s opinion to decrease the nonuniqueness of the parameters used for the predictive simulations.*

Response: Tetra Tech agrees that calibrating to fluxes and transient conditions improves model uniqueness. Observed stream flows at the gaging stations were discussed in Section 5.8 of the groundwater modeling report (Tetra Tech, 2010j) and their use as steady-state model calibration targets were discussed in Section 6.1. The stream-flow calibration process and results were provided in Section 6.2.6 of the groundwater report. The lack of observed regional transient water levels available for model calibration and Tetra Tech’s approach for a transient calibration was discussed in the Section 7.0 of the groundwater report.

Models to Predict Mining and Post-Mining Conditions

- **Comment:** *The specific storage parameter for bedrock units was assumed to be $S_s=9.86 \times 10^{-6} \text{ ft}^{-1}$ based on the geometric mean of the values estimated from the radial flow modeling analysis of the 30-day pumping test. SRK is of the opinion that this*

number represents the high range of specific storage values and is not conservative enough to estimate the possible maximum extent of the cone of depression during mining and post-mining conditions. Storage parameters derived from the short stress tests tend to overestimate values. Based on SRK experience for low permeability bedrock units, a more realistic and conservative value could be $S_s=1.0 \times 10^{-6} \text{ ft}^{-1}$, which is recommended for use in a Best Case, or, as the value for the transient sensitivity analysis.

Response: Additional discussion was provided to Section 7.1 of the groundwater modeling report (Tetra Tech, 2010j) to support the specific storage estimate of $9.84 \times 10^{-6} \text{ ft}^{-1}$. In addition, the sensitivity analysis used specific storage values of $9.84 \times 10^{-5} \text{ ft}^{-1}$ and $9.84 \times 10^{-7} \text{ ft}^{-1}$ to evaluate the impact of higher and lower values in mining-phase and post-closure simulations (Sections 9.4.6 and 9.5.7). While there was a difference in simulated drawdown at 150 years due to the different storage values, these differences become less important as the groundwater system approached steady-state conditions, i.e., when there was virtually no water flowing into or out of aquifer storage. The specific storage value of $9.84 \times 10^{-7} \text{ ft}^{-1}$ used in the sensitivity analysis provided the conservative value for evaluation that SRK suggested.

- **Comment:** *It is not clear how the values for conductance of the lake cells were assigned and how groundwater inflow to the pit was simulated by drain cells at the end of mining, as compared to the inflow by the lake cells at the beginning of pit lake infilling.*

Response: The lake-cell conductance was set equal to or greater than the conductance of the adjacent aquifer material. This was added to Section 8.2.1 of the groundwater modeling report (Tetra Tech, 2010j) as suggested. Pit inflows at the end of operations were approximately 400 gpm (Section 8.1.1). Pit inflows at the start of the post-closure simulation were approximately 311 gpm (Section 8.4). This difference in pit inflows was discussed in Section 8.4.1 of the groundwater report, as suggested.

In summary, the differences in pit inflows were a combination of numerical instability and changing from drain-cells to lake-cells. Hydraulic oscillations during the first 60 days of the post-closure simulation caused numerical instability that likely influenced the simulated inflow rates.

Pit inflows were likely different due to differences in drain-cell and lake-cell elevations. Simulated dewatering extended beyond the pit shell since the drain-cell elevations were set 33 feet below the pit. Lake-cell elevations, however, closely matched the pit shell elevations. Dewatered aquifer material had to re-saturate following the end of dewatering before groundwater flowed into the pit and reached the lake-cells. This resulted in a delayed inflow response following the end of dewatering. During this delay, water levels surrounding the pit were re-equilibrating and the hydraulic gradients that drove inflows were changing. This likely contributed to the simulated decrease in pit groundwater inflows exactly at the end of operations relative to inflows several time steps into the post-closure simulation.

- **Comment:** *It is not clear what boundary conditions are along the western model boundary for mining and premining simulation. SRK requests an explanation of how the boundary conditions were constructed for mining and post-mining conditions.*

Response: Clarifying text was added to the groundwater modeling report (Tetra Tech, 2010j) to indicate that the external boundary conditions, including the western model

boundary, were constant for the steady-state, mining-phase, and post-closure simulations (Section 5.10). The western boundary was altered during the sensitivity analysis and is discussed in Section 9.3 of the groundwater report.

- **Comment:** *It was assumed that the pit lake will reach a steady-state elevation 1,000 years after mining has ceased. This was estimated by extending the predicted post-mining conditions estimated in the 100-year prediction in M&A (2009b). It is not clear whether the assumption is appropriate and representative. SRK recommends completing an assessment of timing to reach steady-state post-mining conditions by using the Tetra Tech model, not M&A model.*

Response: The steady-state elevation of the pit-lake and the groundwater system as a whole is discussed in Section 8.4.1 of the groundwater modeling report (Tetra Tech, 2010j). Figure 8-16 illustrates the pit-lake water balance over the 1,000-year post-closure period. Steady-state conditions were reached after approximately 700 years. As suggested, steady-state conditions were confirmed by an additional figure (Figure 8-14) that illustrates that drawdown did not change between 1,000 and 1,500 years.

Results of Model Calibration and Steady State Sensitivity Analysis

- **Comment:** *Based on the completed analyses, Tetra Tech concluded that the steady-state calibration has a “nearly optimal parameter value for matching water level in the model.” SRK agrees that mathematically this statement is correct. However, as mentioned above, the model should be calibrated to both water level and flow data. It should be noted that SRK did not find the results of the sensitivity analyses of model parameters to the data for groundwater/stream flow interaction.*

Response: Tetra Tech agrees that model calibration to water level and flow data is preferred. Stream flows at the gaging stations were used as steady-state model calibration targets and are discussed in Section 6.1 of the groundwater modeling report (Tetra Tech, 2010j). The stream-flow calibration process and results are provided in Section 6.2.6. The lack of observed regional transient water levels available for model calibration and Tetra Tech’s approach for a transient calibration was discussed in Section 7.0 of the groundwater report. Sensitivity analyses are included in Section 9.0.

5.0 Response to Comments on “Predictive Groundwater Modeling Results” (SRK, 2010f)

Mining Conditions

- **Comment:** *The simulations were made using 3 models – pre-mining, mining, and post – mining. The results of the simulations are presented in Table 7 in Tetra Tech (2010a) and Tables 1 and 3 in Tetra Tech (2010b). The component of the pre-mining steady state water balance should be exactly the same in these three tables.*

Response: In the groundwater modeling report (Tetra Tech, 2010j), Table 8.3 presents the water-balance data as suggested.

Post-Mining Conditions

- **Comment:** *Constant head (CHEAD) boundary condition at the Western boundary likely significantly limits propagation of drawdown to the east. SRK strongly recommends that the influence of the CHEAD boundary be investigated with a General Head Boundary (GHB) along the Western boundary of the model using a sensitivity analysis or post-mining conditions. The GHD utilizes a constant head at a defined distance that would be beyond the current western boundary, thereby mitigating the synthetic effect of a constant head so close to the pit.*

Response: As suggested, the western boundary was simulated as a General Head Boundary (GHB) and as a no-flow boundary in the sensitivity analysis (Section 9.3 of the groundwater modeling report [Tetra Tech, 2010j]). A description of GHB conductance and heads was included. Simulated changes in flows out of the model domain and drawdown propagation were also discussed. Under all simulated conditions, except the no flow boundary sensitivity simulation, there was groundwater flow out of the western boundary. Water was not simulated to flow from the western boundary to the pit. The flux out of the model decreased by approximately 2 percent between the post-closure constant head simulation and the GHB sensitivity simulation, but drawdown propagation was relatively insensitive to these changes.

- **Comment:** *It is not clear why the extent of drawdown cone at steady-state post mining conditions (run by steady-state model) is smaller than the extent at 1000 years after mining ceased. An explanation is required. If the difference has a numerical origin (i.e., steady-state vs. transient simulations), SRK recommends that the transient model be run sufficiently long to demonstrate equilibration with steady-state results.*

Response: As suggested, the post-closure simulation was extended to 1,500 years and drawdown was compared to the 1,000 year simulation (Figure 8-14 of the groundwater modeling report [Tetra Tech, 2010j]). These simulations confirmed that the predicted groundwater system had reached steady-state conditions by 1,000 years.

6.0 Response to Comments on “Results of Sensitivity Analyses” (SRK, 2010f)

Conclusions

- **Comment:** *Include influence of the Western model boundary into the sensitivity analysis. The model predictions indicate that an assigned CHEAD boundary condition limits and, most likely, under-predict propagation of cone of drawdown (and at a minimum, deforms the cone) during post-mining conditions. It is recommended that GHB condition be applied at differing distances from the Western model boundary to evaluate its effect on predictive simulations, especially during post-mining conditions.*

Response: As suggested, the western boundary was simulated as a General Head Boundary (GHB) and as a no-flow boundary in the sensitivity analysis (Section 9.3 of the groundwater modeling report [Tetra Tech, 2010j]). A description of GHB conductance and heads was included. Simulated changes in flows out of the model domain and drawdown propagation were also discussed. Under all simulated conditions, except the

no flow boundary sensitivity simulation, there was groundwater flow out of the western boundary. Water was not simulated to flow from the western boundary to the pit. The flux out of the model decreased by approximately 2 percent between the post-closure constant head simulation and the GHB sensitivity simulation, but drawdown propagation was relatively insensitive to these changes.

- **Comment:** *Though graphs and tables are present the results of the sensitivity analysis, SRK recommends that additional results be included as tables and/or graphs, showing:*
 - a) *Predicted pit inflow in time (for mining phase, graphs);*
 - b) *Pit-lake infilling curves in time (for post-mining, graphs);*
 - c) *Drawdown propagation (for both mining and post-mining, table); and*
 - d) *Impact to surface bodies – cumulative change in stream flow (for both mining and post-mining, table).*

Response: The following figures in the comprehensive groundwater modeling report (Tetra Tech, 2010j) present the suggested results:

- a) **Figure 8-3:** Predicted pit inflow in time (for mining-phase, graphs);
 - b) **Figure 8-16:** Pit-lake infilling curves in time (for post-closure, graphs);
 - c) **Numerous figures were provided with drawdown contours and graphs, presentation in table format was deemed less informative based on the spatial nature of the results:** Drawdown propagation (for both mining-phase and post-closure, table); and
 - d) **Figures 8-6 and 8-15 (tables included on figures):** Impact to surface bodies – cumulative change in stream flow (for both mining-phase and post-closure, table).
- **Comment:** *Explain the difference seen in Figure 23 between the drawdown contours from transient predictions at 1,000 years post mining, and for the steady-state post-mining conditions. Unless otherwise explained, it is SRK’s opinion that steady-state contours of drawdown should not be closer to the pit than the 1,000-year contour generated by the transient predictive runs.*

Response: As suggested, the post-closure simulation was extended to 1,500 years and drawdown was compared to the 1,000 year simulation (Figure 8-14 of the groundwater modeling report [Tetra Tech, 2010j]). These simulations confirm that the predicted groundwater system had reached steady-state conditions by 1,000 years.

- **Comment:** *Add the extent of the steady-state post-closure drawdown to Figure 24 for purposes of comparison. The Figure currently compares drawdown contours at end of mining and after 150 and 1,000 years post closure. Adding the steady-state contour to the figure may shed insight into the differences mentioned in the previous bullet.*

Response: As suggested, Figure 8-14 was added to the groundwater model report (Tetra Tech, 2010j) to illustrate that the 1,000-year and 1,500-year drawdown were the same and represented steady-state conditions. The comparison between end of operations, 150-years post-closure, and 1,000-years post-closure was presented on Figure 9-27. In the groundwater report, the text and figures indicate that the 1,000-year post closure drawdown represented steady-state conditions, so the intent of the comment was addressed.

7.0 References

- AMEC Earth & Environmental, Inc. (2009). *Dry Stack Tailings Storage Facility, Final Design Report*. Prepared for Rosemont Copper Company. Report Dated April 15, 2009.
- Montgomery & Associates, Inc. (M&A) (2009a). *Results of Phase 2 Hydrogeologic Investigations and Monitoring Program, Rosemont Project, Pima County, Arizona*. Prepared for Rosemont Copper Company. Report Dated February 26, 2009.
- M&A (2009b). *Analysis of Long-Term, Multi-Well Aquifer Test – November 2008 through January 2009, Rosemont Project, Pima County, Arizona*. Prepared for Rosemont Copper Company. Report Dated October 28, 2009.
- M&A (2009c). *Groundwater Flow Modeling Conducted for Simulation of Proposed Rosemont Pit Dewatering and Post-Closure, Rosemont Project, Pima County, Arizona*. Prepared for Rosemont Copper Company. Report dated October 28, 2009.
- Tetra Tech (2010a). *Davidson Canyon Hydrogeologic Conceptual Model and Assessment of Spring Impacts Report*. Prepared for Rosemont Copper Company. Report Dated July 2010.
- Tetra Tech (2010b). *Hydraulic-Property Estimates*. Technical Memorandum to Kathy Arnold (Rosemont Copper Company). Technical Memorandum Dated July 9, 2010.
- Tetra Tech (2010c). *Hydrogeologic Framework Model*. Technical Memorandum to Kathy Arnold (Rosemont Copper Company). Technical Memorandum Dated July 9, 2010.
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- Tetra Tech (2010e). *Steady-State Sensitivity Analyses*. Technical Memorandum to Kathy Arnold (Rosemont Copper Company). Technical Memorandum Dated July 26, 2010.
- Tetra Tech (2010f). *Predictive Groundwater Flow Modeling Results*. Technical Memorandum to Kathy Arnold (Rosemont Copper Company). Technical Memorandum Dated July 30, 2010.
- Tetra Tech (2010g). *Rosemont Groundwater Flow Model Sensitivity Analyses*. Technical Memorandum to Kathy Arnold (Rosemont Copper Company). Technical Memorandum Dated August 17, 2010.
- Tetra Tech (2010h). *Infiltration, Seepage, Fate, and Transport Modeling Report, Revision 1*. Prepared for Rosemont Copper Company. Report Dated August 2010.
- Tetra Tech (2010i). *Rosemont Infiltration Analysis*. Technical Memorandum to Kathy Arnold (Rosemont Copper Company). Technical Memorandum Dated April 5, 2010.



- Tetra Tech (2010j). *Regional Groundwater Flow Model, Rosemont Copper Project*. Prepared for Rosemont Copper Company. Report Dated November 2010.
- SRK Consulting (SRK) (2010a). *Technical Review of Davidson Canyon Hydrogeologic Conceptual Model and Assessment of Spring Impacts, Rosemont Copper Project (Tetra Tech, 2010a)*. Technical Memorandum to Dale Ortman (SWCA). Technical Memorandum Dated May 11, 2010.
- SRK (2010b). *Technical Review of Davidson Canyon Hydrogeologic Conceptual Model and Assessment of Spring Impacts, Rosemont Copper Project (Tetra Tech, 2010a)*. Technical Memorandum to Dale Ortman (SWCA). Technical Memorandum Dated August 3, 2010.
- SRK (2010c). *Review of Tetra Tech (2010) Hydraulic Property Estimates*. Draft Memorandum to Dale Ortman (SWCA). Technical Memorandum Dated August 2, 2010.
- SRK (2010d). *Technical Review of Hydrogeologic Framework Model (Tetra Tech, 2010)*. Draft Memorandum to Dale Ortman (SWCA). Technical Memorandum Dated July 30, 2010.
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- SRK (2010f). *Technical Review of Predictive Groundwater Flow Modeling Results (TT, 2010a) and Rosemont Groundwater Flow Model Sensitivity Analyses (TT, 2010b)*. Technical Memorandum to Dale Ortman (SWCA). Technical Memorandum Dated September 27, 2010.

ATTACHMENT 1
SRK REVIEWS OF TETRA TECH (2010A)
DAVIDSON CANYON HYDROGEOLOGIC
CONCEPTUAL MODEL AND ASSESSMENT OF
SPRING IMPACTS REPORTS

**Rosemont Copper Project
Locator Sheet**

Record # 013427

Document Date 2010 05 11

Document Title: Technical Review of Davidson Canyon Hydrogeologic Conceptual Model & Assessment ... & Comparison of Natural Fluctuation in Groundwater ...

Author/Recipient V. Ugorets, M. Sieber, S.J. Day, SRK

Description Comments related to review of two reports.

Other Notes Part I of Attachment I of 013787.

This document is located in the following: [CIRCLE THE CATEGORY (from the list below) IN WHICH THIS ITEM IS FILED]

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| <p>1. Project Management</p> <ul style="list-style-type: none">a. Formal recommendations & Directionsb. Formal meeting minutes & memosc. General Correspondenced. Contracts, Agreements, & MOUs (Rosemont, Udall, SWCA)e. Other <p>2. Public Involvement</p> <ul style="list-style-type: none">a. Announcements & Public Meetingsb. Mailing Listsc. Scoping Period Commentsd. Udall Foundation Working Groupe. Scoping Reportsf. Comments after Scoping Periodg. DEIS Public Comments <p>3. Agency Consultation & Permits</p> <ul style="list-style-type: none">a. Army Corps of Engineers (404 permit)b. US Fish & Wildlife Service (Sec. 7 T&E)c. State Historic Preservation Office (Sec. 106)d. Tribes (Sec. 106)e. Advisory Council on Historic Preservation (Sec. 106)f. Otherg. AZ Dept of Environmental Quality (APP) <p>4. Communication</p> <ul style="list-style-type: none">a. Congressionalb. Cooperating Agenciesc. Organizationsd. Individualse. FOIAf. Internalg. Proponent <p>5. Proposed Action</p> <ul style="list-style-type: none">a. Mine Plan (including compilation)b. Supporting Documentsc. Detailed Designsd. References <p>6. Alternatives</p> | <ul style="list-style-type: none">a. Cumulative Effects Catalogb. Connected Actionsc. Dismissed from Detailed Analysisd. Analyzed in Detail<ul style="list-style-type: none">i. Barrel McClearyii. Barrel Onlyiii. Scholefield McCleary <p>7. Resources</p> <ul style="list-style-type: none">a. Air Quality & Climate Changeb. Biologicalc. Dark Skiesd. Fuels & Fire Managemente. Hazardous Materialsf. Heritageg. Land Useh. Livestock Grazingi. Noise & Vibrationj. Public Health & Safetyk. Recreation & Wildernessl. Riparianm. Socioeconomics & Environmental Justicen. Soils & Geologyo. Transportation & Accessp. Visualq. Water <p>8. Reclamation</p> <ul style="list-style-type: none">a. Plans & Reportsb. Notes & Correspondencec. Referencesd. Other <p>9. DEIS</p> <ul style="list-style-type: none">a. DEISb. References <p>10. FEIS</p> <p>11. Geospatial Analysis (GIS Data)</p> <p>12. FOIA Exempt Documents</p> <p>13. ROD (including BLM & ACOE)</p> |
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Rosemont Copper Project

Locator Sheet

Record # 012651

Document Date 2010 08 03

Document Title: Technical Review of Davidson Canyon Hydrogeologic Conceptual Model & Assessment of Spring Impacts, RCP.

Author/Recipient V. Ugorets, M. Sieber, L. Cope, SRK

Description Comments related to review of Davidson Canyon Hydrogeologic Conceptual Model & Assessment of Spring Impacts.

Other Notes Part 2 of Attachment 1 of 013787

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 - e. Other
2. **Public Involvement**
 - a. Announcements & Public Meetings
 - b. Mailing Lists
 - c. Scoping Period Comments
 - d. Udall Foundation Working Group
 - e. Scoping Reports
 - f. Comments after Scoping Period
 - g. DEIS Public Comments
3. **Agency Consultation & Permits**
 - a. Army Corps of Engineers (404 permit)
 - b. US Fish & Wildlife Service (Sec. 7 T&E)
 - c. State Historic Preservation Office (Sec. 106)
 - d. Tribes (Sec. 106)
 - e. Advisory Council on Historic Preservation (Sec. 106)
 - f. Other
 - g. AZ Dept of Environmental Quality (APP)
4. **Communication**
 - a. Congressional
 - b. Cooperating Agencies
 - c. Organizations
 - d. Individuals
 - e. FOIA
 - f. Internal
 - g. Proponent
5. **Proposed Action**
 - a. Mine Plan (including compilation)
 - b. Supporting Documents
 - c. Detailed Designs
 - d. References
6. **Alternatives**
7. **Resources**
 - a. Air Quality & Climate Change
 - b. Biological
 - c. Dark Skies
 - d. Fuels & Fire Management
 - e. Hazardous Materials
 - f. Heritage
 - g. Land Use
 - h. Livestock Grazing
 - i. Noise & Vibration
 - j. Public Health & Safety
 - k. Recreation & Wilderness
 - l. Riparian
 - m. Socioeconomics & Environmental Justice
 - n. Soils & Geology
 - o. Transportation & Access
 - p. Visual
 - q. Water /
8. **Reclamation**
 - a. Plans & Reports
 - b. Notes & Correspondence
 - c. References
 - d. Other
9. **DEIS**
 - a. DEIS
 - b. References
10. **FEIS**
11. **Geospatial Analysis (GIS Data)**
12. **FOIA Exempt Documents**
13. **ROD (including BLM & ACOE)**

ATTACHMENT 2
SRK REVIEW OF TETRA TECH (2010B)
HYDRAULIC PROPERTY ESTIMATES

**Rosemont Copper Project
Locator Sheet**

Record # 013795

Document Date 2010 08 02

Document Title: Review of Tetra Tech (2010) Hydraulic Property Estimates

Author/Recipient V. Ugorets, Larry Cope, M. Sieber, SRK

Description Technical review of above tech memo.

Other Notes Attachment 2 of 013787

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ATTACHMENT 3
SRK REVIEW OF TETRA TECH (2010C)
HYDROGEOLOGIC FRAMEWORK MODEL

Rosemont Copper Project
Locator Sheet

Record # 013796

Document Date 2010 07 30

Document Title: Technical Review of Hydrogeologic Framework Model

Author/Recipient V. Ugorets, L. Cope, M. Siebers, SRK

Description Technical Review of above.

Other Notes Attachment 3 of 013787

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 - e. Other
- 2. Public Involvement**
 - a. Announcements & Public Meetings
 - b. Mailing Lists
 - c. Scoping Period Comments
 - d. Udall Foundation Working Group
 - e. Scoping Reports
 - f. Comments after Scoping Period
 - g. DEIS Public Comments
- 3. Agency Consultation & Permits**
 - a. Army Corps of Engineers (404 permit)
 - b. US Fish & Wildlife Service (Sec. 7 T&E)
 - c. State Historic Preservation Office (Sec. 106)
 - d. Tribes (Sec. 106)
 - e. Advisory Council on Historic Preservation (Sec. 106)
 - f. Other
 - g. AZ Dept of Environmental Quality (APP)
- 4. Communication**
 - a. Congressional
 - b. Cooperating Agencies
 - c. Organizations
 - d. Individuals
 - e. FOIA
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 - g. Proponent
- 5. Proposed Action**
 - a. Mine Plan (including compilation)
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- 6. Alternatives**
- 7. Resources**
 - a. Air Quality & Climate Change
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- 8. Reclamation**
 - a. Plans & Reports
 - b. Notes & Correspondence
 - c. References
 - d. Other
- 9. DEIS**
 - a. DEIS
 - b. References
- 10. FEIS**
- 11. Geospatial Analysis (GIS Data)**
- 12. FOIA Exempt Documents**
- 13. ROD (including BLM & ACOE)**

ATTACHMENT 4
SRK REVIEW OF TETRA TECH (2010D)
GROUNDWATER FLOW MODEL CONSTRUCTION AND
CALIBRATION
AND
TETRA TECH (2010E)
STEADY-STATE SENSITIVITY ANALYSES

Rosemont Copper Project

Locator Sheet

Record # 013797

Document Date 2010 08 17

Document Title: Review of Tetra Tech Documents...

Author/Recipient V. Ugoretz, L. Cope, M. Sieber, SRK

Description Technical Review of "Groundwater Flow Model Construction & Calibration," & "Steady-State Sensitivity Analyses".

Other Notes Attachment 4 of 013787.

This document is located in the following: [CIRCLE THE CATEGORY (from the list below) IN WHICH THIS ITEM IS FILED]

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 - c. Detailed Designs
 - d. References
6. **Alternatives**
7. **Resources**
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 - b. Connected Actions
 - c. Dismissed from Detailed Analysis
 - d. Analyzed in Detail
 - i. Barrel McCleary
 - ii. Barrel Only
 - iii. Scholefield McCleary
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 - a. DEIS
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ATTACHMENT 5
SRK REVIEW OF TETRA TECH (2010F)
PREDICTIVE GROUNDWATER FLOW MODELING
RESULTS
AND
TETRA TECH (2010G)
GROUNDWATER FLOW MODEL SENSITIVITY
ANALYSES

Rosemont Copper Project

Locator Sheet

Record # 013798

Document Date 2010 09 27

Document Title: Technical Review of 2 Tech Memos...

Author/Recipient Vladimir Ugorets, Larry Cope, Mike Sieber, SRK

Description Review of "Predictive Groundwater Modeling Results" & "Rosemont Groundwater Flow Model Sensitivity Analyses".

Other Notes Attachment 5 of 013787.

This document is located in the following: [CIRCLE THE CATEGORY (from the list below) IN WHICH THIS ITEM IS FILED]

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8. **Reclamation**
 - a. Plans & Reports
 - b. Notes & Correspondence
 - c. References
 - d. Other
9. **DEIS**
 - a. DEIS
 - b. References
10. **FEIS**
11. **Geospatial Analysis (GIS Data)**
12. **FOIA Exempt Documents**
13. **ROD (including BLM & ACOE)**