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Technical Memorandum

To:	Dale Ortman, P.E.	**Date:**	March 31, 2011
cc:	Tom Furgason, SWCA Cori Hoag, SRK File, SRK	**From:**	Vladimir Ugorets, PhD, SRK
		Reviewed by:	Corolla Hoag, R.G., SRK
Subject:	Technical Review of (Tetra Tech, 2010b) *Geochemical Pit Lake Predictive Model, Revision 1, Rosemont Copper Project*	**Project #:**	183101/2300

This memorandum provides a technical review of the report, *Geochemical Pit Lake Predictive Model, Revision 1*, *Rosemont Copper Project, Revision 1* (Tetra Tech, 2010b). This review was undertaken, and the Technical Memorandum prepared, at the request of SWCA and the Coronado National Forest, in accordance with a Statement of Work and Request for Cost Estimate from Mr. Dale Ortman dated December 2, 2010. This memorandum was prepared by Vladimir Ugorets SRK Consulting, Inc. (SRK), and reviewed by Corolla K Hoag, SRK.

Additional supporting Tetra Tech documents (regional groundwater flow model (Tetra Tech, 2010d) and Tetra Tech's response (Tetra Tech, 2010c) to comments on the February 2010 geochemical pit lake model report (Tetra Tech, 2010a) made by SRK (SRK, 2010)) also were reviewed as background for preparing this memorandum.

The comments in the present review are grouped into two topics: (1) pit lake water balance and (2) dynamic system model (DSM) integration. Final review of the geochemical modeling will be provided under separate cover.

In the present review of the revised geochemical pit lake model, SRK is of the opinion that all inconsistencies in the pit water balance that existed in the Tetra Tech (2010a) report and cited in the SRK (2010) Technical Review Memorandum were appropriately adjusted in the revised version of the geochemistry pit lake model (Tetra Tech, 2010b). SRK is further of the opinion that the modeling results appear to be reasonable for this study. SRK has no further comments or questions regarding the pit lake model.

1 Pit Lake Water Balance

Components of the post-mining pit lake water balance include groundwater inflow and outflow, direct precipitation, pit wall runoff, and evaporation, as described below.

1.1 Groundwater Inflow

Tetra Tech (2010b) used groundwater inflow to the pit lake from the results of the 3-D numerical modeling completed by Tetra Tech (2010d). It should be noted that the initial version of the Tetra Tech (2010a) geochemical pit lake predictive model (2010a) was based on the 2009 Montgomery & Associates regional groundwater flow model.

Groundwater inflow is a significant component of the pit lake water balance and depends on hydraulic heads adjacent to and below the pit, the lake stage, and the hydraulic properties of the surrounding country rock. The pit lake stage depends on the depth, size, and geometry of the final pit configuration, and on the other components of the pit lake water balance. Finally, groundwater inflows into the pit lake and lake stage depend on pre-mining hydrogeological conditions and the rate and duration of pit dewatering. They can be evaluated by numerical groundwater modeling iteratively, considering and varying all components of the water balance listed above.

1.2 Groundwater Outflow

The Tetra Tech assumption, that groundwater outflow from the pit lake equals zero, is based on their 2010 modeling results (Tetra Tech, 2010d). These results predicted the pit lake to be a permanent hydrologic sink. SRK agrees with this assumption.

1.3 Direct Precipitation

Average monthly precipitation data of 17.37 inches per year (in/yr) were taken from the NOAA Nogales station, due to the limited duration of the data record at the Rosemont site (since 2006). The data from both stations closely correspond (where data from the Rosemont site are available).

The initial pit lake geochemistry evaluation (Tetra Tech, 2010a) used average monthly precipitation data of 22.2 in/yr taken from the Santa Rita Experimental Range (SRER) at an elevation 4,300 feet above mean sea level (amsl), 8 miles to the southwest of the project. Tetra Tech (2010b) reported they replaced precipitation data from the SRER station with the Nogales station data because of the close data correlation and because Nogales is the closest station to Rosemont that includes more than 50 years of continuous data even though the NOAA Nogales station is located at an elevation only 3,560 feet amsl versus an elevation of 5,350 feet amsl at the mine site.

It should be noted that regardless of why the precipitation stations were changed, SRK is of the opinion that the use of 17.37 in/yr precipitation is a more conservative assumption to evaluate pit lake infilling and the impact to the groundwater system during the post-mining conditions. The data from both stations closely correspond to the Rosemont site station.

1.4 Pit Wall and Upgradient Drainage Runoff

Pit wall runoff was simulated using a fraction of the precipitation that ultimately reaches the pit lake. This fraction was assumed to be 30 percent (reasonable, in SRK's opinion) and applied to the area of exposed pit walls above the pit lake elevation.

Tetra Tech considered the areas above the 5,100 feet amsl boundary of the pit as upgradient catchment areas. Runoff from these areas will reach the pit walls from the unbermed drainages or as sheet flows.

1.5 Evaporation

Tetra Tech estimated a pan evaporation rate of 71.52 in/year. The value was derived from data from the Nogales station, adjusted to the Rosemont site, based on a linear trend with each station elevation. The monthly average projected pan evaporation data were converted to a lake evaporation rate using a coefficient 0.7. SRK considers a lake evaporation of 50 in/year as very reasonable for this study.

SRK is of the opinion, that all inconsistencies in the pit water balance that existed in the Tetra Tech (2010a) report and cited in the SRK (2010) Technical Review Memorandum were appropriately adjusted in the revised version of the geochemistry pit lake model (Tetra Tech, 2010b).

2 Dynamic System Model (DSM) Integration

The DSM computer model for the proposed Rosemont mine pit lake was developed in GoldSimTM to simulate the hydrologic water balance and the mixing of chemical loads from the different components of the water balance (e.g. groundwater inflow, pit wall runoff, precipitation). The DSM outputs from the predictive simulations were used as inputs to a final simulation model using PHEEQC.

The DSM includes both stochastic (variable) and deterministic (fixed) parameters. The stochastic parameters were used to assess the uncertainty in the predictions due to the data and analytical constraints and the natural variability in the input parameters (such as precipitation, pit wall runoff, and lake evaporation). Groundwater inflow to the pit was assumed to be a deterministic parameter and was incorporated into the model by a simplified relationship between groundwater inflow and lake stage. This relationship was developed on the basis of outputs from the post-mining predictions made by the numerical groundwater flow model (Tetra Tech, 2010d).

It should be noted that Tetra Tech improved the description of the used DSM model in the revised version of predictive geochemical model report by illustrating differences in simulation by groundwater flow and DSM models:

a) Groundwater inflow to pit lake vs. lake stage (Illustration 5.01), and
b) Components of pit lake balance and lake stage over time.

The DSM model confirms that a lake will form in the open pit upon cessation of mining in all cases of the variability of the used stochastic elements. Modeling results indicate that the pit lake elevation after 1,000 years can be varied from 4,095 feet amsl to 4,488 feet amsl (5^{th} and 95^{th} percentiles values, respectively) with a mean value of 4,287 feet amsl. The modeling results appear to be reasonable for this study.

3 References

SRK Consulting, 2010, Technical Review of Tetra Tech, 2010 *Geochemical pit lake predictive model*, Rosemont Copper Project: unpublished technical memorandum prepared for SWCA, May 3, 2010, 11 p.

Tetra Tech, 2010a, Geochemical pit lake predictive model, Rosemont Copper Project: unpublished report prepared for Rosemont Copper, Tetra Tech Project No. 114-320777, February 2010, 33 p., 6 appendices.

_____, 2010b, Geochemical pit lake predictive model, Revision 1, Rosemont Copper Project: unpublished report prepared for Rosemont Copper Company, Tetra Tech Project No. 114-320884, November 2010, 43 p., _ appendices.

_____, 2010c, Response to comments on February 2010 *Geochemical Pit Lake Model Report*: unpublished technical memorandum prepared by Mark Williamson for Rosemont Copper, Doc. No. 266/10-320884-5.3, November 16, 2010, 12p plus 5 attachments.

_____, 2010d, Regional groundwater flow model, Rosemont Copper Project: Report prepared for Rosemont Copper, Tetra Tech Project No. 114-320874, November 2010, 118p, appendices.

Vector Arizona, 2006, Preliminary report and phase 1 sampling and analysis plan: unpublished technical memorandum by K. Arnold, Vector, Arizona to J. Sturgess, Augusta Resource Corporation, July 26, 2006, 7 p.

4 Reviewer Qualifications

The Senior Reviewer, Vladimir Ugorets, Ph.D., is a Principal Hydrogeologist with SRK Consulting in Lakewood, Colorado. Dr. Ugorets has more than 31 years of professional experience in hydrogeology, developing and implementing groundwater flow and solute-transport models related to mine dewatering, groundwater contamination, and water resource development. Dr. Ugorets' areas of expertise are in design and optimization of extraction-injection well fields, development of conceptual and numerical groundwater flow and solute-transport models, and dewatering optimization for open-pit, underground and in-situ recovery mines. Dr. Ugorets was directly responsible for reviewing the hydrogeology of the pit lake predictive model.