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Technical Memorandum

To:	Kathy Arnold	**From:**	Mark A. Williamson
Company:	Rosemont Copper Company	**Date:**	May 13, 2011
Re:	Rosemont Scaling of SPLP Source Terms	**Project #:**	112/11-320884-5.3
CC:	David Krizek, P.E. (Rosemont); Paul Ridlen, P.E. (Tetra Tech)		

1.0 Introduction

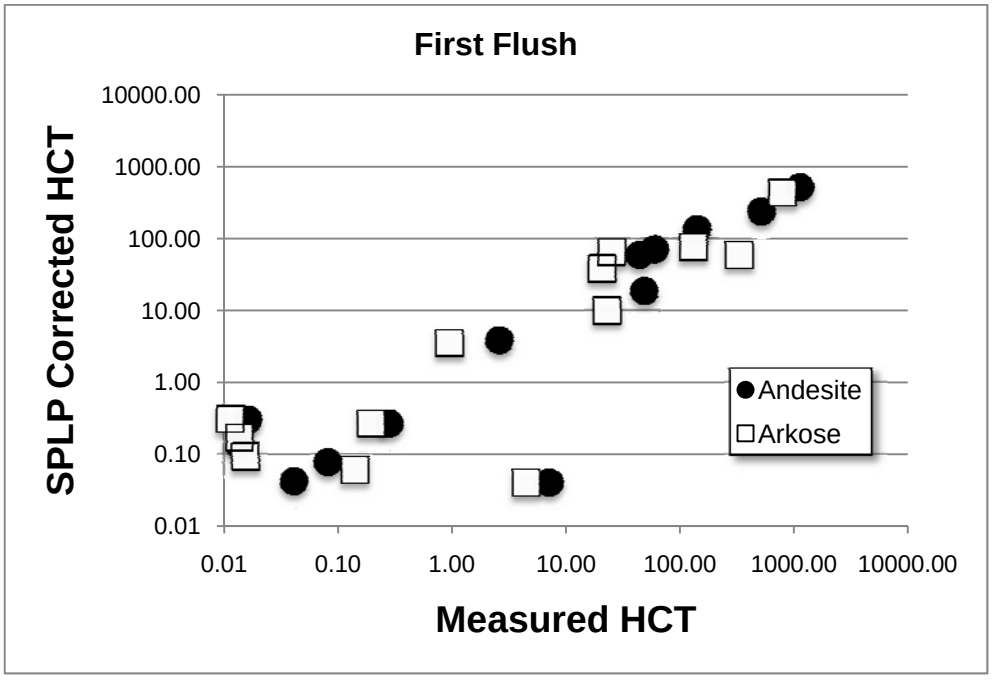
Review comments on the pit lake, including the waste rock and tailings seepage models, have indicated a concern about scaling the results of laboratory leaching tests. That is, should the SPLP laboratory tests with a 20-to-1 water-to-rock ratio (W:R) be adjusted to more closely reflect the lower W:R that may dominate field conditions? Review comments regarding the pit lake geochemical model indicate a reluctance to use Synthetic Precipitation Leaching Procedure (SPLP) results to represent pit wall runoff chemistry. Rather, the use of other testing methods that have water:rock testing ratios lower than the SPLP 20:1 ratio are preferred. Tests such as humidity cell testing (HCT) and the meteoric water mobility procedure (MWMP) are cited as more appropriate. This topic has been given much thought and I am not convinced that scaling of SPLP results would result in any meaningful change in the model results obtained to date. By meaningful, I refer to a change in model results that would affect either the selection of a preferred alternative in the Rosemont Environmental Impact Statement (EIS) or affect the selection and design of mitigation alternatives. With respect to meeting the objectives of the EIS, models are not intended to provide detailed guarantees of performance (as would be the case for specific discharge permits), but to disclose reasonable and expected eventualities. Below I have laid out several considerations regarding this topic with the goal of reconciling this issue and documenting the extent that the inclusion, or exclusion, of scaling might affect projected model results.

Water:Rock Ratio

The concentration of a chemical constituent in water that contacts rock, either in a laboratory test or under field conditions, is often, but not always, related to the proportion of water relative to the rock. In general, the higher the W:R ratio, the lower the concentration expected. Under field conditions, the W:R ratio is low in waste rock, but may not be for pit wall rinsing during the brief, infrequent and substantial rainfall events that may be associated with the Rosemont site. These rainfall events will likely result in rapid wetting, rapid runoff of water, and rapid drying, which is characteristic of the arid conditions in the southwestern U.S.

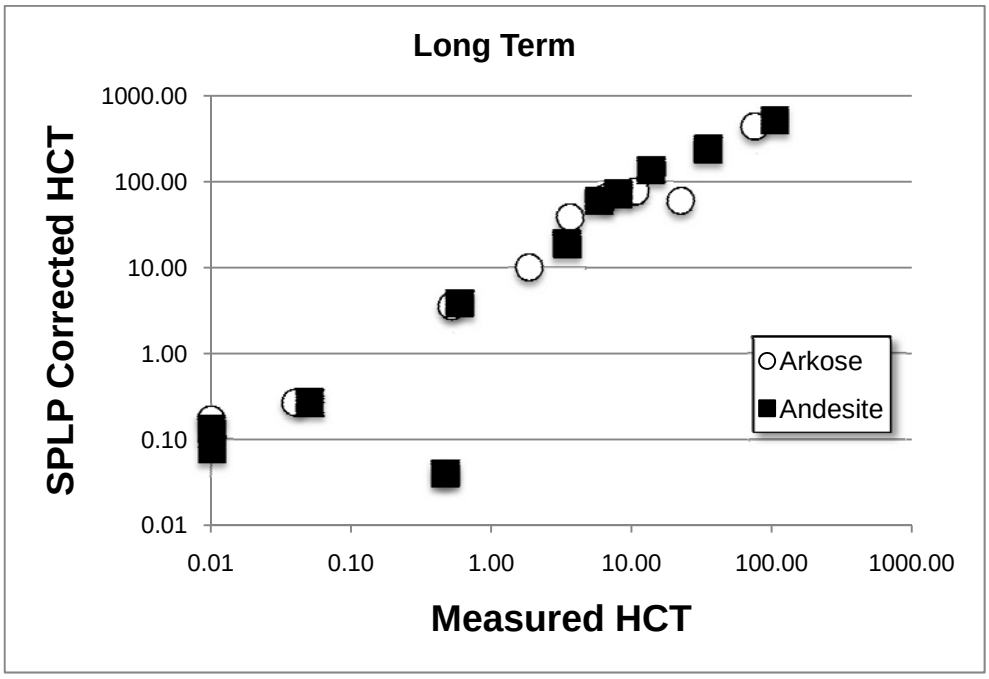
I have compared average SPLP test results with the average first flush of humidity cell tests (HCT), since they are both rinsing equivalent rock, only using different W:R ratio. The W:R ratio for SPLP is 20:1 and for HCT is 1.5:1. So, SPLP results can be scaled to HCT by simply dividing SPLP concentrations by 13.3. Mathematically scaling the SPLP to represent a more concentrated HCT condition results is generally good agreement with actual HCT results for major chemical species (Illustration 1). However, when the same scaling is applied to trace constituents, the scaling correction performs poorly, significantly over estimating concentrations. Nonetheless, the first-flush HCT data (i.e., scaled SPLP) was used to simulate flushing of the blast zone of pit walls on recharging by groundwater.

Illustration 1 First flush HCT compared to scaled SPLP



Scaling of long-term HCT results clearly fails for both major and trace constituents (Illustration 2), as SPLP results are commonly *higher* than the long-term HCT values (see my earlier memo regarding SPLP usage titled *Rosemont SPLP Usage for Pit Wall Runoff* [Tetra Tech, October 26, 2010]). Thus, in instances where one might consider long-term HCT measurements suitable (e.g., rinsing of pit walls by short-term, sparse rain events at Rosemont), the current use of SPLP results actually introduces an environmentally-protective bias. The concentrations of constituents in the SPLP results are consistently higher than in the HCT results. For the pit-lake model, the net effect between the use of either is relatively small. This is because rainfall is infrequent and the resulting chemical loading to the projected pit lake is limited relative to the chemical mass from recharging groundwater.

Illustration 2 Long-term HCT compared to scaled SPLP



The net effect on predictive modeling related to waste rock and the pit lake is discussed below.

Field vs. Laboratory Comparisons

The SRK review team for the EIS provided an example of chemical data for actual field W:R contact solutions (although not at the Rosemont site) compared with laboratory test data. The results of that comparison make it fairly clear that scaling of laboratory SPLP, MWMP, and humidity cell test results, need to be scaled for *acid conditions.* For alkaline conditions, the agreement between lab and field is much more consistent (although variable). The result is that under alkaline conditions, SPLP test results appear to be reasonable to use, particularly when a reasonable number of measurements for a particular rock material are available.

The illustrations in the reference provided by the SRK review team show that, for alkaline field drainage, MWMP measurements:

- generally, but not always, under- predict sulfate,
- are consistent with iron,
- are higher for arsenic, and
- are slightly low for zinc, but generally consistent.

The under-prediction of sulfate is likely tied to the weathering of pyrite, which does not substantially occur in MWMP tests. However, in the absence of appreciable pyrite, in a rock anticipated to produce alkaline drainage (e.g., Rosemont rock), the agreement with respect to sulfate is likely better.

These results suggest that SPLP data for major species (sulfate) might be scaled to provide a closer agreement with field solutions and that scaling of trace constituents (arsenic and zinc) should *not* be scaled. This is consistent with the discussion above comparing SPLP test results for Rosemont rock with first-flush data from HCT tests.

The majority of the waste rock at Rosemont is anticipated to be alkaline (Tetra Tech 2007, Illustration 3.2), with some, but not all, samples of andesite and arkose displaying uncertain character with respect to the formation of low pH drainage. Additional Net Acid Generation (NAG) pH testing (Tetra Tech 2007, Illustration 3.3) further refines waste rock characterization to indicate that even for arkose and andesite, only a very minimal amount of these materials (3 samples of 178 samples of waste rock) can be anticipated to produce low pH drainage. These samples are expected to be associated with limited local occurrences of material containing pyrite at the higher concentrations observed at Rosemont. Therefore, on the basis of these tests any potential drainage from the Rosemont mine is anticipated to be alkaline and that, per the SRK- supplied reference, MWMP results provide a reasonable estimate of source-term water quality.

Despite having a higher W:R ratio than the MWMP (at 1:1), the SPLP (at 20:1) produces test results for Rosemont rock that were consistent with the MWMP. Thus, it would appear that the use of SPLP results is a reasonable representation of the anticipated alkaline conditions for the projected Rosemont rock.

Pragmatic Effects on Predictive Modeling

Ultimately, the discussion of scaling is applied to predictive modeling. Does scaling SPLP test results lead to a better, more reliable model results? With respect to EIS evaluation, in which the objective is to disclose reasonable and expected outcomes, does scaling of the currently used SPLP source terms lead to a different conclusion? As discussed below, I believe the answer is “no”, that scaling will not change the expected outcomes.

Pit Lake

For the pit lake, the W:R ratio applies to leaching of the blasted-rock zone along the ultimate pit surface as groundwater recharges the pit, and to rinsing of pit walls during the infrequent rain events at the Rosemont Project site.

As noted above, the blast zone of the ultimate pit surface was modeled using the first-flush HCT results when available. If first-flush HCT were not available, SPLP data for major constituents was scaled to twice their value, and trace constituents to three times the SPLP value. Pit wall runoff, consistent with the above discussion, was simulated using SPLP results.

The bulk pit lake is predicted to geochemically evolve to a body of water that is saturated with calcium carbonate (calcite), calcium sulfate (gypsum), and atmospheric carbon dioxide, at an alkaline pH. Model calculations indicate that many years (hundreds) will be required to reach this condition. Trace constituents will, like major constituents, also build up over time and scaling will accelerate this process.

Scaling the SPLP tests will not affect this modeled eventual outcome. It can only accelerate the time that it takes to reach such a condition. The time required will still be very long and the disclosure of the likely and expected conditions for the lake's bulk character will remain unchanged. Given the uncertainty associated with such things as weather (temperature, rain patterns), there would appear to little improvement in model resolution with scaling of SPLP leaching test results. Nonetheless, for the pit lake, we have attempted to scale SPLP results.

Waste Rock

Modeling of potential seepage from the waste rock storage area used un-scaled SPLP when MWMP results were not available. While it is true that the W:R ratio in waste rock will be significantly higher than in SPLP tests, scaling SPLP would have no effect at all on the results of waste rock modeling since the waste rock storage area was shown not to produce seepage.