MEMORANDUM

To:	Todd Goodsell, Victoria Gold Corporation	**Date:**	4 May 2012
From:	David Flather	**Project #:**	**J996-1**
Subject:	**Eagle Gold Project Water Quality Predictions**		

1. Introduction

Lorax Environmental Services Ltd. (Lorax) has been retained by Victoria Gold Corporation (VIT) to assist in compiling specific components of a Supplemental Information Report (SIR) to the Yukon Environmental and Socio-economic Assessment Board (YESAB). The SIR is intended to update YESAB on refinements to the Project associated with the completion of the Feasibility Study, and which have occurred since initial submission of the Project Proposal in December 2010. The objective of this memorandum is to evaluate water quality predictions presented in the December 2010 Project Proposal and subsequent supplementary information submitted by VIT upon YESAB request. The most significant aspect of these refinements that could affect water quality predictions are related to increased footprint area and volumes of ore and mine waste rock and optimization of the site wide water balance.

SRK Consulting (SRK) evaluated the Feasibility Study with respect to source term predictions in a memorandum titled: *Narrative on expected effects of Feasibility Study changes to the project design on the predicted source term concentrations* (March 14 2012 and appended to this memorandum). SRK's evaluation used simplified assumptions regarding the increased capacity of the heap leach and waste rock storage area facilities presented by the Feasibility Study. The memorandum suggested that the Project refinements could result in some minor increases in concentrations at closure for a few parameters of interest to the aquatic effects assessment due simply to a greater volume to area ratio of material that is proposed for each facility. However, SRK (2012) highlighted that the potential concentration changes are difficult to predict and largely uncertain due to conservative assumptions inherent in the source term predictions. Accordingly, SRK (2012) concluded that the refined estimates of seepage quality emanating from the heap leach facility and waste rock storage areas are likely to be similar to values previously reported in the Project Proposal.

During operations and the early closure phase, all mine contact water will be delivered to a mine water treatment plant (MWTP) to yield effluent concentrations to meet water quality objectives in the receiving environment (see Stantec 2011, Appendix 25 of the Project Proposal, *Technical Data Report: Water Quality Model*; Section 2.7 and Table 1). Following reclamation activities on the waste rock and heap leach facilities and complete draindown of the latter, if necessary, passive treatment systems are proposed for seepage water emanating from the heap leach facility, Eagle Pup waste rock facility and the combined Platinum Gulch waste rock facility and open pit areas. As such, the active and passive treatment systems effectively negate the effect that potential changes to source term concentrations could have on receiving water quality resulting from expanded facilities. Stated slightly differently, the refined treated effluent (i.e., MWTP and passive treatment) concentrations are effectively the same as those presented in the Project Proposal and therefore effluent water quality delivered to the receiving environment has not undergone modifications. There is one exception to this general statement and relates to sulfate management; this exception is addressed specifically in Section 3.1 of this memorandum.

In consideration of the above, no new water quality modeling has been performed, nor is considered warranted, as part of this SIR; the highly conservative approach adopted for source term development and the commitment to operate a MWTP throughout the operations and draindown phases would not result in material refinements to estimates of contact water chemistry during operations and closure. However, water balance optimizations, associated with the expanded footprint, could influence loadings to the receiving environment. To demonstrate that optimization of the operations and closure water balance as part of the refinements does not materially affect the environmental effects assessment conclusions of the water balance, *threshold* concentrations in effluent were developed for select parameters.

Threshold values represent upper bound concentrations in effluent, at or below which, receiving water quality objectives are achieved after mixing with receiving water under assumed hydroclimatic conditions (e.g., wet, median and dry years). The threshold concentrations are not effluent criteria and by definition are greater than effluent criteria assuming that there is some assimilative capacity in the receiving water body. In contrast, the MWTP effluent criteria were designed for each parameter to be 2 times the value of its respective water quality objective and did not implicitly consider the assimilative capacity of Haggart Creek. By determining the *threshold* (maximum) concentrations in MWTP effluent that yield acceptable water quality in the receiving environment, the sensitivity (if any) of the refinements on the water balance or source term concentrations can be better evaluated and constrained, particularly when compared to the effluent criteria in the water quality effects assessment.

This approach to demonstrate the validity and applicability of the water quality predictions and effects assessment currently under screening review relative to the Project refinements is the subject of the discussion in the following Sections:

1) **Method and Approach** - for determining threshold concentrations that achieve water quality objectives for key parameters of interest;
2) **Results for Operations and Early Closure –** describes analyses for the operations and draindown phases of the project while the MWTP is in operation for key parameters of interest, including sulphate, arsenic, cadmium and selenium;
3) **Results for Post Closure** - discusses the late closure phase, when passive treatment systems are in effect and compares the water balance flows assumed in the Project Proposal to the refined water balance flows to the passive treatment systems.

2. Method and Approach

Threshold values in MWTP effluent for individual parameters of interest were calculated using the following water quality model loading equation from Appendix 25 of the Project Proposal (Stantec 2011) to calculate concentrations in the receiving environment:

$$Q_{W22}*[C_{W22}] + Q_{eff}*[C_{eff}] = Q_{W4}*[C_{W4}]$$

where:

Q_{W22} = mean monthly flow (L/s) in Haggart Creek at W22[1]

Q_{eff} = predicted mean monthly effluent flow (L/s) from the MWTP

Q_{W4} = mean monthly flow (L/s) in Haggart Creek at W4[2]

$[C_{W22}]$ = mean monthly baseline concentration (mg/L) of a selected parameter in Haggart Creek at W22

$[C_{eff}]$ = predicted effluent concentration (mg/L) of a selected parameter, and

$[C_{W4}]$ = predicted monthly baseline concentration (mg/L) of a selected parameter in Haggart Creek at W4.

[1] W22 is an existing water quality and hydrometric station on Haggart Creek located upstream of the proposed MWTP effluent discharge point

[2] W4 is an existing water quality and hydrometric station on Haggart Creek located downstream of the proposed MWTP effluent discharge point and upstream of the confluence of Dublin Gulch

The following key information was used:

- the optimized GoldSim® water balance output for the total flow exiting the MWTP (i.e., Q_{eff}) for the operational and the HLF draindown period (e.g., mine-life years 3 to 19). The water balance output used the median values as described in Knight Piésold, 2012a). The end of the draindown period and cessation of active water treatment (year 19) is only fixed for the purposes of this assessment and it should be recognized that considerable flexibility exists in the timing of the transition from active treatment to passive treatment;
- background mean hydrological flow conditions for Haggart Creek immediately upstream of the discharge location (i.e., Q_{w22}) (Knight Piésold, 2012a);
- there are no additional flows assumed to enter Haggart Creek between W22 and W4, so:

$$Q_{W4} = Q_{W22} + Q_{eff}$$

- the mean monthly background concentration in Haggart Creek immediately upstream of the discharge location for each month for the parameter(s) of interest (i.e., C_{W22}) (see Table 6.5-6 of the Project Proposal); and
- the water quality objective (WQO) and/or site specific water quality objective (SSWQO) for the parameter of interest (i.e., C_{eff}).

Normally, the loading equation described above is used to calculate concentrations in the receiving environment (i.e., C_{W4}) assuming fixed variables including the effluent discharge concentration. For the purposes of this evaluation of predicted water quality as a result of expanded facilities, the loading equation was rearranged to solve for the effluent concentration as the independent variable with the receiving water quality concentration a fixed variable and set at the receiving water quality objective, as follows:

$$[C_{thresh}] = \frac{Q_{W4}*[C_{WQO}] + Q_{W22}*[C_{W22}]}{Q_{eff}}$$

where:

$[C_{thresh}] = [C_{eff}]$, and
$[C_{WQO}] = [C_{W4}]$

Accordingly, by definition the calculated effluent concentration $[C_{eff}]$ represents a threshold value or maximum allowable concentration of effluent $[C_{thresh}]$ that will be less than or equal to water quality objectives under a given baseline water quality and flow condition.

For each month of every mine-life year that the MWTP is in operation and discharging effluent, an effluent threshold concentration can be back-calculated using the receiving water quality objective or site specific water quality objective for a particular parameter as the controlling variable. The equation, using sulfate as an example, is as follows:

$$[C_{thresh(Sulfate)}] = \frac{Q_{W4}*[C_{WQO(Sulfate)}] + Q_{W22}*[C_{W22(Sulfate)}]}{Q_{eff}}$$

where:

$[C_{WQO(Sulfate)}]$ = 100 mg/L at station W4 in Haggart Creek (from Table R8-1 of Stantec December 2011 *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)*;

Q_{W22} = mean monthly flow (L/s) in Haggart Creek at W22;

Q_{eff} = mean monthly effluent (L/s) discharging from the MWTP; and

$[C_{W22(Sulfate)}]$ = mean monthly baseline sulfate concentration (mg/L) in Haggart Creek at W22 from Table 6.5-6 of the Project Proposal.

The approach accounts for the existing background concentration and seasonal flows in Haggart Creek and calculates the threshold values depending upon receiving water flows and concentrations relative to optimized discharge volumes from the MWTP as dictated by the refined water balance (Knight Piésold, 2012a). The refined threshold value can then be compared to the project MWTP effluent criteria used in the original water quality modeling.

Parameters of primary interest for the Eagle Gold Project that were evaluated using this approach included sulfate, arsenic, cadmium, and selenium. These parameters were selected owing to potential source term increases (e.g. sulfate, and selenium) as suggested by SRK (2012) and were identified in the water quality effects assessment as parameters of primary interest. It was not the intent to evaluate all water quality parameters but rather to demonstrate, using select parameters, the robustness of the current water quality impact assessment conclusions and their continued applicability in light of the project refinements.

3. *Operations and Early Closure – MWTP Operation*

As previously discussed, the MWTP will treat mine contact water emanating from the heap leach facility, waste rock storage facilities and open pit contact and overflow water for the majority of the mine life. The active treatment period extends well into the early closure phase and will continue until reclamation activities on the heap leach and waste rock facilities are completed and seepage quality and quantity improves to the extent that passive treatment systems can be successfully implemented (if required by effluent water quality). For the purposes of this evaluation, the period of MWTP operation is defined as years 3 to 19 of the mine life. During the period of MWTP operation, the only discharge to the receiving environment of Haggart Creek is upstream of water quality station W4.

3.1 Sulfate

The evaluation of the refinements on geochemical source terms (SRK 2012) suggest that sulfate concentrations in waste rock contact flow-through seepage and heap leach seepage could increase by up to a factor of 2. This estimate is based solely on an increased volume of material that would accumulate in each facility by closure, and ignores the already conservative nature of the upper bound estimates. Specifically, SRK suggested that upper bound sulfate values could increase from approximately 950 mg/L to approximately 1820 mg/L for waste rock and from approximately 2240 mg/L to roughly 3440 mg/L for the heap leach facility.

As described in the Project Proposal (Stantec, June 2011 Appendix 25 *Technical Data Report: Water Quality Model)*, the assumed MWTP effluent criteria for sulfate was 200 mg/L, based on sulfate treatment capability and a value two times the WQO of 100 mg/L. For the purpose of modeling effects on water quality, MWTP effluent criteria were set at two times the downstream WQG (CCME or BC WQO) for each parameter of interest. These criteria are conservative and considered stringent. Figure 3-1 illustrates the calculated sulfate threshold values [$C_{thresh(Sulfate)}$] in the MWTP effluent using the revised water balance output (FS) for the MWTP operation period of years 3 to 19; the threshold values represent the maximum concentration in the MWTP effluent that achieves a WQO of 100 mg/L sulfate at station W4 in Haggart Creek. As shown, the calculated threshold, or maximum acceptable values are always above the sulfate effluent criteria of 200 mg/L. Although there are periods during later phase rinsing and early draindown (e.g., years 12, 13 and 14) when threshold values approach the effluent criteria of 200 mg/L, the refinements do not alter the environmental effects assessment conclusions for sulfate.

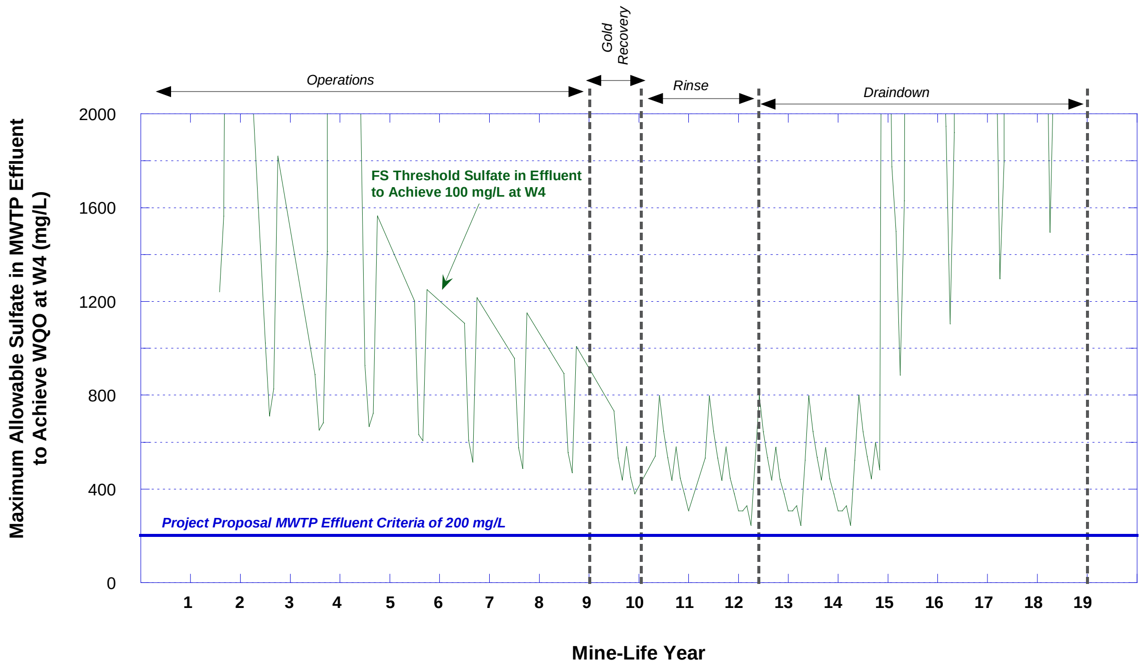

Figure 3-1: Maximum or threshold sulfate concentration in MWTP effluent that achieves 100 mg/L sulfate at W4

However, in Stantec (December 2011) *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)*, VIT indicated that the water balance model could be optimized such that specific sulfate treatment would not be necessary beyond that achieved through lime addition and maintaining sulfate levels at or below approximately 1620 mg/L through gypsum solubility controls. Recalling that all mine contact water from the waste rock facilities and heap leach report to the MWTP feed pond prior to treatment, the above indicated that at feed pond sulfate concentrations less than approximately 1620 mg/L, the sulfate concentration exiting the MWTP would be equal to the feed pond concentration. Conversely, if and when feed pond sulfate concentrations exceeded 1620 mg/L, the MWTP effluent sulfate concentration, or [$C_{eff(Sulfate)}$], would be controlled by gypsum solubility at roughly 1620 mg/L. Figure 3-2 provides a summary graph of the water balance output and water quality model output (represented in the figure as PFS or Pre-Feasibility Study) for the feed pond relative to threshold sulfate concentrations [$C_{thresh(Sulfate)}$] in MWTP effluent using the method described above.

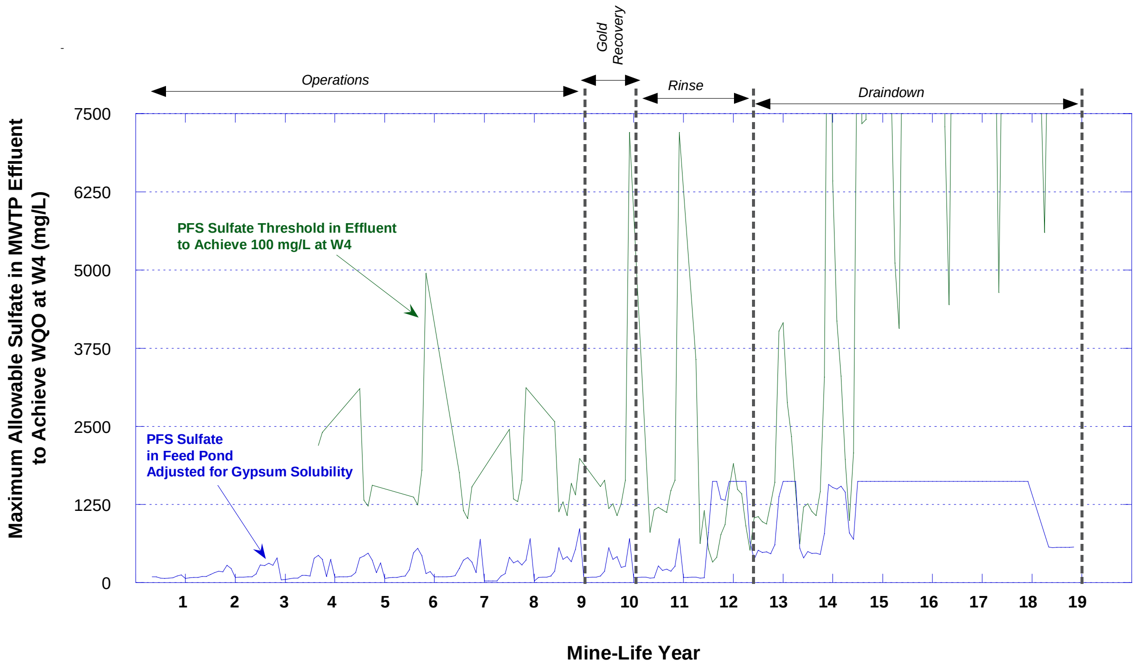

Figure 3-2: Maximum sulfate concentration in MWTP effluent that achieves 100 mg/L Sulfate at W4 relative to predicted sulfate concentrations in the MWTP Feed Pond from the water quality model

The graph illustrates that if MWTP effluent sulfate levels are controlled only through gypsum solubility, there are periods during late rinsing and early draindown when threshold sulfate levels could exceed Feed Pond concentrations. As such, during these periods, sulfate concentrations at W4 would exceed 100 mg/L. This was acknowledged in Stantec (December 2011) *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)* and resulted in VIT proposing a site specific water quality objective (SSWQO) for sulfate of 644 mg/L in Haggart Creek at W4 (see response R9.1 of *Response to Request for Supplemental Information (YESAB Assessment 2010-0267).*

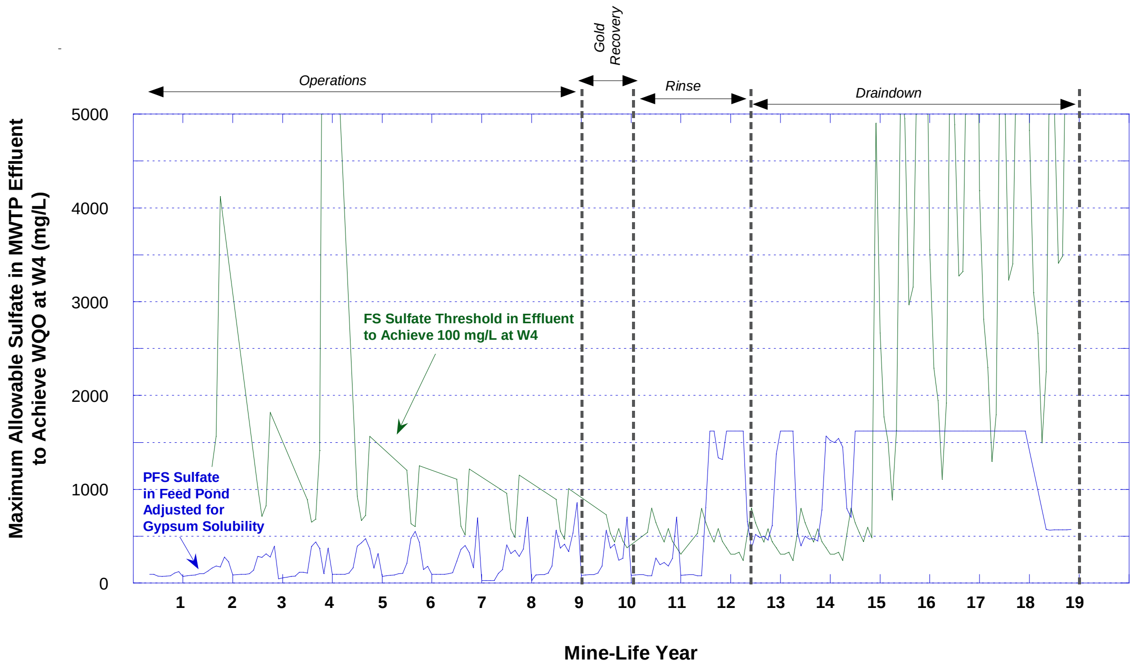

Figure 3-3: Maximum sulfate concentration in MWTP effluent for the refined water balance that achieves 100 mg/L sulfate at W4 relative to predicted sulfate concentrations in the MWTP Feed Pond from the water quality model

The same evaluation was performed for the refined water balance output and the results are presented in Figure 3-3. The term "MWTP feed pond" is not utilized; rather mine contact water is delivered to the Lower Dublin Gulch Pond (LDSP) prior to treatment by the MWTP. The evaluation assumed that refinements to LDSP sulfate concentrations would be equal to or less than that in the MWTP influent water quality model owing to the greater proportion of non-contact water delivered to the LDSP (see Appendix 8 of this submittal: Water Management Plan, Knight Piesold, 2012), and the conservative assumptions underpinning the sulfate source terms (SRK, 2012). Figure 3-3 similarly indicates that during the rinse and early draindown phases of the project, the refinements could result in sulfate concentrations in Haggart Creek, at W4, exceeding the WQO of 100 mg/L. The calculated threshold limits indicate the Stantec (December 2011) *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)* proposed SSWQO of 644 mg/L for sulfate remains achievable for the refined facilities.

To assess the applicability of the SSWQO in Haggart Creek, threshold sulfate concentrations in MWTP effluent were recalculated assuming a receiving water quality objective of 644 mg/L in place of the originally proposed 100 mg/L; Figure 3-4 presents the results of the analysis utilizing the refined water balance output. As illustrated, a SSWQO of 644 mg/L is predicted to result in maximum allowable (threshold) sulfate concentrations in the MWTP effluent well in excess of gypsum solubility controlled sulfate concentrations by over a factor of 3.5 at the most sensitive draindown phase. The large difference between the calculated maximum threshold sulfate concentration for the MWTP effluent and the maximum sulfate concentration that would be realized owing to gypsum solubility indicates that actual sulfate concentrations realized in Haggart Creek at W4 would in fact be well below the SSWQO of 644 mg/L. Stated slightly differently, sulfate concentrations could, theoretically (ignoring gypsum solubility constraints), be as high as approximately 6,000 mg/L in effluent (e.g. the *threshold* value) during the latter stages of rinsing and early draindown and still yield 644 mg/L at W4 in Haggart Creek. However, because sulfate in effluent is anticipated to be almost 4 times lower (e.g. 1620 mg/L) than the threshold concentration when accounting for gypsum solubility, the resultant sulfate concentrations at W4 in Haggart Creek are predicted to be well below 644 mg/L for the same period.

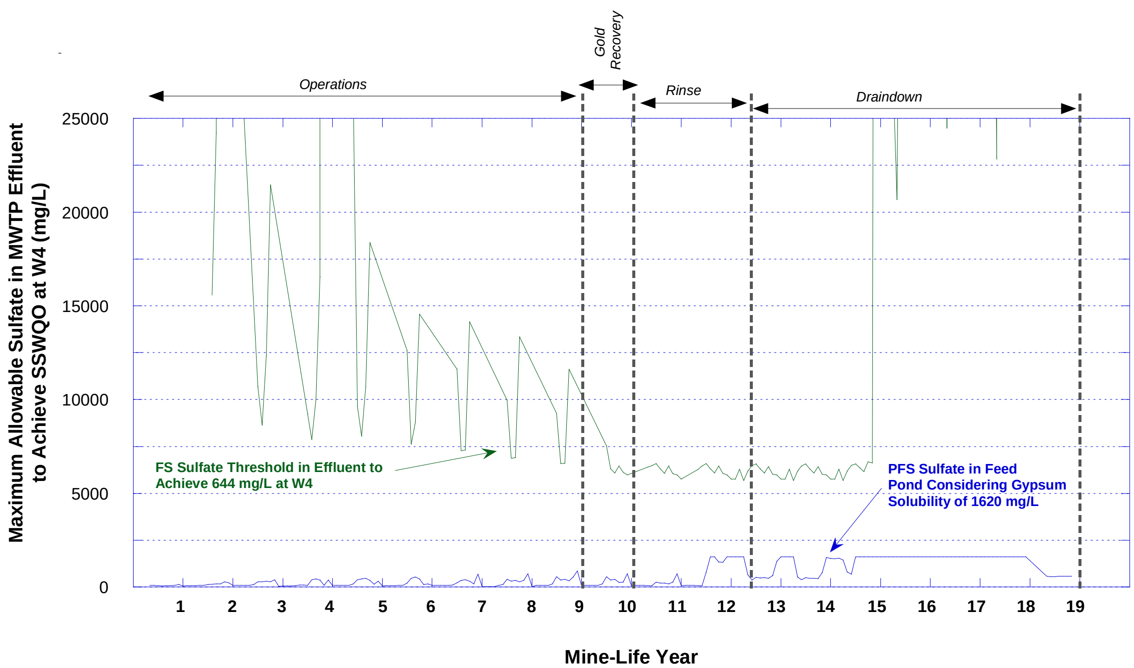

Figure 3-4: Maximum sulfate concentration in MWTP effluent for the refined water balance that achieves 644 mg/L sulfate at W4 relative to predicted sulfate concentrations in the Feed Pond from the water quality model

While the proposed SSWQO for sulfate of 644 mg/L is considered to be protective of aquatic life in Haggart Creek, an evaluation was performed to determine if a more stringent SSWQO of 250 mg/L was achievable under the project refinement optimized water balance conditions. Figure 3-5 presents the results of this analysis.

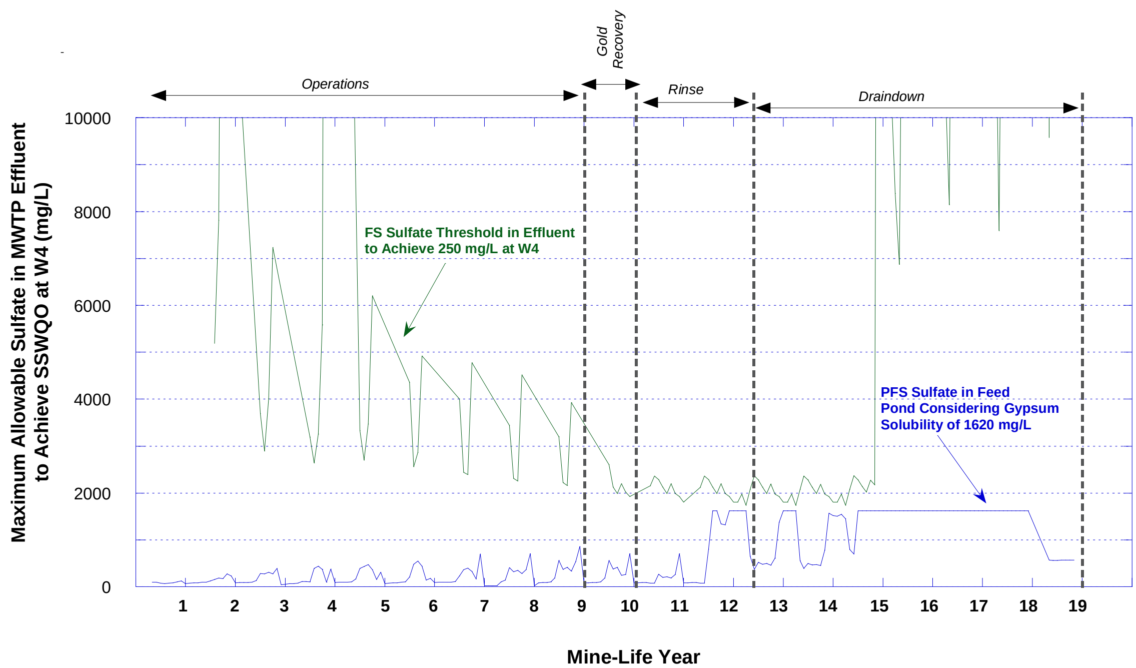

Figure 3-5: Maximum sulfate concentration in MWTP effluent for the refined water balance that achieves 250 mg/L sulfate at W4 relative to predicted sulfate concentrations in the Feed Pond from the water quality model

The results clearly demonstrate that the MWTP threshold sulfate values are above the sulfate concentrations in the MWTP influent and above the maximum sulfate concentrations that would be discharged owing to gypsum solubility control. As such, resultant sulfate concentrations in Haggart Creek, while not explicitly modeled, would be below 250 mg/L. Potential revision to the proposed SSWQO for sulfate will be further evaluated via an updated water quality model that will be submitted as part of the Type A Water Use License application as required for the project by the Yukon Water Board.

Collectively, the results of the threshold analysis, considering optimized operations and draindown water balance and geochemical information for the proposed refinements, indicate that the conclusions of the Project Proposal water quality environmental effects assessment analysis for sulfate remain applicable and valid.

3.2 Arsenic

Arsenic has been identified as a parameter of interest for the Eagle Gold project owing to its elevated solid phase concentrations in ore and waste rock as well as from naturally elevated concentrations in Project soils and receiving streams, namely Dublin Gulch, Eagle Creek and Haggart Creek. A SSWQO for As has been proposed for Haggart Creek downstream of the confluence of Dublin Gulch of 0.014 mg/L and for Dublin Gulch and Eagle Creek of 0.07 mg/L to account for the naturally elevated concentrations observed in these streams (see Table R9-1 of Stantec 2011 *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)*. However, for the purposes of assessing project water quality effects, an arsenic receiving water quality guideline of 0.005 mg/L was assumed. Based on this, the MWTP effluent concentration for arsenic was established at 0.010 mg/L using the very conservative approach of establishing it as 2 times the WQO.

Project refinements are not anticipated to result in material increases in source term arsenic concentrations in contact waters emanating from the HLF, waste rock storage facilities or open pit water (SRK 2012). Threshold calculations for arsenic to achieve a water quality objective of 0.005 mg/L in Haggart Creek at W4 are provided below in Figure 3-6.

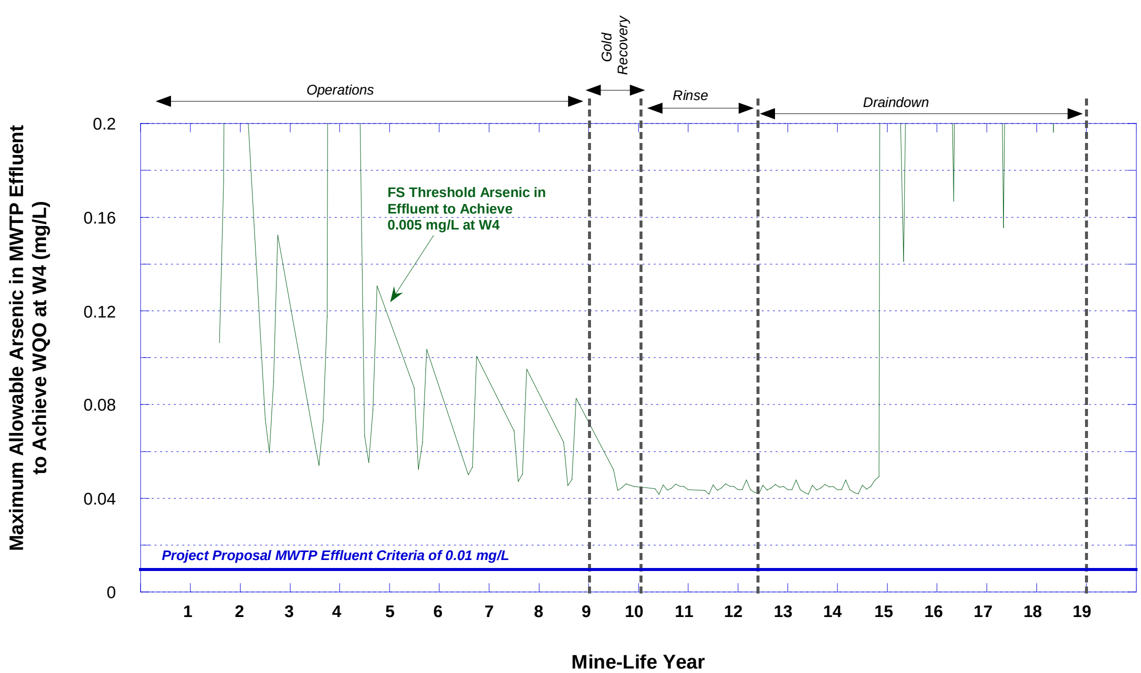

Figure 3-6: Maximum or threshold arsenic concentration in MWTP effluent that achieves 0.005 mg/L arsenic at W4

As illustrated in Figure 3-6, threshold arsenic concentrations in MWTP effluent for the refined median water balance conditions are well above the MWTP effluent concentration by over a factor of 4. For the Project water quality effects assessment, arsenic concentrations at W4 were not predicted to exceed 0.005 mg/L at W4 throughout the operation and draindown period when the MWTP is in operation because a significant assimilative capacity exists in Haggart Creek for arsenic at station W4; these predictions covered the average flow as well as wet year and dry year flow conditions.

However, concentrations of arsenic at downstream station W29 in Haggart Creek were predicted in the to be slightly over the 0.005 mg/L water quality objective owing to natural (non-Project) arsenic loadings in Dublin Gulch and Eagle Creek that enter Haggart Creek downstream of W4. The SSWQO for arsenic of 0.014 mg/L was proposed to address the naturally elevated arsenic levels in Haggart Creek as a result of the Dublin Gulch and Eagle Creek inputs.

No adverse water quality effects from arsenic were identified for those periods when the MWTP is in operation. Therefore, the water quality effects assessment for the operation and draindown phase, based on treatment of arsenic to 0.01 mg/L, remains valid and accurate for the refined project.

3.3 Cadmium

Cadmium concentrations in mine contact seepage waters are not anticipated to increase as a result of the refinements. However, cadmium was identified as a parameter of interest owing to predicted elevated concentrations in seepage water of up to 15 to 20 times higher than the proposed Cd water quality objective of 0.0003 mg/L. Threshold calculations for Cd, assuming the refined water balance output and a receiving water criteria of 0.0003 mg/L are presented in Figure 3-7. Threshold concentrations of Cd that meet the water quality objective are well above the MWTP effluent discharge criteria assumed in the water quality modeling. Indeed, the lowest calculated threshold value for the refined water balance is approximately 0.003 mg/L and is similar in magnitude to the highest predicted cadmium source term (e.g. untreated and undiluted) concentration from refined waste rock storage areas of 0.008 mg/L (see Table 13 of SRK 2012). This indicates that even in the absence of proposed mitigation of seepage for cadmium, the likelihood of exceeding the water quality objective would be very low.

Based on the threshold analysis, concentrations of cadmium in effluent could be approximately 5 times greater than the proposed effluent concentration for cadmium of 0.0006 mg/L, even during the most sensitive period of rinsing and draindown when the volume of water discharged through the MWTP is anticipated to be highest, and still achieve water quality objectives at W4. As with arsenic, an important control on cadmium releases to the environment is the use of the MWTP during the operation and draindown period.

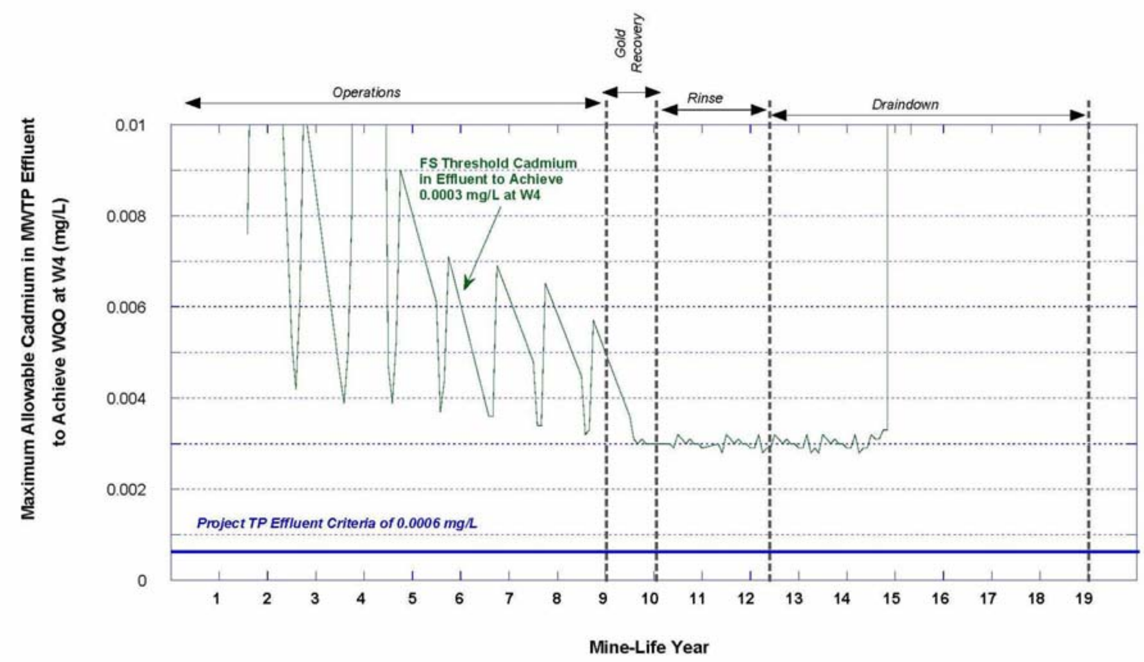

Figure 3-7: Maximum or threshold cadmium concentration in MWTP effluent that achieves 0.0003 mg/L cadmium at W4

No adverse aquatic effects were predicted for cadmium as a result of discharges from the mine water treatment plant. Any changes in cadmium releases resulting from the project refinements is not predicted to alter the existing water quality effects assessment.

3.4 Selenium

Selenium has been identified as a parameter of interest at the Eagle Gold project and implementation of the Project refinements could result in increases in selenium source term concentrations by approximately 40% (SRK 2012).

During the mine life phases when the MWTP is in operation, the water quality effects assessment was conducted assuming selenium concentrations in treated effluent of 0.004 mg/L. The calculated lowest threshold selenium values from the refined water balance output of approximately 0.016 mg/L, occur during the rinsing and early draindown period; these are roughly 4 times higher than the proposed MWTP effluent criterion. Thus, the threshold analysis for selenium, demonstrates that threshold concentrations for selenium in MWTP effluent are well in excess of the proposed effluent criteria (Figure 3-8), such that the likelihood of exceeding the water quality objective for selenium in Haggart Creek would be very low.

The water quality effects assessment in the Project Proposal did not identify adverse impacts associated with selenium for the operational period. These conclusions remain appropriate and valid for the refined project design.

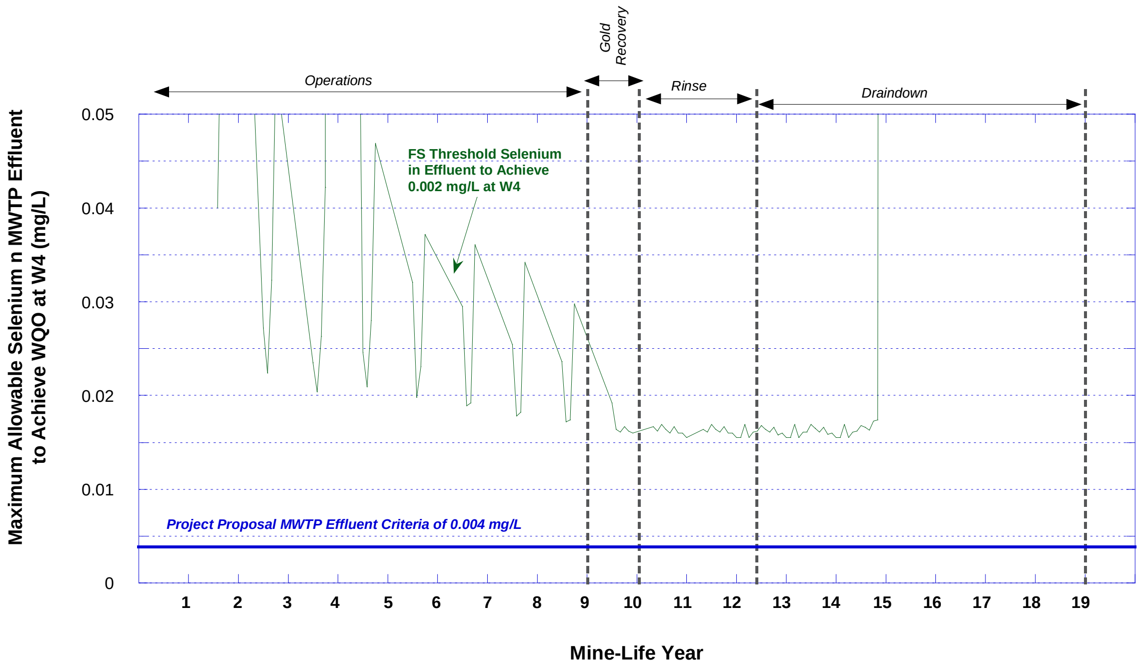

Figure 3-8: Maximum or threshold selenium concentration in MWTP effluent that achieves 0.002 mg/L selenium at W4

4. Post Closure – Passive Treatment Systems

In the Project Proposal, and subsequently in Stantec 2011 *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)*, the concept of constructing passive treatment systems for each of the three post closure mine discharge areas of the HLF, Eagle Pup WRSA and Platinum Gulch WRSA and open pit was proposed. Passive treatment systems for the Eagle Gold project are being proposed as a mitigation strategy to reduce seepage contaminant concentrations to values less than MMER criteria and to ensure water quality and site specific water quality objectives continue to be met in Haggart Creek and Dublin Gulch following the cessation of active water treatment at the MWTP.

In Stantec 2011 *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)*, Section 4.0 addresses specific questions raised by YESAB related to the implementation and performance of the proposed passive treatment systems. Response R10 and Appendix 10 of that document provide information on influent chemistry and influent flow rates for each passive treatment system. Influent chemistry predicted for the Eagle Pup WRSA, Platinum Gulch WRSA/open pit overflow and HLF are presented in Tables 2, 3 and 4 of Appendix R10 of that document.

With respect to the Project refinements, SRK (2012) has noted that a limited number of parameters, primarily sulfate and selenium, may increase in concentration in seepages from the refined WRSAs and HLF. By contrast, no changes are anticipated for the refined open pit source terms (SRK 2012). This notwithstanding, it was also concluded by SRK (2012) that the source term predictions conducted for the project where made in a highly conservative manner and, as such, these source term predictions remain relevant and applicable to the project despite the refinements.

Given the above, the influent source term chemistries entering the passive treatment systems as described in the Project Proposal and Appendix R10 of Stantec 2011 *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)* are considered valid and applicable for the refined project. As with the operations and draindown phases, the primary refinements to the project will be related to the water balance and anticipated flows to the passive treatment system.

In Appendix R10 of Stantec 2011 *Response to Request for Supplemental Information (YESAB Assessment 2010-0267)*, estimates of average flow rates to each passive treatment system were presented for the Project Proposal. These values have been updated to reflect the most recent water balance modeling and compare FS passive treatment flows to Project Proposal flows for average an annual monthly maximum flows for the average climate condition and are summarized in Table 3-1 below.

Table 3-1:
Inflow Rates Reporting to Passive Treatment Systems for Project and that Result from Project Refinements

Mine Water Stream	**Project Flow** *Freshet Flow* **(L/s)**	**Project Flow** *Average Flow* **(L/s)**	**Refined flow** *Freshet Flow* **(L/s)**	**Refined flow** *Average Flow* **(L/s)**
Eagle Pup WRSA	31	8	35	13
Platinum Gulch WRSA/Open Pit Overflow	44	11	53	17
Heap Leach Facility	8	2	13	3

Average flow calculated from water year of April to March

Comparisons of inflow rates with the refined water balance flows to the passive treatment systems for each of the reclamation areas are presented in Figures 3-9 to 3-11. As illustrated, the Project refinements result in increased flows reporting to each passive treatment system. Specifically, maximum (average climate condition) montly flows to the Eagle Pup passive treatment system are anticipated to be approximately 35 L/s or 11% higher than predicted for the Project. For the Platinum Gulch passive treatment system, maximum monthly average flows are predicted to be approximately 53 L/s or an increase of roughly 17% over those flows. Maximum monthly average flows emanating from the heap leach facility are expected to increase from 8 L/s to approximately 13 L/s or an increase of roughly 38%. The increase in flows are largely the result of increase in facility footprint as well as a more conservative assumption for infiltration into the reclamation cover for each facility of 20% of net precipitation.

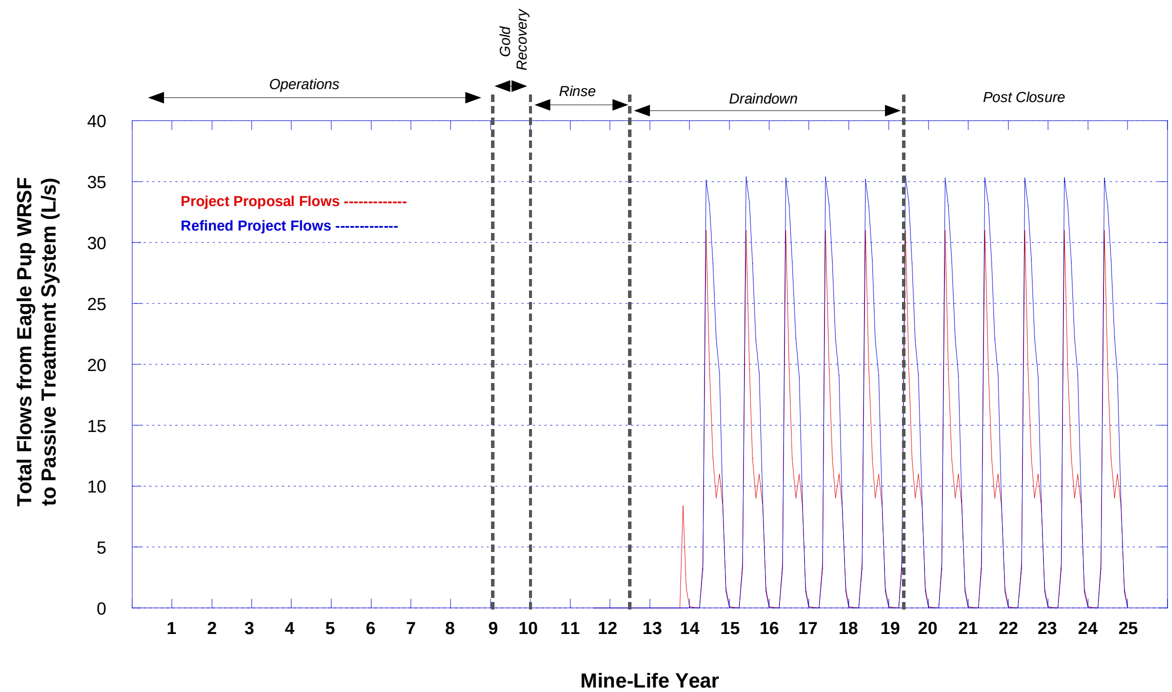

Figure 3-9: Comparison of Project and Refined flows to the Eagle Pup passive treatment system

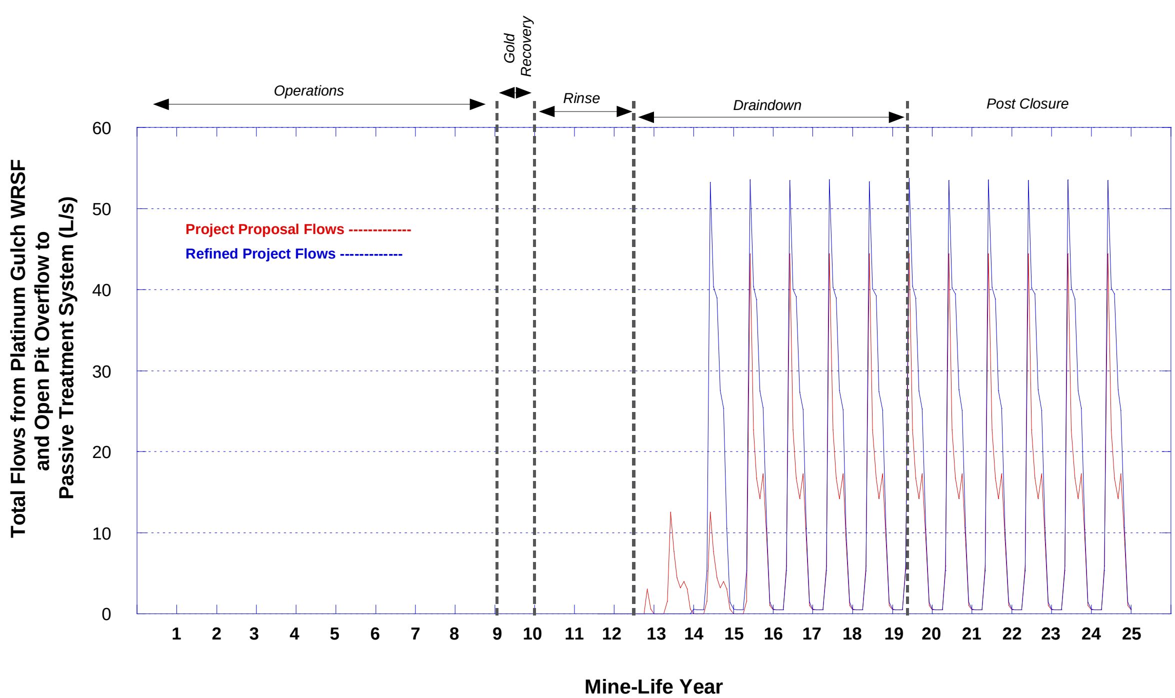

Figure 3-10: Comparison of Project and Refined flows to the Platinum Gulch passive treatment system

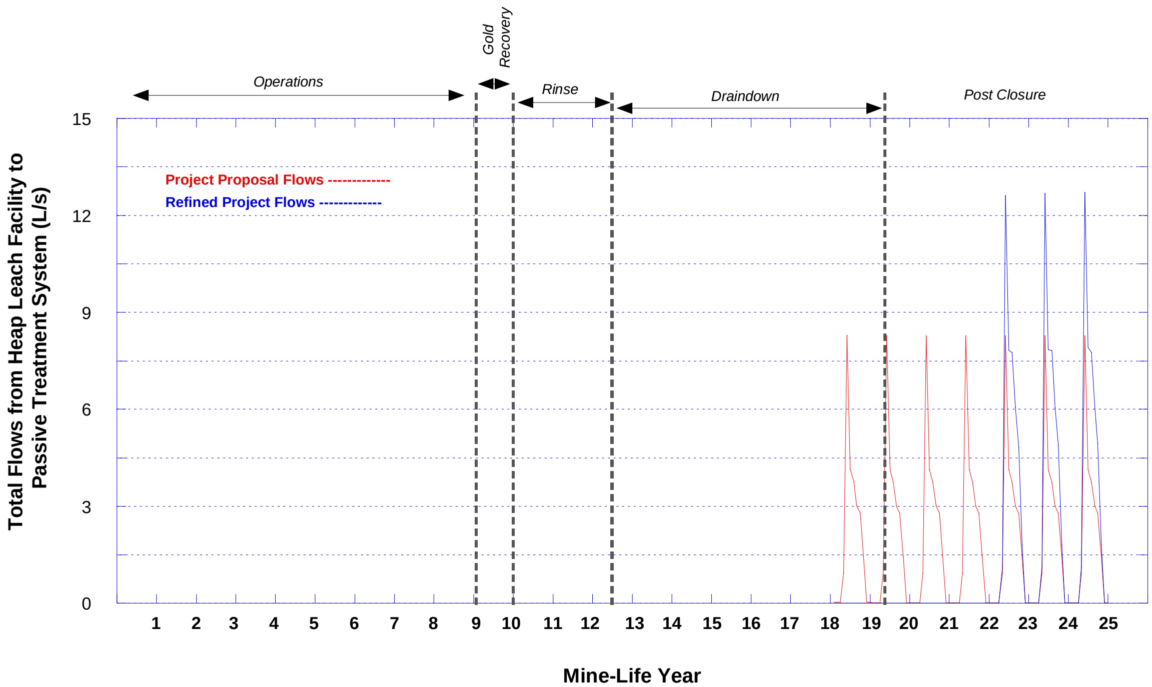

Figure 3-11: Comparison of Project and Refined flows to the Heap Leach Facility passive treatment system

The predicted performance of the proposed passive treatment systems was not explicitly modeled for the Project Proposal. It was acknowledged that performance of passive treatment systems will be dependent on a number of factors including influent water (facility seepage) chemistry, the effectiveness of the covers to reduce infiltration, inflow (facility seepage) rates, and treatment cell size and residence times. Recognizing that source term chemistries for the inflow to each passive treatment facility are not materially different as a result of the Project refinements. The refinements will result in higher flows and the requirement for increased treatment cell size to maintain adequate residence times in the passive treatment cells.

The slightly higher flows to the passive water treatment systems for the project refinement scenario can be readily accommodated by construction of larger treatment cells. Accordingly, no material changes to the post closure water quality effects assessment is warranted under the project refinement scenario.

Appendix
SRK 2012 Memorandum

SRK Consulting (Canada) Inc.
Suite 2200 - 1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	Steve Wilbur and Todd Goodsell	**Date:**	March 14, 2012
Company:	Victoria Gold	**From:**	Shannon Shaw, Kelly Sexsmith
Copy to:	Justin Stockwell, Lorax, Tracy Delaney, TetraTech	**Project #:**	1CV004.000
Subject:	Narrative on expected effects of Feasibility Study changes to the project design on the predicted source term concentrations.		

1 Introduction

SRK has been asked to review and describe how the previous source term predictions provided in the project proposal could change with updated project details as in the recently completed feasibility study for the project. The items that have materially changed in the feasibility study that could influence predicted source term concentrations for contact waters include:

- 21.4% increase in the footprint of the open pit
- 39.4% increase in the volume of the heap leach facility and total ore production
- 100% increase in the total tonnage of waste rock
- 23% increase in the waste rock storage area footprints
- revised crushing method
- a new 100-day temporary ore storage area

This memo summarizes the calculation steps used in the earlier predictions, potential limits on concentrations that were used to bound the original predictions, and a discussion of how the predictions could change as a result of changes to the project description.

2 Summary of Calculation Steps and Results from Earlier Predictions (SRK 2010)

Source term concentrations were predicted based on extrapolating or scaling metal release rates from lab-based humidity cell testing (in units of mg/kg/wk) to contact water concentrations from the field scale facility (in units of mg/L) using the equations 1 and 2 below.

$$M_{adj} = R \times k_{rm} \times k_{gs} \times k_f \times k_T \qquad (1)$$

Where:

M_{adj} = the adjusted metal leach mass (in mg/wk)
R_i = metal leach rate as observed by humidity cell testing (in mg/kg/wk)
K_{rm} = adjustment factor to correct for rock mass and material mixtures (in kg)
K_{gs} = adjustment factor to correct for grain size effects (unitless)
k_f = adjustment factor to correct for flow path development, or degree of flushing (unitless)
k_T = adjustment factor to correct for temperature effects (unitless)

$$C_{adj} = (M_{adj} / Q) \times 52 \qquad (2)$$

Where:

C_{adj} = the adjusted unequilibrated field concentration (in mg/L)
M_{adj} = the adjusted metal leach rate (in mg/wk)
Q = flows in contact with leachable rock (in L/wk)

Despite the application of scaling factors, concentrations of several parameters were unrealistically high in comparison to monitoring data from other geologically similar sites. Therefore, the scaled concentrations were evaluated against theoretical saturation limits for selected mineral phases[1] and analog data from sites that are geologically and climatically similar[2]. In some cases, the scaled concentrations were limited to either the saturation limits or the analog data. One of the key assumptions in determining whether saturation limits or analogs would be applicable was that pH conditions would remain in the circum-neutral range. This was supported by the geochemical characterization work described in SRK (2010[3]), which showed that the majority of the waste rock would be not potentially acid generating.

The analog data was found to be most relevant for parameters that; a) were often below or near analytical detection limits in the humidity cell leachate (e.g. boron, bismuth, chromium, phosphorus, thallium, vanadium) and/or b) were not constrained by supersaturated species in thermodynamic modeling runs and/or c) are involved in processes that cannot be reliably modelled such as attenuation, co-precipitation etc.

Source term concentrations as provided in SRK, 2010 are attached to this memo for reference (Attachment A), though the reader is referred to that report for detailed discussion and rationale for the application of analog data where used.

The potential limits on concentrations that were identified for each of the parameters are summarized in Tables 1 and 2 below. For the sake of brevity, only those parameters that were predicted to be within approximately 50% of a receiving water guideline, or predicted to exceed guidelines in the site wide water quality predictions (Stantec, 2010[4]) are discussed in this memo.

3 Potential Effects of Changes in Project Description

3.1 Waste Rock Storage Facility

As shown in Table 1, parameters that were in some instances limited by equilibrium concentrations including Al, Ba, Cd, Cu, Fe, Si and U and/or by analog concentrations including P, As, B, Bi, Cr, Cu, Hg, Mo, Ni, Ag, Sb, Se and Sn are noted. Of these, only Al, As, Cd, Cu, Hg, Ag, Sb and Se were close to receiving water criteria. The equilibrium and analog limits would not be expected to change as a result of changes to the project description. Therefore, concentrations for these parameters would not be expected to change.

Predictions for those parameters that were not previously limited by either empirical analog data or theoretical saturation limits (i.e. SO_4, F, Ca, Pb, Mg, Mn and Zn), could be influenced by two variables in equations 1 and 2 above. Specifically the factor for rock mass (K_{rm}) and flow (Q). Increased rock mass would mathematically increase the mass of each parameter that could be leached while increased flow would result in decreased predictions in terms of concentrations. For double the mass of waste rock, the maximum potential increase would be by a factor of 2. This would however be offset to some degree by the increased footprints and therefore increased flows.
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[1] Secondary mineral phases allowed to precipitate if supersaturated included gypsum, fluorite, gibbsite, barite, otavite, brochantite, ferrihydrite, chalcedony and uraninite.
[2] Analog sites included Fort Knox, True North, Pogo, Brewery Creek, Zortman, Landusky and the Eagle Pup baseline data.
[3] SRK Consulting (2010). Geochemical Characterization and Water Quality Predictions. Report prepared for Stantec Ltd., November 2010.
[4] Stantec Ltd. (2010). Eagle Gold Project, Project Proposal for Executive Committee Review. Report prepared for Victoria Gold Corp., December 2010.

Possible changes for those key parameters that were not limited by analogs or saturation limits include:

- Fluoride: Previous predictions for fluoride in the waste rock were below the analog limit and just undersaturated with respect to fluorite. Increases could therefore result with increased mass of waste with values still expected to be below the analog limit.

- Manganese: Predictions of Mn based on the pre-feasibility design were not dissimilar to those in the analog dataset. A few mg/L Mn can be expected. Increased mass of waste rock and ore could result in slightly higher predictions perhaps up to levels seen at the analog sites. No specific secondary mineral phase was included in the predictions to control Mn, though typically it may be Mn oxide or carbonate could form as are often noted in mining environments. Previous predictions provided a maximum value of 3.07 mg/L. Increases up to 4.6 mg/L which is the analog limit could result, but nothing higher would be expected (i.e. not as great as 2 times previous predictions).

- Selenium: Predictions for Se were based on an empirical ratio between Se and SO_4 with resulting concentrations close to, but not quite as high as the analog limit of 0.06 mg/L. Increased mass of waste rock is predicted to potentially influence the concentration of SO_4 (described below) and therefore Se concentrations could also increase. Increases would only be to values up to the analog limit.

- Sulphate: Predictions for SO_4 were not limited by either the analog limits or the saturation limit of gypsum (both close to approximately 2000 mg/L). Increased mass of waste could influence predictions for SO_4 by approximately double. In some cases modeled the predicted values would be slightly lower than the analog limit and in other cases the analog limit could be reached. The revisions based on the feasibility design could therefore result in higher concentrations approaching and/or reaching concentrations of ~1820 mg/L.

In summary, of the parameters that exceed or are close to receiving water quality guidelines in the overall site discharge, fluoride, manganese and selenium concentrations could increase slightly, and sulphate concentrations could increase by up to a factor of 2x.

Table 1. Summary of limits previously applied to source term concentration predictions for waste rock.

Parameter (in mg/L unless otherwise noted)	*Upper Bound from Analog Assessment*	*Analog - based, not likely to change*	*Saturation phase possible*	*Parameter predicted to be close to receiving water criteria*	*Post Closure Predictions for Eagle Pup WRP**	*Comments*
pH (s.u.)					7.1	Expect pH to remain near neutral
SO4	1820		gypsum [$CaSO_4.2H_2O$]	Y	946	SO4 may increase up to values ~2000
F	2.87		fluorite [CaF_2]		1.4	May increase slightly to analog value
P	8.5	Y			0.78	Considered already high due to DL issues
Al	0.6		gibbsite [$Al(OH)_3$]	Y	0.03	High in baseline, limited by saturation of gibbsite
As	1.4	Y		Y	1.4	High in baseline, limited by analog values
Ba	1.78		barite [$BaSO_4$]		0.005	Limited to saturation of barite
B	0.05	Y			0.05	Limited by analog value
Bi	0.008	Y			0.01	Limited by analog value
Cr	0.032	Y			0.03	Limited by analog value
Ca	1060				365	Possible increase, though influenced by saturation of gypsum
Cd	0.005		otavite [$CdCO_3$]	Y	0.007	Previous predictions influenced by DLs, probably already high, otavite predicted to be supersaturated in some cases
Cu	0.07	Y	brochantite [$Cu_4SO_4(OH)_6$]	Y	0.07	No change expected, relatively immobile in near neutral pH, limited in some cases by saturation of brochantite
Fe	6.4		ferrihydrite [FeOOH]		1.0	While buffered shouldn't change, limited by saturation of ferrihydrite
Pb	0.0746				0.05	Scaled values near to analog value, wouldn't expect much increase
Mg	374				29	Possible increase, though influenced by secondary minerals such as gypsum
Mn	4.6			Y	0.91	High in baseline, scaled values are near to the analog value, might increase to analog, but not much higher
Hg	0.0001	Y		Y	0.0001	No change expected, scaled values influenced by DLs
Mo	0.1	Y			0.09	No change expected, limited to analog value
Ni	1.3	Y			0.60	No change expected, limited to analog value
Ag	0.002	Y		Y	0.002	No change expected, high in baseline
Sb	1.4	Y		Y	1.4	No change expected, high in baseline
Se	0.0627	Y		Y	0.05	No change expected, high in baseline
Tl	0.002				0.002	Limited to analog limit and highly influenced by DLs
U	0.141		uraninite [UO_2]		0.42	Limited to saturation of uraninite
Zn	1.8				0.23	Possible increase, not expected to be as high as analog value

Notes: * Post closure concentrations in Platinum Gulch waste rock pile are typically less than these for parameters not currently limited by analog or equilibrium constraints.

3.2 Pit Walls

In general, concentrations predicted for the pit walls were limited by the relatively low rock to water ratio. These ratios would not increase as a result of increased pit size. Therefore, the pit wall concentrations would not change.

3.3 Heap Leach Facility

In a similar manner to the summary above for the waste rock predictions, Table 2 provides an overview of the selected parameter list for the heap leach facility predictions with; (1) an indication of which of those were limited by analog data, (2) which may be influenced by secondary mineralogy and (3) a commentary on anticipated changes.

Predictions provided in the project proposal to represent contact water source terms during operations and detoxification/rinsing of the heap were sourced directly from monitored leachate waters from the column test program and were not influenced by scaling factors. These predictions therefore would not change based on feasibility design revisions. Further, water treatment would be in place to treat water from the heap leach facility during these phases if required. This discussion therefore focusses on the post closure phases of the facility when a passive system has been proposed to treat waters draining from the spent ore heap leach facility. Previous predictions for this post closure phase were determined by scaling lab-based parameters as was done for the waste rock predictions.

Numerically, increased mass of ore loaded on the heap leach facility could influence the predicted leachable mass and resulting concentrations of parameters that were not previously limited by either saturation limits or analog data[5]. The maximum increases anticipated would be 40%, concomitant with the anticipated increase in ore mass. Again, this potential increase is considered an over estimate as increased footprints would result in increased flow and some degree of dilution. Those parameters that were previously limited, and that would not change include: As, B, Bi, Cr, Mo, Sb, Si, Ag, and U.

Also contrary to a potential increase due to increased mass, previous work was based on an HPGR crushed ore sample while the feasibility design now includes a coarser crush. It would be expected that predictions based on the finer ground sample tested previously would be conservative compared to a coarser sample. This potential effect has not been quantified to date, but will be assessed with on-going testwork.

Possible changes for those key parameters that were not limited by analogs or saturation limits include:

- Copper: Predictions for Cu were well below the analog limits and no equilibrium concentrations were imposed. Values could be marginally higher than that provided here (by a factor of 40%), but as mentioned for the waste rock, Cu is expected to be immobile at neutral pH values once the rinsing of CN related complexes is complete.
- Fluoride: Increased ore mass could result in slightly higher F concentrations, saturation limits of fluorite might be approached, analog limits would not be expected.
- Manganese: Predictions presented in the project proposal were below the analog limit; an increase of 40% in Mn would not be as high as the analog limit and therefore could occur.
- Mercury: Predictions for Hg were higher from the heap leach facility than from the waste rock storage facility; however values were often below detection and in some cases higher than was expected from the column testwork. QA/QC issues were suspected in many of the Hg values

[5] The analog dataset for the heap leach facility was in part influenced by monitoring data from the Zortman and Landusky mines where localized acid rock drainage may have resulted in elevated concentrations of certain parameters beyond that expected at Eagle Gold. These were included as a measure of conservatism in the previous predictions and are still believed to be a conservative upper bound in many instances.

that were measured therefore the predictions are considered to be overly conservative. Increases by 40%, while not expected would not be as high as the analog limit.

- Selenium: Previous predictions for Se were not limited by the analog value or equilibrium of secondary minerals. Increases by 40% would however approach the analog limit and may be realized.

- Sulphate: Previously predicted SO_4 concentrations were on the order of 2400 to 2800 mg/L from the heap leach facility post closure. An additional 40% increase in mass may result in 40% increase in concentrations, but not greater. This amount of increase would approach and be limited to the analog value of approximately 3400 mg/L.

In summary, once parameters related to processing have fully rinsed from the heap (CN complexes and elevated pH) long term concentrations may be expected to have minor increases in concentrations of Cu, F, Mn, Hg[6], Se and SO_4.

3.4 Low Grade Ore Stockpile

The previous predictions did not include a source term for the low grade ore stockpile. A new 100-day stockpile has been proposed in the feasibility study to store ore during the winter months. This stockpile would be gradually depleted during the spring and summer, resulting in a maximum of 9 months residence time for material placed in this area. Given that this stockpile will only be present for short periods of time during operations, and the generally non-reactive nature of the rock, it is not expected that poor quality contact water quality will arise during the 9 month (or less) exposure of rock in this area. Should poor quality contact water occur, there will be water treatment capabilities in place during operations to manage the water. This change to the design would not be expected to have a measurable effect on the receiving environment beyond the degree of uncertainty already included in the source terms for the other facilities. Further, this facility would not persist on closure.

[6] QA/QC issues related to Hg data may have influenced predictions.

Table 2. Summary of limits previously applied to source term concentration predictions for the heap leach spent ore.

Parameter (in mg/L unless otherwise noted)	*Upper Bound from Analog Assessment*	*Analog - based, not likely to change*	*Saturation phase possible*	*Parameter predicted to be close to receiving water criteria*	*Long Term HLF Prediction (EA Values)*	*Comments*
pH (s.u.)					7.2	Expect pH to stabilize to near neutral values after rinsing
SO4	3443		gypsum [$CaSO_4.2H_2O$]		2244	SO4 may increase up to values ~3400
F	5.6		fluorite [CaF_2]		2.22	May increase slightly approaching fluorite equilibrium or 40% increase
P	1.3				0.4	Considered already high due to DL issues
Al	3.8		gibbsite [$Al(OH)_3$]	Y	0.03	High in baseline, limited by saturation of gibbsite in the long term
As	6	Y		Y	4.3	High in baseline, limited by analog values
Ba	0.7		barite [$BaSO_4$]		0.002	Limited to saturation of barite
B	0.5	Y			0.5	Limited by analog value
Bi	0.007	Y			0.005	Limited by analog value
Cr	0.02	Y			0.02	Limited by analog value
Ca	343				268	Possible increase, though influenced by saturation of gypsum
Cd	0.03		otavite [$CdCO_3$]	Y	0.002	Previous predictions influenced by DLs, probably already high,
Cu	0.47		brochantite [$Cu_4SO_4(OH)_6$]	Y	0.12	Minor increases could be seen, but would not approach the analog limit, relatively immobile in near neutral pH once CN complexation is reduced
Fe	21.4		ferrihydrite [FeOOH]		0.61	Should be limited by saturation of ferrihydrite once CN complexation effects are reduced, wouldn't approach analog limit
Pb	0.12				0.01	Short term scaled values near to analog value, wouldn't expect much increase and anticipate a decrease over time
Mg	135				248	Possible increase, though influenced by secondary minerals such as gypsum
Mn	1.4			Y	0.7	High in baseline, scaled values are near to the analog value, might increase to analog, but not much higher
Hg	0.007				0.002	No change expected, scaled values influenced by DLs
Mo	0.2	Y			0.2	No change expected, limited to analog value
Ni	0.9				0.1	No change expected, scaled values influenced by DLs
Ag	0.04	Y		Y	0.0006	No change expected, high in baseline, influenced by DLs
Sb	1.7	Y		Y	1.7	No change expected, high in baseline
Se	0.35			Y	0.3	Minor change possible, approaching analog value
Tl	0.009				0.004	Minor change possible, strongly influenced by DLs
U	0.37	Y	uraninite [UO_2]		0.37	Limited to analog value
Zn	15				0.14	Possible increase, not expected to be as even 10x less than analog value

4 Summary and Conclusions

Given the degree of uncertainty in source term predictions for mining facilities, predictions of this nature are made in a very conservative manner. Due to that approach and as rationalized in the discussion above, the source term concentrations provided based on the pre-feasibility work are considered appropriate for the feasibility design.

It should be recognized that while we would not expect concentrations to change markedly, the evaluation of how loadings may change from the facility will need to be assessed in the context of the site-wide water and load balance. Specifically, the effect of changing footprints may have an influence on predicted water qualities within the hydrological basins of interest and should be considered in this evaluation.

Regards

SRK Consulting (Canada) Inc.

Shannon Shaw, P.Geo (B.C.)
Associate Geochemist

Kelly Sexsmith, P.Geo (B.C.)
Principal Environmental Geochemist

Attachment A Tables 13 and 14 from SRK, 2010: predicted source term concentrations.

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Table 13: Predicted source term water qualities for the waste rock storage facilities and pit wall run-off

Parameter[1] (in mg/L unless otherwise noted)	Minimum Detection Limits	Upper Bound from Analog Assessment	Highest Value from Humidity Cell Leachates[2]	Platinum Gluch WRSA			Eagle Pup WRSA					Pit Wall Runoff (includes small backfill pile on closure)				
				Average Years			Average Years					Average Years				
				Year 1	Year 3	Closure	Year 1	Year 3	Year 5	Year 7	Closure	Year 1	Year 3	Year 5	Closure	
pH (s.u.)				7.5	7.1	7.1	7.1	7.1	7.2	7.0	7.1	7.5	7.5	7.5	7.5	
SO_4		1820	866	236	1002	909	935	962	1589	774	946	129	128	137	143	
alkalinity as HCO_3		433	176	159	248	234	244	248	321	218	245	106	121	124	149	
Cl	<0.5	159	20	10	14	13	8	8	10	9	8	3	4	4	4	
F		2.9	2.9	1.8	1.5	1.4	1.4	1.4	1.9	1.2	1.4	1.1	1.0	1.1	1.1	
P[5]	<0.002	0.78	0.03	0.9	0.78	3.8	0.78	0.78	0.78	0.78	0.78	0.5	0.6	0.6	0.7	
Al		0.60	0.15	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
As[5]		1.40	0.18	0.2	1.4	1.2	1.4	1.4	1.4	1.4	1.4	0.2	0.3	0.2	0.2	
Ba		1.78	0.10	0.01	0.004	0.004	0.003	0.003	0.002	0.005	0.003	0.01	0.01	0.01	0.01	
B[5]	<0.05	0.05	<0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Bi[5]	<0.000005	0.01	0.0001	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Cr[5]	<0.0001	0.03	0.001	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	
Ca		1060	190	142	375	409	368	360	256	461	365	82	85	88	98	
Cd	<0.000005	0.005	0.004	0.001	0.007	0.008	0.007	0.007	0.006	0.008	0.007	0.001	0.001	0.001	0.001	
Cu[5]		0.07	0.02	0.03	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.02	0.02	0.02	0.03	
Fe		6.40	0.36	0.07	1.1	0.4	1.0	1.1	2.8	1.7	1.0	0.05	0.05	0.05	0.06	
K		22	20	27	43	41	28	27	35	30	27	12	14	15	17	
Li		0.02	0.07	0.05	0.60	0.21	0.50	0.60	1.74	0.91	0.50	0.03	0.03	0.04	0.04	
Pb		0.07	0.01	0.004	0.05	0.02	0.05	0.05	0.16	0.08	0.05	0.003	0.003	0.003	0.004	
Mg		374	48	43	73	68	27	29	37	33	29	6	7	7	9	
Mn		4.60	0.29	0.08	1.08	0.36	0.91	1.06	3.07	1.62	0.91	0.05	0.05	0.05	0.06	
Hg[5]	<0.00001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	
Mo[5]		0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.07	0.08	0.08	0.09	
Ni[5]		1.28	0.10	0.06	0.77	0.26	0.66	0.76	1.28	1.11	0.60	0.04	0.04	0.04	0.05	
Ag[5]	<0.000005	0.002	0.0001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	
Na		38	136	7	12	11	4	4	6	5	5	2	3	3	4	
Sb[5]		1.40	0.69	0.10	1.40	0.60	1.15	1.40	1.40	1.40	1.40	0.09	0.10	0.08	0.14	
Se[6]		0.06	0.06	0.01	0.05	0.05	0.05	0.05	0.08	0.04	0.05	0.01	0.01	0.01	0.01	
Si		34	4	4	5	5	5	5	5	5	5	2	2	2	3	
Sn[5]	<0.00001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	
Tl[5]	<0.000002	0.002	0.000	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	
Ti[5]	<0.0005	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	
U		0.14	0.14	0.02	0.40	0.14	0.26	0.41	0.51	0.73	0.42	0.02	0.03	0.02	0.04	
V[5]	<0.0002	0.02	0.001	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
Zn		1.80	0.10	0.02	0.28	0.09	0.24	0.27	0.81	0.40	0.23	0.01	0.02	0.02	0.02	

Notes:

1 Parameters noted in red suffer from detection limit influences, i.e. humidity cell leachate values were consistently or often less than detection and scaling of detection limits results in excessively conservative numbers (possibly by an order of magnitude or more).

2 Highest concentrates most often were reported from the larger humidity cell consisting of 15 kg of sample (27 cm x 36 cm cell) in which water application rates of 682, 71, 0 and 920 mL per week over 4 consecutive weeks was conducted to simulate seasonal infiltration variations (Lawrence, 1997).

3 Nitrogen species not included in source term calculations (as they are based on drill core test results)

4 CN species not included in waste rock storage area predictions

5 Concentrations limited by upper bounds in analog assessment

6 Concentrations adjusted based on observed ratios with SO4 from humidity cell leachate and predicted SO4 from thermodynamic equilibrium

Table 14: Predicted source term water qualities for the heap leach facility

Parameter[1] (in mg/L unless otherwise noted)	Minimum Detection Limits	Upper Bound from Analog Assessment[2]	Highest value from modified humidity cell (Hcol 7B)	HLF – Average Hydrologic Conditions			
				Operations[3]	Detoxification / Rinsing[4]	Post Closure	
						Short Term[5]	Long Term[6]
pH (s.u.)		8		11.3	10.0	7.3	7.2
SO4		3443	2800	990	1400	2800	2244
alkalinity as HCO3		601	170	570	570	352	347
Cl		36	36	35	44	36	36
F		5.6	2.4	0.50	0.50	2.40	2.22
P	<0.5	1.3	0.06	0.3	0.3	0.1	0.4
Al		3.8	2.6	0.30	0.30	2.60	0.03
As		6	2.1	0.4	0.7	6.0	4.3
Ba		0.7	0.17	0.083	0.083	0.17	0.002
B	<0.1	0.5	0.5	0.15	0.15	0.5	0.50
Bi	<0.000005	0.007	0.007	0.3	0.3	0.007	0.005
Cr	<0.005	0.02	0.003	0.01	0.01	0.004	0.02
Ca		343	530	260	260	530	268
Cd	<0.0003	0.03	0.0005	0.009	0.009	0.004	0.002
Cu		0.47	0.04	9.80	9.80	0.11	0.12
Fe		21.4	0.74	2.60	2.60	0.74	0.61
Pb		0.12	0.12	0.25	0.25	0.19	0.01
Mg		135	13	1.5	1.50	45	248
Mn		1.4	0.03	0.02	0.0190	0.6	0.7
Hg[7]	<0.00001	0.007	0.00008	0.00095	0.00008	0.0004	0.002
Mo		0.2	0.2	0.3	0.3	0.2	0.2
Ni	<0.010	0.9	0.01	0.1	0.100	0.01	0.1
Ag	<0.005	0.04	0.03	0.02	0.0170	0.03	0.0006
Na		1988	720	780	780	720	165
Sb		1.7	1.7	0.10	0.27	1.7	1.7
Se		0.35	0.09	0.1	0.1	0.2	0.3
Tl	<0.001	0.009	0.0002	0.002	0.002	0.0004	0.004
U		0.37	0.37	0.001	0.01	0.37	0.37
Zn		15	0.2	8.80	8.80	0.57	0.14

Notes:

1 Parameters noted in red suffer from detection limit influences, i.e. humidity cell leachate values were consistently or often less than detection and scaling of detection limits results in excessively conservative numbers (possibly by an order of magnitude or more).

2 Upper Bound Values from Analog Assessment could be influenced by cyanide complexes, particularly for As, Cu, Co, Fe, Hg, Ni and Zn

3 Assumes maximum values from the KCA metallurgical column (operation phase) to reflect a build-up of constituents over time with re-circulation. A few notable exceptions were Ba (high outlier excluded), as well as Cd, Cr and Hg which did not show cumulative build-up with cycles (median values used in these cases).

4 Given the method of rotational irrigation proposed, including during the detox/rinsing phase, the water quality in this period is likely to be a mixture of various water types evaluated to date. Throughout the detox phase, when solutions will continue to be re-circulated, it has been assumed that solutions could still reflect operational phase chemistry for many parameters. A few notable exceptions are for parameters that reported higher values in the detox stage of the metallurgical column evaluation. Therefore the higher of the operations phase expectations and the monitored values for the detox testwork have been assumed (except for pH).

5 Based on calculations of pore volume flushes and treatment activities, this short-term stage is anticipated to be on the order of 10's of years following detox/rinsing

6 Currently assumes 100% net infiltration, i.e. no cover; current best estimates of timing is many 10's to 100 years post detox

7 Additional analytical work is being conducted to confirm Hg values as a result of QA/QC issues.