APPENDIX 14-B

Water Quality Assessment of the Reasonable Upper Limit Case

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

470 Granville Street, Suite 630, Vancouver, BC V6C 1V5 t 604-629-9075

Memorandum

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To: Max Brownhill, Brownhill Consulting Services Ltd.

From: May Mason and Rob Marsland, Palmer Environmental Consulting Group Inc.

cc: Rick Palmer, Palmer Environmental Consulting Group Inc.

Re: Red Mountain Underground Gold Project – The Reasonable Upper Limit Case – Water Quality

1 Introduction

The Surface Water Quality Effects Assessment (Volume 3, Chapter 13) uses the Base Case, which are the median (P50) predictions of the Water and Load Balance Model (Appendix 14-C). This case is generally what would be 'expected' as water quality predictions for the proposed Red Mountain Underground Gold Project (the Project). To compensate for the inherent nature of uncertainties associated with water quality modelling and the dependencies on numerous input sources, water quality models tend to be a conservative assessment of predicted water quality. However, the inherent uncertainty can also lead to reduced confidence in the predictions. Therefore, to address the uncertainty and increase confidence, a Reasonable Upper Limit Case is presented in this memo using the 90th percentile (P90) predictions. The same residual effects assessment methodology from Volume 3, Chapter 13 is applied to the P90 predictions with full characterization of residual effects.

The two residual effects outlined in Volume 3, Chapter 13 are: 1) Change in Surface Water Quality from Mine Discharge and 2) Change in Surface Water Quality from Tailings Management Facility (TMF) Discharge. Definitions of residual effects criteria for Surface Water Quality are in Volume 3, Chapter 13.

2 Change in Surface Water Quality from Upper Limit Mine Discharge

2.1 Residual Effect Analysis

Both the Mine Discharge and TMF Discharge residual effects were assessed using the predictions from Appendix 14-C and so this analysis addresses residual effects for both discharges.

Identification of contaminants of potential concern (COPCs) for Surface Water Quality is based on an initial list of parameters predicted to exceed water quality guidelines (BC[1] or CCME[2]) and then a screening to evaluate suitability of parameters to be brought forward as a COPC.

The measurement indicators for assessment of residual effects on Surface Water Quality are covered in the list of the 31 parameters in the model (
Table 2.1-1). Full results from the model are summarized by monthly maximums for Background, Operations and Post-Closure in Appendix 14-C. The only activity that is included in the water and load balance model during the Construction Phase is the movement of waste rock to the temporary development waste storage area. This results in negligible changes in surface water quality from background. Comparisons of water quality predictions in the reasonable upper limit case were made with BC and CCME guidelines. Where there were both short-term and long-term guidelines, the long-term guidelines were used as a conservative measure. A high-level summary of parameters that exceed the BC or CCME WQG is shown in Table 2.1-2.

Table 2.1-1: Surface Water Quality Parameters Included in Predictions

Parameters Included in Predictions		
Total Hardness	Boron, dissolved	Mercury, dissolved
Alkalinity	Cadmium, dissolved	Molybdenum, dissolved
Acidity	Calcium, dissolved	Nickel, dissolved
Fluoride	Chromium, dissolved	Selenium, dissolved
Sulphate	Cobalt, dissolved	Silver, dissolved
Nitrate as N	Copper, dissolved	Thallium, dissolved
Nitrite as N	Iron, dissolved	Uranium, dissolved
Ammonia as N	Lead, dissolved	Zinc, dissolved
Aluminum, dissolved	Magnesium, dissolved	Cyanide, total
Antimony, dissolved	Manganese, dissolved	Cyanide, WAD
Arsenic, dissolved		

[1] *British Columbia (BC) Ministry of Environment (MOE) Approved and Working Water Quality Guidelines for the Protection of Aquatic Life*
[2] *Canadian Council of Ministers of Environment CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life*

Table 2.1-2: Summary of Parameters that Exceed CCME or BC Water Quality Guidelines (P90 Case)

Parameter	GSC02	RBC02	BC08	BC06	BC02	BR06
Mercury, dissolved[1]	*O*	-	*O*	*O*	*O*	-
Fluoride	-	-	BG, O, PC	BG, O, PC	-	-
Nitrite as N	O	-	-	-	-	-
Antimony, dissolved[2]	O	-	O		-	-
Arsenic, dissolved	O	-	-	-	-	-
Cadmium, dissolved	BG, O, PC	O, PC	BG, O, PC	O, PC	BG, O, PC	BG, O, PC
Cobalt, dissolved	O, PC	-	-	-	-	-
Copper, dissolved	BG, O, PC	-	O	O	BG, O, PC	-
Manganese, dissolved	O	-	-	-	-	-
Selenium, dissolved	BG, O, PC	BG, O, PC	BG, O, PC	BG, O, PC	BG, O, PC	BG, O, PC
Silver, dissolved	PC	PC	PC	PC	PC	-
Zinc, dissolved	BG, O, PC	PC	BG, O, PC	O, PC	O, PC	O

BG = Background concentration exceeds BC / CCME WQG
O = Predicted concentration during Operations exceeds BC / CCME WQG
PC = Predicted concentration during Post-Closure exceeds BC / CCME WQG
1) Mercury exceeds guidelines due to model artifacts (see Appendix 14-C)
2) BC Working Water Quality Guidelines

2.1.1 Mercury

Mercury exceeds guidelines during Operations in Goldslide Creek and Bitter Creek; these exceedances are due to a detection limit issue in source term development and are model artifacts.

2.1.2 Fluoride

Predicted fluoride concentrations exceed the CCME WQG (0.12 mg/L) during Operations and Post-Closure in Bitter Creek. The maximum monthly concentration is 0.17 mg/L (May and June) at BC08 and 0.21 mg/L (May and June) at BC06. Background concentrations are the same.

2.1.3 Nitrite

Predicted nitrite exceeds the BC WQG (0.002 mg/L) during Operations in Goldslide Creek. The maximum concentration is 0.048 mg/L (December), which is 2.4 times the guideline.

2.1.4 Antimony

Predicted antimony exceeds the BC Working WQG (0.009 mg/L) during Operations in Goldslide Creek and Bitter Creek at BC08.

- The maximum concentration in Goldslide Creek is 0.026 mg/L (December), which is 2.9 times the guideline.
- The only exceedance in Bitter Creek at BC08 is 0.0094 in the month of December, which is 1.05 times the guideline.

2.1.5 Arsenic

Predicted arsenic exceeds both the BC and CCME WQGs (0.005 mg/L) during Operations in Goldslide Creek. The maximum concentration is 0.008 mg/L (December), which is 1.6 times the guideline.

2.1.6 Cadmium

Predicted cadmium exceeds both the BC and/or CCME WQGs (hardness dependent) during Operations and Post-Closure in Goldslide Creek, Rio Blanco Creek, Bitter Creek and Bear River.

- The maximum concentration in Goldslide Creek during Operations is 0.00069 mg/L (December), which is 15.9, 19.6 and 25.7 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.00095 mg/L (July), which is about 4.3, 5.7 and 2.2 times the BC WQG, CCME WQG, and background concentrations, respectively.
- The maximum concentration in Rio Blanco Creek during Operations is 0.00026 mg/L (September), which is below the BC WQG but 1.1 and 2.6 times the CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.00058 mg/L (July), which is 2.2, 2.9 and 2.6 times the BC WQG, CCME WQG, and background concentrations, respectively.
- The maximum concentration in Bitter Creek during Operations at BC08 is 0.00209 mg/L (December), which is 5.1, 6.2 and 20.9 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is 0.0003 mg/L (June), which is 1.5, 2.1 and 1.5 times the BC WQG, CCME WQG, and background concentrations, respectively.
- The maximum concentration in Bitter Creek during Operations at BC06 is 0.00185 mg/L (December), which is 4.5, 5.5, and 19.0 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is 0.00040 mg/L (December), which is 1.2, 1.4, and 4.1 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum concentration in Bitter Creek during Operations at BC02 is 0.0013 mg/L (December), which is 3.3, 4.1, and 11.6 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is 0.00032 mg/L (December), which is below the BC WQG but 1.1 and 2.8 times the CCME WQG, and background concentrations, respectively

- The maximum concentration in Bear River during Operations at BR06 is 0.00055 mg/L (December), which is 2, 2.5, and 5.5 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is 0.00022 mg/L (June), which is 1.5, 2.1 and 1.1 times the BC WQG, CCME WQG, and background concentrations, respectively

2.1.7 Cobalt

Predicted cobalt exceeds the BC WQG (0.004 mg/L) during Operations and Post-Closure in Goldslide Creek. During Operations, the maximum concentration is 0.0092 mg/L (December), which is 2.3 and 20.4 times the BC WQG and background concentrations, respectively. During Post-Closure, the maximum concentration is 0.0049 mg/L, which is 1.2 and 10.8 times the BC WQG and background concentrations, respectively.

2.1.8 Copper

Predicted copper exceeds the BC and/or CCME WQGs (hardness dependent) during Operations and Post-Closure in Goldslide Creek and Bitter Creek:

- The maximum copper concentration in Goldslide Creek during Operations is 0.016 mg/L (December), which is 1.5, 4, and 3.4 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0095 mg/L (July), which is 2.2, 3.8, and 1.1 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum copper concentration in Bitter Creek at BC08 during Operations is 0.0053 mg/L (December), which is below the BC WQG, but 1.3 and 5.3 times the CCME WQG, and background concentrations, respectively.

- The maximum copper concentration in Bitter Creek at BC06 during Operations is 0.0047 mg/L (December), which is below the BC WQG, but 1.2 and 4.7 times the CCME WQG, and background concentrations, respectively.

- The maximum copper concentration in Bitter Creek at BC02 during Operations is 0.0047 mg/L (December), which is below the BC WQG, but 1.2 and 2.2 times the CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0041 mg/L (September), which is below the BC WQG, but 1.4 and 1.03 times the CCME WQG, and background concentrations, respectively.

2.1.9 Manganese

Manganese exceeds the hardness dependent BC WQG (1.75 mg/L) during Operations in Goldslide Creek. The maximum concentration is 1.83 mg/L (December), which is 1.04 times the BC WQG.

2.1.10 Selenium

Predicted selenium exceeds the BC (0.002 mg/L) and/or CCME (0.001 mg/L) WQGs during both Operations and Post-Closure in Goldslide Creek, Rio Blanco Creek, Bitter Creek and Bear River.

- The maximum selenium concentration in Goldslide Creek during Operations is 0.0086 mg/L (December), which is 4.3, 8.6, and 3.8 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0042 mg/L (February and November), which is 2.1, 4.2 and 1.9 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum selenium concentration in Rio Blanco Creek during Operations is 0.0047 mg/L (October and November), which is 2.3, 4.7 and 1.04 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0055 mg/L (October), which is 2.8, 5.5 and 1.2 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum selenium concentration in Bitter Creek at BC08 during Operations is 0.0044 mg/L (December), which is 2.2, 4.4 and 2.1 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0024 mg/L (February and March), which is 1.2, 2.4 and 1.1 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum selenium concentration in Bitter Creek at BC06 during Operations is 0.0044 mg/L (December), which is 2.2, 4.4 and 1.8 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0028 mg/L (February), which is 1.4, 2.8 and 1.2 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum selenium concentration in Bitter Creek at BC02 during Operations is 0.0050 mg/L (December), which is 2.5, 5.0 and 1.4 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0039 mg/L (February), which is 2, 3.9, and 1.1 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum selenium concentration in Bear River at BR06 during Operations is 0.0021 mg/L (December), which is 1.1, 2.1, and 1.3 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.0017 mg/L (February), which is below the BC WQG, but 1.7 and 1.1 times the CCME WQG, and background concentrations, respectively.

2.1.11 Silver

Predicted silver exceeds the BC (hardness dependent) and/or CCME (0.00025 mg/L) WQGs during Post-Closure in Goldslide Creek, Rio Blanco Creek, and Bitter Creek.

- The maximum silver concentration in Goldslide Creek during Post-Closure is 0.00036 mg/L (February), which is below the BC WQG, but 1.5 and 18 times the CCME WQG, and background concentrations, respectively.

- The maximum silver concentration in Rio Blanco Creek during Post-Closure is 0.00029 mg/L (February), which is below the BC WQG, but 1.2 and 15 times the CCME WQG, and background concentrations, respectively.

- The maximum silver concentration in Bitter Creek at BC08 during Post-Closure is 0.00010 mg/L (February); however, this concentration does not exceed silver's BC WQG, which is hardness dependent (BC WQG is 0.0015 mg/L for February). Exceedances occur May to August, when hardness is lower. The maximum concentration during this period is 0.000095 mg/L (July), which is lower than the CCME WQG, but 1.9 and 5.6 times the BC WQG, and background concentrations, respectively.

- The maximum silver concentration in Bitter Creek at BC06 during Post-Closure is 0.000099 mg/L (December); however, this concentration does not exceed silver's BC WQG, which is hardness dependent (BC WQG is 0.0015 mg/L for December). Exceedances occur during the months of July and August, when hardness is lower. The maximum concentration during these months is 0.000085 mg/L (July), which is lower than the CCME WQG, but 1.7 and 4.5 times the BC WQG, and background concentrations, respectively.

- The maximum silver concentration in Bitter Creek at BC02 during Post-Closure is 0.000074 mg/L (December); however, this concentration does not exceed silver's BC WQG, which is hardness dependent (BC WQG is 0.0015 mg/L for December). Exceedances occur during the months of June to August, when hardness is lower. The maximum concentration during these months is 0.000062 mg/L (July), which is lower than the CCME WQG, but 1.2 and 3.6 times the BC WQG, and background concentrations, respectively.

2.1.12 Zinc

Predicted zinc exceeds both the BC (hardness dependent) and/or CCME (0.03 mg/L) WQGs during Operations and/or Post-Closure in Goldslide Creek, Rio Blanco Creek, Bitter Creek and Bear River.

- The maximum zinc concentration in Goldslide Creek during Operations is 0.426 mg/L (December), which is 3.1, 14, and 23 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to

be 0.057 mg/L (June), which is 6.8, 1.9, and 2.0 times the BC WQG, CCME WQG, and background concentrations, respectively.

- The maximum zinc concentration in Rio Blanco Creek during Post-Closure is 0.0304 mg/L (November), which is below the BC WQG, but 1.01 and 6.1 times the CCME WQG, and background concentrations, respectively.

- The maximum zinc concentration in Bitter Creek at BC08 during Operations is 0.131 mg/L (December), which is 1.03, 4.4 and 17.6 times the BC WQG, CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.015 mg/L (June), which is below the BC WQG, but 2.0, and 1.6 times the CCME WQG, and background concentrations, respectively.

- The maximum zinc concentration in Bitter Creek at BC06 during Operations is 0.092 mg/L (November), which is below the BC WQG, but 3.1 and 8.7 times the CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.039 mg/L (December), which is below the BC WQG, but 1.3, and 3.7 times the CCME WQG, and background concentrations, respectively.

- The maximum zinc concentration in Bitter Creek at BC06 during Operations is 0.092 mg/L (November), which is below the BC WQG, but 3.1 and 8.7 times the CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.039 mg/L (December), which is below the BC WQG, but 1.3, and 3.7 times the CCME WQG, and background concentrations, respectively.

- The maximum zinc concentration in Bitter Creek at BC02 during Operations is 0.079 mg/L (December), which is below the BC WQG, but 2.6 and 14 times the CCME WQG, and background concentrations, respectively. During Post-Closure, the maximum concentration is predicted to be 0.025 mg/L (December), however, this concentration does not exceed zinc's BC WQG, which is hardness dependent (BC WQG is 0.089 mg/L for December). Exceedances occur in June to August, when hardness is lower. The maximum concentration during these months is 0.011 mg/L (July), which is lower than the CCME WQG, but 1.5 and 1.6 times the BC WQG, and background concentrations, respectively.

- The maximum zinc concentration in Bear River during Operations is 0.035 mg/L (December), which does not exceed the BC WQG but is 1.2 and 5.3 times the CCME WQG and background concentrations, respectively.

2.1.13 Summary of Contaminants of Potential Concern (COPC) for the P90 Case

A subset of the parameters discussed above is brought forward to be considered a COPC. These parameters are:

- Goldslide Creek
  Operations: antimony, arsenic, cadmium, cobalt, copper, selenium, zinc

Post-Closure: cadmium, copper, selenium, silver and zinc

- Rio Blanco Creek
  Operations: none
  Post-Closure: cadmium, silver, selenium

- Bitter Creek
  Operations: cadmium, selenium, zinc
  Post-Closure: cadmium, silver, zinc

- Bear River
  Operations: cadmium
  Post-Closure: none

Fluoride was not brought forward. Exceedances are entirely (~100%) due to the background concentrations.

Nitrite was not brought forward. Nitrite exceedances in Goldslide Creek are a result of blasting residues; however, they are highly unlikely to stay in this form in surface water, as natural oxidation processes will convert the nitrite to nitrate. BC and CCME long-term and short-term WQGs for nitrate are several orders of magnitude higher than respective guidelines for nitrite and so even if all the nitrite is converted to nitrate, no guidelines will be exceeded.

Antimony was not brought forward for Bitter Creek. There is only 1 month (December) where the working WQG is exceeded and the exceedance is marginal (1.05 times).

Cadmium was not brought forward for Rio Blanco Creek during Operations. There are just 3 months (July to September) where the maximum monthly predictions for cadmium exceed the CCME WQG during Operations. Exceedance of the CCME WQG is marginal (10% above) and is within natural variability and model error. Furthermore, the BC WQG, arguably more relevant to streams in the BC-based Project, is not exceeded at any point. Cadmium was also not brought forward for Bear River during Post-Closure. Background concentrations of cadmium exceeds both the BC and CCME WQG in Bear River, and during Post-Closure, background concentrations will account for over 90% of the predicted concentration.

Cobalt was not brought forward for Goldslide Creek during Post-Closure. Exceedances of the BC WQG occur in 6 months and are within 20% of the guideline, which is within natural variability and model error.

Copper was not brought forward for Bitter Creek for Operations or for Post-Closure. Predicted concentrations of copper in Bitter Creek do not exceed BC WQGs. Exceedances at BC08 and BC06 occur in only 1-2 months (November/December) and are 20-30% above CCME WQGs. BC WQG are more relevant as guidelines as they are intended to represent more closely the conditions in BC waters. Background concentrations of copper exceed CCME WQG; exceedances at BC02 are almost entirely due to the elevated background concentrations.

Manganese was not brought forward was the BC WQG exceedance occurs in just the month of December, is marginal and is well within natural variability, analytical uncertainty, and model error.

Selenium was not brought forward for Rio Blanco Creek during Operations; for the majority of the monthly maximums, the background concentrations accounted for more than 90% of the predicted selenium concentrations. Selenium was also not brought forward for Bitter Creek during Post-Closure. Background concentrations of selenium exceeds both the BC and CCME WQGs and, during Post-Closure, accounts for between 77-100% of predicted concentrations. Selenium was also not brought forward for Bear River during Operations or Post-Closure. Background selenium concentrations exceeds the CCME WQG. During Operations, the maximum monthly selenium concentration exceeds the BC WQG by just 7% and background selenium accounts for between 76% and 97% of predicted concentrations. During Post-Closure, the maximum monthly selenium concentration is below the BC WQG and background selenium accounts for between 94% and 96% of predicted concentrations.

Zinc was not brought forward for Rio Blanco Creek during Post-Closure as it is below the BC WQG and at the CCME WQG for the maximum monthly concentration. Zinc was also not brought forward for Bear River during Operations because it does not exceed the BC WQG and exceeds the CCME WQG by just 15%. This is considered to be within natural variation, analytical uncertainty, and model error.

2.2 Characterization of Residual Effect

The residual effect to Surface Water Quality from the Upper Limit Mine Discharge is characterized as follows:

- Magnitude is Moderate; the majority of the parameters have a negligible to low magnitude rating with up to 60% of parameters in Goldslide Creek having a moderate magnitude for certain months at the predicted maximum concentrations in the P90 case. A high magnitude rating was flagged for cadmium and zinc in Goldslide Creek and cadmium in Bitter Creek during the winter low flow period of Operations. The majority of the parameters with a moderate rating was moderate in only certain months and in many cases the moderate rating was due to parameters that already exceeded guidelines at background concentrations;

- Geographical extent is Regional; while the bulk of the changes to Surface Water Quality from mine discharges is limited to the Local Study Area (LSA), there are also minor changes in Bear River predicted from the combined Mine and TMF discharges, which is in the Regional Study Area (RSA);

- Duration is Permanent; changes to Surface Water Quality from Mine Discharge are predicted to continue beyond Post-Closure;

- Frequency is Regular; discharges to the receiving environment (via Goldslide Creek) occur during dewatering events at the mine which occur regularly throughout Operations. During Closure and Post-Closure, inputs into Goldslide Creek will be from groundwater that has been influenced from the mine flooding and backfilling activities;

- Reversibility is Irreversible; it is expected that the effect from the groundwater that is influenced from the mine backfill during Post-Closure, will result in a change in some water quality parameters over the long-term compared to baseline conditions in receiving water bodies. The likelihood of complete reversibility is so low and so far in the future, that the residual effect is characterized as irreversible; and

- Context is High; the receiving water bodies in the Project LSA are dynamic, fast-moving systems that naturally experience a wide-range of flow and water chemistry conditions. The assimilative capacity of these water bodies are considered high and therefore Surface Water Quality would have a high natural resilience to the mine discharges and would be able to return to baseline conditions once the stressor has expired.

2.3 Likelihood

The probability of this predicted residual effect occurring is low. The likelihood of this residual effect on Surface Water Quality from mine discharges occurring is low, i.e., the effect has less than a 40% chance of occurring. This is based on the predictions of the Water and Load Balance Model (Appendix 14-C) for the Reasonable Upper Limit Case of P90, which has a 10% chance of occurring.

2.4 Significance

Although there will be changes to the receiving environment water quality, only a subset of parameters will increase above guidelines/background levels. Minor changes to Surface Water Quality is predicted in Bear River but the overall baseline conditions of the receiving environment will be maintained after the Project ceases. This residual effect is considered not significant. The maintenance of the quality of water in the receiving environment may be altered in Goldslide Creek but not to the extent that the maintenance of other VCs that are influenced by Surface Water Quality are affected.

2.5 Confidence and Risk

The level of confidence applied for the residual effect is considered high. This is based on the conservative approach taken to compensate for the inherent nature of uncertainties associated with water quality modelling and the dependencies on numerous input sources.

The upper case (P90) predictions are intended to represent the reasonable worst case, or the upper bound of expected water quality. Mitigation measures have not necessarily been incorporated to address potential water quality considerations identified in the upper case predictions, as contingency planning and/or adaptive management may be more appropriate if concentrations above the base case are observed during monitoring.

It should be noted that the water quality model is a conservative assessment of predicted water quality. As such, there is high confidence that water quality will be as good or better than predicted. Hence, there is high confidence that the effects assessment is conservative.

To reduce uncertainty and maintain the quality of water in the receiving environment of the TMF, as well as other VCs that are influenced by Surface Water Quality, monitoring and adaptive management

strategies for water quality will be implemented, as described in the AEMRP (Volume 5, Chapter 29.5) and the Adaptive Management Plan (Volume 5, Chapter 29.2). These management plans have been designed to mitigate the risk related to a residual effect on Surface Water Quality. The objectives of the AEMRP is to minimize the risk of effects to the aquatic environment through Project design, monitoring and adaptive management. The AEMRP includes an Aquatics Effects Monitoring Program (AEMP) that will provide feedback via the receiving environment on the performance of IDM's management and mitigation during Construction, Operations, Reclamation and Closure, and Post-Closure phases of the Project. The AEMRP also includes management response measures (additional assessment, monitoring and mitigation measures) that would be implemented in response to an unanticipated effect on Surface Water Quality.

3 Change in Surface Water Quality from Upper Limit TMF Discharge

3.1 Residual Effect Analysis

Both the Mine Discharge and TMF Discharge residual effects were assessed using model predictions (Appendix 14-C) and so analysis from the Mine Discharge residual effect applies here as well.

3.2 Characterization of Residual Effect

The residual effect to Surface Water Quality from the TMF Discharge is characterized as follows:

- Magnitude is Low; the majority of the parameters have a negligible to low magnitude rating with up to 30% of parameters in Bitter Creek having a moderate magnitude for certain months at the predicted maximum concentrations in the P90 case. The majority of the parameters with a moderate rating was moderate in only certain months and in many cases the moderate rating was due to parameters that already exceeded guidelines at background concentrations;

- Geographical extent is Regional; while the bulk of the changes to Surface Water Quality from TMF discharges are limited to the LSA, there are also minor changes in Bear River, which is in the RSA;

- Duration is Permanent; changes to Surface Water Quality from TMF discharge are predicted to continue beyond Post-Closure;

- Frequency is Sporadic; discharges to Bitter Creek are from the discharge of surplus water from the TMF, which occurs seasonally depending on precipitation and water use for the Project;

- Reversibility is Partially Reversible; once Closure and Reclamation activities are completed for the TMF, the Surface Water Quality downstream of the TMF is expected to revert back to within baseline levels for the majority of the water quality parameters after a number of years; and

- Context is High; the receiving water bodies in the Project LSA are dynamic, fast-moving systems that naturally experience a wide-range of flow and water chemistry conditions. The assimilative capacity of these water bodies are considered high and therefore Surface Water Quality would have a high natural resilience to the mine discharges and would be able to return to baseline conditions once the stressor has expired.

3.3 Likelihood

The likelihood of this residual effect on Surface Water Quality from TMF discharges occurring is low, i.e., the effect has less than a 40% chance of occurring. This is based on the predictions of the Water and Load Balance Model (Appendix 14-C) for the Reasonable Upper Limit Case of P90, which has a 10% chance of occurring.

3.4 Significance

Although there will be changes to the receiving environment water quality, only a subset of parameters will increase above guidelines/background levels. Minor changes to Surface Water Quality is predicted in Bear River but the overall baseline conditions of the receiving environment will be maintained after the Project ceases. This residual effect is considered not significant. Maintenance of the quality of water in Bitter Creek and Bear River, as well as the maintenance of other VCs that are influenced by Surface Water Quality are maintained after the Project ceases.

3.5 Confidence and Risk

The level of confidence applied for the residual effect is considered high. This is based on the conservative approach taken to compensate for the inherent nature of uncertainties associated with water quality modelling and the dependencies on numerous input sources.

The upper case (P90) predictions are intended to represent the reasonable worst case, or the upper bound of expected water quality. Mitigation measures have not necessarily been incorporated to address potential water quality considerations identified in the upper case predictions, as contingency planning and/or adaptive management may be more appropriate if concentrations above the base case are observed during monitoring.

It should be noted that the water quality model is a conservative assessment of predicted water quality. As such, there is high confidence that water quality will be as good or better than predicted. Hence, there is high confidence that the effects assessment is conservative.

To reduce uncertainty and maintain the quality of water in the receiving environment of the TMF, as well as other VCs that are influenced by surface water quality, monitoring and adaptive management strategies for water quality will be implemented, as described in the AEMRP (Volume 5, Chapter 29.5) and the Adaptive Management Plan (Volume 5, Chapter 29.2). These management plans have been designed to mitigate the risk related to a residual effect on Surface Water Quality. The objectives of the AEMRP is to minimize the risk of effects to the aquatic environment through Project design, monitoring and adaptive management. The AEMRP includes an Aquatics Effects Monitoring Program (AEMP) that

will provide feedback via the receiving environment on the performance of IDM's management and mitigation during Construction, Operations, Reclamation and Closure, and Post-Closure phases of the Project. The AEMRP also includes management response measures (additional assessment, monitoring and mitigation measures) that would be implemented in response to an unanticipated effect on Surface Water Quality.

4 Contingency Measures

Of the COPCs listed in 2.1.13, the P90 prediction for cadmium concentrations appears to be of most concern as these concentrations persist down to fish-bearing reaches of Bitter Creek and to the Bear River.

Contingency measures for cadmium is warranted and will be developed during permitting, once the final surface water quality model predictions are available. These measures would be implemented if monitoring suggests that predicted residual effects could be exceeded (e.g., magnitude or frequency).

5 Conclusions

The Reasonable Upper Limit Case for Surface Water Quality predictions were presented in this memo as an upper bound to the water quality predictions used in the Surface Water Quality assessment (Volume 3, Chapter 13). Surface Water Quality residual effects from Mine and TMF discharges in the reasonable upper limit case show additional parameters as COPCs, compared with the base case. Additional COPCs include arsenic, cobalt and copper in Goldslide Creek during Operations; cadmium and zinc in Bitter Creek during Operations; and cadmium in Bear River during Operations.

Application of the residual effects characterization criteria show that both residual effects have the same magnitude ratings (moderate for the Mine Discharge and low for the TMF Discharge) as the base case, although the overall number of parameters with moderate or high magnitude rating is greater. The geographical extent extends to the Bear River, duration is permanent, frequency is regular with the mine discharge and sporadic with the TMF discharge. Effects are partially to irreversible but the context is high as Surface Water Quality in the Project receiving water bodies have high natural resilience to stressors. The maintenance of the quality of water in the receiving environment may be altered in Goldslide Creek but not to the extent that the maintenance of other VCs that are influenced by Surface Water Quality are affected. Therefore, the Surface Water Quality residual effects using the reasonable upper limit case is non-significant.