Technical Memorandum O

Proposed Discharge Limits for the Jericho Project, Nunavut

Report Prepared for

Tahera Diamond Corporation

Report Prepared by

SRK Consulting
Engineers and Scientists

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1 Introduction

This report provides proposed discharge limits for the Jericho Project in Nunavut, as requested by the Nunavut Water Board (NWB) in their guidelines to Tahera Diamond Corporation (NWB 2004).

The proposed discharge limits for the site are "water quality based discharge limits" intended to protect the aquatic life and drinking water quality in the receiving environment. The proposed limits were developed on the basis of: 1) guidelines, objectives or site specific thresholds that ensure minimal impacts to aquatic resources in Lake C3 and Carat Lake, and 2) dilution modelling to determine the assimilative capacity at key locations in the receiving environment. The proposed limits also consider discharge limits in water licences from the other northern diamond mines, including the Ekati Diamond Mine™, the Diavik Diamond Mine, and the Snap Lake Project.

With this approach, the proponent recognizes that they will need to carefully manage discharge flows to ensure that the expected minimum dilutions are maintained. Monitoring programs to address this issue are presented in *Technical Memorandum W: Site Water Management* (SRK and Clearwater 2004a).

This report is organized as follows:

- Section 2 presents aquatic thresholds or targets for water quality at a location 200 metres from the mouth of Stream C3 where discharges from the PKCA will be allowed to mix with receiving waters.
- Section 3 summarizes results of dilution modelling used to calculate the available assimilative capacity in the receiving environment;
- Section 4 presents calculations to develop proposed discharge criteria for the site, and a comparison of the proposed criteria with licences from the Ekati and Diavik mines, and with estimated discharge water quality from the site;
- Section 5 presents a summary and conclusions; and
- Section 6 provides a complete list of references cited in this report.

SRK would like to acknowledge significant contributions to this work made by Don Dunbar of Lorax Environmental (Princeton Ocean modelling), Bruce Ott of AMEC (approach and review), and James Elphick of AMEC (Site Specific Water Quality Criteria).

2 Aquatic Thresholds

Aquatic thresholds were established on the basis of guidelines, or site specific objectives that were selected to ensure minimal impacts to aquatic resources in Lake C3 and Carat Lake. For the majority of the parameters, values presented in the Canadian Council of Ministers of the Environment (CCME) Guidelines for freshwater aquatic life and drinking water (CCME 1999) were adopted without modification.

The CCME Guidelines for aluminum, cadmium, copper, and nitrite were considered to be overly conservative with respect to protection of aquatic life. Therefore, site specific objectives were proposed on the basis of a detailed literature review prepared by AMEC (Attachment O1). CCME does not have a recommended guideline for Total Dissolved Solids (TDS) concentrations, nor, with the exception of sulphate (Health Canada drinking water guideline of 500 mg/L), any of the components of TDS (i.e. chloride, bicarbonate, calcium, magnesium, sodium, and potassium). Therefore, a literature review was completed to determine appropriate thresholds for TDS in the receiving environment. The results of the literature review on TDS are provided in Attachment N5 of "*Technical Memorandum N: Estimates of Receiving Water Quality for the Jericho Project, Nunavut*" (SRK 2004b). Brief summaries of these reviews are provided as follows:

- Aluminum: A site specific receiving water quality objective of 0.16 mg/L has been proposed. This value represents a two-fold factor of safety below the lowest effects levels identified in the literature for waters with similar pH conditions (Attachment O1). This value is considered to be conservative with respect to potential for aquatic effects because the majority of the aluminum is expected to occur as fine suspended silicate minerals, which are not biologically available. This is in contrast to the toxicity tests, typically completed using soluble aluminum salts. The aluminum in those tests speciates to Al^{3+} or $Al(OH)_4^-$, which are considered to be the more toxic forms of aluminum.

- Cadmium: A hardness based site specific receiving water quality objective has been proposed, ranging from 0.000075 mg/L (at a hardness of 40 mg/L) to 0.00017 (at a hardness of 100 mg/L) (Attachment O1). At the mixing ratio of 10:1 used in the derivation of discharge water quality objectives (see Section 3), the hardness is expected to be in the range of 100 mg $CaCO_3$ eq/L, and the site specific cadmium objective would be 0.00017 mg/L. These values were derived by dividing the lowest effects level measured in toxicity testing by two. Although it is incidental to derivation of the water quality guidelines, the proposed threshold would be in the range where it would be possible to detect any changes above the current detection limit of 0.00005 mg/L using standard and verifiable laboratory methods, which is an important practical consideration in the monitoring programs.

- Copper: A site specific receiving water quality objective of 0.004 mg/L has been proposed for the Jericho site (Attachment O1). This value has been proposed on the basis of chronic toxicity data from the U.S. Environmental Protection Agency (EPA), which indicates only one test with adverse effects at copper concentrations of less than 0.004 mg/L (the effect level in this test was at 0.0039 mg/L). Baseline copper concentrations in the Jericho River system are already at 0.002 mg/L. Therefore, the proposed water quality objective represents only a slight increase above current levels.

- Nitrite: A site specific receiving water quality objective that varies over a range of chloride concentrations has been proposed for the Jericho site, ranging from 0.10 mg/L nitrite (at a chloride concentration of 5 mg/L) to 0.25 mg/L nitrate (at chloride concentrations of >20 mg/L). At the mixing ratio of 10:1 used in the derivation of discharge water quality objectives (see Section 3), chloride is expected to be in the range of 48 mg/L, and the site specific objective would be 0.25 mg/L nitrate.

- TDS: The review of potential aquatic effects from TDS ("*Technical Memorandum N: Estimates of Receiving Water Quality for the Jericho Project*", SRK 2004b), indicated that there would be negligible effects at concentrations below 400 mg/L bulk TDS. The most stringent guidelines for TDS components are from British Columbia, at 150 mg/L for chloride and 100 mg/L for sulphate. These values are below the lowest effects levels identified in the literature. Effects levels for the cations (i.e. calcium, magnesium, potassium, and sodium) present in the PKCA discharge are generally below the lowest effects levels. Therefore, minimal dilution is required to ensure concentrations are below effects levels in the receiving environment.

The Aquatic Thresholds proposed for this project are summarized in Table 2.1. The table includes all of the parameters specified in recent water licences issued for Ekati, Diavik and Snap Lake, plus additional parameters raised as potential concerns at this site. However, consistent with these other applications, aquatic thresholds for TSS and phosphorus are not applicable. Therefore, as discussed in Section 4, the discharge criteria for these parameters are based on precedents set for other northern water licences that are also considered to be protective of the receiving environment.

Table 2.1: **Selected Aquatic Thresholds**

Parameter	Aquatic Threshold	Derivation
Major Ions		
TDS	400 mg/L	Proposed Site Specific Objective (see Attachment N5 of Technical Memorandum N).
chloride	150 mg/L	B.C. chronic aquatic life guideline (BCMWLAP, 2003)
Nutrients		
ammonia	0.59 mg/L	CCME (1999)**, assumes total ammonia. (Concentrations in N equivalents)
nitrite	0.25 mg/L (at chloride concentrations of >20 mg/L)	Proposed Site Specific Objective – see Attachment O1. The proposed objective is linked to chloride concentrations. Chloride concentrations of 24 to 48 mg/L are predicted for the edge of the mixing zone, assuming 10 to 20 times dilution. (Concentrations in N equivalents)
nitrate	3 mg/L*	CCME (1999), (Concentrations in N equivalents)
Total Metals		
aluminum	0.16 mg/L	Proposed Site Specific Objective – see Attachment O1.
arsenic	0.005 mg/L	CCME (1999)
cadmium	0.00017 (at a hardness of 100 mg/L)	Proposed Site Specific Objective – see Attachment O1. The proposed objective is linked to hardness. A hardness of 100 mg CaCO3 eq/L is predicted for the edge of the mixing zone.
chromium	0.0089 mg/L	CCME (1999)
copper	0.004 mg/L	Proposed Site Specific Objective – see Attachment O1.
lead	0.001 mg/L	CCME (1999)
molybdenum	0.073 mg/L	CCME (1999)
nickel	0.025 mg/L	CCME (1999)
uranium***	0.02 mg/L	CCME (1999)
zinc	0.030 mg/L	CCME (1999)

Notes:

* Ammonia, Nitrite and Nitrate thresholds are presented in units of mg N/L, consistent with standard laboratory protocols

** CCME 1999 guidelines tables were updated in 2002. The 2002 values are used in this summary.

*** The threshold for uranium is for the protection of drinking water supplies that are used on an ongoing and regular basis.

3 Summary of Dilution Modelling Results

During operations water will be discharged from the PKCA through Stream C3 to Lake C3. The discharge flows will be controlled to match the pattern of flows in the Jericho River, and will occur from early June through to the end of September. Lake C3 flows into Carat Lake. Carat Lake discharges into the Jericho River, which connects downstream to the Burnside River system. The drainage basin area upstream of Carat Lake is 148 km^2 and thus there is substantial natural flow generated before the proposed Jericho Mine is reached. Receiving water bodies, Lake C3 and Carat Lake, have volumes of approximately 4.5 and 27 million cubic metres, respectively. Based on average flow conditions Lake C3 flushes on average five times per year and Carat Lake once.

Dilution modelling was completed as part of the assessment of impacts to receiving water quality *"Technical Memorandum N: Estimates of Receiving Water Quality"* (SRK 2004b). A simple box model approach was used to estimate whole lake dilutions for Lake C3 and Carat Lake on a monthly basis throughout the mining operations. However, because it assumes complete mixing of the discharges, the box model does not adequately simulate spatial variations in concentration resulting from time dependent mixing processes. Therefore, the output from this model was used as a starting condition for additional modelling using the Princeton Ocean Model to simulate spatial variations in the lakes. Details on the model inputs and scenarios are provided in "*Technical Memorandum N: Estimates of Receiving Water Quality"* (SRK 2004b).

The results of the box model indicated that under base case conditions (Scenario 1), minimum whole lake dilutions in Lake C3 would reach approximately 50 within one season of discharge and minimum dilutions in Carat Lake would reach approximately 58 within three seasons of discharge. A Princeton Ocean model simulation (Scenario 4) was completed using the above dilutions as starting concentrations, and the same assumptions of discharge and receiving water flows. The simulation indicated that minimum dilutions of approximately 20 could occur within 200 metres of the mouth of Stream C3 for a period of approximately 1 week prior to break-up of the ice (assumed to be June 18th in the modelling), and would increase to approximately 40 by mid-July. At the outlet of Lake C3, minimum dilutions would be on the order of 30 for a few weeks immediately after the wind begins to mix the lake (on June 19th), and would also increase to approximately 40 by mid-July.

Box model results simulating release of one year of stored site flows into average receiving water flows during the second year of operations (Scenario 3a) indicated minimum whole lake dilutions of 27 in Lake C3, and minimum whole lake dilutions of 53 in Carat Lake. A Princeton Ocean Model simulation of this latter case (Scenario 5) indicated that minimum dilutions of approximately 10 could occur within 200 metres of the mouth of Stream C3 for a period of approximately 1 week prior to break-up of the ice (assumed to be June 18th in the modelling). Dilutions would then increase rapidly to approximately 20 by the beginning of July. At the outlet of Lake C3, minimal dilutions would be on the order of 20 for a short period immediately after the wind begins to mix the lake (on June 19th), would increase to approximately 27 by mid-July.

The Princeton Ocean Model concentrations are thought to be lower than those predicted by the Box model for two reasons: 1) Flows into the west arm of Lake C3 do not mix with the effluent, and therefore do not contribute to the dilution; and 2) A large amount of unimpacted water from the Jericho River may pass through the main part of Lake C3 before the ice is off the lake and wind driven mixing begins to take effect. Once mixing occurs, the effluent load originating from the site begins to mix with the Jericho River water, but it takes a few weeks to reach steady state mixing. The Princeton Ocean Model results are considered conservative because observations by field staff (*pers. comm.* Rick Pattenden, Mainstream Aquatics Ltd.) indicate that the ice cover in Lake C3 tends to break-up more rapidly than on Carat Lake (up to one week sooner), therefore wind driven mixing is likely to start sooner than the date specified in the modelling (June 18th). This should result in a less accumulation of loading in the system, and therefore higher dilutions when the wind driven mixing begins.

It should also be noted that the dilution modelling is generally expected to give conservative estimates of dilution because the estimates of release volumes are based on conservative estimates of inflows to the PKCA. Lower discharges will generally result in higher dilutions at all locations in the receiving environment.

Based on the above considerations, a dilution factor of 10 is suggested as a very conservative estimation of the minimum dilution available 200 m from the Stream C3 mouth. It should be recognized that even under worst case conditions with release of excess stored water from the PKCA, dilutions are expected to exceed 20 during the majority of the discharge season in most of Lake C3 and in all of Carat Lake. Consistent with the Snap Lake Type “A” Water Licence issued by the Mackenzie Valley Land and Water Board, a mixing zone of 200 m is suggested.

4 Proposed Discharge Limits

4.1 Methods

Discharge limits for the outlet of the PKCA were developed as follows:

1. Provisional discharge limits for average monthly concentrations were calculated by subtracting the background concentrations from the aquatic thresholds defined in Section 2, and multiplying the resulting value by the expected minimum dilutions in Lake C3, i.e.:

   $$C_{PL} = (C_G - C_B) \cdot D$$

   Where:

   C_{PL} = Provisional Licence Limit
   D = Dilution Factors (Section 3 and Technical Memorandum N)
   C_B = Background Concentrations
   C_G = Aquatic Thresholds

   According to standard convention, discharge limits for grab samples were set at two times these values.

   In the calculations, a minimum dilution of 10 was assumed to occur at the boundary of the 200 metre mixing zone in Lake C3. This value conservatively represents minimum dilutions estimated for a 10 day period prior to break-up of the ice for the worst case scenario with release of stored flows. As discussed in Section 2, dilutions for this scenario are expected to be greater than 20 after break-up of the ice. Under more typical discharge conditions, minimum dilutions are expected to be greater than 20, and typical dilutions are expected to be greater than 40. Steady-state dilutions in Carat Lake are expected to be at least 58.

2. The provisional discharge limits were compared to the expected discharge quality from the PKCA and discharge criteria used at other sites to determine whether they were reasonably achievable given the proposed operational controls and contingency plans, and whether they would exceed any known acute toxic thresholds. If required, adjustments were proposed to achieve consistency or to ensure the targets will be achievable. These adjustments are documented in Section 4.2. The adjusted values were the basis for the final proposed discharge limits.

Exceptions to this method were for pH, TSS, and phosphorus. For these parameters, discharge limits equivalent to those specified in recent water licences for the Ekati Diamond Mine™ and Diavik Diamond Mine are proposed because discharges regulated at these level have been demonstrated to have negligible impacts on receiving water quality.

It should be noted that this approach is conservative because it does not consider the additional reduction in concentrations that is likely to occur as a result of settling, sorption, degradation or uptake by plants.

4.2 Proposed Discharge Limits

4.2.1 Operations

A summary of the aquatic thresholds, background concentrations, and calculated provisional discharge limits is presented in Table 4.1. As indicated in Table 4.1, adjustments to the provisional criteria have been proposed for TDS, chloride, aluminum, uranium and zinc:

- In the case of TDS and chloride, the proposed amendments would conservatively lower the discharge limits to values that are below the thresholds for potential chronic effects in the receiving environment. These amendments are proposed due to uncertainties in the potential for acute toxicity of TDS, and known effects above 1083 mg/L chloride. Effluent toxicity testing proposed as part of the monitoring programs will ensure that the proposed values are non-acutely toxic in the discharge.

- In the case of aluminum, the proposed amendment could lead to occasional and brief exceedances of the aquatic thresholds at the edge of the mixing zone in Lake C3. However, such exceedances would only occur under the worst case discharge scenario, and would only occur just prior to break-up of the lake ice, a maximum of 10 days. Furthermore, as discussed in Attachment O1, the aquatic thresholds for aluminum are based on toxicity tests that used soluble aluminum salts, which speciate to dissolved aluminum (Al^{3+} and aluminum hydroxide complexes) and fine particulates of aluminum hydroxide. In contrast, most of the aluminum in the discharge is expected to occur bound within silicate minerals, which are considered to be significantly less toxic. Therefore, for consistency with the Ekati and Diavik water licences, discharge limits of 3 mg/L (grab) and 1.5 mg/L (average) are proposed.

- In the case of uranium, it may not be possible to achieve the provisional criteria throughout operations. The proposed aquatic thresholds for uranium are based on protection of human drinking water supplies that are used on a regular and sustained basis (i.e. for a lifetime of using the water supply). Therefore the much higher dilutions in Carat Lake (consistently greater than 40, and typically approximately 58) should be considered. At dilutions of 40, discharges could be as high as 1.6 mg/L (grab) and 0.8 mg/L (average). Based on conservative estimates of discharge water quality, concentrations of 1 mg/L (grab) and 0.5 mg/L (average) should be achievable, and would still provide a sufficient margin of safety for workers living at the camp. At these concentrations, Lake C3 could potentially locally reach levels of 0.1 mg/L for short time periods (less than 10 days) when the ice is still on the lake, but only if discharge flows are higher than normal to allow release of stored excess water from the PKCA and discharge concentrations reach the maximum values predicted in the water and load balance. Despite the low frequency and likelihood of these conditions occurring, occasional use of water at these concentrations is not expected to result in acute or chronic health effects on humans.

- The concentration for zinc has been adjusted to a slightly lower value to ensure the proposed value is below acute toxicity thresholds. Actual concentrations are expected to be significantly lower than these values.

As indicated in Table 4.1, the proposed values for total suspended solids (TSS) during regular operations are consistent with the values in the Ekati and Diavik water licences. These sites have receiving environments that are more similar to Jericho than the receiving environment of Snap Lake, and are therefore the discharge limits considered more appropriate for Jericho. During construction, Tahera will follow best management practices to minimize discharge of sediments in surface runoff and in the PKCA. However, it is recognized that sediment concentrations could occasionally exceed the proposed operational discharge limits. Consistent with the water licences recently issued for Diavik and Snap Lake, Tahera requests consideration of TSS discharge limits of 100 mg/L (grab) and 50 mg/L (average) for surface runoff and PKCA discharges during the construction period.

The final proposed discharge limits for Jericho are summarized in Table 4.2.

Table 4.1 Provisional Discharge Criteria

Parameter mg/L, or specified	Carat Lake Background Conc. (mg/L)	Aquatic Thresholds (mg/L)	**Provisional Discharge Limits for Jericho based on 10:1 minimum dilutions (mg/L)**		Predicted PKCA Discharge Concentrations (mg/L)		Are the discharge limits acheivable?	Other Licences in the North (mg/L)						Comparison			Conclusions/Suggested Modifications
								Diavik		Recent Ekati		Snap Lake		Diavik	Ekati	Snap	
			grab	**avg**	Max Source Conc.	Avg Source Conc.		grab	avg	grab	avg	grab	avg				
pH	6.63		**6-9**	**6-9**	8.2	8.2	yes	6-9	6-9	6-9	6-9	6-9	6-9				Consistent with other licenses in the North
Total Dissolved Solids	11	400	**7780**	**3890**	1635	1074	yes	na	na	na	na	350	na	na	na	na	**Unknown potential for acute toxicity, therefore propose lower value of 4000 mg/L (grab) and 2000 mg/L (average). These would still be achievable.**
Total Suspended Solids	1.4		**25****	**15****	7	6.3	yes	25**	15**	25	15	14**	7**	same	same	higher	Consistent with other licenses in the North
Chloride - Cl	3.36	150	**2933**	**1466**	647	487	yes							na	na	na	**Potential for toxic effects above 1000 mg/L, therefore propose 1000 mg/L grab and 500 mg/L average**
Ammonia - N (total)	0.009	0.59	**12**	**6**	2.9	1.8	yes	4	2	4	2	20	na	higher	higher	lower	Value is midway between other sites and protective.
Nitrate - as N	0.18	3	**56**	**28**	7.4	5.0	yes					56	28	na	na	same	Consistent with Snap Lake, reasonable and achievable.
Nitrite - as N	0.001	0.25	**5.0**	**2.5**	0.23	0.16	yes	2	1	2	1	2	1	higher	higher	higher	Limits at other mines would still be achievable.
Phosphorus - P	0.0077		**0.4**	**0.2**	0.09	0.09	yes	0.4	0.2	0.4	0.2	0.086	0.043	same	same	higher	Consistent with other licenses in the North
Aluminum - Al	0.052	0.16	**2.2**	**1.1**	0.90	0.49	yes*	3	1.5	3	1.5	2	1	lower	lower	higher	**Although these values would be protective, for consistency with Ekati/Diavik Licenses, we propose a slightly more lenient value of 3 mg/L (grab), 1.5 mg/L (average) because the aluminum is most likely to be in particulate form and bound to silicates.**
Arsenic - As	0.00016	0.005	**0.1**	**0.05**	0.0021	0.0013	yes	0.1	0.050	0.1	0.05	0.04	0.02	same	same	higher	Should be easily achievable at these or lower Snap Lake values
Cadmium - Cd	0.00005	0.00017	**0.0024**	**0.0012**	0.0011	0.0008	yes*	0.003	0.0015	0.003	0.0015	0.002	0.001	lower	lower	higher	May be challenging to meet, but acceptable at these levels.
Chromium - Cr	0.0002	0.0089	**0.17**	**0.087**	0.0099	0.0047	yes	0.040	0.020	0.003	0.0015	0.04	0.02	higher	higher	higher	Should be achievable at these values, even for kimberlite particulates.
Copper - Cu	0.0020	0.004	**0.04**	**0.02**	0.021	0.020	yes*	0.040	0.020	0.040	0.020	0.020	0.010	same	same	higher	May be challenging to meet, but acceptable at these levels.
Lead - Pb	0.00005	0.001	**0.02**	**0.01**	0.0040	0.0038	yes	0.020	0.010	0.020	0.010	0.009	0.005	same	same	higher	Achievable, and consistent with Diavik and Ekati water licenses
Molybdenum - Mo	0.00005	0.073	**1.5**	**0.73**	0.14	0.075	yes	na	na	na	na	na	na	na	na	na	Achievable and reasonable.
Nickel - Ni	0.0005	0.025	**0.5**	**0.25**	0.062	0.042	yes	0.10	0.050	0.10	0.050	0.10	0.05	higher	higher	higher	Proposed values are achievable, reasonable and protective. Values in other licenses could be challenging to meet
Uranium - U	0.0002	0.02	**0.4**	**0.2**	0.68	0.12	No	na	na					na	na	na	**Concentrations only apply to human drinking water supplies that are used on a regular and sustained basis. Therefore the much higher dilutions in Carat Lake should be considered. At dilutions of 25, discharges could be 1 mg/L (grab) and 0.5 mg/L (average). These would be achievable, and would ensure a 2 to 4 times safety factor for the camp drinking water supply.**
Zinc - Zn	0.002	0.03	**0.56**	**0.28**	0.034	0.015	yes	0.02	0.01	0.02	0.01	0.02	0.01	higher	higher	higher	Proposed limit is protective and achievable, although a somewhat lower value could also be acceptable. However, values in the other northern licenses are below CCME guidelines, are overly protective, and could be difficult to achieve.

Notes: 1. Background concentrations are from the Baseline Summary Report in the EIS (Tahera 2000). However, the background chromium concentration was re-evaluated using data with appropriate detection limits

* Although these values would be acheivable, they may be challenging. Provision for amending these values following site specific studies should be considered

** These values are proposed for the operations period. Water licences for Diavik and Snap Lake included a provision for limits of 100 mg/L (grab) and 50 mg/L (average) TSS during the construction period. Similar consideration is requested for Jericho.

Table 4.2: Proposed Discharge Limits

Parameter	Proposed Jericho Discharge Limits (mg/L)	
	Grab	Average
pH	6-9	6-9
Total Dissolved Solids	4000	2000
Total Suspended Solids*	25	15
Chloride - Cl	1000	500
Ammonia - N (total)	12	6
Nitrate - as N	56	28
Nitrite - as N	5.0	2.5
Phosphorus - P	0.4	0.2
Total Metal Concentrations:		
Aluminum - Al	3.0	1.5
Arsenic - As	0.1	0.05
Cadmium - Cd	0.0024	0.0012
Chromium – Cr	0.17	0.087
Copper - Cu	0.04	0.02
Lead - Pb	0.02	0.01
Molybdenum - Mo	1.5	0.73
Nickel - Ni	0.5	0.25
Uranium - U	1.0	0.5
Zinc - Zn	0.50	0.25

Notes: * Tahera requests discharge limits for TSS of 100 mg/L (grab) and 50 mg/L (average) for surface runoff and PKCA discharges during the construction period.

5 Summary and Conclusions

Discharge limits have been proposed for the site that will ensure concentrations in the receiving water meet aquatic thresholds within the capabilities and expected performance of current operational controls and contingencies. The proposed discharge limits are based on conservative estimates of dilution in the receiving environment, and reflect a worst case discharge scenario based on release of two times the normal amount of effluent in a single year. In addition, normal estimated effluent volumes are expected to also be conservative (SRK Consulting and Clearwater Consultants, 2004a). Despite this, the limits are within the range of recent precedents set at other northern diamond mines.

6 References

AMEC, 2004. Proposed Site-Specific Water Quality Criteria For Copper, Cadmium, Aluminum And Nitrite, Submitted to Tahera Diamond Corporation, August 10, 2004. (provided in Attachment O1.

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ATTACHMENT O1

Proposed Site-Specific Water Quality Criteria for Copper, Cadmium, Aluminum and Nitrite

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PROPOSED SITE-SPECIFIC WATER QUALITY CRITERIA FOR COPPER, CADMIUM, ALUMINUM AND NITRITE

Submitted to:

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Burnaby, BC

10 August 2004

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IMPORTANT NOTICE

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1.0 INTRODUCTION

Tahera Corporation is in the process of applying for a water licence for the Jericho Mine. As part of this application, it is necessary to determine discharge criteria for various parameters in order to meet targets for acceptable water quality in the receiving environment.

The purpose of this review is to determine whether the data used to derive the CCME guidelines for copper, cadmium, aluminum and nitrite are appropriate for the Jericho Mine to use as targets for receiving environment water quality guidelines. In particular, the species which were used in the CCME derivations were reviewed to determine whether they reflect of the type of species which occur in Lake C3 and Carat Lake. In addition, the safety margins associated with the guidelines were reviewed to determine whether they were unnecessarily conservative. Proposed site-specific guidelines are presented where appropriate. Note that wherever the term "guideline" is used, it is the a guideline for the protection of chronic health of organisms in the receiving environment.

2.0 COPPER

2.1 Comparison of CCME and USEPA Guidelines

The CCME guideline for copper is 2 µg/L for waters with a hardness of less than 120 mg/L, as $CaCO_3$. This guideline is conservative compared with the USEPA chronic criterion for copper, which is linked to hardness across the full range of hardnesses (Figure 1) (USEPA, 2002). The difference between the guidelines results from differences in their intent. In particular, the CCME guideline is designed to be protective of the most sensitive endpoint from the most sensitive test, whereas the USEPA guideline is designed to protect overall ecosystem function, but recognizes that there may be impacts on individual species. The USEPA guideline is designed to be protective of 95% of the genera tested.

LC_{50} data from acute toxicity tests that were used as part of the CCME guideline derivation ranged from 16.7 µg/L to greater than 10 mg/L for tests conducted at a hardness of 50 mg/L (which corresponds to the approximate hardness of the discharge at a 20-fold dilution). Chronic toxicity data evaluated in the CCME guideline were taken from the derivation of the USEPA guideline for copper, in which chronic toxicity test data for five invertebrate and ten fish species were summarized. The values for fish were generally the most sensitive and ranged from 3.9 µg/L for early life-stage tests with brook trout, to 60.4 µg/L for an early life-stage test with northern pike.

Birge and Black (1979) reported chronic toxicity test data for rainbow trout, catfish, goldfish and bass, which demonstrated that rainbow trout were 60 to 70 times more sensitive than the other species, and exhibited LC50 values of approximately 100 µg/L Cu. Based on these data and a summary of other data from the literature, these authors concluded that the practical limits for copper should be established in the range of 2 – 5 µg/L in soft or medium hard water, and 5 –8 µg/L in hard water.

Early life-stages of amphibians are potentially more sensitive to copper than salmonids; however, no amphibians occur in arctic ecosystems and, consequently, these data need not be considered.

The USEPA has recently released a draft revised water quality criteria document for copper (USEPA, 2003). As part of this derivation, the Agency has summarized the available data for copper toxicity. Chronic toxicity data summarized in this draft document is presented in Figure 1, compared with the current USEPA and CCME guidelines. It should be noted that the chronic toxicity data is presented on the basis of dissolved copper.

2.2 Factors Affecting Copper Toxicity

The toxicity of copper is dependant on a number of water quality characteristics, such as hardness, alkalinity and pH. In addition, copper can also form complexes with Dissolved Organic Material (DOM), resulting in a decrease in the observed toxicity. In general, increases in pH, alkalinity, DOM and hardness all result in a decrease in toxicity of copper. As a result of the substantial effect that these parameters can have on toxicity, the USEPA is currently revising its water quality criteria for this metal to incorporate the effects of various ions and DOM on the toxicity of copper (USEPA, 2003).

2.3 Proposed Guideline

Background concentrations of copper in Lake C3 have typically been 2 µg/L, which is equivalent to the CCME criterion value for the hardness of the lake. The proposed guideline for the Jericho site is 4 µg/L. This value generally falls below reported data for adverse effects associated with copper. In fact, the only chronic value from the recent USEPA data summary (USEPA, 2003) that fell below this value was for a rotifer, *Brachionus calyciflorus*. Although rotifers are present in the lake, the particular species tested is not. The relative sensitivity of the rotifer species present in the lake compared with *B. calyciflorus* is not known.

In a study of biota in Lake C3 conducted in 1999 (RL&L, 2000), the density of rotifers was approximately 20,000/m^3 compared with approximately 200 cladocerans/m^3 and 13,000 copepods/m^3; however, when evaluated on the basis of biomass, rotifers comprised a small proportion of the zooplankton. Biomass of rotifers was less than 500 µg/m^3, whereas cladocerans exceeded 100,000 µg/m^3, and copepods exceeded 30,000 µg/m^3. Thus, it is likely that, overall, rotifers comprise a relatively small percentage of the diet of fish in the lake; however, they may provide an important dietary component for larval fish, particularly round whitefish.

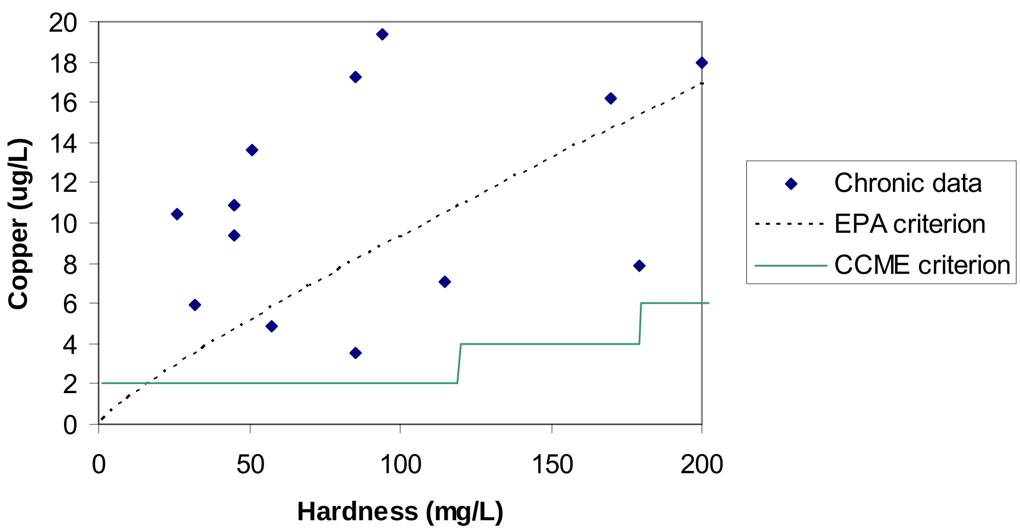
This proposed value also exceeds acute toxicity data from one study for the cladoceran *Bosmina longirostris*, which has been reported to exhibit a 48-hr LC50 for copper of 1.4 and 3.7 µg/L under low and high food conditions, respectively (Koivisto et al., 1992). However, these values are substantially lower than other data for this species in which adverse effects were observed in a chronic (14-d) exposure to concentrations ranging from 10 – 18 µg/L, but no effects on survival were observed within 48 hr at these concentrations (Koivisto and Ketola, 1995). Note that these two studies were not included in either the USEPA or CCME derivations of copper criteria. Moreover, the results of the two studies are somewhat contradictory in terms of concentrations that caused effects, and chemical concentrations were not measured. Thus, their relevance to the dataset as a whole and to the specific study site is uncertain. *B. longirostris* were present in Lake C3 in a baseline study conducted in 1999, but represented a relatively small contribution to zooplankton biomass.

A guideline greater than 4 µg/L may be appropriate based on the water quality conditions associated with the site. For example, the presence of DOM may reduce the bioavailability of copper in the discharge. Given the preponderance of zooplankton in the diet of fish in the lakes studied in the region, caution is advised in applying a criterion in which the "effects" range overlaps or approaches the sensitivity exhibited by taxa present in the system.

2.4 Summary

A water quality guideline of 4 µg/L copper is proposed for the Jericho site. Effects at or below this level have been observed with one species of cladoceran, which is present in Lake C3, and to a rotifer; however, these organisms appear to represent a relatively minor contribution to the zooplankton. Furthermore, the lake has typically contained background concentrations of copper of 2 µg/L; thus, this reflects a relatively small increase from background.

Figure 1. Chronic toxicity data summarized in the draft USEPA criterion compared with the current USEPA and CCME criteria for copper.



3.0 CADMIUM

3.1 Basis for CCME and USEPA Guidelines

The CCME freshwater criterion for cadmium of 0.017 µg/L was derived based on application of a safety factor of 0.1 to the lowest reported effect level for the most sensitive species. This lowest value was for adverse effects on reproduction in a 21-day test with *Daphnia magna,* reported by Biesinger and Christensen (1972). In addition to the criterion value of 0.017 µg/L, the CCME also provided an equation to calculate a site-specific water quality criterion based on water hardness, as follows:

Water Quality Guideline (µg/L Cd) = $10^{(0.86[\log(\text{hardness})]-3.2)}$

The USEPA presented revised water quality guidelines for cadmium in 2001, which updated the previous USEPA guidance based on a comprehensive review of available data. This document summarized acute toxicity data from 39 species of invertebrates, 24 species of fish and two amphibians. For data from acute toxicity tests, salmonids represented six of the seven most sensitive species tested, and *D. magna* was the most sensitive invertebrate species tested.

Chronic toxicity data summarized by USEPA (2001) included data for seven invertebrate and fourteen fish species. The USEPA derivation did not use the data presented by Biesinger and Christensen (1972) because the concentrations of cadmium were not measured in that study; however, the Agency did use results for other 21-d *D. magna* tests which exhibited effects at similar concentrations. Corrected to a hardness of 50 mg/L, the lowest chronic values utilized by USEPA (2001) were for *D. magna* (0.12 to 0.15 µg/L), followed by the freshwater amphipod *Hyalella azteca* (0.27 ug/L). All other chronic values exceeded 1 µg/L. Interestingly, *Ceriodaphnia dubia*, another cladoceran which is widely used in toxicity tests, was substantially less sensitive to cadmium than *D. magna*, having a chronic value of 27 µg/L at a hardness of 50 mg/L.

3.2 Comparison of CCME and USEPA Guidelines

There is a substantial difference between the USEPA and CCME guidelines for cadmium, primarily associated with a ten-fold safety factor that was applied to the lowest toxicity value in the literature at the time the CCME guideline was derived. In comparison, the USEPA guidelines for acute and chronic toxicity utilized the entire dataset of suitable toxicity test results derive numbers that would protect 95% of tested genera. Thus, the USEPA guidelines are designed to be protective of overall ecosystem function, but datapoints from some toxicity tests are expected to fall below the calculated criteria values.

The toxicity data used in the USEPA criteria derivation, as well as the data upon which the CCME guideline was primarily based are shown in Figure 2. Figure 3 provides a comparison of the most sensitive of these data with the hardness dependent site-specific CCME criteria and the USEPA guidelines. Clearly, the CCME guidelines reflect a highly conservative position with respect to environmental safety since the toxicity data fall well above the curve associated with this criterion.

3.3 Proposed Site-Specific Modification to the CCME Guideline

Cladocerans are an important component of the ecosystem in Lake C3 and species of *Daphnia* (the genus associated with the lowest effect level) are present. Furthermore, field studies have shown that two of the cladocerans present in Lake C3 are sensitive to cadmium. Lawrence and Holoka (1987) showed that a 14-day exposure of 1 µg/L cadmium resulted in a 60 – 70% reduction in biomass of zooplankton at pH 6.7 – 6.8. Cladocerans (*Bosmina longirostris* and *Holopedium gibberum*) were more sensitive than the other species evaluated (calanoid and cyclopoid copepods). Similarly, Marshall and Mellinger (1980) demonstrated that zooplankton density was adversely affected in an exposure to 1.2 µg/L Cd.

Marshall et al. (1981) also reported adverse effects on zooplankton density and diversity resulting from a 3-wk exposure to 1 µg/L cadmium. These authors suggested that adverse effects may occur on zooplankton communities at concentrations of 0.2 µg/L and higher. *H. gibberum* was more sensitive to cadmium than *B. longirostris* or *Daphnia galitea*; the abundance of the latter two species was essentially unaffected, whereas *H. gibberum* were largely eliminated as a result of the exposure. These results have significant relevance to the proposed discharge site; *H. gibberum* represented more than 50% of the density and 99% of the biomass of cladocerans in Lake C3 in a survey conducted in 1999 (RL&L, 2000).

A two-fold safety margin should be sufficient to determine a concentration at which no effect would be expected in the tests used to derive the guideline. Thus, applying a safety factor of two to the lowest effect value of 0.17 µg/L from Biesinger and Christensen (1972) would appear to be sufficient to protect even the most sensitive test organism. Similarly, values can be calculated across a range of hardnesses using the hardness dependant calculation provided in the CCME guidance. These data are shown in Table 1 and are also presented in Figure 4. As the figure shows, all of the known toxicity values are above the proposed guideline, suggesting that this proposed guideline should be protective of aquatic resources in the receiving environment.

3.4 Summary

The CCME water quality criteria for cadmium are highly conservative with respect to risk for adverse effects associated with aquatic biota. An alternative guideline has been proposed here which applies a safety factor of two to the most sensitive data, rather than a factor of ten. This proposed guideline still falls below concentrations associated with adverse effects in the literature and, therefore, is expected to be protective.

It does not appear appropriate to establish a higher criterion than that proposed here because of the sensitivity to cadmium of the cladoceran *H. gibberum*, which dominated the zooplankton biomass in Lake C3 in the 1999 survey. Since the diet of fish in the lake was composed of 50 - 90% zooplankton, this species is clearly of a high degree of importance in this ecosystem. If *H. gibberum* are adversely affected as a result of exposure to elevated concentrations of cadmium, it is likely that other less sensitive species of cladoceran present in the lake, such as

B. longirostris, will increase in density. However, the larger size of *H. gibberum* likely makes it more desirable as a prey species for the larger fish.

It should be noted that water quality characteristics such as DOM can reduce the toxicity of this metal and, consequently, if meeting this guideline will be problematic, additional investigations could be conducted to determine whether the specific conditions associated with the lake and discharge warrant a higher guideline at this particular site.

Table 1. CCME and USEPA guidelines for cadmium (µg/L) over a range of hardnesses, in addition to the proposed guideline based on the CCME data, but incorporating a safety factor of two rather than ten.

Hardness (mg/L as $CaCO_3$)	USEPA chronic criterion	CCME criterion	Hardness adjusted CCME criterion	Proposed Jericho criterion
10	0.049	0.017	0.005	0.023
20	0.082	0.017	0.008	0.041
30	0.111	0.017	0.012	0.059
40	0.137	0.017	0.015	0.075
50	0.162	0.017	0.018	0.091
60	0.185	0.017	0.021	0.107
70	0.208	0.017	0.024	0.122
80	0.229	0.017	0.027	0.137
90	0.250	0.017	0.030	0.151
100	0.271	0.017	0.033	0.166

Figure 2. Toxicity data used for derivation of the USEPA and CCME water quality criteria for cadmium.

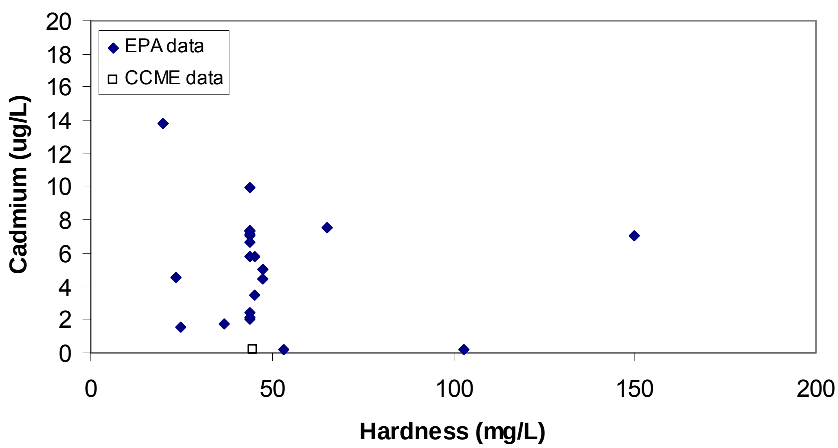


Figure 3. CCME and USEPA water quality criteria for cadmium compared with the most sensitive data from CCME and USEPA criteria derivations.

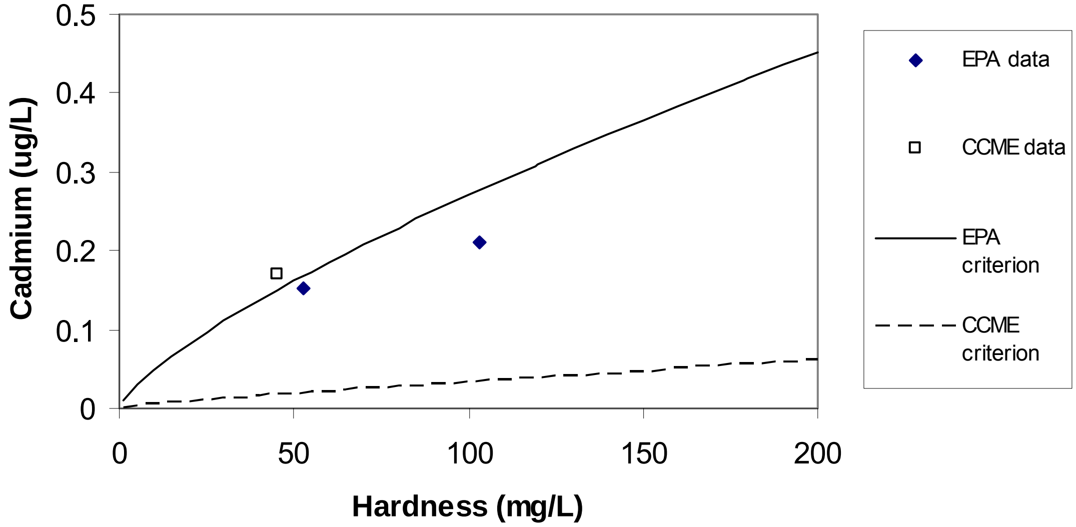
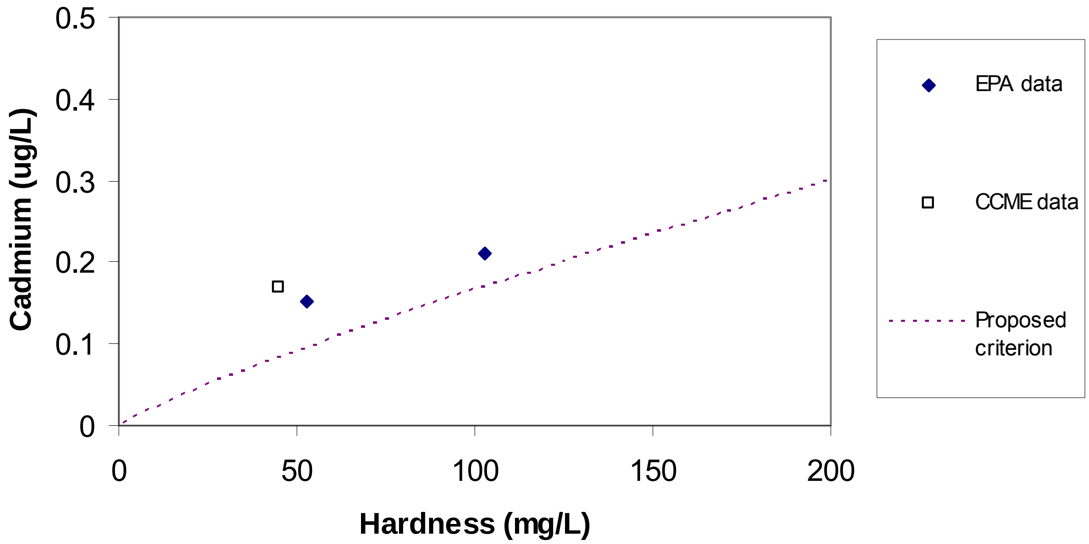


Figure 4. Proposed water quality criteria for cadmium compared with the most sensitive data from CCME and USEPA criteria derivations.



4.0 ALUMINUM

4.1 Summary of Aluminum Chemistry

Aluminum chemistry is complex because, dissolved in water, this metal can be present as a number of monomeric and polymeric hydroxide complexes, as well as Al^{3+}. In addition, this metal forms complexes with a number of other ligands, most notably fluoride, dissolved organic material (DOM), phosphorus, silicon and sulfate. Each of these forms have their own chemical and toxicological properties and, consequently, the characteristics of the matrix in which aluminum is dissolved can have a profound effect on the toxicity of this metal.

The toxicity of aluminum is also highly dependent on pH and, in general, is substantially higher under acidic conditions than in neutral waters. This is largely related to the solubility of the most toxicologically significant forms, $Al(OH)_2^+$ and Al^{3+}, which are relatively insoluble above pH 6. Consequently, the vast majority of toxicity data in the literature have been obtained from tests conducted in acidic conditions and are not directly relevant to Jericho. Toxicity of aluminum has also been shown to be increased at alkaline pH as a result of the increased solubility of $Al(OH)_4^-$ above pH 8. The effect of pH on the toxicity of aluminum is generally associated with alterations in the solubility and speciation of the various complexes.

4.2 Basis for CCME Guideline

The CCME guideline for aluminum has separate criteria of 0.005 mg/L for environments with pH equal to or less than 6.5, and 0.1 mg/L for waters with pH values which exceed 6.5. The guidelines are identified as being "tentative" because of significant gaps in knowledge and the complexity of aluminum chemistry.

Relatively few studies included in the derivation of the aluminum criterion were conducted in the range of pH associated with the receiving environment at Jericho (pH 6.5 – 7.5). Adverse effects on survival (37% mortality) were observed using *Tanytarius dissimilis*, a chironomid, following long term exposure (55 days) to a 0.8 mg/L Al solution at pH 6.8 (Lamb and Bailey, 1981). A 50% impairment of *Daphnia magna* reproduction was reported at a concentration of 0.68 mg/L at pH 6.5 to 7.5 (Schofield and Trojnar, 1980). Although apparently not included in the CCME guideline, Biesinger and Christensen (1972) reported similar data for *D. magna*; 50 and 16% impairment of reproduction was observed in a 21-day exposure at aluminum concentrations of 0.68 and 0.32 mg/L Al in Lake Superior water (pH 7.4 – 8.2).

4.3 Site Specific Factors Affecting Aluminum Toxicity

The pH of the receiving environment at Jericho is generally between 6.5 and 7.5; consequently, the CCME guideline of 0.1 mg/L applies at this site because the solubility of aluminum is predicted to be low across this range of pH.

Aluminum in the discharge will be predominantly present as aluminum silicates, which are components of a wide variety of minerals. In general, toxicity data from the literature are from tests conducted by addition of aluminum salts (e.g., chloride or sulphate) to the test media, resulting in formation of Al^{3+} and aluminum hydroxide complexes. Aluminum silicates appear to exhibit a lower degree of toxicity; this has been demonstrated previously with a fish, a diatom and a green alga (data summarized by Gensemer and Playle, 1999). Thus, the data used to derive the CCME guideline are likely conservative in relation any effects associated with aluminum silicates.

Interestingly, the most dominant cladoceran species in the lakes associated with the Jericho site (*Holopedium gibberum*) appears to be less sensitive to aluminum than other cladocerans. This species was found in an aluminum contaminated lake (0.49 mg/L Al) in a study of acidified Ontario lakes (Bleiwas, 1983), and has been shown to be relatively insensitive to aluminum in laboratory toxicity tests (Havas and Likens, 1985); no adverse effects on survival were observed with this species in an exposure to 1 mg/L Al at pH 6.5.

4.4 Summary

As a result of the complexity of aluminum chemistry and associated toxicity, it is problematic to establish guidelines that are protective for all sites without being unnecessarily conservative. The CCME guideline of 0.1 mg/L provides approximately a 3-fold safety factor over the most sensitive toxicity endpoint within the pH range of interest. A two-fold safety margin below the most sensitive data would likely be sufficient to protect aquatic life. Thus, a site-specific guideline of 0.16 mg/L is proposed. It should be noted that this value is likely conservative with respect to the potential for effects in the receiving environment at this particular site because of the mitigating effects of silicates and neutral pH on aluminum toxicity. However, determining the extent to which these parameters would mitigate toxicity would require a site-specific investigation.

5.0 NITRITE

5.1 Basis for the CCME Guideline for Nitrite

Salmonids are generally considered to be among the most sensitive species to nitrite (Lewis and Morris, 1986). Elevated nitrite concentrations cause methemoglobinemia resulting in a reduction of the oxygen carrying capacity of the blood (Brown and McLeay, 1975), in addition to exhibiting adverse effects on the liver (Jensen, 1996) and the retina (Hofer and Gatumu, 1994).

Russo et al. (1974) reported 96-hr LC50 values for toxicity of nitrite to rainbow trout ranging from 0.19 to 0.39 mg/L. These authors also reported that the highest concentration tested that did not result in mortalities to rainbow trout in a 10-day exposure was 0.06 mg/L for 235 g fish and 0.14 mg/L for 2.3 g fish; 240-hr LC50 estimates were 0.39 and 0.20 in these tests, respectively.

Steelhead trout exhibited a small amount of tissue damage in the gills following a 6-month exposure to 0.06 mg/L, although no adverse effects were observed on survival or growth (Wedemeyer and Yasatuke, 1978).

Thurston et al. (1978) reported 96-hr LC50s for cutthroat trout of 0.5 – 0.6 mg/L and 0.4 mg/L for a 36 day exposure, and concluded that cutthroat trout were generally similar to rainbow trout in their sensitivity to this parameter. In summarizing the available literature, these authors concluded that LC50 values fall in the range of 0.2 to 0.4 for rainbow trout and 0.4 to 0.6 for cutthroat trout.

The CCME guideline for nitrite is 0.06 mg/L and is largely based on the data presented above for rainbow and cutthroat trout. This value is approximately one-third of the lowest reported LC50 from the studies identified above of 0.19 mg/L (Russo et al., 1973).

5.2 Relevance of the Guideline to the Receiving Environment at Jericho

The data upon which the CCME guideline was derived appear to be applicable to the receiving environment at Jericho because salmonids occur in the receiving environment. However, information on the mechanism of nitrite toxicity have been presented which are applicable to determining safe levels for this parameter to salmonids under the water quality conditions associated with this particular site and discharge.

Uptake of nitrite across the gill generally occurs through chloride channels, which are responsible for maintaining the chloride gradient across the gill in freshwater fish. In particular, these channels are designed to concentrate chloride inside the gill relative to the external environment. Because nitrite is able to enter the fish through these channels, under some circumstances, salmonids will also concentrate nitrite against its concentration gradient (Bath and Eddy, 1980), such that the internal concentration of this parameter can exceed the external concentrations.

Elevated external concentrations of chloride inhibit uptake and toxicity of nitrite, likely as a result of competition at the uptake sites. For example, Eddy et al. (1983) demonstrated that nitrite was almost harmless to Atlantic salmon except in waters with very low chloride concentration. Bartlett and Neumann (1998) also reported decreased toxicity of nitrite to brown trout alevins in water with 10 mg/L, relative to 3 mg/L chloride. Similarly, Russo et al. (1981) demonstrated that increasing chloride from approximately 1 to 10 mg/L resulted in a ten-fold reduction in the sensitivity of trout in a 96-hr exposure.

Wedemeyer and Yasatuke (1978) showed that acute nitrite toxicity to salmonids is ameliorated by the addition of calcium chloride and sodium chloride. Addition of 25 mg/L calcium chloride to the exposure water decreased the toxicity of nitrite by a factor of twelve (LC50 values were 0.6 and 7.3 mg/L NO_2 in 2 and 19 mg/L chloride solutions). Addition of sodium chloride did not have as dramatic an effect, resulting in only a two-fold reduction in toxicity between concentrations of 1 and 18 mg/L chloride. The much lower degree of toxicity reduction associated with sodium chloride addition than with calcium chloride does not appear to agree with other literature, which demonstrate that chloride is the primary factor responsible for modulation of nitrite toxicity to salmonids (Lewis and Morris, 1986). The explanation for the inconsistency in these data is not known; regardless, all of the data demonstrate that the presence of chloride ameliorates the toxicity of nitrite to salmonids.

Acute toxicity data (LC50s) summarized above are presented in Figure 5 in relation to the chloride concentration in the water in which the tests were conducted. Only the maximum and minimum value are shown (connected by a line) for studies in which multiple data points were reported for the same chloride concentration. In general, toxicity is substantially reduced with increasing chloride concentration. As indicated above, the salmonid toxicity data resulting from sodium chloride additions conducted by Wedemeyer and Yasatuke (1978) do not appear to agree with the other data with regard to the degree of protection afforded by chloride; these data are shown as open round datapoints in Figure 5 to distinguish them from the remainder of the dataset. In a review of the effects of nitrite of toxicity to fishes, Lewis and Morris (1986) excluded these data as inconsistent; however, in taking a conservative approach to developing a proposed site-specific guideline, we have included those data, regardless.

Average discharge conditions at Jericho are predicted to contain approximately 490 mg/L of chloride. Thus, a twenty-fold dilution of the discharge will contain approximately 20 mg/L chloride. Tests conducted in water with 10 mg/L chloride, or higher, all exhibited LC50s exceeding 3 mg/L nitrite, except for the LC50 data of 0.8 – 1.5 mg/L nitrite for the NaCl spiked waters from Wedemeyer and Yasatuke (1978). Thus, the LC50 data for sodium chloride spiked water from Wedemeyer and Yasatuke (1978) reflect a highly conservative estimate of the LC50 to salmonids across this range of chloride concentrations, particularly considering that the chloride in the discharge is present with a mixture of counter-ions, in particular, magnesium, calcium and sodium, rather than sodium alone.

Consistent with the original CCME derivation, applying a three-fold safety margin to the lowest value reported by Wedemeyer and Yasatuke (1978) results in a site-specific guideline value of

0.25 mg/L nitrite for chloride concentrations of 20 mg/L or higher. The CCME guideline (0.06 mg/L) appears appropriate for waters with a chloride concentrations less than 1 mg/L. Extrapolating between these values results in a proposed guideline for nitrite for waters with chloride concentrations between 1 and 20 mg/L chloride given by the equation:

Proposed nitrite guideline (mg/L NO_2-N) = (0.01 x [chloride (mg/L)]) + 0.05

The proposed site-specific guidelines are shown in Figure 6 in relation to the most sensitive data from Figure 1. This figure shows that the proposed guideline is well below all reported LC50 values for chloride.

5.3 Summary

The CCME guideline for nitrite is based on toxicity to salmonids. Data in the literature demonstrate that uptake and toxicity of nitrite to salmonids is directly linked to chloride concentrations in the sample matrix; thus, it appears appropriate to alter the guideline in cases where chloride concentrations are elevated, as will occur at the Jericho mine. Proposed guideline values are shown in Figure 6 and summarized in Table 2.

A 10-, 20- and 50-fold dilution of the discharge would contain approximately 47, 24 mg/L and 10 mg/L chloride under average conditions, at which point the proposed guideline would be 0.25, 0.25 and 0.15 mg/L nitrite, respectively.

Table 2. Proposed site-specific water quality guideline for nitrite.

Chloride Concentration (mg/L)	Proposed Nitrite Guideline (mg/L NO_2-N)
≤ 1	0.06
2	0.07
5	0.10
10	0.15
15	0.20
≥ 20	0.25

Figure 5. LC50 data for nitrite presented on the basis of chloride concentration in the water used for the test. Open round datapoints are from Wedemeyer and Yasatuke (1978) and are conservative indicators of potential for effects at the corresponding chloride levels.

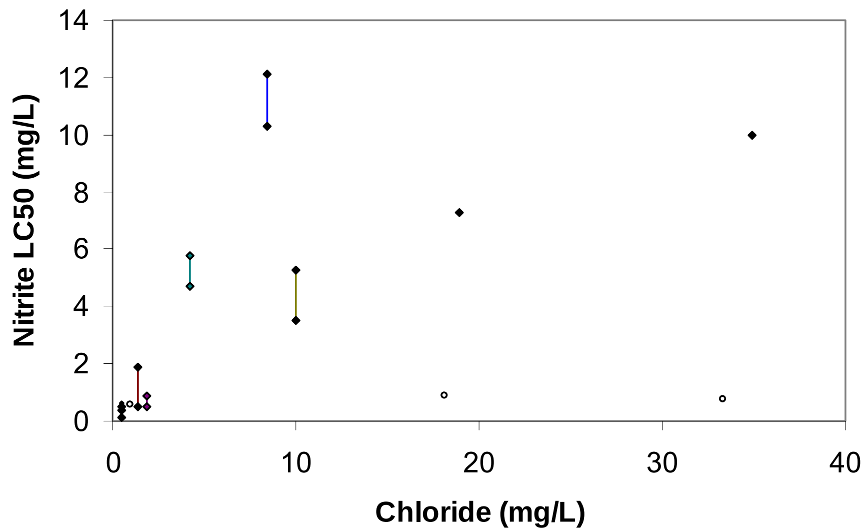
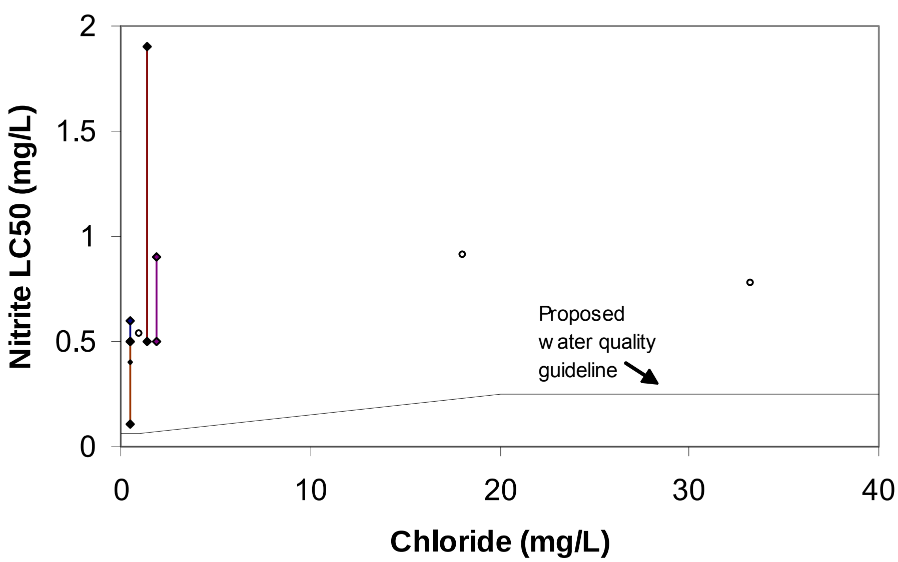


Figure 6. Proposed site-specific water quality guideline for nitrite compared with the most sensitive salmonid LC50 data from the literature.



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