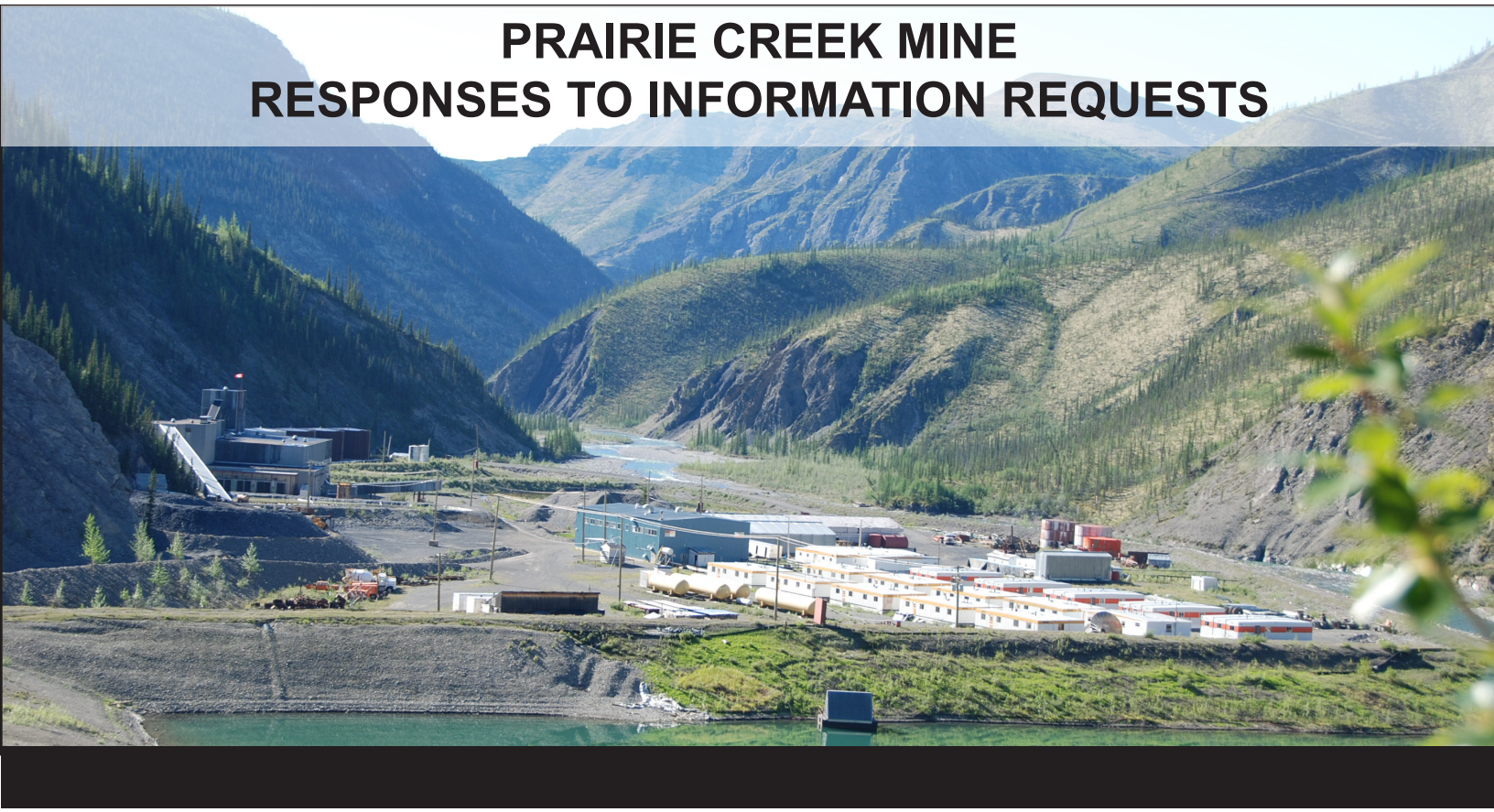
CANADIAN ZINC CORPORATION

PRAIRIE CREEK MINE
RESPONSES TO INFORMATION REQUESTS



SUBMITTED IN SUPPORT OF:

Environmental Assessment of
Prairie Creek Mine EA0809-002

SUBMITTED TO:

Mackenzie Valley Review Board

SUBMITTED BY:

Canadian Zinc Corporation
Vancouver, BC V6B 4N9

September 2010

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1.0 INTRODUCTION

This document provides responses to the information requests (IR's) received from regulators, CPAWS and the Mackenzie Valley Review Board (MVRB) in connection with the environmental assessment (EA) of the Prairie Creek Mine (EA0809-002). Responses are provided to each parties' IR's by section below. A complete copy of the IR's is provided in Appendix A.

2.0 PARKS CANADA IR REPLIES

IR Number: Parks_Canada_1

Subject: Vegetation reclamation and invasive species assessment

Request:

1. To assess reclamation potential, describe a study design and when Canadian Zinc Corporation will collect information on the status of re-vegetation of the former access road within NNPR to natural species; particular attention should be given to Riparian Alluvial, Black Spruce Muskeg, and Aspen Liard Floodplain communities (as described in Section 3.1.5 of Appendix 17) – owing to concerns about the effects of altered drainage on these particular vegetation communities.

2. To assess the potential for invasive plant species, describe a study design and when previously disturbed sites within will be sampled for invasive plant species.

3. Assess the costs and benefits of mitigation measures to prevent introduction of viable propagules of invasive species from trucks and road equipment (e.g., vehicle cleaning station – see wheel wash description in Section 4.3.1.3.4).

4. Describe natural reclamation relative to various vegetation communities and discuss which types may require additional reclamation efforts. Outline the benefits and detrimental effects of active reclamation in these vegetation types.

See report from EBA Engineering Consultants Ltd. in Appendix B.

IR Number: Parks_Canada_2

Subject: Road routing impacts on vegetation

Request: Describe and compare the potential impacts on vegetation of the proposed route with other potential routes.

See report from EBA Engineering Consultants Ltd. in Appendix B.

IR Number: Parks_Canada_3

Subject: Road routing impacts on wildlife

Request:

1. Describe and compare the potential impacts on all wildlife of the proposed Polje By-Pass and Silent Hills Alternative relative to the original route.

2. Describe and compare the potential adverse effects of the existing route and proposed alterations on caribou populations, and calving and wintering range relative to other potential routes.

See report from Golder Associates in Appendix C.

IR Number: Parks Canada 4

Subject: Mitigating wildlife effects

Request:

1. Demonstrate that the Solid Waste Facility identified in Figure 6-13 and 6-16 will keep wildlife away from attractants by providing a detailed drawing with particular reference to fence height, type, depth, whether the fence is electrified or entirely enclosed, and the surface area encompassed and depth of each area (page 197 and 209 of the DAR). Outline the volume of solid waste expected to be produced on an annual basis and the volume available for storage.

The Solid Waste Facility will consist of four different cells: belts and tires; incinerator; hydrocarbon contaminated material; and, sewage sludge. Of these, only the sewage sludge is expected to be an attractant to wildlife. This cell will be fenced, chain link, non-electrified with a minimum 6 foot height. The fence will include solid, reinforced posts. The fence will be placed along the centre-line of the containment berm (see Figure 6-16 in the DAR), and there will be a gate of similar height on wheels to allow for truck entry. The elevated location of the fence and low annual snow depth will keep out bears in snow free seasons and wolves and wolverine in the winter.

We estimate sewage sludge production at approximately 10 kg/day, or 360 kg/year. Over a 14 year mine life, production would be 5,040 kg. To include some variance and the construction and closure periods, we can assume 6,000 kg, or 6 tonnes. At a density of 1.3 tonnes/m^3, the sludge would occupy a volume of approximately 5 m^3. Note that this is conservative because the organic content of the sludge will decompose, and there will be shrinkage. The sewage sludge cell shown in DAR Figure 6-16 has an area of approximately 160 m^2, and is therefore more than adequate for the required storage.

2. Provide aircraft heights and flight paths for the airstrip. Please indicate how often helicopters are expected to be used.

See report from Golder Associates in Appendix C.

Helicopters are not expected to be used often during operations. All crew changes and delivery of supplies outside of the winter road season will be by fixed wing aircraft. Occasional helicopter use may occur for investigation work along the access road, or possibly to access outlying monitoring locations. CZN still holds a LUP for exploration drilling, and the permit provides for helicopter use to drill in outlying areas not accessible by road. CZN has no plans for further helicopter-supported drilling at this time.

3. Spatially describe prescribed speed limits for vehicles on the road.

During winter road construction for the first operating season, speed limits will be established and posted for all sections of the road. This will be done by driving the length of the road and assessing safety. Factors that will be considered will include road bed condition, grade, side slopes, corners and turns, visibility, local terrain and vegetation, and possible wildlife presence. The intent will be to ensure safe driving, and time and opportunity to react to wildlife presence and for that wildlife to flee. As such, speed limits can only practically be established during the construction phase. The limits will also be subject to change based on driver feedback. Problem areas may require that limits be adjusted.

4. Will the road have any effect on drainage? If so, there will likely be effects on vegetation. What vegetation communities will be affected? Where and how? What mitigation measures are planned? Please include a description of any study design and methods in coming to the conclusions above.

There appears to be a misunderstanding with respect to the timing of the initial road construction period. It will not "be during spring, summer and/or fall". Construction will start in late fall/early winter from the Mine. With the higher elevations and lower temperatures, winter conditions will prevail earlier in the Mine area. The road is considered to have an all season bed to Km 38 (Cat Camp). However, road use for operations will be in winter, and will have no effect on drainage. The majority of the road will use an existing road alignment and bed. Some new alignments have been proposed to avoid more sensitive terrain/habitat. Vegetation types will be considered in the final selection of these new alignments. Road design will include consideration of spring runoff and how flows can be passed over the road without interrupting flow or causing erosion.

5. Describe beaver distribution in proximity to the access road and mine. Describe the mitigations that would be used if a beaver dam was going to affect the development.

Beavers are prevalent in the lowland areas crossed by the road in the east, notably Tetcela valley, Fishtrap Creek and the wetlands between the First Range and the Silent Hills. Road operation through these areas will primarily be during the January-March period. Beaver dams are not expected to affect road construction or operations. Minor road realignment could be made if a dam occupies a specific alignment location. Alternatively, the dam could be removed after prior consultation and agreement with either Parks Canada (inside the park) or INAC (outside the park and with GNWT input).

6. For the initial road construction during spring/summer/fall, describe the potential impacts of vegetation clearing and cut and fill work on wildlife. Include, use of the Weaver grizzly habitat model to assess the potential for grizzly conflicts and describe mitigations.

As noted above, road construction will start in late fall/early winter from the Mine. Vegetation will need to be cleared from the existing and new road alignments during the first construction season. Limited cut and fill will be required along the new alignments to create a level road bed. However, the areas involved are minimal in the context of the region, and impacts to wildlife will be insignificant. The road construction and operating period will be within the period of bear hibernation.

7. Describe active deterrence measures for bears and wolverines at the mine site (many territorial/provincial and state agencies have programs to use as templates) including:

a. how food and waste attractants will be stored and handled at the mine site, transfer stations, and at any other locations associated with the development prior to permanent disposal;

See report from Golder Associates in Appendix C.

b. management of the Solid Waste Facility to minimize interactions with wildlife;

See Item 1 above.

c. When operating inside NNPR, consider appropriate wildlife deterrents as provided for in the Canada National Parks Act and Regulations, particularly in reference to firearms.

CZN has a no hunting policy for all employees, and will extend this policy to at least non-aboriginal contractors. Aboriginal contractors will also be discouraged from hunting. CZN's preference is to only have firearms for safety on site or along the access road. Personnel that are required to operate inside the NNPR will carry appropriate wildlife deterrents. However, as the vast majority of operations will be within the period of bear hibernation, wildlife deterrents will mostly not be required.

8. Whether and where salts may be used on the road alignment and if so mitigations to address salt as an attractant that leads to traffic related injury or mortality.

Salt will not be used on the road alignment.

9. Describe how dead or injured wildlife that may be encountered will be dealt with inside and outside of NNPR.

See report from Golder Associates in Appendix C.

IR Number: Parks_Canada_5

Subject: Wildlife Monitoring

Request:

1. Indicate when and how baseline estimates for Woodland Caribou, Dall's sheep, and moose in proximity to the development including the access road, and mine site, claims and leases will be obtained prior to construction.

2. Provide details of the monitoring program proposed to detect potentially detrimental changes in distribution and abundance. Geographic distribution, methodology, effect size, power, confidence, sample size, and frequency of sampling should all be addressed.

3. Provide an assessment of harvest potential, and hypothesized local and population level effects along the access route for Dall's sheep, moose, and Woodland caribou in particular. Outline what a harvest will be measured, reported, and subsequent mitigations decided upon and implemented as generically outlined in the DAR (i.e. what adaptive management will entail and how it will be measured).

See report from Golder Associates in Appendix C.

IR Numbers: Parks Canada 6-10

Subject: Karst Topography and the Access Road

See Golder Associates report in Appendix D.

IR Number: Parks Canada 11

Subject: Abandonment and restoration planning for the access road

Request: With regards to the existing access road that will be by-passed as a result of the construction the proposed re-aligned sections, provide additional details on the use of these sections of the road during mine operations, and a plan and schedule for abandonment and restoration.

Assuming the proposed new alignments are used, the old alignments they replace will not be used or disturbed from their present state. The existing alignment has naturally reclaimed very well. In some places, vegetation has completely re-established and is comparable to adjacent areas. Further restoration does not appear to be necessary since natural reclamation is very effective.

IR Number: Parks Canada 12

Subject: Operation and maintenance of the access road

Request: Provide the criteria that will be applied to determine when the winter road construction and operations is to commence and complete.

As noted above, road construction will start from the Mine. Two criteria in particular will govern the progress of the road east: firmness of the road bed; and, stream crossings. A firm road bed is considered to exist year round to Km 38 (Cat Camp). The first potentially fish-bearing stream crossing occurs at approximately Km 26, Sundog Creek. There are several crossings of Sundog Creek to Km 38. By late fall/early winter, flows in the creek are expected to be zero to negligible, with any standing water frozen. Typical winter road snowfall/ice crossings will be made. Sundog Creek consists of a wide channel of alluvial outwash gravels from Km 28. The road will advance east from Km 38 when the ground is sufficiently frozen to support the weight of machinery without rutting.

As road construction progresses east, road construction will also commence from the location of the Liard River ice bridge west when the ground is sufficiently frozen. CZN plans to barge machinery over the river to the west bank before freeze-up so that road building can commence while the ice bridge is being built.

Road operations will continue until the ground is not sufficiently frozen to support vehicles, or the ice bridge is too thin, whichever comes first.

IR Number: Parks_Canada_13

Subject: Operation and maintenance of the access road

Request:

Estimate the yearly volume of water use for access road construction and operation. Provide the water source locations be detailed on a map, general description of the water source and a description of the potential environmental impacts for its use.

See Appendix E.

IR Number: Parks Canada 14-18

Subject: Spill Contingency Planning

See Appendix F.

IR Number: Parks_Canada_19

Subject: Paste backfill volume balance

Request:

Complete a volume balance to demonstrate that there is sufficient volume in the underground voids to contain all paste produced.

The volume of underground voids is provided in the DAR in Table 6-4, and is 1,799,719 m^3. Table 6-4 is a volume balance, and shows that all tailings can be placed underground with approximately three-quarters of the total DMS rock production as paste backfill. The remaining DMS rock will be placed in the Waste Rock Pile in a non-paste form.

IR Number: Parks_Canada_20

Subject: Geochemical testing – representative samples

Request:

1. Provide additional details about the humidity geochemistry program, specifically addressing:

- *the limited number of samples tested to date;*
- *the heterogeneity of the ore deposit;*
- *and, the expected sensitivity of humidity test results if the composition (e.g., material amounts and size, mineralogy, etc.) of the paste changes compared to that initially tested.*

2. Describe the geochemical testing program during operation of the mine that will be used to understand the changes and the associated impacts, if any, in paste backfill geochemical characteristics compared to that initially tested. This should include a conceptual understanding of the objectives, sampling frequency, and testing approach that would form the basis of the geochemical testing program.

See report from pHase Geochemistry Inc. in Appendix G.

IR Number: Parks_Canada_21

Subject: Flush and steady state leaching conditions

Request:

1. Develop a conceptual model of groundwater interaction with the paste backfill and use it to support the following additional requests. If relevant, the reliance of bulkheads installed in the underground voids should be included in the response.

See report from Robertson Geoconsultants Ltd.Inc. in Appendix H.

2. Describe the potential for flushing and steady state conditions for metal leaching to occur within the paste backfill during mine operations and post-closure?

See report from pHase Geochemistry Inc. in Appendix G.

3. Water that passes through the backfilled paste may contain elevated metal concentrations. Provide a summary description of interaction of groundwater passing through the backfilled paste. Provide an estimate of groundwater flow leaving entering/leaving the paste backfill and the level of certainty in the estimate.

See report from Robertson Geoconsultants Ltd. in Appendix H.

4. Prepare a detailed summary of the uncertainties with regards to groundwater interaction with the backfill material, and how this uncertainty will be addressed.

See report from Robertson Geoconsultants Ltd. in Appendix H.

5. With regards to the paste backfill in the underground voids, further discuss the impact of flushing and steady state conditions on groundwater quality and how this is considered in predictions of drainage water quality from the paste.

See report from pHase Geochemistry Inc. in Appendix G.

6. If flushing conditions are anticipated to occur within the backfilled paste in the underground voids, discuss the estimated timeframe required to establish quasi steady state conditions.

See report from pHase Geochemistry Inc. in Appendix G.

7. In all responses, provide reference to any hydrogeological testing/analysis results that support the discussion. If there are instances where no hydrogeological testing/analysis results are available to support the discussion, provide additional detail on how to fill the information gap (e.g., confirmatory testing/analysis, monitoring, etc.) and provide confidence to interested parties.

See report from Robertson Geoconsultants Ltd. in Appendix H.

IR Number: Parks_Canada_22

Subject: Humidity and permeability cell leachate characteristics for paste backfill

Request:

Provide additional discussion on the application of the permeability cell leachate quality results in predicting leachate quality from the paste backfill.

See report from pHase Geochemistry Inc. in Appendix G.

IR Number: Parks_Canada_23

Subject: Discharge of paste backfill leachate to the environment

Request:

Describe and evaluate options to collect and/or treat the leachate, if it exceeds MMER limits.

See reports from pHase Geochemistry Inc. in Appendix G and Robertson Geoconsultants Ltd. in Appendix H.

IR Number: Parks_Canada_24

Subject: Scaling factors to relate laboratory humidity cell leach rates to field scale leach rates for paste.

See report from pHase Geochemistry Inc. in Appendix G.

IR Number: Parks_Canada_25

Subject: Water quality source term predictions for paste

See report from pHase Geochemistry Inc. in Appendix G.

IR Number: Parks_Canada_26

Subject: Calibration of the water quality prediction model

See report from pHase Geochemistry Inc. in Appendix G.

IR Number: Parks Canada 27-31

Subject: Paste Backfill

See report from Mine Paste Engineering Ltd. in Appendix I.

IR Number: Parks_Canada_32

Subject: Sources of nutrients and their linkages to the selection of environmental indicators as part of the Aquatic Effects Monitoring Plan

Request:

1. Provide clarification on sources of nutrient loadings to the water storage pond;

2. Specifically describe how loadings nutrients will influence the selection of appropriate environmental monitoring indicators.

CZN recognizes the interest in understanding the nutrient load discharged to the environment. However, it should be noted that the Water Storage Pond (WSP) is not the source of direct discharge from the site. In the water management plan, the WSP feeds water to the mill process. Direct discharge occurs via treated mine water and process water. Therefore, the nutrient levels in these flows are the primary concern, and will be monitored (ammonia, nitrate, nitrite, phosphorous) as part of an overall AEMP.

Treated sewage water is clearly not the only potential source of phosphate and other nutrients to the WSP. However, not only will the level of phosphate in sewage effluent be low because of the use of non-phosphate detergents, but the total nutrient contribution from sewage effluent will also be low because of the very small flow compared to other inflows. The WSP water balance in DAR Appendix 9 shows that sewage water will constitute approximately 1.7% of total WSP inflow.

IR Number: Parks_Canada_33

Subject: Aquatic ecosystems

Request:

Include an evaluation of a potential increase in loadings of mercury to Prairie Creek and an evaluation of their potential environmental effects on biological communities in this system.

See Appendix J. With regards to mercury (Hg) in fish tissue, Dr. M. Dube of the University of Saskatchewan made the following comments: “In Spencer at al., 2008, Table 4 outlines metal levels in sculpin muscle. Mercury in reference tissues measured 0.028 +\- 0.018 ug/g; near-field measured 0.066 +\- 0.024 ug/g; far-field measured 0.078 +\- 0.021 ug/g. A one way ANOVA was performed on the results (factor-site) after parametric assumptions were tested and showed no statistically significant difference in Hg in sculpin muscle tissue among sites (p=0.070). This is standard and rigorous statistics applied as per EEM protocols. If you examine the standard errors in the measurements, it is also clear that the variances overlap among the sites and no

statistical differences would be expected. Thus, based on the analysis, Hg in sculpin muscle was not different among sites."

IR Number: Parks_Canada_34

Subject: Aquatic ecosystems

Request:

Complete chronic toxicity studies to quantify the chronic effects of treated process water, given its projected chemical characteristics or explain why these studies were not completed and when they will be completed.

Chronic toxicity studies were not completed on treated process water because the water was found to be acutely toxic, hence the water would also be chronically toxic. It should be noted that the toxicity testing was completed on treated mine water and treated process water before CZN had finalized its proposed water management strategy. This strategy provides for reduction of treated process water discharge in the lower flow months, and curtailment of discharge January-March. Also, at no time will treated process water be discharged without treated mine water, it will always be a blend. CZN plans to conduct further toxicity testing during the mine commissioning phase when actual treated process water and mine water will be available, and the different seasonal blends can be simulated. During this period, the Water Storage Pond (WSP) will be filling, and treated water can be re-circulated back to the WSP.

IR Number: Parks_Canada_35

Subject: Hydrogeology – zinc concentration in Prairie Creek Alluvium Aquifer

Request:

1. Describe the potential (if any) after closure of the mine, for groundwater to discharge into Harrison Creek, in addition to Prairie Creek.

2. Provide additional details on proposed monitoring (during mine operations and post-closure) to understand the movement of metals within groundwater in the bedrock, PCAA, and Harrison Creek Alluvium Aquifer.

See report from Robertson Geoconsultants Ltd. in Appendix H.

IR Number: Parks_Canada_36

Subject: Hydrogeologic contaminant transport modeling

Request:

Provide additional details regarding any proposed hydrogeologic investigations to refine the hydrogeologic model and surface water load balance model predictions for pre-mining, mining, and post-closure, including but not limited to: a summary of the primary assumptions applied in the hydrogeologic model and how future hydrogeologic investigation data will support to

confirm the assumptions; and, scheduling to complete future hydrogeologic investigations relative to pre-mining, mining, post-closure phases of the project.

See report from Robertson Geoconsultants Ltd. in Appendix H.

IR Number: Parks_Canada_37

Subject: Load balance calculations

Request:

Provide additional details regarding any proposed surface water quality and quantity investigations used to refine the load balance predictions for pre-mining, mining, and post-closure, including, but not limited to: a summary of the primary assumptions applied in the load balance calculations and how future investigation data will support to confirm the assumptions; and, scheduling to complete the investigation relative to pre-mining, mining, post-closure phases of the project.

The load balance calculations for Prairie Creek are based on a creek flow record spanning 16 years. This is considerably longer than is the norm for most project assessments. The water quality record is almost as long. The other primary assumptions for the mining-phase load balances are the quality of treated mine water and process water. We believe these are sufficiently understood at this point, although verification will be undertaken during the mine start-up phase. Surface water quality will continue to be monitored before and during mining. Flow monitoring before mining will validate that flows are as expected in the site water management plan, and monitoring during mining will be an operational requirement in order to adjust treated water discharge rates on a daily basis to minimize impacts. Initial monitoring results will be used to assess any need for further adaptive changes. Operating phase monitoring will also allow re-assessment of predicted post-closure load estimates and impacts. Note that the load balance for pre-mine conditions was made to estimate the loads that were naturally discharging to Prairie Creek prior to any site development.

IR Number: Parks_Canada_38

Subject: Load balance model – pre-mining and post-closure

Request:

Provide a prediction of the water quality concentrations in Prairie Creek at the NNPR boundary in the load balance model for pre-mining and post-closure conditions.

See Appendix J.

IR Number: Parks_Canada_39

Subject: Discharge location and point of compliance

Request:

1. Provide location information for the diffuser proposed for installation in Prairie Creek; specifically: the map location of the diffuser, and distances from the diffuser to key points within Prairie Creek. The key points of interest include: existing and proposed Prairie Creek water quality monitoring stations; the Prairie Creek – Harrison Creek location; the NNPR boundary; the proposed Metal Mining Effluent Regulations (MMER) point of compliance; and proposed compliance point for consideration in the water licence.

CZN has considered four options for the discharge of water from the site:

The existing culvert to Harrison Creek

A new culvert to Prairie Creek

A diffuser in the bed of Prairie Creek

An effuser in the bed of Prairie Creek

The last two options were assessed by Northwest Hydraulics Consultants (NHC). Their report is given in Appendix K.

In considering the four options, we have taken into account operational issues (blockages, plugging, ice formation) and environmental impacts (construction, mixing zone). The plan to discharge water via a diffuser was based on a need to avoid icing in winter, and promote mixing to minimize impacts. The belief was that a deep, single channel location could be found in Prairie Creek. NHC's assessment raises doubts in this regard. The creek channel near the site is not as deep as expected. Also, from the perspective of impacts, while a diffuser would promote mixing, it would also introduce site water to the probable location of any over-wintering fish. Therefore, diffuser use would seem to be counter-productive. Complications could also arise during operations from blockages or damage during floods, and impacts may result from repairs in addition to those from initial construction. An effuser was also considered. A deep channel location would not be required, and therefore the over-wintering impacts would be avoided. However, there would still be construction and operation issues similar to a diffuser. Consequently, CZN now believes the use of a culvert is the better approach. Of the two culvert options, the Prairie Creek location is preferred because this avoids the possibility of ice build-up in lower Harrison Creek. The Prairie Creek culvert would be located approximately 10-20 m upstream of Harrison Creek.

We believe the Prairie Creek culvert location will remain ice-free in winter because the discharge will be several degrees above freezing. Any ice build-up downstream will melt in the spring without impacts. The Harrison Creek culvert will be retained for emergency use only.

The Prairie Creek culvert would be the point of MMER compliance. In addition to the existing upstream downstream monitoring locations (see DAR Figure 4-5), an additional 'near-field' downstream station is proposed, perhaps approximately 200 m downstream of Harrison Creek. At this location, site discharge should be completely mixed with creek water. However, we are awaiting the results of a mixing assessment and we will propose a more exact location once the results are available. Regarding compliance points in a water licence and the proposed approach to compliance, please refer to Appendix L.

2. Provide additional information with regards to mixing conditions in the Prairie Creek in the vicinity of the diffuser.

As noted above, this information will be forth-coming in the near future.

3. Provide predicted water quality at proposed MMER point of compliance.

The treated process water and mine water qualities used for receiving water impact assessments have been combined according to CZN's proposed water management plan in Table PC.39. Note that the results do not include natural site runoff which also reports to the Catchment Pond and would be a contributor to the blended stream entering the proposed discharge culvert, which also represents the proposed point of MMER compliance. Note also that the water qualities in Table PC.39 are based on expected treatment qualities from normal operations. Water Licence limits would need to account for short-term treatment plant upsets and possible Catchment Pond water quality variations from abnormal site runoff.

4. Provide predicted water quality at the proposed compliance point for consideration in the water licence.

This is a complex question, but is answered by a combination of point 3 above and by considering Appendices J and L in conjunction.

IR Number: Parks_Canada_40

Subject: Underground mine water flows during operation

Request:

1. Provide a summary of how the "worst-case scenario" for mine flow rate (i.e., 100 L/s) was considered in the sizing of the water storage facilities (e.g., water storage pond).

In CZN's water management plan, only enough mine water and mill water is sent to the Water Storage Pond (WSP) to sustain feed to the mill. Excess mine and mill water is treated and discharged. The excess mill water flow will remain constant, and the treatment circuit for this stream will be sized accordingly, but will include some ability to treat higher flows for operational flexibility. This is normal engineering practice. The capacity of the mine water treatment circuit is dependent on the magnitude of mine water flows. Initial capacity will be 55 L/sec, but the plant will be designed to facilitate doubling and even quadrupling this capacity. Mine flows will be monitored and expansion plans will be in place before treatment capacity is exceeded. Therefore, 'worst-case' mine flows are accommodated by increased treatment

TABLE PC.39: PREDICTED WATER QUALITY AT PROPOSED MMER POINT OF COMPLIANCE

		Treated Water		MMER
		Process	**Mine**	**Mo. Mean**
Cadmium	mg/L	0.00262	0.00001	-
Copper	mg/L	0.0021	0.0072	0.3
Lead	mg/L	0.0932	0.0001	0.2
Selenium	mg/L	0.0392	0.0033	-
Zinc	mg/L	0.039	0.017	0.5

Note: Treated mine water lead concentration was <0.0002 mg/L, value set at half the detection limit

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)		Discharge Concentrations (mg/L)				
Month	**Process**	**Mine**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**
Jan	0.000	0.019	0.0000	0.0072	0.0001	0.0033	0.0170
Feb	0.000	0.019	0.0000	0.0072	0.0001	0.0033	0.0170
Mar	0.000	0.019	0.0000	0.0072	0.0001	0.0033	0.0170
Apr	0.002	0.019	0.0003	0.0067	0.0090	0.0067	0.0191
May	0.020	0.019	0.0013	0.0046	0.0478	0.0217	0.0283
Jun	0.020	0.019	0.0013	0.0046	0.0478	0.0217	0.0283
Jul	0.020	0.019	0.0013	0.0046	0.0478	0.0217	0.0283
Aug	0.020	0.019	0.0013	0.0046	0.0478	0.0217	0.0283
Sep	0.019	0.019	0.0013	0.0047	0.0467	0.0213	0.0280
Oct	0.007	0.019	0.0007	0.0058	0.0252	0.0130	0.0229
Nov	0.003	0.019	0.0004	0.0065	0.0128	0.0082	0.0200
Dec	0.002	0.019	0.0003	0.0067	0.0090	0.0067	0.0191
Mean	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)		In-Stream Concentrations (mg/L)				
Month	**Process**	**Mine**	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Zinc**
Jan	0.000	0.090	0.0000	0.0072	0.0001	0.0033	0.0170
Feb	0.000	0.090	0.0000	0.0072	0.0001	0.0033	0.0170
Mar	0.000	0.090	0.0000	0.0072	0.0001	0.0033	0.0170
Apr	0.002	0.090	0.0001	0.0071	0.0021	0.0041	0.0175
May	0.020	0.090	0.0005	0.0063	0.0170	0.0098	0.0210
Jun	0.020	0.090	0.0005	0.0063	0.0170	0.0098	0.0210
Jul	0.020	0.090	0.0005	0.0063	0.0170	0.0098	0.0210
Aug	0.020	0.090	0.0005	0.0063	0.0170	0.0098	0.0210
Sep	0.019	0.090	0.0005	0.0063	0.0163	0.0096	0.0208
Oct	0.007	0.090	0.0002	0.0068	0.0068	0.0059	0.0186
Nov	0.003	0.090	0.0001	0.0070	0.0031	0.0045	0.0177
Dec	0.002	0.090	0.0001	0.0071	0.0021	0.0041	0.0175
Mean	0.0094	0.090					

Bold = Value exceeds MMER

capacity, and WSP capacity is not relevant, except that the WSP will be used to allow seasonal variation of discharges to minimize impacts.

2. Describe how mine water will be treated/managed if the "worst-case scenario" mine flow rate occurs.

As note above, 'worst-case scenario' mine flows will be managed by increased treatment capacity.

3. If the "worst-case scenario" was not considered in the sizing of the storage facilities or water treatment plant, describe the contingencies that will be in place to manage/treat the water flows above the design values.

'Worst-case' mine flows were considered in the sizing of the water treatment plant, and contingencies have been included to manage/treat the water flows above the design values and even above the expected worst-case.

IR Number: Parks_Canada_41

Subject: Water storage pond freeboard volume

Request:

1. Provide additional detail with regards to the configuration of the water storage pond dam: specifically, the elevation of the dam crest; 1 m freeboard elevation; dam outlet elevation; spillway elevation; and, water level elevation in the water storage pond that will be used in the design of the dam. Further, identify the location of the dam spillway on a map.

As noted on page 4 of the DAR Addendum, the crest of the Water Storage Pond crest will be at elevation 881 m. The operating range for the WSP water level will be between elevations 877 m and 880 m. The dam outlet and spillway are one and the same, and will be incrementally below the 881 m crest elevation. The spillway will be located in the eastern dyke of the WSP so that in the highly unlikely event of an emergency, controlled discharge, flows would report to the site surface water management system inside the flood protection berm.

2. Discuss the potential for water to breach the dam crest, if the freeboard is temporarily exceeded.

The use of the 1 m freeboard in the WSP during the unlikely event of an extended treatment plant malfunction was intended to demonstrate that significant, temporary storage potential will be available so that the discharge of untreated water to the environment will not occur. Should there be a need to use the WSP for emergency temporary storage, it is unlikely that the water level in the WSP will be at the maximum elevation. Even if it is, a 1 m freeboard would provide 12.5 days of storage for a mine flow of 100 L/sec, the worst-case flow expected. It is inconceivable that the treatment plant would be inoperable for this period of time, given the redundancy of replacement and spare parts that would be available, plus the opportunity to fly-in parts on short notice if the need arises. In any event, a situation would never occur where water

would be allowed to breach the WSP dam crest. Any release would be a controlled release via an emergency spillway.

3. Provide additional detail with respect to the implications should the "worst-case scenario" occur during a water treatment plant break down or extreme precipitation events.

See point 2 above.

IR Number: Parks_Canada_42

Subject: Waste rock pile drainage water

Request:

1. Provide additional information for a monitoring program with regards to the collection of climatic, engineering, and geochemical data that are necessary to complete final design of the waste rock pile, and to predict water quality of the waste rock pile drainage water.

2. Provide additional details on the proposed monitoring and management/treatment of waste rock pile drainage waters post-closure.

See report from pHase Geochemistry Inc. in Appendix G.

IR Number: Parks_Canada_43

Subject: Water treatment plant and water storage pond sludge management

Request:

Estimate the volume of sludge to be removed from the water treatment plant and water storage pond and provide further detail on the management of sludge from the water storage pond. Discuss the impact of adding sludge to the paste backfill, with respect to paste geochemistry and paste drainage water quality.

The volume of sludge that would be produced if mine flows were 'worst-case' is estimated to be approximately 900 tonnes/year. A very conservative life of mine estimate is 12,600 tonnes. This is conservative because mine flows would not reach the 'worst-case' immediately, if at all. The life of mine backfill tonnage is estimated at 3,401,470. Therefore, the very conservative sludge estimate represents 0.37% of this. Sludge from the Water Storage Pond (WSP) will be a combination of settled sediment from mine water and mill water. The latter consists of fine tailings which have already been accounted for in the backfill calculation. The quantity of mine water sediment is not expected to be as great as treatment plant sludge. Sludge accumulations in the WSP can be dredged out if necessary, although it is more likely the sludge will remain until mine closure and WSP decommissioning when it will be removed and made into paste for backfill.

Considering the very small quantities of sludge relative to the backfill mix, no impact is expected on paste geochemistry or paste drainage water quality from inclusion of the sludge in the mix.

IR Number: Parks_Canada_44

Subject: Water treatment of mine water

Request:

1. Discuss the likelihood that lime addition could remove the following metals from mine water: cadmium, antimony, selenium, and mercury.

Water treatment testing determined that lime alone is not sufficient to remove cadmium, antimony, selenium, and mercury from process water to acceptable levels. The issue here is whether these metals will leach from the paste backfill and report to mine water flows which will be treated with lime only. First, hydrogeologic assessment (Appendix H) has determined that groundwater will preferentially flow in the fractured rock proximal to the mined-out vein rather through the backfill. Second, the properties of the paste are such that bleed of pore water is expected to be minimal after placement (see Appendix I). Third, if either of these expectations proves to be incorrect, selective collection of 'contaminated' mine water (with significant metal concentrations other than zinc) could be implemented, with the collected water managed subsequently as mill water.

2. Discuss the potential ability of the water treatment plant to be retrofitted if the mine water contains metals that cannot be reduced to adequate levels using lime addition.

The mine water treatment circuit would not be retrofitted. As explained above, 'contaminated' mine water would be managed as mill water and either sent to the WSP or treated in the mill water treatment circuit.

IR Number: Parks_Canada_45

Subject: Water treatment of process water

Request:

1. Provide target concentrations of metals in the treated process water.

Metals will be removed from process water to the lowest concentrations possible using the chosen treatment process. Efficient treatment will provide greater flexibility in terms of discharge management to minimize impacts. That will be the target. Plant operators will determine the normal operating range for metals in treated water, and adjustments will be made if concentrations exceed the range. The ultimate determinant of the acceptable operating range will be the metal concentrations that can be discharged without exceeding the limits specified in a Water Licence.

2. For the chemicals used in process water treatment and ultimately discharged into Prairie Creek, provide additional discussion with regards to the impacts of these chemicals to aquatic life.

The chemicals to be used for process water treatment are: sulphuric acid, sodium sulphide, lime, ferric sulphate and a flocculant. The acid and low pH are neutralized by lime addition. Only enough sodium sulphide will be used to be completely consumed in the precipitation of metals. Quantities of ferric sulphate and flocculants will be small to aid sediment settling. Residues from any of these chemicals are not expected to be toxic to aquatic life. This will be verified by toxicity testing of treated water during the mine start-up phase.

3. Discuss further the expected concentrations of arsenic, and chemicals utilized in treatment, within Prairie Creek and at the NNPR boundary.

For arsenic and iron, refer to Appendix J. For treatment chemicals, refer to point 2 above.

IR Number: Parks_Canada_46

Subject: Discharge criteria to Prairie Creek

Request:

1. Describe how the selection of the proposed pre-determined background Prairie Creek water quality concentrations will consider Prairie Creek flow rate; seasonal variations; and climatic conditions.

The proposed pre-determined background Prairie Creek water quality concentrations will not consider Prairie Creek flow rate, seasonal variations or climatic conditions. As Parks Canada noted, it is not practical to monitor these concentrations continuously and adjust the assumed background concentrations with regulatory review. More to the point, in most cases, the background concentrations do not vary significantly with season and flow rate. Also, any modification of the background concentration would result in an adjustment of the site-specific guideline. If the background concentration increases, so does the site-specific guideline. The net result would be a similar load could be discharged without exceeding the guideline.

Pre-determined background Prairie Creek water quality concentrations could be reviewed and adjusted on an annual basis, although as noted, the site-specific guidelines would then need to be adjusted also.

2. Present additional options to determine discharge criteria, along with the pros and cons for adoption.

See Appendix L.

IR Number: Parks_Canada_47

Subject: Site specific water quality guidelines for Prairie Creek

Request:

1. Further discuss how the site specific water quality guidelines may be updated, as additional upstream water quality concentration data becomes available.

Refer to reply to IR PC46, point 1.

2. Further discuss how the site specific water quality guidelines may be updated using data obtained from the environment effects monitoring and aquatic effects monitoring programs, after the mine enters into operation

The site-specific water quality guidelines were determined from existing data on the range and variability of background concentrations. As this database is expanded, through monitoring and EEM/AEMP programs, the guidelines could be adjusted. As noted, the pre-determined background concentrations would then also be adjusted.

3.0 GNWT IR REPLIES

IR Number: GNWT 1-1

Subject: Spill Contingency Planning

Request:

1. Modify the Spill Contingency Plan to address all potential spill scenarios, not only those limited to fuel. Figure 1 included in the Plan should reflect storage locations of all reagents, hazardous substances, chemicals and explosives.

2. Include information on the management of contaminated soil, snow, water and ice from spills and de-icing activities.

3. Identify clear disposal options for all potential spill scenarios.

4. Provide a clear linkage between the Spill Contingency Plan and the proposed landfarm, noting contaminants available for treatment and level of treatment (with considerations for future land use).

5. Describe approach or activities to address remediation of a large scale (e.g. Remedial Action Plan, Environmental Site Assessment).

6. Please provide a clear commitment that contractors will adhere to CZN's Spill Contingency Plan.

See Appendix F.

IR Number: GNWT 1-2

Subject: Draft Closure and Reclamation Plan

Request:

1. The Draft Closure and Reclamation Plan include an outline and timelines for a Reclamation Research Plan identifying the necessary information required to evaluate options and develop measurable closure criteria.

CZN's draft closure plan includes complete backfilling of the underground mine, removal of surface facilities on the Prairie Creek floodplain (unless relevant parties wish some to remain), and covering the Waste Rock Pile (WRP) in the Harrison Creek valley. Continuing research elements are associated with each of these main reclamation actions. Hydrogeological and geochemical data will be collected routinely during operations in order to update predictions of the behaviour of the backfill and groundwater and surface water quality after mine closure. Observations of natural revegation around the mine site and along unused portions of the access road will be recorded to justify the adoption of this approach to reclaim disturbed areas. WRP drainage will be monitored routinely during operations, and further consideration will be given to

the composition of a suitable cover for the pile after mine closure. CZN proposes to provide further details on the main closure components, including updated predictions, at the time of Water Licence renewal which is normally every 5 years.

2. Include rationale, where possible on closure options selected (e.g. natural invasion of 20-30 years vs. re-vegetation).

The rationale for proposing to place all of the tailings and as much of the DMS rock underground as a backfill is that this is the most secure and environmentally sound approach, mine waste is removed from the Prairie Creek floodplain, and the process of mine backfilling enables the underground to be closed and sufficiently sealed to avoid long-term water treatment liabilities.

Natural invasion as a method of reclamation is clearly evident around the mine site and along the access road. Further confirmation of this is contained in a report from EBA Engineering Consultants. An Interim Report from EBA is included in Appendix B.

The location of the WRP was selected because it is proximal to the mine, off the Prairie Creek floodplain, and in a location that receives little runoff and can be readily covered and contoured into the landscape.

3. Provide timelines for consultation and future revisions/updates to the Plan.

As noted in point 1 above, we propose a 5 year time step coincident with Water Licence renewal for revisions of the closure plan. Consultations can also be held at these junctures to determine preferences for final site closure.

IR Number: GNWT 1-3

Subject: Waste Management - Incineration

Request:

1. Please provide an outline for an incineration management plan. We recommend this be consistent with Environment Canada's Technical Document for Batch Waste Incineration (www.ec.gc.ca/drgd-wrmd/default.asp?lang=En&n=82401EC7-1). The management plan outline should include commitments for annual reporting on a number of items, for example:

- *Incineration technology selected;*
- *Waste audit -- amount and types of waste incinerated;*
- *Operational and maintenance records;*
- *Operator training;*
- *Emission measurements; and*
- *Incineration ash disposal*

See Appendix M. As noted in the DAR, incinerator ash will be disposed of in the mine backfill mix.

IR Number: GNWT 1-4

Subject: Waste Management- Wildlife Attractant

Request

1. Provide details on deterrent measures to be implemented in order to minimize animal attraction associated with the solid waste facility, waste transfer area and incinerator activities.

The solid waste facility (SWF) will be located within the footprint of the Waste Rock Pile (WRP) and near active rock dumping. Site waste, including kitchen waste, will be incinerated at the facility on a daily basis. Hence, there will be frequent activity at the SWF, which itself will be a deterrent to wildlife. The sewage sludge storage cell will be the main attractant at the facility. This cell will be fenced and gated.

IR Number: GNWT 1-5

Subject: Geochemical Characteristics of the Paste Backfill

Request

1. Provide information regarding an operational geochemical monitoring and testing program to determine and confirm the geochemistry of the paste backfill and its subsequent impacts to groundwater.

See Appendix G.

IR Number: GNWT 1-6

Subject: Archaeological Impact Assessment of Access Road Re-alignments

Request

1. Please provide the PWNHC with a timeline for completion of an AIA of the proposed access road re-alignments.

CZN conducted further assessment this summer of the locations of the proposed road re-alignments between the expanded NNPR boundary and the Liard River. CZN proposes to complete an AIA of the re-alignments next summer.

IR Number: GNWT 1-7

Subject: Social Impacts

Request

1. Please list what mitigating steps will be taken to reduce the impact of absentee workers on child care in the community.

CZN understands the stress some families may suffer within the mining career culture. CZN has always tried to communicate the possible lifestyle effects which can occur for potential employees which have worked at the remote project. Potential employees that have families with

young children might determine that a mining career at this current time would not be in the best interest of their family. Since the project's expected mine life would be more than 14 years, these families could decide to participate at a later date. Aside from the 220 direct jobs, the project will also provide many indirect work options which would allow many families to gain employment closer to their communities. Many of the project's potential business opportunities located nearby these communities are being identified as set aside and evergreen contracts and pursued through the IBA negotiations. Applicants to work at the mine will be notified on employment that they should make appropriate arrangements for child care in their absence.

2. Please list the information, and/or educational materials will be available on site regarding the prevention of STIs.

To assist CZN's medical personnel the following information materials will be available to staff regarding the prevention of STIs:

Posted Website Links

Public Health Agency of Canada

http://www.phac-aspc.gc.ca/std-mts/index-eng.php

Northwest Territories Health and Social Services

http://www.hlthss.gov.nt.ca/english/default.htm

World Health Organization

http://www.who.int/topics/sexually_transmitted_infections/en/

Reports & Pamphlets Located in the Library

Report on Sexually Transmitted Infections in Canada (pdf)

http://www.phac-aspc.gc.ca/std-mts/report/sti-its2008/PDF/10-047-STI_report_eng-r1.pdf

Sexually Transmitted Infections Pamphlet

http://www.phac-aspc.gc.ca/publicat/std-mts/index-eng.php

Directions for Wellness

http://www.hlthss.gov.nt.ca/pdf/reports/community_wellness/2009/english/directions_for_wellness_2007_2008.pdf

World Health Organization – Sexually Transmitted Infections

http://www.who.int/mediacentre/factsheets/fs110/en/print.html

3. List the measures CZN will take to protect workers from the spread of communicable diseases on site.

The on-site measures CZN would pursue to protect workers from the spread of communicable diseases include the following:

- Having trained medical personnel to identify communicable diseases
- Providing advice regarding personal hygiene.
- Designating potential areas to isolate infected workers if required
- Pre-screening employment candidates with medical check-ups
- Requesting employees to be up-to-date with their vaccinations
- Post the contact number for the Chief of Public Health
- Discuss possible outbreaks of STIs at Health & Safety meetings
- Provide educational materials in the project's library

4. Please indicate what medical and counselling personnel will be available on site. How many hours a day will they be available? If the medical personnel determine a patient has a reportable or notifiable disease, please ensure the medical professional is aware of his or her duty to report under Part 4 of the Public Health Act to the appropriate authorities.

The project will have trained medical personnel on a rotational basis. Such personnel will be on call 7 days a week, 24 hours a day to provide medical, educational and counselling services, as required. To complement the advanced medical personnel, there will also be the appropriate levels of first aid attendants available to assist the company's Health and Safety services as needed.

IR Number: GNWT 1-8

Subject: Hiring Policy for Northern and Aboriginal Residents of the NWT

Request

1. To better understand CZN's commitments for maximizing direct employment and retention of both Northern and Aboriginal Residents in and outside the Dehcho region, describe the hiring practices around Dene and Northern preference. For example: Priority Hire and Order for: Members of Aboriginal Authorities in the Dehcho or Study Are; Aboriginal People residing in the NWT; NWT Residents; Others.

To maximize and retain Aboriginal and Northern Resident employment levels at the project CZN expects to follow the hiring preferences which will be negotiated with its IBAs holders. CZN has always preferred employing local qualified residents within the Study Area to assist with the project's advancement. The order of priority CZN has been using for hiring applicants with similar qualifications can be defined as:

1. Members of the Nahanni Butte Dene Band
2. Members of the Liidlii Kue First Nation Band
3. Dene descendants within the Dehcho Region
4. Residence within the Northwest Territories

5. Others

2. Please list the steps that will be taken to ensure that CZN contractors and subcontractors adhere to the same hiring policy.

To ensure these same hiring policies are followed by CZN's contractors and subcontractors, the company will require affiliated businesses to sign an Employment Contract and Code of Conduct which reflect the policies of the company. Businesses who are bidding on contracts will be made aware of the northern employment criteria that will be part of CZN's evaluation for submitted proposals.

To improve the efficiency of CZN's employment policy, the company will coordinate information of potential employees to contractors, notify Study Area communities of construction timelines and timelines for hiring, and pass along applications from local workers to contractors.

IR Number: GNWT 1-9

Subject: Training and Employment Plans and Strategies

Request

1. Please describe CZN's plans and strategies and detail commitments to maximize direct employment and retention for NWT residents outside of the Study Area.

Once CZN has fulfilled its commitments with its IBA holders, the company will promote the direct employment of NWT residents outside the Study Area promoting available employment positions with advertising in regional newspapers, and postings with NWT employment agencies. Some of these agencies would include MTS and the employment coordinators with various First Nation Bands in NWT. The company will consider a pick-up point in Yellowknife if employee numbers warrant it and it is economically justified.

2. Please list the types of training programs (entry level, semi-skilled, skilled, professional, or management) to be delivered by CZN or in partnership with other agencies that could lead to construction or operation employment or advancement within the CZN Prairie Creek Project.

CZN has worked very closely with several agencies to help coordinate the types of training the project will require. The Mine Training Society (MTS) and Aurora College have already assisted CZN in providing two Environmental Monitoring Training Programs at the Prairie Creek Mine. MTS has the project's human resource requirements listed in their database and are assisting CZN in obtaining additional funding listed under the new Skills and Partnership Fund (SPF) to be directed solely for the Prairie Creek Mine's operation. Some of the existing training programs have included Class 1 Driver, Underground Mining, Mineral Processing, Heavy Equipment Operator, Environmental Monitoring, and Cooking. MTS recently held an Open House in Nahanni Butte during CZN's Annual Community BBQ event in August 2010.

To complement the MTS training, CZN has been enhancing a working relationship with Dehcho First Nations as a common facilitator for its Aboriginal Skill and Partnership Program. These programs will focus on transferable trade skills which can be associated with the apprenticeship

positions provided with the project. These apprentice positions could include electricians, plumbers, welders, pipe-fitters, general machinists, carpenters, mechanics, and draftspersons.

The company is also committed to providing mentoring programs at the mine, ongoing school workshop presentations at local schools, and annual scholarships to promote the abilities of future generations within the Dehcho Region.

3. Please provide an estimate on the number of Apprenticeship positions to be offered.

CZN will be making commitments to apprentice positions with its IBA holders. The company expects to have several apprentice positions available with the project although priority will be given to CZN's IBA holders.

4. Does CZN plan to provide summer employment opportunities? If so, please identify the strategy and procedures CZN will undertake to provide student employment.

CZN expects to provide several summer positions for various responsibilities. The areas of work could relate to general labourers, office assistance or help with annual events held in neighbouring communities. These annual positions could be posted at the mine site, regional CZN offices, and advertised in local newspapers. Priority will be given to relatives of mine staff from the IBA communities.

IR Number: GNWT 1-10

Subject: Adaptive Management

Request

1. Please indicate what adaptive management systems will be put in place to deal with problematic socio-economic impacts identified during monitoring.

CZN defines "Adaptive Management" as a monitoring system to measure key indicators and a response system to modify actions. The Company's approach assumes a need for continual learning and that its policies and management practices will be subject to continuous review to ensure improvements in socio-economic outcomes can occur throughout the life of the project.

Highlighting CZN's Adaptive Management System will be:

- *A Monitoring System* consisting principally of a year-long process of collecting and analysing data and trends regarding the outcomes from participation in the Project and more general socio-economic progress of the Study Area.
- *A Response System* consisting of a formal session to communicate results and receive input from representatives of the affected communities on areas where changes could improve outcomes and productivity.

CZN's reporting commitments are outlined in the DAR and are also presented in the response to the Information Request no. GNWT 1-15. The Company will generate an annual report on production, employment, procurement and socio-economic trends. It will be the principal communication tool that informs the public of the results from the Company's monitoring

system. This monitoring includes information gathered from employees and their communities by the community information officers. Other company officials will remain active in the communities through their participation in sponsorships, promotions and investments. Information gathered "on-the-ground" will be combined with the technical approach used in gathering and reporting operations' data and socio-economic statistics.

The monitoring system will direct when and where action is needed from within the Company's response system. CZN has committed to altering its programs where possible when existing ones are ineffective or problematic. The company feels experimenting with the manner in which it interacts with the Study Area's human environment is simplified by the relatively small size and scope of the Project.

The central component within the response system will be a formal consultation process whereby CZN presents the results of the monitoring system to the affected Study Area communities and opens a dialogue with community representatives who will learn from the results, and also describe their own analysis of changes in their community, and offer suggestions on improved participation, interaction, and communication. The opportunity to communicate with company officials is not bound to this annual meeting. The process of collecting information and gathering input will be ongoing throughout the year.

The Prairie Creek Mine will remain operational long enough that CZN can anticipate measurable changes occurring across numerous aspects of the Study Area's human environment. From the perspective of pure statistical analysis, it is unlikely that a direct causal link could be drawn between the Project and many of the changes that will take place. While this needs to be appreciated in its own right, CZN's real concern is that the Study Area is better off having had the Project proceed than it would be without it and that the quality of life in these communities improves. The Company sees itself as a member of the Study Area communities, so regardless of whether a direct link can be drawn between its actions and the socio-economic outcomes, its' interest is in promoting positive adaptation where needed and where possible.

IR Number: GNWT 1-11

Subject: Socio-Economic Transitioning Measures for Closure

Request

1. What steps will the Canadian Zinc Corporation take to mitigate the negative effects of mine closure for local and regional employees, businesses, and communities?

CZN's mitigation strategy includes numerous commitments that are aimed at strengthening communities' resiliency to economic change. These commitments will materialise throughout the life of the project, leaving behind a legacy of improved community well-being that will have a positive impact during the transition to mine closure.

Greater resiliency comes from improved economic well-being, awareness, greater capabilities, and security. There are many dimensions to these factors. The first is the most straightforward. Economic well-being is achieved through access to income, material possessions, and savings. CZN can have an impact in this area through its expenditures on capital and labour.

To address issues around savings, CZN will offer money management training. There is great complexity in understanding and addressing issues related to the behaviour of employees' spending patterns and to formulate an appropriate level of intervention. And while it is an important issue for employees and their families, when talking about life beyond that of the Project, what is most important is the ability to create wealth through other means such as other productive activities or investment. A savings account can prolong the necessity of this need for new sources of wealth creation, but it will not replace it. For this reason, CZN will place a lot of emphasis on human capital development within its mitigation strategy.

An awareness of mine activity and future outlook is also important for the company to convey to the regional work force. Further informed education relating to commodity prices, market fluctuations, supply/demand and operational costs will be made available to the public through disclosure for the region to follow and prepare for.

Capabilities refer to a broad set of factors influencing the growth of human capital. Greater human capital is an essential component for the sustainability and resiliency of a community. The focus for CZN will be education. It will provide substantive opportunities to enhance education and skills. For employees, on-the-job training will include:

- Occupational Health and Safety;
- Safety Oriented First Aid and required levels of Mine Rescue;
- Driver Education;
- Environmental Awareness;
- Workplace Hazardous Material Information;
- Hazardous Materials Handling, Storage and Transport;
- Waste Management;
- Spill Response and Reporting - ensure employees know the site layout, and where to find safety, medical and environmental help;
- Review emergency response procedures and responsibilities;
- Make employees aware of wildlife policies, and specifically how to respond to bear encounters; and,
- Make employees aware of drug and alcohol policies, and where to find help if needed.

For the Study Area community as a whole, regarding additional investments in education, CZN will:

- Sponsor students attending higher education through a scholarship program. To date, 43 scholarships have been awarded with $43,500 being awarded to recipients.
- Work with the NWT Mine Training Society and Aurora College to provide education and training opportunities.
- Work with Study Area schools to provide details of its operations, its future labour and supply needs, and opportunities for students.
- Work with Study Area communities and businesses to improve participation and productivity.
- Remain very active in the communities through investments, sponsorships, promotions, and attendance at community events.

Through its Impact and Benefit Agreement holders and the Deh Cho First Nation, CZN is looking to invest in education and training specific to the needs identified by the Dehcho residents. Emphasis is on skills that are applicable to many job descriptions and not necessarily specific to mining.

The last component necessary for a resilient community is security. This is another broad issue but here we focus on social exclusion. How society interacts, its social networks, the level of trust between individuals, families, communities, governments and industry plays an important role in how a society can manage change such as that brought on by the closure of a mine. CZN has and will continue to influence issues of exclusion through its own best practices and being inclusive in its operations, expenditures and community investments. Beyond that, it is appropriate for the effected individuals, families and communities to develop and advance systems to enhance their own security and reduce any exclusionary practices. CZN will invest in communities to improve quality of life there and believes this will indirectly influence issues of security and exclusion. Much of the community investment will take place through the Impact and Benefit Agreements and centre on direct investment and financial transfers.

IR Number: GNWT 1-12

Subject: Impact of the Mine on Traditional Economic Activity

Request

1. Please provide a dollar-value estimate of the impact of the mine on traditional economic activity in the study area.

Data on current traditional economic activity, specifically harvesting, is not available, primarily because of confidentiality concerns expressed by the Nahanni Butte Dene Band (NBDB). CZN is engaged with the NBDB in IBA negotiations which will include consideration of impacts on traditional activity.

The information request suggests a presumption that the mine will have a negative impact on traditional activity. Our information suggests the opposite. Several NBDB harvesters indicated that the proposed access road will actually facilitate their use of trap-lines in the Second Gap area.

2. Please provide detailed information on monitoring and adaptive management plans to be undertaken to mitigate and minimize possible adverse effects on traditional economic activity in the study area.

As noted above, the mine may in fact render positive impacts on traditional activity. However, CZN has undertaken to employ NBDB members as environmental monitors at the mine and for the access road. CZN is also looking to NBDB members first for the operation of checkpoints on the road to manage traffic and the possible use of the road by individuals not on mine business. As with all mine operations, continuous review of the effectiveness of control measures will occur, and modifications made as appropriate in consultation with local communities and the relevant regulatory authorities.

IR Number: GNWT 1-13

Subject: NWT Business Contracting and Procurement Opportunities

Request

1. How does CZN intend to identify businesses which maximize NWT content?

In order to identify potential businesses to maximize NWT content, CZN will be provided with a registry of businesses and joint venture businesses by its IBA holders. This registry will be regularly updated and overseen by the IBA holder's Development Corporation Managers.

2. What steps will Canadian Zinc Corporation take to ensure NWT businesses can successfully compete on contract and procurement opportunities (e.g., break contracts down into sizes that make it easier for smaller local businesses to compete)?

CZN is expecting to have set aside and evergreen contracts for its IBA holders. CZN has also initiated a Nahendeh Aboriginal Economic Council to help create a dialogue to build local capacity for bidding on various components of the project. The first meeting was held in Fort Liard and participants included the communities of Nahanni Butte, Fort Simpson, Fort Liard, and Trout Lake. Jean Marie community was not able to make this meeting but was interested in attending the next meeting to be held in the near future.

3. Please provide additional information on the efforts CZN will make to ensure NWT businesses are aware of business and procurement opportunities.

It is CZN's intent to provide IBA holders advance notice on all contracts and procurement opportunities. The specific timeframes are still in IBA negotiation. Further to this commitment, CZN expects to advertise sourcing needs in local and regional newspapers in the NWT, and notify local businesses of the project's requirements.

4. Please provide a table which lists the percentage of expenditures to be spent with NWT businesses during the construction, operations and reclamation phases. Also, please detail how the estimated percentages are calculated.

The estimations for business procurement were determined from several sources. In 2007, through the support of CZN, the ADK Group of Companies and Nogha Enterprises Limited commissioned a detailed study of the business opportunities that would develop as a result of the Company's mining expenditures. The report was produced by Michael Pealow and was titled *Business Opportunity Assessment of Canadian Zinc's Prairie Creek Mine* and was completed in March 2007. This report provided a line-by-line inventory of the goods and services needs of the mine. The summary table is provided at the end of this reply.

The report's results helped in the determination of business opportunities and provided some valuable input into the IBA negotiations for procurement. The results also provide some detailed insight into the results from the input-output simulation of construction and operations performed by Impact Economics.

Using the Statistics Canada Inter-provincial Input-Output Model, the combined direct and indirect gross domestic output from the construction phase will equal $110.7 million. Of that amount, $70.6 million will occur in the NWT. That equates to 64 per cent. In addition, the model provided an estimate for the total output that takes place in the NWT by industry (see the table below).

	Total Expenditure ($,000's)	**Percentage Allocated to the NWT**
Crop and Animal Production	110	2.2%
Forestry and Logging	320	1.6%
Fishing, Hunting and Trapping	1	0.3%
Support Activities for Agriculture and forestry	46	18.7%
Mining and Oil and Gas Extraction	7,686	39.0%
Utilities	488	18.6%
Construction	60,104	99.6%
Manufacturing	14,218	2.2%
Wholesale Trade	3,821	27.2%
Retail Trade	730	35.7%
Transportation and Warehousing	3,881	34.2%
Information and Cultural Industries	888	16.1%
Finance, Insurance, Real Estate and Rental and Leasing	5,667	21.5%
Professional, Scientific and Technical Services	8,425	29.4%
Administrative and Support, Waste Management and Remediation Services	937	18.5%
Educational Services	24	36.3%
Health Care and Social Assistance	31	17.1%
Arts, Entertainment and Recreation	77	28.1%
Accommodation and Food Services	291	26.2%
Other Services (Except Public Administration)	454	6.8%
Transportation Margins	1,872	21.3%
Non-Profit Institutions Serving Households	6	13.8%
Government Sector	605	27.4%
	110,681	63.8%

The direct and indirect gross domestic output generated from the expenditures of goods and services during operations was calculated to equal $937.7 million. Of that amount, 41.9 per cent was calculated to take place in the NWT. That equates to $393 million (see table below).

	Total Gross Output ($,000's)	**Percentage Allocation to the NWT**
Crop and Animal Production	4,209	0.5%
Fishing, Hunting and Trapping	25	2.4%
Support Activities for Agriculture and forestry	2,314	71.5%
Mining and Oil and Gas Extraction	100,973	29.1%
Utilities	7,086	39.0%
Construction	57,040	87.6%
Manufacturing	156,728	2.9%
Wholesale Trade	57,101	32.1%
Retail Trade	45,639	70.8%
Transportation and Warehousing	331,173	55.4%
Information and Cultural Industries	12,890	31.1%
Finance, Insurance, Real Estate and Rental and Leasing	54,427	29.3%
Professional, Scientific and Technical Services	30,003	14.4%
Educational Services	407	62.1%
Health Care and Social Assistance	173	82.3%
Arts, Entertainment and Recreation	913	63.4%
Accommodation and Food Services	34,654	69.2%
Other Services (Except Public Administration)	8,205	15.9%
Transportation Margins	32,240	23.8%
Non-Profit Institutions Serving Households	219	66.8%
Government Sector	12,334	80.1%
	937,748	41.9%

The results from the Input-Output model are formulated on a 'domestic' basis, not a 'national' basis. Domestic production counts all activities that occur within a region's boundaries regardless of the origin of the producer. National production would count only the activity of producers originating from the NWT. In other words, this economic model does not differentiate the results based on the head office location of producers. With that said, it should be reiterated that these estimates do come from detailed surveys of NWT construction and mining activities, and are representative of the existing business community and its current capacity.

The results demonstrate where the NWT business community has capacity. For example, there are construction companies with their head office in the NWT that could manage the construction project. CZN has not committed to any of these firms, but will look at them seriously. CZN will emphasise local procurement by its contractors and will make this a valued component in how bids are evaluated. Businesses outside the Study Area will be encouraged to participate, and CZN will extend to them the same opportunities given to Study Area businesses should those companies be unable to fill certain contracts. CZN would prefer to offer contracts to NWT-based companies that can provide goods and services at a competitive price and meet local sub-contracting criteria.

It is also important to note that these results are not limitations. That is, while they represent the existing NWT business capacity, should this capacity expand over the next twenty years, the opportunity to grow the local content exists.

Business Opportunity Assessment of CZN's Prairie Creek

Summary of Business Opportunities

Opportunity	Need	Duration/Frequency
Aircraft Maintenance	The aircraft servicing the mine site will require regular maintenance.	Regular and ongoing, but infrequent
Aggregate Supply – Crushing	Mobile crusher for supply of aggregate on all-season road and airport runway.	During road construction with occasional crushing if aggregate stockpiles are not adequate.
Bookkeeping & Administration Service	Delivery of bookkeeping and administration for mine operations.	Ongoing
Bridge Supply	Supply of bridges for creek and river crossings.	One-time.
Building Construction – Project Management	Management of various construction projects.	One-time/construction project.
Building Construction – Equipment	Supply of equipment for various construction projects.	One-time/construction project
Building Construction – Materials	Supply insulation, paint, wood, electrical, plumbing, concrete, etc.	One-time/construction project. Some irregular supply in production.
Building Construction – Labour	Supply of general labour for various construction projects.	One-time/construction
Building – Supply	In some cases, metal structures, trailers, or pre-fabricated buildings might be used.	One-time
Camp Equipment & Supplies	Utensils, cutlery, cooking equipment, etc.	Ongoing
Camp Operations, including: •Cleaning •Cooking •Grocery Supply •Maintenance	100 person camp	Ongoing
Camp Supply (sale or lease)	- 7-8 accommodations buildings (possibly more) on site. - 2 small buildings along access road	One-time

Mine

	- Accommodations in Fort Nelson - Accommodations at staging area	
Cement Mix – Supply	~3-4,000 tonnes/year for back-fill, plus additional cement for emergency stations and construction.	Back-fill: Ongoing/Regular Construction: One-time
Cement – Back-Fill Mixing and Placement	Mixing and placement of waste material (324,000 tonnes plus cement)	Ongoing/Frequent
Charter or Scheduled Aircraft Service	A plane capable of transporting up to twenty passengers with luggage and additional cargo. Route to be determined.	Ongoing/Weekly
Charter Helicopter Service	a) Two sling-capable helicopters required for drilling. b) One standby medivac-capable helicopter	a) During exploration for two months for two years, possibly lasting into production b) Ongoing/Infrequent
Chemical Supply – Bulk	Supply reagents for mill (937 tonnes/year).	Ongoing/Annual
Compressed gas – Supply (O_2, breathable air)	Compressed air will be needed for emergency air packs. O_2 will be needed for emergency purposes at safety stations.	Ongoing/Regular
Compressed gas – Tank inspection/certification	Welder's bottles, air packs and other compressed gas tanks will require regular inspection/certification.	Ongoing/Regular but infrequent
Computer Supply	- Possible need for open access computers for staff leisure time. (Quantity unknown) - 12 computers for operations	Every few years.
Confectionary	Sale of magazines, hygiene products, tobacco, etc. (unknown if a confectionary will be included)	Ongoing
Coolant Supply	Unknown volume – to be used for generators, heavy equipment and other vehicles.	Ongoing/Frequent
Core Samples – Analysis	Analysis of core samples for identifying ore bodies.	Ongoing/Frequent
Core Samples – Cataloguing/Photographing	Cores for 5000 core sample boxes/year to be photographed and catalogued.	Ongoing/Frequent
Core Samples – Box Supply	5000 boxes/year to be produced for core sample storage.	Ongoing/Frequent
Cross-Cultural Training	Training of mine management/employees about local culture, history and practices.	Ongoing/Infrequent
Diesel Supply	Greater than 1 million gallons/year.	Ongoing/Frequent
Drill Supply	Supply of 1-2 mobile heli-portable drills	One-time
Drill Labour	Supply of drilling labour.	Above-ground: Ongoing/Seasonal Below-ground: Ongoing/Regular
Drill Rod Supply	Supply of drill rods for heli-portable rigs.	Ongoing/Regular
Drilling Mud Supply	Supply of polymers for drilling.	Ongoing/Regular
Electrical Services	New buildings will need to be wired. Some existing buildings, such as the mill, will need upgrades and to be completed.	Short-term/Infrequent
Electricians	Four electricians will be required on-site at all times.	Ongoing
Employee Assistance/Counselling Services	Delivery of drug/alcohol/lifestyle counselling to mine employees.	Ongoing/Regular
Energy Efficiency Consulting	Significant energy-efficiency upgrades will be required to several of the buildings currently on-site. Energy management consulting will be used to keep operational energy costs to a minimum.	Short-Term, Infrequent
Engineering Services – Mining	Mining engineering will be needed at all stages of the mine's life. This will likely be included with an underground mining contract.	Ongoing/Regular
Engineering Services – Civil	Civil engineering services will be needed during road, airport, and building construction.	Short-Term, Infrequent
Environmental equipment supply	Spill kits, oil mats, etc.	Up-front/Infrequent
Environmental monitoring	1-2 monitors at all times (2-4 on-site) with more located along the access road.	Ongoing/Frequent
Environmental response training	Some mine site staff will require environmental	Ongoing/Infrequent

services	response training.	
Explosives – Supply	a) Supply of explosives for road construction. Quantity unknown. b) Supply of explosives for mining. Quantity unknown.	a) During construction only. b) Ongoing/Regular
Ferry/Barge – Operations	Operation of a ferry/barge capable of transporting loaded ore trucks. 24-hour service.	Ongoing during ice-free months
Ferry/Barge – Supply	Supply of ferry/barge capable of transporting loaded ore trucks.	Ongoing during ice-free months
Fire Truck – Supply	Supply of one 1000-gallon fire truck with foam capabilities.	One-time
Fuel Tank Supply	Supply of fuel tanks for the maintenance stops, barge landing and staging area.	One-time
Gauge supply	Supply replacement gauges for mill.	Ongoing/Infrequent
Generator Supply	4 1MW generators	One-time
Generator Maintenance	All generators will require frequent maintenance.	Ongoing/Frequent
Geologists/Geo-Technicians	Geologists/geo-technicians will be needed at all stages of the mine's life.	Ongoing/Regular
Graphic design	Design work for reports and promotional materials. Unknown quantity of work.	Ongoing/Irregular
Heavy Equipment – Mechanical Services	a) Repair of existing, salvageable equipment. b) Three heavy equipment mechanics will be required on-site. c) Two heavy equipment mechanics will be required on the access road. d) Maintenance of equipment used in facility and site construction.	a) Ongoing during construction phase b) Ongoing c) Winter Road – Seasonal/ All Season Road – Ongoing d) Ongoing during construction.
	e) Maintenance of heavy equipment during winter and/or all-season road construction, Liard Highway upgrades, and during road and airport maintenance operations. f) Maintenance of fire truck. g) Maintenance/Repair of ferry/barge and barge landing equipment. h) Maintenance and repair of underground equipment.	e) Winter Road – Seasonal/All Season Road – Ongoing f) Ongoing/Regular g) Ongoing during ice-free months h) Ongoing/Regular
Heavy Equipment – Operation	a) Operation of heavy equipment during winter and/or all-season road construction, Liard Highway upgrades, and during road and airport maintenance operations. b) Operation of heavy equipment to maintain barge landings c) Operate heavy equipment for site restoration.	a) Winter Road – Seasonal All Season Road – Ongoing b) Ongoing during ice-free months c) Ongoing during reclamation.
Heavy Equipment – Parts Supply	a) Supply of parts for existing, salvageable equipment and for equipment used in construction. b) Supply of parts for underground equipment.	a) Ongoing in construction b) Ongoing/Regular
Heavy Equipment – Supply	a) Equipment for mine operations/construction (sale or lease) b) Rental or lease of heavy equipment during winter and/or all-season road construction, Liard Highway upgrades, and during road and airport maintenance operations.	a) One-time supply b) Winter Road – Seasonal/All Season Road – Ongoing

	c) Equipment for airport runway(s) clearing and maintenance. d) Equipment used to maintain barge landings. e) Equipment for site restoration.	c) Ongoing/Regular d) Ongoing during ice-free months e) Ongoing during reclamation
Hotshotting/Expediting – Aircraft	Expediting by aircraft will be used on occasion for timely deliver of supplies and critical pieces of equipment.	Ongoing/Irregular
Hotshotting/Expediting – Truck	Expediting by truck will be used on occasion for timely delivery supplies and critical pieces of equipment.	Ongoing/Irregular
Ice Bridge Construction	Construction of Ice Bridge across Liard River.	Seasonal
Industrial Salvage	Buildings, parts of buildings, and equipment that are still useable, but no longer needed for the mine can be salvaged and sold.	Unknown.
Industrial Waste/Hazardous Materials – Handling/Transformation	a) 43,000 kg of cyanide to be sealed in new containers. Possibility of cyanide treatment beforehand. b) During reclamation, if appropriate, treatment and transportation of industrial waste. Containment of industrial waste. Volumes are unknown at this time.	a) One-time b) Unknown.
Industrial Waste/Hazardous Materials – Storage	a) Storage of 43,000 kg of cyanide or treated by-product. b) Post-reclamation off-site storage/treatment of industrial waste. Volume to be stored and duration of storage is unknown.	a) Ongoing/One-time b) Unknown
Insurance Brokerage	- Mine asset insurance - Liability insurance - Asset insurance (private businesses)	Ongoing/Regular
Laboratory – Equipment Supply	Equipment requirements unknown.	Ongoing/Infrequent
Laboratory – Operations	Operating lab that analyses mine ore.	Ongoing
Millwrights	a) Four millwrights will be required on-site at all times. b) Millwrights for mill and back-fill plant construction	a) Ongoing b) One-time/construction projects.
Mining Supply	Supply rods and mesh for mine reinforcements.	Ongoing/Regular
Oil/Lubricant Supply	Unknown volume – to be used for generators, heavy equipment, helicopters, and other vehicles.	Ongoing/Frequent
Office Materials – Supply	Office supplies for all on-site administrative work.	Ongoing/Regular
Pilot Cars	Transportation of large pieces of equipment/materials.	Construction: Short-term/Frequent Production: Irregular/Infrequent Reclamation: Short-term/Frequent
Plant Operations (Concrete batch plant)	Operations management of batch plant and back-pasting	Ongoing
Plumbing/Pipefitting	a) Two plumbers/Pipe fitters will be required on-site at all times. b) Installation, maintenance and repair of piping systems for back-paste plant. c) Installation, maintenance and repair of mine plumbing systems. d) Plumbing and pipefitting for new buildings and completion of mill. e) Maintenance and upgrading of mill "plumbing" systems.	a) Ongoing b) Ongoing c) Ongoing d) One-time/construction project. Regular services in production. e) Ongoing

Power Supply	Supply of power for mine site, two maintenance stops on the access road, barge landing and staging area.	Ongoing/Regular
Promotional Materials – Supply	Production and supply of promotional materials for CZN. Volume unknown at this time.	Ongoing/Irregular
Printing	Printing of reports and promotional materials. Volume unknown at this time.	Ongoing/Irregular
Procurement Services	Management of purchasing/receiving and service contracts.	Ongoing.
Propane supply	Questionable demand – may be phased out of mine-site.	Unknown
Pump Maintenance	a) Maintenance and repair of mine pumps. b) Maintenance of back-fill plant pumps. c) Maintenance of mill pumps (50). d) Maintenance of fire truck pump.	a) Ongoing b) Ongoing c) Ongoing d) Ongoing/Regular but infrequent
Pump Supply	a) Supply pumps (50 in mill). b) Pumps for water input and pasting of materials. Unknown quantity required.	a) Ongoing/Regular b) Ongoing/Infrequent
Rough-Cut Timber	2x4x16 to 16x16x16 – 2000 board feet per dimension per year.	Ongoing/Regular
Road Construction – Project Management	Management of construction for the winter road, all-season road, Liard Highway upgrades, airport construction and/or ice bridge.	One-time during construction.
Road Construction Supply	Supply of culverts, barricades and other materials needed for road construction.	One-time during construction. Infrequently afterwards.
Road Maintenance	Maintenance of winter road/all-season road and ice bridge.	Ongoing/Regular
Radio supply	50-100 hand-held radios	Ongoing/Infrequent
River Taxi Service	Transportation of passengers and small loads across the Liard River. 24-hour on-demand service.	Ongoing during ice-free months.
Runway Maintenance	The airport runway(s) will require regular clearing and maintenance.	Ongoing/Regular
Satellite Television Supply	Satellite television service for accommodations.	Ongoing
Salvage	Salvage of condemned camp buildings.	One-time
Sign Supply	a) Supply of signage for winter and/or all-season road b) Supply of safety signage for mine-site, maintenance shops, barge landing and staging area.	a) One-time during construction. Infrequently after that. b) One-time during construction. Infrequently after that.
Slashing/Brushing	Slashing/brushing road and right-of-way to re-open winter road. Will be required if all-season road is re-routed.	One-time during winter road construction. Possibly during construction of all-season road.
Scrap metal recovery	a) Old equipment, unused drill rods, piping systems, electrical wiring, old building frames and other metals can be recovered and sold. Volumes are unknown. b) Removal of old equipment/vehicles, etc.	a) Unknown. b) Infrequent
Safety Equipment – Inspection	Regular inspection of fire extinguishers, sprinkler systems and safety stations.	Ongoing/Regular
Safety Equipment – Supply	Supply of safety clothing and equipment for above- and below-ground operations, including ferry/barge activities. Supply of fire-retardant foam for fire truck.	Ongoing/Regular
Safety Training	Provision of various training requirements to mine employees.	Ongoing/Regular
Sign Supply	Supply of safety-related signage.	One-time/Irregular
Surveying – Aboveground	Roads and airstrip construction. Exploration/mining-related.	Ongoing/Frequent

Surveying – Belowground	Exploration/mining-related.	Ongoing/Frequent
Satellite communications system (supply and service)	1 data-dedicated connection 1 VOIP-dedicated connection	Supply – One-time Service – Ongoing
Tire Supply	50 ore-haul trucks at 100,000kms0 km/season (winter road) *or* 14 ore-haul trucks at ~365,000kms0 km/year (all-season road) including various on-site vehicles and equipment.	Winter Road – Seasonal All Season Road – Ongoing
Trucking – Aggregate Supply	Transportation of aggregate along all-season road route and airport runway.	Ongoing during construction. Regularly, but infrequently during road maintenance.
Trucking – Driving	50 trucks at 100,000kms0 km/season (winter road) *or* 14 trucks at ~365,000kms0 km/year (all-season road).	Winter Road – Seasonal All Season Road – Ongoing
Trucking – General	Transportation of Equipment, building materials, mine supplies, new camp buildings, generators, water treatment plant and more.	*Construction phase:* Short-term/Frequent *Production:* Ongoing/Regular
Trucking – Industrial Waste/Hazardous Materials	a) Transportation of 43,000 kg of cyanide or treated by-product b) Transport industrial waste to an appropriate storage/disposal facility (as part of reclamation). Volumes to be transported are unknown. c) Transportation of detergents into mine. (937 tonnes/year)	a) One-time b) Reclamation activity/Unknown c) Ongoing/Annual
Trucking – Logistics Management	50 trucks at 100,000kms0 km/season (winter road) *or* 14 trucks at ~365,000kms0 km/year (all-season road).	Winter Road – Seasonal All Season Road – Ongoing
Trucking – Scrap metal/Salvage	Transportation of scrap metal, old camps, waste, and other salvage materials.	Unknown/Infrequent
Trucking – Supply/Rental	50 trucks at 100,000kms0 km/season (winter road) *or* 14 trucks at ~365,000kms0 km/year (all-season road).	Winter Road – Seasonal All Season Road – Ongoing
Towing	Standby towing of Heavy Equipment/Tractor trailers.	Ongoing/Irregular
Television Supply	Possible need for televisions in each private room.	One-time
Traditional Arts & Crafts Sales	Southern-based mine employees seeking northern clothing/crafts	Ongoing/irregular
Underground Mining	Underground development work throughout the lifespan of the mine.	Ongoing
Warehouse management service	Management of warehouse for mine operations.	Ongoing.
Waste water treatment system	- Supply of system capable of treating wastewater from 100+ person camp. -Construction/installation of system	One-time
Water treatment maintenance	Regular maintenance and management of water treatment plant.	Ongoing/Regular
Water quality testing	a) Organics testing of potable and waste water b) Chemical and metal content testing for mine and mill water.	a) Ongoing/Regular b) Ongoing/Regular
Welding Services	a) Four welders will be required on-site at all times. b) Welding for building construction	a) Ongoing b) One-time/construction projects.

5. Please provide a list of required contractor and subcontractor goods and services for the Reclamation phase.

The mine site reclamation plan is in draft form, and it is premature to consider service requirements. However, as the plan is developed during the course of the project, its profile of expenditures can be evaluated on the same basis as the construction and operation projects. CZN

will apply its local and NWT procurement policies to the reclamation project. Reclamation activities are similar to general construction and mining, though labour would make up a greater share of the overall costs. Nevertheless, one can expect a calculation of NWT business involvement to be close to 64 per cent of the total gross output. But for a more accurate estimate, one should also factor in changes likely to take place in the NWT economy over the next 20 years. Reclamation will be a more important component of the economy by that time and local expertise will have grown. This would suggest that NWT will be in a position to capture a greater percentage of the overall business expenditures. It is too early to determine an exact estimate of how much this industry and local capacity will grow.

6. Will the developer commit to doing a public Request for Qualifications to establish a list of NWT businesses that have the capacity to successfully compete for opportunities related to the Prairie Creek Mine?

CZN's IBA holders will produce and maintain a registry of qualified businesses for participation on set aside, evergreen, and general contracts.

CZN has initiated formal meetings with the Development Corporations of neighbouring communities to form a Nahendeh Aboriginal Economic Council (NAEC) to help take full advantage of the business opportunities with the project and notify the company of the several businesses wishing to be listed in the company's database. The first meeting was held in Fort Liard and the next meeting will likely be held in one of the smaller communities in fall 2010. It is our understanding GNWT and INAC have both expressed a willingness to provide funding to facilitate future NAEC.

After the company has fulfilled its obligations to its IBAs and the Nahendeh Aboriginal Economic Council, CZN will advertise its needs in regional newspapers and continue participating in regional NWT trade shows to communicate the opportunities associated with the project. The company expects to maintain a database of NWT qualified businesses related to various services and supplies.

7. Please provide a copy of CZN's NWT Procurement Strategy to the public registry and include details on how commitments in the strategy will be implemented and monitored.

A general overview of CZN's Aboriginal and NWT procurement strategy is outlined below.

CZN will focus on a general Northern procurement policy by adhering to the following principals:

i. Wherever practical, construction projects will be split into phases or segments so that small northern contractors and suppliers can have the opportunity to bid.
ii. Wherever practical, goods contracts will be tendered by grouping so that northern contractors and suppliers have the opportunity to bid and compete.
iii. Whenever practical, contracts for the supply of goods will be tendered in a manner which provides opportunities for northern contractors or suppliers.

Commitments in the procurement strategy will be monitored by the appropriate body identified in the IBAs.

IR Number: GNWT 1-14

Subject: Transportation/Rotation Policy Impacts on NWT Participation and Residency

Request

1. Will the developer commit to reduce its rotation schedule, to prevent out-migration and maximize local participation?

CZN chose the three weeks in, three weeks out (3 and 3) rotation schedule for three reasons:

- Rotations will be by air and the site airstrip is in a valley in a mountainous area. Weather delays are common because of poor weather, low cloud and fog. Shifts will be required to continue working if there are flight weather delays, and workers will be compensated. A shorter rotation schedule would result in severe operational difficulties
- Our crews working at the site during the care and maintenance period chose to move to a 3 and 3 rotation because they said they preferred the 3 weeks off, less time being too short a break
- Flights in and out of the site are an impact in terms of disturbance of wildlife. The chosen rotation schedule minimizes those impacts

2. Will the developer commit to add Yellowknife as a pick-up point, to encourage participation from other regions of the NWT and facilitate in-migration?

Our information is that the availability of labour in the Yellowknife area is limited. However, if a significant number of employees are travelling from or through Yellowknife, we will consider adding it as a pick up point.

IR Number: GNWT 1-15

Subject: Human Environment Monitoring

Request

1. Please itemize the indicators that will be tracked and publicly reported by Canadian Zinc's human environment monitoring efforts.

CZN will produce an annual report on its operations. It will provide the public with information regarding the production schedule at the Prairie Creek Mine, its employment record, and planned activities for the upcoming year. This report will serve as CZN's submission to inform Study Area, Deh Cho and NWT residents and regulators. The report will include information on employment and business procurement. The statistics reported will include:

- total workforce, new hires, terminations, and total labour income,
- training programs, number of participants, and apprenticeships,
- gross value of operation expenditures, a list of procurement contracts, and participating Aboriginal and NWT businesses,

- road access—the details of this information such as volume of commercial and non-commercial traffic depends on the final decision regarding road ownership and public access,
- community activities, investments and sponsorships, and
- a schedule of upcoming procurement opportunities and operational expenditures.

The annual report will include information on the socio-economic performance of the Study Area. These data will be gathered from secondary sources, including the NWT Bureau of Statistics and Statistics Canada. This information will be combined with knowledge gathered by company officials including community information officers working in the Study Area and communicating with active employees, their families, and other community members to determine the overall socio-economic changes taking place.

2. Please indicate what criteria will be used to classify a business as a NWT Business or as an Aboriginal Business.

CZN will focus on procurement of Aboriginal services with the following policy:

"Aboriginal Business" means a business owned by one or more of the Participating First Nations, directly or through their respective development corporations, or a Member or Members of the Participating First Nations. The Aboriginal Business must comply with all the legal requirements to carry on business in the Dehcho region and must be certified by the relevant Participating First Nations and meet one of the following criteria:

i. Is a corporation or limited company with at least 51 percent of the company's voting shares beneficially owned by a Participating First Nation, a Participating First Nation development limited partnership or a Participating First Nation Member or Members;
ii. Is a cooperative with at least 51 percent of the cooperative's voting shares beneficially owned by one or more Participating First Nations, a Participating First Nation development limited partnership or Participating First Nation Members;
iii. Is a sole proprietorship, the proprietor of which is or is owned by one or more of the Participating First Nations, Participating First Nations development limited partnership or Participating First Nations Members; or,
iv. Is a partnership, the majority interest in which is owned by one or more of the Participating First Nations, Participating First Nations development limited partnership or Participating First Nations Members, or in which the majority of benefits under the partnership agreement accrue to the Participating First Nations or Participating First Nations Member(s).

3. Please indicate what criteria will be used to determine NWT residency and Aboriginal ethnicity.

Where the disclosure of information does not compromise confidentiality, data will be separated by ethnicity and geography; that is, Aboriginal versus non-Aboriginal, and Study Area communities versus the rest of the NWT and non-NWT.

CZN will include all Status, non-Status, Métis, and Inuit as Aboriginal for the purpose of reporting ethnicity. NWT Residency will be defined as living in the territory. Determining

whether an individual qualifies for preferential hiring through an IBA subject to their residency is a matter for each IBA holder. But for the purpose of general reporting, residency will be defined geographically.

The detailed reporting specific to IBA holders will remain confidential.

4. Please specify how person years will be calculated and defined for each phase of the project (i.e., how many hours per year will make up a person year).

The construction project is relatively small and will span only a short period of time. Reporting during this phase will be simplified. Employment will be reported as number of people worked.

A person year will be defined as 2,184 hours during operations. Reporting during closure will be the same as that for construction.

4.0 ENVIRONMENT CANADA IR REPLIES

IR Number: EC-1

Subject: Contaminant loading from mine operations and transport of lead and zinc concentrate.

Requests:

EC/ENR requests that the proponent provide a list of potential mitigation strategies that could be used to minimize contaminate loading from fugitive dust associated with mining activities, and the handling and transport of ore and concentrate. In particular, EC/ENR requests that the proponent discuss the mitigation strategies used at other mines, such as the Red Dog Mine, and the potential for implementing these mitigation strategies at the Prairie Creek Mine.

EC/ENR requests that the proponent discuss and justify its decision to use bags on flat deck trailers to transport concentrate rather than using mechanically sealed trucks similar to the trucks used at the Red Dog Mine. EC/ENR further requests an assessment of alternative methods of containment during transport, including secondary containment options for the proposed method.

The bagged concentrate transportation plan is modelled after the Eskay Creek mine which produced a zinc/gold concentrate requiring multiple storage locations, with bags transported by both road and rail between the mine and the smelter. The Eskay Creek mine operator indicated that some of their bagged concentrate was handled nine times. Due to the short winter road haulage window, the Prairie Creek Mine also requires interim storage locations (three) serviced by trucks prior to rail gondola loading. The bags to be used will be designed with a >4 safety factor.(as per the Eskay operating method).

A detailed bagging strategy for Prairie Creek is provided in Appendix N. CZN's focus is to have clean bags leaving the bagging plant and the concentrate storage shed. The filled bags will be cleaned with a compressed air lance before leaving the bagging building so that no concentrate is transferred to the floor in the concentrate storage building. If the bags are punctured at any of the storage areas, the punctured bag will be slipped into a new bag and any spillage recovered (again, as per the Eskay operating method). Trucks shall not enter the concentrate storage building. A simple truck-loading bay similar to the former Eskay load out at Kitwanga will be used where the trucks drive by, not through, the concentrate storage shed so that they cannot track concentrate out of the building.

Prairie Creek should not be compared to the Red Dog Mine in terms of concentrate management. As Environment Canada note, the Red Dog operation is all season. There is one road transfer from the mine to the port site. Loading truck boxes with bulk concentrate by loader or slusher generates spillage that can be walked out of the loading area on truck tires. Bulk transfers at the Prairie Creek intermediate storage locations would magnify the potential spillage problem. Mechanically sealed truck boxes require a dedicated fleet of special trucks. Prairie Creek will be heavily reliant on a contractor fleet for the concentrate haul, making the acquisition of such trucks impractical. Bagging of the concentrate, like Eskay, is the only practical solution.

Because of the multiple storage locations needed for Prairie Creek, and the handling involved, secondary containment is not practical. Further, with the proposed bagging strategy and the fact that hauling is done in winter, we do not believe secondary containment is necessary. We will be undertaking sampling and dust monitoring along the haul route to verify these assumptions and the effectiveness of mitigation measures.

Capstone Mining's Minto Mine in the Yukon was transporting bagged concentrates on open flat-deck trailers after start-up. Since they are an all season operation without multiple storage locations, they have since changed to mechanically sealed truck boxes.

IR Number: EC-2

Subject: Incineration of sewage

Requests:

EC/ENR requests that the proponent clarify if sewage will be incinerated at the Prairie Creek Mine site. If sewage is to be incinerated, EC/ENR requests that documentation be provided indicating that the equipment is designed to handle this waste stream, and the conditions under which it must be operated.

Neither sewage nor sewage sludge will be incinerated. Sewage sludge will be stored in a cell in the Solid Waste Facility for later use in reclamation.

IR Number: EC-3 to EC-5

Subject: Air quality modelling and monitoring

See Appendix M.

IR Number: EC-6

Subject: Closure and Reclamation

Request:

When the term 'significant' is used, please either define the term or provide a context for its use.

The context for this request is a comment in the DAR: "The WRP…must not leach metals to an extent that groundwater and surface water quality are significantly impacted." This can be rephrased to: "must not leach metals to an extent that groundwater and surface water quality parameters reach concentrations exceeding pre-determined guidelines."

IR Number: EC-7

Subject: Closure and Reclamation

Request:

Include a comprehensive list of all structures/facilities on and off site and the intended and/or potential closure options for each.

The preamble to this request included "no mention is made of the flood protection berms lining Prairie Creek". If any continued use of the site is to occur after closure, the flood protection berms should remain as is. If not, they can also be lowered and blended into the landscape along with the berms lining the Harrison Creek channel.

The preamble also included "details are provided on the reclamation plan for the all-season road bed along Funeral Creek, but it is unclear what reclamation is planned for the full length of the winter road". CZN believes that observations and recent studies (EBA Engineering) indicate that natural invasion is the best reclamation strategy for the access road bed excluding the all season portion.

We agree that a more detailed closure and reclamation plan (CRP) should include a comprehensive list of all structures/facilities on and off site and the intended closure strategy. We believe the appropriate timing for this detail is after further consultation has occurred regarding uses of the site after closure. CZN proposes that this occurs at the time of Water Licence renewal, at which time a more detailed CRP can be produced.

IR Number: EC-8

Subject: Closure and Reclamation

Request:

Clarification on what is meant by maintenance in terms of closure activities is requested, as well as the criteria to be used to determine that maintenance activities should be implemented.

Mine closure will involve removal of berms, installing a cover on the Waste Rock Pile, and potentially establishing surface water runoff controls. Immediately after closure works have been completed, disturbed surfaces may be erodable and may periodically require repair until they have stabilized. This is what is meant by "maintenance", essentially activities that are required to prevent erosion or instability until conditions have stabilized.

IR Number: EC-9 and EC-10

Subject: Waterfowl use of water impoundment pond at mine site and Wildlife Management Plan

See Appendix C.

IR Number: EC-11

Subject: Source of toxicity in treated process water

Request:

The proponent should more fully investigate the source of the observed toxicity in the treated process water and identify how it would be mitigated at the site, including but not limited to the

water treatment plant. The proponent should fully develop contingency plans to manage toxicity in wastewater, including routine testing of water throughout the treatment system so as to ensure that toxic effluent is not released.

See reply to Parks Canada IR No. 34.

IR Number: EC-12

Subject: Potential treatment requirement for Radium -226 removal

Request

The proponent should assess the necessity for any radium-226 removal in the proposed water treatment plant.

A mine water sample has been collected for analysis. Results and comment will be provided in due course.

IR Number: EC-13

Subject: Site Water Balance

Request

The proponent should provide clarification on the operation of the WSP and any revised inflows and outflows for this key water management component. And in related matter, the proponent is required to revisit its "event" water management plan to confirm the statement that extreme runoff and precipitation events could be accommodated in the WSP and related catchment ponds at the waste rock pile and underground sumps.

See reply to Parks Canada IR Nos. 40 and 41. Please note that Figures 6-18 and 6-19 in the DAR are seasonal simplifications of the Water Storage Pond water balance. DAR Appendix 9 is the appropriate document for the relevant details.

IR Number: EC-14

Subject: Total Dissolved Solids within Prairie Creek

Request

Provide the predicted TDS and TSS loading into Prairie Creek. 2) Provide the expected impacts to the receiving environment from an increase in TDS and TSS loads 3) Assess the impacts to the aquatic ecosystem from an increase in the TDS and TSS loads to Prairie Creek and describe mitigation measures.

See Appendix J. Regarding TSS, site activities to date have shown that the surface water management system is more than capable of managing extreme precipitation events without the production sediment or discharge of water with elevated TSS. Apart from surface runoff, site discharge will consist of treated water which will have passed through a clarifier to remove

suspended matter. Consequently, no increases in TSS load to Prairie Creek are expected. As we have noted previously elsewhere, our experience is that site activities, such as drilling and crossing Prairie Creek, have had no discernible impact on turbidity or TSS levels in Prairie Creek. The dominant control on these levels is the magnitude of creek flows. We have witnessed creek water changing from a clear state to a chocolate colour within a few hours in response to a 'cloud burst'.

IR Number: EC-15

Subject: Spill Contingency Plan

See Appendix F.

IR Number: EC-16

Subject: Sewage treatment plant effluent quality

Request:

How will an understanding of the treated effluent quality be gained in order to track and optimize performance of the sewage treatment system?

Monthly monitoring of sewage effluent was proposed because the efficiency of sewage treatment will not vary significantly and effluent quality is also not expected to vary significantly. Monitoring would include all potential nutrients, including phosphorous. However, we do not consider the sewage effluent to be a significant potential nutrient contributor because the flow will be only approximately 1.7% of the total inflow to the Water Storage Pond.

IR Number: EC-17

Subject: Fuel Storage Tanks

Requests:

How will the project comply with the' Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations'?

See report from Roosdahl Engineering Enterprises in Appendix O.

5.0 INDIAN AND NORTHERN AFFAIRS IR REPLIES

IR: INAC01

Subject: Water – Hydrology - Groundwater

See report from Robertson Geoconsultants Ltd. in Appendix H.

IR: INAC02

Subject: Water – Hydrology - Groundwater

Request:

1. Demonstrate that the Water Storage Pond has the capacity to deal with periods of high flow.

2. Alternatively, demonstrate that the Water Treatment Plant capacity would be sufficient to effectively treat the high flow scenario, including providing calculations that demonstrate plant capacity to accommodate high flow scenarios.

See response to Parks_Canada_40.

IR: INAC03

Subject: Water – Hydrology - Groundwater

1. What will be the predicted effect of mine dewatering on the HCAA and the PCAA?

2. Provide calculations to demonstrate if there is the possibility of reduced flows in Harrison Creek and Prairie Creek.

See report from Robertson Geoconsultants Ltd. in Appendix H.

3. Provide details for the calculation of the in stream flow concentrations should flows be reduced.

Flows in Prairie Creek are not expected to be significantly reduced, therefore the predicted concentrations in Appendix J are considered valid.

4. Demonstrate that flow rates would not be reduced from the dewatering of the HCAA such that it affects the ability of Prairie Creek to handle effluent discharge.

Flows in Prairie Creek are not expected to be significantly reduced, therefore the ability of Prairie Creek to handle effluent discharge is not expected to be affected.

IR: INAC04

Subject: Water – Groundwater/water quality

Request:

Provide details for how leakage from the mine and ditch system into the groundwater will be minimized?

Any leakage in the mine will collect at the main sump at the lowest elevation in the mine and will be pumped to surface for management. The surface water runoff ditch system on site is expected to only contain clean runoff. This includes the Mill Ditch which may currently receive groundwater from the bedrock. This groundwater source to the Mill Ditch will stop during operations as mine development progresses to deeper levels and the water table is lowered. Measures will be taken on surface to ensure that contaminated water does not enter the ditch system (containments for stockpiles, heat tracing of pipes as necessary).

IR: INAC05

Subject: Water – Hydrology - Groundwater

Request:

1. If a leak was to develop, the pond (Water Storage Pond) would presumably have to be drained. How would this be done?

First, a leak in the WSP is very unlikely given the existing clay liner, the surface of which will be repaired as necessary when the pond is drained for reconstruction, and given the placement of a new synthetic liner in addition to the clay. In the unlikely event of a leak, remedial action will depend on the location, type and magnitude of the leak. Repairs may be possible without draining the pond. If the pond ultimately had to be drained, the water would be treated for discharge.

2. What is the estimated time to order replacement parts and make the repair?

This would depend entirely on the nature of the leak, but most materials could likely be sourced and brought in within several weeks.

3. How would the mine and process water be managed during this time?

If the WSP was not available for water storage, mine water would continue to feed the mill and any excess would be treated and discharged. Mill process water would also be treated and discharged. WSP repairs would preferably be timed for the open water season when the unrestricted discharge of treated process water should be possible.

IR: INAC06

Subject: Water – Water Quality – Water Quality Objectives

Request:

1. Provide greater detail on the discharge plan.

2. Outline in detail the type of changes to the regulatory approach Canadian Zinc sees being required.

See Appendix K.

IR: INAC07

Subject: Water – Water Quality – Surface Water

Request:

1. Site specific guidelines should be calculated for parameters such as but not limited to: Fe, As, Sb, Ag, SO4, ammonia, nitrate, nitrite, and phosphorous. This should include a calculation of their expected in stream concentrations.

2. Describe how each of these parameters will be addressed/mitigated should they rise above guideline levels?

See Appendix J.

IR: INAC08

Subject: Water – Water Quality – In Stream

Request:

Provide information for the in stream concentrations of metals using an accepted estimate of probable low flow.

Mean flows were used to assess the in stream concentrations that would occur most of the time. It would not be appropriate to use probable low flows for this assessment. However, we also included an assessment using low flows based on the lowest flow reported for each month over a 16 year period. This demonstrated that certain parameters could exceed their guidelines in the seasonally lower flow months (winter). As a result, CZN developed a water management strategy including reduction or curtailment of mill water treatment and discharge based on the magnitude of creek flows occurring so that guidelines would not be exceeded. Any number of hypothetical low flows could have been used for this assessment and the result would have been the same in terms of the selected management action.

IR: INAC09 and INAC10

Subject: Water – Water Quality – Water Treatment and Nutrification

See Appendix J.

IR: INAC11

Subject: Water – Hydrology – Groundwater

Request:

Provide a framework outlining how the different levels of significance will be determined (i.e. negligible, low, medium, high). The outline should include Magnitude, Duration, and Geographic extent.

A framework containing the elements described above was presented in Section 7 of the DAR Addendum.

6.0 FISHERIES AND OCEANS IR REPLIES

IR Number: DFO_01

Subject: Nutrient Loading

Request:

1. Based on existing data, provide a map of the locations where increases in nutrient levels have been observed downstream from the mine site within Prairie Creek. This data could be used to determine sensitive areas as part of a monitoring program.

A suitable map showing the INAC/University of Saskatchewan site where sampling was conducted was provided as Figure 3.1 in "Review of the Status and Future of Cumulative Effects Monitoring at the Prairie Creek Mine", prepared for INAC by Senes Consultants Limited, March 2009. A copy is provided here,

2. Assess the potential impacts on aquatic organisms, including fish and fish habitat, due to potential increases in nutrient loading into the system and provide mitigation measures, where appropriate.

See Appendix J.

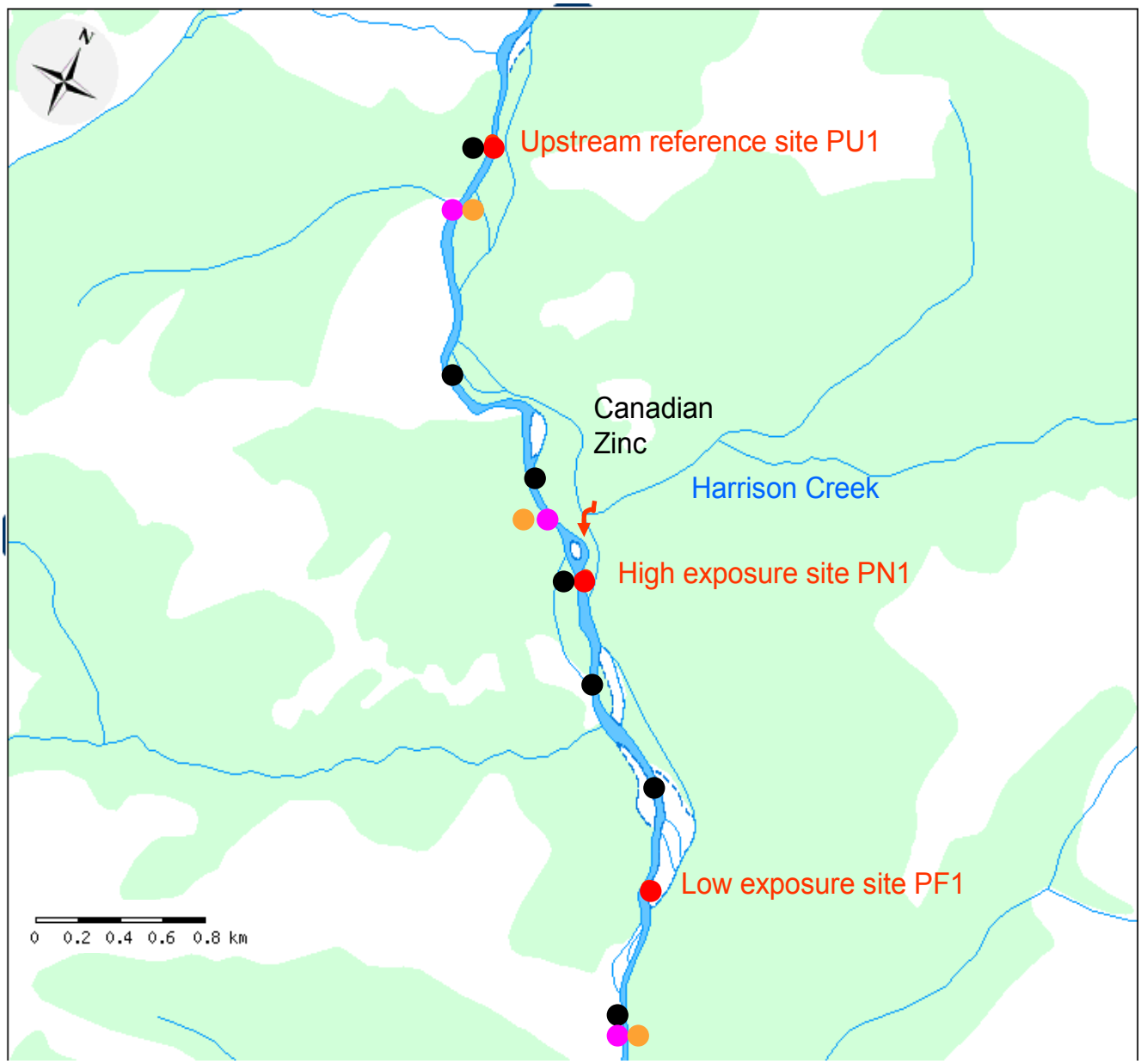
IR Number: DFO_02

Subject: Source of Aggregate for road construction and maintenance

Request:

1. Provide the exact locations of aggregate sources required for the construction and maintenance of Mine site and access roads.

Figure 3.1
Locations of sampling sites on Prairie Creek for Proposed, Previous and Ongoing Aquatic Monitoring Programs



Dots indicate approximate locations of sampling sites by the following parties:
- Parks Canada sites (2006-2009) (One other site not shown, 3 km downstream from mine site)
- University of Saskatchewan sites (2006)
- Canadian Zinc sites (2005-2008) (estimation; exact location unknown)
- SENES proposed baseline sites (2009)

See Section 5 of the DAR Addendum. Additional aggregate sources may be available along the access road, particularly over the road section from Sundog Creek to Polje Creek, and in the Tetcela and Fishtrap valleys. However, ground investigation (probing) will be required to confirm whether such sources exist.

2. Confirm that these sources of aggregate will not be situated in river beds or within the high water mark of the alluvial fans.

Sources of aggregate will not be situated in river beds or within the high water mark of alluvial fans.

IR Number: DFO_03

Subject: Diffuser

Request:

See reply to Parks_Canada_39 and Appendix K.

IR Number: DFO_04

Subject: Construction of Winter Road - Water withdrawal

Request:

1. Identify the exact locations and volumes of water required for the construction and maintenance of the access road. It should be noted that details regarding the proposed water sources, bathymetric survey results as well as the calculation of the total available water volume under ice of each source will be required. Please refer to DFO's updated water withdrawal protocol for waterbodies (June 2010).

See Appendix E.

IR Number: DFO_05

Subject: Access road – Erosion, Runoff and Extreme Events

Request:

1. During extreme events

a. Please describe how the new proposed alignments of the road will be constructed to ensure that it can withstand extreme events, including reduce the likelihood of washouts, slumping and erosion.

b. Identify vulnerable sections of the existing road, and describe measures necessary to prevent further erosion.

The new road section between Sundog Creek (Cat Camp) and Polje Creek will include shallow cuts through a number of side-hills. Water passage structures (i.e. culverts) may be required to pass cross drainage to avoid road bed erosion. A span is proposed for Polje Creek. The re-alignment on the west side of Wolverine Pass has been abandoned because the ground is

unstable. The existing switch-backs will be revised to provide for better grades and easier turns, and cross-drainage measures will be incorporated into these.

Vulnerable areas along the existing road were mainly along the Prairie and Funeral Creek sections. Legacy issues with these sections of the road (no armouring) have largely been addressed with remedial works (slope angle reduction, armouring) over the last few years, and this work is on-going. The last remaining vulnerable location is the crossing of a Sundog Creek tributary at Km 23. This is a non-fish bearing, incised channel that the road ramps down into and out of. See Appendix E for further discussion.

2. Describe monitoring activities for the access road to ensure effective sediment and erosion control measures are employed and that the road will not be a sediment source to the adjacent watercourses during the construction, operation, temporary closure in the summer and during extreme events.

The existing road bed is in a relatively good and stable condition, with no evidence of significant erosion. Construction and maintenance of the new alignments will be overseen by a CZN representative, including regular inspections. An inspection of these sections, stream crossings and the entire road is proposed immediately after the first operating season. Drainage control structures will be assessed for functionality, and plans made to rectify any deficiencies. The road section from the Mine to Km 23 on Sundog Creek will be accessible to ground transport year round, facilitating more frequent inspection (during and after freshet, and after major rainfall events, for example) and remedial works if necessary. Ground transport could also reach Km 27 without crossing fish-bearing creeks.

3. Section 10.2.5 under Best Management Practices suggests that there is "little to no opportunity to mitigate [possible unknown impacts to incubating Bull Trout eggs in Funeral Creek]". CZN should be aware that Funeral Creek is the only known location of spawning Bull Trout in the NWT, and that the species is listed as May be at Risk under the Government of the Northwest Territories listing. Special care must be taken along this creek to ensure that all impacts are fully mitigated. Please provide specifics on how CZN will ensure that Bull Trout are not affected by activities along the access road, with special focus on the stretches along Funeral creek.

CZN is well aware of the sensitivity of operations along Funeral Creek. As noted above, legacy issues with this section of the road are being addressed with remedial works (slope angle reduction, armouring). Further work was conducted this year, the details of which will be forthcoming in due course. CZN is continuing to evaluate and implement measures to stabilize the road and limit the potential for sediment production. Note that our remedial activities in and around the creek are limited to a window of July 15 – August 15 each year to avoid sensitive periods for bull trout.

IR Number: DFO_06

Subject: Groundwater Discharge to Prairie Creek

Request:

1. Identify areas within Prairie Creek, near the mine site, where groundwater discharges to the surface.

See Appendix H.

2. Provide predicted impacts to the Bull Trout, during their various life stages, as a result of potentially removal of groundwater upwellings within Prairie Creek.

Since no sites of groundwater upwellings have been noted in Prairie Creek near the mine site, no impacts are expected. It should also be noted that only low numbers of adult bull trout have been recorded along this reach of the creek, and habitat has been classified as migratory only. No spawning activity or juvenile fish have been recorded.

3. Provide mitigation measures to reduce or eliminate impacts to Bull Trout.

The proposed mitigation is CZN's water management and water discharge plans. See Appendix J.

IR Number: DFO_07

Subject: Waste Rock Pile – Land Fill area

Request:

1. How is CZN intending to prevent mobilization of sediment carried by the drainage channels during construction, operations and closure?

See Appendix D.

2. At closure, how will seepage from the waste rock pile be managed, so that impacts to Harrison or Prairie Creek do not occur?

An appropriate cover will be placed over the pile to limit seepage to an extent that impacts on surface water do not occur.

IR Number: DFO_08

Subject: Access Road - Fish Habitat Assessment

Request:

See Appendix E.

IR Number: DFO_09

Subject: Closure and Reclamation Plan

Requests:

1. Under section 3.9, Off-Site Infrastructure of Appendix 27, it states that one of the objectives is to "Modify Funeral Creek road bed to promote stable long-term runoff."

a. It is indicated that the road will be "given a gentle slope towards the creek" to prevent channel formation and erosion on the road bed. What measures will CZN take to prevent sediment from entering the creek?

Coarse material or organic material will be placed adjacent to the creek to prevent sediment discharge until vegetation has established. Any channels flowing over the recontoured road area will be armoured. Silt fence will be used where necessary to control sediment immediately after recontouring.

b. How will the road bed and culverts be removed, so that Funeral creek and the residing Bull Trout population are not impacted?

The road bed will be recontoured into a natural slope. Where the road bed crosses a channel and either backs-up drainage or contains a culvert, the bed and culvert will be removed. These locations may need to be armoured. Silt fence or other means of silt control will be used until surfaces have stabilized.

c. It is indicated that "Coarse material or organic material will be placed along the bed adjacent to the creek to prevent sediment discharge until vegetation has established." Please confirm that materials will be placed on the road bed and not the bed of Funeral creek. No material should beplaced below the normal high water mark of any watercourse and that organic material must be stabilized (i.e. use of fibrous matting) while vegetation is establishing.

Materials will be placed on the road bed and not the bed of Funeral Creek.

d. How will CZN ensure that Bull Trout and their habitat are not impacted by the proposed closure activities?

By using the mitigation measures described above.

IR Number: DFO_10

Source: Fisheries and Oceans Canada

Requests:

1. Please provide an outline of the Environmental Effects Monitoring (EEM) program and describe how it will be integrated with the Aquatic Effects Monitoring Program (AEMP).

The EEM program will include annual sampling at reference, near field and far field locations, similar to the INAC/University of Saskatchewan/Parks Canada study program which has provided a solid baseline for future sampling. Results from that program indicate that the appropriate media for sampling will include periphyton, benthic invertebrates, sediments and possibly slimy sculpins. The proposed program would be developed at the permitting stage. The EEM program will form part of a broader AEMP which will include water sampling. This program would also be developed at the permitting stage.

2. As stated in previous IRs, provide an outline of a monitoring program designed to ensure the effectiveness of sediment and erosion control methods for the access road.

See response to DFO_05, point 2.

IR Number: DFO_11

Subject: Impact Assessment - Fish and fish habitat

Request:

1. Please provide more details on the "thresholds" used to assess the magnitude of impacts on fish and fish habitat in order to better understand the difference between low, moderate and high ranking.

In this particular case, the appropriate "thresholds" are the site-specific criteria that were developed. However, no site-specific criterion was developed for TSS. As noted in the response to EC_14, high sediment loads are observed in Prairie Creek after intense rainfall events. Therefore, a representative database of naturally occurring TSS would likely provide a relatively high site-specific criterion. We would hope to limit sediment production to low levels and, thus, a low threshold.

2. Please provide more details around how rankings were given in Table 5 in the Addendum, page 13 under Section 7.2.

3. Accidents and malfunctions listed in Table 5 of the addendum (page 13) should be broken into two pieces: the mine site and the access road. Time for response along the access road may be quite different than around the mine site. Factors such as this will likely affect the classification within the categories of geographic extent, duration, frequency, variance and reversibility and should be reflected and adequately described.

A revised version of Table 5 from the DAR Addendum, 'Impact Significance Matrix – Fish and Aquatic Habitat', is provided below.

			Geographic Extent	Duration	Frequency	Variance	Reversibility
Water quality, operations	Rank	Moderate	Moderate	Moderate	High	Moderate	Low
	Basis	Above baseline, below SSC	Portion of Prairie Ck	Mine Life	Continuous over mine life	Discharge & flow variation	Quickly resolved
Water quality, post-closure	Rank	Low	Moderate	High	High	Moderate	High
	Basis	Near baseline	Portion of Prairie Ck	Perpetuity	Perpetually continuous	Flow variation	Hard to resolve
Sediment	Rank	Low	Moderate	Low	Low	Moderate	Low
	Basis	History	Mine/Road	Stable in few years	Occur <monthly	Intense rainfall	Quickly resolved
Habitat alteration	Rank	Low	Moderate	Moderate	Low	Low	Low
	Basis	Very little	Mine/Road	Mine Life	Minor in winter	Stable footprint	Little to begin with
Accidents and malfunctions – mine	Rank	Low	Low	Moderate	Low	Moderate	Low
	Basis	Oversight	Mine	Mine Life	Awareness & precautions	If performance poor	Rapid clean-up
Accidents and malfunctions – access road	Rank	Moderate	Moderate	Low	Low	Moderate	Low
	Basis	Limited quantities	Road	No sources	Awareness & precautions	If performance poor	Rapid clean-up

Note: SSC = Site-Specific Criteria

7.0 NATURAL RESOURCES CANADA IR REPLIES

IR Number: NRCan 1

Subject: The requirement for an explosives factory on-site

Request:

1. CZN has been requested to provide additional information on whether a factory to manufacture explosives is likely to be required at or near the site.

CZN is proposing to manufacture emulsion explosives on-site in a factory. Discussions with an explosives manufacturer are at an early stage, and requirements have only been discussed at a conceptual level. The answers provided below are the best available at present. We intend to provide more detail in the near future.

2. If CZN has determined that a factory to manufacture explosives is likely to be required, then NRCan typically recommends that the following information be considered in the environmental assessment:

- *Explosives to be manufactured*

A bulk emulsion explosive will be manufactured, called 'Subtech'. This explosive is currently being manufactured at Snap Lake. The chemical composition is similar to that given in Table 1 of Annex J4, which can be found in Appendix J attached to this document.

- *Maximum quantity of explosives at each facility*

The expected maximum quantity of emulsion manufactured will be 2,000 kg/day, 500,000 kg/year. The plant will be sized to produce a single batch up to 10,000 kg.

- *Specified location (i.e. detailed site plan) with distances to vulnerable features such as dwellings, roads, camps, railways, bodies of water, etc. Infrastructures should be identified and include: explosives and detonator magazines, fuel storage, ammonium nitrate storage, maintenance/wash area, process trucks and their parking area, any offices, warehouses, buildings, etc. The proponent needs to demonstrate that safety distances required by the Explosives Regulatory Division of NRCan have been considered and met*

Figure 4-5 in the DAR provides a layout of the Prairie Creek Mine site. The explosives storage and manufacture would be located in the south-east portion of the site, south of the Mill and Camp. The emulsion plant would be located at the south-eastern extremity of this area. The location would be approximately 960 m south from the site of the existing Fuel Tank Farm and the Mill and main Camp are even further away. The plant would be set back from Prairie Creek by at least 120 m. A 350 tonne ammonium nitrate storage facility would be located near the plant, but not within 35 m. Explosive 'boosters' and detonators will be located approximately where existing magazines are located. These are approximately 570 m from the Tank Farm, and will be more than 240 m from the emulsion plant. Based on the size

of the plant and storage quantities, these distances should ensure that the plant and related facilities all comply with ERD safety guidelines. The road accessing the area from the Camp will be gated and the area will be restricted access.

- *Fuel and ammonium nitrate storage plans. Storage of ammonium nitrate is to be in conformance with ERD guidelines*

Fuel will be stored at the plant site in a small double-walled enviro-tank. Ammonium nitrate storage was noted above.

- *Liquid effluent disposal plans*

Liquid effluent from the plant is reportedly small, less than 1,000 L/day, and consists mostly of wash water. This water will be collected and trucked to the site water management system and sent to the WSP as mine water. Given that mine flows will be at least 2.5 million L/day (29 L/sec), the wash water represents 0.04 of 1% and will be insignificant.

- *Evaluation of worst case scenarios (i.e. accidental explosion)*

The distances of facilities noted above are intended to provide for worst case scenarios. These will be reviewed as part of the overall site Risk Plan.

- *Spill contingency plans*

CZN will prepare a detailed spill contingency plan suitable for the mine and access road, including the transport, manufacture and use of explosives and components of explosives, prior to operations. We propose to prepare this plan at the permitting stage or as a condition of permits, and will circulate a draft for regulatory review and approval.

- *Details on any temporary explosive facilities to be used for starting the project must be provided, giving the same information requirements above*

The Prairie Creek Mine is already partially developed. There will be no need to construct temporary explosives facilities. We will proceed to permanent facility construction.

IR Number: NRCan 2

Subject: The feasibility of using paste backfill for underground tailings disposal

See report from Mine Paste Engineering Ltd. in Appendix I.

IR Number: NRCan 3

Subject: Earthquake hazards

See Golder Associates report in Appendix D.

IR Number: NRCan 4

Subject: Deposit Geology/mineralogy/structural geology

Request:

Provide more information on more recent feasibility studies done since the NI43-101(2007) report, or any plans to update the NI43-101 (2007) report.

A feasibility study was completed in 1980 by Kilborn Engineering designed around a 1,000 tpd mining and milling operation at Prairie Creek. Prior to this, numerous economic studies and evaluations were carried out by predecessor companies. The Feasibility Study was based on a then defined mineral reserve of just over 2 million tons giving the mine a 7 year life, with silver being the main commodity of focus. After a number of exploration drilling campaigns aimed at expanding the mineral resource were completed on the main zone, MRDI Canada completed a resource calculation for Zone 3 in January 1998 for San Andreas Resources Corporation (CZN predecessor company).

CZN completed a scoping study in January 2001. The Scoping Study included a preliminary review of the economics of the operation which suggested that a number of key components warranted re-examination in order to optimize operational efficiencies. These included:

- Increased throughput to maximize economies of scale.
- Increased use of mechanization both in the mine and mill to reduce the manpower costs of the operation.
- Reduced use of power per tonne since the operation will use expensive diesel power.
- The provision of an all weather road access to the site to ease shipping and inventory constraints and reduce shipping and road costs to the smelter.
- Reduction of the volume of tailings to the tailings pond and required size of tailings storage facilities.
- Reduction of mercury in the concentrate to reduce smelter penalties by increasing the volume of Strata-bound mineralization treated.

Since 2001, a number of bulk composite samples of mineralized material have been collected from underground and drill core in order to carry out further metallurgical studies. From these numerous studies, a metallurgical flow sheet has been determined and the preliminary design of the milling circuit was completed. SGS Lakefield Research Limited, along with a number of key metallurgical consultants, conducted these studies.

On the backs of the detailed underground exploration and development program during 2006/7, the 43-101 study "Technical Report on the Prairie Creek Mine" by Minefill Services was completed, dated October 12, 2007.

Prior to the issue of the Technical Report in 2007, pre-feasibility studies were underway incorporating previous work completed on various aspects of the proposed operations, along with investigating further ways to optimize the proposed operations pending the release of the Technical Report. Once the Technical Report was released, which indicated at least a 14 year mine life, further on-going draft pre-feasibility studies were carried out by SNC Lavalin Inc. (Vancouver), pending further advancement in the regulatory process and timelines. These draft studies incorporated the input of numerous engineers, consultants, companies, service providers

etc., including SGS Lakefield Research Limited (includes work by CEMI labs, metallurgy and water treatment), Minefill Services Inc., CZN (resources, mining), DRA Americas (design of DMS plant), Golderpaste Tec (backfill studies and plant design), Golder Associates (site engineering and design), and Finning Intl. (power supply). The studies remain in draft stage and will be finalized when more certainty exists regarding the parameters of the proposed Prairie Creek operation are established, such as the regulatory process and construction timeline, concentrate transport plan, and site/road construction/management requirements.

IR Number: NRCan 5

Subject: Deposit Geology/mineralogy/structural geology

Request:

Provide any more information (if available) on the roles of the regional and property-scale faults on the mineralization.

Prairie Creek mineralization is somewhat unique in the region since there does not appear to be another significant deposit of Pb/Zn for hundreds of kilometres. In addition there does not appear to be a local geological thermal source capable of driving the mineralizing fluids (igneous or volcanic rocks). The region is completely surrounded by the sedimentary terrane of the Mackenzie Mountains.

There have been numerous exploration campaigns completed by CZN and its predecessors on the Prairie Creek property and area. The exploration work to date has indicated that significant mineralization is proximal (spatially) or local to fault-type structures. Such structures may have provided the necessary ground preparation and fluid pathways to enable metal-bearing fluids to be transported along regional fault-type structures.

Regional horizontal fault structures are evident in the deep-penetrating seismic profiles carried out by the Geological Survey of Canada in their lithoprobe transects of the Mackenzie Mountain foreland belt. These regional, listric-type, fault structures have resulted from deformation, dislocation and basal translation during the Laramide orogeny (mountain building phase) within the Mackenzie Mountains. The main listric-type fault structures (such as the Nahanni Thrust on Figure 4-17 of the DAR) are at significant depth below the Prairie Creek mine site, of which the distal extensions are expressed locally on surface in the form of regional, steep north-south reverse-type fault structures, such as the Prairie Creek (PC) and Gate Faults.

The mineralized vein at Prairie Creek, which contains the bulk of the defined mineral resource, is a fault structure itself ("vein-fault") and was formed as a tensional axial-plane-type fault related to the property wide north-south antiformal structure between the PC and the Gate Faults. The vein-fault has been tested at depth and appears to coalesce with the more regional PC fault. Multiple phases of mineralization are evident within the vein. The vein-fault host units of Whittaker and Road River, and these may have provided a favorable environment for the mineralizing fluids to precipitate.

Morrow and Cook (GSC Memoir 412, 1987 entitled The Prairie Creek Embayment and Lower Paleozoic Strata of the Southern Mackenzie Mountains) note that "lead isotope determinations

from twelve samples of Cadillac galena from scattered locations are extremely homogenous and radiogenic and appear to fit the isochron of young silver-rich vein-type deposits of Godwin et al. (1979). This isochron was derived from other similar deposits in the Mackenzie Arch that apparently were mineralized about 60 million years ago during the Laramide Orogeny. Some of the metals may have been derived from the Whittaker Formation itself, which is anomalously enriched in zinc."

Fluid inclusion studies from a University of Alberta MSc thesis by Stuart Fraser in 1996 indicate relatively low temperatures of sphalerite formation. In Zone 6, drillhole 94-062 intercepted significant zinc mineralization within the PC fault which may be evidence of metal bearing fluid movement within the faults.

In summary, the regional listric-type fault structures, and more locally the reverse-type faults within the Prairie Creek paleo-basin, may have provided the pathway through ground preparation for these structures to act as paleo-conduits, allowing the mineralizing fluids to move on a regional and local basis.

IR Number: NRCan 6

Subject: Deposit Geology/mineralogy/structural geology

Request:

Provide, if known, any further information on the width on the true width of the vein system at Prairie Creek. Provide more information, if known, on the continuity of the vein system known underground, and on surface in terms of its width, thickness and length including any information on changes from north to south and with depth.

Within the main defined mineral resource, the vein averages 2.5 metres in width and is exposed in all three existing underground levels (970, 930 and 870 levels). The vein, being a fault-structure, contains variations both in width (0.1m to 10m true width), and dip (45°E to vertical). The vein structure (fault structure) can be readily followed over a 160 m strike length in 6 crosscuts within the 970 m level, in over 950 m of strike length in 32 crosscuts within the 930 m level workings, and over 560 m of strike length in 6 crosscuts within the 870 m level workings.

A strike length of 2.1 km has presently been defined by diamond drilling within the Main Zone, however the structure remains open-ended to the north.

On a more local scale, the vein-structure can be seen both underground and at surface to undergo en-echelon type structural development. At such locations, the vein-structure appears to be translated obliquely, generally into the hanging wall, across a few metres to upwards of tens of metres, then continues along its normal strike direction. In these locations, the vein can actually be doubled up on itself and have two parallel veins developed side-by-side for a short distance.

The vein structure has been drill tested in detail at the mine site within the upper 300 m panel, and this panel is the primary location of mineralization. The overlying Cadillac Formation and upper part of the Road River Formation, contain a high percentage of fine-grained material forming mostly shaly to laminated dolostones/siltstones that do not appear competent enough to

host the vein structure and concentrate the mineralization. As evident in the 930 m level workings, the vein fault-structure becomes more dissipated within the upper units, which is attributed to the lithologies absorbing the stress and not inducing a brittle type response to deformation stress as the more competent underlying Whittaker units do. A few diamond drillholes at depth to the mineralization panel have still penetrated a quartz-carbonate bearing structure within the mid-lower Whittaker Formation siltstones and nodular dolomites. The structure contains a significant amount of quartz-carbonate material, however most intersections have only returned moderate to weak sulphide mineralization. Further delineation and definition of the vein at depth is required to properly assess its potential.

IR Number: NRCan 7

Subject: Deposit geology/mineralogy/structural geology

Request:

Provide any further information, if available, on the strata bound zone, including the true thickness, its attitude and structural relationship to regional faults, such as the HC and PC faults and other structures.

Strata-bound sulphide mineralization was originally discovered in 1992 in Zone 3 at Prairie Creek, and drill intersections of this style of mineralization have now been located along 4 kilometres of vein-type mineralization from the main zone down to Zone 6. Part of the exploration strategy at Prairie Creek has been to drill target the vein-type occurrence within a basal unit of the Upper Whittaker, which is host to the main strata-bound deposit, in hopes of intersecting strata-bound mineralization in addition to vein. Since this strategy has been employed, all strata-bound mineralization presently discovered is spatially proximal to the vein.

The largest strata-bound resource body has been defined in the immediate vicinity of the Prairie Creek Vein and contains a mineral resource estimated at 1.4 million tonnes grading 10.3% Zn, 5.0% Pb and 53 gpt Ag. The strata-bound resource is contained in a composite mass of sulphides up to several hundred metres in width, and 28 metres in thickness which includes numerous individual massive sulphide intervals, most often from 2-5 metres in thickness separated by the unaltered host Whittaker unit.

To date, exploration strategies for further strata-bound have focused on specific units of the Whittaker formation in the immediate vicinity of the vein-fault. From drill core, it appears that the vein mineralization cuts the strata-bound mineralization indicating the strata-bound is older.

Little is known about the lateral extent of the strata-bound mineralization since, at the minesite, the host unit Whittaker Formation dips steeply west and east down the flanks of the Prairie Creek antiform. Strata-bound mineralization appears to generally follow the primary bedding planes of the Whittaker Formation although some convolutions and flow patterns also are evident. It is unknown if there is any direct relationship of the strata-bound mineralization with the local or regional faults. There are, at this time, no underground workings which penetrate deep enough to intersect the strata-bound type mineralization. This would greatly assist in understanding its nature.

IR Number: NRCan 8

Subject: Deposit geology/mineralogy/structural geology

Request:

1. Provide a summary table with host rock and mineralization geochemistry and the range of values.

A report by Mesh Environmental Inc. for CZN entitled "Geochemical Characterization Report for the Prairie Creek Project, NWT" and dated April 2008 contains appropriate geochemical data. Summary Table 4.4 shows host rock and mineralization analysis by Aqua-Regia Digestion with ICP finish. Also, Figure 2.6 shows the Main Zone stratigraphy and rock descriptions that relate to Table 4.4. This report is filed on the Mackenzie Valley Review Board website on the CZN registry dated August 14th, 2008. However, the table and figure are reproduced in Appendix P.

2. Provide any information on the background Cu, Pb, Zn, Sb, Cd, Ag, As and W concentration values in the Road River Formation.

Summary Table 4.4 referred to above gives background Cu, Pb, Zn, Sb, Cd, Ag, As and W values.

3. Describe the results of sulphide oxidation and redistribution from nearby ore into adjacent host rock in terms of Ag, Cd, Hg, Pb, Sb, As, and Zn. Provide information on the mobility As, Cd, Pb and Hg including information on co-precipitation with secondary zinc minerals and if some of these elements stay behind.

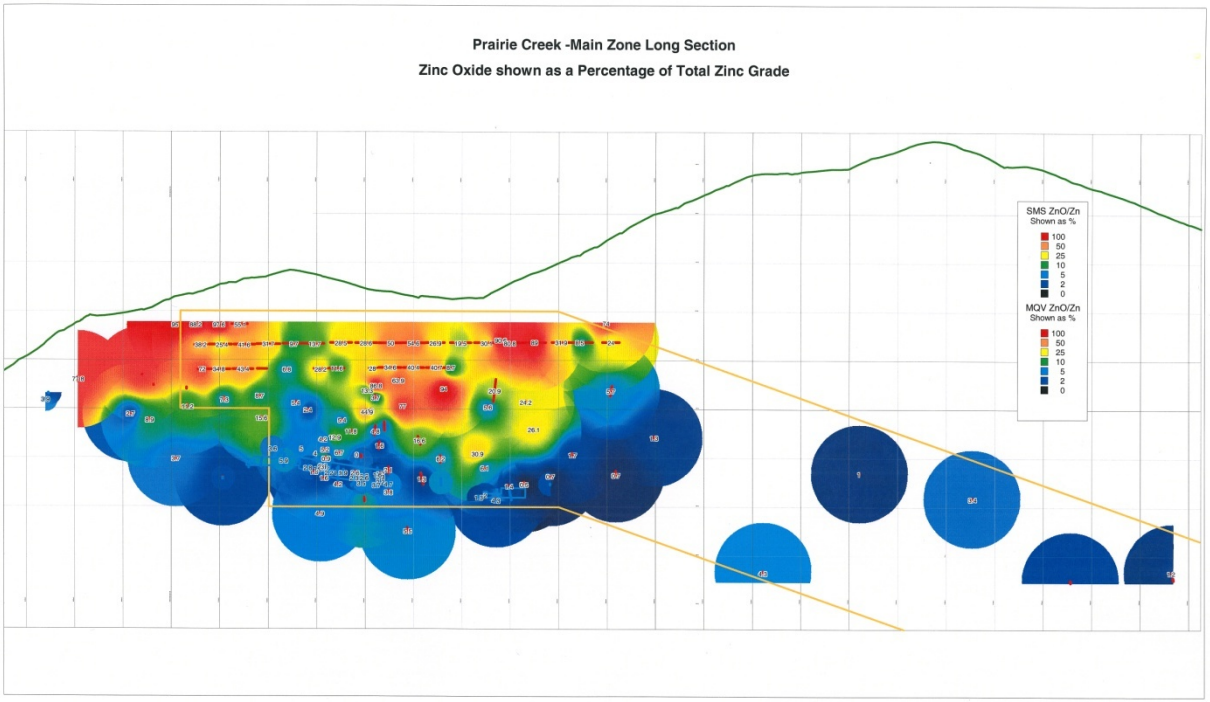
There appears to be very little alteration associated with the host rock adjacent to mineralization. There also appears to be very little remobilization and redistribution of nearby ore into the adjacent host rock. The oxidation of the primary mineralization, while heavily oxidized in some locations, appears to be spatially confined within the original mineralization aureole. Zinc appears to be the most mobile element, while Pb and Hg appear to be the least. A further discussion of this is included on page 17 of the Mesh Environmental Inc. report referred to above.

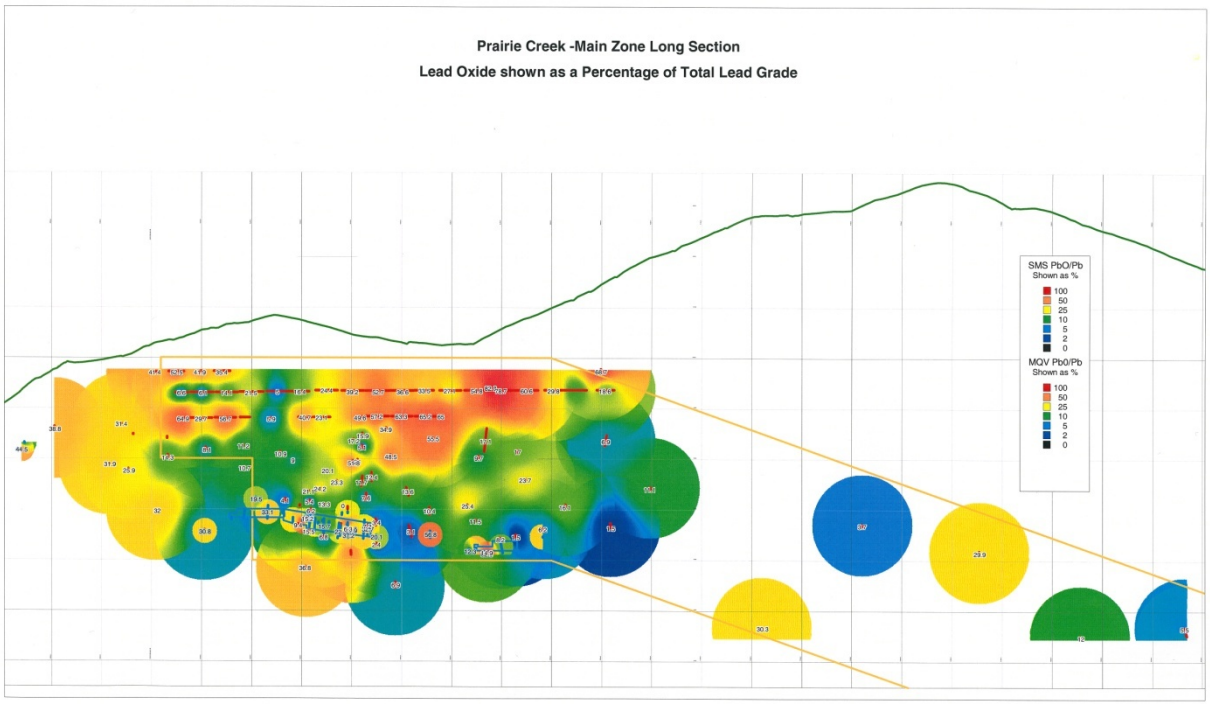
4. Provide the depth of the Pb/Zn oxidation level. Describe if this level is constant at the scale of the property.

As might be expected, the overall Pb/Zn oxidation level appears to reduce with depth at the minesite. It was reported by Cadillac Exploration that the average oxidation percent within the 970 level (ranging from 40-60 m from surface) was 70%, the mid-level 930 level (ranging from 40-100 m from surface) was approximately 25%, and the lower 870 level (ranging from 70-140 m from surface) was reduced to 15%. This is difficult to verify today since there has been 30 years of surficial oxidation within the workings and fresh surfaces would need to be sampled, however, the general trend in depletion of oxidation with depth is apparent.

Through detailed drilling within the immediate area of the levels and at depth, the oxidation component can be seen to be decreasing. However, even in the deepest drill holes that intercept the vein, there remains a significant sulphide oxidation component (4-5%). It is concluded from this that, since the vein is a known water bearing unit, oxidation of some components may be taking place due to groundwater flow through the system.

For further reference, long section Zn and Pb oxide % plots for the immediate vicinity of the existing underground workings are provided below. These two plots do not incorporate recent work, however, overall they demonstrate the decreasing component of oxidation with depth.





5. Provide a table with a range of the values characteristic of Prairie Creek ores. Describe which minerals are responsible for anomalous chromium values.

Reference is made to the 2008 Mesh report discussed above. Table 4.4 contains data for three samples from the Main Quartz Vein (MQV) collected from the underground, three from drillcore, and for samples from the 50,000 ton coarse ore stockpile located in the main yard. Six samples from the strata-bound deposit are also included which were also collected from drill core since no underground development penetrates this deposit at this time.

As evident in the chromium analyses, no significant chromium anomalies appear to be associated with the Prairie Creek mineralization.

IR Number: NRCan 9

Subject: Operation of access road and potential impacts to Karst

See Golder Associates report in Appendix D.

IR Number: NRCan 10

Subject: Baseline climatic conditions

1. A clear statement of the source of the climate data utilized for water balance calculations, design (and stability assessments) for project components such as the waste rock pile, water storage pond and water retention structures and the rationale for the data source,

It is implied that the available climate data for the site is deficient because "this is only available for a short period of time (2005-07)". We believe this length of record is normal for resource assessments, and it is always necessary to correlate with regional stations with a much longer record. Perhaps more importantly, the quality of the climate database needs to be considered in the context of the facilities being built. Both the Waste Rock Pile (WRP) and Water Storage Pond (WSP) will be located in areas with small upstream catchments. Diversion structures will be designed to pass appropriate runoff peaks, likely over-designed since the effect on diversion structure size will be small. The water storage pond already exists and has no defined upstream diversion ditches. Despite this, no issues have arisen (flows, erosion) in response to intense rainfall events over the 30 years of the pond's existence. CZN has also had the opportunity to observe site conditions and the performance of structures for nearly 20 years, including site runoff management structures. Similarly, no significant issues have been noted. The water balance for the WSP demonstrated that the balance is insensitive to climatic effects because of the magnitude of mine and mill water flows by comparison. Therefore, we believe the concerns regarding the site climate data to be unfounded.

2. A description of the analysis performed to develop site climatology from the limited onsite data and Environment Canada data from nearby stations. This should also include a discussion of how uncertainties (including the lack of onsite winter precipitation data) are dealt with in design of project components and impact assessment.

As noted above, design of diversion structures for the WRP and WSP, and the water balance for the WSP, are relatively insensitive to climate variables, and as such did not require a detailed analysis of site climatology in the context of regional stations. Where assumptions needed to be made (e.g. annual precipitation, evaporation), these were conservative. Site runoff management structures are already built, were conservatively designed and constructed by Kilborn Engineering Ltd. and have performed well for 30 years. CZN has also benefited from the fact that a 16 year record of monthly flows recorded on Prairie Creek adjacent to the site is available. This is considerably longer than the norm for most resource development projects. This was particularly valuable in assessing impacts from proposed discharges, and facilitated the development of a site water management plan. In addition, the flow record was useful for reviewing peak flood elevations for comparison to 1980 estimates (see DAR Addendum, Section 8). As such, the lack of onsite winter precipitation data was not an impediment to the design of those components not already built.

3. A description of how climate variability and extreme events (in particular those associated with precipitation) were included in the design of project components (e.g. water storage pond, waste rock pile, water retention structures), assessments of terrain stability surrounding these structures (e.g. erosion potential and slope stability) and the impact analysis.

Refer to responses to points 1 and 2 above, the geotechnical reports in DAR Appendices 11, 12 and 16, and Appendix D attached to this document.

IR Numbers: NRCan 11-14

Subject: Terrain Conditions along the Access Road and at Prairie Creek Mine, and Water Storage Pond, Waste Rock Pile and slope stability

See Golder Associates report in Appendix D.

8.0 TRANSPORT CANADA IR REPLIES

IR Number: TC – Access Road 1

Subject: Polje By-Pass route, span crossing across Polje Creek (km 42 – km 49)

Request:

Provide additional details on the span crossing that will be constructed at this location. Include information such as the potential dimensions of the crossing, the ordinary high water mark, and the height above the bed of the waterway.

The location of the Polje Creek crossing is shown in a photograph in Appendix E. The creek is approximately 5 m wide with banks 0.5-1 m high. Mature vegetation on both sides indicates the normal high water mark is close to the creek margins. A prefabricated 15 m long metal girder bridge span is being considered for this crossing, to rest on suitable abutments approximately 1 m high, which will mean a distance between the span deck and the bed of the creek of approximately 2.5 m. The span would be swung onto the abutments by crane, and ramps built at each end.

IR Number: TC – Access Road 2

Subject: Sundog Creek (km 22 - km 31), 5 crossings & temporary span structures

Request:

Provide details of the proposed structure to be constructed. Include information such as the potential dimensions of the crossing, the ordinary high water mark, and the height above the bed of the waterway.

The location of the Km 13 crossing is shown in a photograph in Appendix E. The creek is approximately 1 m wide with banks 1 m high. Mature vegetation on both sides indicates the normal high water mark is just less than 1 m from the creek bed. Metal girders >5 m long will be slung across the channel at top of bank to support decking, similar to those used for the Casket Creek crossing. The distance between the deck and the bed of the creek will be approximately 1.5 m.

IR Number: TC – Access Road 3

Subject: Seasonal construction of the access road, frozen soil beds

Request:

Provide additional details for the construction of the frozen soil beds, specifically:

- *Any additional materials that will is integrated in the construction of the road; such as log fills*

  Only snow and ice will be used.

- *If all materials will be removed before the end of the winter season*

  Snowfills will be removed from creek crossings as per normal practice.

- *The yearly estimate of the volume of snow and ice required for road construction*

  See Appendix E.

- *Dates when access to the frozen soil beds will be operational for the season.*

  Mine to Km 84 (Tetcela Transfer Facility (TTF)): December 1 – March 31, with potential shoulder periods either side depending on prevailing conditions.

Km 84 to the Liard Highway: January 15 – March 31, with potential shoulder periods either side depending on prevailing conditions.

IR Number: TC – Access Road 4

Subject: Nahanni Front Range Alternative (Km 125 to Km 170), ice bridge crossing the Liard River

Request:

Provide additional details for design/construction of the ice bridge, specifically:

a. Additional materials to be incorporated in the construction of the crossing.

As far as we are aware, only snow and water are used to make the ice bridge to a suitable thickness. No other materials are included.

b. Projected dates for the season when the ice bridge will be in operation.

January 15 – March 31, with potential shoulder periods either side depending on prevailing conditions.

c. Projected dates when all parts of the works will be removed from the water way.

Based on the answer to a., there will be no materials to remove. Any material on the crossing, such as signs, will be removed on bridge closure as ordered by the Inspector.

d. The yearly estimate of the volume of snow and ice required for the construction of the crossing

We do not know this answer, and we are not sure why the question is being asked. The quantities will depend on prevailing weather conditions at the time of construction. There is no shortage in water supply from the underlying river.

9.0 CPAWS IR REPLIES

1. What are the limitations to building a covered temporary storage facility with a capacity (60,000 tonnes) to hold the 50,000 tonnes from the first 5 months of operations and the 10,000 tonnes proposed for storage in the building adjacent to the concrete shed? If this was feasible would it not be a superior solution to storage in the WSP?

The limitations are space, and the practicality of tailings placement and recovery. The delivery of tailings as a slurry via pipeline to the WSP, and recovery by dredging, is inherently easier than placing and recovering a filtered solid in/from a building.

2. Duration of tailings storage in the WSP

Temporary storage is an arbitrary timeframe considering the estimated life of the mine could be 14 years or more.

Does the length of temporary tailings storage in the WSP consider transfer to an available mine opening immediately when one becomes available (0-2years?) or will this be done opportunistically some time during the life of the mine (0-14years)?

The temporarily stored tailings will likely be recovered within several years of start-up. This will be opportunistic depending on the availability of open stopes. Note that sediment from process water settling in the WSP will be similar to tailings, and will be recovered at the end of mine life, unless accumulations are excessive, in which case they will also be dredged out.

3. Method of tailings removal from the WSP

What would be the method of dredging tailings from the WSP?

A floating suction dredger will be used to reclaim the tailings. The suction pipe is pushed vertically into the tailings deposited. If necessary, water jets can be used to help mobilize the material.

Is it possible that this method will puncture or tear the geo-synthetic liner?

No. The liner will have a protective cover, and dredging will not occur to the full depth of the pond.

If heavy equipment is used, is there a risk that this could cause ground instability around the WSP?

No heavy equipment will be used.

Will above-ground storage of dredged tailings be required prior to transferring to the backfill plant?

No. The dredge will feed a pump and pipeline delivering the slurry directly to the tailings thickener located at the paste backfill plant.

4. Would you continue to call the pond a water storage pond or rename it a water storage and tailings pond to clarify the true function?

We will continue to call the pond a water storage pond because tailings storage will be temporary and the volume (~33,000 m^3) will be small compared to that of the pond (>450,000 m^3).

10.0 MVRB IR REPLIES

IR Number: MVRB 1-2

Subject: Waste Rock Pile - Stability Analyses, Drainage and Seepage Collection Pond

See Golder Associates report in Appendix D.

IR Number: MVRB 3

Subject: Dyke - Selection of Design Flood Level

Request

1. To follow along the discussion on the PMF estimate, other independent estimates of PMF potential could be considered for comparison with the current PMF estimate of 500 m3 s. For example, the Creagar diagram [Ref. 2] could be used, in combination with existing PMF estimates for other northern locations, to provide another estimate of this extreme flood potential. This would provide a better understanding between the magnitude of PMF value and the value obtained from the 1:10000 year flood. Were these additional estimates completed?

Additional estimates of the PMF were not completed because neither our consultant nor the MVLWB considered it necessary. Our response to request 2 below indicates that the appropriate design flood for the dyke would be less than the PMF, based on the CDA guidelines and assuming they are applicable. The flood estimates made, and the nature of the structures built, were and are considered more than suitable for the intended purpose.

2. We note that while the approximate PMF value of 500 m^3/s was accepted by MVLWB, there is still no decision on exactly what design flood to use for these dykes. The same Hay & Co. reports (dated March and July 2004) recommend that the dyke design crest elevations be based on a 1:200 year flood event with a minimum 0.5 m freeboard. It is our opinion that the Inflow Design Flood (IDF) for this dyke should be selected based on recommendations made within the 2007 Canadian Dam Association (CDA) guidelines.

These guidelines recommend selection of an IDF based on the overall hazard posed by the structure to the surrounding environment. The hazard is assessed based on overall potential for loss of life to occur in the event of overtopping and failure of the dyke, and also on the extent or magnitude of environmental damage economic loss that might occur. Given that a portion of this dyke acts as a containment barrier for the tailings (temporary) and process water storage pond and to contain the mine plants, it is expected that a review of the potential environmental damages would be important in selecting the hazard classification for this structure. Depending on the magnitude and nature of these damages, the IDF for the dyke design could range from 1:100 years up to PMF. We request additional information on the nature of the environmental damage that might occur in the event that the dyke is overtopped or alternatively breached, and then an appropriate IDF can be selected for this structure based on the 2007 CDA guidelines.

It is important to note that the flood estimates made to date are relevant to the elevations of the armour along the Water Storage Pond (WSP) dyke and the Flood Protection Berm (FPB). The

height of the WSP dyke is several metres higher than the armour. Therefore, even if a flood damaged or overtopped the armour, failure of the dyke is extremely unlikely, although erosion damage would occur.

It is debateable whether the CDA guidelines are applicable in this instance. This is a flood protection issue rather than a dam safety issue, and the WSP will be a storage pond without the passage of runoff into it and out of it as a matter of normal course. However, a consideration of the guidelines has been made. A dam classification guideline is given as Table 2-1 in the guidelines. Classifications based on risks of failure are defined as follows:

High risk - permanent population downstream, potential loss of life of 10 or fewer, a significant loss/deterioration of important fish habitat, and high economic losses affecting infrastructure.

Very high risk - permanent population downstream, potential loss of life of 100 or fewer, a significant loss/deterioration of critical fish habitat, and very high economic losses affecting important infrastructure.

Extreme risk - permanent population downstream, potential loss of life of more than 100, a major loss/deterioration of critical fish habitat, and extreme losses affecting critical infrastructure.

A complete failure of the southern WSP dyke would release water containing metals into Prairie Creek, but there would be no risk of loss of life. A complete failure of the eastern WSP dyke might ultimately release water containing metals into Prairie Creek if site storage facilities were inundated, and there would be some risk of loss of life if the failure was sudden and personnel were near or on the dyke. The risk to personnel safety is not considered as high as the environmental risk. Considering the environmental risk, a flood of the magnitude that could cause failure of the dyke would consist of a substantial volume of water. If the dyke failed, the loss of water containing metals would be diluted by the flood water. The resulting blended water quality would likely not be significantly worse in terms of dissolved metals. Note that the total metal load in the flood water would be extreme because of the sediment being transported. Prairie Creek hosts a low density of certain fish species, including bull trout, but is not noted as a spawning stream with a high habitat value. Therefore, we would not classify the habitat as critical, and in the event of a substantial flood, any habitat lost would not be considered major. Therefore, we believe a ‘high’ or ‘very high’ classification is appropriate for the WSP.

According to Table 6-1 in the guidelines, a high classification corresponds to a suggested design flood of ⅓ between a 1 in a 1,000 year return period flood and the PMF. A very high classification corresponds to a suggested design flood of ⅔ between a 1 in a 1,000 year return period flood and the PMF. The important point here is the design flood is less than the PMF in both cases.

IR Number: MVRB 4

Subject: Dyke - Slope Protection

See report from Northwest Hydraulics Inc. in Appendix Q.

IR Number: MVRB 5

Subject: Dyke - Stability Analyses

See Golder Associates report in Appendix D.

IR Number: MVRB 6

Subject: Tailings Paste Backfill — Scheduling and Utilization

Request

1. The report says all flotation tailings and partially DMSA will be used for underground filling system, but mine production and paste backfill scheduling during all mine life and availability of the underground stopes for filling will be very critical to achieve this goal. Typical mining operations can use 50% to 60% of their mill tailings. Please elaborate on how to achieve the implementation of the Tailings Paste Backfill as proposed (i.e. all tailings will be used as paste backfill underground)

In terms of paste backfill, Prairie Creek will not be a typical mining operation because the mineralization is very high grade, with a content of up to 50% economic minerals in places. This means a considerably greater volume available for backfill than the norm, even after swell factors for the tailings and DMS rock have been applied. Nevertheless, careful scheduling will be required, hence the need for temporary tailings and DMS rock storage.

2. DMSA would typically decrease the flotation tailings amount required for placing the backfill mix underground. However, if development waste rock will remain underground, there is likely more DMSA to be left for surface deposition. Please confirm and provide details of whether the development waste rock will remain underground and whether this will affect the amount of paste backfill that can be stored underground.

Development waste rock will be brought to surface, except for a small quantity at the bottom of the spiral access ramp. This has been factored into the materials balance in DAR Table 6-4.

3. Mine and paste backfill scheduling is critical throughout the entire mine life. Is mine storage capacity enough to eliminate future bottlenecks, as some development waste rock may be left underground? According to the mine development waste usage, what is the plan and how will this affect the backfilling operation and utilization of all tailings for paste backfill, if excessive tailings remain?

Once the initial mine development phase is over, there should not be any bottlenecks, hence the need for initial temporary storage. Mine development rock will not be allowed to displace tailings. All tailings will go underground as paste.

IR Number: MVRB 7

Subject: Tailings Paste Backfill - Water Bleed

See report from Mine Paste Engineering Ltd. in Appendix I, and response to Parks_Canada_44.

Appendix A

Information Requests related to Vegetation and Wildlife

IR Number: Parks_Canada_1
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Vegetation reclamation and invasive species assessment
References: Appendix 17
Terms of Reference Section: 3.2.4, 3.3.3 (4)

Preamble:
As suggested by Section 3.2.4 of the Terms of Reference, the DAR briefly considers what the existing (baseline) vegetation is relative to pre-development. In particular, a number of contentions about vegetation are made that are testable:

(1) 63 km of old access road has re-vegetated naturally since the 1980s (Appendix 17, page 42);
(2) Invasive alien plant species are not thought to be an issue (Appendix 17, page 44).

Unfortunately, no evidence is provided to substantiate these claims. The current status of the road as "naturally reclaimed", having not been used by heavy traffic in over 25 years allows for an assessment of reclamation rates in various vegetation types. This information is important to help us assess the potential significance of impacts of the road on vegetation and wildlife habitat after reclamation. If invasive alien species are present on the road from previous use, there is a potential for significant effects if the species is further spread through the proposed development. This information also provides evidence as to the potential risk of introducing alien plant species through the new use of the road and could indicate a need for stronger mitigation measures and a more hands on approach to reclamation.

Request:
1. To assess reclamation potential, describe a study design and when Canadian Zinc Corporation will collect information on the status of re-vegetation of the former access road within NNPR to natural species; particular attention should be given to Riparian Alluvial, Black Spruce Muskeg, and Aspen Liard Floodplain communities (as described in Section 3.1.5 of Appendix 17) – owing to concerns about the effects of altered drainage on these particular vegetation communities.
2. To assess the potential for invasive plant species, describe a study design and when previously disturbed sites within will be sampled for invasive plant species.
3. Assess the costs and benefits of mitigation measures to prevent introduction of viable propagules of invasive species from trucks and road equipment (e.g., vehicle cleaning station – see wheel wash description in Section 4.3.1.3.4).
4. Describe natural reclamation relative to various vegetation communities and discuss which types may require additional reclamation efforts. Outline the benefits and detrimental effects of active reclamation in these vegetation types.

IR Number: Parks_Canada_2
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Road routing impacts on vegetation
References: DAR 4.8, 4.9, 9.4, Appendix 17
Terms of Reference Section: 3.2.4 (8 & 9), 3.3.3 (4b), 3.3.6 (1a & 1b)

Preamble:
The DAR's information on vegetation has deficiencies. Vegetation work from the early 1980's is relied upon extensively for this report. Surveys are limited and out of date. Vegetation mapping completed in the early 1980's concluded that 12 vegetation communities are encountered along the access road, yet this was based on a total sample of 14 transects. This is nearly 1 transect per community which is clearly insufficient; more sampling would have likely yielded more and may have better defined rare or important vegetation community types. Additionally, since the original surveys natural variability (e.g. fires) have significantly altered many vegetation communities. Unfortunately, recent (EBA 2009) vegetation work only focused on detecting of rare species on the existing roadway, not providing an update to the dated mapping nor assessing communities that may be encountered along routing alternatives.

Although there may be some actions that can mitigate impacts to vegetation, potentially significant effects are best mitigated through proper routing of the access road at the environmental assessment stage. There was no consideration of unique or important vegetation (vascular and non-vascular) communities that may be encountered on the proposed alternate routes. Furthermore, there was no evidence to demonstrate that the current route was better or worse than other routes for mitigating potentially significant effects on rare vegetation communities or species.

Request:

Describe and compare the potential impacts on vegetation of the proposed route with other potential routes.

IR Number: Parks_Canada_3
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Road routing impacts on wildlife
References: DAR 4.8, 4.9, 9.4, Appendix 17
Terms of Reference Section: 3.2.4 (8 & 9), 3.3.3 (4b), 3.3.6 (1a & 1b)

Preamble:
Woodland caribou (Boreal and Northern Mountain ecotypes) have been indicated as a species listed under Schedule 1 of the Species at Risk Act (SARA) that uses habitat within the EA Study Area. Additionally, wolverine and grizzly bear occur throughout the EA Study Area and are considered wildlife-at-risk. Finally, moose, Dall's sheep, and beaver have been indicated as key harvested species by the Terms of Reference that should be given special consideration.

The DAR's information on wildlife has significant deficiencies. Wildlife work from the early 1980's is relied upon extensively for this report. Surveys are limited and out of date. Wildlife communities, populations, and behaviour are more susceptible to change than vegetation communities and vary within and among years. Consequently, the baseline data from 1980 and 1981 are of limited use except as a historic point of comparison for current and future conditions. A 1994 RES report is cited but little information is provided on the nature of the survey. Within the past 15 years the wildlife survey work in the area has consisted of a one day road survey in June 2006; a one day aerial reconnaissance in April 2007; and a two day survey in 2009 during which the mine site and access road vegetation and wildlife were evaluated from either helicopter or all-terrain vehicle. As such, only one survey (April 2007) captures the winter period when road use will occur, and the consultant's report suggests results from that survey only captured tracks made between April 3-7 due to wind conditions and snow drift. The survey conducted in June occurred at the peak of calving and lambing for most ungulate species and coincides with the hiding phase for most species, thus making observations difficult. The last survey described in Appendix 13 (July 2009) was not designed to detect wildlife species and can be best described as incidental observations of wildlife sign (e.g. vegetation browse, feces, or tracks) encountered at several vegetation plots and transects. In the EA Study Area, Woodland caribou, wolverine and grizzly bear are considered wildlife-at-risk, while moose, Dall's sheep, and beaver have been indicated as key harvested species by the Terms of Reference. Clear, adequate, defensible, and current information is needed for these species to inform decisions on potential significant effects.

Although there may be some actions that can mitigate impacts to wildlife, potentially significant effects are best mitigated through proper routing of the access road. For example, the frequency of truck travel along the winter road will be high and if there is wildlife habitat of value adjacent to or intersecting the road, there could be significant negative effects on wildlife. There was no evaluation of the varying degree of effects expected to occur on wildlife from the proposed alternate routes relative to the existing route. Furthermore, there was no evidence to demonstrate that the current route was better or worse than other routes for mitigating potentially significant effects on wildlife.

Of particular importance, the impact of the proposed alternative and existing routes on at-risk or key harvested species has not been considered. Specifically, Woodland Caribou (Boreal and Northern Mountain ecotypes) are a species listed under Schedule 1 of the SARA that use habitat within the EA Study Area. As stipulated in 3.3.6 of the Terms of Reference, any species listed under Schedule 1 of the SARA must be identified and any adverse impacts of the development on them thoroughly assessed and mitigated, regardless of whether the impact(s) are deemed "significant". This stipulation is to meet legislated requirements and to ensure that the species is minimally impacted. In particular, SARA requires that an assessment:

a) identify the adverse effects of the project on the listed wildlife species and its critical habitat and,
b) if the project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them.
c) The measures must be taken in a way that is consistent with any applicable recovery strategy and action plans.

Request:

1. Describe and compare the potential impacts on all wildlife of the proposed Polje By-Pass and Silent Hills Alternative relative to the original route.
2. Describe and compare the potential adverse effects of the existing route and proposed alterations on caribou populations, and calving and wintering range relative to other potential routes.

IR Number: Parks_Canada_4
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Mitigating wildlife effects
References: DAR 4.8, 4.9, 9.4, Appendix 17
Terms of Reference Section: 3.2.4 (8 & 9), 3.3.3 (4b), 3.3.6 (1a & 1b)

Preamble:
The DAR does not identify project details that may have significant effects on wildlife. For example, aircraft overflights can have significant effects on calving/fawning animals; improperly stored waste can attract wildlife and lead to an increase in defense kills; speeds of vehicles can influence the frequency and therefore the significance of wildlife mortality on the road; and road construction could alter drainage and therefore vegetation and wildlife habitat. The DAR also does not identify mitigation for some potentially significant impacts on wildlife. For example, potential impacts and mitigation are not identified for the initial road construction period which will be during spring, summer and/or fall and could have different significant impacts on wildlife than annual winter road construction and operation.

Request:
1. Demonstrate that the Solid Waste Facility identified in Figure 6-13 and 6-16 will keep wildlife away from attractants by providing a detailed drawing with particular reference to fence height, type, depth, whether the fence is electrified or entirely enclosed, and the surface area encompassed and depth of each area (page 197 and 209 of the DAR). Outline the volume of solid waste expected to be produced on an annual basis and the volume available for storage.
2. Provide aircraft heights and flight paths for the airstrip. Please indicate how often helicopters are expected to be used.
3. Spatially describe prescribed speed limits for vehicles on the road.
4. Will the road have any effect on drainage? If so, there will likely be effects on vegetation. What vegetation communities will be affected? Where and how? What mitigation measures are planned? Please include a description of any study design and methods in coming to the conclusions above.
5. Describe beaver distribution in proximity to the access road and mine. Describe the mitigations that would be used if a beaver dam was going to affect the development.
6. For the initial road construction during spring/summer/fall, describe the potential impacts of vegetation clearing and cut and fill work on wildlife. Include, use of the Weaver grizzly habitat model to assess the potential for grizzly conflicts and describe mitigations.
7. Describe active deterrence measures for bears and wolverines at the mine site (many territorial/provincial and state agencies have programs to use as templates) including:
    a. how food and waste attractants will be stored and handled at the mine site, transfer stations, and at any other locations associated with the development prior to permanent disposal;
    b. management of the Solid Waste Facility to minimize interactions with wildlife;

    c. When operating inside NNPR, consider appropriate wildlife deterrents as provided for in the *Canada National Parks Act and Regulations*, particularly in reference to firearms.
8. Whether and where salts may be used on the road alignment and if so mitigations to address salt as an attractant that leads to traffic related injury or mortality.
9. Describe how dead or injured wildlife that may be encountered will be dealt with inside and outside of NNPR.

IR Number: Parks_Canada_5
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Wildlife Monitoring
References: DAR 4.8, 4.9, 9.4, Appendix 17
Terms of Reference Section: 3.2.4 (8), 3.3.3 (4a, 4b)

Preamble:
Monitoring wildlife populations before and during operation will be critical to ensuring action can be taken to detect and then mitigate significant adverse effects. The DAR does not provide a mechanism to establish either baseline information or monitoring approaches that may be used to determine whether impacts are occurring and what magnitude those impacts are having on wildlife and/or vegetation. While PCA appreciates that the developer has indicated that monitoring will occur, PCA encourages the selection of a monitoring approach and the acquisition of appropriate baseline data, as suggested by Section 3.2.4 of the Terms of Reference, and to establish a method to assess changes in the Ecological Integrity of NNPR caused by the development as per Section 3.3.3. In regard to wildlife, this is particularly relevant for species that are at-risk or of increased harvest interest such as Woodland Caribou, Dall's sheep, and moose. Determination of baseline status and subsequent monitoring approaches are required to determine whether a significant component of NNPR's Ecological Integrity has been impacted by the development.

Request:
1. Indicate when and how baseline estimates for Woodland Caribou, Dall's sheep, and moose in proximity to the development including the access road, and mine site, claims and leases will be obtained prior to construction.
2. Provide details of the monitoring program proposed to detect potentially detrimental changes in distribution and abundance. Geographic distribution, methodology, effect size, power, confidence, sample size, and frequency of sampling should all be addressed.
3. Provide an assessment of harvest potential, and hypothesized local and population level effects along the access route for Dall's sheep, moose, and Woodland caribou in particular. Outline what a harvest will be measured, reported, and subsequent mitigations decided upon and implemented as generically outlined in the DAR (i.e. what adaptive management will entail and how it will be measured).

Information Requests related to Karst topography & the access road

The North Nahanni Karst area is considered to be internationally significant. The Developers Assessment Report does not provide sufficient information to ensure that the route and road building techniques through the karst will provide the best mitigation to potentially significant effects on the karst from spills and damage from use of the road.

IR Number: Parks_Canada_6
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Significant earthquake event and impacts on access road design, re-alignment and operation
References: DAR 10.4.2
Terms of Reference Section: 3.3.3 (4)(c)

Preamble:

It was noted that the likelihood of large rock slope failures occurring due to seismic activity is very remote. Natural Resources Canada reported a 6.9 degree (significant) earthquake in the area of the Prairie Creek mine in 1985. The potential for impacts on the access road resulting from the occurrence of a significant earthquake are unclear and therefore the potential for significant impacts on the environment are unclear.

Request:

1. Provide additional detail on the potential impacts to the access road if a significant earthquake occurred in the area of the access road, including, but not be limited to, the potential for a significant earthquake to generate small, moderate, and large soil/rock failures.
2. Provide additional detail on how earthquake loadings and frequency will be considered in the final design of the road and road re-alignment, including, but not be limited to: slope stability analysis and the magnitude (and return event) of the earthquake that will be considered.

IR Number: Parks_Canada_7
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Karst area access road re-alignment
References: DAR 4.11.2, 4.12.2
Terms of Reference Section: Section 3.2.4, Item 11

Preamble:
It was stated that small scale slope failures are believed to represent the most significant risk to the access road within the karst valley near kilometer 56. A proposed re-alignment of the access road between kilometer 46 and kilometer 59 is proposed to avoid the karst terrain. It is unclear how the access road can avoid the karst formation since it extends over a large area; however, a map showing the locations where karst is present at ground surface, or near ground surface was not provided in the DAR. It is noted that identification and extent of the Nahanni North Karst landform was required as per Section 3.2.4, Item 11 of the MVEIRB's Terms of References.

Request:

1. Provide a map that details the access road alignment and the spatial extents where karst formation exists at, or near, ground surface.

   Refer also to Information Request NRCan 9 (1)

2. Provide a comparison of the current route, the Polje By-Pass, and other routes to demonstrate which route poses the least risk to karst based on the information in IRs Parks_Canada_8 and Parks_Canada_17.

IR Number: Parks_Canada_8
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Road geotechnical field investigation
References: Appendix 16
Terms of Reference Section: 3.3.3 (4)(d)(i), 3.3.7(2)

Preamble:
It is understood that the proposed access road re-alignments were determined primarily through a desktop exercise approach (i.e., terrain maps, aerial photos, etc.) with limited, to no, field geotechnical investigation. It is understood that there are ground features that are important to characterize for access road design and proposed re-alignment, such as: karst formations; ice rich permafrost; sensitive soils, ice-rich soils, weaker surficial geology and geo-hydrology.

It is unclear if a geotechnical field investigation will be completed to aid in the design of the access road, and proposed re-alignment.

Request:

Provide details of any proposed geotechnical field investigations planned to support access road design and re-alignment including, but not be limited to:

a. Scheduling of the geotechnical investigation relative to: road final design; road re-alignment; and, road construction.

b. An overview of the proposed geotechnical investigation approach with specific reference to characterizing and mapping karst formation/features, ice rich permafrost, sensitive ground, weaker surficial geology and geo-hydrology.

c. How the findings from the geotechnical investigation will be used to complete final road design and proposed re-alignment.

Refer also to Information Request NRCan 9 (4) and to NRCan 11(2)

IR Number: Parks_Canada_9
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Operation of access road and potential impacts to karst features
References: DAR 6.21.2, 10.4.2, Appendix 16
Terms of Reference Section: 3.3.3 (4)(d)(i)

Preamble:
It was recognized that the karst landscape has features (e.g., sinkholes between km 50 and km 75) that exist that could result in subsidence and partial or complete loss of road grade locally.

A description of the geotechnical stability of the road in light of the characteristics of the karst, traffic loadings, and traffic activities was not detailed, as required in Section 3.3.3, Item 4(d)(i) of the Terms of Reference.

CZN stated that the proposed re-alignment will avoid karst. It was also recommended that an investigation within 200 m either side of the road be completed in sections of the road within vicinity of sinkholes. Further, periodic reviews of sinkhole features are proposed to be carried out to document changes that may take place. Sinkhole features are considered by Parks Canada to be a feature of the karst. Thus, it is unclear how CNZ can claim that the re-alignment will avoid karst.

Request:

1. As requested in Section 3.3.3, Item 4(d)(i) of MVEIRB's Terms of Reference, provide details for areas of the access road that are constructed where karst is at, or near, ground surface, as well as sinkhole locations. Specifically, describe the geotechnical stability of the road in light of the characteristics of the karst, traffic loadings, and traffic activities.

   Refer also to Information Request NRCan 9 (1) (2)

2. Describe how the 200 m distance from the road over which an investigation to assess road impact on sinkholes was selected, and what information was used to determine this distance is adequate to understand potential impacts.

   Refer also to Information Request NRCan 9 (3)

3. Provide additional details regarding the proposed monitoring of sinkholes, to identify any potential impacts caused by the road including but not be limited to, a description the methods and frequency of measurement.

   Refer also to Information Request NRCan 9 (5)

4. Describe the criteria used to determine the impact of the road to sinkhole features. In the event that the road impacts the sinkholes, describe the mitigation measures and plans that CZN are committed to implementing.

IR Number: Parks_Canada_10
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Access road design/construction
References: DAR 6.21, 6.22
Terms of Reference Section: 3.2.5 (21)

Preamble:
General principles of design/construction of the access road were provided, including: avoidance of side hill cuts and fills; grading with snow and/or ice; and, preservation/maintenance of the organic layer to limit permafrost degradation. The level of detail to describe access road design/construction was insufficient to understand potential impacts.

Request:

Provide additional details for design/construction of the access route, specifically:

a. Criteria for the ground conditions, or other local characteristics, that will be used in the decision to avoid side hill cuts and fills, sensitive soil areas, and, grading with snow and/or ice.

b. Additional information on how the frequency, magnitude and type of rock failures along the access road since construction will be considered in the final road design, and the proposed re-alignment sections of the access road

c. If snow and/or ice are not present in the local area of construction, the alternative plans for construction.

d. The yearly estimate of the volume of snow and ice required for road construction and maintenance.

e. A comparison of snow requirements to site conditions.

f. If cut and fill locations do occur to achieve desired road grade/slope, the mitigation measures to minimize permafrost degradation.

g. Typical cross-section diagrams of the access road to depict the various construction situations that are be encountered on site, including, but not limited to: construction on well drained and poorly drained soils, ice rich permafrost soils, sensitive soils, weaker soils, cut and fill locations, and, approaches for stream crossings.

h. Description of localized surface water drainage and management with specific regards to the likelihood of standing water accumulation adjacent to road shoulders which could lead to permafrost degradation.

i. Additional details of the maintenance activities considered for the organic layer to limit permafrost degradation, as well as, additional alternatives to limit permafrost degradation and minimize disturbance during construction and operation of the road.

j. Discussion on the potential for climate change to impact the road and proposed re-alignment.

k. Details regarding the potential effects of climate change on the operation of the road, permafrost degradation, road settlements, and slope failure in vicinity of access road.

l. If monitoring of the access road occurs during construction and operation, a description of the monitoring program. The response is specifically to address: frequency of access road inspection to assess the need for maintenance/repair; items considered in access road inspections (e.g., signs of permafrost degradation); if road repair/maintenance is required, and, the timeframe to complete repair.

m. Description of potential quarries that may be utilized for road construction, including, maps of quarry locations, approximate volume of quarry materials required, and remediation of the quarries after use.

IR Number: Parks_Canada_11
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Abandonment and restoration planning for the access road
References: DAR 6.21, 6.22
Terms of Reference Section: 3.2.5 (21)

Preamble:
It was proposed to re-align sections of the existing access road. If re-alignment occurs, there will be sections of the existing access route that may not be utilized. The use or abandonment and restoration of these sections of the road are unclear.

Details regarding the abandonment and closure of the existing access road, in areas that will not be in operation as a result of the proposed re-alignment, were not detailed.

Request:

With regards to the existing access road that will be by-passed as a result of the construction the proposed re-aligned sections, provide additional details on the use of these sections of the road during mine operations, and a plan and schedule for abandonment and restoration.

IR Number: Parks_Canada_12
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Operation and maintenance of the access road
References: DAR 6.21, 6.22
Terms of Reference Section: 3.2.5 (21)

Preamble:
It is generally recognized that construction and operation of winter roads too early in the fall and too late in the spring can account for the majority of total environmental damage that occurs over the season[1]. It is unclear what criteria will be used to determine when to open and close the access road each year.

Request:

Provide the criteria that will be applied to determine when the winter road construction and operations is to commence and complete.

[1] Stanley Associates Engineering Ltd. And Sentar Consultants Ltd. 1993. Environmental Guidelines for the Construction, Maintenance and Closure of Winter Roads in the Northwest Territories. Prepared for the Department of Transportation Government of the Northwest Territories.

IR Number: Parks_Canada_13
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Operation and maintenance of the access road
References: DAR 6.21, 6.22
Terms of Reference Section: 3.2.5 (21)

Preamble:
Annual construction and grading of the winter road will partially rely on using snow and ice at specific locations. The locations and volume of water for use in the winter road construction and operation is unclear.

Request:

Estimate the yearly volume of water use for access road construction and operation. Provide the water source locations be detailed on a map, general description of the water source and a description of the potential environmental impacts for its use.

Refer also to Information Request DFO 05

Information Requests related to Spills and Spill Contingency

IR Number: Parks_Canada_14
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Spill Contingency Plan Scope
References: s. 8.9.1 of the DAR, Appendix 28
Terms of Reference Section: 3.3.2 (9)(a)

Spills are of particular importance to Parks Canada for two reasons. First, the history of one spill per year on the access road when it was previously in use suggests that there is a high probability of a spill. Second, a single spill of the wrong substances in the wrong place on the road or at the mine site could have significant negative effects on the ecological integrity of NNPR.

Effective spill response is one approach to mitigating the potential significant effects of a spill. The "2010 Fuel Spill Contingency Plan" in Appendix 28 has numerous deficiencies. At the environmental assessment stage we would expect that the scope of the plan would outline all components of an effective spill response, would use and refer to existing regulatory guidelines, and would develop a link to local agencies responsible for managing the road. Only with this information, can we be confident that potentially significant effects can be mitigated. We have highlighted outstanding issues not currently addressed and request that Canadian Zinc Corporation provide a complete Spill Contingency Plan that incorporates each Request.

Part I

Preamble: Links to regulators and their guidance should be appropriately considered in the plan. Specifically, INAC's 2007 "Guidelines for Spill Contingency Planning" are a recognized guideline referenced by Proponents for development projects on Crown land in the NWT. The CZN 2010 Spill Contingency Plan does not reference this set of guidelines or any other guidelines that may have been utilized to guide plan development. Additionally, PCA may provide onsite assistance in the event of any serious spills.

Request:

1. Modify the plan to use and refer to INAC's 2007 "Guidelines for Spill Contingency Planning".
2. Modify the plan to reference Parks Canada appropriately:
    a. in the formal distribution of the plan
    b. as a source of additional resources and assistance
    c. as requiring notification prior to any planned mock spill exercises within NNPR and an option to observe any on-site exercises

Part II

Preamble: The "2010 Fuel Spill Contingency Plan" is only for fuel, but the Terms of Reference asked for a "Spill Contingency Plan" for all proposed mine site activities and activities along the transportation route. Spills caused by other materials must be considered in the Contingency Plan to ensure appropriate tools and safety mechanisms are in place to protect both the environment and workers.

Request:

1. Modify the plan to consider all relevant substances used at the proposed development. The substances considered in the Plan should include, but are not limited to, materials that have potential to impact the environment or human health, are hazardous, and/or deleterious. Along with fuel this will include, without limitation: water treatment chemicals and concentrate.
2. Include all Material Safety Data Sheets for all substances considered in the plan as an annex to the spill contingency plan.
3. Modify the plan to detail all sources and quantities of all substances stored at the mine site, access road, and transfer stations. The location for storage of all substances should be depicted on a map.

Part III

Preamble: The DAR acknowledges risk to groundwater from a large spill "if the spill is not completely absorbed by snow and surficial soil, and the underlying bedrock is permeable". The DAR claims that the dolomitic rocks of the Ram Plateau "represent probably the only part of the road where [all of] these criteria could be met". This insinuates all other portions of the road will have either: adequate snow or surficial soil to absorb the spill if the underlying bedrock is permeable; or impermeable bedrock if there is insufficient snow or soil to absorb the spill. However, no details of snow cover and surface ground temperature measurements/analysis were correlated with geology along the remainder of the road to support this conclusion.

The assertion that materials transported during a frozen winter environment will limit the risked posed by spills for they are "usually not able to travel far in winter conditions, are easily contained and can be readily completely cleaned-up with minimal risk to surface water and groundwater" is a generalization. This may be realistic if there are frozen ground conditions that have sufficient snow cover. Early and late season transport of materials will not have the same frozen ground conditions, and snow cover, compared to mid season transport. Blowing snow may also result in sections of the transport route that have limited snow cover. Chinooks and warm days may result in partially thawed materials while the ground remains frozen enough to travel on.

Request:

1. Modify the Plan to include spill responses to the following site conditions: frozen and snow covered ground; frozen and non-snow covered ground, and non-frozen and non-snow covered ground.
2. Modify the Plan to include special provisions throughout the plan for the karst landform due to the special circumstances of the "likelihood of rapid spread of contamination via surface or groundwater flows" relative to other landforms.

Part IV

Preamble: Spill contingency planning beyond an initial response is limited in details, or not addressed. If a large spill occurs on land or water, environmental management plans must be in place after the initial response to ensure the remediation of the area to acceptable levels. This will serve to limit impacts to environmental and human health.

Request:

Include procedures to address remediation of spill impacted areas after initial response. This may include, but is not limited to: completion of an environmental site assessment and remedial action plan; characterization of spatial extents of impacted area; dealing with contaminated wildlife (especially waterfowl and aquatic species); transferring, storing, and managing spill-related waste; and environmental monitoring and reporting to demonstrate remediation to acceptable criteria.

IR Number: Parks_Canada_15
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Spill Contingency Plan
References: s. 8.9.1 of the DAR, Appendix 28
Terms of Reference Section: 3.3.2 (9)(a)

Preamble:
The CZN 2010 Fuel Spill Contingency Plan partially relies on 3rd party contractors to assist or complete selected spills. As spills requiring 3rd party contractors are most likely larger, they have the greatest potential for significant effects to ecological integrity of NNPR. Reference to Shell Bulk Petroleum is made to assist with large or complicated spills for they have additional spill response equipment. Further, reference is made to Villers Air Service to assist with aircraft requirements. For example, CZN stated that if fuel escapes under ice, expertise should be sought immediately and "Shell Bulk Petroleum's response team can be made available in a matter of hours". It is unknown if there are formal agreements in place with 3rd party contractors to assist with spill contingency planning, and if so, the limitations of the agreements.

Request:
Provide copies of formal agreements between CZN and all 3rd party contractors that contribute to execution of the spill contingency plan.

IR Number: Parks_Canada_16
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Compliance of 3rd party contractors
References: s. 8.9.1 of the DAR, Appendix 28
Terms of Reference Section: 3.3.2 (9)(a)

Preamble:
The construction and operation of the proposed development will partially rely on 3rd party contractors to complete specific activities on site. For example, hauling of materials to and from site will make use of a 3rd party fleet. The CZN 2010 Fuel Spill Contingency Plan stated that "contractors will be introduced to the salient aspects of initial response actions to a spill as part of site orientation on arrival". It is hypothesized that hauling contractors likely have their own spill contingency protocols that may differ compared to CZN. It is critical that 3rd party contractors follow an approved CZN spill contingency plan in order to ensure that potential significant effects are mitigated.

Further, it was not stated in the DAR if 3rd party contractors will assist with the construction and operation and maintenance of the access road. It is critical that 3rd party contractors follow an approved operations and maintenance plan for the access road in order to ensure that potential significant effects are mitigated.

Request:
1. Provide information on the type of formal agreements between CZN and 3rd party contractors to require the CZN 2010 Spill Contingency Plan to be used while on-site.
2. If 3rd party operators be used for road construction and operation, please provide information on the type of formal agreements requiring they adhere to CZN road construction, operation and maintenance plans.
3. Canadian Zinc provide information on an environmental management system be established to monitor and record the performance of 3rd party contractors to implement the CZN 2010 Spill Contingency Plan and access road construction, operations and maintenance plan in their operations.

IR Number: Parks_Canada_17
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Planning to reduce spills along the road
References: DAR 9.2
Terms of Reference Section: Section 3.3.3, Item 4.d.ii.

Preamble:
The history of one spill per year on the access road when it was previously in use suggests that there is a high probability of a spill on the road. Furthermore, a single spill of the wrong substances in the wrong place on the road or at the mine site could have significant negative effects on the ecological integrity of NNPR. Therefore, Parks Canada requires information to ensure that sufficient mitigative measures from construction to operations are in place to minimize the risk of a significant effect occurring.

The reduction of spill risk along the access road as presented in the DAR relies on three strategies to reduce the risk of spills. These include hauling during freezing conditions, availability of natural materials to either absorb or retain contaminants, and re-alignment of the existing roadway to avoid features that may lead to higher risk.

The DAR states that risk of spills can "be reduced by proper planning and procedures, including design and construction of the road, with avoidance of steep terrain and hairpin turns where possible". Further, controlled "use of the road will also reduce the risk of spills" and "appropriate speed for all sections of the road will improve safety." It is noted that exact route of re-alignment and ground truthing has not been determined. While conceptually positive, there is a lack of detail or evidence to assess the true potential of this mitigation.

Additionally, as recognized but not addressed by the DAR, karst landforms are a special circumstance owing to the "likelihood of rapid spread of contamination via surface or groundwater flows" provided by the porous quality of the rock. Specifically in reference to the three mitigation strategies it can be assumed that when the former two mitigations are not available in sufficient quantities, the likely consequence of a spill in the karst landform is a significant alteration of the ecological integrity of NNPR. As suggested and outlined in Information Request Parks_Canada_12 , these conditions may manifest anytime during the hauling season, but particularly during the early and late winter periods. Given the significant risk posed by this threat, a very strong consideration to the alignment, design and construction of the road as suggested above is critical.

Request:
1. List and define the criteria used to reduce spill risk along the access road including without limitation, the criteria that will be used in road alignment selection, design, and construction. Where possible, the criteria should include measurable/numerical limits.
2. What operational procedures will be in place to minimize the risk of spills? Include speed limits, site specific directions, training for drivers etc.

3. Describe the “likelihood of rapid spread of contaminant via surface or groundwater flows associate with the karst landform” and detail the special consideration of karst landforms in planning to avoid spills.

IR Number: Parks_Canada_18
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Spills risk assessment
References: DAR 8.9, 9.2,10.1.2, 10.2.6,Appendix 28
Terms of Reference Section: 3.3.2 (9), 3.3.3(2), 3.3.4 (2), 3.3.5 (5)

Part I
Preamble:
The history of one spill per year on the access road when it was previously in use suggests that there is a high probability of a spill on the road. Furthermore, a single spill of the wrong substances in the wrong place on the road or at the mine site could have significant negative effects on the ecological integrity of NNPR. Therefore, Parks Canada requires information to ensure that sufficient mitigative measures from construction to operations are in place to minimize the risk of a significant effect occurring.

The CZN 2010 Fuel Spill Contingency Plan provides description of select fuel sources, quantities, storage location, and spill control points for the mine site. A map of the mine site is provided to aid in understanding the location of fuel storage. Fuel storages associated with the access road were less defined; however, will involve fuel storage at each transfer facility and small fuel caches along the route for emergency needs.

The proposed locations and method of storage, of the small fuel caches along the access road are unknown. During road construction, it is hypothesized that temporary fuel storage will be necessary to supply the equipment. The method of temporary fuel storage, and associated spill risk, are unknown.

Select non-fuel substances used to support mine operation, which have potential to spill and have a significant impact the environment, are currently stored at the mine site. Additional substances will be stored at the mine site and at the transfer stations during operations. A list of non-fuel substances that may be important for spill contingency planning was provided in Section 6.14 of the DAR. The quantity and storage of these substances was detailed; however, the spill control points are not detailed.

Request:
Provide an estimate of the size of spill that could occur for each substance stored along the access road, transfer stations, and mine site. Based on the size of the spill and the site specific characteristics (e.g., proximity to water, geology, etc.), it is requested that the potential impacts are described.

Part II
Preamble:
The CZN 2010 Fuel Spill Contingency Plan provided a description of spill kit locations at the mine site. It was stated that mobile storage units containing emergency spill kits and equipment will be placed along the access road. The locations of emergency spill kits along the access road, and transfer station, were not detailed.

The items contained in the spill kit were provided in the CZN 2010 Fuel Spill Contingency Plan. The kit includes standard items for fuel spills; however, it is unknown if the spill kit is acceptable to manage spills of non-fuel substances.

Request:

1. Provide the location of spill kits and materials along the road or the criteria for choosing these locations in the future. Consideration should be given to: the locations where materials will be stored; the location of sensitive areas; timeframes to mobilize spill response equipment and personnel for small and large spills.
2. Conduct an analysis of the substances that will be transported to and stored at the mine and report what items are necessary in spill kits to respond to spills of each substance.

Information Requests related to Geochemical Predications for tailing backfill

CZN proposes to transport all tailings to the subsurface mine workings as backfill. This management approach aims to permanently store the tailings during operation for the mine, eliminating the need for a long term tailings impoundment area on the mine surface.

Over the life of the mine, CZN estimates that approximately 75% of DMS rock and 100% of the tailings generated in the mining and milling process will be used to produce paste backfill, stored in underground voids after mining. The waste will be stored in perpetuity.

The paste backfill method has the potential to cause significant impacts through a variety of pathways, including mobilization of contaminants from the paste, inadequate storage volume, and structural failures during mining operations. The potential for these impacts to occur long after the mine is closed and to affect the water quality flowing into NNPR make them of importance to Parks Canada. It is essential that Parks Canada understand the physical and the geochemical characteristics of the paste backfill in the environment at the Prairie Creek Mine site. Parks Canada poses a number of information requests with respect to paste backfill.

These information requests are based on a review of the following documents:

Prairie Creek Mine Developer's Assessment Report. Main Report. March 2010 (DAR)

DAR Appendix 3. pHase Geochemisty 2010. *Final Humidity Cell Report., Prairie Creek Project, NWT Canada*

DAR Appendix 4. pHase Geochemistry 2010. *Geochemical Characterization of Paste and Paste Components, Prairie Creek Project, NWT Canada.*

DAR Appendix 5. pHase Geochemistry 2010. *Source Term Water Quality Predictions. Prairie Creek Project, NWT Canada.*

DAR Appendix 15A. Golder PasteTec 2009. *Pre-feasibility Engineering study for Cemented Paste Backfill Plant for the Prairie Creek Project.*

DAR Appendix 15B. Golder PasteTec 2009. *Technical Memorandum – Laboratory Evaluation of Prairie Creek Mine Backfill.*

DAR Appendix 15C. Golder PasteTec 2009. *Laboratory Evaluation of Canadian Zinc Mine Tailings for Use as Prairie Creek Mine Backfill.*

IR Number: Parks_Canada_19
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Paste backfill volume balance
References: DAR 6.12.1 Mine Waste Management
Terms of Reference Section: 3.2.5 (10) and (11) (Development Description)

Preamble:

An estimated 3,401,470 tonnes of paste is proposed to be backfilled in the underground voids. Using an assumed density of 1.89 tonnes/m^3 for the paste, the volume occupied by paste is calculated to be 1,799,719 m^3. The volume of underground voids is not provided in the DAR to assess if there is sufficient volume to contain the paste in the underground; however, it was stated that 100% of the tailings will be transported underground.

Request: Complete a volume balance to demonstrate that there is sufficient volume in the underground voids to contain all paste produced.

IR Number: Parks_Canada_20
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Geochemical testing - representative samples
References: DAR 8.2 Waste/Material Characteristics
DAR8.6 Potential Impacts
Appendix 3: Final Humidity Cell Report

Terms of Reference Section:
3.3.2 (3) Key Line of Inquiry: Mine Site Water Quality

Preamble:

A limited number of humidity tests were completed to gain information regarding the geochemical characteristics of the paste backfill, DMS rock, and tailings.

- Paste backfill – 2 samples;
- Tailings – 1 sample for 4-con tailings, 1 sample for 2-con tailings; and,
- DMS – 2 samples.

Further, it is understood that mineralogy of the ore body is heterogeneous. The geochemistry of the tailings, and therefore, paste, may change from that tested if the mineralogy of the mined rock changes. Further details are required in order to understand the confidence of the humidity geochemistry program to represent the characteristics of the paste, and associated leach water characteristics over the duration of mining.

Request:

1. Provide additional details about the humidity geochemistry program, specifically addressing:
   - the limited number of samples tested to date;
   - the heterogeneity of the ore deposit;
   - and, the expected sensitivity of humidity test results if the composition (e.g., material amounts and size, mineralogy, etc.) of the paste changes compared to that initially tested.
2. Describe the geochemical testing program during operation of the mine that will be used to understand the changes and the associated impacts, if any, in paste backfill geochemical characteristics compared to that initially tested. This should include a conceptual understanding of the objectives, sampling frequency, and testing approach that would form the basis of the geochemical testing program.

IR Number: Parks_Canada_21
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Flush and steady state leaching conditions
References: Appendix 3: Final Humidity Cell Report
Terms of Reference Section: 3.3.2 Key Line of Inquiry: Mine Site Water Quality

Preamble:

The humidity cell tests showed that metals are released from the paste. A flush of metals occurs when water initially passes through the paste, and then with time, a quasi steady state flushing of metals occurs. The humidity cell test results show metal concentrations in the drainage waters spike during flush conditions and then stabilize as quasi steady state conditions occur.

Parks Canada requires further information to understand the effects of groundwater interaction with the paste backfill, and the potential for metal leaching.

Request:

1. Develop a conceptual model of groundwater interaction with the paste backfill and use it to support the following additional requests. If relevant, the reliance of bulkheads installed in the underground voids should be included in the response.
2. Describe the potential for flushing and steady state conditions for metal leaching to occur within the paste backfill during mine operations and post-closure?
3. Water that passes through the backfilled paste may contain elevated metal concentrations. Provide a summary description of interaction of groundwater passing through the backfilled paste. Provide an estimate of groundwater flow leaving entering/leaving the paste backfill and the level of certainty in the estimate.
4. Prepare a detailed summary of the uncertainties with regards to groundwater interaction with the backfill material, and how this uncertainty will be addressed.
5. With regards to the paste backfill in the underground voids, further discuss the impact of flushing and steady state conditions on groundwater quality and how this is considered in predictions of drainage water quality from the paste.
6. If flushing conditions are anticipated to occur within the backfilled paste in the underground voids, discuss the estimated timeframe required to establish quasi steady state conditions.
7. In all responses, provide reference to any hydrogeological testing/analysis results that support the discussion. If there are instances where no hydrogeological testing/analysis results are available to support the discussion, provide additional detail on how to fill the information gap (e.g., confirmatory testing/analysis, monitoring, etc.) and provide confidence to interested parties.

IR Number: Parks_Canada_22
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Humidity and permeability cell leachate characteristics for paste backfill
References: DAR 8.6.1 Potential Impacts: Mine Operations
Terms of Reference Section: 3.3.2 (2)(a)

Preamble:

Various laboratory analyses were completed to understand the geochemistry of the paste. Humidity cell tests provided information regarding leach rates that were applied to prediction modeling. Permeability cell leachate was also geochemically characterized, and its composition measured concentrations higher than that of the humidity cell leachate. It is likely that the differences in leachate concentrations between the humidity and permeability cells are a result of the testing conditions. The humidity cells resulted in leachate that did not have metal concentrations above Metal Mines Effluent Regulations (MMER); however, the permeability cells did have leachate with select metal concentrations above MMER. It is understood that future water licence limits may or may not be in harmony with MMER limits. It is unclear if, and how, the permeability cell leachate quality testing was utilized in predicting leachate quality from the paste backfill.

Request:

Provide additional discussion on the application of the permeability cell leachate quality results in predicting leachate quality from the paste backfill.

IR Number: Parks_Canada_23
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Discharge of paste backfill leachate to the environment
References: DAR 8.6.1 Potential Impacts: Mine Operations
Terms of Reference Section: 3.3.2.(2)

Preamble:

The geochemical testing and predictions revealed that select metals (e.g., Zn) and pH of the paste backfill leachate may have values that approach or exceed MMER limits. It is understood that future water licence limits may or may not be in harmony with MMER limits. No mechanism to collect paste backfill leachate, if quality exceeds MMER limited, was presented in the DAR.

Request:

Describe and evaluate options to collect and/or treat the leachate, if it exceeds MMER limits.

IR Number: Parks_Canada_24
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Scaling factors to relate laboratory humidity cell leach rates to field scale leach rates for paste

Preamble:

Scaling factors to translate the laboratory humidity cell leach rates to field scale leach rates were presented. The following adjustment factors were utilized to account for the following differences between laboratory and field scales: temperature; particle size/surface area; and contact water flow path. It is unclear if the scaling factors presented in the DAR are valid for the paste.

Request:

1. *Temperature:* A rate reduction factor of 0.3 was applied to account for reductions of chemical oxidation rates due to differences between laboratory and field temperature. The humidity cell tests reported that the paste is non potentially acid generating. It is unclear if metal leaching occurs as a result of oxidation.

   Clarify whether the metal release from the paste is a result of oxidation. Further, it is requested that additional information is provided to explain the use of a rate reduction factor, which is based on relations between oxidation rate and temperatures, for the paste material.

2. *Particle size/surface area:* A 0.2 adjustment factor was used to account for the larger surface area of the field material size than that used for laboratory testing. Since the paste contains small size particles, it is unclear if there would be a significant particle size difference for the paste between the laboratory and field conditions. It is requested that CZN compare the size of particles in the paste used in the humidity cell test to the typical size particles anticipated for the paste in the field. It is requested that CZN further explain the selection of the adjustment factor with consideration to the differences in particle size of the paste in the laboratory and field.

3. *Contact Water Flow Path:* A 0.1 adjustment factor was adopted to account for flow path differences that exist in the laboratory that may not occur at the field scale for the paste. It is requested that CZN compare flow paths through the paste in the laboratory to those in the field. It is requested that CZN further explain the selection for the adjustment factor with consideration to the differences in flow path in the laboratory and that expected in the field.

IR Number: Parks_Canada_25
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Water quality source term predictions for paste

Preamble:

Predicted source term concentrations for the paste were presented. The source term concentrations are likely to be applied to contaminant loading/water balance predictions for the mine site. The source term concentrations were calculated from the humidity cell test results, application of adjustment factors, and calibration of the water quality model. The humidity cell tests for the paste materials measured Zn concentrations in the leachate to be less than 0.5 mg/L; however, the predicted source term Zn concentrations for the paste leachate were about 1.5 to 2.0 mg/L. If the adjustment factors to translate the laboratory results to field scale are reduction factors, it is unclear how the predicted source term concentration is larger than the humidity cell tests.

Request:

Describe the calculation to develop the source term concentration. It is specifically requested that the calculation for predicted source term concentrations for Zn from the paste be presented as an example.

IR Number: Parks_Canada_26
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Calibration of the water quality prediction model

Preamble:

A calibration of the water quality prediction model was completed for select mine water sources that discharge from the mine site. The calibration was completed to develop adjustment factors to predict field scale water quality from laboratory data. The calibration could not be completed for paste backfill contact water as there are no data to support completion at this time.

Request:

1. Due to the uncertainty associated with using a non-calibrated model to predict paste backfill leachate quality, it is requested that a sensitivity analysis be completed on the predictions of water quality. The analysis should consider varying the adjustment factors, over a reasonable range, to predict the leachate quality of the paste.
2. Further discuss how the calibration of the model to predict leachate quality of the paste will be completed.
3. Provide additional description to further understand model verification (and re-calibration) timing, method, and field data inputs.
4. Further discuss the field testing that is anticipated to be completed during operations of the proposed development to verify if the model adequately depicts site conditions.

IR Number: Parks_Canada_27
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Characteristics of the paste cement

Preamble:

The characteristics of the cement used in the laboratory for paste strength testing and geochemistry testing were not specified in the DAR. It is unclear if the laboratory cement characteristics are representative of the expected cement characteristics that are proposed for use at the mine. Further, it was stated that additional testing is required to explore the use of cement, slag and fly ash binder cement replacement products. It is unclear if the cement characteristics used at the proposed mine will be different from that utilized in the laboratory testing reported in the DAR. If differences in cement exist between field and laboratory, it is unclear if the laboratory geochemistry testing/results will be valid.

Request:

1. Provide additional information on the likelihood of using cement binder replacement products or admixtures for paste backfill.

   Refer also to Information Request NRCan 2(7)

2. Provide a description/technical characteristics of the cement used in the laboratory and that expected for use in the paste backfill plant.

   Refer also to Information Request NRCan 2(7)

   If differences exist between the laboratory and the paste backfill plant, it is requested that description is provided with regards to: the expected changes to the strength and geochemistry compared to that reported in the DAR; and, any additional strength and geochemistry testing that is necessary to characterize the paste.

3. Parks Canada assumes that the amount of cement in the paste will be a controlled operational parameter during operation of the paste backfill plant and that QA/QC testing will be completed to ensure the cement content in the paste is within specification tolerance. It is requested that CZN addresses the validity of this assumption.
4. Based on previous experiences in the operation of paste backfill plants at other mines, it is requested that the typical spread in operating range in cement content is detailed. Considering the typical operation spread in cement content, discuss how the cement content may change the geochemistry and leaching characteristics of the paste compared to that presented in the DAR.

IR Number: Parks_Canada_28
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Paste backfill strength

Preamble:

Preliminary strength testing of paste was presented. Unconfined compressive strengths measured values approximately 150 to 200 kPa, with a couple of measurements with greater strength values. It was stated that additional strength testing should be completed to optimize binder admixtures/concentrations, ensure strength gain, and assess the effect of slump consistency on final strengths. The required unconfined compressive strength of the paste to support underground mining operations was not specified. It is unclear if the strength values of 150 to 200 kPa are reasonable.

Request:

1. Provide additional details on the required unconfined compressive strength of the paste to support underground mining operations.

   Refer also to Information Request NRCan 2(8)

2. Provide additional discussion on the amount of cement necessary to achieve the required unconfined compressive strength. It is requested that CZN provides an opinion on the likelihood that the amount of cement, and its characteristics, will change from the conditions reflected in the completed geochemical testing presented in the DAR.

   Refer also to Information Request NRCan 2(8)

IR Number: Parks_Canada_29
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Paste backfill production

Preamble:

Additional design and testing is necessary to advance the paste backfill plant beyond an advanced conceptual level. For example, testing on paste strength and concrete characteristics may be necessary. Additionally, dewatering and its associated challenges may need to be further discussed. It is unclear if there are other testing and studies that are required to be completed to support final design and operations of the paste backfill plant. The impact of additional tests and studies on the composition of the paste, and therefore paste leaching characteristics, is uncertain.

Request:

Provide a detailed summary of additional tests and studies that are required to support the design and operations of the paste backfill plant. For each test and study, the summary should address the relative impact of the results on the composition of the paste, and paste geochemisty, compared to that presented in the DAR.

IR Number: Parks_Canada_30
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Long term mechanical behavior of paste backfill

Preamble:

The paste backfill is the long-term storage method to manage tailings. The DAR provides limited, or no, discussion on the long-term mechanical behaviour of the paste backfill. For example, the following long-term paste characteristics and associated potential impacts are unknown: strength, degradation rate, and settlements.

Request:

Provide additional discussion on the long term mechanical behaviour of the paste backfill. The response must include, but not be limited to, the importance of long-term strength and settlement/consolidation of the paste; and, the potential impact of cavities created in the underground void as a result of post-mine operation settlement of the paste on ground surface settlement, slope stabilities, and groundwater transport.

Refer also to Information Request NRCan 2(3)

IR Number: Parks_Canada_31
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Cement paste backfill plant

Preamble:

With regards to the paste backfill plant, there is potential for challenging dewatering conditions to occur as a result of mineralogy of the ore body. It was stated that additional test work was required to confirm the implications of the dewatering conditions. The ability to overcome the possible challenging dewatering conditions, at the design stage and/or through additional testing, is unclear.

Request:

Provide professional opinion with regards to the likelihood of anticipated challenging dewatering conditions.

Describe the potential impacts of the challenging dewater conditions on the operations of the paste backfill plant, proposed paste backfilling operations, and paste backfill geochemistry.

Information Requests related to Water Management & Treatment at the Prairie Creek Mine Site

Nahanni National Park Reserve was expanded in 2009 and encompasses the entire southern portion of the South Nahanni Watershed. Protecting the waters in NNPR consistently been a priority for Parks Canada throughout its history, and is a significant concern for the Dehcho in the recent expansion, and in the ongoing management of NNPR.

The proposed mine will involve management and eventual discharge of large volumes of mine and process water to Prairie Creek, a tributary of the South Nahanni River. During mine operations, or in temporary mine shut-downs or emergency situations, there is a potential for contaminated water to be discharged to Prairie Creek, and downstream to NNPR. Degradation of water quality in the South Nahanni watershed could have a significant impact on one of the key ecological indicators for NNPR.

It is important, therefore, that Parks Canada clearly understand how water is proposed to be managed and monitored throughout mine operations, and post-closure. Parks Canada must understand the full nature of the design and operational mitigations proposed, and how effects were predicted, to prevent significant effects to the South Nahanni watershed.

These information requests are based on a review of the following documents:

Prairie Creek Mine Developer's Assessment Report. Main Report. March 2010 (DAR)

DAR Appendix 1A. Robertson GeoConsultants Inc. 2009. *Site Hydrology Report, Prairie Creek Mine Site, Northwest Territories, Canada.*

DAR Appendix 1B. Robertson GeoConsultants Inc. 2010. *Addendum to Site Hydrology Report – Results of Transient Groundwater Modeling, Prairie Creek Mine, NWT.*

DAR Appendix 1C. Robertson GeoConsultants Inc. 2010. *Load Balance Calculations for Mine Water and surface Water, Prairie Creek Mine, NWT.*

DAR Appendix 2. SGS-CEMI 2010. *Prairie Creek Water Treatment Testing, including Appendix A; Relevant Toxicity Data.*

DAR Appendix 6. SNC Lavalin 2009. *Water Treatment Plant Operations.*

DAR Appendix 7. Saskatchewan Research Council 2010. *Development of Site-specific Water Quality Guidelines for Prairie Creek, NWT.*

DAR Appendix 8. CZN 2010. *Mine Area Background Receiving Water Quality.*

DAR Appendix 9. CZN 2010. *Water Balance.*

DAR Appendix 10. CZN 2010. *Receiving Water Quality During Operations and Discharge Criteria.*

DAR Appendix 11. Golder Associates 2010. *Preliminary Design: Waste Rock Pile at Prairie Creek mine NWT.*

DAR Appendix 12. Golder Associates 2010. *Preliminary Design: Water Storage Pond at Prairie Creek Mine NWT.*

DAR Appendix 22. O'Kane Consulting Inc. 2010. *Results of Preliminary Numerical Modelling Program of WRP Cover System Alternatives at Prairie Creek.*

DAR Addendum. Dube (2010) *Aquatic Effects Monitoring Final Plan.*

IR Number: Parks_Canada_32
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Sources of nutrients and their linkages to the selection of environmental indicators as part of the Aquatic Effects Monitoring Plan
References: DAR 10.7 Monitoring and Management Plan; Addendum report (2010) Aquatic Effects Monitoring Plan.
Terms of Reference: 3.3.1 Impact Assessment steps and significance determination factors

Preamble:
As for all aquatic monitoring programs, the choice of appropriate environmental indicators reflects considerations of: i) the chemical composition of the discharge, ii) the extent that the chemical characteristics of the discharge can be can be altered due to waste water treatment processes, and iii) the assimilative capacity of the receiving water.

In June 2010 Canadian Zinc Corporation released a report by Dube (2010) titled "Aquatic effects monitoring final plan". The objective of the report was to present a draft aquatic effects monitoring plan for the Prairie Creek Mine which would focus discussions and ultimately support the development of a final aquatic effects monitoring plan.

The addendum report (sub-section "2.1 Site)" states that: "The sewage effluent flow sent to the WSP [Water Storage Pond] will also be small, and should not contain nutrients (because of the use of non-phosphate detergents)." The above statement by Dube (2010) suggests that the aquatic effects monitoring program framework will be developed: i) assuming that detergents are the sole source of phosphorus loadings, and ii) loadings of other nutrients, such nitrogen, are not being considered. It is doubtful that detergents would be the only source of nutrients to the WSP, and clarification on the exact meaning of the above statement is required.

Request:

1. Provide clarification on sources of nutrient loadings to the water storage pond;
2. Specifically describe how loadings nutrients will influence the selection of appropriate environmental monitoring indicators.

Refer also to Information Request INAC10

IR Number: Parks_Canada_33
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Aquatic ecosystems
References: DAR 9.0 Impact Assessment – NNPR; DAR 9.3 Aquatic ecosystems – Impact Assessment
Terms of Reference Section: 3.3.1; 3.3.2; 3.3.5

Preamble:
As for all environmental assessments, identifying possible environmental effects needs to be accompanied with descriptions of why the effects are likely to occur, and the activities that the developer is proposing to mitigate them. Conversely, dismissing a possible effect needs to be accompanied with supporting documentation for why effects are unlikely to occur.

Section 8.1.3 *Impacts of Historic Mine Water Discharge,* documents projected loadings of zinc, cadmium and sulphate to Prairie Creek and the Flat River. By contrast, assessments of loadings of mercury are not provided despite the fact that the published study by Spencer et al. (2008) in a peer reviewed scientific journal (Integrated Environmental Assessment and Management, 4: 327-343) documented elevated levels of mercury in slimy sculpin body tissues immediately downstream of the Prairie Creek mine (i.e., near-field downstream site, mean Hg level = 0.066 ug/g) compared to the upstream reference site of 0.028 ug/g. This difference represents a 2.35-fold increase in mercury levels. Although the overall mercury levels are low, the data presented by Spencer et al. (2008) identify the potential for enrichment of mercury, and possible food-web bioaccumulation, due to mining activities, and that an additional level of evaluation is warranted.

Request:
Include an evaluation of a potential increase in loadings of mercury to Prairie Creek and an evaluation of their potential environmental effects on biological communities in this system.

Refer also to Information Request INAC09

IR Number: Parks_Canada_34
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Aquatic ecosystems
References: DAR 9.0; 9.3; Appendix 7
Terms of Reference Section: 3.3.1; 3.3.2

Preamble
Toxicity tests are an integral and approved method to assess potential toxic effects of industrial effluents on aquatic life. Appendix 7, completed by Dube and Harwood (2010), reported chronic toxic effects of treated mine water on reproduction of zooplankton. By contrast, their evaluation did not include an assessment of toxic effects of treated process water. This represents a potentially important gap in the assessment of plausible significant environmental effects.

Request
Complete chronic toxicity studies to quantify the chronic effects of treated process water, given its projected chemical characteristics or explain why these studies were not completed and when they will be completed.

IR Number: Parks_Canada_35
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Hydrogeology – zinc concentration in Prairie Creek Alluvium Aquifer

Preamble:

It was stated that the Prairie Creek Alluvium Aquifer (PCAA) currently has elevated zinc concentrations in the groundwater. One source of the zinc to the PCAA may be from water that exits the 870-level portal as surface water and is not currently collected. This surface water can then infiltrate into the PCAA. Another source of the zinc may be elevated zinc groundwater discharging from the bedrock aquifer into the PCAA. The PCAA groundwater discharges into Prairie Creek. It was also identified that Harrison Creek may have elevated zinc concentrations as a result of groundwater discharge from the aquifer into the surface water.

During mine operation, it is predicted that groundwater in the bedrock aquifer will be drawn to the underground workings, and pumped out of the underground as mine water. At closure of the mine, the mine water will no longer be actively pumped from the underground workings. As a result, during post-closure, the groundwater in the bedrock aquifer can discharge to the PCAA.

Also, at closure, a plug is proposed to be installed in the 870-level portal to restrict mine water release to surface water. The installation of the plug will increase the potential for groundwater in the bedrock aquifer to flow into the PCAA.

The groundwater in the bedrock aquifer may contain metals (e.g., Zn, Cd) released from the underground workings (i.e., mine walls, paste, etc.). Therefore groundwater that enters the PCAA from the bedrock aquifer may have elevated metals. This aspect is important for PCAA groundwater discharges into Prairie Creek and therefore has potential to impact surface water.

Request:

1. Describe the potential (if any) after closure of the mine, for groundwater to discharge into Harrison Creek, in addition to Prairie Creek.
2. Provide additional details on proposed monitoring (during mine operations and post-closure) to understand the movement of metals within groundwater in the bedrock, PCAA, and Harrison Creek Alluvium Aquifer.

IR Number: Parks_Canada_36
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Hydrogeologic contaminant transport modeling

Preamble:
The groundwater and contaminant transport modeling contained various simplifications and assumptions to represent the hydrogeology of the mine site subsurface. The results of the hydrogeologic contaminant transport modeling are partially used to predict contaminant loads to the Prairie Creek.

Request:

Provide additional details regarding any proposed hydrogeologic investigations to refine the hydrogeologic model and surface water load balance model predictions for pre-mining, mining, and post-closure, including but not limited to: a summary of the primary assumptions applied in the hydrogeologic model and how future hydrogeologic investigation data will support to confirm the assumptions; and, scheduling to complete future hydrogeologic investigations relative to pre-mining, mining, post-closure phases of the project.

IR Number: Parks_Canada_37
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Load balance calculations

Preamble:
Numerous assumptions and estimations were included in the load balance calculations. For example, various surface water flow rates were selected based on limited information, limited testing, or were estimated/assumed. As a result, there is uncertainty in the predicted values. Further, it was stated that the predicted pre-mining and post-closure concentrations for Prairie Creek are preliminary in nature and should be updated once additional data and/or analysis become available.

Request:

Provide additional details regarding any proposed surface water quality and quantity investigations used to refine the load balance predictions for pre-mining, mining, and post-closure, including, but not limited to: a summary of the primary assumptions applied in the load balance calculations and how future investigation data will support to confirm the assumptions; and, scheduling to complete the investigation relative to pre-mining, mining, post-closure phases of the project.

IR Number: Parks_Canada_38
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Load balance model – pre-mining and post-closure
Terms of Reference: 3.3.3 (1)(a) Ecological Integrity of the Nahanni National Park Reserve

Preamble:

The Terms of Reference require consideration of the potential impacts of contaminated groundwater or surface water on the ecological integrity of Nahanni National Park Reserve (NNPR), with a focus on impacts on water quality where Prairie Creek enters NNPR. The load balance model provides predictions of water quality at the NNPR boundary only for operational conditions. In order to understand the potential impacts on NNPR, Parks Canada requires this information for pre-mining and post-closure conditions as well.

Request:

Provide a prediction of the water quality concentrations in Prairie Creek at the NNPR boundary in the load balance model for pre-mining and post-closure conditions.

IR Number: Parks_Canada_39
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Discharge location and point of compliance
Terms of Reference: 3.3.2 (4) Key Line of Inquiry: Mine Site Water Quality

Preamble:

Treated water will discharge from the mine site catchment pond to Prairie Creek through a diffuser. The proposed location of the diffusion is unclear; however, it is likely to be near the Prairie Creek – Harrison Creek location. No discussion was provided on plume movements in Prairie Creek and mixing zones.

A MMER point of compliance for the Prairie Creek mine was not proposed. It is unclear how the discharge location (and water quality concentrations) would compare to the proposed MMER point of compliance (and water quality concentrations).

Parks Canada understands that future water licence water quality concentrations and location may or may not be in harmony with MMER concentrations and point of compliance. A compliance point for consideration in the water licence was not proposed. The location for the proposed compliance point for consideration in the water licence is critical for Parks Canada to understand environmental impacts to Prairie Creek. It is unclear how the discharge location (and water quality concentrations) would compare to the proposed compliance point for consideration in the water licence.

Request:

1. Provide location information for the diffuser proposed for installation in Prairie Creek; specifically: the map location of the diffuser, and distances from the diffuser to key points within Prairie Creek. The key points of interest include: existing and proposed Prairie Creek water quality monitoring stations; the Prairie Creek – Harrison Creek location; the NNPR boundary; the proposed Metal Mining Effluent Regulations (MMER) point of compliance; and proposed compliance point for consideration in the water licence.
2. Provide additional information with regards to mixing conditions in the Prairie Creek in the vicinity of the diffuser.
3. Provide predicted water quality at proposed MMER point of compliance.
4. Provide predicted water quality at the proposed compliance point for consideration in the water licence.

IR Number: Parks_Canada_40
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Underground mine water flows during operation

Preamble:
To facilitate mining, mine water will be removed from the underground voids. The mine water contains elevated zinc and requires treatment prior to discharge. The water balance calculation assumes a mine water flow rate of 50 L/s. The water treatment plant preliminary design assumed mine flow rate of 32 L/s for mine water flow rate and a treated water maximum flow rate of up to 55 L/s. The load balance calculation during mine operations considered mine flow rates of 29 L/s and 100 L/s. The 100 L/s was considered to be a "worst-case scenario".

The design flow rates appear to be reflective of medium flow rates, not the "worst-case scenario". It is unclear if the water storage facilities (e.g., water storage pond) and water treatment plant are capable of managing/treating water for the "worst-case scenario".

Request:

1. Provide a summary of how the "worst-case scenario" for mine flow rate (i.e., 100 L/s) was considered in the sizing of the water storage facilities (e.g., water storage pond).

   Refer also to Information Request INAC02

2. Describe how mine water will be treated/managed if the "worst-case scenario" mine flow rate occurs.

   Refer also to Information Request INAC02

3. If the "worst-case scenario" was not considered in the sizing of the storage facilities or water treatment plant, describe the contingencies that will be in place to manage/treat the water flows above the design values.

IR Number: Parks_Canada_41
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Water storage pond freeboard volume

Preamble:
It was stated that in cases where the water treatment plant breaks down or for an extreme precipitation event, the freeboard for the water storage pond can be used to store water. The area of the water storage pond is 108,000 m^2. With a 1 m freeboard, this equates to a calculated freeboard storage volume of 108,000 m^3. It is unclear if the entire freeboard elevation can be utilized for storage volume.

Calculations of the time to utilize freeboard volume were presented. For example, if the mine water flow rate was 50 L/s, it would take 25 days to reach this volume. The implications of the "worst-case scenario" for mine water flows (i.e., 100 L/s) on storage were not discussed. Mine flow rates greater than 50 L/s would reduce the time to utilize the freeboard volume to less than 25 days. It is unclear if the reduced timeframe is sufficient to recover from a break down in the water treatment plant or extreme precipitation event.

Request:

1. Provide additional detail with regards to the configuration of the water storage pond dam: specifically, the elevation of the dam crest; 1 m freeboard elevation; dam outlet elevation; spillway elevation; and, water level elevation in the water storage pond that will be used in the design of the dam. Further, identify the location of the dam spillway on a map.
2. Discuss the potential for water to breach the dam crest, if the freeboard is temporarily exceeded.
3. Provide additional detail with respect to the implications should the "worst-case scenario" occur during a water treatment plant break down or extreme precipitation events.

Refer also to Information Request INAC01 with respect to calculation of flow rate in providing detail requested.

IR Number: Parks_Canada_42
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Waste rock pile drainage water

Preamble:
CZN proposes to cover the waste rock piles as part of the closure strategy for the mine. Based on preliminary analysis, a cover would reduce the net infiltration into the waste rock to 18% to 29% of the precipitation. Additional information will be needed prior to closure to facilitate final cover design, such as: characterization of materials, construction of a long-term climate database, installation of a net radiometer, and completion of annual snow surveys.

The drainage from the waste rock pile post-closure is into Harrison Creek. The waste rock pile drainage waters may be high in metals. It is unclear what monitoring and management/treatment of this water source will occur post-closure.

Request:

1. Provide additional information for a monitoring program with regards to the collection of climatic, engineering, and geochemical data that are necessary to complete final design of the waste rock pile, and to predict water quality of the waste rock pile drainage water.
2. Provide additional details on the proposed monitoring and management/treatment of waste rock pile drainage waters post-closure.

IR Number: Parks_Canada_43
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Water treatment plant and water storage pond sludge management

Preamble:
CZN proposed to direct the sludge from the water treatment plant clarifier to the paste backfill plant. The volumes of sludge produced in the clarifier were not estimated. It is likely that the sludge will be high in metals; however the total sludge volume may be low compared to the total paste volume. It is unclear if the addition of sludge to the paste backfill will impact paste backfill geochemistry and paste drainage water quality.

Limited discussion was provided on the sludge that may be produced in the water storage pond, and the management of this sludge. It is likely solids will settle in the water treatment pond and may require periodic removal. The management of sludge from the water storage pond is unclear.

Request:

Estimate the volume of sludge to be removed from the water treatment plant and water storage pond and provide further detail on the management of sludge from the water storage pond. Discuss the impact of adding sludge to the paste backfill, with respect to paste geochemistry and paste drainage water quality.

IR Number: Parks_Canada_44
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Water treatment of mine water

Preamble:
Treatment of mine water is required during mine operations. The treatment of mine water is primarily focused on lime addition to remove zinc. The capability of the proposed water treatment method to remove zinc, as well as other metals that may leach (cadmium, antimony, selenium, and mercury) from the paste backfill is uncertain.

Request:

1. Discuss the likelihood that lime addition could remove the following metals from mine water: cadmium, antimony, selenium, and mercury.
2. Discuss the potential ability of the water treatment plant to be retrofitted if the mine water contains metals that cannot be reduced to adequate levels using lime addition.

IR Number: Parks_Canada_45
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Water treatment of process water

Preamble:
Treatment of process water from the mill is required during mine operations. Based on water treatability studies, treatment may involve pH reduction, addition of coagulants/flocculants (sulphide and/or ferric addition), as well as lime addition to raise the pH. The process water contains metals such as: arsenic, cadmium, lead, antimony, selenium, and zinc that may require removal prior to discharge. The target concentrations for these metals in the treated water are unclear.

The treated process water combines with the treated mine water and is then directed to the catchment pond where it is discharged to Prairie Creek. The load balance calculations for water quality in Prairie Creek during operations considered only cadmium, copper, lead, selenium, and zinc in the predictions. The treated process water may contain arsenic, alkaline pH, and chemicals used in water treatment, that are not considered in the load balance model. These constituents may have potential to impact aquatic life if concentrations are elevated.

Request:

1. Provide target concentrations of metals in the treated process water.
2. For the chemicals used in process water treatment and ultimately discharged into Prairie Creek, provide additional discussion with regards to the impacts of these chemicals to aquatic life.
3. Discuss further the expected concentrations of arsenic, and chemicals utilized in treatment, within Prairie Creek and at the NNPR boundary.

   Refer also to Information Request INAC07

IR Number: Parks_Canada_46
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Discharge criteria to Prairie Creek

Preamble:
It is proposed that discharge of water to Prairie Creek from the catchment pond should consider background water quality concentrations, Prairie Creek flow rate, discharge water quality, and discharge flow rate. There are practical limitations for continuous monitoring of background water quality concentrations. Without background water quality concentrations, the concentrations of water in Prairie Creek cannot be predicted, and the discharge loading rate cannot be calculated.

To overcome this limitation, CZN proposed that a pre-determined background Prairie Creek water quality is selected. It is unclear how the pre-determined concentrations would be selected to account for, without limitation, Prairie Creek flow rate, seasonal variations, and climatic conditions.

Request:

1. Describe how the selection of the proposed pre-determined background Prairie Creek water quality concentrations will consider Prairie Creek flow rate; seasonal variations; and climatic conditions.

   Refer also to Information Request INAC08

2. Present additional options to determine discharge criteria, along with the pros and cons for adoption.

IR Number: Parks_Canada_47
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Site specific water quality guidelines for Prairie Creek

Preamble:
Site specific water quality guidelines for Prairie Creek were developed for cadmium, copper, lead, mercury, selenium, and zinc using the reference condition approach. The reference condition approach relies on upstream Prairie Creek water quality measurements to determine site specific water quality guidelines. Parks Canada understands that the site specific water quality guidelines may be considered in the selection water licence effluent criteria.

With time, a larger data set for upstream water quality concentrations may be available. It is unclear if there will be updates to the proposed site specific guidelines as more data is produced.

Request:

1. Further discuss how the site specific water quality guidelines may be updated, as additional upstream water quality concentration data becomes available.
2. Further discuss how the site specific water quality guidelines may be updated using data obtained from the environment effects monitoring and aquatic effects monitoring programs, after the mine enters into operation

IR Number: GNWT 1-1
Source: Government of the Northwest Territories (ENR)
To: Canadian Zinc Corporation
DAR Section: TOR 3.3.2 9a)
Appendix 28

Subject: **Spill Contingency Planning**

Preamble
A spill contingency plan is required in order to anticipate, prevent, mitigate and manage conditions associated with a spill that has the potential to adversely impact the environment. ENR is pleased to see a *2010 Fuel Spill Contingency Plan* accompanying the DAR that outlines initial response and reporting requirements; however response for all spill scenarios (hazardous substances, chemicals, reagents, and explosives) are not fully addressed. Details on final disposal and treatment should be identified at this stage, the statement "contact the government authority identified by the 24 Hour Spill Reporting Line for approval before undertaking this" is not considered complete. ENR is aware that CZN intends to operate a landfarm for hydrocarbon contaminated soils however the linkage from the Contingency Plan to this proposed facility as a disposal and subsequent treatment option is not clearly made.

ENR supports CZN's commitment to the use of Environment Canada's *Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils* for guidance on design consideration, siting, monitoring and decommissioning and recognizes further details on the design and treatment will be carried out in the licensing phase.

Request:

1. Modify the Spill Contingency Plan to address all potential spill scenarios, not only those limited to fuel. Figure 1 included in the Plan should reflect storage locations of all reagents, hazardous substances, chemicals and explosives.

2. Include information on the management of contaminated soil, snow, water and ice from spills and de-icing activities.

3. Identify clear disposal options for all potential spill scenarios.

4. Provide a clear linkage between the Spill Contingency Plan and the proposed landfarm, noting contaminants available for treatment and level of treatment (with considerations for future land use).

5. Describe approach or activities to address remediation of a large scale (e.g. Remedial Action Plan, Environmental Site Assessment).

6. Please provide a clear commitment that contractors will adhere to CZN's Spill Contingency Plan.

IR Number: GNWT 1-2
Source: Government of the Northwest Territories (ENR)
To: Canadian Zinc Corporation
DAR Section: TOR Section 3.5
Section 12
Appendix 27

Subject: **Draft Closure and Reclamation Plan**

Preamble
ENR is pleased to review a Draft Closure and Reclamation Plan as a component of the DAR. ENR encourages CZN to refer to the Land and Water Boards *Draft Approach to Closure and Reclamation for Mines* to gain further guidance on expectations.

CZN has prepared the Plan with an objectives based approach, identifying options to meet these objectives; however the TOR requests that rationale for various options be included in addition to closure criteria for the various mine components. ENR recognizes this is a living document and details of options and criteria will be developed through operational monitoring, and research initiatives.

Request:

1. The Draft Closure and Reclamation Plan include an outline and timelines for a Reclamation Research Plan identifying the necessary information required to evaluate options and develop measurable closure criteria.

2. Include rationale, where possible on closure options selected (e.g. natural invasion of 20-30 years vs. re-vegetation).

3. Provide timelines for consultation and future revisions/updates to the Plan.

IR Number: GNWT 1-3
Source: Government of the Northwest Territories (ENR)
To: Canadian Zinc Corporation
DAR Section: Section 6.14

Subject: **Waste Management - Incineration**

Preamble
General domestic waste (kitchen waste, leftover food including packaging) and oil fabrics (rags, gloves, clothing) are intended for incineration. A new incinerator will be used for operations however, details on the type of incinerator planned for use are lacking. Poor incineration practices, or open burning of waste and produce, increase the release of numerous toxic pollutants to the air, such as dioxins and furans, that lead to direct and indirect hazards to human and environmental health. In accordance with Environment Canada's Technical Document on Batch Waste Incinerations, batch incinerators must be demonstrated to be appropriate for the intended waste types and volumes, and operated in accordance with the manufacturer's recommended conditions and procedures to meet the Canada Wide Standards (CWS) for Dioxins and Furans and Mercury Emissions (of which all Territories/Provinces are signatories, with the exception of Quebec, which apply to incineration and contain emission limits for these toxic contaminants).

Request

1. Please provide an outline for an incineration management plan. We recommend this be consistent with Environment Canada's Technical Document for Batch Waste Incineration (www.ec.gc.ca/drgd-wrmd/default.asp?lang=En&n=82401EC7-1). The management plan outline should include commitments for annual reporting on a number of items, for example:
    - Incineration technology selected;
    - Waste audit -- amount and types of waste incinerated;
    - Operational and maintenance records;
    - Operator training;
    - Emission measurements; and
    - Incineration ash disposal

IR Number: GNWT 1-4
Source: Government of the Northwest Territories (ENR)
To: Canadian Zinc Corporation
DAR Section: TOR 3.3.6

Subject: **Waste Management- Wildlife Attractant**

Preamble

The appropriate storage, timely, and appropriate disposal of food and waste attractants is of critical importance in minimizing safety risks associated with wildlife attraction. The DAR identifies that food waste will be incinerated; however mitigative measures of impacts associated with all waste storage and management activities are not provided (e.g. odor proof containers, fencing etc).

Request

1. Provide details on deterrent measures to be implemented in order to minimize animal attraction associated with the solid waste facility, waste transfer area and incinerator activities.

IR Number: GNWT 1-5
Source: Government of the Northwest Territories (ENR)
To: Canadian Zinc Corporation
DAR Section: TOR 3.3.2
Section 8.2

Subject: Geochemical Characteristics of the Paste Backfill

Preamble

CZN plans to use underground paste backfilling as a disposal method for tailings, DMS float, and incinerator ash. It is noted that a series of geochemical characterization tests were conducted on metallurgical samples and paste backfills samples. The tailing samples contain substantial amounts of trace metals, including Cd, Pb and Zn. A proportion of each is present in a readily leachable form, such as carbonates. The DMS float sample also contains notable amounts however lower than the tailings. Humidity cell test work indicates that most of these parameters will quickly level off to concentrations one quarter of initial flush values, with the exception of Cd, Pb and Zn that tend to show a much less dramatic decay in concentrations and rather relatively consistent and elevated release rates. This information provides preliminary data on the leachability of the paste backfill, however the geochemistry of the paste backfill during operations may reflect different composition scenarios, therefore ongoing geochemical characterization and water quality monitoring should continue.

Request

1. Provide information regarding an operational geochemical monitoring and testing program to determine and confirm the geochemistry of the paste backfill and its subsequent impacts to groundwater.

IR Number: GNWT 1-6
Source: Government of the Northwest Territories (PWNHC)
To: Canadian Zinc Corporation
DAR Section: DAR Appendix 21

Subject: Archaeological Impact Assessment of Access Road Re-alignments

Preamble
The Prince of Wales Northern Heritage Centre (PWNHC) is responsible for the management of archaeological sites in all areas of the proposed development located outside the boundary of the Nahanni National Park Reserve, including the Prairie Creek Mine and portions of the access road. While the Prairie Creek Mine consists largely of existing infrastructure, Canadian Zinc Corporation (CZN) is proposing major re-alignments to the mine access road. An archaeological impact assessment (AIA) of limited portions of the road was filed with the PWNNHC in 2009; yet, the DAR does not provide an AIA of the entire road re-alignment, and thus it is difficult to assess potential impacts to archaeological sites in relation to development of the access road.

Request

1. Please provide the PWNHC with a timeline for completion of an AIA of the proposed access road re-alignments.

IR Number: GNWT 1-7
Source: Government of Northwest Territories (HSS)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19 – Socio-Economic Impact Assessment

Subject: Social Impacts

Preamble

Section 3.4.3 of the Terms of Reference requests the developer to consider the impacts to the community of shift-work affecting child-care; addictions; and sexually transmitted diseases.

The Socio-Economic Impact Assessment notes that increased family stress may occur as a result of one parent being away from the home, particularly in terms of care for children and the elderly. Section 3.4.3.1.e of the Terms of Reference requires the developer to give consideration to and discuss potential impacts associated with the development on child care. In this case, it appears the development will likely have a negative effect on existing child care by removing a number of caregivers from the home. Since the developer would be responsible for this impact, the developer should indicate what mitigating steps it will take to reduce this impact.

The Socio-Economic Impact Assessment notes that the developer expects that Sexually Transmitted Infection (STI) rates will likely increase as a result of decreased adult supervision (it notes that the effect of in-migration on STIs is likely to be low as predicted in-migration is expected to be low), and that drug and alcohol use are likely to increase as a result increased income. The developer contends that these impacts will be low moderate over the medium to long term because the participation of Study Area residents in the Project is likely to increase bit-by-bit over time. It will start out small, and as it grows larger over time adaptation will occur, reducing the severity and frequency of the impacts.

The developer places the responsibility for dealing with these impacts almost exclusively on government even though the impacts, if actualized, will result from the Project. The developer does discuss briefly some ways in which it will act to prevent, reduce and address addictions, but no mention was made on mitigations it will introduce to reduce the predicted increase in STIs.

Request

1. Please list what mitigating steps will be taken to reduce the impact of absentee workers on child care in the community.

2. Please list the information, and/or educational materials will be available on site regarding the prevention of STIs.

3. List the measures CZN will take to protect workers from the spread of communicable diseases on site.

4. Please indicate what medical and counselling personnel will be available on site. How many hours a day will they be available? If the medical personnel determine a patient has a reportable or notifiable disease, please ensure the medical professional is aware of his or her duty to report under Part 4 of the Public Health Act to the appropriate authorities.

IR Number: GNWT 1-8
Source: Government of the Northwest Territories (ECE)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19: Socio-Economic Impact Assessment
Appendix 30: Human Resources Management Plan

Subject: Hiring Policy for Northern and Aboriginal Residents of the NWT

Preamble
Section 3.4.1.4 of the Terms of Reference requests that Canadian Zinc Corporation provide information on the developer's plans, strategies and commitments for maximizing direct employment and retention of Dehcho residents, northern and Aboriginal persons, including elaboration of its "Hire First" Policy for Dehcho communities.

Appendix 30, Human Resources Management Plan, Section 6, Hiring Practices, states that "CZN is an equal opportunity employer with Dene and Northern preference. As part of our responsibility to the Northwest Territory, we are strongly committed to employing and training people who are native to this area and/or are permanent residents. To achieve this, travel assistance will be provided for employees travelling from designated points of hire."

Appendix 30, Human Resources Management Plan, Appendix A: Socioeconomic Commitments, Section B (3) states, CZN will develop recruitment and hiring policies and procedures that will encourage Dene employment at the Prairie Creek Project. Section B (8) states, CZN will take all reasonable steps to ensure that its Contractors and any Subcontractors adopt a hiring policy consistent with CZN's policy and hiring commitments as set out in this schedule.

Appendix 19, Section 7.3.1.1, states, "Much of the construction activities will be completed by contractors. These contractors will be encouraged to hire from within the Study Area communities."

Request

1. To better understand CZN's commitments for maximizing direct employment and retention of both Northern and Aboriginal Residents in and outside the Dehcho region, describe the hiring practices around Dene and Northern preference. For example: Priority Hire and Order for: Members of Aboriginal Authorities in the Dehcho or Study Are; Aboriginal People residing in the NWT; NWT Residents; Others.

2. Please list the steps will be taken to ensure that CZN contractors and subcontractors adhere to the same hiring policy.

IR Number: GNWT 1-9
Source: Government of the Northwest Territories (ECE)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19: Socio-Economic Impact Assessment
Appendix 30: Human Resources Management Plan

Subject: Training and Employment Plans and Strategies

Preamble
Section 3.4.1.4 of the Terms of Reference requests that Canadian Zinc Corporation provide information on the developer's plans, strategies and commitments for maximizing direct employment and retention of Dehcho residents, northern and Aboriginal persons, including elaboration of its "Hire First" Policy for Dehcho communities.

Section 3.4.1.5 of Terms of Reference requests the developer should provide "a description of any plans, strategies or other commitments the developer has to support increasing the mine-ready workforce, support career paths in mining, and assist training programs in related support activities. The developer will outline how these strategies will create or contribute to training opportunities for northern and Aboriginal persons in general, and its employees in particular, over the life of the mine. The developer will also identify when any committed-to mitigations will be enacted, keeping in mind the lead time required for job-ready training programs."

CZN states in its Human Resources Management Plan, Section 2: Employment and Training that "CZN will endeavour to carry out relevant training programs that are offered through cooperation with other agencies in the Territory to support regional education and build up a further educated Territorial workforce. CZN has already participated in such training programs with the Mine Training Society and Aurora College to carry out two Environmental Training Programs which the company hosted at the Prairie Creek site in 2007 and 2008."

Appendix 30, Human Resources Management Plan, Appendix A: Socioeconomic Commitments, Section C (4), states "CZN recognizes that regardless of the term of the Prairie Creek project, it may have the opportunity to ensure Dene are provided with training as a direct result of the Prairie Creek project. CZN will employ Dene apprentices, if available and if there are qualified tradesmen on site to supervise an apprentice."

The Socio-Economic Impact Assessment (SEIA) notes that, for the Study Area communities, these concerns will be addressed in a private manner between the company and those communities through Impact Benefit Agreement (IBA) negotiation. However, beyond the scope of the IBAs, very little mention is made of efforts the company will make to maximize employment and retention of northern residents, including Aboriginal residents, from outside the Study Area.

In the SEIA, the developer indicates that it will not be able to meet all of its labour needs with the labour available in the Study Area. Furthermore, the developer makes predictions for likely levels of employment for the NWT as a whole. More information on plans, strategies and commitments for maximizing NWT employment and employee retention is needed to determine the likelihood of whether NWT employment will reach predicted levels.

Request

1. Please describe CZN's plans and strategies and detail commitments to maximize direct employment and retention for NWT residents outside of the Study Area.

2. Please list the types of training programs (entry level, semi-skilled, skilled, professional, or management) to be delivered by CZN or in partnership with other agencies that could lead to construction or operation employment or advancement within the CZN Prairie Creek Project.

3. Please provide an estimate on the number of Apprenticeship positions to be offered.

4. Does CZN plan to provide summer employment opportunities? If so, please identify the strategy and procedures CZN will undertake to provide student employment.

IR Number: GNWT 1-10
Source: Government of Northwest Territories (ITI)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19: Socio-Economic Impact Assessment

Subject: Adaptive Management

Preamble

When developing monitoring and management plans for the human environment it is important for developers to be adaptive to changing and unexpected conditions, impacts and effects.

Section 3.4.5.4 of the Terms of Reference requests that the developer indicate what adaptive management systems will be in place to deal with issues identified during monitoring in relation to the human environment.

In Appendix 19: Socio-Economic Impact Assessment, Canadian Zinc Corporation does mention it will monitor and make changes where necessary. However, it is important to have adaptive management to ensure there are clear processes in place to address problematic impacts identified during monitoring. These processes should include mechanisms for gathering and conveying input from the public.

Request

1. Please indicate what adaptive management systems will be put in place to deal with problematic socio-economic impacts identified during monitoring.

IR Number: GNWT 1-11
Source: Government of Northwest Territories (ITI)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19 – Socio-Economic Impact Assessment
Appendix 23 – Draft Preliminary Closure and Reclamation Plan

Subject: Socio-Economic Transitioning Measures for Closure

Preamble

When a mine has completed its life cycle it is important that the local workforce, local businesses, and the broader community are prepared for a successful transition away from reliance on the mine project once it is closed.

Section 3.4.2.3 of the Terms of Reference requests the developer to discuss plans, strategies or other commitments intended to help potentially-affected communities avoid over-exposure to "boom and bust" economic fluctuations.

Appendix 23: Draft Preliminary Closure and Reclamation Plan of the Developer's Assessment Report does not identify what efforts will be made by Canadian Zinc Corporation to minimize the possible negative effects of mine closure on local and regional employees, businesses and communities.

Appendix 19: Socio-Economic Impact Assessment (SEIA) discusses other possible development projects in the region that may be in operation at the time of closure. It also notes that the population will be more skilled and educated and in a better financial position at the end of the project, and states that this will put residents in a better position to be able to deal with the prospect of being without a major employer for the first time in 17 years. The SEIA also notes that reclamation activities offer the study area communities an additional year of employment and contracts as they transition into other economic opportunities.

It is important that plans and strategies exist to minimize the possible negative effects of mine closure on the local and regional employees, businesses, and communities during and after reclamation.

Request

1. What steps will the Canadian Zinc Corporation take to mitigate the negative effects of mine closure for local and regional employees, businesses, and communities?

IR Number: GNWT 1-12
Source: Government of Northwest Territories (ITI)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19 – Socio-Economic Impact Assessment

Subject: **Impact of the Mine on Traditional Economic Activity**

Preamble

Traditional economic pursuits are not only a significant contributor to local economies; they are also a fundamental part of the NWT's Aboriginal Peoples culture and traditions.

Section 3.4.4.6.c of the Terms of Reference requests that the developer provide information on plans for any ongoing monitoring and adaptive management to mitigate and minimize possible adverse effects on traditional land use and resource harvesting or to compensate for losses that the developer cannot prevent.

In Appendix 19: Socio-Economic Impact Assessment (SEIA), the developer acknowledges there may be impacts to wildlife and harvesting as a result of the increased access along the winter road. The possibility of a monitoring program for non-Aboriginal hunting is discussed in the SEIA. Predictions of the impact the increased access will have on traditional harvesting in the area is needed, along with mitigation measures in order to properly assess the impacts the access road may have on the traditional economic pursuits of the Aboriginal Peoples in the area.

Furthermore, section 3.4.4.5 of the Terms of Reference requests that the developer provide a prediction of the total impact of the Prairie Creek Mine on traditional economic activity in the study area (expressed in dollar terms as well as in terms of reduced or increased harvesting success).

The SEIA did not provide information on the impacts of the project on traditional economic activities. This information is needed in order to fully assess the impacts of the project on the local economy.

Request

1. Please provide a dollar-value estimate of the impact of the mine on traditional economic activity in the study area.

2. Please provide detailed information on monitoring and adaptive management plans to be undertaken to mitigate and minimize possible adverse effects on traditional economic activity in the study area.

IR Number: GNWT 1-13
Source: Government of the Northwest Territories (ITI)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19 – Socio-Economic Impact Assessment, Appendix 30 – Human Resource Management Plan

Issues: **NWT Business Contracting and Procurement Opportunities**

Preamble
It is important that Aboriginal and Northwest Territories (NWT) businesses have the opportunity to, and can, successfully compete on contracts within the NWT. To facilitate this objective, it is important that developers clearly outline mechanisms to ensure that Aboriginal and NWT-owned and operated business contracts will be maximized.

Section 3.4.1.7 of the Terms of Reference requests that Canadian Zinc Corporation provide an estimate of all contractor and subcontractor goods and services that the Prairie Creek Mine will require, by project phase, as well as an estimate of what percentage of required goods and services can feasibly be sourced from local and regional businesses.

In Appendix 19: Socio-Economic Impact Assessment (SEIA), Canadian Zinc Corporation was able to provide an estimate of the percentage goods and services that could feasibly be sourced from local businesses during the construction phase. An estimate at the NWT level is also needed for the construction phase. Estimates for both local and NWT levels are needed for the operations and reclamation phases, which together comprise 15 years of the project.

The SEIA provides a list of the goods and services required by the mine, for the construction and operations phases, but does not provide such a list for the reclamation phase. The reclamation phase is expected to last for one year, and is noted in the SEIA as being an important transition period for local and regional residents, businesses and communities. A list of the goods and services required during this phase will assist local and regional businesses to build up capacity in advance to meet the needs of the project.

Explicit predictions regarding local and Northwest Territories (NWT) employment, contracting and procurement, are necessary for government to understand the extent to which Proponent's mitigation measures will benefit communities and NWT residents and protect them from adverse impacts to the NWT's social, economic or cultural environment over the life of the project.

Section 3.4.1.8 of the Terms of Reference requests that Canadian Zinc Corporation provide the developer's policies, plans and commitments associated with maximizing contracting to Aboriginal and Northern businesses, with emphasis on assisting business development initiatives and joint ventures with local and regional businesses.

Appendix 30: Human Resources Management Plan, provides some information on how the company will try to engage Dene businesses. However, more information is needed with respect to maximizing contracting to Aboriginal and NWT businesses.

NWT businesses that are informed about available contracts and provided with information sessions on business and procurement opportunities are more likely to participate in contract opportunities and thus it is more likely the benefits of the project will be realized within the NWT. Advanced communication of business opportunities is critical for northern businesses to compete to the best of their abilities.

Contracting and procurement from NWT businesses provides secondary employment opportunities for NWT residents and contributes to the NWT's economy. It is important that NWT businesses have the opportunity to compete successfully on contracts and procurement opportunities. For these reasons it is important CZN provide a detailed and thorough NWT procurement strategy designed to maximize contracting and procurement with Aboriginal and NWT businesses.

Request

1. How does CZN intend to identify businesses which maximize NWT content?

2. What steps will Canadian Zinc Corporation take to ensure NWT businesses can successfully compete on contract and procurement opportunities (e.g., break contracts down into sizes that make it easier for smaller local businesses to compete)?

3. Please provide additional information on the efforts CZN will make to ensure NWT businesses are aware of business and procurement opportunities.

4. Please provide a table which lists the percentage of expenditures to be spent with NWT businesses during the construction, operations and reclamation phases. Also, please detail how the estimated percentages are calculated.

5. Please provide a list of required contractor and subcontractor goods and services for the Reclamation phase.

6. Will the developer commit to doing a public Request for Qualifications to establish a list of NWT businesses that have the capacity to successfully compete for opportunities related to the Prairie Creek Mine?

7. Please provide a copy of CZN's NWT Procurement Strategy to the public registry and include details on how commitments in the strategy will be implemented and monitored.

IR Number: GNWT 1-14
Source: Government of Northwest Territories (ITI)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19 – Socio-Economic Impact Assessment

Subject: Transportation and Rotation Policy Impacts on NWT Participation and Residency

Preamble

The size and rate of change of a jurisdiction's population can have a significant effect on the quality of life available in that jurisdiction. In the Northwest Territories (NWT), government capacity to provide programs and services is greatly dependent on population size.[1] Development projects can have positive or negative effects on population size and trends for rate of change.

Section 3.4.3.1.a of the Terms of Reference asks the developer to provide information on the potential impacts on population in- and out-migration.

In Appendix 19: Socio-Economic Impact Assessment (SEIA), the developer states that the Project will have positive impacts on population in- and out-migration in a number of respects. However, it also acknowledges that there is the risk that the 3 weeks in/3 weeks out rotation schedule proposed may contribute to population out-migration. It notes that some Study Area residents would relocate elsewhere given the freedoms associated with their new financial wealth and the ability to retain employment regardless of the community of residency. This suggests that the company's policy on residency may have a negative effect on population out-migration. In addition to having potential negative effects on GNWT fiscal capacity, out-migration can be very hard on communities and families.

The developer states that it considered a one week in/one week out rotation schedule, but rejected it because of severe winter weather may interfere with this schedule. No reference was made in the Developer's Assessment Report to whether a two weeks in/two weeks out rotation schedule was considered. Shorter rotation schedules encourage greater local participation and discourage out-migration; whereas longer rotation schedules are often more difficult for local people not as accustomed to the wage economy and extended absences from their families to adapt to, and facilitate out-migration.

In the SEIA, the developer notes that "Yellowknife will be added [as an additional pick-up point] should there be enough interest from the labour force there." Adding Yellowknife as a pick-up point has significant merit beyond the possibility of employing residents of Yellowknife. For one, Yellowknife serves as the transportation hub for the entire NWT, so adding it as a pick-up point would make it much easier for available,

[1] The funding the GNWT receives from the federal government in the form of the Territorial Formula Financing (TFF) grant is provided based in significant part on the size of the NWT population.

interested and qualified residents from other NWT communities to join the Prairie Creek workforce. Furthermore, adding Yellowknife as a pick-up point would also increase the likelihood of non-NWT resident employees moving to the NWT.[2]

Any population loss resulting from the Project would have a significant impact on GNWT fiscal capability. Additional population enhances GNWT ability to provide much needed programs and services to NWT residents in all regions, including the study area.

Request

1. Will the developer commit to reduce its rotation schedule, to prevent out-migration and maximize local participation?

2. Will the developer commit to add Yellowknife as a pick-up point, to encourage participation from other regions of the NWT and facilitate in-migration?

[2] Yellowknife is the NWT community most able to house new residents, and it is the main transportation hub for the NWT, the easiest way for new residents to travel to their former communities to visit loved ones.

IR Number: GNWT 1-15
Source: Government of Northwest Territories (ITI)
To: Canadian Zinc Corporation – Prairie Creek Mine
DAR Section: Appendix 19: Socio-Economic Impact Assessment

Subject: Human Environment Monitoring

Preamble

Public reporting on employment, training and business efforts by the developer is important in order to monitor the economic opportunities and efforts the developer is making to bring benefits to the Northwest Territories (NWT).

Section 3.4.5.3 of the Terms of Reference requests that the developer indicate how human environment monitoring results will be evaluated and reported to regulators, responsible authorities and potentially affected communities.

Details are needed on how human monitoring results will be reported and evaluated to ensure annual reports produce meaningful information for communities, regulators, responsible authorities and the public. Some examples of items tracked and reported by developers in the NWT include:

a. *Number and proportion of person years employment according to residency (NWT, NWT Aboriginal and Other Canadian), for each phase of the Project;*
b. *Length of time NWT hires and employees have lived in NWT (e.g.: greater or less than six months);*
c. *Employment and hiring by community within the NWT;*
d. *Number and proportion of hires according to residency (NWT, NWT Aboriginal and Other Canadian);*
e. *Participation in and results of training initiatives;*
f. *The gross value of goods and services purchased, by category of purchase, for each phase of the Project*
g. *The gross value of goods and services purchased, by community; and*
h. *Business forecast for the following calendar year.*

This information allows regulators to assess how much and in which ways NWT residents and businesses are participating in the project. This can be used to assess whether predictions made in the Environmental Assessment are accurate, and whether adaptive management may be required.

Request

1. Please itemize the indicators that will be tracked and publicly reported by Canadian Zinc's human environment monitoring efforts.

2. Please indicate what criteria will be used to classify a business as an NWT Business or as an Aboriginal Business.

3. Please indicate what criteria will be used to determine NWT residency and Aboriginal ethnicity.

4. Please specify how person years will be calculated and defined for each phase of the project (i.e., how many hours per year will make up a person year).

IR Number: EC-1
Source: EC/ENR
To: Canadian Zinc Corp.

Subject: Contaminant loading from mine operations and transport of lead and zinc concentrate.

Preamble:
Fugitive dust from the mine operations and the transport of concentrate can result in contaminant loading to land and water. The following describes the most common sources of the fugitive dust:

Mine Operations:

- **Dust generated by mining activities—**Dust can be generated from drilling, blasting, material handling, and truck haulage activities.
- **Dust emissions from materials handling—**Dust can be generated from materials handling activities, including truck haulage activities, placement of waste rock on waste rock stockpiles, and the stockpiling of ore.
- **Dust emissions from mill and concentrate storage facilities—**Dust can be generated from the ore crushers, the coarse ore stockpile building, and from concentrate storage and loading operations.
- **Mechanical or wind-generated dust from surfaces—**Windblown dust can be generated from surfaces around the mine, including the access roads and yards, and other mineralized surfaces.

Transportation:

- **Tracking along roads —**Ore concentrate can be tracked out of loading and unloading facilities on haul truck tires and other truck surfaces and subsequently deposited onto the road.
- **Concentrate spillage and escapement from haul trucks—**This includes leakage from bags of concentrate, blowing of dust collected on the outside of the bags of concentrate on the trucks, or spillage from overturned trailers following accidents.

The Red Dog lead and zinc mine in Alaska provides an example how mine activities and transportation of lead and zinc concentrate can lead to the contamination of soil, vegetation and water bodies. Although the Red Mine is larger than the proposed Prairie Creek Mine, both mines will have similar activities: both are lead and zinc mines that include on-site processing of ore and transportation of lead and zinc concentrate by trucks through a national park. Therefore, there is potential that the Prairie Creek Mine will have similar environmental issues as the Red Dog Mine.

The Red Dog Mine transports lead and zinc concentrate along an all season road 24 miles from the mine site to the sea port. Studies have linked the transport of concentrate from the Red Dog Mine to elevated levels of lead, zinc and other metals in the environment. Ford and Hasselbach (2001) found a strong road-related gradient in heavy metal

deposition along the all season road. They found lichens (Hylocomium splendens) “to be highly enriched in lead (Pb > 400 mg/kg), zinc (Zn > 1800 mg/kg) and cadmium (Cd > 12 mg/kg) near the haul road. Concentrations decreased rapidly with distance from the road, but remained elevated at the transect endpoints 1000 m – 1600 m from the road (Pb > 30 mg/kg, Zn > 165 mg/kg, Cd > 0.6 mg/kg)”. In a follow-up study, Hasselbach, et al. (2004) found that elevated levels of heavy metals extend up to 25 km from the haul road. Elevated levels of lead and zinc were also found in streams and streambed sediments along the haul road (Brabets, 2004). In streams near the mine, cadmium and lead concentrations in tissue of juvenile Dolly Varden were significantly higher in fish downstream from the haul road compared with upstream fish (Ott and Morris, 2004).

Another example of contaminant loading is found at the original Pine Point Mine, NWT. Lead and zinc concentrate was transported from the mine to Hay River along an old CNR railway. Indian and Northern Affairs Canada (INAC) have tested soil samples from the railway bed and found that lead and zinc concentrations exceed the Canadian Council of Ministers of the Environment (CCME) Soil Quality Guidelines for these metals. The sampling program was site specific and too limited to say with certainty, but the pathway of this contamination was potentially linked to the transportation of the mine concentrate. Further details on the INAC soil testing can found on the MVLWB public registry, file number MV2004Q0019.

The Red Dog Mine is managing the contaminant loading by implementing mitigation strategies to reduce fugitive dust from the mine site and transport of concentrate. For example, the Red Dog Mine replaced the concentrate haulage fleet with trailers that have hydraulically operated steel covers to minimize spills, solid sides to eliminate potential for concentrate leakage and more stability, thereby reducing the risk of accidents. The mine also implemented a number of mitigation strategies to control dust at transfer points including negative pressure and bag houses in the concentrate loading building, enclosed conveyors, and truck washing bays to minimize tracking issues. A complete list of mitigations strategies can be found in DMTS Fugitive Dust Risk Assessment Report Appendix L (Tech Cominco, 2007). To ensure that the mitigation is effective the Red Dog Mine has an intensive monitoring program including twenty-five dustfall monitors (Teck Cominco, 2005).

The Prairie Creek Mine is proposing to load lead and zinc concentrate into bags and to transport the bags across the winter road on flat deck trailers. Each truck load will have, at minimum, 30-tonnes of concentrate and 120,000 tonnes of concentrate will be hauled out from the mine each year (4000 truck loads). Limited information is provided on mitigation strategies to be implemented to control dust during the handling and transport of the concentrate.

EC/ENR notes that the proponent has provided an outline of a “Best Management Practices Plan to Control Fugitive Dust and Metals Emissions” (Air Quality Assessment, Section 5.2) which will be completed if the project progresses to the permitting stage. However, for the MVEIRB process it would be helpful to obtain some additional details of potential contaminant loading mitigation strategies.

Requests:
EC/ENR requests that the proponent provide a list of potential mitigation strategies that could be used to minimize contaminate loading from fugitive dust associated with mining activities, and the handling and transport of ore and concentrate. In particular, EC/ENR requests that the proponent discuss the mitigation strategies used at other mines, such as the Red Dog Mine, and the potential for implementing these mitigation strategies at the Prairie Creek Mine.

EC/ENR requests that the proponent discuss and justify its decision to use bags on flat deck trailers to transport concentrate rather than using mechanically sealed trucks similar to the trucks used at the Red Dog Mine. EC/ENR further requests an assessment of alternative methods of containment during transport, including secondary containment options for the proposed method.

References:

Brabets, T., 2004, Occurrence and Distribution of Trace Elements in Snow, Streams, and Streambed Sediments, Cape Krusenstern National Monument, Alaska, 2002-2003, U.S. Department of the Interior and the U.S. Geological Survey, Scientific Investigation Report 2004-5529.
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Hasselbach, L., Ver Hoef, J., Ford, J., Neitlich, P., Crecelius, E., Berryman, S., Wolk, B., Bohle, T., 2004. Spatial patterns of cadmium and lead deposition on and adjacent to National Park Service lands near Red Dog Mine, Alaska, National Park Service.
http://www.nps.gov/akso/NPS_CAKR-Metals_2004.pdf

Horvath, S. (editor). 2007. British Columbia Environmental Laboratory Manual. Water and Air Monitoring and Reporting; Environmental Quality Branch; Ministry of Environment; Victoria BC; Canada.
http://www.env.gov.bc.ca/air/wamr/labsys/lab_man_07.html

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Ott, A.G., and W.A. Morris. 2004. Juvenile Dolly Varden whole body metals analyses, Red Dog Mine (2002). Technical Report No. 04-01. Alaska Department of Natural Resources, Office of Habitat Management and Permitting.
http://www.habitat.adfg.alaska.gov/tech_reports/04_01.pdf

Tek Cominco Alaska Incorporated, 2005, Summary of Mine Related Fugitive Dust Studies: Red Dog Mine Site.
http://www.dec.state.ak.us/air/doc/RD_Mine_Fugitive_Dust_Studies_3-05.pdf

Tek Cominco Alaska Incorporated, 2007, DMTS Fugitive Dust Risk Assessment Volume I -- Report.
http://www.dec.state.ak.us/SPAR/csp/sites/reddog.htm

IR Number: EC-2
Source: EC/ENR
To: Canadian Zinc Corp.

Subject: Incineration of sewage

Preamble:

The project fact sheet, page 3, indicates that garbage and sewage sludge will be incinerated on-site. In Table 6-6 in the Development Description, page 205, it states that sewage sludge will be disposed in the landfill. EC/ENR seeks clarity on if sewage sludge will be incinerated on-site.

Sewage sludge should not be burned in batch waste incinerators that are typically used in the north. Sewage sludge has high moisture content and low heat content that will increase operating costs dramatically and lead to poor incinerator performance. Poor incineration performance produces and increases the release of numerous toxic pollutants to the air, and ultimately the land and water,, such as dioxins and furans, that lead to direct and indirect hazards to human and environmental health. Furthermore, it is unlikely that the sewage will be completely combusted and could lead to the release of pathogens into the environment. High moisture materials can leak from the incinerator hearth and lead to equipment damage and present health hazards to workers.

Sewage sludge should only be burned in incineration equipment designed for this type of waste. If the proponent decides to pursue sewage sludge incineration, it should provide the Board with the design specifications of the incinerator and a letter from the manufacturer stating that this equipment is suitable for burning this type of waste. Any emissions from sewage sludge incineration must be reported to the National Pollutant Release Inventory (NPRI), under the authority of the Canadian Environmental Protection Act, 1999 (CEPA 1999).

http://www.ec.gc.ca/npri

Requests:

EC/ENR requests that the proponent clarify if sewage will be incinerated at the Prairie Creek Mine site. If sewage is to be incinerated, EC/ENR requests that documentation be provided indicating that the equipment is designed to handle this waste stream, and the conditions under which it must be operated.

IR Number: EC-3
Source: EC/ENR
To: Canadian Zinc Corp.

Subject: Air quality modelling input and output data

Preamble:

The quality of model predictions is dependant on the quality of the input data used in the model. The selection of model options and the configuration of model domains and grids can also affect the quality of predictions.

To provide confidence in the air quality model predictions provided in the DAR, all input data and selected model options and configurations must be reviewed.

Requests:

EC/ENR requests that the proponent provide all input and control files used in the CALPUFF model to generate the air quality predictions presented in the DAR. All files should be in a format that can be used directly into CALPUFF. Please include all output files in the raw CALPUFF format.

IR Number: EC-4
Source: EC/ENR
To: Canadian Zinc Corp.

Subject: Air quality modelling results

Preamble:

The proponent introduces a novel concept of a buffer zone, which extends 200 m around the surface mine lease (Air Quality Assessment, Section 2.4). There is no discussion of the significance or the justification of employing the buffer zone in regards to air quality impacts from the mine emissions. EC/ENR notes that the section of Prairie Creek (stream) which runs along the mine site is captured within the buffer zone. This stream could be an important receptor, particularly to the deposition of lead and zinc.

The proponent provides predicted maximum ambient concentrations and deposition rates based on CALPUFF modelling for receptors within the mine lease, receptors on the surface lease boundary, receptors within the buffer zone, receptors on the buffer zone boundary and receptors outside of the buffer zone (Air Quality Assessment, Tables 14, 15, and 16). The model predictions are further discussed in Section 4.2.3, and Section 4.2.4. Spatial plots of the predicted concentration isopleths were not provided. Spatial concentration isopleth plots are commonly included in air quality assessments and are essential to understanding the extent and severity of potential impacts as well as locating appropriate monitoring sites. Other jurisdictions, such as Alberta (Alberta, Air Quality Model Guideline, 2009), require spatial concentration isopleth plots of model predictions to be provided with air quality assessments.

Request:

EC/ENR requests that the proponent discuss the significance and justification of using a buffer zone in the air quality assessment.

EC requests that the proponent provide spatial isopleth plots of predicted maximum ambient concentration and deposition rates for each species modelled.

Reference:

Government of Alberta, 2009, *Air Quality Model Guideline*.
http://environment.alberta.ca/01004.html

IR Number: EC-5
Source: EC/ENR
To: Canadian Zinc Corp.

Subject: Air quality monitoring plan

Preamble:

In the outline of the of air quality monitoring plan, the proponent has identified the parameters to be measured, frequency and location of the monitoring and project phase in which the monitoring will occur (Air Quality Assessment, Table 24). Information on the types of monitoring was not provided. It would appear from the monitoring frequency that TSP, PM_{10}, and $PM_{2.5}$ will be measured using integrated monitors such as a dichotomous sampler, SO_2 and NO_2 will be measured using passive monitors, and lead and zinc will be measured using dustfall samplers. EC/ENR requests that the proponent confirm of types of monitors being proposed in the monitoring plan.

The number of monitors is unclear. The Red Dog Mine has established a network of 25 dustfall monitors at the main mine site, along the haul road and at each transfer site. The Prairie Creek Mine should implement an adequate monitoring program to ensure that fugitive dust mitigation is effective and that dust containing metals are not contaminating areas around the active mine site, haul road and transfer sites. Deposition of lead, zinc, and other contaminants into Prairie Creek is of particular concern.

Obtaining spatial isopleth plots of predicted ambient concentrations and deposition rates is essential to determining the number and location of monitoring sites.

Request:

EC/ENR requests that the proponent provide additional information regarding the air quality monitoring plan. Please provide the type of monitoring planned for each parameter and the number and location of the monitoring sites.

IR Number: EC-6
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Closure and Reclamation

References: Appendix 27

Preamble:
The closure and reclamation objective for the Waste Rock Pile (Section 3.5 of Appendix 27) is given as "The WRP…must not leach metals to an extent that groundwater and surface water quality are significantly impacted". However, in order to limit ambiguity of the objective it is important that the term significantly is clearly defined. As well, in Section 3.11 it is stated that "surface water quality should not be significantly different from operating period." Again, clarification as to the type of significance being referred to would improve the statement.

Request:
When the term 'significant' is used, please either define the term or provide a context for its use.

IR Number: EC-7
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Closure and Reclamation
References: Appendix 27

Preamble:
Section 3.8 of Appendix 27, Mill and On-Site Infrastructure, makes mention of various buildings on site and the berms lining Harrison Creek channel, indicating that they will be lowered in elevation; however, no mention is made of the flood protection berms lining Prairie Creek.

Similarly, in Section 3.9 of Appendix 27 details are provided on the reclamation plan for the all-season road bed along Funeral Creek, but it is unclear what reclamation is planned for the full length of the winter road.

Request:
Include a comprehensive list of all structures/facilities on and off site and the intended and/or potential closure options for each.

IR Number: EC-8
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Closure and Reclamation
References: Appendix 27

Preamble:
Section 3.10 of Appendix 27 is title “Monitoring, Maintenance and Reporting Program” although no mention of maintenance activities are addressed in the section or elsewhere in the plan. As such, the role of maintenance activities in relation to the overall closure plan and schedule, and the interaction between maintenance and monitoring it is not clear.

Request:
Clarification on what is meant by maintenance in terms of closure activities is requested, as well as the criteria to be used to determine that maintenance activities should be implemented.

IR Number: EC-9
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Waterfowl use of water impoundment pond at mine site

References: Prairie Creek Mine Developer's Assessment Report (Section 10.3.1, page 312); Vegetation and Wildlife Assessment Report (Appendix 17, Section 4.3.1.5.2, page 54)
Terms of Reference Section: Wildlife and Wildlife Habitat, Section 3.3.6

Preamble:
Section 5.1 of the *Migratory Birds Convention Act* prohibits persons from depositing substances harmful to migratory birds in waters or areas frequented by migratory birds or in a place from which the substance may enter such waters or such an area. The Developer's Assessment Report and the Vegetation and Wildlife Assessment Report identified that waterfowl have been known to use the large water impoundment pond on the mine site during the spring and summer. It is our understanding that this water impoundment pond could potentially hold tailings from mining activities at least during some of the mine operations. As such, there is a potential that waterfowl and any other aquatic birds that use the pond could be exposed to harmful substances.

The Terms of Reference require the Developer to describe the potential for increased contamination of food and water (Section 3.3.6, 1f), and to describe how planning has considered potential impacts to wildlife and wildlife habitat, best management practices to minimize impacts on wildlife, and what mitigation commitments have been made (Section 3.3.6, 4). The Terms of Reference also require (through the wildlife management plan) the identification of adaptive management measures to avoid, minimize, and mitigate potential impacts to wildlife when detected through wildlife monitoring (Section 3.3.6, 5d).

Request:
For Canadian Zinc Corporation to:

1. Describe potential impacts to waterfowl and other aquatic birds from possible contaminants and other harmful substances that may be found in the water impoundment pond on the mine site;
2. Outline mitigation measures that will be done to ensure that waterfowl and other aquatic birds are not exposed to harmful substances that may be found in the water impoundment pond; and
3. Discuss monitoring that will be done to ensure that the mitigation measures are effective.

IR Number: EC-10
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Wildlife Management Plan

References: Wildlife Management Plan (Appendix 32)
Terms of Reference Section: Wildlife and Wildlife Habitat, Section 3.3.6

Preamble:
In Section 3.3.6 of the Terms of Reference, the Developer is required to provide a Wildlife Management Plan (WMP) as outlined below.

5. *Provision of a wildlife management plan appropriate for full-scale mining covering all activities occurring at the mine site and along the transportation corridor, including discussion of:*

    a. Which other interested parties have been involved in the development of the wildlife management plan;

    b. The adequacy of all pre-existing wildlife mitigation and management plans and commitments in light of increased activity levels during full-scale operations;
    c. Efforts to be undertaken to monitor wildlife in the EA Study Area and report the presence of species to the appropriate authorities when necessary;
    d. Identification of adaptive management measures to avoid, minimize, and mitigate potential impacts to wildlife when detected through wildlife monitoring; and
    e. How monitoring results and mitigation efforts will be reported to regulators, responsible authorities and potentially-affected communities.

It is Environment Canada's view that the WMP submitted with the Developer's Assessment Report did not fully address the requirements of Terms of Reference to provide a WMP appropriate for full-scale mining covering all activities at the mine site and along the transportation corridor. The WMP should include all the impacts to wildlife that may result from this project, mitigation measures to avoid or lessen the specific impacts, and monitoring that will be done to ensure that mitigation measures are effective or to identify where further mitigation measures may be required. Specific details on the methods for monitoring and when adaptive management will be used should be included. Discussions will be required with the appropriate wildlife management authorities to ensure that the WMP is adequate. Environment Canada also encourages the Developer to review WMPs submitted for other northern mining projects in order to assist the Developer in determining the amount of information and level of detail that is required for a large-scale industrial development such as the proposed Prairie Creek Mine.

Request:
EC asks that Canadian Zinc Corporation provide a revised Wildlife Management Plan that addresses all wildlife impacts, proposed mitigations, and monitoring; adequately covers the specific requirements as outlined in the Terms of Reference (Section 3.3.6); and incorporates feedback from other wildlife management authorities, as appropriate.

IR Number: EC-11
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Source of toxicity in treated process water

Preamble:
Water will be managed on site through use of a Water Storage Pond (WSP) to enable recycling of water to the mill, treatment of excess process water and its release to a catchment pond and then by controlled release to adjacent Prairie Creek.

This release to Prairie Creek represents the final discharge point for an effluent as defined under the Metal Mine Effluent Regulations (MMER) of the federal *Fisheries Act*. These Regulations enable the discharge of effluent to fisheries waters as long as certain conditions are adhered to. One of these conditions is that the effluent is non-acutely lethal as defined by a standardized trout toxicity test.

The proponent describes the process reagents used in the mill as non-hazardous (section 6.10.2, page 190). However, water treatment testing, as presented in Appendix 2. Table 20 describes the tested process water (mislabeled as Mine Water in the title) as acutely lethal. An acutely lethal effluent cannot be released to the environment.

Request:
The proponent should more fully investigate the source of the observed toxicity in the treated process water and identify how it would be mitigated at the site, including but not limited to the water treatment plant. The proponent should fully develop contingency plans to manage toxicity in wastewater, including routine testing of water throughout the treatment system so as to ensure that toxic effluent is not released.

IR Number: EC-12
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Potential treatment requirement for Radium -226 removal

Preamble:
Effluent from the Prairie Creek mine would be administered under the Metal Mining Effluent Regulations (MMER) of the federal *Fisheries Act*. These Regulations require, among other provisions, the monitoring of effluent for radium-226 concentrations. Should the effluent be of sufficient quality, this monitoring requirement could be reduced in frequency.

Some non-uranium mines have encountered elevated radium concentrations that required addressing. Radium-226 removal can require specialized water treatment. Often it is best accommodated by design from the start rather than retro-fitting a solution.

It would appear that the proponent has not assessed potential radium-226 in the effluent.

Request:
The proponent should assess the necessity for any radium-226 removal in the proposed water treatment plant.

IR Number: EC-13
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Site Water Balance

Preamble:
Water from divergent locations will be managed through the Water Storage Pond (WSP), with the exception of some site drainage reporting directly to the Catchment Pond. A key to properly sizing the WSP and associated water treatment plant, as well as managing the controlled release to Prairie Creek from the Catchment Pond, is a reasonable understanding of the site water balance. An overall understanding is needed of the long-term balance of inflows and outflows, and in the short-term handling of extreme or seasonal variations.

Section 6 presents the site water balance for summer and winter, reflecting the seasonal variation of inputs. Tables 6-18 and 6-19 graphically present the assumed flow volumes (rates) for the components. A summing of inputs for the summer flows indicates a net inflow into the WSP of about 8.4 liters per second. A similar calculation shows that the winter balance also has a net inflow to the WSP of 9 liters per second. These values do not consider any water added to the WSP as a consequence of Catchment Pond safety return. Although it is recognized that in a season water could accumulate in the ponds; typically, water over the course of the year should be net zero, with no net storage of water in the WSP.

Request:
The proponent should provide clarification on the operation of the WSP and any revised inflows and outflows for this key water management component. And in related matter, the proponent is required to revisit its “event” water management plan to confirm the statement that extreme runoff and precipitation events could be accommodated in the WSP and related catchment ponds at the waste rock pile and underground sumps.

IR Number: EC-14
Source: Environment Canada/DFO
To: Canadian Zinc Corporation

Subject: Total Dissolved Solids within Prairie Creek

Preamble:
Canadian Zinc Corporation has estimated the total loads of zinc, cadmium and sulphate concentrations from treated mine water and process water into Prairie Creek, however, did not provide estimates for total dissolved solids (TDS) and total suspended solids (TSS). CZN did predict that the magnitude of the TDS loads would be similar to the predictions made for sulphate (approximately 50 tonnes annually). Later in the DAR, specifically in Section 8.6, CZN concluded that treated water and discharge from the catchment pond are expected to have low suspended sediment levels.

Request:
1) Provide the predicted TDS and TSS loading into Prairie Creek.
2) Provide the expected impacts to the receiving environment from an increase in TDS and TSS loads
3) Assess the impacts to the aquatic ecosystem from an increase in the TDS and TSS loads to Prairie Creek and describe mitigation measures.

IR Number: EC-15
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Spill Contingency Plan

Preamble:
CZN has provided a spill contingency plan for the current maintenance status of the mine site. The DAR indicates that a large quantity of sulphuric acid will be transported along the access road. Sulphuric acid is highly soluble and can rapidly decrease the pH in a receiving environment.

Requests:
1) Contingency for acid spills

On page 266 of the DAR, it is indicated that "great care and precautions will be taken to limit the potential for spills and leaks during the acid transfer and storage".

a) Please identify all specific measures that will be taken to exercise "care and precautions" for all aspects of acid transfer and storage.
b) Please provide a spill contingency plan with the worst case scenario spill of acid during transport along the winter access road as well as on the mine site

2) For all types of spills

a) Please identify the procedures that would occur if there was a spill on the access road, including preventative measures, how equipment and resources would be mobilized to site in case of a spill, mitigation measures, etc.

Under section 5.2.1 of the access road protocols provided in Appendix 28, it states that "any significant fuel spill will be reported to the environmental and minesite manager."

b) Please quantify a "significant fuel spill".
c) Please confirm that spills that are not fuel will also be reported.

3) Materials not amenable to landfarming

How will contaminated materials such as gravel and rocks be remediated and disposed of?

IR Number: EC-16
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Sewage treatment plant effluent quality

Preamble:
Monitoring of sewage effluent is proposed to be done monthly, and only for ammonia and nutrients. The DAR states in Section 6.18 that "monitoring need not be frequent. …Other constituents are not of concern because of the residence time and dilution in the WSP." The DAR also states that effluent targets are <20 mg/L for both TSS and BOD_5.

The contribution of camp wastewater to the nutrient loading may also have been underestimated as the sewage effluent has been discounted as a source of phosphorus, which tends to be a key limiting nutrient in productivity of oligotrophic waters in the North. It will be important to fully characterize the camp wastewater both for system operation and for tracking of nutrient loading, so that appropriate management response can be actioned.

Request:

1. How will an understanding of the treated effluent quality be gained in order to track and optimize performance of the sewage treatment system?

IR Number: EC-17
Source: Environment Canada
To: Canadian Zinc Corporation

Subject: Fuel Storage Tanks

Preamble:
On June 12, 2008 new regulations governing storage tank systems were enacted (*Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations*). These regulations were enacted to reduce environmental risks associated with the storage of fuels and allied products.

Requests:
How will the project comply with the *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations*?

IR: INAC01

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated/Robertson Geotechnical Consulting Limited

Subject: Water – Hydrology – Groundwater

Preamble: The issue of ground water interaction between the Main Quartz Vein (MQV), Harrison Creek Alluvial Aquifer (HCAA) and the Prairie Creek Alluvial Aquifer (PCAA) essentially affects every aspect of the water management of the site, specifically, storage capacity of the Water Storage Pond (WSP), metal and ion loads (water quality), water level of the surface creeks, and the calculation of the water quality parameters. As such, it is critically important to understand the potential variability in the predicted volume of mine water. Unfortunately, it is not realistic to determine the actual flow rate of the mine until it has been mined. In order to deal with this situation the hydrogeology report (Appendix 1) provides 'low flow scenarios' and 'high flow scenarios'. These different scenarios are models that are generally meant to give an idea of the range of flows that can be expected. The hydrogeology report states that 'Significant uncertainty remains about the effective transmissivity of the vein fault (MQV)' (p- e-2) and 'No current information on the hydraulic properties of the vein fault extending beyond immediate limits of the MQV'. Using the different flow rate scenarios (low and high) the predicted flow rates from the mine towards the end of mine life were calculated to range from 2,500 m3/ day (29 L/s) for low flow to 18,000 m3/day (200 L/s) for the high flow scenario (hydrogeology report p-34).

Request:

1. Since Canadian Zinc Incorporated/Robertson Geotechnical Consulting Limited provided low and high flow rates, what is the most likely average annual flow rate?
2. What is the level of certainty surrounding the low, high and average annual flow rate (ie. percentage above or below expected)?

IR: INAC02

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated/Robertson Geotechnical Consulting Limited

Subject: Water – Hydrology – Groundwater

Preamble: Section 6.16.2 (DAR p-211) states that 'They [Robertson Geotechnical Consulting] conclude that inflows of up to 100 L/sec as an annual average (8,640 m^3/day) are possible. Therefore, CZN has developed a water management plan for this flow, with contingencies should a greater flow occur.' However, the water balance model (DAR Figure 6-18) indicates a mine flow of 50L/s (annual average flow).

The use of annual average flow when determining water balance does not account for periods of high flow. Certain times of the year are likely to have much higher flows. The capacity of the Water Storage Pond is 220,000 m^3 (pers. Comm. David Harpley). Using the flows provided in the hydrogeology report (see preamble INAC01) of 200 L/s (18,000 m3/day) to represent higher flows, the Water Storage Pond would have capacity for just over 12 days, assuming the Water Storage Pond is empty. The fact that the highest flows will likely come in the spring when the Water Storage Pond is not empty is a reason for concern. (See Parks_Canada_40 and Parks_Canada_41, as well.)

Request:

1. Demonstrate that the Water Storage Pond has the capacity to deal with periods of high flow.
2. Alternatively, demonstrate that the Water Treatment Plant capacity would be sufficient to effectively treat the high flow scenario, including providing calculations that demonstrate plant capacity to accommodate high flow scenarios.

IR: INAC03

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated/Robertson Geotechnical Consulting Limited

Subject: Water – Hydrology – Groundwater

Preamble: The hydrogeology report highlights the hydrological connection between the MQV, Harrison Creek Alluvial Aquifer (HCAA) and the Prairie Creek Alluvial Aquifer (PCAA). Although there is some uncertainty about the volumes concerned, it is clear that dewatering of the mine working (particularly at depth) will create a drawdown cone of influence around the mine workings. This cone of influence will draw down the water in the HCAA. The hydrogeology report also points out that the HCAA recharges the PCAA in the mine area.

Site water quality objectives consider the seasonal variation in flow rates to determine the in stream flow concentrations within Prairie Creek.

Request:

1. What will be the predicted effect of mine dewatering on the HCAA and the PCAA?
2. Provide calculations to demonstrate if there is the possibility of reduced flows in Harrison Creek and Prairie Creek?
3. Provide details for the calculation of the in stream flow concentrations should flows be reduced?
4. Demonstrate that flow rates would not be reduced from the dewatering of the HCAA such that it affects the ability of Prairie creek to handle effluent discharge?

IR: INAC04

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated

Subject: Water – Groundwater/water quality

Preamble: One of the potential sources of contaminants to the aquifers is loss or seepage through the mine and ditch system itself. In order to reduce this input CanZinc should use insulated heat trace piping along the existing ditch system to minimize seepage/leakage of the ditch system.

Request:

1. Provide details for how leakage from the mine and ditch system into the groundwater will be minimized?

IR: INAC05

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated

Subject: Water – Hydrology – Groundwater

Preamble: The mine footprint is on the Prairie Creek Alluvial Aquifer (PCAA). The aquifer in this area is very shallow. The Water Storage Pond (WSP) and catchment pond have been dug into the aquifer thereby connecting them hydrologically to Prairie Creek. It is critical that water does not seep through the proposed liner into the ground water and ultimately enter Prairie Creek. As a solution to this problem CanZinc has proposed to place liners in both the WSP and the catchment pond. The liners should be built in a way that will allow for them to be monitored should a leak(s) develop (potentially an instrumented double liner with sand between the layers).

Request

1. If a leak was to develop, the pond would presumably have to be drained. How would this be done?
2. What is the estimated time to order replacement parts and make the repair?
3. How would the mine and process water be managed during this time?

IR: INAC06

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated

Subject: Water – Water Quality – Water Quality Objectives

Preamble: Section 8.6.1 (DAR p-272) states that 'It is clear from the modelling that a simple list of parameter concentrations that site discharge should not exceed will not be practical because of the seasonally large range of fluctuation in creek flows. To provide the greatest capacity for site discharge, and still minimize receiving water parameter concentrations, a different regulatory approach will be required.'

The purpose of water quality criteria is to be protective of the environment. Therefore a water quality objective is calculated to determine the concentration at which the aquatic environment will not be significantly impacted. That concentration is then back calculated to provide the water quality criteria which must be met at the end of pipe (last point of control). This is the concentration which has been determined to be acceptable to not cause significant impacts to the environment. If levels exceed the Water Quality Objectives then it is considered to cause significant impact and cannot be released into the environment.

The capacity of Prairie Creek to meet these levels may change seasonally. Prairie Creek may be able to accept more treated effluent in the spring and summer and still meet the Water Quality Objectives. The volume of discharge will change seasonally, but the concentration of the effluent at the end of pipe will remain the same. If the concentration of the effluent at the end of pipe cannot be met then it is either a capacity or a treatment issue.

Request:

1. Provide greater detail on the discharge plan.
2. Outline in detail the type of changes to the regulatory approach Canadian Zinc sees being required.

IR: INAC07

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated/Robertson Geotechnical Consulting Limited

Subject: Water – Water Quality – Surface Water

Preamble: Appendix 1 Hydrogeology Report (p-21); 'Water samples collected from the flooded decline indicate that ground water contains no detectable levels of dissolved Zinc, but higher concentrations of Fe, SO_4, alkalinity and major cations than ground water from other sections of the bedrock aquifer.'

Appendix 3 p ii; 'Elevated metals may result as indicated by laboratory results described herein. Parameters of particular note include SO_4, As, Sb, Cd, Pb and Zn, and to a lesser extent also Cu, Se, Hg and Ag.'

The site specific water quality guideline report does a good job defining the water quality guidelines (WQG) for the presumed metals of concern in the mine water. There are a number of additional parameters, including some non-metals that will likely increase due to mining practices such as blasting and processing. The concentrations of Fe, As, Sb, Ag, SO_4, alkalinity, phosphorous, ammonia (nitrates) have the potential to increase. The proponent has not provided site specific WQGs for the additional constituents. (See also Parks_Canada_45.)

Request:

1. Site specific guidelines should be calculated for parameters such as but not limited to; Fe, As, Sb, Ag, SO_4, ammonia, nitrate, nitrite, and phosphorous. This should include a calculation of their expected in stream concentrations.
2. Describe how each of these parameters will be addressed/mitigated should they rise above guideline levels?

IR: INAC08

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated

Subject: Water – Water Quality – In stream

Preamble: The Development of Site Specific Water Quality Guidelines for Prairie Creek Report (SSWQGR) Table 4 lists the expected in stream concentrations of metals. The concentrations are based on the mean monthly average over a 16 year period. The values listed in the table are below the calculated site specific guidelines, however there is little margin for error as the numbers are very close. Long term minor changes in flow, such as draught or draw down of the aquifer(s) could potentially effect the in stream concentrations. The 16 year average is unlikely to represent the actual flows throughout the mine life. Selecting the lower flow years would better represent a more conservative approach. The flow rates should not be calculated with the mean values.

Request:

1. Provide information for the in stream concentrations of metals using an accepted estimate of probable low flow? (Also see Parks_Canada_46(1).)

IR: INAC09

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated

Subject: Water – Water Quality – Water Treatment

Preamble: Section 8.3 Table 8-5 (DAR) lists the predicted water quality parameters for both treated mine and process water. Many of the parameters of interest are above CCME guidelines after treatment.

Parameter	Treated Mine Water	Treated Process Water	CCME
Arsenic	0.0028	0.0018	0.005
Cadmium	0.00001	0.0262	0.000017
Lead	<0.0002	0.0932	0.007
Phosphorous	0.17	0.721	0.004
Zinc	0.017	0.039	0.030

*Units were not mentioned in Table 8.5 but appear to be in mg/l.

Cadmium, lead and zinc are addressed in the Site-Specific Guidelines Report. Curiously, mercury and nitrate are missing from Table 8.5. The treated concentration of mercury is not listed in Table 8.5, but an in stream concentration is listed for mercury in Appendix 7 Table 4. Appendix 2 Table 6-7 lists tailings water quality from metallurgical testing. The table lists total mercury at 0.069-0.183 mg/l and dissolved mercury at 0.47-0.62 mg/l. These numbers are very high. The CCME guideline for inorganic mercury is 0.000026 mg/l and methyl mercury is 0.000004 mg/l. (See also Parks_Canada_33.)

Request:

1. How was the estimated in stream concentration for mercury calculated if there is no value for treated concentration?
2. What will the mercury concentration after treatment be for both mine and process water?
3. Provide assurances that mercury will not pose a long term water quality issue?

IR: INAC10

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated

Subject: Water – Water Quality – Nutrification

Preamble: Nitrogen (ammonia, nitrate, and nitrite) is a major by product of blasting residues. It is also a nutrient in aquatic systems. At higher concentrations, and in certain forms, it can be toxic. Phosphorous, another major nutrient, will be present in the process and mine water (DAR Table 8.5). Prairie Creek has been defined as a pristine low nutrient system. As such, the addition of nutrients is of concern. When discussing nutrient additions into an aquatic system it is important to consider nitrogen's relationship with Dissolved Oxygen (DO). Generally, as nutrient levels increase biological activity increases, this growth and decomposition consumes oxygen (O_2). Low DO conditions can impact fish and other aquatic organisms. (See also Parks_Canada_34.)

Request:

1. What will the in stream concentrations of nitrogen and phosphorous be entering the system?
2. What impact will the nutrient concentrations have on the aquatic system from both a nutrient and toxin perspective? Provide these calculations using expected worst case conditions of low flow and low DO.

IR: INAC11

Source: Indian and Northern Affairs – Water Resources Division

To: Canadian Zinc Incorporated/Robertson Geotechnical Consulting Limited

Subject: Water – Hydrology – Groundwater

Preamble: The Environmental Assessment is in place to determine the potential significance of a Project. The DAR in general and Section 8 in particular, does not really address significance in a systematic way. As the EA moves forward a framework for significance should be discussed.

Request: Provide a framework outlining how the different levels of significance will be determined (ie. negligible, low, medium, and high). The outline should include Magnitude, Duration and Geographic extent.

Canadian Zinc Corporation
Prairie Creek Mine

Fisheries and Oceans Information Request

IR Number:	**DFO_01**
Source:	**Fisheries and Oceans Canada**
To:	**Canadian Zinc Corporation**
Subject:	**Nutrient Loading**
DAR Section:	**4.7.4 – 2006-2008 Aquatic Studies (p. 106)**
ToR Section:	**3.2.4 item 6** **3.3.2 item 1 (b-c) and 4 (e);** **3.3.3 item 3b;** **3.3.5 item 2(b-c);**

Preamble:
As stated in section 4.7.4 of the DAR, Prairie Creek is considered to be a naturally oligotrophic stream (having low productivity) and could be sensitive to any additional loading of nutrient into the system. It was also discovered that "*more species of algae were found at high-exposure sites as compared to low-exposure and reference sites*" (Spencer et al., 2007) which may indicate that a mild nutrient enrichment has already occurred due to historic mine site discharge and phosphate residue in camp sewage.

Algae communities may vary considerably within river reaches in relation to current velocity, depth, light intensity, and water chemistry factors. Mild nutrient enrichment could cause an increase in algae growth and could affect the levels of available dissolved oxygen, in part of the creek, for aquatic organism and fish.

Request:

1) Based on existing data, provide a map of the locations where increases in nutrient levels have been observed downstream from the mine site within Prairie Creek. This data could be used to determine sensitive areas as part of a monitoring program.
2) Assess the potential impacts on aquatic organisms, including fish and fish habitat, due to potential increases in nutrient loading into the system and provide mitigation measures, where appropriate.

IR Number: **DFO_02**
Source: **Fisheries and Oceans Canada**
To: **Canadian Zinc Corporation**
Subject: **Source of Aggregate for road construction and maintenance**
DAR Section: **6.13 – Aggregates (p. 200)**
ToR Section: **3.2.5, item 13 and 21;**
3.3.5 item 2 (a and d)

Preamble:
The Terms of Reference require the proponent to provide a description of the development which includes:

> *13) Locations (s) and proposed activities of aggregate production and storage, with an estimate of the amount of aggregate that will be produced per year over the life of the mine, by locations; and*
> *21) All existing or proposed access roads required for the Prairie Creek Mine, with particular emphasis on the winter road, including analysis of necessary one-time improvements, initial and annual construction techniques, proposed water crossing types by location and amount of water and other materials required.*

In Section 6.13 of the DAR, it states that aggregate materials will be required in order to build and maintain the Mine site and access roads, but specific locations have not yet been provided. The proponent also states that "*possible sources of gravel <u>may</u> exist outside of the stream and riparian zone*".

Request:

1) Provide the exact locations of aggregate sources required for the construction and maintenance of Mine site and access roads.
2) Confirm that these sources of aggregate will not be situated in river beds or within the high water mark of the alluvial fans.

IR Number:	**DFO_03**
Source:	**Fisheries and Oceans Canada**
To:	**Canadian Zinc Corporation**
Subject:	**Diffuser**
DAR Section:	**6.16 – Water Management System (p. 208 and p. 216-217)**
ToR Section:	**3.2.5, items 15-16;**
	3.3.2 item 3c and 4b

Preamble:
The Catchment pond is the last control point in the water management system for the mine site and collects water from the site runoff ditches, mine water and the water treatment plant prior to release to the environment. Canadian Zinc Corporation is proposing to discharge the water from the Catchment pond via diffuser into Prairie Creek.

Request:

1) Provide the location and conceptual design, including details on the anchoring and footprint of the diffuser in Prairie Creek.
2) Specifics on fish use and type of habitat within the area of influence from the construction and operation of the diffuser.
3) Describe the methods for the installation, maintenance and subsequent decommissioning of the diffuser and any mitigation measures necessary to reduce disturbances to substrate and mobilization of sediment.
4) Assess the potential impacts downstream, including changes to the flow regime in the river, any potential disturbance of the sediment and any degradation of downstream habitat as a result of velocities (i.e. creation of scour holes, etc).

IR Number: **DFO_04**
Source: **Fisheries and Oceans Canada**
To: **Canadian Zinc Corporation**
Subject: **Construction of Winter Road - Water withdrawal**
DAR Section: **6.22 – Access Road Water Management (p. 230)**
ToR Section: **3.2.5, item 21**

Preamble:
Canadian Zinc Corporation will require water in order to construct even road beds and to build snow and ice fills at stream crossings. The road will be constructed on seasonal basis and will require maintenance throughout the operational period. Water withdrawals from nearby sources will be required. CZN has not identified the locations and volumes of the water needed for the construction and maintenance of road, and have only stated that they will be using local sources, "*such as lakes*".

Request:

1) Identify the exact locations and volumes of water required for the construction and maintenance of the access road. It should be noted that details regarding the proposed water sources, bathymetric survey results as well as the calculation of the total available water volume under ice of each source will be required. Please refer to DFO's updated water withdrawal protocol for waterbodies (June 2010).

IR Number:	**DFO_05**
Source:	**Fisheries and Oceans Canada**
To:	**Canadian Zinc Corporation**
Subject:	**Access road – Erosion, Runoff and Extreme Events**
DAR Section:	**4.4.1 – Watershed Surface Water (p. 81)**
	9.3.2 – Access Road (p. 292)
	10.1.2 - Potential Impacts and Mitigation (p. 300-301)
	10.2.5 – Best Management Practices (p. 307)
ToR Section:	**3.3.2 item 8a and 9b**
	3.3.4 item 1 (a)
	3.3.5 item 4 and 5

Preamble:
Based on the data from the hydrometric stations located on Prairie Creek, the highest monthly flows occur during May to September, with the peak flow being in June at the same time as freshet. The annual low flow month is typically in March when flows are approximately 50 times less than in June. Despite these seasonal fluctuations, extreme events such as intense summer rainfalls can also create peaks in flow. The Developer's Assessment Report (DAR) mentions that two such events occurred in July 2006 and August 2007, where a considerable amount of erosion was observed on the stream banks and along the access road. Although these extreme events may not be common, erosion of stream banks or washouts of the access road could increase the amount of sediment entering waterways adjacent to the access road. Since Nahanni Formation is already naturally susceptible to erosion and/or dissolution by surface and ground waters, additional measures should be taken to avoid additional erosion and runoff due to extreme events.

CZN has also concluded that the risk of significant erosion and sedimentation is low along the access road based on their proposed crossing methods and the minimal amount of disturbances to the terrain. However access roads require maintenance, such as grading, gravelling or sanding to provide traction on inclines, crossings, etc. Few specifics have been given on mitigation measures to ensure that these activities will not increase deposition of sediment within the watercourses.

Request:

1) During extreme events
    a. Please describe how the new proposed alignments of the road will be constructed to ensure that it can withstand extreme events, including reduce the likelihood of washouts, slumping and erosion.
    b. Identify vulnerable sections of the existing road, and describe measures necessary to prevent further erosion.
2) Describe monitoring activities for the access road to ensure effective sediment and erosion control measures are employed and that the road will not be a

sediment source to the adjacent watercourses during the construction, operation, temporary closure in the summer and during extreme events.

3) Section 10.2.5 under Best Management Practices suggests that there is "little to no opportunity to mitigate [possible unknown impacts to incubating Bull Trout eggs in Funeral Creek]". CZN should be aware that Funeral Creek is the only known location of spawning Bull Trout in the NWT, and that the species is listed as *May be at Risk* under the Government of the Northwest Territories listing. Special care must be taken along this creek to ensure that all impacts are fully mitigated. Please provide specifics on how CZN will ensure that Bull Trout are not affected by activities along the access road, with special focus on the stretches along Funeral creek.

IR Number:	**DFO_06**
Source:	**Fisheries and Oceans Canada**
To:	**Canadian Zinc Corporation**
Subject:	**Groundwater Discharge to Prairie Creek**
DAR Section:	**8.3 – Discharges during Operations (p.267); Appendix 1**
ToR Section:	**3.2.4 item 4 and 7** **3.3.5 item 2a**

Preamble:
CZN has identified that a cone of groundwater level depression around the Mine will occur as a result mining operations. Bull Trout have a strong association with groundwater discharge, often locating spawning redds in areas of groundwater upwellings. These areas are important for incubation of eggs, emergence and survival of juveniles. Over-wintering habitat is also associated with areas of groundwater upwellings.

Request:

1) Identify areas within Prairie Creek, near the mine site, where groundwater discharges to the surface.
2) Provide predicted impacts to the Bull Trout, during their various life stages, as a result of potentially removal of groundwater upwellings within Prairie Creek.
3) Provide mitigation measures to reduce or eliminate impacts to Bull Trout.

IR Number: **DFO_07**
Source: **Fisheries and Oceans Canada**
To: **Canadian Zinc Corporation**
Subject: **Waste Rock Pile – Land Fill area**
DAR Section: **6.12.1 - Waste Rock and DMS Rock;**
ToR Section: **3.2.4 item 4**

Preamble:
Canadian Zinc Corporation is proposing to locate their WRP in a valley that drains into Harrison Creek. Drainage ditches will be constructed around the WRP to divert clean upslope runoff around the WRP. Seepage from the WRP will be collected in the seepage collection pond and transported by pipeline or borehole into the water management system.

Request:

1) How is CZN intending to prevent mobilization of sediment carried by the drainage channels during construction, operations and closure?
2) At closure, how will seepage from the waste rock pile be managed, so that impacts to Harrison or Prairie Creek do not occur?

IR Number:	**DFO_08**
Source:	**Fisheries and Oceans Canada**
To:	**Canadian Zinc Corporation**
Subject:	**Access Road - Fish Habitat Assessment**
DAR Section:	**9.3.2 – Access Road, p. 292** **Appendix 14 - Winter Road Re-Alignment Stream Crossing Fish Habitat Assessments**
ToR Section:	**3.2.4 item 7** **3.2.5 item 21 and 22** **3.3.5 item 4**

Preamble:
The existing access road and the four proposed alternative routes cross a number of creeks and rivers, but specifics on crossing structures or types have not been provided. DFO routinely reviews these types of activities to determine if *Fisheries Act* Authorizations may be required, especially if there is a potential for impacts to fish and fish habitat. It should be noted that for certain crossing methods and structures, such as fording and the installation of culverts, can result in harmful alterations, disruptions or destruction of fish habitat, and will need to be reviewed individually. It should be noted that CZN indicated in the DAR that DFO's Operational Statement for culvert installation will be followed but no such operational statement exists.

DFO noticed a discrepancy in CZN's findings in Appendix 14, where a large number of streams were deemed to support fish and provide fish habitat, while the DAR indicated that only Polje and Fish Trap Creeks provide fish habitat. DFO also noticed that several crossings have not been assessed for fish and fish habitat and of those assessed, most were done aerially.

Request:

1) Please provided additional details on each water crossings as per DFO's *Proponent's Guide to Information Requirements for Review Under the Fish Habitat Protection Provisions of the Fisheries Act* (http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14155 /requirements-exigences/pdf/index-eng.pdf)
2) On page 303 of the DAR, CZN indicated that they intend on fording some of the crossings along the access road. DFO strongly recommends that CZN consider proper crossing structures, such as a clear span bridge. Fording of watercourses can release sediments downstream, destabilize the channel, bed and banks of the stream, and is detrimental to various life stages of fish, particularly the fall spawners whose eggs will be incubating throughout the winter. Please provide the following details:
    a. Fording locations;

   b. fish and fish habitat assessment, mitigation measures and predicted impacts at those locations;
   c. prediction of the number of trucks crossing at those locations per day; and
   d. assessment of other alternatives, if fording has been selected as the preferred option.

3) In order to better predict impacts on fish and fish habitat along the access road, please provide a table containing the following:
   a. each crossing location with latitude and longitudes,
   b. proposed crossing structure and size;
   c. where DFO Operational Statements will be used (i.e., snow fills and ice bridges).
   d. methods for installation and mitigation measures taken to reduce or eliminate impacts to fish and fish habitat.
4) CZN has identified that snow fills and ice bridges will be used to cross many of the smaller streams. Integrity of the banks will be dependent upon the climatic conditions, (i.e. if the banks are frozen or not). If the banks are not frozen and cannot support the weight of trucks and other heavy equipment, the stability of the banks may be compromised and result in sedimentation of the creeks. Annually what criteria will CZN use to determine when the environmental conditions are suitable and will be in compliance with DFO's Operational Statements, especially timing for building snow fill and ice bridges?

IR Number: **DFO_09**
Source: **Fisheries and Oceans Canada**
To: **Canadian Zinc Corporation**
Subject: **Closure and Reclamation Plan**
DAR Section: **Appendix 27 - Preliminary Closure and Reclamation Plan**
ToR Section: **3.5**

Preamble:
Appendix 27 provides initial considerations for closure and reclamation of the CZN mine site including closure objectives and activities. DFO noted that some of the activities described may impact fish and fish habitat, particularly those associated with reclamation of the Funeral Creek portion of the access road.

CZN should be aware of the draft document *Approach to Closure and Reclamation for Mines within the Mackenzie Valley* found at (http://www.mvlwb.ca/WGDocs/DRAFT_Closure_and_Reclamation_Guidelines-Jun15-09.pdf). Particular attention should be paid to Appendix 3. This document is a work in progress between INAC and the Land and Water Boards, however contains the current expectations of all stakeholders in the North for Closure and Reclamation.

Requests:

1) Under section 3.9, Off-Site Infrastructure of Appendix 27, it states that one of the objectives is to "*Modify Funeral Creek road bed to promote stable long-term runoff.*"
    a. It is indicated that the road will be "*given a gentle slope towards the creek*" to prevent channel formation and erosion on the road bed. What measures will CZN take to prevent sediment from entering the creek?
    b. How will the road bed and culverts be removed, so that Funeral creek and the residing Bull Trout population are not impacted?
    c. It is indicated that "*Coarse material or organic material will be placed along the bed adjacent to the creek to prevent sediment discharge until vegetation has established.*" Please confirm that materials will be placed on the road bed and not the bed of Funeral creek. No material should be placed below the normal high water mark of any watercourse and that organic material must be stabilized (i.e. use of fibrous matting) while vegetation is establishing.
    d. How will CZN ensure that Bull Trout and their habitat are not impacted by the proposed closure activities?

IR Number: **DFO_10**
Source: **Fisheries and Oceans Canada**
To: **Canadian Zinc Corporation**
Subject: **Monitoring and Management Systems**
DAR Section: **10.7 – Monitoring and Management Plans**
ToR Section: **3.2.5 item 21**

Preamble:
In mining projects there is typically a number of monitoring programs that are required to verify the predictions of the environmental assessment, to determine the effectiveness of mitigation measures and to provide early warning signs should impacts that were not predicted or were greater than predicted become apparent. When developing these programs, CZN should be aware of the AEMP guidelines that have been developed by INAC.

Requests:

1) Please provide an outline of the Environmental Effects Monitoring (EEM) program and describe how it will be integrated with the Aquatic Effects Monitoring Program (AEMP).
2) As stated in previous IRs, provide an outline of a monitoring program designed to ensure the effectiveness of sediment and erosion control methods for the access road.

IR Number: **DFO_11**
Source: **Fisheries and Oceans Canada**
To: **Canadian Zinc Corporation**
Subject: **Impact Assessment - Fish and fish habitat**
DAR Section: **10.2 – Fish and Aquatic Habitat (p.302); Section 7.0 of the Addendum**
ToR Section: **3.3.1**

Preamble:
A number of terms were used to assess and characterize impacts to fish and fish habitat but in some cases they are too vague and need further elaboration.

Request:

1) Please provide more details on the "thresholds" used to assess the magnitude of impacts on fish and fish habitat in order to better understand the difference between low, moderate and high ranking.
2) Please provide more details around how rankings were given in Table 5 in the Addendum, page 13 under Section 7.2.
3) Accidents and malfunctions listed in Table 5 of the addendum (page 13) should be broken into two pieces: the mine site and the access road. Time for response along the access road may be quite different than around the mine site. Factors such as this will likely affect the classification within the categories of geographic extent, duration, frequency, variance and reversibility and should be reflected and adequately described.

IR Number: NRCan 1

Source: Natural Resources Canada – Minerals and Metals Sector

To: Canadian Zinc Corporation (CZN)

Subject: The requirement for an explosives factory on-site.

Preamble

NRCan's understanding of the proposal, during the review of the Terms of Reference, was that an explosives factory was not a component of the proposed mine plan. Rather, we understood that CZN planned to rely on packaged explosives to be stored in on-site magazines permitted through the Government of the Northwest Territories Workers Compensation Board. NRCan thus advised the Board that we did not expect to be a "Responsible Minister" under the Mackenzie Valley Resource Management Act (MVRMA).

In reviewing the DAR however, we have noted the following:

- Section 6.3.13 - Explosive Magazine "The economics of an emulsion plant on site verses transporting explosives will be investigated."

- Section 6.8 - Explosives "CZN will consider the viability of an emulsion explosives plant for the production stage."

The manufacture of explosives is regulated by the federal *Explosives Act*, administered by NRCan's Explosives Regulatory Division. An identified future need for a factory licence for the project may change whether NRCan is considered to have 'jurisdiction in relation to the development under federal or territorial law' under the MVRMA.

Requests

(1) CZN has been requested to provide additional information on the whether a factory to manufacture explosives is likely to be required at or near the site.

(2) If CZN has determined that a factory to manufacture explosives is likely to be required, then NRCan typically recommends that the following information be considered in the environmental assessment:

- Explosives to be manufactured.

- Maximum quantity of explosives at each facility.

- Specified location (i.e., detailed site plan), with distances to vulnerable features such as dwellings, roads, camps, railways, bodies of water, etc. Infrastructures

should be identified and include: explosives and detonator magazines, fuel storage, ammonium nitrate storage, maintenance/wash area, process trucks and their parking area, any offices, warehouses, buildings, etc. The proponent needs to demonstrate that safety distances required by the Explosives Regulatory Division of NRCan have been considered and met.

- Fuel and ammonium nitrate storage plans. Storage of ammonium nitrate is to be in conformance with ERD guidelines.
- Liquid effluent disposal plans.
- Evaluation of worst case scenario (i.e. accidental explosion).
- Spill contingency plans.
- Details on any temporary explosive facilities to be used for starting the project must be provided, giving the same information requirements above.

IR Number: NRCan 2

Source: Natural Resources Canada – Minerals and Metals Sector

To: Canadian Zinc Corporation

Subject: The feasibility of using paste backfill for underground tailings disposal for the Prairie Creek Mine.

(NB – The Board is also directed to Parks Canada IRs #27, #28 and #30 requests related to sub-items 3, 7 an 8 below)

(1) *Preamble*

It is proposed that the backfill will be made up of filtered tailings (FPT), float rock from the mill – dense media separation aggregate (DMSA), and cement. DMSA was not available for the laboratory testing performed in 2005 and therefore a dolomite limestone sourced from Manitoulin Island in Ontario was crushed and the fines washed out to simulate the DMSA.

Request

A plan for Unconfined Compressive Strength (UCS) testing incorporating the actual DMSA material should be provided.

(2) *Preamble*

Chemical and mineralogical compositions for the FPT are provided, however those for the DMSA are not.

Request

Chemical and mineralogical compositions for the DMSA should be provided.

(3) *Preamble*

UCS testing of the paste backfill was conducted up to 28 days of curing. Since underground disposal as paste backfill is planned to be a long-term storage method for the tailings, longer term strength as well as consolidation of the material is important to determine.

Request

A plan for long-term UCS testing, up to a minimum of one (1) year should be provided.

(4) *Preamble*

The number of samples tested for UCS and individual variability of the UCS results were not provided.

Request

The detailed results of the UCS testing program to be provided, including individual sample results, calibration reports for equipment used, as well as details of the materials used in the mix recipes to prepare the UCS samples.

(5) *Preamble*

The UCS testing was conducted without the addition of flocculants.

Request

If addition of flocculants is planned, a plan for UCS testing incorporating flocculants should be provided.

(6) *Preamble*

The details of the water used for sample preparation for UCS testing were not provided.

Request

A plan for UCS testing incorporating Prairie Creek Mine process water should be provided.

(7) *Preamble*

The details of the cement used for sample preparation for UCS testing were not provided. It was also stated that a combination of cement, slag, and fly ash may be used as the binder.

Request

Either a plan for UCS testing incorporating the cement available at the Prairie Creek Mine location, or the details of the cement used showing its characteristics are the same as that available at the Mine location, should be provided. It is further requested that a plan be provided which includes the likelihood of using alternative binder materials (such as slag and fly ash) as well as UCS testing plan incorporating those alternative materials.

(8) *Preamble*

Since the UCS testing done to date was for a feasibility study, it was limited in scope.

Request

To conduct a proper optimization of the backfill mix recipe, numerous further tests are required to ensure the proper strength required for the excavations will be achieved. It is requested that a detailed plan of the future UCS testing, with the aim of optimizing the binder content and composition, be provided.

(9) *Preamble*

The particle size distribution of the tailings was conducted on those provided, assuming that the same grind can be expected in a full scale plant.

Request

A plan for particle size analysis of the tailings produced from the full scale plant should be provided. As backfill properties will vary with varying particle size, it is important to use a representative sample of the tailings.

IR Number: NRCan 3

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation (CZN)

Subject: Earthquake hazards

Preamble

It is clear that the proponents are aware of the earthquake history of the region, the current National Building Code of Canada (NBCC) seismic provisions, and current seismic databases. There are numerous references to the 1985 Nahanni earthquakes (M 6.6 and 6.9) that occurred about 80 km from the mine site. The proponents note that "mine site did not appear to suffer any significant consequences" during those earthquakes. This is important and valid information. However, stronger shaking (a larger or closer earthquake) cannot be ruled out in the future, and hence a thorough seismic hazard assessment should be performed at this site. Underground storage of all tailings from the mill is noted – this certainly minimizes any risk from future earthquakes in the long-term. In this proposal, seismic hazard during the operation phase of the Prairie Creek Mine and the stability of the "Water Storage Pond" will likely dominate the seismic risk assessment. For example, if the flood protection berm failed, and if water flooded the mine site, are there life-safety issues? Will the water retention system utilize the provisions in the 2005 Dam Safety Guidelines? Also, any site infrastructure the falls under the building code provisions should be designed to the current standards (2005NBCC or equivalent). Details on all aspects of the seismic hazard assessment and proposed mitigation measures need to be provided.

Requests

(1) DAR – Main Volume "Site Infrastructure" (p. 20) "The existing buildings will be upgraded and modernized. New facilities will include a kitchen/accommodation block, concentrate shed, power generation units, and an incinerator."
Question: Are any of the existing buildings engineered structures? Will any of the new facilities be engineered structures? If so, what building code standards have been used / or will be used?

(2) DAR – Main Volume Section 4.12.1 "Seismic History" (p. 136) "The Prairie Creek Mine site was constructed in 1980-1982 and did not appear to suffer any significant

consequences of the 1985 seismic events." (the M 6.6 and 6.9 earthquakes 80 km to the northeast of the mine site).
Question - What were the ground shaking levels estimated at the mine site during the 1985 events? Is there any evidence for active faulting near the site? A deterministic hazard assessment (in addition to the standard probabilistic hazard assessment) should be considered.

(3) DAR – Main Volume (p. 280) "Earthquakes: Earthquakes have occurred in the area previously (refer to Appendix 25), and since the Mine was originally built. No earthquake damage is evident in the berms and dykes. The structures have been inspected annually for 4 years and found to be stable. Recent geotechnical studies (see Appendices 12 and 18) by Golder Associates have confirmed the suitability of the structures for their intended purpose during normal conditions and during seismic events."
Question – what level of seismic design was used for the berms and dykes?

(4) DAR – Main Volume Section 8.8.3 WSP at Full Capacity (p. 280) "In addition to considering the potential for dyke and berm failures, it is also appropriate to consider the consequence of failures. If the flood protection berm failed, water from Prairie Creek could potentially flood the Mine site. There would undoubtedly be some damage to the accommodation block and other buildings, but there would be very limited impact in terms of contamination."
Question –Are there life-safety issues here? Will the Canadian Dam Association Guidelines (2005) be utilized?

(5) DAR – Main Volume (p. 318) "Future performance of the subject slopes during earthquake events cannot be determined with certainty, but the current evidence indicates that the likelihood of large rock slope failures occurring due to seismic activity is very remote."
Question – what was the estimated level of shaking in these areas during the 1985 Nahanni earthquakes and how does this compare to expected/possible levels of shaking during future earthquakes?

(6) DAR – Addendum (p. 15) "Geotechnical designs for mine site structures account for potential seismic events, and stability should not be significantly comprised should such events occur…."
Please provide details. What level of seismic hazard was utilized in the geotechnical design?

(7) (Refer also to IR NRCan 5 for a related request) Appendix 11 - Preliminary Design – Waste Rock Pile (p. 4). "During the 1985 earthquakes, significant vertical ground accelerations were measured (Wetmiller et al. 1988). A thorough review of the available seismic data should be undertaken to identify if additional considerations are warranted for final design and analysis."
Agreed. Question – will other potential seismic sources be considered? Is there any evidence for active faults closer to the mine site?

(8) Appendix 11 - Preliminary Design – Waste Rock Pile (p. 4). "For design options, the pseudo-static seismic analyses were completed using a ratio of horizontal pseudo-static acceleration to gravity (kh) of 0.125. This value represents roughly one half of the peak ground acceleration (PGA) determined for firm ground (NBCC 2005)."
Question - Why was a value that is one-half the PGA in code provisions used? This should be explained.

(9) Appendix 12 - Preliminary Design – Water Storage Pond (p. 7). "During the 1985 earthquakes, significant vertical ground accelerations were measured. A review of the available seismic data should be undertaken to identify if additional remedial considerations are warranted during the detailed design."
Agreed. Question – will other potential seismic sources be considered? Is there any evidence for active faults closer to the mine site?

(10) Appendix 12 - Preliminary Design – Water Storage Pond (p. 7). "For remediation and design options, the pseudo-static seismic analyses were completed using a ratio of horizontal pseudo-static acceleration to gravity (kh) of 0.125. This value represents roughly one half of the PGA determined for firm ground (NBCC 2005)."
Question – Why was a value that is one-half the PGA in code provisions used? (As noted above, this should be explained.) Is it appropriate to use the same coefficient for the "Water Storage Pond" as for the "Waste Rock Pile"? Is the material strength comparable?

IR Number: NRCan 4

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject of request: Deposit geology/mineralogy/structural geology

Preamble

A feasibility study usually precedes environmental applications and permitting. Such a study increases the understanding of the geology baseline as part of the description of the existing environment. Canadian Zinc Corporation mentions in the project description report of May 2008 (p.20) that Kilborn Engineering (B.C.) Ltd. completed a feasibility study in 1980 for mining the "Main Zone" area. Completion of the NI 43-101 report was done in 2007 (p.23).

Request

Provide information on more recent feasibility study done since the NI43-101 (2007) report, or any plans to update the NI43-101 (2007) report.

IR Number: NRCan 5

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject of request: Deposit geology/mineralogy/structural geology

Preamble

Canadian Zinc Corporation describes in the Prairie Creek Mine Developer's Assessment Report Section 4.11 Geology on pages 127 and 134 that the Prairie Creek area is folded and dissected by numerous faults and fracture zones. A good understanding of the regional and mine fault and fracture systems are critical for the mine development and seismicity evaluation.

Request

Provide any more information (if available) on the roles of the regional- and property-scale faults on the mineralization.

IR Number: NRCan 6

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject of request: Deposit geology/mineralogy/structural geology

Preamble

Canadian Zinc Corporation describes on page 36 of the Project Description Report and page 128 of the Prairie Creek Mine Developer's Assessment Report Section 4.11 Geology

the vein system that carries the mineral resource. Veins by their geological nature have a tendency to vary in width, thickness and length. More detailed information on the vein stock work might help delineate more ore underground and identify other similar vein system in the region.

Request

Provide, if known, any more information on the true width of the vein system at Prairie Creek. Provide more information, if available on the continuity of the vein system known underground and on the surface i.e., in terms of its width, thickness, and length, including any information on changes towards the north and south, and with depth.

IR Number: NRCan 7

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject of request: Deposit geology/mineralogy/structural geology

Preamble

Canadian Zinc Corporation describes on page 38 of the Project Description Report and page 128 of the Prairie Creek Mine Developer's Assessment Report Section 4.11 Geology, the strata bound mineralization, including apparent thicknesses. It would be helpful to have a better definition of the sulphide ore potential towards the north at depth and towards the south, i.e., between 50,100mN and 49,800mN, where exploration drilling is presently limited (see Figure 2-3, p. 36 of the Project Description Report).

Request

Provide any additional information (if available) on the strata bound zone, including the true thickness, its attitude and the structural relationship to regional faults, such as the HC and PC faults and other structures.

IR Number: NRCan 8

Source: Natural Resources Canada – Earth Sciences Sector

To: Canadian Zinc Corporation

Subject of request: Deposit geology/mineralogy/structural geology

Preamble

Canadian Zinc Corporation provides information on the chemical composition of the host rock on page 130 of Prairie Creek Mine Developer's Assessment Report Section 4.11 Geology. A brief summary of the chemical composition of the host rocks is provided, however, there is not enough information provided in this report on the chemistry of the sulphide ore and host rocks to have a clear understanding of the chemistry of the host rocks and ores. A summary table with the range of values may be useful.

Requests

(1) Provide a summary table with host rock and mineralization geochemistry and the range of values.

(2) Provide any information on the background Cu, Pb, Zn, Sb, Cd, Ag, As and W concentration values in the Road River Formation.

(3) Describe the results of the sulphide oxidation and redistribution from nearby ore into adjacent host rock in terms of Ag, Cd, Hg, Pb, Sb, As and Zn. Provide information on the mobility of As, Cd, Pb and Hg, including information on co-precipitation with secondary zinc minerals and if some of these elements stay behind.

(4) Provide the depth of the Pb/Zn oxidation level. Describe if this level is constant at the scale of the property.

(5) Provide a Table with the range of values characteristic of the Prairie Creek ores. Describe which minerals are responsible for anomalous chromium values.

IR Number: NRCan 9

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject: Operation of access road and potential impacts to Karst

(NB – The Board is also directed to consider Parks Canada IRs #7, #8 and #9 for related requests)

Preamble

According to CZC the risks to the proposed access route from the potential for renewed subsidence associated with the karst features appear to be small. No evidence of subsidence at any location along the road was noted. However CZC notes that the zone of intense karst terrain that exists in the vicinity of Km 56 be avoided by re-routing the access route to the north of the karst valley (Polje by-pass route). All karst features within 200 m of the access road should be identified and monitored. It is unclear how, when and at what frequency this identification and monitoring will be done.

Requests

(1) Provide a map of karst features along the proposed new route

(2) Provide an analysis of the size and orientation of the karst sinkholes

(3) Comment on the features that control sinkhole distribution (lithology and stratigraphy, faulting and fracturing?) and their bearing on road location

(4) Provide details of the geotechnical investigation that will examine these and other factors related to road stability (ice-rich permafrost; weak soils)

(5) Provide a monitoring plan, including the methods that will be used to monitor karst-related subsidence

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IR Number: NRCan 10

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject: Baseline climatic conditions

Preamble

Terms of Reference section 3.2.4 requires that baseline climatic conditions, including temperature and precipitation be provided. Information on temperature and precipitation is essential to determine the water balance and also for determining terrain stability and effects of the environment on the stability and performance of project components such as the water storage pond, waste rock pile and water retention structures. In addition, an assessment of the variability in climatic conditions, especially precipitation (including determination of extreme events), is also required to determine the long-term terrain stability (including erosion potential, slope stability) as well as stability of project

components. The DAR and supporting documents indicate that some onsite data for the Prairie Creek site were collected but this is only available for a short period of time (2005-07, with additional data from the Cadillac site for 1980) and the Proponent must therefore rely on data collected from surrounding Environment Canada Stations (e.g. Fort Simpson). Since conditions for the project site may be different than those at Fort Simpson, the proponent may through analyses of data available develop a site climatology or alternatively, deal with uncertainty in climate conditions through sensitivity analysis for example. In addition, only information on summer precipitation is available for the site and the lack of snow data could lead to uncertainties in hydrological modeling, water balance calculations and terrain stability analysis. There are also inconsistencies in the source of climate data utilized for the various analyses presented by the Proponent. For example, for the air quality assessment, data from Fort Simpson are utilized, while data from Ft. Liard and Ft. Simpson along with the limited site data appear to have been used for the waste rock pile modeling. Only 1980 values appear to have been used for other water balance calculations. It is not clear why these inconsistencies exist. To adequately assess the impact assessment provided by the Proponent, a clear statement of the source of the climate data and the rational for selecting the data are required. Further information is also required on how the Proponent incorporated extreme events into their analysis and how uncertainties, particularly with onsite precipitation (including the lack of local winter precipitation and snow data), are dealt with in project component design and impact assessment.

Request

Please provide the following with respect to the climate data utilized:

(1) A clear statement of the source of the climate data utilized for water balance calculations, design (and stability assessments) for project components such as the waste rock pile, water storage pond and water retention structures and the rationale for the data source.

(2) A description of the analysis performed to develop site climatology from the limited onsite data and Environment Canada data from nearby stations. This should also include a discussion of how uncertainties (including the lack of onsite winter precipitation data) are dealt with in design of project components and impact assessment.

(3) A description of how climate variability and extreme events (in particular those associated with precipitation) were included in the design of project components (e.g. water storage pond, waste rock pile, water retention structures), assessments of terrain stability surrounding these structures (e.g. erosion potential and slope stability) and the impact analysis.

IR Number: NRCan 11

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject: Terrain Conditions along the Access Road

Preamble

Terms of Reference sections 3.24, 3.3.7 and 3.3.3 require the Proponent to provide information on soil and terrain conditions and to also address the impacts that the project may have on the terrain or that the terrain may have on the project. The access road may traverse areas of permafrost and removal of vegetation and surface disturbance due to grading along realignments may result in changes to the ground thermal regime which may result in terrain instability including thaw settlement and slope instability. Changes to surface water (e.g. ponding of water) or erosion associated with these instabilities may also result in impacts to terrestrial and aquatic ecosystems (TOR 3.3.3). From the documentation provided it appears that there have been no subsurface investigations to characterize sediments including thermal and ground ice conditions along the access route. The terrain analysis report (App. 16) indicates that ice-rich material may be present along the route and instabilities (e.g. mudflows) may have resulted from thawing permafrost. Additional investigations have been recommended to the Proponent by Golder (authors of the terrain analysis report). The Proponent states that where possible, organic layers will be maintained in a viable and uncompacted state in order to maintain the ground thermal state. Observations of the ground thermal regime by the Geological Survey of Canada in the Fort Simpson area indicate that permafrost where present is at temperatures close to 0°C and clearance of vegetation and disturbance of the organic layer may lead to permafrost thaw and ground instability (e.g. Smith et al. 2004, 2008, 2010). It is not clear if the Proponent has additional information on the ground thermal conditions along the access road that would indicate that the ground thermal state could be maintained during any construction and operation activities. It is unclear how the Proponent will maintain the ground thermal conditions after clearing of vegetation (even if the organic layer is largely undisturbed) which will reduce shading of the soil and may also result in increased snow cover. Removal of vegetation could also lead to a loss of surface protection during extreme precipitation events leading to increased erosion but is not clear whether there are mitigation plans to deal with this possibility.

Preparation of the access road and its period of operation will be highly dependent on climate and warmer conditions could result in later onset of freezing and less frost penetration and earlier thaws. Low snow conditions could also reduce the protection for the ground surface. It is not clear what monitoring procedures will be in place to ensure that ground conditions are adequate and the activities associated with the road will not result in any damage to the ground surface.

Request

(NB – The Board is also directed to consider Parks Canada IRs #8, #10 and #12 for related requests)

Please provide the following:

(1) Any additional information the Proponent may have consulted or any other observations regarding the properties of the surficial materials along the road alignment including thermal conditions (permafrost existence and ground temperatures) and ground ice conditions where permafrost exists.

(2) A description of plans for further geotechnical investigations to further characterize ground conditions (including ground ice conditions).

(3) A description of monitoring plans to (i) ensure that ground conditions are adequate for activities associated with the road to occur; (ii) to determine if there are any changes to ground stability, increased erosion or other impacts associated with the preparation or operation of the access road.

(4) A description of mitigation plans to ensure that impacts to the ground surface (including the organic layer) and subsequent impacts (ground instability, erosion etc) that may result from changes to the ground surface, ground thermal regime etc. are minimized.

IR Number: NRCan 12

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject: Stability of the Water Storage Pond (WSP)

Preamble

The Water Storage Pond (WSP) is an essential component of the project water management strategy and any instability that could result in impacts on its integrity could have impacts on water quality, a key line of inquiry (TOR 3.3.2). Adequate information is therefore required on the factors that may affect the terrain stability in the area near the WSP, in particular the north slope of the pond. From the documentation provided, it appears that there has been much work done to characterize subsurface conditions of the North Slope. These investigations include recent investigations conducted by Golder (results provided in App. 12) and earlier studies conducted by BGC in 1994. Although a description of the results from the earlier investigations has been provided, the detailed

information from the BGC reports has not been provided. Thawing of ice-rich permafrost has been proposed as one of the factors exacerbating previous instability of the North Slope and BGC collected data indicating that permafrost was likely originally present. Recent, ground temperature measurements from one site (provided in App. 12), which is located near a stream, indicate that permafrost is not present. More detailed information from the earlier BGC studies however, may be useful in determining whether permafrost may be present beneath the North Slope and whether its continued thawing may result in further instability. The Proponent indicates that the effect of degrading permafrost appears to have abated. However, slope inclinometers have been installed recently and although there has only been one set of measurements, there appears to be movements of several mm per year. It is not clear whether this ongoing creep may be related to additional thawing of permafrost. Slope inclinometers were also installed previously by BGC but these data have not been provided and it is difficult to compare present movements to those in the past.

The Proponent provides documentation of the design options and stability analysis in App. 12. It is not clear however, whether the occurrence of extreme events such as excessive snowmelt or intense rainfall events which might result in elevated pore water pressures or erosion was considered in the stability analysis.

Request

Please provide the following:

(1) Any additional data and information collected during previous investigations utilized to characterize subsurface conditions at the WSP and surrounding area including the North Slope.

(2) Information associated with previous measurements of slope movements on the North Slope in order to compare with the more recent measurements.

(3) Further information related to how extreme events (high rainfall, excessive snow melt) have been incorporated in stability analysis and designs of the WSP, in particular the stability of the North Slope. Please provide any additional information regarding measures that may be utilized to ensure stability of the WSP should these extreme events occur.

IR Number: NRCan 13

Source: Natural Resources Canada - Earth Sciences Sector

To: Canadian Zinc Corporation

Subject: Stability of the Waste Rock Pile

Preamble

Stability of the waste rock pile (WRP) and the surrounding terrain is an essential component of the project water management strategy and impacts on the integrity of the WRP could result in impacts on water quality, a key line of inquiry (TOR 3.3.2). The proponent has provided information regarding the design of the WRP (App. 11) and modeling associated with the cover system design (App. 22). It is not clear however whether extreme precipitation events have been incorporated into the design of the cover system to ensure that there will be no excessive erosion of the cover, and therefore maintaining the integrity of the cover and limiting percolation. Runoff from surrounding terrain will be diverted around the pile and it is unclear whether there has been consideration of the impact that extreme rainfall events (which will also result in runoff from the pile to the surrounding terrain) may have with respect to stability of the terrain surrounding the pile (where runoff is diverted) and erosion that may occur which may have impacts on downstream water quality.

Request

NRCan requests that the Proponent provide further information describing how extreme precipitation events have been incorporated into the design of the WRP including its cover system and the associated stability analysis, including that for the surrounding terrain. Please also describe any measures to be implemented to reduce terrain instability or erosion associated with extreme precipitation events.

IR Number: NRCan 14

Source: Natural Resources Canada – Earth Sciences Sector

To: Canadian Zinc Corporation

Subject: Surficial geology, slope stability at Prairie Creek Mine.

Preamble

The surficial geology of Prairie Creek Mine property boundary and access road indicates that they are located in a glaciated (70 %) and unglaciated (30%) terrain. The surficial glacial materials arrived to the sites in question are from the east (Laurentide Ice Sheet) and local cirques in Funeral and Manetoe ranges. Scattered Shield erratics are found at the top of the ranges east of the mine site indicating that the Laurentide glacier overtopped the lowest parts of it. The surficial materials for the mine property are mostly colluvium of different thickness and bedrock surfaces wide spread in location. A minimum amount of sediments derive from glaciofluvial, lacustrine and till deposits

while most are derived from the north part of the Prairie Creek basin. All the terrains are affected by a great variety of slope processes in particular within the mine property: rock fall, debris flows, mudflows, snow avalanches and a minimum of bedrock rotational slides are found in the west part of the property.

The access road presents different percentages of surficial materials. As soon as the road reaches CAT Camp these deposits are in its majority glacial in origin (80%). The maximum thickness of glacial deposits is found on the intermontane basins that served as a sediment trap. These are filled with outwash and lacustrine deposits and less till deposits. Colluvial deposits here have glacial provenance. Lacustrine deposits are commonly affected by permafrost and therefore by retrogressive thaw-flow slides, debris flows and rotational slumping. Plateau areas have carbonate rocks and karst development is common. Recommendations have been proposed for road re-alignment along stretches where the terrain is susceptible to slope instability. These major proposed changes to the winter road have been presented in Appendix 16. Multiple recommendations are given on the subject of instability along the access road i.e. "…appropriate planning and design decisions can minimize the impact", "it is recommended that this issue be assessed in detail…". However, the report does not specify where and what measure will be taken. Tables with information on the stability are provided, however, no detail mapping of the features are presented. The scale of work is much too small.

Request

The report indicates that aerial photographs have been used in the identification of slope processes as well as fieldwork. Please provide the following:

(1) Surficial geology mapping at the scale of the aerial photograph (approximately 1:50 000 scale or less).

(2) Aerial photographs with the interpretation of landslide processes: karst, rock fall, debris flow, mudflow, snow avalanches, rotational slides, retrogressive thawflow slides etc.

IR Number: TC – Access Road 1
Source: Transport Canada
To: Canadian Zinc Corporation
Subject: Polje By-Pass route, span crossing across Polje Creek (km 42 – km 49)
References: DAR 10.4.2

Preamble:
The proposed Polje re-alignment route will eliminate three crossings and includes the use of a temporary span structure to cross the Polje Creek, which has been identified as a significant stream.

Request:

- Provide additional details on the span crossing that will be constructed at this location. Include information such as the potential dimensions of the crossing, the ordinary high water mark, and the height above the bed of the waterway.

IR Number: TC – Access Road 2
Source: Transport Canada
To: Canadian Zinc Corporation
Subject: Sundog Creek (km 22 - km 31), 5 crossings & temporary span structures
References: DAR 10.2.2

Preamble:
It was noted that the route from the Mine to the headwaters of Sundog Creek, has two major crossings. The first is Casket Creek at Km 6, and Funeral Creek at Km 13. The Funeral Creek had culverts constructed by Cadillac, but has been washed-out. CZN is proposing to construct another span structure at this location.

Request:

a) Provide details of the proposed structure to be constructed. Include information such as the potential dimensions of the crossing, the ordinary high water mark, and the height above the bed of the waterway.

IR Number: TC – Access Road 3
Source: Transport Canada
To: Canadian Zinc Corporation
Subject: Seasonal construction of the access road, frozen soil beds
References: DAR 6.2.2

Preamble:
The construction of the access road will incorporate frozen soil beds, as an alternative to ice roads. It is identified that the frozen soil beds will be built by clearing and roughly leveling the bed, and then allowing the ground to freeze.

Request:
Provide additional details for the construction of the frozen soil beds, specifically:

- Any additional materials that will is integrated in the construction of the road; such as log fills
- If all materials will be removed before the end of the winter season
- The yearly estimate of the volume of snow and ice required for road construction
- Dates when access to the frozen soil beds will be operational for the saeson.

IR Number: TC – Access Road 4
Source: Transport Canada
To: Canadian Zinc Corporation
Subject: Nahanni Front Range Alternative (Km 125 to Km 170), ice bridge crossing the Liard River
References: DAR 6.21

Preamble:
The Nahanni Front Range Alternative will cross the Liard River via an ice bridge in the vicinity of Swan Point. After crossing the ice bridge, the route joins an old logging road which follows the east side of the Liard River to join into the existing Nahanni Butte all season road.

Request:
Provide additional details for design/construction of the ice bridge, specifically:

a. Additional materials to be incorporated in the construction of the crossing.
b. Projected dates for the season when the ice bridge will be in operation.
c. Projected dates when all parts of the works will be removed from the water way.
d. The yearly estimate of the volume of snow and ice required for the construction of the crossing

IR Number: TC – Access Road 5
Source: Transport Canada
To: Canadian Zinc Corporation
Subject: Seasonal operation of winter and ice roads
References: DAR 6.21, 6.22

Preamble:
The optimization of the access roads is anticipated to reduce environmental, logistical and economic risks. The re-alignment of the route will utilize both winter and ice roads.

Request:
- Provide the details with regards to the construction, timing, and operation of the winter and ice roads.

CANADIAN PARKS AND WILDERNESS SOCIETY

NWT CHAPTER, BOX 1934, YELLOWKNIFE, NT, X1A 2P5
p 867.873.9893 f 867.873.9593 nwtadmin@cpaws.org

Chuck Hubert & Paul Mercredi
Environmental Assessment Officers
Mackenzie Valley Environmental Impact Review Board
#200 Scotia Centre
5102 – 50th Avenue
Yellowknife, NT X1A 2N7

Via email: *chubert@reviewboard.ca*
pmercredi@reviewboard.ca

Re: EA0809-002, Prairie Creek Mine

CPAWS-NWT is pleased to provide the Mackenzie Valley Environmental Impact Review Board with information requests in response to the Developer's Assessment Report submitted by Canadian Zinc Corporation (CZN) to the Board.

Request for Information for:
IR Number: EA0809-002 Prairie Creek Mine

Directed to:
Canadian Zinc Corporation
Suite 1710-650 West Georgia Street
P0 Box 11644
Vancouver, BC
V6B 4N9

Subject: Questions regarding temporary storage of tailings in the Water Storage Pond (WSP)

In section 2.0 of your addendum to the Developer's Assessment Report (DAR) and 6.12.2 of the DAR you have outlined how you would use the WSP as a second storage area to store up to 50,000 tonnes of tailings until sufficient mine openings are available for backfill. You have outlined why you think this option is a "superior solution" compared to storing tailings above ground.

To better understand how this would be a "superior solution" we ask that the following be clarified.

1) What are the limitations to building a covered temporary storage facility with a capacity (60,000 tonnes) to hold the 50,000 tonnes from the first 5 months of operations and the 10,000 tonnes proposed for storage in the building adjacent to the concrete shed? If this was feasible would it not be a superior solution to storage in the WSP?

2) Duration of tailings storage in the WSP

Temporary storage is an arbitrary timeframe considering the estimated life of the mine could be 14 years or more.

Does the length of temporary tailings storage in the WSP consider transfer to an available mine opening immediately when one becomes available (0-2years?) or will this be done opportunistically some time during the life of the mine (0-14years)?

3) Method of tailings removal from the WSP

What would be the method of dredging tailings from the WSP?

Is it possible that this method will puncture or tear the geo-synthetic liner?

If heavy equipment is used, is there a risk that this could cause ground instability around the WSP?

Will above-ground storage of dredged tailings be required prior to transferring to the backfill plant?

4) Would you continue to call the pond a water storage pond or rename it a water storage and tailings pond to clarify the true function?

Thank-you for responding to these information requests,

Kris Brekke
Acting Executive Director - Conservation Coordinator
Canadian Parks and Wilderness Society
NWT Chapter
867-873-9893 ext.24

IR Number: MVRB 1

Source: Mackenzie Valley Review Board

To: Canadian Zinc Corporation

Subject: Waste Rock Pile - Stability Analyses
Appendix 11: Section 6.3 Discussion.
Appendix 11: Appendix D Slope Stability Analysis.

Preamble

Appendix 11 provided a preliminary design for the Waste Rock Pile, including the stability analyses for the rock pile. Figure 3 shows a typical section of the rock pile, and containment berm at the toe of the rock pile. Slope stability runs utilizing Slide software are presented in Appendix D of the Appendix 11 report.

Request

1 Did the stability analyses include cases for the end of the mine life, in which there will be additional surcharge load for cover materials to be placed on top of the rock pile? What thickness of cover material is assumed?

2 Did the stability analyses include cases for snow loads on top of the rock pile?

3 Was sensitivity analysis carried out to account for variation of water table within the rock stockpile, particularly for cases during the spring freshet where some of the water at the toe of the stock pile may still be frozen and create some back-up of water level behind the pile?

IR Number: MVRB 2

Source: Mackenzie Valley Review Board

To: Canadian Zinc Corporation

Subject: Waste Rock Pile - Drainage and Seepage Collection Pond
Addendum Report: Figure 3.
Appendix 11: Section 6.5 Water Management.
Appendix A – Golder's 2008 Report (Conceptual Design).

Preamble

Figure 3 of Appendix 11, as well as the cross sections shown for the slope stability analyses in Appendix D of Appendix 11, showed that in the lower portion of the rock pile, the rock pile will be placed directly on top of the bedrock. It is assumed that this was intended to increase the stability of the rock pile. A liner will be placed for the containment berm, with no details on the upslope extent of this liner.

Request

1 It has been assumed that metal leaching may occur through the Waste Rock Pile. The lower portion of the Waste Rock Pile will be founded directly on bedrock (as shown in cross-section and in stability analyses). How tight is the bedrock in this area? Is water infiltration into the bedrock a concern as it will bypass the seepage collection pond? What volume of water is assumed to go into the seepage pond?

2 At the top of the Waste Rock Pile, the crest was sloped 1% to the north or upstream. Where does the drainage water eventually go from the north end of the rock pile?

3 The 2008 Conceptual Design Report (page 5) mentioned the design flows associated with spring snow melt/freshet. However, there is no follow-up provided in the Appendix 11 of the main Report (2010). These flows need to be determined to evaluate the impact if diversion ditches fail in the long term after the mine closure, and upstream runoff flows through rather than around the Waste Rock Pile.

4 Please provide further detail on how the capacity volume of the collection pond (6500 m3) is calculated, and what assumptions such as rainfall events, snowmelt, etc were used? Will the pond generally be empty most of the time during the mine operation?

IR Number: MVRB 3

Source: Mackenzie Valley Review Board

To: Canadian Zinc Corporation

Subject: Dyke - Selection of Design Flood Level
Addendum Report: Appendix C.

Preamble

The Appendix C of the Addendum Report provides the historical background of the discussion related to the selection of the Design Flood Level. It contained some information from reports by Hay & Co, as well as excerpts taken from Ker Priestman and Associates' report (1980).

Appendix C of the Addendum report indicated that MVLWB approved the use of the Probable Maximum Flood (PMF) estimate presented by the Hay & Co. report in March 2004. In this report, it was assumed that the PMF value would be the same magnitude as the 1:10000 year flood. Past studies have shown, however, that the PMF is typically larger than the 1:10000 year flood by a certain margin. Judge and Zhou [Ref. 1] indicate that depending on the characteristics of the statistical distribution used, the PMF can be anywhere from 1.2 times to well over 2 times the 10,000 year flood estimate.

We agree that the development of a first principles PMF estimate can be quite involved. However, it is our opinion that it could be done if absolutely necessary – data availability would not preclude such an analysis. Such estimates have been prepared for other nearby areas in the Yukon, northern Alberta and northern BC.

Request

1 To follow along the discussion on the PMF estimate, other independent estimates of PMF potential could be considered for comparison with the current PMF estimate of 500 m3/s. For example, the Creagar diagram [Ref. 2] could be used, in combination with existing PMF estimates for other northern locations, to provide another estimate of this extreme flood potential. This would provide a better understanding between the magnitude of PMF value and the value obtained from the 1:10000 year flood. Were these additional estimates completed?

2 We note that while the approximate PMF value of 500 m3/s was accepted by MVLWB, there is still no decision on exactly what design flood to use for these dykes. The same Hay & Co. reports (dated March and July 2004) recommend that the dyke design crest elevations be based on a 1:200 year flood event with a minimum 0.5 m freeboard. It is our opinion that the Inflow Design Flood (IDF) for this dyke should be selected based on recommendations made within the 2007 Canadian Dam Association (CDA) guidelines.

These guidelines recommend selection of an IDF based on the overall hazard posed by the structure to the surrounding environment. The hazard is assessed based on overall potential for loss of life to occur in the event of overtopping and failure of the dyke, and also on the extent or magnitude of environmental damage/economic loss that might occur. Given that a portion of this dyke acts as a

containment barrier for the tailings (temporary) and process water storage pond and to contain the mine plants, it is expected that a review of the potential environmental damages would be important in selecting the hazard classification for this structure. Depending on the magnitude and nature of these damages, the IDF for the dyke design could range from 1:100 years up to PMF. We request additional information on the nature of the environmental damage that might occur in the event that the dyke is overtopped or alternatively breached, and then an appropriate IDF can be selected for this structure based on the 2007 CDA guidelines.

1. Zhou, R. D., C. R. Donnelly and D. G. Judge, 2008. "On the Relationship Between the 10,000 Year Flood and Probable Maximum Flood", Hatch Ltd., Paper presented at the HydroVision 2008 Conference, Sacramento, California.

2. Watt, W.E, Lathem, K.W., Neill, C.R., Richards, T.L. and J. Rousselle, "Hydrology of Floods in Canada: A Guide to Planning and Design", Natural Resources Canada (NRCAN), Ottawa, 1989.

IR Number: MVRB 4

Source: Mackenzie Valley Review Board

To: Canadian Zinc Corporation

Subject: Dyke - Slope Protection
Main Report, Appendix 18A: Northwest Hydraulic Consultants (NHC) Memorandum (August 14, 2009). Main Report, Appendix 18B: Canadian Zinc Corporation Report on Repairs to Flood Protections (September, 2009).
Main Report, Appendix 18C: Golder's Report on Berm Repairs (March 2009).

Preamble

The reports by NHC (Appendix 18A), Golder (Appendix 18B and 18D), and CZN (Appendix 18C) provided detailed discussion and information regarding the riprap conditions along the flood dyke and adjacent to the Prairie Creek. Repairs work on the riprap materials along the slope was reported by Golder and CZN, following recommendations provided by NHC.

Request

1 For periodic monitoring and observations, it is important that the existing conditions along the slope of the flood protection dykes be defined, clarified, and properly documented. The annual reports and status report on the repair work in 2009 should include a site plan and stationing along the flood dyke (both the western portion which is part of the Water Storage Pond, and the eastern portion which is adjacent to the Mine Plant). Survey cross section along the dyke, extent and size of riprap placed along the slope should also be established along the specified Monitoring Stations. This information can be provided in a spreadsheet table, which can then be updated at the time a new inspection is carried out.

2 NHC Report (Appendix 18A) provided some information about the size of riprap for the slope protection (approximately 0.5 m). However, no information was provided regarding the design velocities in the creek that would dictate the rip rap size. The creek appears to be relatively steep and therefore will exhibit relatively high velocities and high shear stresses along the channel. Have the riprap sizes been calculated or determined to ensure that they are adequate for the design flood along the creek?

3 The NHC report indicates that it is suspected some rip rap damage occurred during passage of a flood event in 2005. It is noted that no estimate of the magnitude of the flood event was available. However, we understand that a video file exists that documents this event, as observed from the upstream part of the pond embankment berm. It may be possible to roughly determine peak water levels on the dyke at this location from the video file. Using these peak water levels, and comparing them to those determined using the backwater model which has been set up, it may be possible to roughly estimate the flow associated with this event, and the peak velocities to which the rip rap has been exposed (and failed). Please confirm that the above approach using the video file has been explored in order to gain a better understanding on the flood magnitude, and riprap issues along the Prairie Creek based on the historical flood event in 2005. If so, what was the maximum back-calculated velocity the riprap was exposed to in 2005?

IR Number: MVRB 5

Source: Mackenzie Valley Review Board

To: Canadian Zinc Corporation

Subject: Dyke - Stability Analyses
Appendix 12: Appendix D Slope Stability Analysis Results.
Appendix 18A: Draft Report by NHC.

Preamble

Slope stability analyses, including the analyses utilizing a pseudo-static seismic coefficient were completed and reported for the portion of the dyke located on the western area of the flood dyke line (part of the Water Storage Pond, Appendix 12). The eastern portion of the flood protection dyke, which is adjacent to the mine plant was reported to have lower crest elevation in the NHC report (Appendix 18A, page 1, 2nd and 3rd paragraph).

Request

1 It appears that no analyses or discussion about the stability were provided for the portion of the dyke adjacent to the Mill Plant on the eastern area. Were these analyses carried out and reported in previous or different reports? If this is the case, reference needs to be made with respect to the stability analyses of the dyke along the Mine Plant.

2 What materials were used to build the dyke adjacent to the Mine plant? It is understood that the crest of this portion of the dyke is lower than the crest at the Water Storage Pond. Is the cross section similar to the one of the perimeter dyke for the Water Storage Pond?

IR Number: MVRB 6

Source: Mackenzie Valley Review Board

To: Canadian Zinc Corporation

Subject: Tailings Paste Backfill – Scheduling and Utilization
Main Report: Section 6.12.1. Appendix 15A: Table 11

Preamble

If development waste is stored underground, Dense Media Separation Aggregates/Coarse Reject (DMSA) and Flotation Processed Tailings (FPT) usage for backfill will decrease. Table 11 shows backfill requirement according to the mine production, but it assumes that no development waste is stored underground. In the Main Report, Section 6.12.1 Waste Rock and DMS Rock, it was mentioned that some of the development waste rock may be left underground to avoid haulage to surface.

Request

1 The report says all flotation tailings and partially DMSA will be used for underground filling system, but mine production and paste backfill scheduling during all mine life and availability of the underground stopes for filling will be very critical to achieve this goal. Typical mining operations can use 50% to 60% of their mill tailings. Please elaborate on how to achieve the implementation of the Tailings Paste Backfill as proposed (i.e. all tailings will be used as paste backfill underground)

2 DMSA would typically decrease the flotation tailings amount required for placing the backfill mix underground. However, if development waste rock will remain underground, there is likely more DMSA to be left for surface deposition. Please confirm and provide details of whether the development waste rock will remain underground and whether this will affect the amount of paste backfill that can be stored underground.

3 Mine and paste backfill scheduling is critical throughout the entire mine life. Is mine storage capacity enough to eliminate future bottlenecks, as some development waste rock may be left underground? According to the mine development waste usage, what is the plan and how will this affect the backfilling operation and utilization of all tailings for paste backfill, if excessive tailings remain?

IR Number: MVRB 7

Source: Mackenzie Valley Review Board

To: Canadian Zinc Corporation

Subject: Tailings Paste Backfill - Water Bleed
Appendix 15A: Figures 2, 3 and 8.

Preamble

There are differences in moisture content for the slump between 2005 and 2009 samples (Golder Report, Figure 3). Slump vs. solids content is important to determine the water separation. The moisture retention test shows high water release (Figure 8).

Request

1 No discussion was provided with regards to the effect of groundwater quality if there is water bleed into the groundwater. What are the allowances or acceptance criteria for the water bleed from the backfilling into the mine groundwater?

2 The water bleed is approximately 15% for 7 in. slump and 20% for 10 in. slump (FTP 2005). However, for FTP 2009 samples, the water bleed is approximately 6% for 7 in. slump and 9% for 10 in. slump compared to FTP 2009 samples (Figure 2). Please explain and clarify the differences.

3 The concentrations of As, Cd, Pb, Hg analyses in tailings are of concern. Leach tests on mixtures of paste + cement show concentrations in leachate of Cd, Hg, Pb close to, or exceeding, Water Quality limits. For this reason, high bleed rates would result in an environmental risk of groundwater contamination. Risk would be higher above the water table where groundwater may be moving and thus promote more dispersal of bleed water. Please provide clarification on the bleed rates, and how it may affect the ground water quality.

Appendix B

September 6, 2010 EBA File: Y22101185

Canadian Zinc Corporation
Suite 1710
650 West Georgia Street
PO Box 11644
Vancouver, British Columbia
V6B 4N9

Attention: Mr. D. Harpley
VP Environment & Permitting Affairs

Subject: Interim Field Results for an Invasive Plant Survey and a Rare Plant Survey Prairie Creek Mine Access Road

1.0 INTRODUCTION

The purpose of this letter is to provide interim results for an invasive plant survey and natural revegetation assessment of the existing Prairie Creek Mine access road, and a rare plant survey along proposed road re-alignments, conducted on behalf of Canadian Zinc Corporation (CZN). The surveys were undertaken inside the Nahanni National Park Reserve (NNPR) and were designed in consultation with Parks Canada (PC) staff.

The surveys were undertaken between August 9th to 13th.

The Prairie Creek Mine is undergoing environmental assessment (EA) for operations. CZN has received a number of information requests (IR's) from various parties. These interim results are provided to respond to two PC IR's. A detailed report is in preparation.

2.0 IR PC_01: VEGETATION RECLAMATION AND INVASIVE SPECIES ASSESSMENT

2.1 PREAMBLE

PC raises two points, "As suggested by Section 3.2.4 of the Terms of Reference, the DAR briefly considers what the existing (baseline) vegetation is relative to pre-development. In particular, a number of contentions about vegetation are made that are testable:

1. 63 km of old access road has re-vegetated naturally since the 1980s (Appendix 17, page 42); and
2. Invasive alien plant species are not thought to be an issue (Appendix 17, page 44)."

EBA Engineering Consultants Ltd.
p. 867.920.2287 • f. 867.873.3324
PO Box 2244 • 201, 4916 - 49 Street • Yellowknife, Northwest Territories X1A 2P7 • CANADA

The current status of the road as "naturally reclaimed", having not been used by heavy traffic in over 25 years allows for an assessment of reclamation rates in various vegetation types. This information is important for PC to help us assess the potential significance of impacts of the road on vegetation. If invasive alien species are present on the road from previous use, there is a potential for significant effects if the species is further spread through the proposed development.

PC requested the following:

1. Design a study that will collect information on the status of re-vegetation of the former access road within NNPR to natural species;
2. Design a study that will collect information to assess the potential for invasive plant species; and
3. Describe natural reclamation relative to adjacent vegetation communities and discuss which types may require additional reclamation efforts.

2.2 STUDY DESIGN

A field program was designed in consultation with Dr. Jim Rettie of Parks Canada in Winnipeg. The full length of the existing access road within the boundaries of the NNPR was surveyed in the context to reclamation processes. In addition, each habitat type was surveyed for invasive alien plant species using a systematic ground survey method of transects.

2.2.1 Methodology

2.2.1.1 Invasive Species Assessment

The methodology used for the invasive alien plant survey involved a quantitative approach, similar to that employed by PC in other parks. Survey design was fine-tuned to accommodate local conditions[1]. The finer points of sampling methodology were adapted for the nature of the survey, *i.e.* the patchy distribution of the species of interest (invasive species), the nature of the mature forest adjacent to the road bed, and the age of road bed (1981).

Community types surveyed were selected from an already existing habitat classification. The composition of plant communities were determined from visual inspection of sites and subjectively assessed as being representative of a particular targeted community type.

[1] Survey methodology was similar to that already used by PC for invasive plant species but was adjusted to the local site conditions, *e.g.* number of sample units, systematic placement of transects, distance between successive quadrats, number of quadrats per sampling unit, and the size of the quadrat (5 m radius).

The sample unit was a single 100 m transect, consisting of consecutive quadrats placed along the tape. A tape measure was laid out along the ground perpendicular to the road way and secured with pegs held under tension by means of a stretch cords. Transects were systematically placed along the road way at 250 metre (m) intervals.

A 100 m buffer was used from the edge of a community type to avoid edge effects. Starting at the origin (centre of the road bed), a circular quadrat of 5 m radius was placed with one side touching the tape. The centre of the first quadrat represented 0 m along the transect. Each consecutive quadrat was at 15 m intervals, thus 5 m between quadrat boundaries. Up to 11 quadrats were to be employed where warranted. However, if two consecutive quadrats produced zero detections of invasive alien plants, then sampling for that transect was terminated. The method employed was an adaptation from Daubenire's methodology for vegetation analysis with the use of a two-dimensional reference frame of fixed size.

Each quadrat was marked off using 30 inch pins with flagging. Four pins were placed around the perimeter of a given quadrat, with a fifth pin in the centre. Surveyors envisioned the circular boundary of the quadrat between the pins. All invasive alien plant species were recorded on standardized data forms, the same data sheets used by PC. The objective was to document invasive species occurring within the quadrats. However, invasive species found incidentally along the roadway were also recorded.

The survey objective was to determine the presence of invasive alien plants, the frequency in which they occur, and how their frequency diminishes from the point of origin (mid-line of road bed). Therefore, alien plant species were to be recorded in each quadrat. Frequency was to be calculated as the percentage of quadrats containing the species of interest.

For each sampling unit, the following information was entered onto a standardized data form: site number and location, Universal Transverse Mercator (UTM) coordinates (from a Global Positioning System (GPS); Map Datum North American Datum 83), date, topographic position, slope, aspect, dominant vegetation type, percent closed canopy, ground cover, moisture regime, elevation, plant community type, plant species present, animal and evidence of animal presence (*e.g.* animal sign). For each quadrat, only invasive alien plant species were recorded. All vascular plants were identified on site. Representative samples of invasive alien plants were collected, as well as other species that might be difficult to identify in the field. These were identified later under magnification with the aid of taxonomic guides.

Prior to going into the field, a plant list of targeted invasive alien plant species was assembled with the help of PC and Dr. Suzanne Carrière, Ecosystem Management Biologist with the Wildlife Division of Environment and Natural Resources, Government of the Northwest Territories (GNWT). Information on these species, photographs and their respective habitat requirements were assembled into a binder and studied prior to going into the field. The binder was used in the field to aid in proper identification. In addition, the

list of invasive alien species was reviewed prior to the start of each transect. This helped to keep a pertinent species search focus.

2.2.1.2 Vegetation Reclamation

The methodology used to document the status of vegetation reclamation along the road was to record the species occurring on the road alignment and those species occurring in adjacent habitat, then comparing the two species lists. Aerial photographs were taken for each point surveyed on the ground along with the adjacent community types. In addition, the entire road way lying within the NNPR boundary was photographed showing the present state of the reclamation status with that of adjacent habitat.

2.3 RESULTS

2.3.1 Invasive Alien Plant Survey

A previous habitat classification was completed by Beak Consultants Ltd. (Beak 1981). Despite being 30 years old, the habitat classification is still relevant, accurate, highly functional and readily recognizable in the field and, consequently, was employed for these surveys.

Based on the existing habitat classification, eight community types occur along the existing road alignment within the boundaries of the NNPR, and include: Alpine Tundra, Subalpine Shrub, Spruce-Lichen, Black Spruce Parkland, Riparian Alluvial, Pine Parkland, Mixed Conifer-Deciduous, and Black Spruce Muskeg. Seven of the eight community types were surveyed. The eighth community type, Black Spruce Muskeg, was not surveyed due to accessibility issues. A helicopter was not able to land within reasonable hiking distance from this community type. However, it was assessed from the air.

No invasive alien plant species were documented along the existing road alignment surveyed.

A detailed analysis of the results is still be written up and will be presented in the final report.

2.3.2 Vegetation Reclamation

Vegetation reclamation work consisted of documenting the vegetation growing along the existing access road within the NNPR. Documentation occurred at each of the invasive plant survey sites, plus additional sites as deemed appropriate. Documentation occurred on the ground as well as aerial photographs that were taken. Species presented on the road were recorded, followed by the recording of species present in adjacent community types. Detailed notes were taken at each site. As in the invasive plant survey, a 100 m buffer was used from the edge of a community type to avoid edge effects. All community types were

surveyed from the ground expect for the Black Spruce Muskeg; it was surveyed from the air.

The road alignment has been not been used for nearly 30 years and appears to be naturally revegetating very well without assistance. Remarkably, the revegetation process is proceeding according to the adjacent vegetation (Photographs 1 to 9). Virtually the entire road has been re-colonized by adjacent vegetation. This is because, to a large extent, the organic layer was not compromised (i.e. not scraped off) during initial road construction, except in a few minor spots.

EBA's initial assessment is that the habitat on the road within the Alpine Tundra is at an advanced seral stage (Photo 1), while those sections within the Subalpine Shrub (Photo 2) and Spruce-Lichen (Photo 3) are at a younger seral stage.

The Black Spruce Parkland, Pine Parkland, and Mixed Conifer-Deciduous communities have completely vegetated with a younger seral stage of the adjacent habitat (Photos 4 to 6).

The Black Spruce Muskeg community type occurs on a wetter stretch of road and is heavily vegetated with willow shrubs (Photo 7).

The section of road traversing the Riparian Alluvial habitat is more or less identical to adjacent sites (Photo 8 and 9). Being in the braided sections of the river, the Riparian Alluvial habitat is disturbed on a regular basis, sometimes annually, by ice and water. Regular disturbance is a natural, re-occurring event and the species present reflect this situation.

Detailed information of species occurring on the road and adjacent habitats will be presented in the final report.

3.0 IR PC02: RARE PLANT SURVEY ALONG THE PROPOSED ROAD RE-ALIGNMENTS

3.1 PREAMBLE

Vegetation work from the early 1980's is relied upon extensively for this report. Additionally, since the original surveys, natural variability (*e.g.* fires) has significantly altered many vegetation communities. Recent (EBA 2009) vegetation work focused on detecting rare species on the existing roadway, not assessing communities that may be encountered along routing alternatives.

Although there may be some actions that can mitigate impacts to vegetation, potentially significant effects are best mitigated through proper routing of the access road at the environmental assessment stage. There was no consideration of unique or important vegetation (vascular and non-vascular) communities that may be encountered on the proposed alternate routes. Furthermore, there was no evidence to demonstrate that the

current route was better or worse than other routes for mitigating potentially significant effects on rare vegetation communities or species.

PC requested that CZN describe and compare the potential impacts on vegetation of the proposed route with other potential routes.

3.2 STUDY DESIGN

A field program was designed to address the above issues. Within the NNPR boundaries, CZN proposed two road re-alignments, called Polje By-Pass and Wolverine Pass. The latter re-alignment was ultimately not surveyed because CZN concluded it was not feasible due to slope stability concerns.

3.2.1 Methodology

The approach to this study component involved searching for rare plants or sensitive habitats along the propose road alignment. A digital facsimile of the proposed road alignment was uploaded onto a GPS, providing the field crew with a line to follow across the landscape while searching for rare plants or sensitive habitats.

Plant species designated with special conservation status[2] by the Government of Northwest Territories Environment and Natural Resources (ENR), the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the federal Species At Risk Act (SARA) were the main focus of this survey.

Similar to the previous year's rare plant work, prior to conducting the fieldwork, relevant literature was reviewed to familiarize the team with the plant species expected to occur in the vicinity of the proposed road alignment. The same preliminary list of vascular plants, including a rare species list, used in 2009 was used again in 2010.

The species list was based on range maps found in taxonomic guides and environmental reports. The list was created using the rare plants of the NWT from the National Herbarium database in Ottawa, Vascular Plants of Continental Northwest Territories (Porsild and Cody 1980), Rare Vascular Plants in the Northwest Territories (McJannet *et al.* 1995) and other reports, including Beak Consultants Ltd. (1981) and Ker, Priestman and Associates Ltd. (1980).

All vascular plants were identified on site. Information for rare plants or animal sign was recorded for each observation and included GPS waypoint, species, number of observations, and habitat type.

[2] Species with special conservation status include those designated as May Be At Risk, At Risk, Special Concern, Threatened, and Endangered.

3.3 RESULTS

Only the proposed Polje By-Pass alignment was surveyed for rare plants and sensitive habitats.

The entire Polje By-Pass road alignment was flown three times by the vegetation crew and then surveyed, in its entirety, from the ground. This area has been burned by a forest fire and replaced by a young jack pine stand (Photo 10). Much of the ground cover is still littered by burnt timber (Photo 11).

No rare plants or sensitive habitats were documented along the proposed Polje By-Pass alignment.

This re-alignment is well situated to avoid rare plants and sensitive habitats.

4.0 CLOSURE

The above details will be more thoroughly discussed and presented in the final report. EBA continues working on the data and report writing. If you have any questions please feel free to phone me at (867) 920-2287.

Sincerely,

Steve Moore

Photo 1
Natural vegetation reclamation occurring on an access road in alpine habitat, 30 years after disturbance.

Photo 2
Reclamation occurring on an access road in subalpine habitat. This stretch of road is driven on annually.

Photo 3
Reclamation within the spruce – lichen habitat, 30 years after disturbance.

Photo 4
Natural reclamation within the black spruce parkland is very advanced, with virtually no exposed areas.

Photo 5
Spruce parkland heading upto the Ram Plateau, completely revegetated with spruce.

Photo 6
Naturally revegetated deciduous stand on road.

Photo 7
Black spruce muskeg habitat occurs on a wetter stretch of road and is heavily vegetated with willow shrubs. That is the over-grown road in the lower half of the photograph.

Photo 8
The riparian alluvial habitat consists of braided sections of the river and are disturbed on a regular basis, by ice and water.

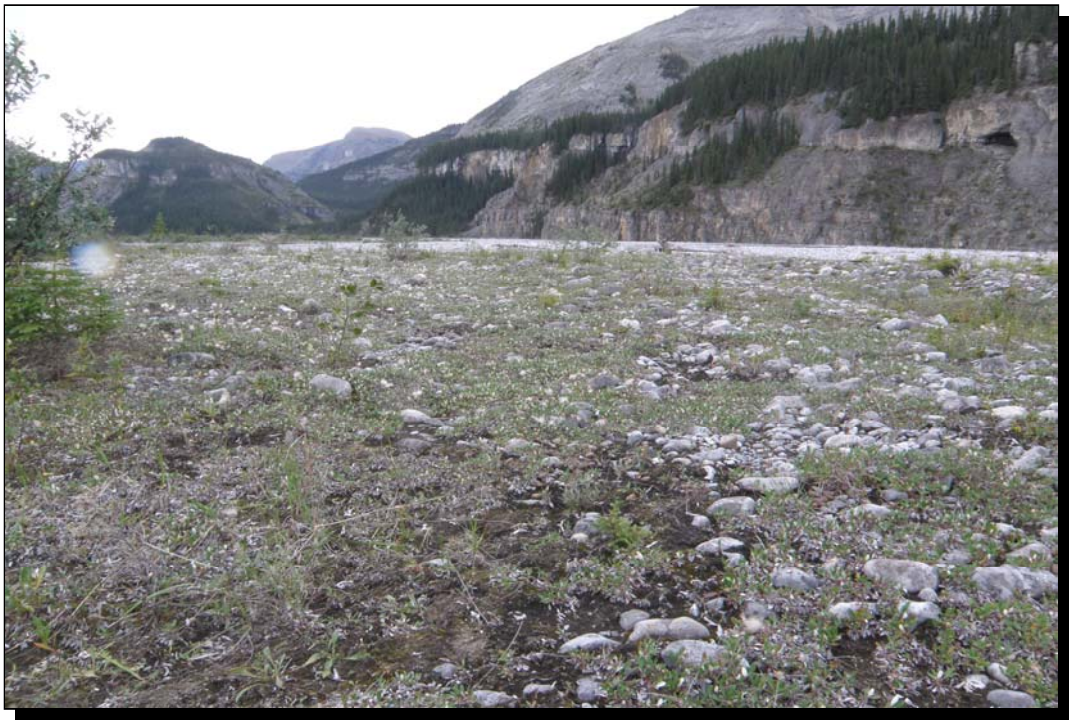

Photo 9
Section of road traversing the riparian alluvial habitat, road in foreground.

Photo 10
Young jack pine habitat occurring along the proposed Polje By-Pass road alignment.

Photo 11
Much of the ground cover is still littered by burnt timber in the jack pine stand.

Appendix C

September 9, 2010

Project No. 09-1422-5007
E/10/1644

David Harpley, P.Geo., Vice President Environment and Permitting Affairs
Canadian Zinc Corporation
Suite 1710 - 650 West Georgia Street
Vancouver, BC
V6B 4N9

RESPONSES TO INFORMATION REQUESTS - PRAIRIE CREEK MINE DEVELOPER'S ASSESSMENT REPORT TO MACKENZIE VALLEY ENVIRONMENTAL IMPACT REVIEW BOARD

Dear Mr. Harpley,

As per your request, Golder Associates Ltd. (Golder) has prepared the following responses to Information Requests (IR) from Environment Canada and Parks Canada related to their review of the Canadian Zinc Corporation (CZN) Prairie Creek Mine project Developer's Assessment Report (DAR). The information requests as stated by Environment Canada and Parks Canada are presented below, with responses summarized under each information request. The responses are based on information reviewed during preparation of Appendix 17 of the DAR, subsequent discussions with the Dehcho Regional Biologist, and discussions with CZN representatives.

1.0 ENVIRONMENT CANADA INFORMATION REQUESTS

INFORMATION REQUEST EC-9 - WATER STORAGE POND WATER QUALITY AND WATERFOWL AND WATER BIRDS

EC requests further information to describe the potential effects of water quality at the water storage pond (WSP) at the mine site on migratory birds and what kind of adaptive management measures will be used to avoid, minimize or mitigate impacts from increased contamination of food and water.

Request:

Describe potential impacts to waterfowl and other aquatic birds from possible contaminants and other harmful substances that may be found in the water impoundment pond on the mine site.

Response:

At present, a small number of waterfowl and other water associated birds (~20, CZN estimate) use the Water Storage Pond (WSP) during the spring and summer. The WSP does not appear to be on a migration route,

rather the waterfowl present stay for part of the spring and summer. Several species of ducks have been observed on the WSP in spring, and breeding mew gulls have been observed by CZN as nesting near the WSP for the last several years. While greater site activity during mine operations may discourage this use, the possibility remains that some waterfowl or other water associated birds may continue to use the pond.

Based on an analysis of data prepared by CZN, during operations the pond will receive water primarily from the Mine (drainage) and Mill (process water). Water quality data for both are given in the attached table (prepared by CZN). The 2005 process water results are an average of the data from Table 6-7 in the Developer's Assessment Report (DAR). The dissolved metal data were used as being representative of water quality in the WSP after 'settling' of suspended matter. (Note: the 870 Level sample had a high TSS and commensurately high metal concentrations. The 2010 mine water data are from a June 8 sample.) The 2009 process water and mine water data were derived from Table 8-5 in the DAR. In this case, the metal concentrations are total values. (Note: the arsenic and lead values are particularly elevated and may be influenced by suspended matter).

Review of the pond water balance contained in Appendix 9 of the DAR shows that the annual quantity of inflowing process water is approximately equal to the other sources. Therefore, to estimate 'mixed' pond water quality during operations, an un-weighted average of the process water and mine water data were used in the attached table. Results are compared to the 2005 CCME guidelines for the protection of livestock.

Estimated pond water quality exceeds CCME livestock guidelines for arsenic, lead and mercury. However, these are related to elevated results from simulated process water. CZN believes actual process water in the pond during operations is unlikely to have similarly elevated values due to residence time, allowing settling of sediment and reaction/attenuation of dissolved metals.

Request:

Outline mitigation measures that will be done to ensure that waterfowl and other aquatic birds are not exposed to harmful substances that may be found in the water impoundment pond.

Response:

CZN propose to evaluate the practicality of mitigation measures, aimed at reducing the number of birds that use the WSP. Such measures could involve the use of scare tactics to dissuade birds from landing on the WSP, such as noise makers or markers (flags, long stringers of flagging). The need for and effectiveness of using scare tactics will be evaluated at the site once the Mine has been activated.

Request:

Discuss monitoring that will be done to ensure that the mitigation measures are effective.

Response:

Monitoring of bird activity at the WSP will be carried out by Mine environmental staff. Observers will record the species of birds, number, ages, and activity and will assess how effective scare tactics are if they are in use. The results of the monitoring will be summarized in an annual report to EC and the NWT Regional Biologist.

INFORMATION REQUEST EC-10 - WILDLIFE MANAGEMENT PLAN (APPENDIX 32)

The EC review of the DAR has requested a revised Wildlife Management Plan (WMP) to address the five points of the Terms of Reference (TOR) provided by the Mackenzie Valley Environmental Impact Review Board (MVEIRB). Responses to the five points identified in the TOR are given below.

Request:

EC asks that Canadian Zinc Corporation provide a revised Wildlife Management Plan that addresses all wildlife impacts, proposed mitigations, and monitoring; adequately covers the specific requirements as outlined in the Terms of Reference (Section 3.3.6); and incorporates feedback from other wildlife management authorities, as appropriate.

Response:

CZN proposes that a formal WMP is not necessary at the environmental assessment stage, but accepts that it is important that an appropriate WMP is in place before operations commence. It is understood that CZN would commit to produce such a plan.

The following addresses each of the five points raised by Environment Canada, based on the TOR Section 3.3.6.

i) Which other interested parties have been involved in the development of the wildlife management plan.

A number of discussions have been held with the Dehcho Regional Wildlife Biologist concerning wildlife occurrence and distribution in the project area, and the types of monitoring that could be carried out with mine and access road operation, and hauling along the Liard Highway. Potential concerns with respect to wildlife impacts were identified, including:

- Effects on Dall's sheep near the mine site and the airstrip;
- Wildlife mortality along the access road;
- Bison mortality along the south end of the access road at the Liard River;
- Wildlife mortality along portions of the Liard Highway (bison, moose, caribou, bears); and
- Wildlife encounters at the mine site (*i.e.,* bears, wolverine).

A number of suggestions for monitoring approaches were put forward by the Dehcho Regional Biologist, including:

- Monitoring of Dall's sheep population near the mine site and airstrip to document numbers, activity and range use;
- Document Dall's sheep natality areas through aerial and ground survey prior to mine start up (April to early July period). Survey area would include the mineral claims around the mine site and airstrip to provide a broader picture than just the immediate development footprint. The objective is to identify specific birthing locations so that these can be monitored in the first year of production and subsequent years.

- Monitor reaction of sheep to aircraft, and depending on findings, suggest adjustments to the Flight Impact Management Plan to lessen potential for effects, particularly for the lambing period.
- Monitor and report on effectiveness of managing potential for wildlife encounters (bear awareness program, waste management and containment).

These approaches will be evaluated and incorporated into future development of the WMP, toward operation of the mine and the access road, as well as hauling along the Liard Highway.

We understand that CZN has also had discussions with Nahanni Butte residents and has received input with respect to wildlife occurrence in the project area, and requests with respect to alignment changes for the access road.

ii) The adequacy of all pre-existing wildlife mitigation and management plan and commitments in light of increased activity levels during full-scale operations.

CZN previously prepared a WMP with respect to a Land Use Permit for underground decline development and a Land Use Permit for Phase 3 drilling outside of the immediate mine site area. Those plans formed the basis of the WMP provided in the DAR (Appendix 32). CZN recognizes that for mine and access road operation, the WMP needs to be further developed to include specific details of wildlife data collection and monitoring for the mine site area and the access road.

iii) Efforts to be undertaken to monitor wildlife in the EA Study Area and report the presence of species to the appropriate authorities when necessary.

An outline of specific steps to be taken with respect to monitoring of wildlife and reporting of results will be provided in a revised WMP. It is proposed that the programs to be put forward will in part be based on a review of recent reports from other northern mine sites where access considerations have been incorporated into monitoring programs. CZN operates a wildlife sightings log for the mine site. An expanded log or a similar log will be incorporated into access road operations.

iv) Identification of adaptive management measures to avoid, minimize, and mitigate potential impacts on wildlife when detected through wildlife monitoring.

The basics of adaptive management strategy have been established in the WMP (Appendix 32 of the DAR). The strategy will be further developed, and integrated with future monitoring programs which will provide real time, effective data upon which to base decisions with respect to wildlife incidents and measures for reducing risks to wildlife and to workers. Several approaches to this strategy were outlined in Appendix 17 of the DAR (Golder Associates Ltd. “Vegetation and Wildlife Assessment Report”, March 22, 2010), for both the mine operation and the access road.

v) How monitoring results and mitigation efforts will be reported to regulators, responsible authorities and potentially-affected communities.

An outline of how information from wildlife monitoring and mitigation (including adaptive management approaches) will be reported and disseminated has been provided in the WMP (Appendix 32 of the DAR) and in Appendix 17 of the DAR (Golder Associates Ltd. “Vegetation and Wildlife Assessment Report”, March 22, 2010). The mechanics of how this information will be structured will be further elaborated once the WMP is developed prior to mine start up. It is expected that territorial government (ENR) and federal government (Environment

Canada, Parks Canada) and the Nahanni Butte Dene will be the principal parties to be engaged by CZN. CZN has proposed to present monitoring data at regular technical meetings open to regulators and the public. The need for, and form of, adaptive management actions will be open to discussion in this forum.

2.0 PARKS CANADA INFORMATION REQUESTS

INFORMATION REQUEST PC-03 - ROAD ROUTING IMPACTS ON WILDLIFE

Parks Canada (PC) states that the information on wildlife has significant deficiencies, primarily based on the assumption that surveys in the early 1980s are insufficient as baseline data for impact assessment, and specifically insufficient to inform the access road routing. PC states that the impact of alternative routing and the existing route on species at risk or key harvest species (wildlife) has not been considered.

CZN is of the view that surveys carried out in 1981-1982 are sufficient to establish a baseline with respect to the mine site, claim areas and the access road corridor. These earlier surveys provided identification of important wildlife ranges in proximity to the mine site and extended claim areas of the Prairie Creek valley, and along the access road corridor. This information was reviewed when re-alignments of the access road were being considered. CZN also points out that the access road re-alignment options were considered to be improvements in terms of ground conditions, and will also avoid sensitive features in the landscape.

PC has made two specific requests for information with respect to road routing impacts on wildlife.

Request:

Describe and compare potential impacts on all wildlife of the proposed Polje by-pass and Silent Hills alternative relative to the original route.

Response:

CZN are of the opinion that the Polje by-pass is a technically necessary route adjustment to avoid karst features and avoid bisecting the poljes west of Mosquito Lake. This by-pass lessens the potential for impact on those features and the ecosystems associated with them, thereby lessening the potential for impact to wildlife associated with these features.

The Silent Hills alternative to the existing route reduces the distance traversed over frozen wetlands by crossing the wetlands perpendicularly before climbing a wooded slope, thus placing the route onto firmer substrate. This alignment lessens the potential for impact on wildlife species that may be associated with the wetland ecosystem.

Request:

Describe and compare the potential adverse effects of the existing route and proposed alterations on caribou populations, and calving and wintering range relative to other potential routes.

Response:

Based on existing information, neither the Polje by-pass alignment nor the Silent Hills alternative intersect known seasonal caribou range. The existing route in both of those sections also does not intersect known seasonal caribou range.

The re-alignment on the east side of the Nahanni Ranges lies within known caribou winter range, as does the existing route; therefore, there is no real difference in that section of the access road with respect to caribou. The new alignment was selected with input from Nahanni Butte, and the proposed routing avoids areas known by Nahanni Butte residents to be used by ungulates. The route is still well below the ridges potentially used by Dall's sheep.

In summary, the alignment revisions have been adopted for technical reasons that should also lessen the potential for effects on wildlife.

INFORMATION REQUEST PC-04 - MITIGATING WILDLIFE EFFECTS

Parks Canada (PC) states that the DAR does not provide project details that may have a significant effect on wildlife. PC raises a number of points with their request for information; the following responses address the questions.

1) Refer to the response provided by CZN.

2) It is anticipated that fixed-wing aircraft will provide the bulk of air service requirements. Flights will likely be 2 to 3 per week after mine start up. Flight paths are along the valley direction (NE-SW). Flight altitude and height above ground are determined by local topography, with little if any opportunity for adjustments. Note that CZN has previously prepared a Flight Impact Management Plan which will be updated for mine operations. With respect to helicopter use, this is expected to be infrequent (likely not more than 8 hours per month, on average).

3) Refer to the response provided by CZN.

4) Refer to the response provided by CZN.

5) Refer to the response provided by CZN.

6) Refer to the response provided by CZN.

7a) Active deterrent methods for bears and wolverines at the mine site are not proposed. The DAR provides an outline of measures to reduce the attractants of bears and wolverines to the mine site and transfer stations, with active management of food materials and food and other camp wastes. Food will be stored at the Mine site in the Kitchen/Diner Complex. Food waste will be collected and incinerated on a daily basis. This is done at present, and no animal attraction issues have been encountered to date. Limited food supplies will be stored inside the Transfer Stations, and waste will also be collected for transfer to the Mine. As noted above, the road construction and operating period will be within the period of bear hibernation. These measures will follow northern industry practices.

b) and c) Refer to the responses provided by CZN.

8) Salts will not be used on the access road, as this is a winter road dependent on frozen conditions.

9) Dead wildlife (mammals larger than ermine; ptarmigan) encountered along the access road will be reported by drivers to the Mine Manager and will be geo-referenced as to location, and reported to the Dehcho Regional Biologist. Recorded dead wildlife inside the NNPR will also be reported to Parks Canada.

INFORMATION REQUEST PC-05 - WILDLIFE MONITORING

Parks Canada (PC) states that the DAR does not provide a mechanism to establish either baseline information or monitoring approaches to determine if impacts are occurring and the magnitude of impacts. PC outlines three points for clarification.

Request:

Indicate when and how baseline estimates for woodland caribou, Dall's sheep and moose in proximity to the development including the access road and mine site, claims and leases will be obtained prior to construction.

Response:

We believe that the wildlife surveys carried out in 1981-1982 were generally adequate to establish an initial baseline with respect to the mine site, claim areas and the access road corridor. Recent surveys carried out by CZN (2006, 2007) suggest that the general pattern of wildlife distribution has not changed from those interpreted from the early 1980's surveys. Also, note that the mine site is already established and much of the access road is in place, with some re-alignment to be completed. Sufficient information was provided from the 1981-1982 aerial surveys to identify ranges for the three species in question in proximity to the mine site and extended claim areas of the Prairie Creek valley. Ground surveys were extensive and provided description and mapping of habitat units, and identified valued habitat units. Populations are not likely to have changed significantly in the intervening 30 years since those surveys were carried out, given that this is an isolated wilderness area with no current road access. Landscape level changes have not occurred in the mine site area. Along the access road route, there have been several wildfires, one from the late 1980's in the km 66 area and one large burn on the east side of the Nahanni Ranges from 1994 (mentioned in a 1994 report by Robertson Environmental Services). These burns may have affected moose populations through changes in availability of early seral habitat. Hunting activity is largely limited to the guide outfitter operating in the larger region, with fly in access.

The distribution of wildlife and identification of ranges based on these earlier surveys is considered to be sufficient to identify locations where the potential for effects could occur from mining activity or operation of the access road (refer to Figure 1 of Appendix 17 of the DAR "Vegetation and Wildlife Assessment Report", March 22, 2010 prepared by Golder Associates Ltd.). For Dall's sheep, the likely natality ranges were identified in 1981-1982 and 2006, and approximate locations and numbers of sheep were identified that use the natality ranges in proximity to the mine site and airstrip, and through Grainger Gap in the Nahanni Ranges. For caribou and moose the baseline surveys have identified that population levels are low in the mine site area and along the access road alignment, and this was confirmed through 2006 and 2007 aerial surveys.

The logging of wildlife sightings during operations will provide data to inform the Wildlife Management Plan and assist in determining whether adaptive management approaches to deal with potential effects on wildlife are required.

Request:

Provide details of monitoring program proposed to detect potentially detrimental changes in distribution and abundance. Geographic distribution, methodology, effect size, power, confidence, sample size, and frequency of sampling should all be addressed.

Response:

It is proposed that the details of an operational monitoring program will be further developed prior to mine start up and the first year of initial upgrades to the access road. This program will be prepared by a qualified wildlife biologist for implementation by CZN environmental staff, with input from interested parties. Monitoring will be year round at the mine site and air strip and during the winter period along the access road. The general approach for monitoring was provided in the DAR. The advantage of operational monitoring is that continuous updates can be provided on wildlife information and can be provided on a rapid basis to inform decisions on adaptive management approaches. Operational monitoring will provide real time data which will inform the Wildlife Management Plan and provide direct input to formulating mitigation.

Request:

Provide an assessment of harvest potential, and hypothesized local and population level effects along the access route for Dall's sheep, moose and woodland caribou in particular. Outline how a harvest will be measured, reported, and subsequent mitigations decided upon and implemented as generically outlined in the DAR (*i.e.,* what adaptive management will entail and how it will be measured).

Response:

The access road will not be accessible during the non-winter months (cut off by the Liard River) and during the winter will be controlled by a check-point and First Nation monitors from Nahanni Butte. The intent is to promote road safety and deter hunters, both non-aboriginal and aboriginal from outside the NWT, from using the road. Further, the access road will not be in a readily drivable condition by ATVs during the non-winter period.

We understand that during CZN's discussions with Nahanni Butte members, some trappers indicated that the access road would assist them in setting and monitoring their traplines, which should improve the effectiveness of trapping effort and possibly increase furbearer harvests for those trappers, particularly in the Second Gap area. Since Nahanni Butte community members consider harvest data to be confidential, it is not possible to predict how much harvests would increase.

In summary, the impacts on local and population levels of wildlife from the access road are expected to be limited to possibly increasing the harvest of furbearers.

3.0 CLOSING

Please contact the undersigned if you have any questions or require further clarification with respect to these responses to Environment Canada and Parks Canada Information Requests.

Yours very truly,

GOLDER ASSOCIATES LTD.

Chris Schmidt, B.Sc., R.P.Bio.
Senior Wildlife Biologist, Associate

John Hull, M.Sc., P.Eng.
Senior Geotechnical Engineer, Principal

CHS/JH/asd
Attachment: CCME (2005) Livestock Water Quality Guidelines for Selected Constituents

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CCME (2005) Livestock Water Quality Guidelines for Selected Constituents

Parameter	CCME Guideline	Process Water		Mine Water		Average
		2005	2009	2009	Jun 8 2010	
Arsenic	0.025	**0.082**	**0.509**	0.0009	0.0035	**0.149**
Cadmium	0.08	0.01105	**0.0825**	0.0208	0.0253	0.035
Calcium	1000	43.6499996			0.145	21.897
Chloride	None	20				
Chromium	0.05	0.0025	<0.001	<0.001	<0.001	
Cobalt	1	0.0006			<0.0005	
Coliforms, fecal**	None					
Copper	0.5 to 5.0	0.074	0.0032	0.0128	0.0374	0.032
Fluoride	1 to 2	0.7				
Iron	None	1.11500004	0.147	0.014	0.199	0.369
Lead	0.1	**0.598**	**5.26**	0.0006	0.0314	**1.473**
Magnesium	None	7.0599997			0.0678	3.564
Manganese	None	0.08685			0.015	0.051
Mercury	0.003	**0.0545**	0.00168		0.00008	**0.028**
Molybdenum	0.5	0.003775	0.073	0.003	0.002	0.020
Nickel	1	0.02	0.008	0.018	0.015	0.015
Nitrate + Nitrite	100	<0.6				
Nitrate nitrogen	23	<0.5				
Nitrite	10	<0.6				
Nitrite nitrogen	3					
Selenium	0.05	0.0345	**0.104**	0.0028	0.006	0.037
Silver	None	0.0003			<0.00002	
Sodium	None	871			0.00091	435.5
Sulphate	1000	200			350	275
TDS	3000	**3275**			870	2073
Uranium	0.2	0.00305	0.0162	0.0341		
Zinc	50	1.176	3.42	4.25	6.78	3.91

All values in mg/L
Values in bold exceed guidelines

SOURCE: Canadian Zinc Corporation

Appendix D

9 September 2010 Project No. 09-1376-1009 IR

Mr. Dave Harpley
Canadian Zinc Corporation
Suite 1710, 650 West Georgia Street
Vancouver, B.C. V6B 4N9

RESPONSES TO INFORMATION REQUESTS – PRAIRIE CREEK MINE, NWT

Dear Dave,

Introduction

The following are responses to information requests related to the Developers Assessment Report submitted by Canadian Zinc Corporation for the Prairie Creek Mine. This memorandum is in response to those requests related to geotechnical issues and terrain evaluation.

Parks Canada

IR Number: Parks_Canada_6
Subject: Significant earthquake event and impacts on access road design, re-alignment and operation

Request 6.1:

Provide additional detail on the potential impacts to the access road if a significant earthquake occurred in the area of the access road, including, but not be limited to, the potential for a significant earthquake to generate small, moderate, and large soil/rock failures.

Response:

This request is answered in two parts; one relating to rock slope failures and one relating to soil slope failures.

Parks Canada 6.1(a): To frame this response, it should be noted that hazards associated with rock slope failures generally exist along the access route between the mine site (km 0) and approximately km 40 (Cat Camp on Sundog Creek). Elsewhere along the access route significant rock slopes generally don't exist and

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therefore rock slope failures are generally not a hazard. This response, therefore, is intended to apply to the portion of the access route between the mine site and Cat Camp.

As described in Section 5.4 of Appendix II of the Terrain Assessment Report (Appendix 16 of the DAR), '…the current evidence indicates that the likelihood of large rock slope failures occurring due to seismic activity is very remote.' That statement is based on the lack of evidence of historical large scale rock slope failures in the general area of the access route and the mine site. If earthquake activity (probably including events larger than the 1985 events) over the last several thousand years (post-glacial period) has not generated large scale slope instability in this area, it appears unlikely that it will do so within the life of the proposed development.

With respect to the potential for an earthquake to cause small or moderate sized rock falls, Section 5.4 of Appendix II of the Terrain Assessment Report (Appendix -16 of the DAR) states 'Smaller rock fall failures may have been triggered by past seismic shaking, however, these past events are not readily distinguished from other forms of small scale rock fall.' Stated another way, small to moderate sized rock fall events may have been caused by past seismic shaking. If significant seismic events occur during the life of the proposed development small to moderate sized rock fall events may occur as a consequence.

If they do, effects could range from no impact to local blocking of the road, depending on the nature of the failure and the location of the road with respect to the base of the mountain slope. The most likely impact would be minor rock fall debris on the road, requiring clearing.

Parks Canada 6.1b: Evidence of large scale historical slope failures in soil and/or weak rock does exist along the access route, particularly between approximately km 40 (Cat Camp) and km 60 (East of Poljes); and between km 92 and km 99 (western side of Silent Hills, west of Wolverine Pass). Earthquakes may have affected movement of these features in the past and potentially could trigger new movement on these historical failures. If new movement occurred it is expected to affect the ground as described in Section 7.2 of Appendix II of the Terrain Assessment Report (Appendix 16 of the DAR). Updated road routing has generally avoided these areas and construction plans have taken account of soil conditions.

Request 6.2:

Provide additional detail on how earthquake loadings and frequency will be considered in the final design of the road and road re-alignment, including, but not be limited to: slope stability analysis and the magnitude (and return event) of the earthquake that will be considered.

Response:

A road alignment has been selected to avoid most areas of potential instability, including those that might arise from seismic events. Generally, areas of potential instability have been identified by evidence of past (historic) slope instability and/or current instability.

In the event that earthquake loadings need to be specifically considered in slope stability analyses that may be undertaken as part of final road design, the return period for the design earthquake (and consequent magnitude of loads to be considered in design) will be in conformance with Canadian geotechnical / civil engineering practice and will consider design earthquake loadings commensurate with the consequence of failure.

IR Number: Parks_Canada_7
Subject: Karst area access road re-alignment

Request 7.1:

Provide a map that details the access road alignment and the spatial extents where karst formation exists at, or near, ground surface.

Response:

See Figure II-4 (August 2010), attached.

Request 7.2:

Provide a comparison of the current route, the Polje By-Pass, and other routes to demonstrate which route poses the least risk to karst based on the information in IRs Parks_Canada_8 and Parks_Canada_17.

Response:

The rationale for the proposed Polje By-Pass route, from the perspective of the major karst features was provided in Section 10 of Appendix II of the Terrain Assessment Report (Appendix 16 of the DAR). Briefly, the proposed by-pass route avoids the intense karst land (the poljes) and is downstream of surface and subsurface drainage from the polje area. Another benefit of the by-pass, not directly related to the karst features is that it also avoids areas of historic landslide movement and recent rotational landslides and flow slides (See Figure II-2 and II-3, Appendix II of the Terrain Assessment Report (Appendix 16 of the DAR).

IR Number: Parks_Canada_8
Subject: Road geotechnical field investigation

Request:

Provide details of any proposed geotechnical field investigations planned to support access road design and re-alignment including, but not be limited to:

a. Scheduling of the geotechnical investigation relative to: road final design; road re-alignment; and, road construction.

b. An overview of the proposed geotechnical investigation approach with specific reference to characterizing and mapping karst formation/features, ice rich permafrost, sensitive ground, weaker surficial geology and geo-hydrology.

c. How the findings from the geotechnical investigation will be used to complete final road design and proposed re-alignment.

Refer also to Information Request NRCan 9 (4) and to NRCan 11(2)

Response:

The geotechnical investigation to support access design and re-alignment is intended to be undertaken in three phases. Phase 1 and 2 are reconnaissance level programs intended to support preliminary planning and design.

The first phase was undertaken in the fall of 2009 and involved helicopter supported field review of the alignment as well as office based review of 1994 (1:20,000 scale) stereo air photos. Of note, the 2009 program included a foot traverse over approximately 5 km of the former access route through the polje features between approximately km 54 and km 59. The results of the 2009 program work were incorporated into the DAR submitted in March 2010.

The second phase was undertaken in August 2010 and consisted of more detailed (reconnaissance level) work focussed on specific portions of the proposed route. This phase also involved additional review of the 1994 air photos. The results of this phase have been incorporated in these responses to the IR's.

Phases 1 and 2 focussed on characterizing geological hazards and ground conditions along the proposed access route in sufficient detail to support planning of the route. Mapping of major karst features, possible glacio-fluvial channel remnants, major post-glacial historic slope failures, recent flowslides, recent rotational slides etc. in the vicinity of the poljes was included in Phase 1 and reported in the DAR (Figures II-2 and II-3, Appendix II, Terrain Assessment Report (Appendix 16 of the DAR)). This information was also incorporated into Tables III-1 and IV-1 included in Appendices III and IV respectively of the Terrain Assessment Report (Appendix 16 of the DAR). The information was used to support recommendations for alignment changes where appropriate and to identify design, construction and operational issues.

The mapping provided in Figure II-2 and II-3 has been extended and updated as part of Phase 2 and is attached as Figure II-2, Rev.1 to these responses to the IR's. The Phase 2 mapping includes surficial geological mapping at a scale of 1:50,000 of a corridor along the proposed access route.

A third phase of the geotechnical investigation is proposed to support the final design of the access road. It is anticipated that final design will be commenced in the period after receipt of regulatory approval in principle for this project and before road construction. This investigation is intended to focus on portions of the access route west of the Tetcela Transfer Station (km 85) since this portion of the route may require local regrading and adjustment of horizontal curves within the existing route. Further, the proposed by-pass route north of the poljes will involve new construction probably including the placement of road embankment fill.

The third phase may also investigate the portion of the existing winter road immediately west of Wolverine Pass. The switchbacks in this portion of the existing winter road route are likely to require adjustment to increase the radius of curvature and to reduce the grade of the alignment in this area. Additional geotechnical information may be required to assist with this design.

The third phase of the investigation will include a ground survey and may involve intrusive probing at select locations. While the details of this program have not yet been established, consideration will be given to probing tools, including the possible use of a heliportable drilling rig. The intent of this work is to confirm ground conditions, particularly at locations where excavation and/or filling may take place. Other candidate locations could include abutment locations for stream crossing spans, confirmation of potential borrow materials and areas of possible side hill cuts that are currently believed to be free of ice-rich permafrost. Instrumentation to measure ground temperatures may be installed at select locations.

Specific drilling investigation of karst features is not anticipated at this time. If on-going monitoring of the karst features (see response to Parks Canada 9) identifies active karst development in an area that could affect the access route, the need for detailed subsurface investigation will be considered at that time, along with minor re-alignment of the road.

IR Number: Parks_Canada_9
Subject: Operation of access road and potential impacts to karst features

Request 9.1:

As requested in Section 3.3.3, Item 4(d)(i) of MVEIRB's Terms of Reference, provide details for areas of the access road that are constructed where karst is at, or near, ground surface, as well as sinkhole locations. Specifically, describe the geotechnical stability of the road in light of the characteristics of the karst, traffic loadings, and traffic activities.

Response:

With respect to portions of the access route that traverse through land that contains karst features, this section extends approximately from km 48 to km 85, with intense karst terrain in the vicinity of km 56. Collapse features in the vicinity of the former access route through the poljes are shown on Figure II-2 of the Terrain Assessment Report (approximate scale 1:20,000). The extent of the Ram Plateau is shown on Figure II-4 (August 2010) at an approximate scale of 1:50,000. The locations of some individual features are shown at this scale. Generally sinkhole features are not evident in the vicinity of the access route east of approximately km 75.

With respect to the geotechnical stability of the karst features, reliance was placed on three lines of inquiry: 'Do any of the closed depressions and karst features appear to have formed recently?', 'Do any of the existing features appear to have been recently active?' and, 'Within the valley that contains the poljes is there any evidence of land movement along the former access route?' Answers to these questions are included in Section 10 of the Terrain Assessment Report and are discussed below:

- No new closed depressions or specific karst features appear to have formed recently.
- One significant subsidence feature that appears to be recently active is evident, though it is located approximately 5 km south of approximate km 63 on the former access route. This feature is approximately 500 to 600 meters across and is evident on the 1994 air photos. A review of this feature in September 2009 also showed evidence of relatively recent subsidence movement. Other than this feature, no other features in the vicinity of the access route appeared to be currently active.
- A foot traverse along the former access route through the polje valley revealed one example of dislocation of the road grade since it was abandoned 28 years ago. This feature is located at approximately km 54+500 at the elevation of the plateau and consists of vertical displacement of approximately 1 to 3 meters over a length of approximately a hundred meters. It is believed that this feature is a large rotational slide near the crest of the valley slope and is not related to subsidence due to solution cavity collapse. This feature is also shown on Figure II-2 in the Terrain Assessment Report. The polje re-alignment avoids this area. Elsewhere along the access road within the Ram Plateau, no evidence of subsidence activity that disrupts the road is apparent.

It was concluded from this evidence that the land in the general vicinity of the access route is stable from the perspective of active subsidence formation. Notwithstanding this evidence, it was recommended that the former route through the polje valley not be used and that a new route downstream of these features be developed. The potential hazards associated with renewed subsidence were one of several reasons for this recommended

re-routing. Other reasons are discussed in Section 7.0 of Appendix II of the Terrain Assessment Report (Appendix 16 of the DAR).

Request 9.2:

Describe how the 200 m distance from the road over which an investigation to assess road impact on sinkholes was selected, and what information was used to determine this distance is adequate to understand potential impacts.

Response:

The recommended 200 meter distance from the access route within which recording and cataloguing existing sinkholes and other closed depressions would occur is based on judgement balancing risk to the access route with the practicality of undertaking the assignment and maintaining the data. The likelihood of an individual subsidence event affecting the roadway given a separation between the roadway and the re-activated sinkhole of several tens of meters (or greater) is very remote. As a consequence, close monitoring of sinkholes within approximately 100 meters would probably be adequate from this strict perspective. However, since there are very few features that are this close to the road, it was judged to be practical to expand the zone.

With respect to the potential impacts of the road on the sinkhole features, see Response 4 below.

Request 9.3:

Provide additional details regarding the proposed monitoring of sinkholes, to identify any potential impacts caused by the road including but not be limited to, a description the methods and frequency of measurement.

Response:

It is proposed that recording and monitoring of sinkhole features and other closed depressions be carried out within a zone that extends 200 meters either side of the access route (400 meters total width). See Response 2 above with regards to selection of the 200 meter width. It is intended that the initial recording activity take place after regulatory approval for the project has been received. It is proposed that the initial recording activity would consist of specifically identifying, briefly characterizing and photographing each feature. Each feature would be mapped onto ortho-corrected, high resolution satellite imagery and given a unique identifier. The attributes of each feature, along with associated photos and other related data (date, category of sink hole etc) would be handled within a GIS system.

It is proposed that the review of potential subsidence features be repeated after the first winter of road operation, and a decision made at that time regarding the frequency of review thereafter, depending on the results obtained. It is suggested that the repeated review be undertaken initially by re-photographing the corridor and making an image comparison with the original image. Anomalies that are apparent from that comparison (if any) should be reviewed in the field. Alternatively, the review could be carried out entirely on the ground.

If specific sinkhole features become active following initial construction and commencement of operation of the access route, then a decision to investigate/monitor in more detail and/or to select a remedy, could be made at that time. Investigation techniques at specific locations could include the use of Ground Penetrating Radar and/or other appropriate geophysical techniques; along with drilling and the installation of precise ground movement monitors. Remedial options can vary considerably depending on the specific engineering issue, however, the primary technique would be avoidance by locally re-routing the road.

Request 9.4:

Describe the criteria used to determine the impact of the road to sinkhole features. In the event that the road impacts the sinkholes, describe the mitigation measures and plans that CZN are committed to implementing.

Response:

The discussions above primarily consider the potential impact of renewed subsidence activity on the road. With respect to the potential impact of the presence and operation of the road on the likelihood of renewal of subsidence, this potential was judged in the following manner:

- What mechanical effect (load, vibration) might the presence of the road have on the future performance of sinkholes;
- What other changes such as drainage changes might occur due to the presence of the road?

From the perspective of the potential mechanical effect, loads from vehicles will be very small compared to other loading changes such as grade changes and significant grade changes will be avoided. In any event, vehicle load would only be a potential concern if a void existed directly below the road, within meters of the road surface. There is no evidence that this type of feature exists.

With respect to vibration from traffic potentially affecting subsidence activity, there is no commonly accepted standard for a threshold vibration magnitude above which vibration would be of concern. However, in the building industry ground vibration (from any source) with a peak particle velocity of 2 cm/sec is considered a normally acceptable threshold for the initiation of damage to buildings. This is a significant vibration and is likely to be beyond that which may be generated by the proposed truck traffic. Even if vibrations of this magnitude are generated by the proposed truck traffic immediately adjacent to (or below) the wheel path, the vibrations will attenuate rapidly with distance from the source over distances of approximately several meters to values well below any normally acceptable threshold.

The proposed 200 meter zone for the purposes of monitoring ground performance is well beyond the zone that may be impacted by ground vibration.

From the perspective of the impact that drainage changes could make, it is recommended that existing drainage be maintained and that culverts (not for creeks) and/or temporary snow fills be managed so that changes to the drainage do not take place.

IR Number: Parks_Canada_10
Subject: Access road design/construction

Provide additional details for design/construction of the access route, specifically:

Request 10a:

Criteria for the ground conditions, or other local characteristics, that will be used in the decision to avoid side hill cuts and fills, sensitive soil areas, and, grading with snow and/or ice.

Response:

With respect to side hill cuts and fills they will generally be avoided except where the evidence is that the ground is free of ice rich permafrost. Significant side hill cuts that cannot be avoided may be specifically investigated to confirm the presence or absence of ice-rich permafrost. There are a few locations on the Ram Plateau where side-hill cuts are likely to be developed partially in bedrock of the Horn River Formation (shale). The Horn River shale at the locations considered is unlikely to be ice-rich.

With respect to sensitive soil, areas where ice-rich permafrost appears to exist within sloping ground are considered to be potentially most sensitive. The sensitivity relates to both the potential for slope failures (of various forms) to affect the road as well as the potential for the presence of the road to affect the initiation and frequency of slope failures. Of particular note is the western flank of the Silent Hills, on the proposed re-alignment west of Wolverine Pass (approximately km 92 to km 100). A number of moderate sized slope failures (generally flow slides) have occurred in this area in the past year and it is apparent that this section is unstable and is likely to be a very high maintenance piece of road.

An observation was made during the August 2010 reconnaissance that the section of mountain slope that contains the switchbacks on the existing access route (west of Wolverine Pass) does not display the instability evident on the adjacent sections of mountain slope. Consequently, the previously proposed re-alignment in this area has been abandoned and the intention is now to re-grade and re-align sections of the road through the area immediately west of Wolverine Pass to create a route with acceptable vertical grades and horizontal curves.

With respect to grading with ice and snow, it is anticipated that normal winter road construction practices will be employed.

Request 10b:

Additional information on how the frequency, magnitude and type of rock failures along the access road since construction will be considered in the final road design, and the proposed re-alignment sections of the access road.

Response:

The magnitude and type of rock failures and rocky debris flows that have accumulated on the old road bed provide a cumulative 28 year sample of this activity. With the exception of a few locations between approximately km 27 and km 29 on the upper reaches of Sundog Creek, the volume of accumulated debris is small considering the time frame represented.

With respect to the use of information regarding the accumulation of debris on the old road, this information will be used to plan final road positioning with respect to the toe of the slope (in the active debris areas) and to plan those areas where retaining and/or catchment zones may be considered. At some locations, particularly between approximately km 27 to km 29, there may be insufficient room for retention or catchment areas and operational protocols may be required to maintain road safety.

With respect to re-aligned sections of the access road, rock fall and rocky debris flows are not expected to be an operational issue.

Request 10j and 10k:

Discussion on the potential for climate change to impact the road and proposed re-alignment.

Details regarding the potential effects of climate change on the operation of the road, permafrost degradation, road settlements, and slope failure in vicinity of access road.

Response:

A general warming trend could have the following effects on the access route:

- Potential local (relatively minor) flow slides at some locations along Funeral Creek. These slides could locally block the road and require removal;
- The potential for erosion of road grade along Sundog Creek valley due to increased peak flow events, requiring maintenance of the road in those areas;
- The potential for thaw settlement of new road grade between approximately km 53 and km 55 on the proposed polje bypass route, if the area proves to contain ice rich permafrost;
- The potential for minor flow slides and possibly rotational slides between approximately km 55 and km 58 that could cause loss of part of the road grade;
- Portions of the Tetcela Valley may be delayed in freezing along the road each year;
- The likelihood of increased incidence of flow slides on the western flank of the Silent Hills and the possible development of larger rotational slides. These events appear to be less likely to occur in the immediate vicinity of the existing switchback access route.
- The potential for flow slides to develop on the eastern side of the Front Range, some of which may reach the proposed access route. Since road use is in winter, disruption to the road may only involve some regrading in the winter;
- The potential for an overall reduction of the operation window for use of the winter road.

Request 10m:

Description of potential quarries that may be utilized for road construction, including, maps of quarry location, approximate volume of quarry materials required, and remediation of the quarries after use.

Response:

Figure II-4 (August 2010) attached to this document identifies a number of potential borrow locations. The development of specific borrow areas will depend on common fill needs for initial road grading, maintenance needs during operation and sanding needs during operation.

Natural Resources Canada

IR Number: NRCan3
Subject: Earthquake hazards

Request 3.1:

Are any of the existing buildings engineered structures? Will any of the new facilities be engineered structures? If so, what building code standards have been used / or will be used?

Response:

Existing Prairie Creek Mine buildings and structures were designed and constructed by Kilborn Engineering Ltd. to the National Building Code. All new facilities, both engineered or modular, will also be to the standards of the National Building Code.

Request 3.2:

What were the ground shaking levels estimated at the mine site during the 1985 events? Is there any evidence for active faulting near the site? A deterministic hazard assessment (in addition to the standard probabilistic hazard assessment) should be considered.

Response:

The ground shaking levels at the mine site during the 1985 events cannot be estimated. As far as we know, ground acceleration was not measured in the vicinity of the mine site, only immediately adjacent to the epicentre of the events. There are a series of faults within the Prairie Creek Valley, but to our knowledge, there is no evidence of active faults near the mine site. Following customary practice, the preliminary design was based on seismic parameters from the standard probabilistic hazard assessment. During the detailed design phase, a deterministic hazard assessment (DHA) for the project site will be undertaken. Subsequently, all design and analyses will be based on parameters from the DHA.

Request 3.3:

What level of seismic design was used for the berms and dykes?

Response:

For remediation and design options, accelerations corresponding to a 2,475 year return period seismic event was considered (i.e., a 2% probability of exceedance in 50 years). Pseudo-static seismic analyses were completed using a ratio of horizontal pseudo-static acceleration to gravity (k_h) of 0.125. This value represents roughly one half of the PGA determined for firm ground (NBCC 2005).

Request 3.4:

Are there life-safety issues here? Will the Canadian Dam Association Guidelines (2005) be utilized? (questions in relation to the flood protection berm)

Response:

It is considered highly unlikely that the flood protection berm will fail during a flood event. It is also expected that if the berm was to fail, given that the creek runs parallel to the berm, that there would be sufficient warning to evacuate the mine site prior to the failure. The Canadian Dam Association (CDA) Guidelines do not apply to 'flood protection / deflection berms', and as there is no reservoir, it is not technically considered a dam. CDA Guidelines will apply to the embankments of the Water Storage Pond.

Request 3.5:

What was the estimated level of shaking in these areas during the 1985 Nahanni earthquakes and how does this compare to expected/possible levels of shaking during future earthquakes?

Response:

The design earthquake event that would be used for the analysis of specific natural slopes (if they are to be disturbed (to remediate the Water Storage Pond backslope, for example), should that be required at the final design stage, would depend on the consequences of failure and may be greater than or less than that which occurred in 1985.

See also Response – Parks Canada 6.

Request 3.6:

Please provide details. What level of seismic hazard was utilized in the geotechnical design?

Response:

See response 3.3.

Request 3.7:

Will other potential seismic sources be considered? Is there any evidence for active faults closer to the mine site?

Response:

The Deterministic Hazard Assessment to be undertaken during detailed design will likely cover all possible seismic sources. To our knowledge, there is no evidence of active faults near the mine site, besides that at the epicentre of the 1985 events.

Request 3.8:

Why was a value that is one-half the PGA in code provisions used? This should be explained.

Response:

The values for the horizontal pseudo-static coefficient used in analysis are chosen to reflect conditions applicable to the design. In engineering practice, a factor of one half the PGA is typically used for similar analysis. Once the deterministic hazard assessment is completed, the selected value may be revisited.

Request 3.9:

Will other potential seismic sources be considered? Is there any evidence for active faults closer to the mine site?

Response:

See response 3.7.

Request 3.10:

Why was a value that is one-half the PGA in code provisions used? (As noted above, this should be explained). Is it appropriate to use the same coefficient for the "Water Storage Pond" as for the "Waste Rock Pile"? Is the material strength comparable?

Response:

See 3.8. It is appropriate to use the same coefficient for both structures for the preliminary design. As noted in 3.2 above, the coefficients will be revisited at final design. The material strength does not have a bearing on the selected coefficient.

IR Number: NRCan9
Subject: Operation of access road and potential impacts to Karst
(NB – The Board is also directed to consider Parks Canada IRs#7, #8 and #9 for related requests)

Request 9.1:

Provide a map of karst features along the proposed new route.

Response:

A partial map of karst features in the vicinity of the poljes is shown in Figure II-2 in Appendix II of the Terrain Assessment Report (Appendix 16 of the DAR). This map has been updated and a revised version is attached as Figure II-2, Rev. 2. In addition, a map of the full access route at a scale of 1:50,000 is also provided and is attached as Figure II-4.

Request 9.2 and 9.3:

Provide an analysis of the size and orientation of the karst sinkholes.

Comment on the features that control sinkhole distribution (lithology and stratigraphy, faulting and fracturing?) and their bearing on road location.

Response:

Please refer to Response to Parks Canada 9. In addition, the following response is provided:

Where the Nahanni Formation (limestone) is exposed at or near the ground surface, the structural influence on the distribution and shape of sinkholes is reasonably evident. Where the limestone is covered by remnants of the Horn River Formation (shale) and/or glacial sediments, the structural control on the position of closed

depressions on the ground surface is less evident. It is believed that a number of the closed depressions are kettle holes associated with post-glacial depositional processes; however, all closed depressions will be mapped and monitored as part of the karst monitoring described in the Response to Parks Canada 9.

The zone of intense karst formation near km 56 probably appears to be governed by a fault or fracture zone. It is likely that the proposed route re-alignment crosses the northern extension of this fault or fracture zone, however, this crossing is believed to be a more beneficial choice than the existing access route through the poljes since it is lower down in the stratigraphic sequence and may indeed be below the Nahanni Formation.

Elsewhere along the Ram Plateau potential evidence that the route crosses important structural zones within the underlying Nahanni Limestone is not apparent.

Request 9.4:

Provide details of the geotechnical investigation that will examine these and other factors related to road stability (ice-rich permafrost; weak soils).

Response:

At this point in time, we see no need to further investigate the sinkhole features. The current condition of each sinkhole within a zone 400 meters wide centered on the access route will be recorded and periodically re-examined. If movement or subsidence activity is noted, specific investigation may be initiated. Investigation tools could include geophysical techniques (resistivity, seismic, ground penetrating radar) complemented by drilling. The details of any particular investigation will be developed as appropriate for the situation. Alternatively, a minor re-alignment of the road could be made. The 30 years of existence of the road without any subsidence related to karst appears to indicate general stability from the perspective of this potential hazard and indicates the long time frame required for the process of karstification.

Investigation of other aspects of the roadway is discussed in the Response to Parks Canada 8.

Request 9.5:

Provide a monitoring plan, including the methods that will be used to monitor karst-related subsidence.

Response:

Please refer to Response to Parks Canada 9.

IR Number: NRCan11
Subject: Terrain Conditions along the Access Road

Request 11.1:

Any additional information the Proponent may have consulted or any other observations regarding the properties of the surficial materials along the road alignment including thermal conditions (permafrost existence and ground temperatures) and ground ice conditions where permafrost exists.

Response:

Information regarding the properties of the surficial materials along the roadway has been obtained primarily by observation of the shape and form of the ground along with observation of the nature of the soils and rock that are exposed at some locations. In addition, a comparison of the condition of the ground as evident in the 1994 air photos, the September 2009 site reconnaissance and an August 2010 site reconnaissance has also provided information on the condition of the ground.

The interpretation of the ground conditions was described in Table III-1 and Table IV-1, provided in Appendices III and IV respectively in the Terrain Assessment Report (Appendix 16 of the DAR). In addition, an interpretation of the ground conditions is shown graphically at a scale of 1:50,000 on the attached Figure II-4 (August 2010).

A significant number of new rotational and flow slides have been noted that appear to have occurred within the last year or two. These are identified on Figure II-4 (August 2010). These features appear to be related to degradation of permafrost and, as a consequence, it is assumed in this assessment that where ice-rich permafrost exists, it is probably only marginally below zero.

Request 11.2:

A description of plans for further geotechnical investigations to further characterize ground conditions (including ground ice conditions).

Response:

Please refer to Response to Parks Canada 8.

Request 11.3:

A description of monitoring plans to (i) ensure that ground conditions are adequate for activities associated with the road to occur; (ii) to determine if there are any changes to ground stability, increased erosion or other impacts associated with the preparation or operation of the access road.

Response:

Monitoring plans for the closed depressions and karst features through the Ram Plateau area of the access route are discussed in Response to Parks Canada 9.

Monitoring plans for the portion of the route east of the proposed Tetcela Transfer Station at km 85 (intended for winter use only) are expected to include an annual visual review of the alignment before the following winter for the purposes of planning the re-instatement of the winter road. Observations from this review will be incorporated into planning for the construction and operation practices.

For the portion of the access route constructed through Wolverine Pass, a spring review of the drainage management will be conducted after the first winter of road operations.

Monitoring plans for the portion of the route west of the proposed Tetcela Transfer Station are expected to include an annual visual review of the alignment following spring thaw, with specific emphasis on the function of cross-road drainage. Changes may be required locally to better facilitate cross drainage during break-up.

Within the Sundog valley, annual clearing of rock fall and debris flow material may be required at some local locations. This material potentially can be processed and re-used as winter road bed material.

IR Number: NRCan12
Subject: Stability of the Water Storage Pond (WSP)

Request 12.1

Any additional data and information collected during previous investigations utilized to characterize subsurface conditions at the WSP and surrounding area including the North Slope.

Response:

Relevant information from previous investigations was reviewed and consolidated in the Golder Associates report contained in DAR Appendix 12. These investigations were primarily reported in a Bruce Geotechnical Report and this is attached.

Request 12.2

Information associated with previous measurements of slope movements on the North Slope in order to compare with the more recent measurements.

Response:

This information is available in the reports provided in response to NRCan 12.1.

Request 12.3

Further information related to how extreme events (high rainfall, excessive snow melt) have been incorporated in stability analysis and designs of the WSP, in particular the stability of the North Slope. Please provide any additional information regarding measures that may be utilized to ensure stability of the WSP should these extreme events occur.

Response:

The final design of the Water Storage Pond (WSP) will include surface water diversion ditches and other water diversion techniques which will direct the majority of the water around the pond. This will minimise infiltration into the toe area of the north slope. These features will be designed after the site grading plans have been prepared as part of the final design for the north slope area at the WSP. The final design will also incorporate a monitoring plan as part of the WSP operation to manage the surface water ditches.

IR Number: NRCan13
Subject: Stability of the Waste Rock Pile

Request:

NRCan requests that the Proponent provide further information describing how extreme precipitation events have been incorporated into the design of the WRP including its cover system and the associated stability analysis, including that for the surrounding terrain. Please also describe any measures to be implemented to reduce terrain instability or erosion associated with extreme precipitation events.

Response:

Provision for extreme precipitation events has been included in the preliminary design of the water management system, including diversion and collection structures. Preliminary values for rainfall were used to determine the required size of the seepage collection pond (including freeboard). The size of the pond and details for the emergency spillway will be confirmed during final design.

The final design of the cover system will include appropriate materials and technologies to help reduce infiltration, erosion and sedimentation. These measures are designed to accommodate extreme precipitation events.

Extreme precipitation events are not likely to increase the water table within the waste rock due to the high permeability of the material, therefore such events should have a negligible impact on slope stability. The diversion ditches that will be created at the perimeter of the WRP will act to direct surficial waters around the WRP similar to the existing drainage in the present ravine.

The surrounding terrain includes mature vegetated slopes, bedrock slopes, colluvium deposits and access roadways. Aside from the access roads to the waste rock pile, impacts on the surrounding terrain should be negligible from a slope stability perspective. Extreme precipitation events will continue to affect the stability of the natural terrain in the same manner as prior to construction of the waste rock pile. The waste rock pile operation plan will include preservation of the adjacent vegetation to maintain the slope cover.

IR Number: NRCan14
Subject: Surficial Geology, slope stability at Prairie Creek Mine

Request:

The report indicates that aerial photographs have been used in the identification of slope processes as well as fieldwork. Please provide the following:

1) Surficial Geology mapping at the scale of the aerial photograph (approximately 1:50 000 scale or less).

2) Aerial photographs with the interpretation of landslide processes: karst, rock fall, debris flow, mudflow, snow avalanches, rotational slides, retrogressive thawflow slides, etc).

Response:

Please see attached Figure II-4 (August 2010).

Figure II-2 in Appendix II of the Terrain Assessment Report (Appendix 16 of the DAR) provides interpretation of landslide processes and other geomorphological features in the vicinity of the poljes. This work is developed on the 1994 stereo air photos at a scale of 1:20,000. This Figure has been updated and is attached as Figure II-2, Rev. 2.

Additional interpretative mapping of landslide processes is also provided on Figure II-4 (August 2010), attached to this document. This work is developed on a 1:50,000 base map provided by CZN.

Department of Fisheries and Oceans

IR Number: DFO_07
Subject: Waste Rock Pile – Landfill Area

Request:

How is CZN intending to prevent mobilization of sediment carried by the drainage channels during construction, operations and closure?

3) At closure, how will seepage from the waste rock pile be managed, so that impacts to Harrison or Prairie Creek do not occur?

Response:

1) During construction, sedimentation will be controlled using readily available techniques and products. This may include the use of silt fencing, erosion control blankets or other technologies as necessary.

   The completed drainage channels will include erosion and sedimentation control technologies. The performance of these channels will be monitored as part of the monitoring program to ensure controls are functioning.

   The collection pond will also act as a settling pond prior to the water being transported to the mine water management system.

2) Seepage from the waste rock pile will be limited by the cover design, which will minimize infiltration into the pile.

MVRB Requests

IR Number: MVRB 1
Subject: Waste Rock Pile – Stability Analyses

Request 1.1:

Did the stability analyses include cases for the end of the mine life, in which there will be additional surcharge load for cover materials to be placed on top of the rock pile? What thickness of cover material is assumed?

Response:

Cover material was considered part of the total volume of the pile. No thickness was assumed as the cover materials will be part of the total volume of the waste rock pile.

Request 1.2:

Did the stability analyses include cases for snow loads on top of the rock pile?

Response:

Snow loads were considered as part of the total volume of the pile, as the snow load is considered to add the equivalent of 0.5 m of waste rock to the pile.

Request 1.3:

Was sensitivity analysis carried out to account for variation of water table within the rock stockpile, particularly for cases during the spring freshet where some of the water at the toe of the stock pile may still be frozen and create some back-up of water level behind the pile?

Response:

The waste rock pile is to be designed to prevent the accumulation of water and reduce the likelihood of such conditions. Surface water will be diverted around the pile to prevent buildup of pore pressures within the pile. Therefore, no sensitivity analysis for the accumulation of water was completed.

IR Number: MVRB 2
Subject: Waste Rock Pile – Drainage and Seepage Collection Pond

Request 2.1:

It has been assumed that metal leaching may occur through the Waste Rock Pile. The lower portion of the Waste Rock Pile will be founded directly on bedrock (as shown in cross-section and in stability analyses). How tight is the bedrock in this area? Is water infiltration into the bedrock a concern as it will bypass the seepage collection pond? What volume of water is assumed to go into the seepage pond?

Response:

Water infiltration below the Waste Rock Pile (WRP) would be a function of bedrock characteristics relating to general discontinuities (fracturing, bedding, etc.) and the presence of infilling. It is anticipated that any water that flows into the bedrock from the pile will flow into the mine which would be located in the area below the pile and the seepage would be collected by the mine water management system.

The seepage collection pond is assumed to collect all surface water draining within the footprint of the WRP. The pond is sized to collect the anticipated volume from an extreme storm event and then pass this water to the water management system. The total volume of water that passes through the pond will vary annually with precipitation amounts each year.

Request 2.2:

At the top of the Waste Rock Pile, the crest was sloped l0º to the north or upstream. Where does the drainage water eventually go from the north end of the rock pile?

Response:

Water from the north end of the waste rock pile will pass into drainage channels leading to the collection pond or drain to the collection pond from within the waste rock pile.

Request 2.3:

The 2008 Conceptual Design Report (page 5) mentioned the design flows associated with spring snow melt freshet. However, there is no follow-up provided in the Appendix 11 of the main Report (2010). These flows need to be determined to evaluate the impact if diversion ditches fail in the long term after the mine closure, and upstream runoff flows through rather than around the Waste Rock Pile.

Response:

The diversion ditches will be designed at final design using predicted stream flow events. The WRP will be covered at closure to minimise infiltration. The final closure profile will promote shedding of runoff, but in a way that concentration of flows is avoided. Any areas of flow concentration will be suitably armoured.

Request 2.4

Please provide further detail on how the capacity volume of the collection pond (6500 m3) is calculated, and what assumptions such as rainfall events, snowmelt, etc were used? Will the pond generally be empty most of the time during the mine operation?

Response:

An estimated extreme water event was used and volumes determined using the footprint of the WRP to size the seepage collection pond. After the pond water level reaches a certain elevation, water will flow either to the water management system or underground via a borehole. This elevation will be selected so that most of the pond capacity will be available most of the time during mine operation.

IR Number: MVRB 5
Subject: Dyke – Stability Analyses

Request 5.1:
It appears that no analyses or discussion about the stability were provided for the portion of the dyke adjacent to the Mill Plant on the eastern area. Were these analyses carried out and reported in previous or different reports? If this is the case, reference needs to be made with respect to the stability analyses of the dyke along the Mine Plant.

Response:

It is not clear if the reviewer is referring to the flood protection berm or the portion of the Water Storage Pond (WSP) embankment facing the mine site (east side of the WSP), so answers will be provided for both.

The portion of the WSP embankment facing the mine site has the same configuration as that facing Prairie Creek and that presented in the report.

The flood protection berm has the same configuration and is understood to be constructed of the same materials as the WSP embankment. Thus, the stability analyses that are presented for the Prairie Creek side of the embankment are considered appropriate for the flood protection berm as well (pg. 15 of the WSP report).

Request 5.2:
What materials were used to build the dyke adjacent to the Mine plant? It is understood that the crest of this portion of the dyke is lower than the crest at the Water Storage Pond. Is the cross section similar to the one of the perimeter dyke for the Water Storage Pond?

Response:

The flood protection berm has the same configuration and is understood to be constructed of the same materials as the Water Storage Pond (WSP) embankment. Thus, the stability analyses that are presented for the Prairie

Creek side of the embankment are considered appropriate for the flood protection berm as well (pg. 15 of the WSP report).

The original design for the flood protection berm specified that the berm be constructed of the same sand and gravel as the WSP embankments. Visual examination of the surface of the structures indicates that this is likely the case. The cross section is similar to the WSP embankment, without the clay core.

GOLDER ASSOCIATES LTD.

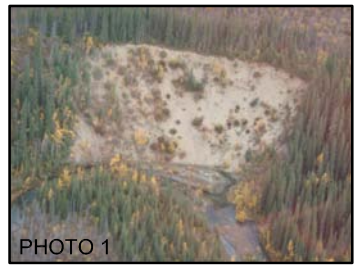
Dave Caughill
Associate, Senior Geotechnical Engineer

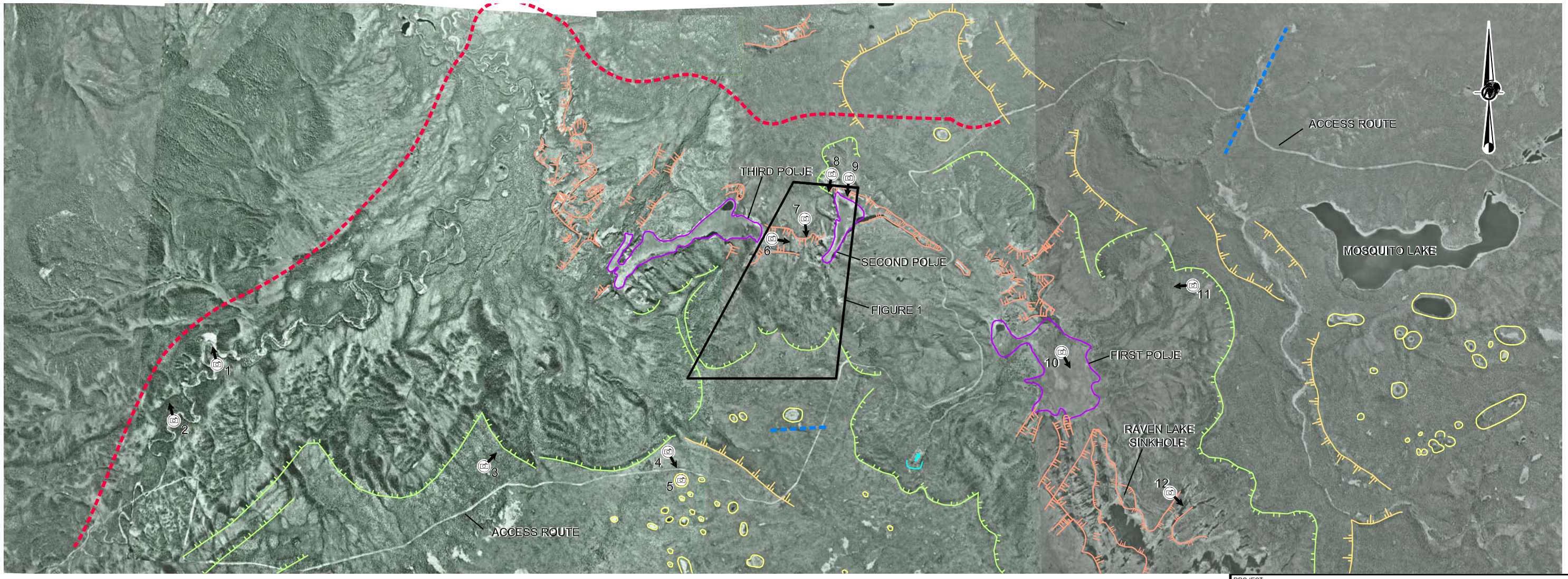
Doug Pelly
Principal, Senior Geotechnical Engineer

DC/DP/aw

Attachments: Bruce Geotechnical Report
Figures

c:\documents and settings\anwight\desktop\can zinc\can zinc irs_aw (2).docx





LEGEND

- LOCATION OF PHOTOGRAPH
- POLJE
- BLOCK SUBSIDENCE, COLLAPSED SOLUTION CAVITY IN LIMESTONE
- SMALL SINK HOLE DUE TO COLLAPSED SOLUTION CAVITY IN LIMESTONE AT DEPTH; MAY INCLUDE KETTLE HOLES
- HEADSCARP OF SLOPE FAILURE IN GLACIAL SOILS & UNDERLYING SHALE/SILTSTONE
- SHALLOW SLOPE FAILURE
- GLACIO-FLUVIAL TERRACE EDGE AND/OR CHANNEL EDGE
- PROPOSED ROAD ALIGNMENT
- SURFICIAL LINEAMENT

REFERENCE

AIR PHOTOS OBTAINED FROM CANADIAN ZINC DATED JUNE 16, 1994, ORIGINAL SCALE 1:20,000 FLIGHT LINE A28094 PHOTOS 219, 220, 222 AND 224

DRAFT

500 0 500
SCALE METRES
SCALE IS APPROXIMATE

PROJECT
CANADIAN ZINC CORPORATION
PRAIRIE CREEK MINE
NWT

TITLE
AIR PHOTOS

Golder Associates
Calgary, Alberta

PROJECT 09.1376.1009.4000			FILE No. 09137610094000B001	
DESIGN	DP	25/11/09	SCALE AS SHOWN	REV. 0
CADD	VI	10/09/10		
CHECK				
REVIEW				

FIGURE: II-2

L:\2009\1376\09-1376-1009\4000\Report B\Fig II-2 09137610094000B001 Air Photograph Map.dwg Sep 10, 2010 — 5:08pm

Prairie Creek Mine Access Road
Surficial Geological Conditions

LEGEND

ACCESS ROAD

PROPOSED ALIGNMENT CHANGES

WATERCOURSES

WETLAND

ORGANIC TERRAIN - VARIABLE THICKNESS ORGANICS, OVERLYING FLUVIAL AND / OR GLACIAL LACUSTRINE SOIL.

FLUVIAL SEDIMENTS (SAND) - PRIMARILY SAND, SILT, MINOR GRAVEL

FLUVIAL SEDIMENTS (GRAVEL) - PRIMARILY COBBLES, GRAVEL, SAND, MINOR SILT

COLLUVIAL/ALLUVIAL APRON - TALUS, DEBRIS FLOWS, ALLUVIAL FAN

GLACIO - FLUVIAL TERRACE - SILT, SAND, MINOR GRAVEL, LOCAL ERRATICS

GLACIAL GROUND MORAINE - WELL GRADED SILT, SAND, GRAVEL, MINOR COBBLES

RAM PLATEAU (SEE NOTE ABOVE)

BEDROCK - UNDIFFERENTIATED, INCLUDES THIN COLLUVIAL

- EDGE OF TERRACE COMMONLY INCLUDES LARGE HISTORIC LANDSLIDES
- EDGE OF TERRACE COMMONLY INCLUDES LARGE HISTORIC LANDSLIDES

INCLUDES CLOSED DEPRESSIONS FORMED BY LOSS OF SEDIMENT INTO SOLUTION CAVITY IN UNDERLYING NAHANNI LIMESTONE

MINESITE

FAST CREEK

FUNERAL CREEK

PRAIRIE CREEK

SUNDOG CREEK

RAM PLATEAU

RAVEN LAKE SINKHOLES

SECOND POLJE

FIRST POLJE

KARST

HORSESTO LAKE

SHORT HILLS

GRANDER GAP

RAVEN CREEK

Re-Alignment A (1.5 km)

Re-Alignment B (4.5 km)

Re-Alignment C (3.5 km)

Re-Routing to Nahanni Butte

Old Nahanni Loggers Road

Liard Highway

Liard Transfer Facility

VILLAGE OF NAHANNI BUTTE

LIARD RIVER

OUTWASH CHANNEL

FERRY CROSSING

NNPR BOUNDRY

Nahanni National Park Reserve Boundary

Scale

0 1 2.5 5 10

kilometres

DRAFT

APPENDIX I
BRUCE GEOTECHNICAL REPORT

BRUCE GEOTECHNICAL CONSULTANTS INC.
AN APPLIED EARTH SCIENCES COMPANY

Suite 210, 1290 Hornby Street
Vancouver, B.C. V6Z 2G4
Phone: (604) 684-5900
Fax: (604) 669-0430

July 20, 1995
File No. 0059-001-01

San Andreas Resources Corporation
Suite 900, 595 Howe Street
Vancouver, B.C. V6C 2T5

Attention: Mr. David Elgee, President

RE: PRAIRIE CREEK PROJECT, N.W.T.
SUMMARY OF GEOTECHNICAL ASPECTS
TAILINGS FACILITY AND ACCESS ROAD

Dear Sir:

I am pleased to provide this summary of geotechnical aspects of the tailings facility and access road based on Bruce Geotechnical Consultants Inc. (BGC) involvement to date with the Prairie Creek Project. The summaries include, **in bold face**, recommendations for geotechnical work which I believe should be undertaken in parallel with your continued exploration activities. Following the summaries I present a BGC budget status report. I look forward to discussing these matters with you tomorrow.

TAILINGS FACILITY

Generalized Background

Initial geotechnical investigation and design for the tailings facility was carried out in the early 1980s by Golder Associates. Performance from 1982 through 1985 was reviewed by Hardy Associates (1978) Ltd. A summary of these early studies follows.

Two potential tailings retention areas, denoted T2 and T3, were selected for detailed site investigation from amongst nine alternatives. T2 is the present location. T3 is situated on the left side of Prairie Creek approximately 1 km downstream where the meteorological station is now located.

Detailed site investigations were carried out between July 7 and September 3, 1980 using a skid mounted Longyear 38 diamond drill. Samples were collected and laboratory testing completed. Piezometers and temperature sensing instruments were installed.

T2 was selected as the better location because of:

1. its proximity to the plant site;
2. it was substantially cleared of brush;
3. it was enclosed by existing river dykes which could be incorporated into the design cross-section; and,
4. an impervious clay stratum present over most of the base area was extensive enough to provide a basal seal as well as borrow material for construction of an impervious clay core in the upstream side of the perimeter embankment.

Construction of the T2 tailings retention impoundment involved expanding the river dykes to form the perimeter embankment dyke. It is believed that material excavated from the natural slope against the north valley wall was also used to construct the embankment dyke. Excavating the natural slope, referred to here as the backslope, also served to increase the available pond volume.

Construction of the perimeter embankment dyke was, for the most part, completed between July and September, 1981. Further field investigations in 1981 led to suspicion that the basal clay stratum was not continuous in the vicinity of the backslope. A synthetic liner and drainage system associated with it was installed in March 1982.

Almost continuous shallow failures developed on the upstream face of the perimeter dyke in June 1982 in conjunction with a period of heavy rain which followed melting of a higher than average snow pack. Observations through 1985 attest to increased severity in the extent of instability. In particular, gravel covering the clay blanket was almost completely removed and cracking retrogressed into the crest of the embankment.

The backslope also became unstable during this period. Numerous imbricate failures ranging from shallow to moderately deep-seated and causing distortion and local tearing of the synthetic liner were reported. Permafrost degradation was believed to have been a factor in parts of the backslope.

Despite poor performance of the tailings pond slopes, no seepage from the pond was detected in observations reported as late as 1985.

BGC Site Investigations

I undertook a site reconnaissance on June 12, 1994, for the purpose of evaluating the condition of the tailings facility and scoping preliminary geotechnical investigations.

Three landslide mechanisms were confirmed or identified as listed below:

1. shallow instability affecting the upstream face of the perimeter embankment dyke;
2. shallow to moderately deep-seated instability affecting the backslope; and
3. possible deep-seated translational instability affecting the backslope.

The first two are consistent with the failure characteristics discussed above for the perimeter embankment dyke and backslope. Evidence suggesting the third mechanism was recognized during the site reconnaissance. A detailed site investigation program was planned on the basis of the June 1994 visit and with a view to complementing earlier geotechnical studies.

Drilling, sampling and instrumentation activities were carried out by BGC between October 18 and November 4, 1994, using your skid mounted Longyear 38 diamond drill. A total of nine holes were advanced, eight in the backslope area (comprising two profile lines across the large backslope landslide) and one in an undisturbed region of the T3 area for the

purpose of establishing base-line ground temperatures and permafrost conditions. The holes ranged in depth from 20.1 to 29.7 m. Samples were collected. Three piezometers, five slope indicator casings and four thermistor strings were installed, and initial readings were obtained for all instruments before leaving the field.

Four test pits were excavated into the upstream face of the perimeter embankment dyke. In situ tests were completed with a pocket penetrometer and vane shear device in each test pit. Samples were collected at each in situ test site.

The drill holes and test pits were located by ground surveys and profiles were surveyed for later stability analyses. These two profiles are shown in Figures 1 and 2, attached.

Site visits to obtain follow-up instrument readings were made on December 15, 1994, and May 17, 1995.

Results Obtained To Date and Preliminary Conclusions

Laboratory testing of samples is completed and the results incorporated into final drill and test pit logs. I have not included these (17 sheets) with this summary but would be happy to supply copies if you wish them.

Plots summarizing the slope indicator results are presented in Figures 3 to 6. The depths of recorded movement in the A direction (the slope direction or line of cross-section shown in Figs. 1 and 2) correspond to the depths at which clay was observed in most of the boreholes. Between the December and May visits, all casings experienced sufficient deformation that the downhole probe would not penetrate to total depth on May 17. Since measuring from bottom (a known reference point) to top is a necessity for deformation analysis, the casings are no longer operative, technically speaking. All that can now be determined is the depth to the uppermost sliding surface by simply sounding the hole. The sounding depths are generally consistent with zones where the December readings indicated movement and/or where stratigraphic evidence suggested movements. Hence the installations have already provided most of the data needed for analysis and design.

Figures 7 to 10 show the downhole temperature profiles. BH94-6 (Fig. 10) leaves little doubt that permafrost is present in the T3 area. This site is representative of the condition of T2 prior to development of the tailings facility. My suspicion that degradation of permafrost accounted for development of both forms of backslope instability is substantiated by these data. There is some evidence in BH 94-5 that limited permafrost remains in the backslope and will require further investigation, analysis and design.

Remaining Work

When we were asked to stop work in early February, we were nearing completion of our field data reduction and beginning the analysis phase of our work. These activities lead up to preliminary re-design concepts, which should be developed interactively with your overall tailings disposal strategy. For example, it is my belief that the backslope instabilities can be effectively stabilized by engineered placement and careful selection of waste in the tailings facility. **It is recommended that we finalize our report of preliminary investigations after having the benefit of working with you on the mine waste strategy.** Our final report would set out the requirements for further geotechnical investigations to be undertaken as part of final design.

Regulatory Position

Failure of the original tailings retention pond was viewed as a serious concern by regulators in the Northwest Territories. I first became aware of this in 1990 while working with the DIAND Senior Environmental Scientist, Dr. K.L. MacInnes, on another project in southwestern NWT. The presentation made by the project team in Yellowknife on January 27, 1995, has, I believe, allayed the regulatory concerns. It is now generally accepted that satisfactory explanations for the poor performance have been delineated and solutions are both possible and feasible.

ACCESS ROAD

Generalized Background

The present route was selected for winter road access. Limited grading was undertaken and existing seismic lines were followed with the exception of the western third where grading was extensive. In general, there is very limited background documentation available.

BGC Involvement

Both Dr. Iain Bruce and myself flew most of the route on different occasions. Our basic conclusions are that the existing road has caused virtually no significant terrain disturbance and upgrading the road to an all weather standard is reasonable. We informally suggested a scope of geotechnical work on several occasions, recommending route selection, terrain analysis, site investigation and design. None was undertaken.

Regulatory Position/Expectations

Unfortunately, the significance of 'upgrading' was seriously under-rated at the January meeting in Yellowknife and it has provided a rallying point for opponents of the project. The two main geotechnical reasons for this are as follows:

1. The original road location was for winter access. It is not reasonable to assume that this is also the best location for an all-weather road. This must be demonstrated through a route selection exercise followed by terrain analysis which supports detailed description of soil/rock and permafrost conditions expected. DIAND obtained excellent airphoto coverage of the winter access road in 1994 as I pointed out to Allan Taylor a couple of weeks ago. Should route selection support a preferred proximal location for the all-weather road, then this 1994 coverage would be well suited for terrain analysis purposes. **I recommend that route selection and terrain analysis proceed immediately.**
2. The Ram Plateau is an area of world class karst (limestone solution) features which have been studied in detail and reported by Dr. Derek Ford of McMaster University. **The all-weather road should be routed so as to minimize impact on this sensitive terrain.** In my opinion this can be done. In fact, I am more concerned about large landslides in the karst area which I don't believe are yet known to the opponents who have, presently, only embraced the karst issue as their cause célèbre.

BUDGET

Tailings Facility

Our initial authorized budget was approximately $87K. Extras requested amount to approximately $15K for a total of $102K. To date we have expended approximately $60K. Remaining authorized budget, including extras, is $42K.

Access Road

No specific budget was set up for this work. We merely responded to specific requests and tracked costs separately. The total billing to date is approximately $6K.

CLOSURE

I trust the foregoing information provides you with an overview of our geotechnical activities. I'll be happy to respond to any questions you may have tomorrow and supply any further information as required. I look forward to meeting you.

Yours very truly
Bruce Geotechnical Consultants Inc.

per K. Wayne Savigny, P.Eng., P.Geo.
Principal

attachments
C:\BGC\0059\LET09.DOC

Eastern Cross-section

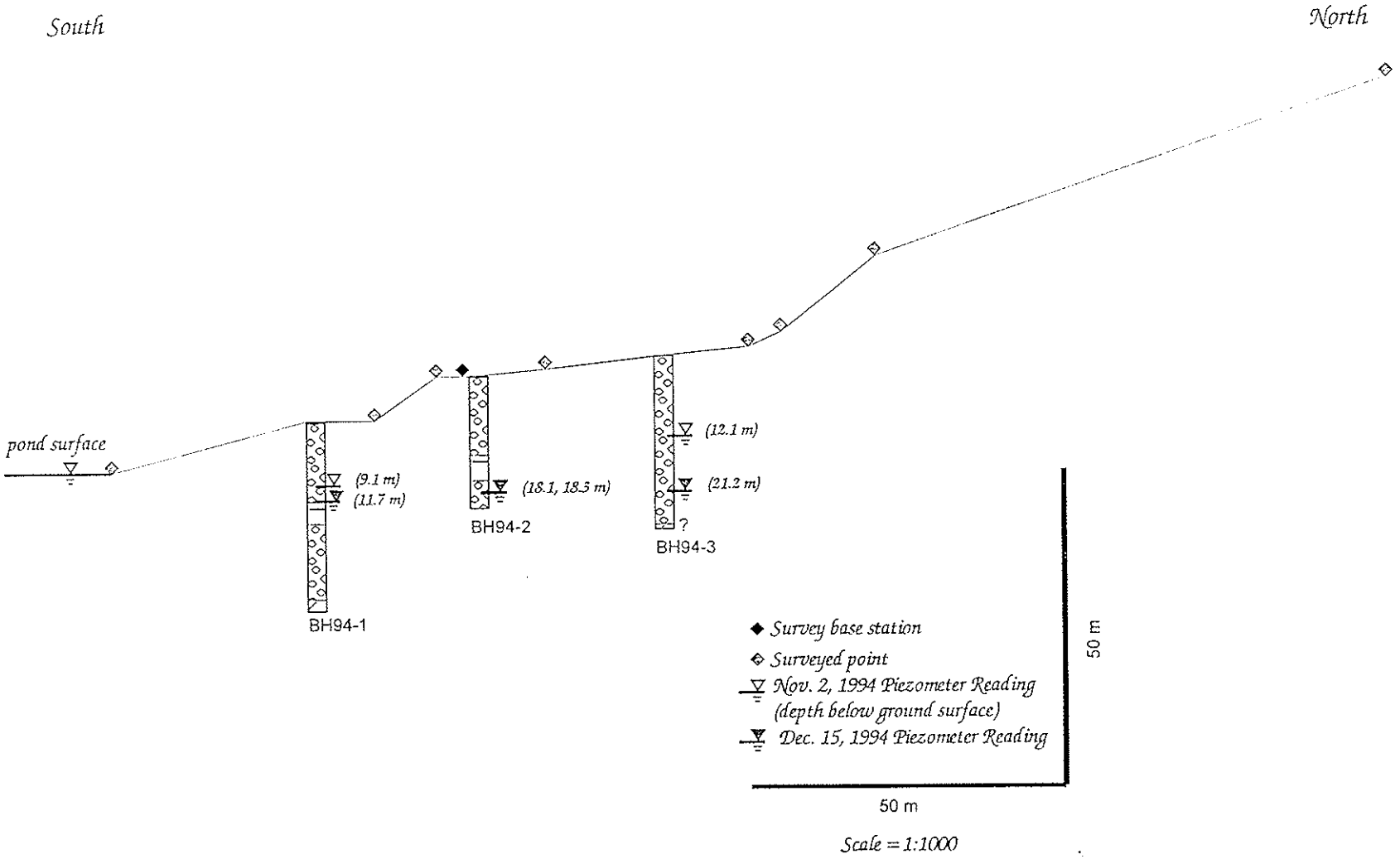


FIGURE 1

Western Cross-section

South

North

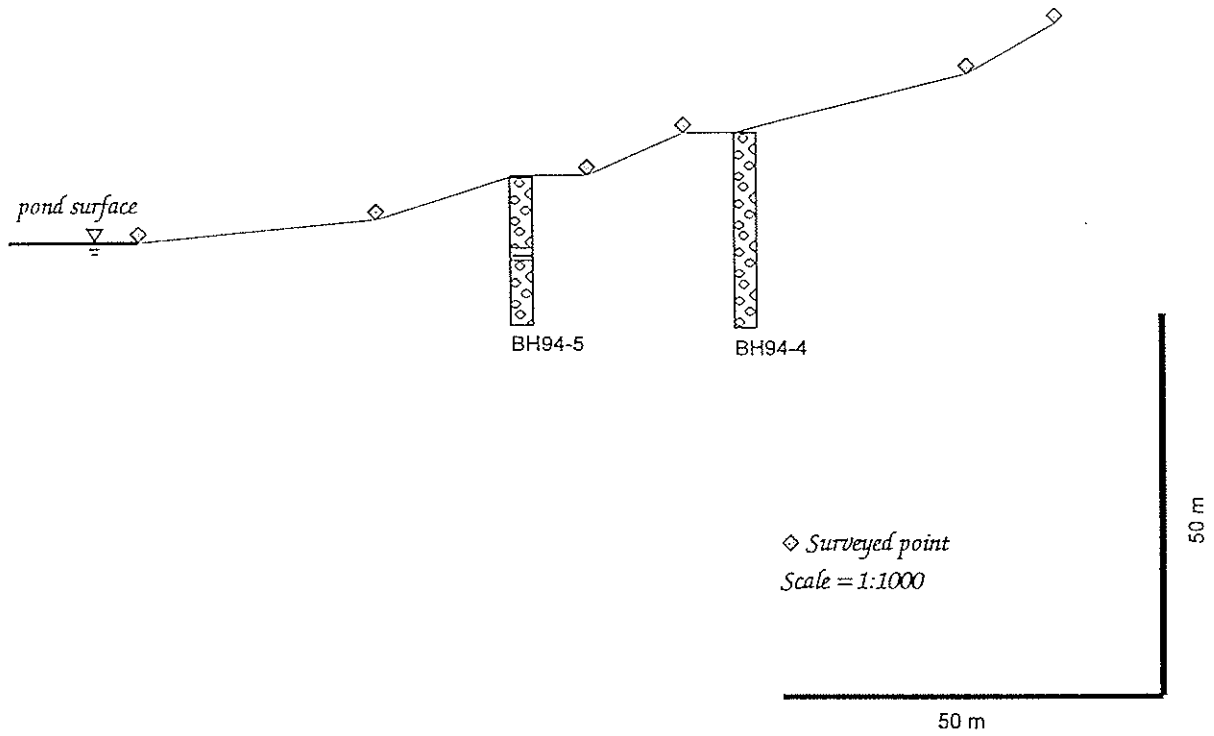
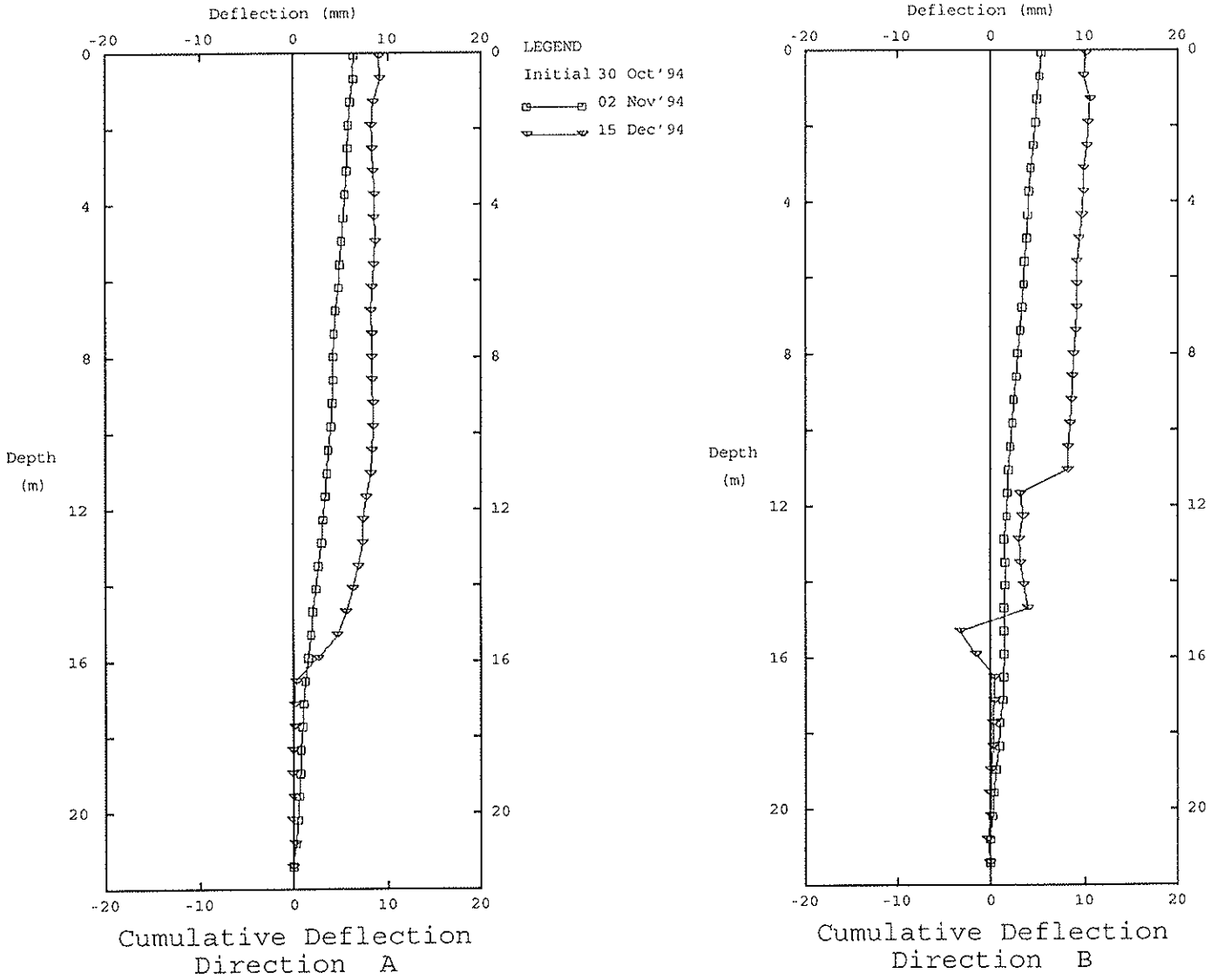


FIGURE 2

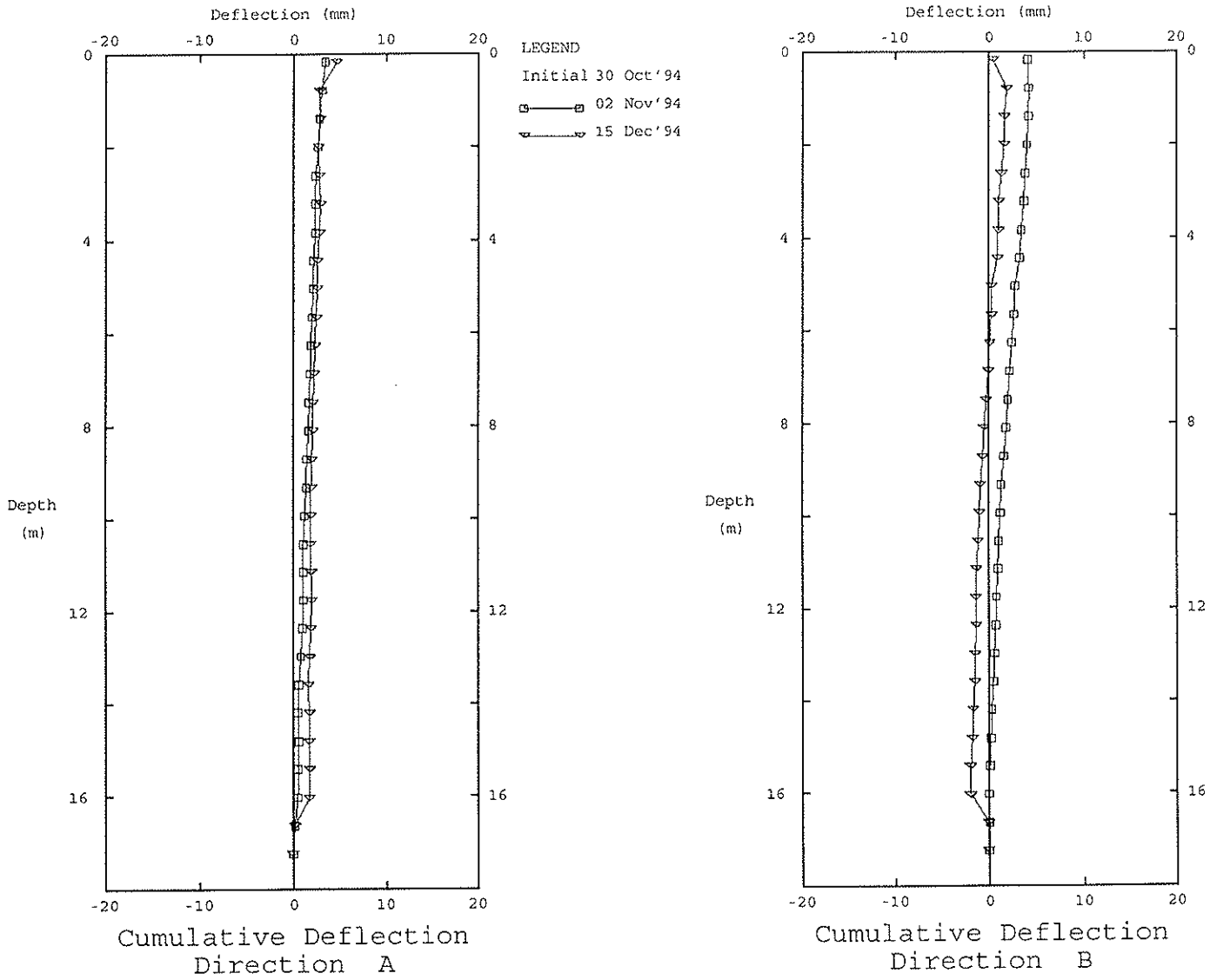
Bruce Geotechnical Consultants Inc. - Vancouver, B.C.



Prairie Crk. (0059-001), Inclinometer BH94-1a
San Andreas

FIGURE 3

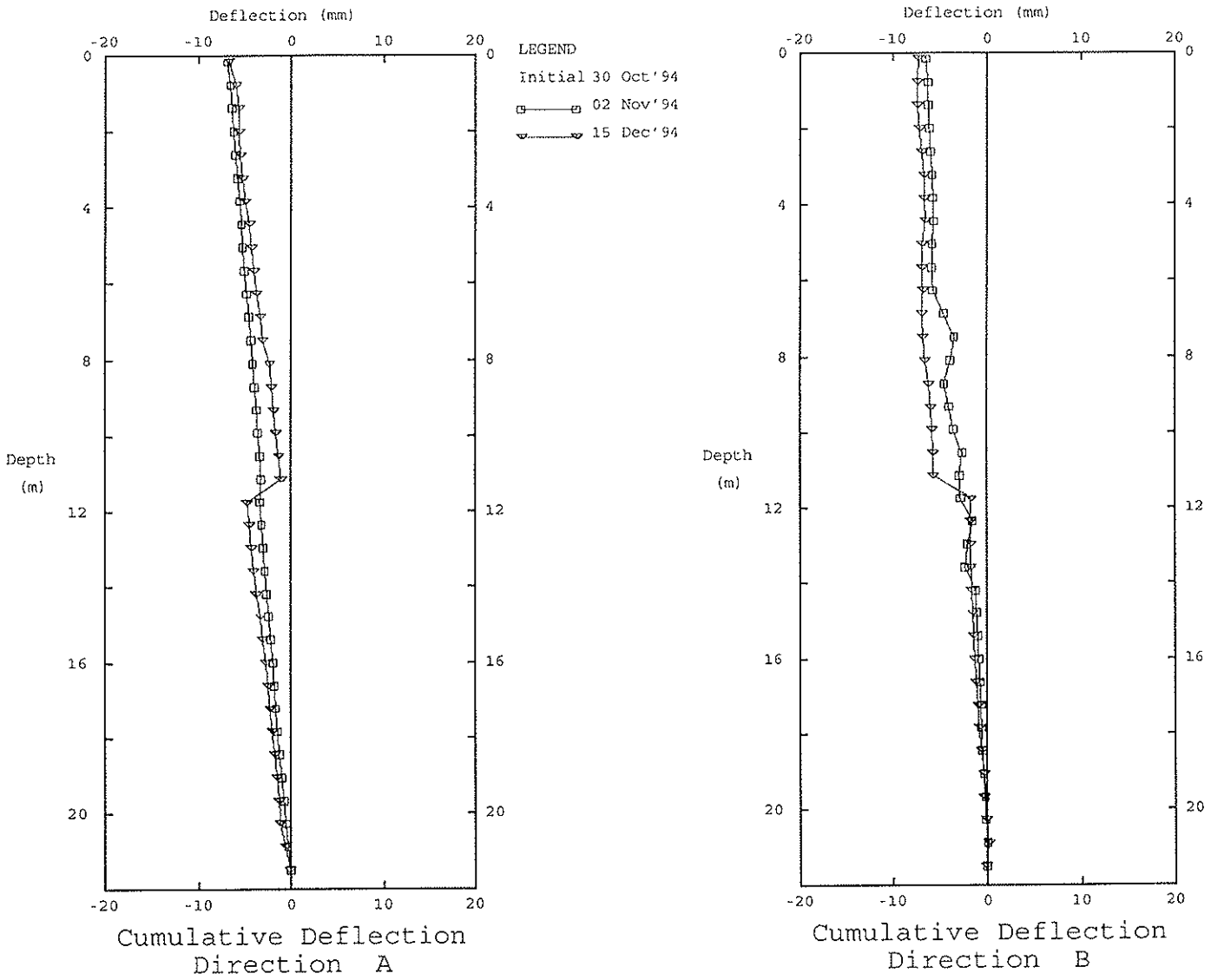
Bruce Geotechnical Consultants Inc. - Vancouver, B.C.



Prairie Crk. (0059-001), Inclinometer BH94-2A
SAN ANDREAS

FIGURE 4

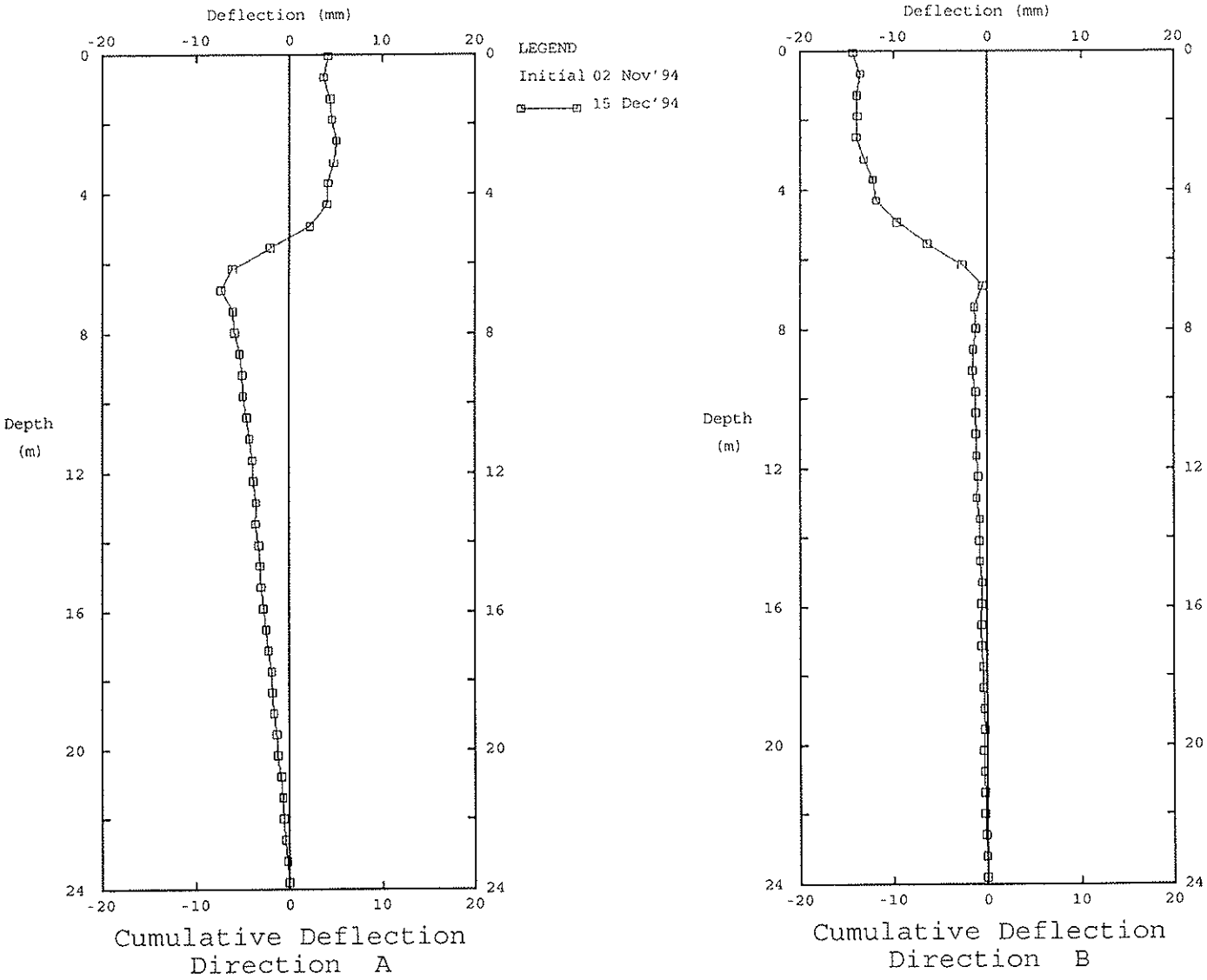
Bruce Geotechnical Consultants Inc. - Vancouver, B.C.



Prairie Crk. (0059-001), Inclinometer BH94-3a
San Andreas

FIGURE 5

Bruce Geotechnical Consultants Inc. - Vancouver, B.C.



Prairie Crk. (0059-001), Inclinometer BH94-4
San Andreas

FIGURE 6

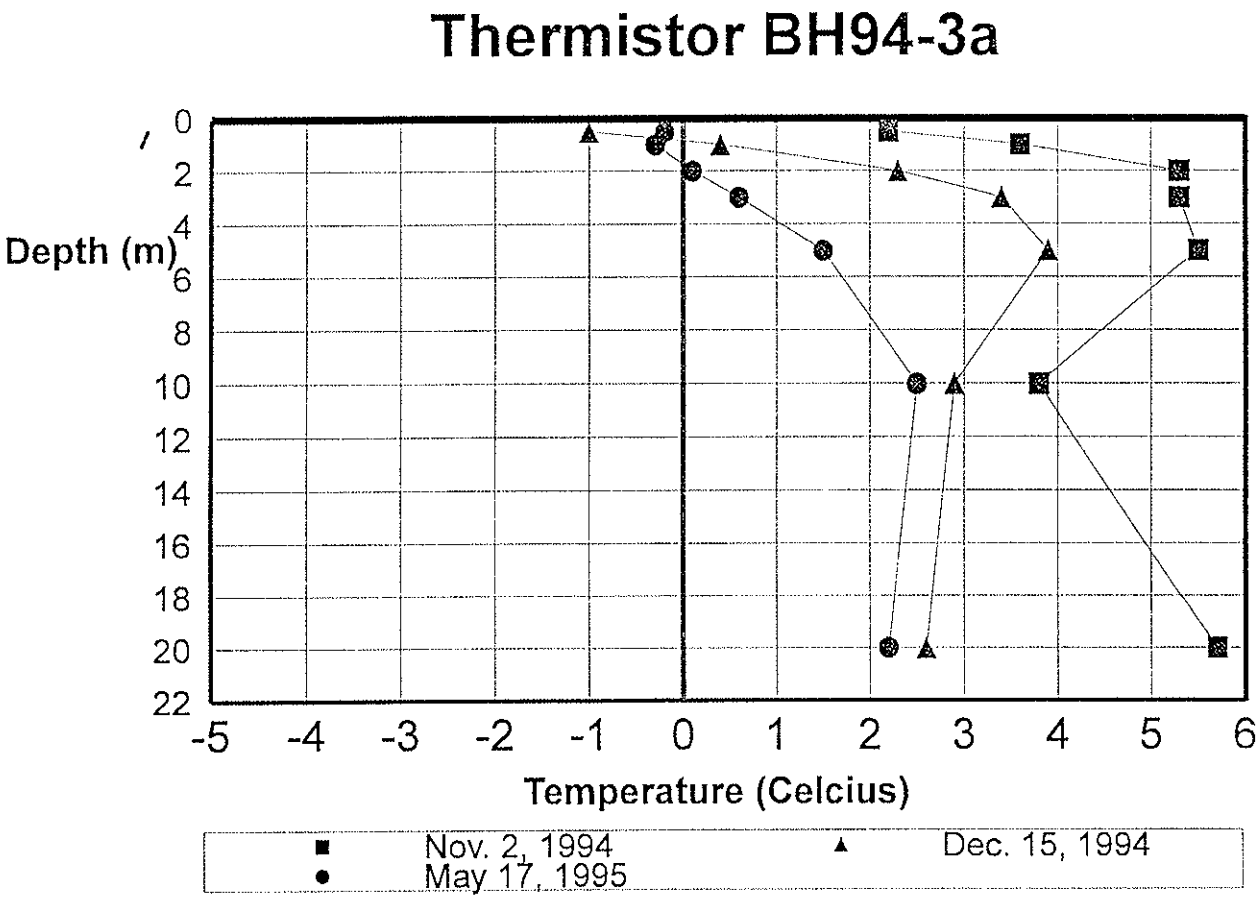
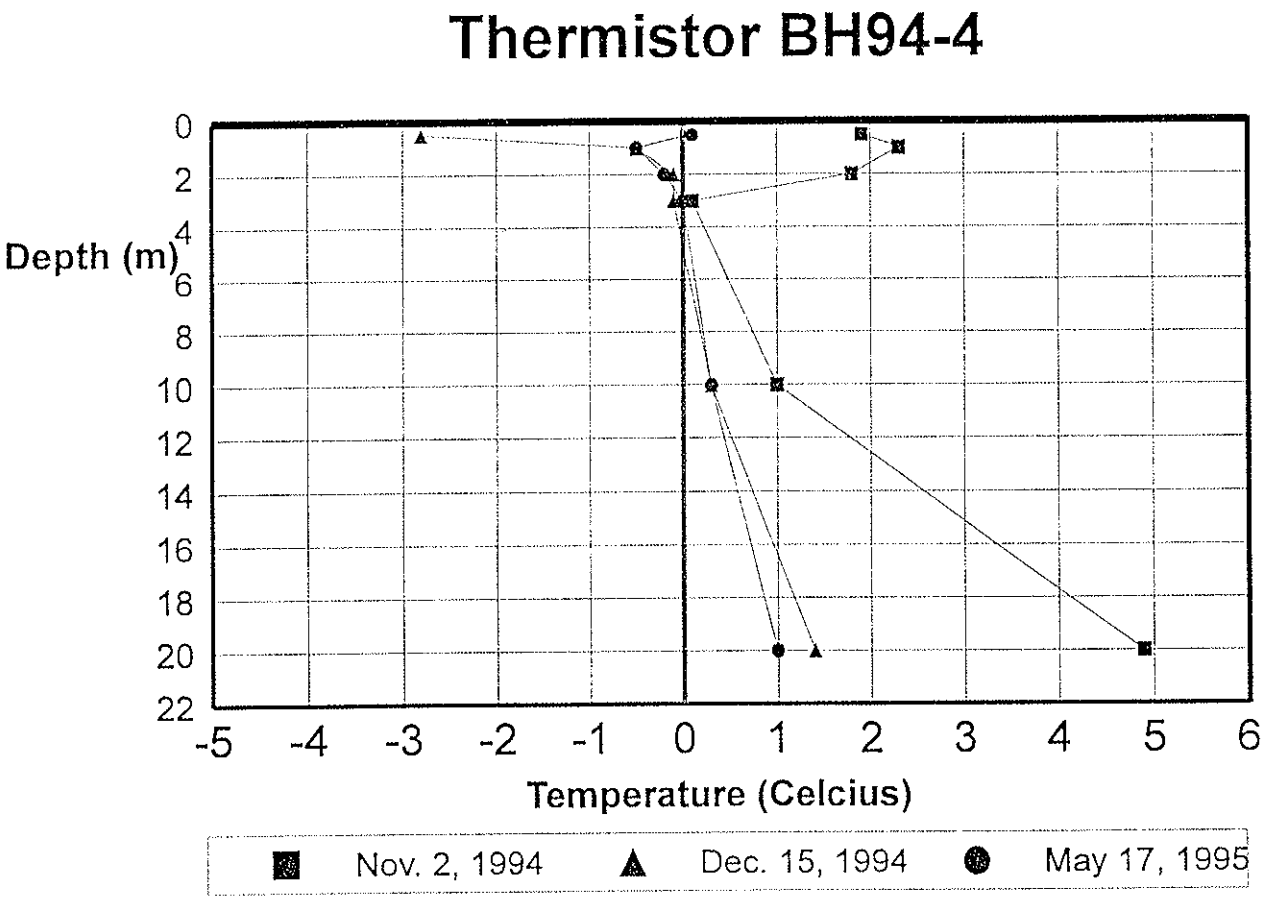

Thermistor BH94-3a
Depth (m)
0
2
4
6
8
10
12
14
16
18
20
22
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Temperature (Celcius)
Nov. 2, 1994
May 17, 1995
Dec. 15, 1994

FIGURE 7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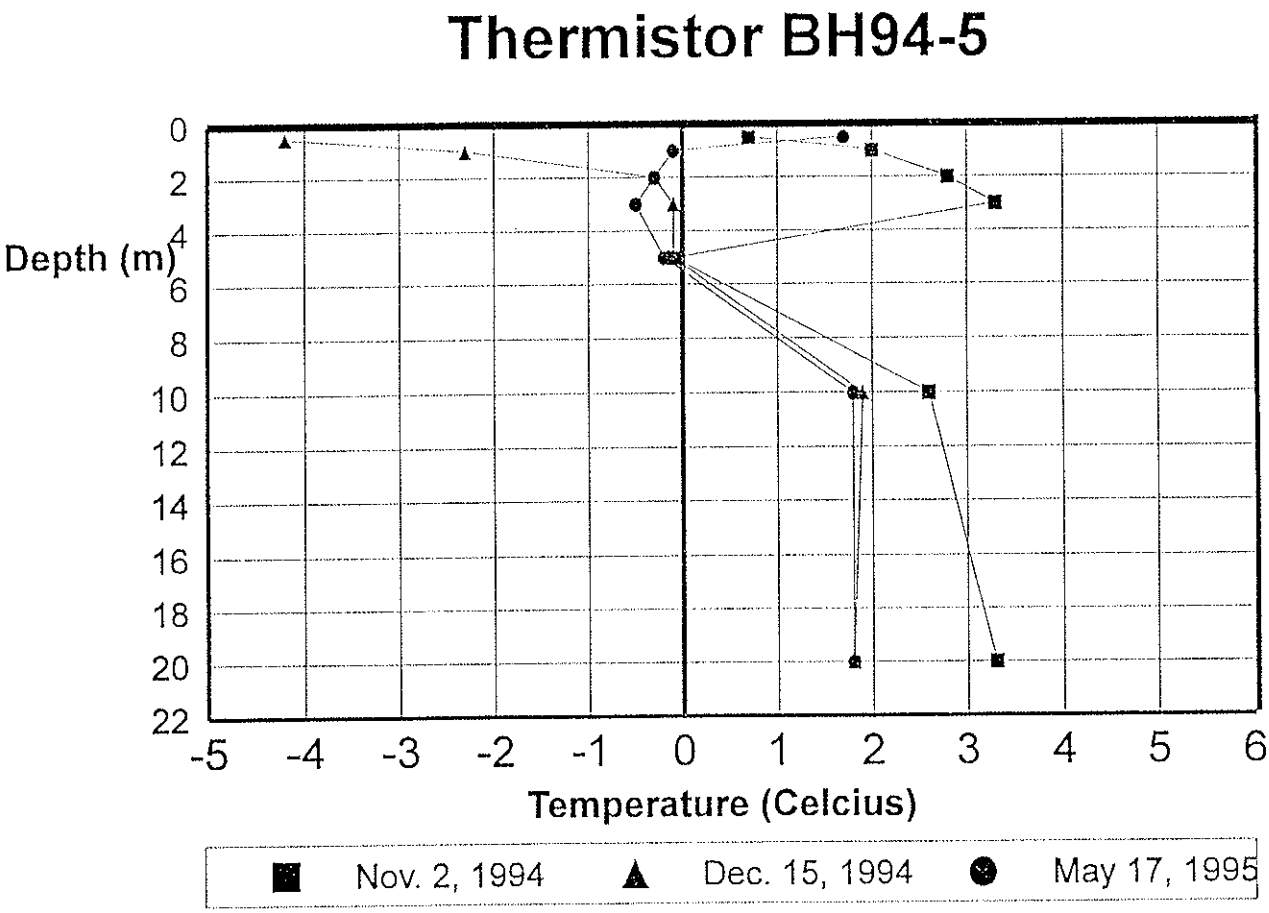
14
16
18
20
22
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Temperature (Celcius)
Nov. 2, 1994
Dec. 15, 1994
May 17, 1995

FIGURE 8


Thermistor BH94-5
Depth (m)
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-3
-2
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2
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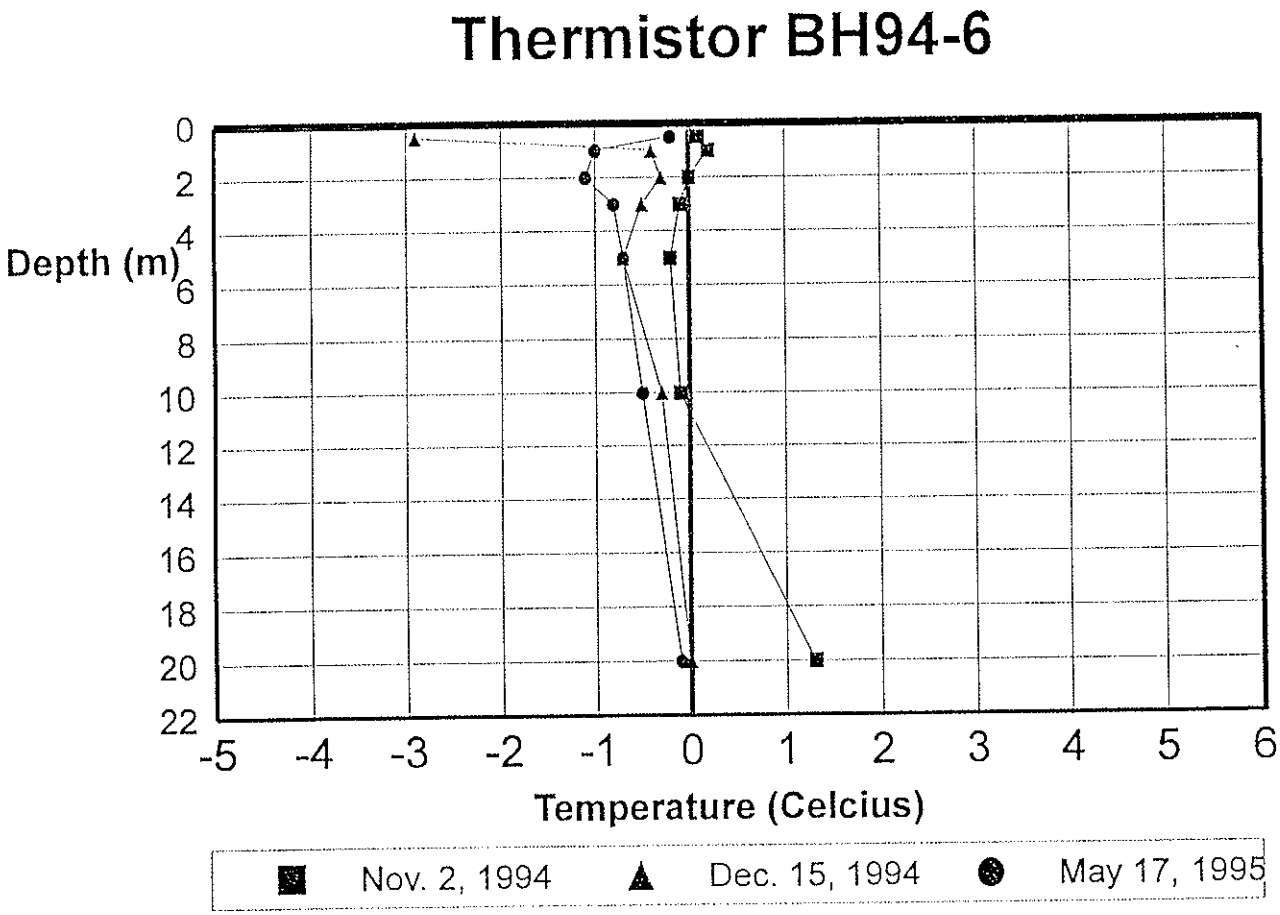
5
6
Temperature (Celcius)
Nov. 2, 1994
Dec. 15, 1994
May 17, 1995

FIGURE 9


Thermistor BH94-6
Depth (m)
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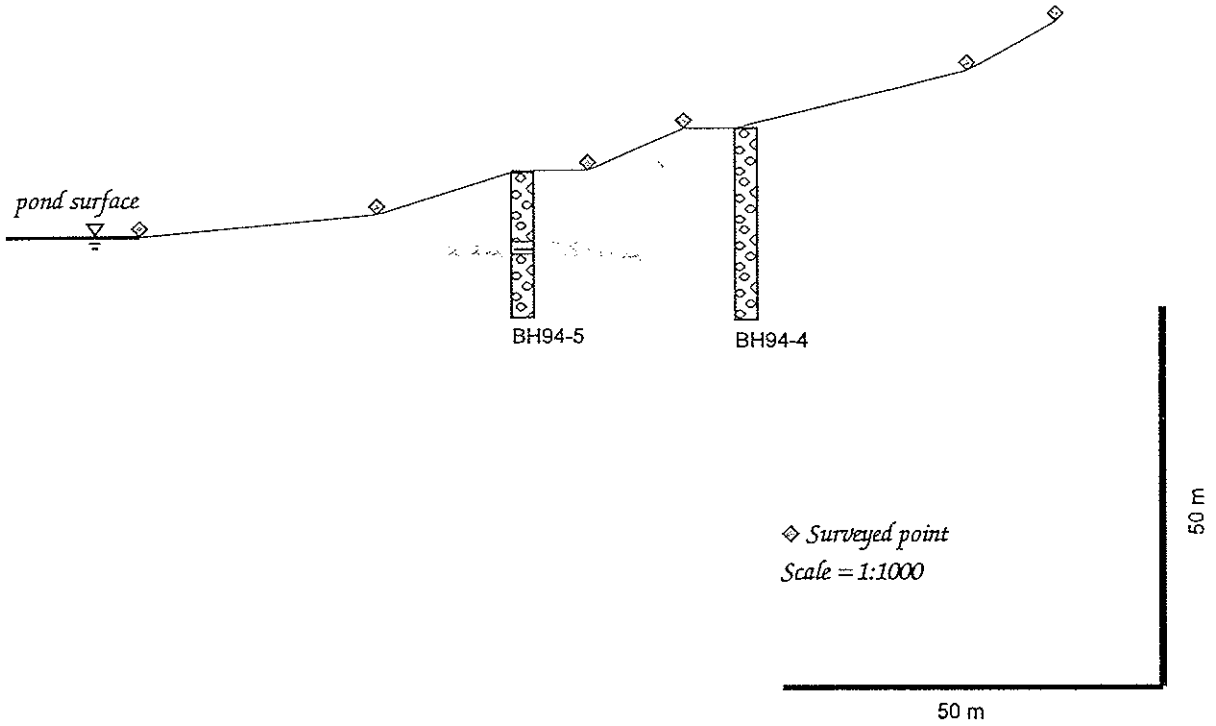
14
16
18
20
22
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Temperature (Celcius)
Nov. 2, 1994
Dec. 15, 1994
May 17, 1995

FIGURE 10

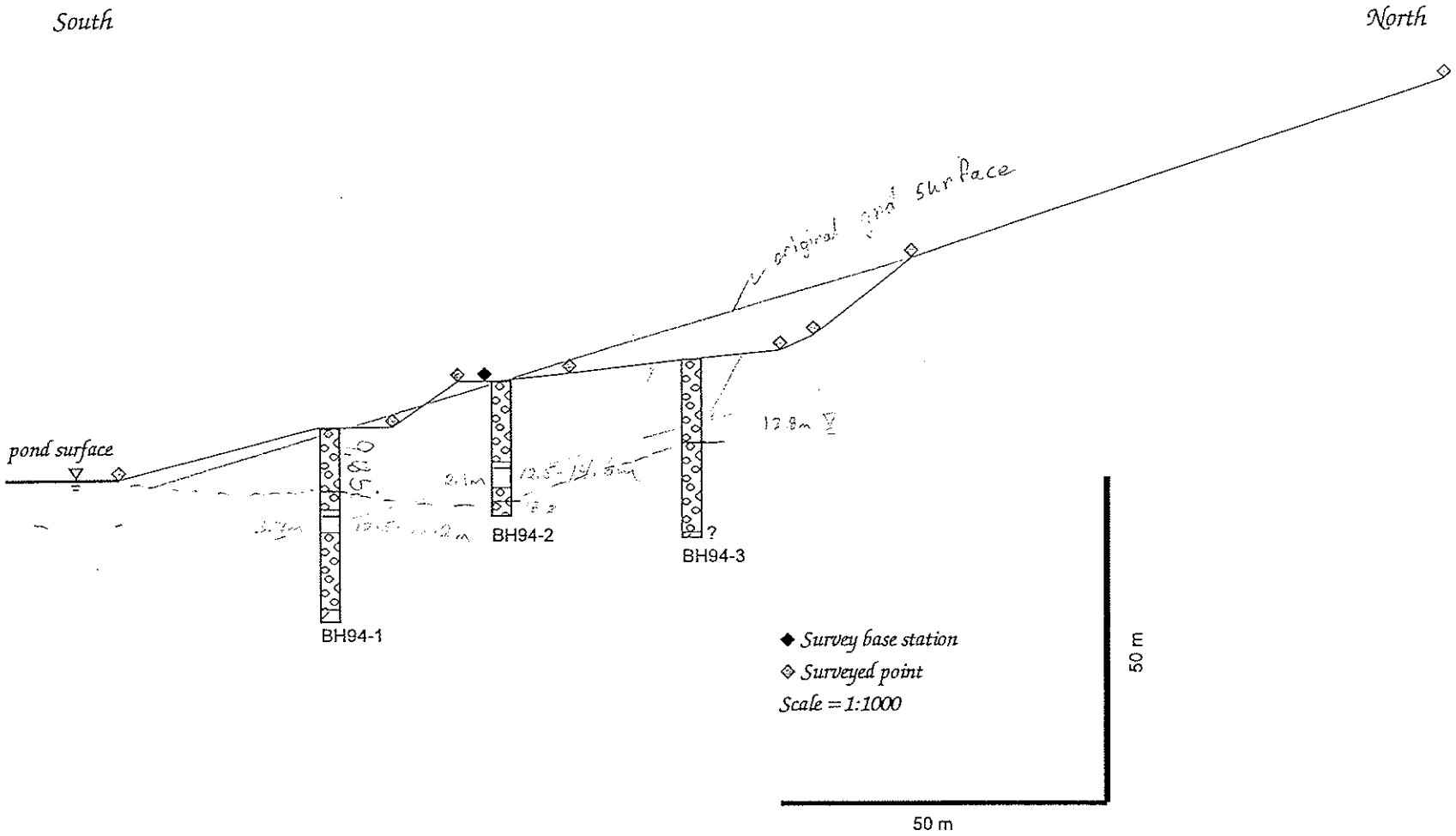
Western Cross-section

South

North



Eastern Cross-section



Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-1a

Date Drilled: Oct. 19, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

NOTES: logged by B. Burton from 0 to 20.1 m

Depth (m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
0.0						0.21m
1.0					NW Casing	
2.0					Gravel -matrix washed out, rock pieces from 2mm to core diameter	
3.0	.05m of 1.52					
4.0	no recovery					
	.05m of .60	G	1		Gravel -medium brown -size: gravel, sandy, some silt, trace clay (fines=30%, low plastic) -gravel is subangular to angular, platy (some blocks), up to 20 mm -argillite and black argillaceous limestone/dolomite -gravel is estimated to be 20% of in situ material	Slope Indicator Grout
5.0	.10m of .90m				-same as above -medium to low plastic, some gravel is partially cored	
6.0	.10m of .60				-gravel, trace fines, as above but more material is washed -some disks of core	
7.0	.10m of 1.52	G	2		-as above but most gravel is blocky with some platy -trace fines; gravel from 2 mm to cored disks	
8.0	.20m of 1.52				-same material as above but coarser, 2 pieces of 20 mm thick core -most gravel is blocky, some is platy; mostly subangular -fines=10%, brown, as above	
9.0	.20m of 1.52	G	3		-black limestone (argillite?), washed, blocky, and partly cored -in shoe: limestone and dark grey, medium plastic silty clay	
10.0						

DRILL HOLE # BH94-1a

Date Drilled: Oct. 19, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES:	
10.0					**Gravel**	
11.0	10m of 1.52				-gravel; angular to subangular black limestone -blocky, some platy; from sand to 20 mm partly cored pieces -fines=10%, brownish grey clay (CI to CH), slippery -finely laminated (1 mm), dips at shallow angle to core axis (15 degrees)	
12.0		G	4		**Clay** -dark grey, stiff, high plastic -not fissured, no pebbles -size: clay and silt, trace sand [13.1-13.3 m] - soft (higher moisture content), no slickensides	
13.0	1.52m of 1.52	G	5			
14.0	1.1m of 1.52	G	6	shear zone	-as above -slickensided surfaces at 15.0, 15.28, 15.3, 15.4 m {14.0-14.7 m} - completely remoulded, no texture, sticks to split spoon (shear zone)	Slope Indicator
15.0		G	7		-slickensided, irregular spacing (approximately 20 mm) -pocket penetrometer results can vary by 50 KPa over 10 mm	
16.0	1.1m of 1.52	G	8		**Gravel** -limestone core with quartz stringers	
17.0	10m of 1.52				-gravel; subangular, slightly polished black argillite/limestone -mostly blocky, some platy; from 4 mm to core	
18.0						
19.0	05m of 76				-core of limestone (up to 50 mm thickness), and angular and subangular chips	
	05m of 76				-mostly gravel (as above), but 1 piece of sand and gravel in a matrix of dark grey silty clay (low to intermediate plasticity) -unsorted, clasts are subangular (fluvial)	
20.0						

DRILL HOLE # BH94-1a

Date Drilled: Oct. 19, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

Depth (m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES: logged by J. Small from 20.1 m to end of hole	
20.0						
	.35m of .61	G	9		**Gravel** -same as above; from 7 mm to almost core diameter -larger subangular pieces in top half of run, bottom half is more rounded and smaller (7mm to 20 mm)	
21.0					-as above, slightly coarser (15 mm to core, most is 20 to 40 mm)	Slope Indicator
	.10m of .91					
22.0					-same as above -subangular, trace of subrounded; from 5 to 40 mm	
	.20m of 1.52	G	10			
23.0						
	.32m of 1.52	G	11		-same as above -subangular, trace of angular and subrounded -from 2 mm to 40 mm, one piece partly oxydized, one 30 mm light grey piece -trace clay on two pieces, some pieces polished (fluvial) -very difficult to advance drilling past 25.3m	
24.0						
25.0	.40m of .61				-same as above -from 5 mm to core diameter; subangular, some subrounded -varying rock type, some polished (fluvial) -one 16 mm long section of core with polished ends (trace boulders)	
	.20m of 1.22				-same as above -top .15 m of sample is 30 to 60 mm sections of core with polished ends (trace cobbles), limestone with quartz stringers -bottom .05 m of sample is 2 to 10 mm subangular to angular dark grey gravel (trace of brown on sides of flat pieces), trace to some clay	
26.0		G	12		-top .1 m of sample: gravel, 7 to 30 mm, subangular, trace of subrounded; occasional light grey rock (fluvial) -.1 to .3 m of sample: gravel and silty clay; gravel is 1 to 7 mm, angular and friable, some oxydized surfaces (colluvium) -.3 to 1.0 m of sample: core (boulders), mostly 10 to 30 mm, brown fines along some faces, end of run was a trace of material similar to that in .1 to .3 m	
	1.0m of 1.37					
27.0						
28.0	.25m of .61	G	13		-top .15 m of sample: gravel; brown and grey, subrounded to subangular (fluvial), from 5 to 20 mm -bottom .10 m of sample: black, angular (fractured), most pieces friable, from 1 to 20 mm with one piece of core	
	1.37m of 1.52				**Bedrock (?)** -pervasively fractured, dark grey to black with trace of white (argillaceous limestone with minor quartz stockworking) -trace oxidation on some fracture surfaces -all fractures (joints) at approximately 50 degrees, spaced from 10 to 120 mm [28.25-28.28]-broken pieces from 5 to 10 mm [28.39]-12 mm of soft, brownish grey clay with clasts (1 to 10 mm) [28.77]-10 mm of clay as above but grey [29.3, 29.52]-4 mm of grey and dark grey clay, as above	
29.0					END OF HOLE AT 29.7m	

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-2a

Date Drilled: Oct. 23, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES: logged by B. Burton	
0.0						0.12m
1.0					Casing	
2.0						
3.0	.20m of 0.91	G	1		Gravel -black argillaceous limestone(/dolomite?) with quartz stringers -angular; 10 to 50 mm, most are 15 mm, some cored pieces	
4.0					-as above -subangular to angular, 10 to 40 mm -one piece with polished faces	
5.0	.05m of 1.52					Slope Indicator Grout
6.0	.30m of 1.52	G	2		-as above, with some siltstone -3 mm to core diameter, most are 15 mm; subangular -trace brown fines on faces -trace polished faces	
7.0	.30m of 1.52				-same as above -mostly angular, trace subangular, rare subrounded	
8.0					-Gravel, sandy, some silt, trace clay -gravel in matrix of medium brown silt, some clay (ML) -gravel is as above	
8.0	.45m of 1.52	G	3			
	.18m of 1.52	G	4		-bonded sample, two disks of rock at each end of sample -as above; gravel is subangular to angular	

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-2a

Date Drilled: Oct. 23, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES:	
10.0					**Gravel**	
11.0					-subangular to angular gravel, mostly limestone -3 to 40 mm -some fines preserved in shoe, medium brown silt, some clay	
12.0	.35m of 1.52					
13.0		Waxed Core	5		**Clay** -dark grey high plastic clay (CH) -well bonded, laminated -massive (no slickensides) -cored disk of rock in shoe	
14.0	.25m of 1.52					
	.30m of 50	G	6		-top .15 m of sample is CH as above with trace sand/fine angular gravel -bottom .15 m of sample is soft, remoulded CH (shear zone?)	Slope Indicator
	Shear Zone (?)	G	7		(attempted Shelby Tube sampling at 14.6 m; poor recovery -.12 m of .50 m, sample was gravel, tube was slightly dented)	
15.0	.15m of 1.52				**Gravel and Clay** -top .10 m of sample is angular and subangular gravel, 5 to 30 mm, black (limestone?) in clay; with some some polished, subangular to subrounded gravel, 5 mm -in shoe:dark grey high plastic clay	
16.0		G	8		**Clay** -.56 m of dark grey high plastic clay overlying gravel -polished faces (shear surface with no obvious direction of movement) at .15, .25 m depth in clay	
	.65m of 1.52	Waxed Core	9			
17.0					**Gravel** -black (limestone?), subangular, 20 to 30 mm, partly cored	
18.0					-gravel, some silt, trace to some clay, trace sand -gravel in clay matrix -gravel is subangular black limestone, occasionally platy	
	.20m of 91	G	10			
19.0					-gravel -5 mm to core diameter (cobbles or boulders) -mostly subangular, angular on fresh fractures	
	.45m of 1.52					
20.0						

(Difficulties during installation prevented seating the slope indicator deeper)

DRILL HOLE # BH94-2a

Date Drilled: Oct. 23, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

..(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES:	
20.0						
	25m of 1.52				Gravel -as above with less material of core diameter -brownish grey clayey silt on some faces	
21.0					END OF HOLE AT 21.6m	
22.0						
23.0						
24.0						
25.0						
26.0						
27.0						
28.0						
29.0						
30.0						

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-3a

Date Drilled: Oct. 25, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

Depth (m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
0.0					NOTES:	
					Casing	0.11 m; Thermistor; Slope Indicator
1.0						
2.0						
3.0	.20m of 0.91	G	1		Gravel -mostly black argillaceous limestone, some fine grained dark grey/black rock (argillite?) -angular to subangular; 2 to 30 mm, some pieces cored -blocky, rare platy; some polished -trace fines on some faces	
4.0	.15m of .52	G	2		-8 cm section of sample with fines in place (sample 2) (accidentally drilled with very low water pressure) -gravel, sandy, some silt ot silty, trace clay -gravel=sand size to cored disks; angular to subrounded, blocky, subrounded, polished (fluvial?) -medium brown, slightly bonded, moist	Slope Indicator; Cuttings
5.0	.30m of 1.52				-mostly limestone; some subrounded, dark grey to black soft (siltstone) and hard (sandstone) sedimentary rock -angular to subangular trace of medium brown fines on some faces	
6.0	.08 of .46m	SPT 11 26 36	3		-SPT at 21 ft, poor recovery -gravel, sandy, trace silt, trace clay -gravel was up to 15 mm, angular limestone and subangular siltstone (some polished surfaces)	
7.0	.10m of 1.52				-gravel with trace fines on some faces -limestone, sandstone, siltstone, conglomerate with voids -angular and subangular; both platy and blocky; up to 20 mm -rare polished surfaces	
8.0					-as above -5 mm to near core size	
9.0	.25m of 1.52					
10.0	.30m .52	G	4		-as above -5 mm to core size	
10.0						

DRILL HOLE # BH94-3a

Date Drilled: Oct. 25, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

..' (m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES: 0 to 15.5 m logged by B. Burton	
10.0						
11.0					Gravel -angular to subrounded, most are subangular -some polished surfaces (fluvial?) -2 mm to core (40 mm) size -black limestone, siltstone some fines preserved (medium brown, clayey silt)	
12.0	.40m of 1.52					
13.0	.30m of .91				-as above, mostly limestone -angular to subangular, some subrounded	
	.14m of .15				-as above, 10 mm to 10 mm long core	
14.0	.15m of 1.52				-angular, blocky, black argillaceous limestone with crinoids -sugangular, blocky and platy, dark brownish grey siltstone -10 to 30 mm size	Slope Indicator
15.0						
	.20m of .45	G	5		-top .10 m of sample is gravel as above -bottom .10 m of sample is 50% gravel and sand, 50% dark grey high plastic clay (CH) -in shoe: core of black limestone	
16.0					No Recovery	
17.0						
18.0						
19.0						

DRILL HOLE # BH94-3a

Date Drilled: Oct. 25, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗in situ ⊕remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES: logged by J. Small from 15.5 m to 27.4 m	
20.0					No Recovery	
21.0						Slope Indicator
22.0		G	6		**Gravel** -dark grey limestone, some brown (siltstone?) -from 10 mm to almost core diameter -subangular to subrounded, trace of angular -some pieces are polished (possibly cored boulders)	
23.0	.15m of 1.52	G	7			
24.0	.27m of 1.22	G	8		-top .10 m of sample is same as above -.06 m of dark grey limestone core, planar at end of piece with a trace of brown fines -two pieces of .03 m grey and brown rock (siltstone?) -some gravel, 1 to 20 mm diameter, angular to subangular, trace subrounded; grey and brown	
25.0	.40m of 1.52	G	9		-top .13 m of sample is dark grey gravel, subangular and subrounded (possibly slough) -bottom .27 m of sample is 50% gravel bonded by a matrix of clay/silt -gravel is 1 to 30 mm	
26.0	.48m of 1.52				-top .14 m of sample is gravel; dark grey; 10 to 40 mm; subangular with a trace of subrounded -(limestone with trace of siltstone) **Bedrock (?)** -.14 to .38 m is dark grey with trace of white; two parallel planar joints at 55 deg (possibly bedrock) -bottom .12 m of sample is subangular pieces, dark grey and brown, supported in a clay matrix	
27.0					END OF HOLE AT 27.4m	
28.0						
29.0						

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-4

Date Drilled: Oct. 28, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES: -logged by J. Small from 0 to 13.1 m, and 24.7 to 25.5 m, logged by B. Burton from 13.1 to 24.7 m	
0.0						0.23m
1.0					Casing	Thermistor, Slope Indicator
2.0						
3.0						
4.0					**Gravel** -brown and grey (limestone? and siltstone?) -subrounded, 5 to 30 mm -two .10 m sections of core - (argillaceous limestone with crinoids) (cobbles and boulders)	Slope Indicator Grout
5.0	.32m of 1.52	G	1		-same as above -subangular, trace subrounded, trace angular -10 to 25 mm -mostly blocky, some platy -trace of brown fines on some faces	
6.0	.15m of 1.52					
7.0		SPT (no recovery)			-as above -subangular and subrounded	
8.0	.22m of 1.52				-as above -less subrounded pieces -trace platy	
9.0	.25m of 1.37	G	2			
10.0	.19m of 1.52				-as above -10 mm to discs of core diameter -most faces are smooth, polished	

DRILL HOLE # BH94-4

Date Drilled: Oct. 28, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES:	
10.0					**Gravel**	Slope Indicator
11.0					-grey (limestone?) and some brown (siltstone/shale?) -10 mm to core diameter -subangular, trace subrounded -trace of brown fines on some faces -core is limestone with crinoids (.35 m long), one side is polished (fluvial cobbles?)	
12.0	.33m of 1.52					
13.0	.23m of .76				-as above -trace of both brown and grey fines	
14.0	.32m of .60	G	3		-2 mm to near core diameter, most are 10 mm -black argillaceous limestone with quartz stockworking, and shale -trace of medium brown clay on faces -subangular (usually polished - fluvial) and some angular	
15.0	.60m of 1.37				-as above -2 mm to core diameter, most are 30 mm -one piece of .80 mm long core of black chert -trace of medium brown fines at top of sample, dark grey fines on bottom -mostly blocky	
16.0	.14m of .46	G	4		-as above; most are 20 mm size -angular,some subangular -trace of brownish grey and dark grey sandy fines on some faces	
17.0	.33m of 1.52				-as above -less fines than above	
18.0	.30m of 1.52				-as above -2mm to core diameter; most is 10 to 50 mm long core blocky, mostly angular -core has weathered faces (cobbles) -trace brownish grey fines on some surfaces	
19.0	.23m of 1.52	G	5		-3 to 30 mm, most is 10 mm -mostly shale, rare sandstone and limestone; all black -almost all faces weathered (brown calcite coating) -mostly platy -trace dark brown fines	

DRILL HOLE # BH94-4

Date Drilled: Oct. 28, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

Depth (m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES:	
20.0						
	20m of 76				Gravel -as before, with one 60 mm long piece of core (light grey, very hard - sandstone?) -trace grey fines	
21.0					-as above, no core	Slope Indicator
	19m of 76					
22.0					-as above, with some blocky grey limestone -one piece of limestone core, had matrix preserved -matrix was: -medium grey silt, some sand, some clay -low to medium plastic -gritty, reacts with HCl	
	20m of 1.52	G	6			
23.0						
					No Recovery	
24.0						
25.0					Gravel -5 mm to core diameter; limestone -subangular, trace subrounded -blocky with trace platy	
	23m of 1.52	G	7			
					END OF HOLE AT 25.6m	
26.0						
27.0						
28.0						
29.0						
30.0						

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AN APPLIED EARTH SCIENCES COMPANY

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-5

Date Drilled: Oct. 30, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

NOTES: logged by J. Small from 0 to 4.9 m, logged by B. Burton from 4.9 to 21.0 m

(m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
0.0						0.20m
					Casing	Thermistor; Slope Indicator
1.0						
2.0						
3.0					Gravel -1 mm to core diameter -dark grey (limestone?) and trace brown rock (shale?) -mostly blocky, trace platy -subangular, trace subrounded -some polished surfaces -trace of brown fines on some faces	
4.0	.10m of .30					
	.17m of 1.52					Slope Indicator Grout
5.0					-mostly angular, platy shale, some subangular, blocky limestone -some weathering -trace of medium brown fines on some faces	
6.0	.16m of 1.52					
		SPT 10 16 19 31	1		(SPT sample taken at 6.4m, overdrove sampler to .60m; sample: Sand and Gravel (fine), trace silt, trace clay, greyish brown, saturated, angular, platy, (shale?) - probably sloughed material) -most of material is as in SPT sample -in shoe: 30 mm subangular rock (limestone + intrusive(?))	
7.0	.62m of 1.52					
8.0						
	.01m of 1.52					
9.0					Clay -smear of medium grey clay on shoe	
	.62m of 1.52	waxed core	2		-dark grey high plastic clay, very finely laminated -top .05 m of sample had 20% gravel description continued on page 2	

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-5

Date Drilled: Oct. 30, 1994 | LOCATION: north of tailings pond
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES:	
10.0					**Clay** -continued from page 1 -no slickensides -1 mm layer of fine sand at .15 and .17 m of sample -sample 2 has a bulged section (slickenside?)	
11.0					(Shelby tube sampling tried at 11 m, sample contained gravel and dark grey clay, end of tube was completely dented in)	
	.87m of 1.52				**Gravel** -argillaceous, black, limestone/dolomite core (boulder) -hard -some joints - .10 to .15 m spacing, rough surfaces	
12.0						
					-4 mm to core diameter (120 mm long), most are 20 mm -angular to subangular limestone -some weathering (calcareous coating) -trace greyish brown fines on some faces -trace polished surfaces	
13.0	.50m of 1.52					
14.0					-limestone with crinoids (as above), trace intrusive (?) -2 mm to 250 mm of core (boulder) -trace greyish brown fines on some faces	Slope Indicator
	.0m of 1.52					
15.0					-as above -3 mm to 60 mm of core, most are 15 mm -angular and subangular, some calcareous weathering	
16.0	.21m of .61					
		G	3		-gravel with grey fines on some faces -subangular, blocky, some weathering -top .06 m of sample is light to medium grey, soft, finely laminated (coarser than clay above) clay (Cl); 10% gravel	
17.0	.34m of 1.52					
18.0					-gravel, silty trace sand, tracle clay -limestone gravel in a silt matrix -gravel is 2 mm to near core diameter	
	.34m of 1.52					
19.0						
20.0					END OF HOLE at 21.0 m, but no sampline from 19.2 m to 21.0 m	

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-6

Date Drilled: Nov. 1, 1994	LOCATION: T3 Tailings Site
Rig: Longyear 38	ELEVATION:
Contractor: San Andreas	CO-ORDINATES:
Sampling: NQ core, NW casing	SOIL DESCRIPTION

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa

VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa

MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

NOTES: logged by J. Small from 0 to 17.1 m, logged by B. Burton from 17.1 to 21.6 m

Instrument Installation: Thermistor

0.0

Casing

1.0

2.0

3.0

No Recovery

-slope indicator cap was wedged into casing

4.0

5.0

Clay

G 1 — .87m of 1.52 — waxed core 2

-dark grey high plastic silty clay (CH)
-finely laminated, laminations intersect (cross bedded?)
-slickensides orientated at approximately 60 degrees to core axis
-slickensides at .25, .31, .39, .63, .75, .81 m of sample
-10 mm piece of ice at bottom of sample

6.0

-same as above
-frozen, Nbn, ICE (planar lenses, possibly associated with slickensides)
-ICE lenses at: .33 to .37 m, .57 to .62 m, .80 to .84 m

7.0 — G 3 — 1.0m of 1.52

8.0

-same as above
-Vs to ICE lenses (10 to 40 mm thick) at .40, .61, .75, .89, .98 m of sample
-Vx at .79 m of sample

1.10m of 1.52 — G 4

9.0

.49m .52 — G 5

-as above
-Vs at 10 to20 mm and at 260 mm; Vx at 410 to 450 mm

10.0

DRILL HOLE # BH94-6

Date Drilled: Nov. 1, 1994 | LOCATION: T3 Tailings Site
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

Depth (m)	Recovery	Sample Type	Sample #	Symbols	Instrument Installation	SOIL DESCRIPTION
						NOTES:
10.0						**Clay**
11.0						-same as above -Vx (3 to 5 mm chips) at 0, .10, .14, .21 m of sample -Vs at .340 to .347, .430 to .440 m -slickenside at .200 m -cross bedding of laminations more subtle, almost 90 degrees to core axis
12.0	.67m of 1.52	G	6			
13.0						**Clay and Gravel** -clay is as above -gravel is subangular, 1 to 30 mm -no visible ice, sample soft and moist (possibly due to sample disturbance)
14.0	.68m of 1.52					
15.0	.93m of 1.52	G	7			-50% gravel, 5% clay, as above -5% gravel from 210 to 530 mm of sample -frozen, Vs from .200 to .210 m of sample -ICE from .360 to .410 m of sample -Vx/Vs from .300 to .360 m of sample -joints at 30 degrees to core axis at .490 and .530 m (possibly slickensided)
16.0	.70m of 1.52					**Clay** -as before, approximately 5% gravel -10% ice from .240 to .400 m -ice lenses at .110 to .130, .232 to .240, .365 to.390, .525 to .540 m of sample -joints at approximately 30 degrees to core axis, possibly slickensided, at .120, .220, .430 m -Vx at.430, .580 to 400 m
17.0						**Gravel** -gravel, clayey, sandy, silty -gravel in a dark grey matrix -gravel is angular and subangular, black shale -2 mm to core diameter -unfrozen
18.0	.23m of 1.52					
19.0	.22m of 1.52					-trace dark grey clay on faces -2 mm to core diameter -angular and subangular -black limestone and shale -rare polished surfaces
20.0						

Project: Prairie Creek
Project No.: 0059-001

DRILL HOLE # BH94-6

Date Drilled: Nov. 1, 1994 | LOCATION: T3 Tailings Site
Rig: Longyear 38 | ELEVATION:
Contractor: San Andreas | CO-ORDINATES:
Sampling: NQ core, NW casing

POCKET PENETROMETER VALUES ● 100 200 300 400 Kpa
VANE SHEAR VALUES ⊗ in situ ⊕ remoulded 100 200 300 400 Kpa
MOISTURE CONTENT X % 10 20 30 40 50 60 70 80 90

m)	Recovery	Sample Type	Sample #	Symbols	SOIL DESCRIPTION	Instrument Installation
					NOTES:	
20.0						
	.05m of 1.52				Gravel -same as before -2 to 20 mm	
21.0					END OF HOLE AT 21.6m	
22.0						
23.0					Thermistor placed downhole to a depth of 20.1 m and backfilled with sand. Disturbance of the natural vegetation at the site was minimized.	
24.0						
25.0						
26.0						
27.0						
28.0						
29.0						
30.0						

THURBER ENGINEERING LTD.

Suite 210, 4475 Viewmont Ave.
VICTORIA, B.C. V8Z 6L8
Phone (604) 727-2201
Fax (604) 727-3710

THURBER

PARTICLE-SIZE ANALYSIS REPORT

TO: Mr. Bill Burton

CLIENT: Bruce Geotech. Cons. Inc.
210 - 1290 Hornby Street
Vancouver, B.C.
V6Z 2G4

FILE NUMBER: 19-1997-1

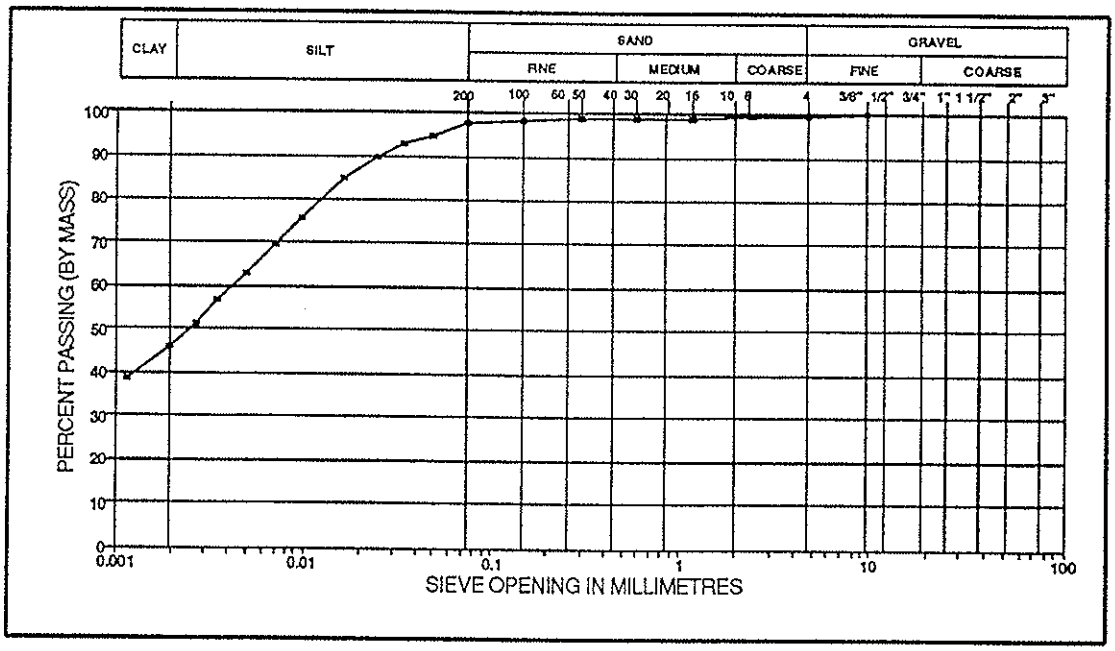
REPORT DATE: December 14, 1994

PROJECT: Prairie Creek

SAMPLE: # 9
SOURCE: BH 94-2A
TEST METHOD: ASTM D-422

DATE SAMPLED:
DATE RECEIVED:
DATE TESTED: December 12, 1994

REMARKS: Gravel = 0.4 % Sand = 2.0 % Silt = 51.3 % Clay = 46.3 %



Gravel Size		Percent	Sand Size		Percent	Hydrometer		Percent	Hydrometer		Percent
Inches	mm	Passing	Inches	mm	Passing		mm	Passing		mm	Passing
3	75		No. 4	4.75	100		0.0488	94.6		0.0035	57.1
2	50		No. 8	2.36	99		0.0349	92.6		0.0027	51.2
1 1/2	37.5		No. 16	1.18	99		0.0251	89.6		0.0020	46.3
1	25		No. 30	0.6	99		0.0163	84.7		0.0012	38.4
3/4	19		No. 50	0.3	99		0.0098	75.8			
1/2	12.5		No.100	0.15	98		0.0071	69.9			
3/8	9.5	100	No.200	0.075	97.6		0.0051	63.0			

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THURBER

CONSOLIDATION TEST REPORT

TO: Mr. Bill Burton

CLIENT: Bruce Geotechnical Cons. Inc.
210 - 1290 Hornby Street
Vancouver, B.C.
V6Z 2G4

FILE NUMBER: 19-1997-1

REPORT DATE: December 14, 1994

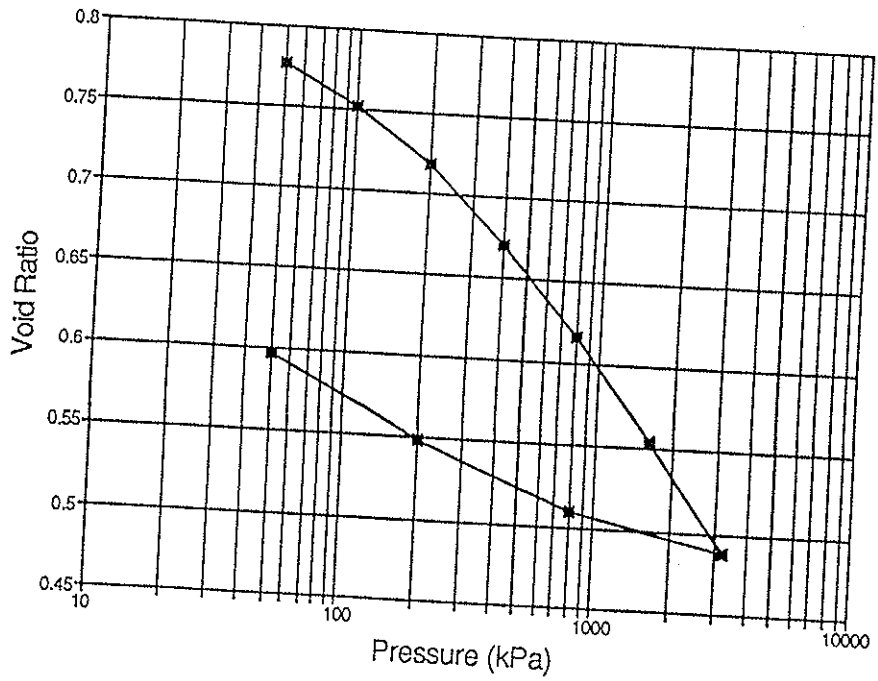
PROJECT: Prairie Creek

SAMPLE: BH 94-2A Sa.9

PROCEDURE: Tested in accordance with Standard Test Method for One Dimensional Consolidation Properties of Soils. ASTM D 2435-80, method B.

	Start of test	End of test
Wet Dens. (kg/m^3)	2,027	2,159
Dry Dens. (kg/m^3)	1,608	1,786
Moisture Cont. (%)	26.6	20.9
Saturation (%)	97	100
Void Ratio	0.780	0.596

NOTE:



CONSOLIDATION TEST REPORT

Bruce Geotechnical Cons. Inc.
Prairie Creek

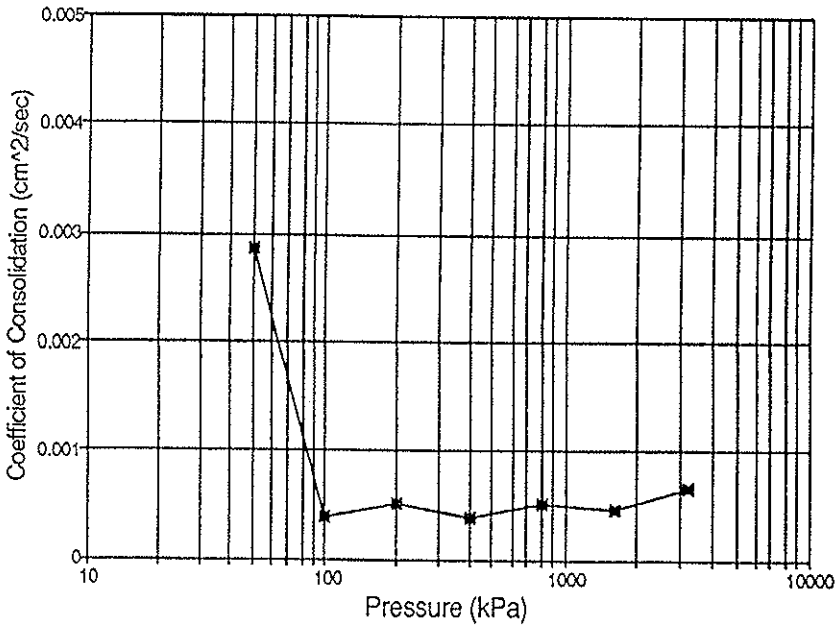
BH 94-2A Sa.9

TRIMMING: The specimen was manually trimmed to size with the aid of a trimming shoe, then mounted in a fixed ring consolidometer.

FLOODING: A 2 kPa seating load was applied and 10 minutes later the consolidometer was flooded with distilled water. As swelling began to occur the load was increased by increments to 25 kPa to prevent swelling. The first consolidation load of 50 kPa was then applied.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root of time method.

Pressure (kPa)	H@D50 (cm)	T90 (sec)	Cv (cm^2/sec)	Void Ratio
50	1.149	390	2.87E-03	0.777
100	1.137	2940	3.73E-04	0.752
200	1.118	2088	5.08E-04	0.719
400	1.091	2694	3.75E-04	0.671
800	1.054	1884	5.00E-04	0.615
1600	1.014	1884	4.63E-04	0.553
3200	0.972	1215	6.59E-04	0.488
800				0.509
200				0.548
50				0.596



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THURBER

DIRECT SHEAR TEST REPORT

TO: Mr. Bill Burton

FILE NUMBER: 19-1997-1

CLIENT: Bruce Geotechnical Cons. Inc.
210 - 1290 Hornby Street
Vancouver, B.C.
V6Z 2G4

REPORT DATE: December 13, 1994

CC:

PRAIRIE CREEK

REPORT NUMBER: DS 94-1, 2 & 3

TEST DATE: Dec. 6 - 12, 1994

SAMPLE: BH 94-2A, Sa 9

DESCRIPTION: Dark grey, silty CLAY (CH), firm, high plastic

Liquid Limit (%):	59	Gravel (%	0.4%
Plastic Limit (%):	19	Sand (%):	2.0%
Plasticity Index (%):	40	Silt (%):	51.3%
Assumed S.G.:	2.82	Clay (%):	46.3%

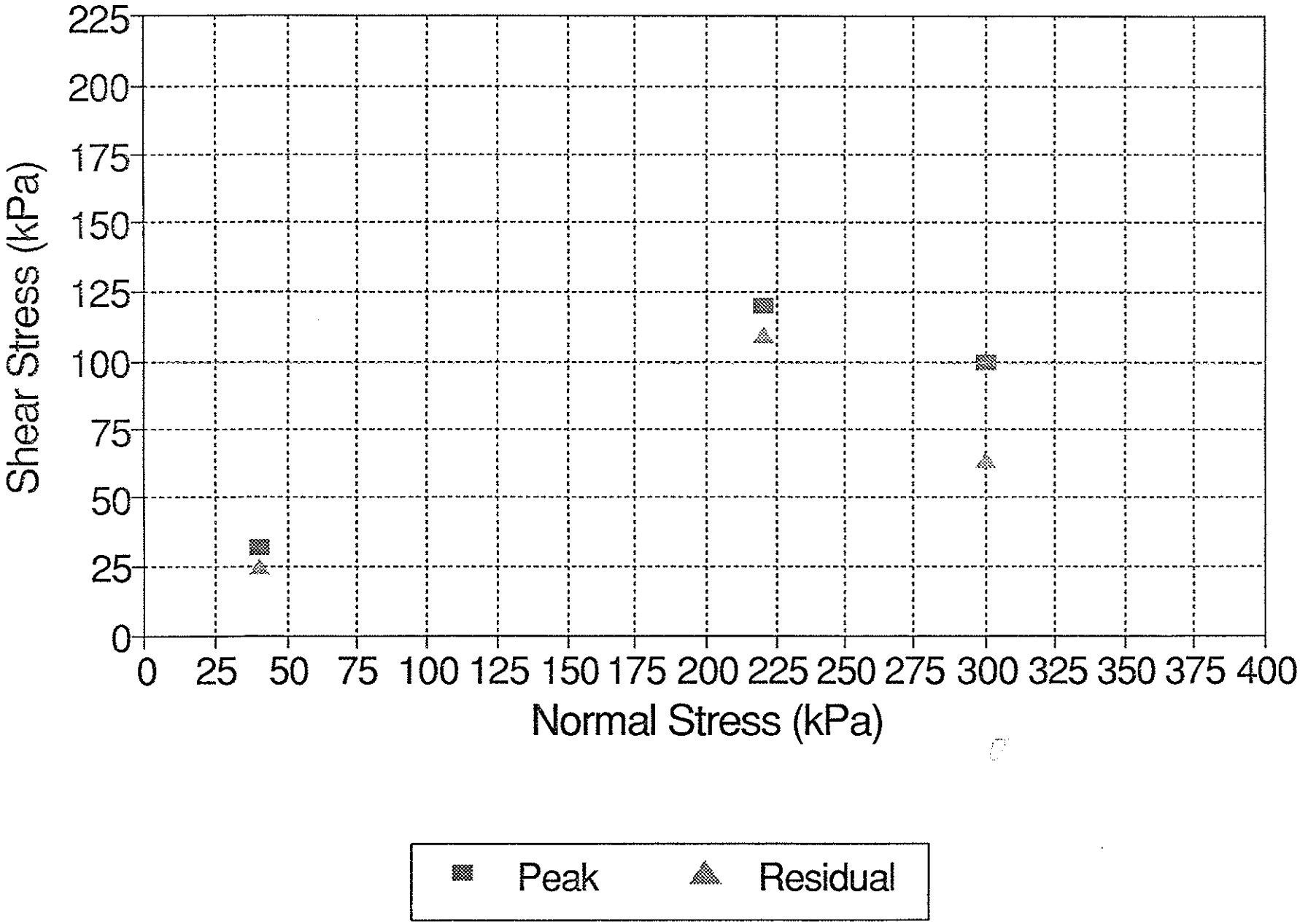
	DS 94-1		DS 94-2		DS 94-3	
	As Set Up	As Tested	As Set Up	As Tested	As Set Up	As Tested
Normal Stress (kPa):		40		220		300
Wet Density (kg/cu.m.):	2,034	-	2,081	-	1,967	-
Dry Density (kg/cu.m.):	1,640	1,654	1,678	1,754	1,586	1,681
Moisture Content (%):	24.0	-	24	-	24	-
Saturation (%):	94	-	100	-	87	-
Void Ratio:	0.720	0.705	0.681	0.608	0.778	0.678
Coeff. of Consolidation (sq.cm./sec):		-		1.58E-03		3.78E-04

Failure Conditions

Peak shear stress (kPa):	32	120	100
Strain at peak shear stress (%):	3.3	12.3	2.5
Peak rate of displacement (%/min):	0.0048	0.0048	0.0048
Residual shear stress (kPa):	25	110	64
Moisture Content (%): (taken from shear zone after test)	26.6	27.3	31

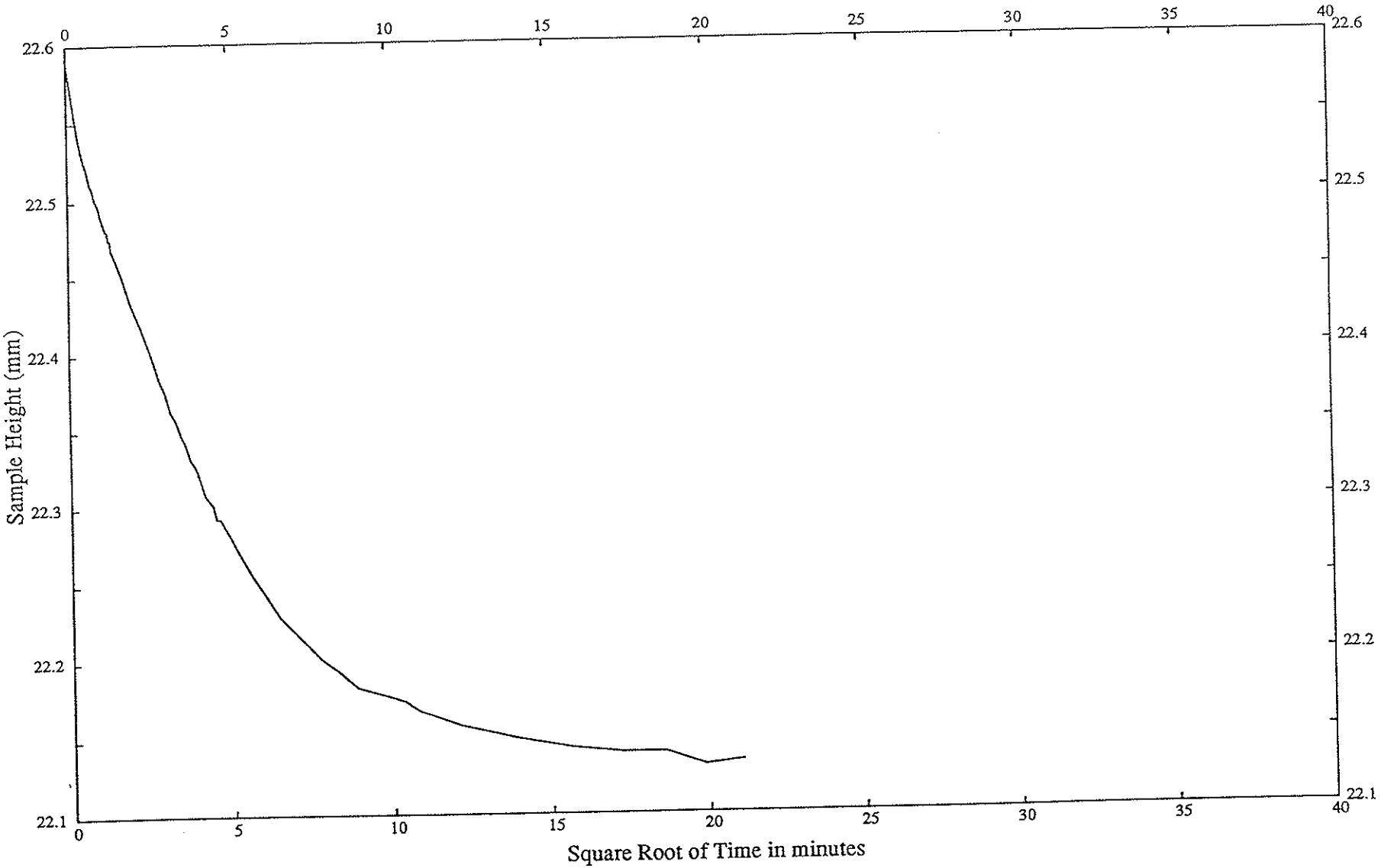
Note: All specimens were trimmed from the same sample.

DIRECT SHEAR TEST REPORT
BH 94-2A, Sa 9



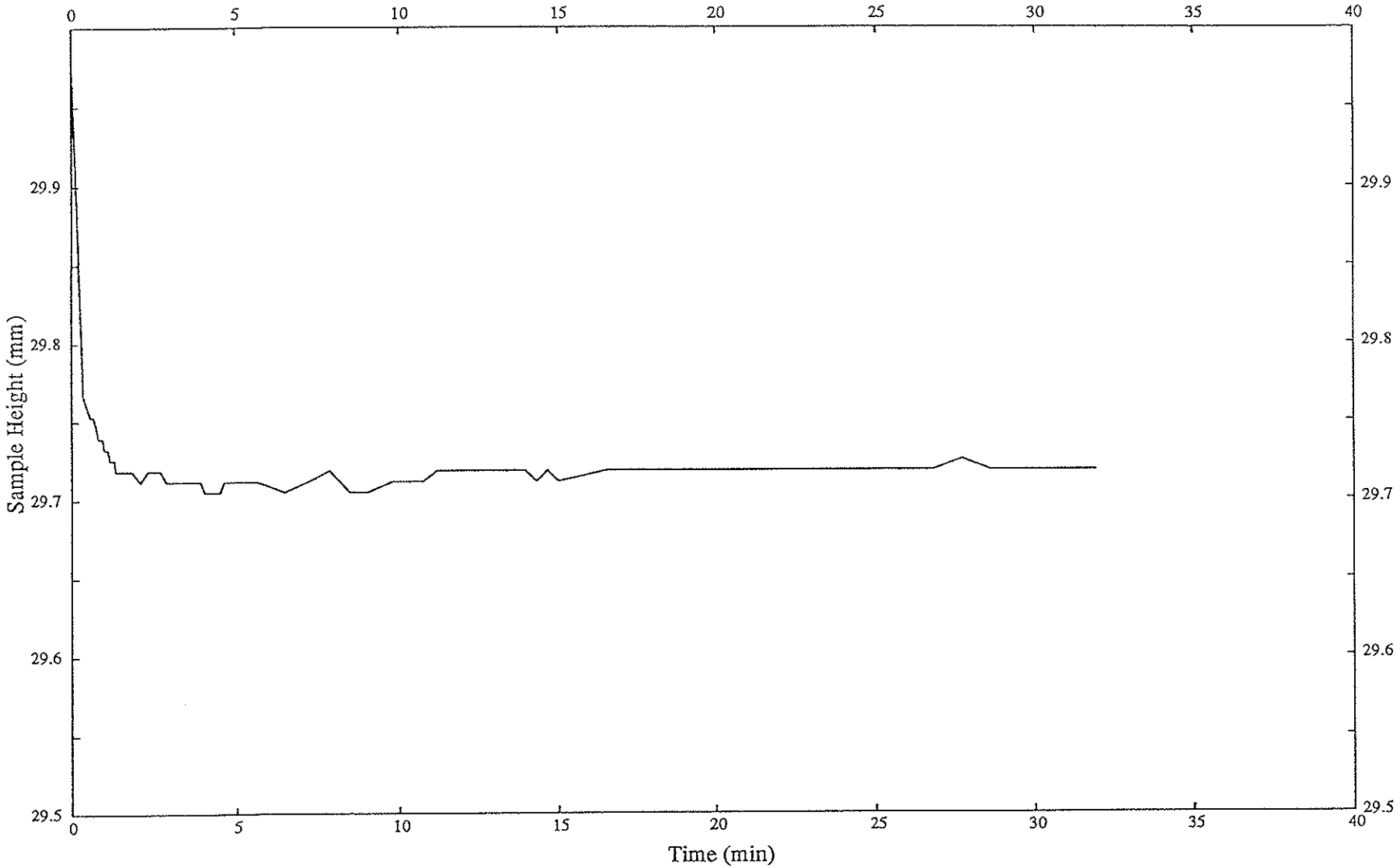
Bruce Geotechnical Cons. Ltd
Prairie Creek
BH94-2A Sa. 9
CONSOLIDATION TEST CO 94-1
Load 200 kPa
07-Dec-1994

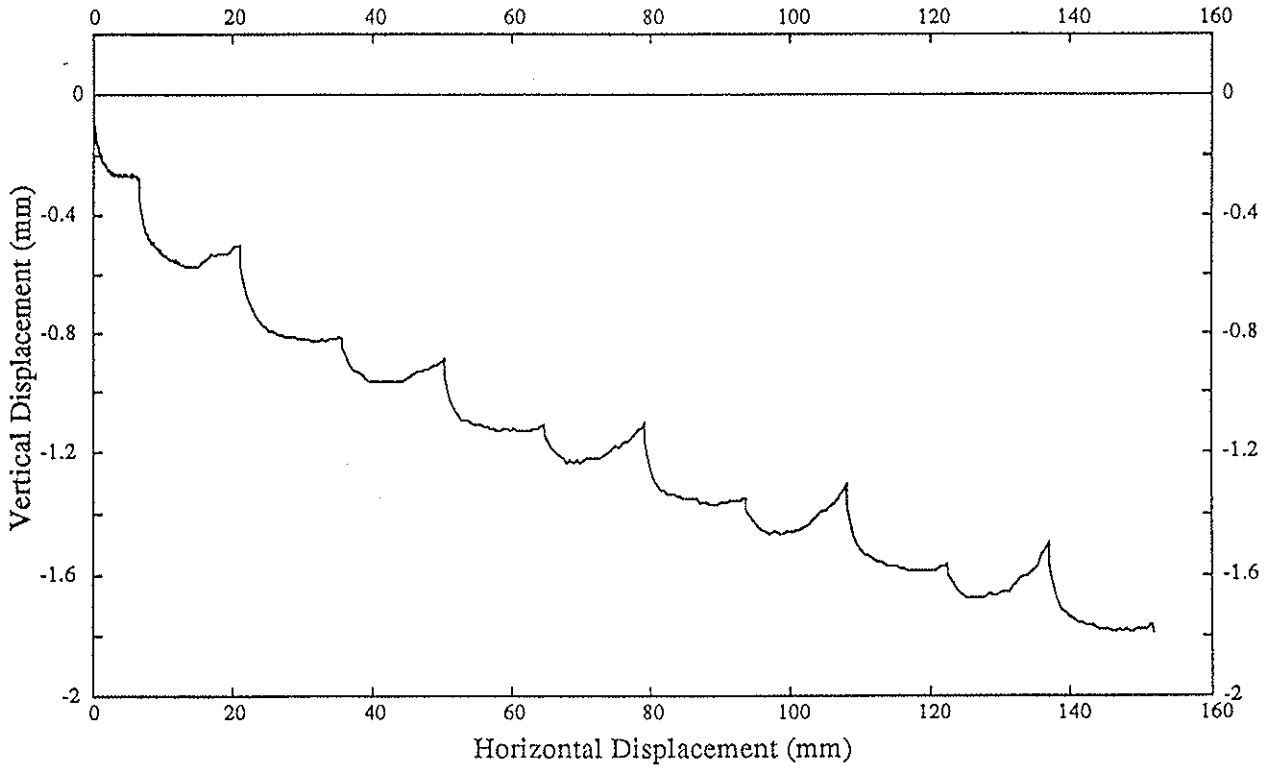
SAMPLE HEIGHT vs TIME

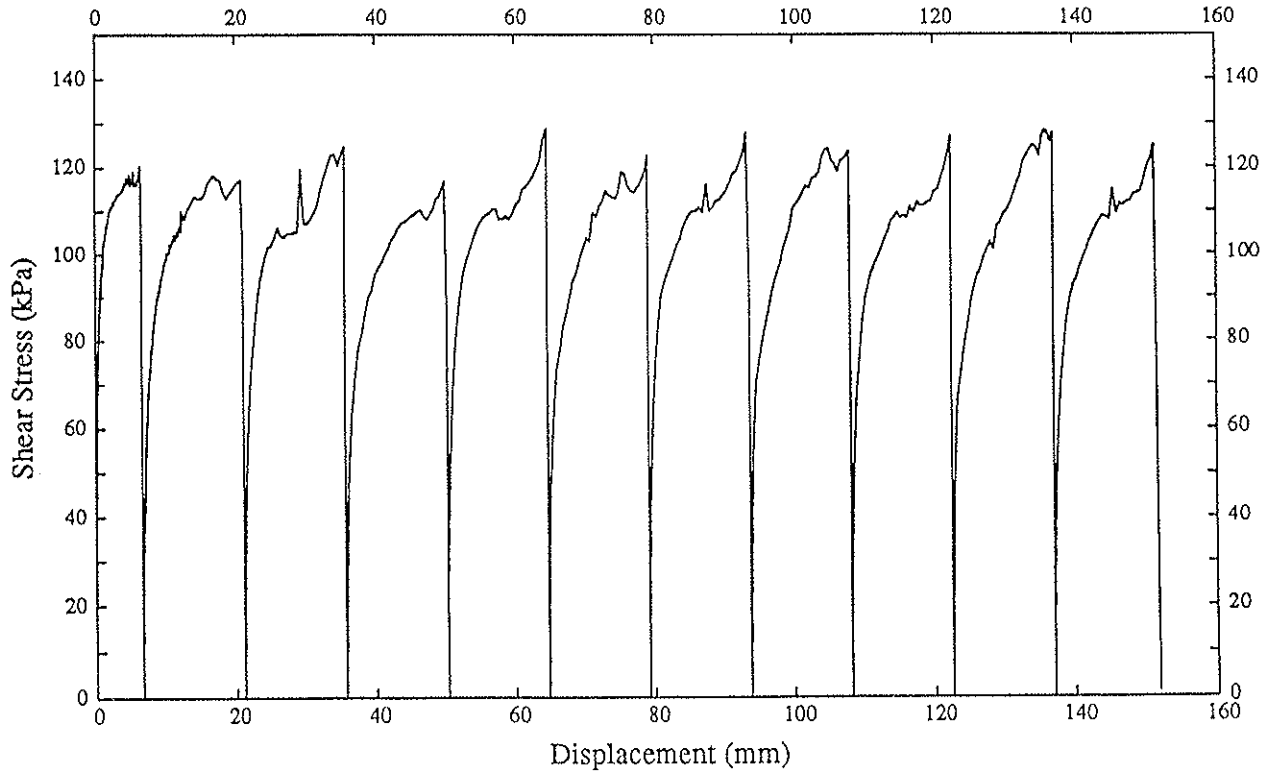


Bruce Geotechnical Consultan
Praire Creek
BH 94-2A, Sa 9
DIRECT SHEAR TEST DS 94-1
Consolidation to 40 kPa
07-Dec-1994

SAMPLE HEIGHT vs TIME

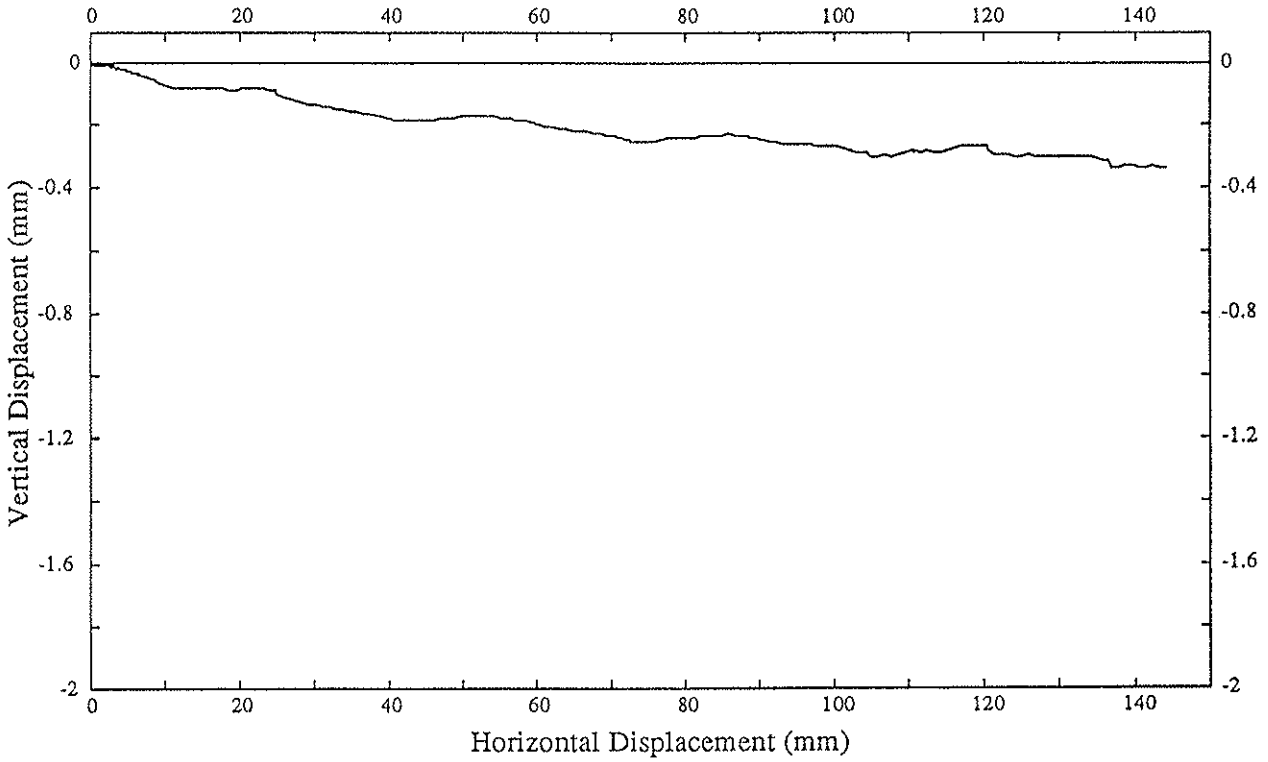


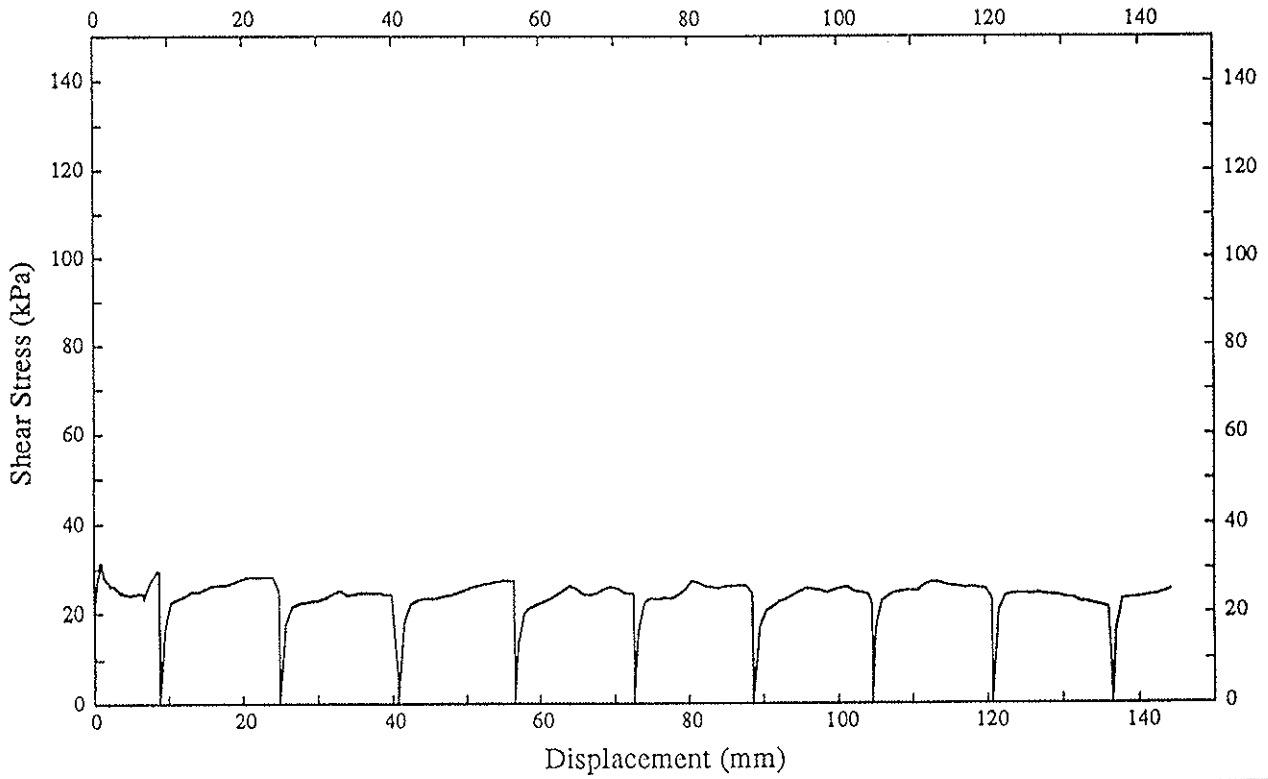




THURBER ENGINEERING LTD
Client: Bruce Geotechnical Cons. Ltd
Project: Prairie Creek
File No.: 19-1997-1

DIRECT SHEAR TEST
Normal Stress = 220 kPa
DS94-2, BH 94-2, Sa.9
13-Dec-1994

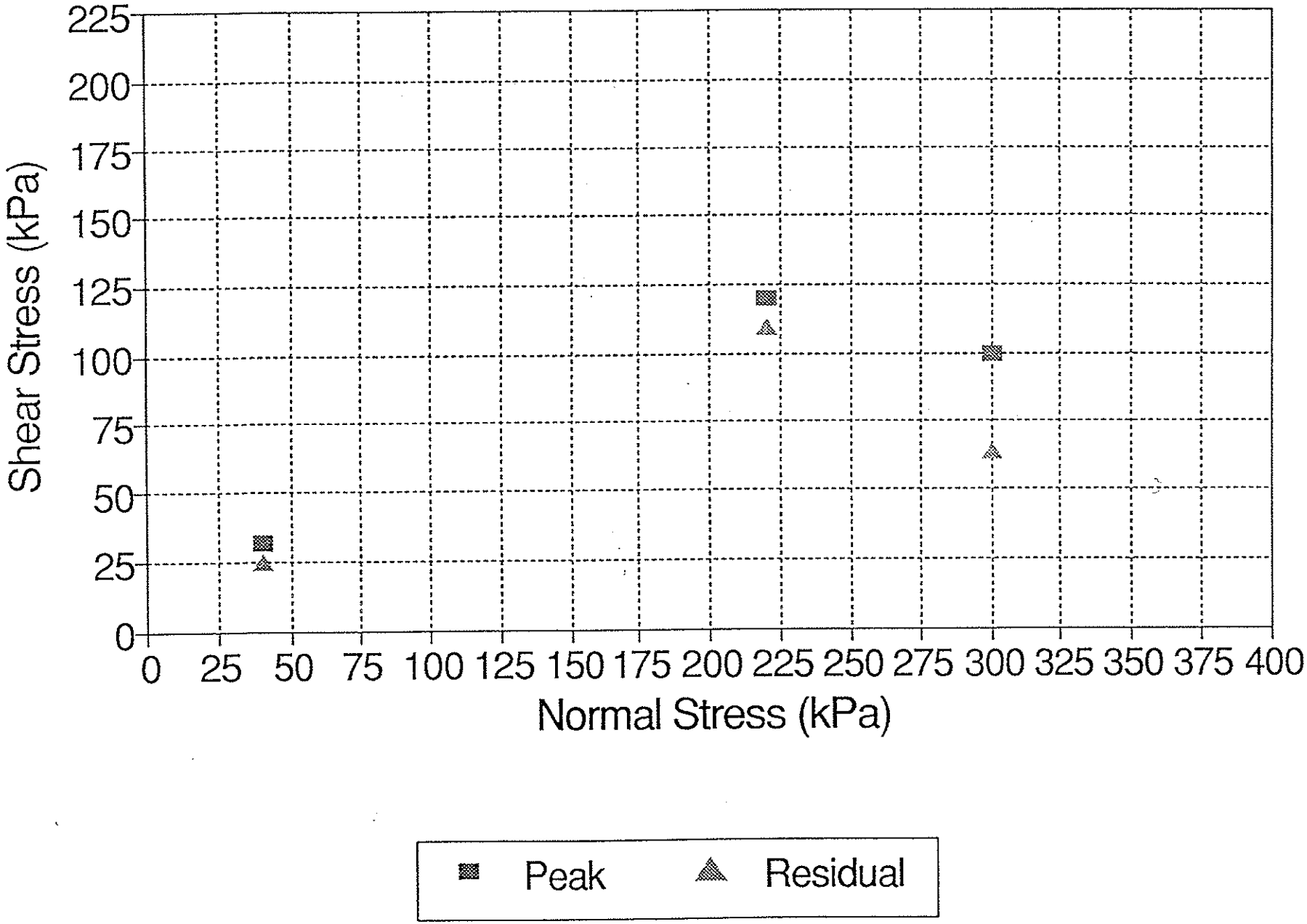




THURBER ENGINEERING LTD
Client: Bruce Geotechnical Consultan
Project: Praire Creek
File No.: 19-1997-1

DIRECT SHEAR TEST
Normal Stress = 40 kPa
DS94-1, BH 94-2A, Sa 9
10-Dec-1994

DIRECT SHEAR TEST REPORT
BH 94-2A, Sa 9



DIRECT SHEAR TEST REPORT

Bruce Geotechnical Consultants Inc.
Prairie Creek

DS 94-1, 2 & 3
December 13, 1994

After Test Notes

DS 94-1 @ 40 kPa:

1) There was no misalignment of the shearbox halves at the end of the test.
2) There was a moderate amount of extruded material around the specimen.
3) The specimen did not separate cleanly and the shear surfaces were smeared by the shearbox during the attempt to separate them.
4) There were no claystone fragments in the shear zone.

DS 94-2 @ 220 kPa:

1) The shearbox halves were misaligned by 1 - 2 mm at the end of the test.
2) There was a moderate amount of extruded material around the specimen.
3) Bottom shear surface:
   There was a 5 - 10 mm diameter lump protruding 4 mm above the shear surface. This lump consisted of several fragments of claystone up to 5 mm in diameter and caused a matching depression in the upper shear surface. There were numerous claystone fragments throughout the bottom half of the sample.
4) Upper shear surface:
   A 10 x 20 mm piece of claystone protruded 4 mm from the shear surface causing a matching depression in the lower surface.

DS 94-3 @ 300 kPa:

1) There was no misalignment of the shearbox halves at the end of the test.
2) There was a moderate amount of extruded material around the specimen.
3) The exposed shear surfaces were generally flat and dull with fine grooves and ridges running parallel with the direction of travel.
4) There was a 1 mm high pinnacle of claystone exposed in the middle of the bottom shear surface which had cut a 1 mm deep groove in the upper shear surface.

APPENDIX II
FIGURES

Appendix E

APPENDIX E

ROAD CONSTRUCTION AND FISH HABITAT

ROAD ALIGNMENT

Further reconnaissance of the proposed access road re-alignments was undertaken in August 2010, consisting of helicopter over-flights and ground inspection at key locations. The reconnaissance was undertaken by CZN staff, a terrain engineer from Golder Associates, and a road construction engineer from Kledo Construction based in Fort Nelson. Some revision of the proposed re-alignments was made as a result of this recent work. Refer to a revised version of DAR Figure 4.1 attached, and the following comments:

- The Polje re-alignment was confirmed with no significant changes (DAR Figure 6-21 is attached), although the precise location of the proposed Polje Creek crossing was defined;
- The re-alignment west of Wolverine Pass was abandoned because of the unstable slope north of the pass. The slope area containing the switchbacks was found to be generally stable, and measures were considered to revise the route in the immediate vicinity of the switchbacks to reduce grades and the tightness of turns for better safety;
- The re-alignment from Wolverine Pass to Grainger Gap was revised. The southern part of the re-alignment was moved further west to be on firmer ground and further upstream for the crossing of several small streams; and,
- The re-alignment running along the eastern slope of the Front Range was similarly revised to move certain sections further west to be on firmer ground and further upstream for the crossing of several small streams.

STREAM CROSSINGS

Streams crossings are catalogued in Table E1, with information on road kilometre markers, latitudes and longitudes where available, location of habitat details, and the intended mechanism of crossing. Habitat data are contained in Annexes E1 through E3 attached to this document, and in DAR Appendix 14. The information for the Wolverine to Grainger and Front Range re-alignments is based on data prior to the alignment revisions this August. An updated table with revised data and the missing latitudes and longitudes will be provided in due course. Photographs of many stream crossings are also attached to this document according to kilometre marker, and also can be found in the habitat data sources.

The present crossing at Km 22.5 is an incised tributary of Sundog Creek. Crossing involves ramping down into and out of the channel. The stream is not fish bearing as it is upstream of a major waterfall. Currently, the winter crossing mechanism would be snowfall. However, a clear span is being considered, but further engineering design and consultation is required before a proposal can be brought forward. There are four other crossings of upper Sundog Creek downstream of Km 22.5 that currently will be crossed by snowfill in winter, but could be

candidates for span structures. In all cases, the span would be a prefabricated steel deck supported on appropriate abutments, and above and outside of the high water mark.

The crossing of Polje Creek at Km 51.2 would be a clear span. The creek is approximately 5 m wide with banks 0.5-1 m high. Mature vegetation on both sides indicates the normal high water mark is close to the creek margins. A prefabricated 15 m long metal girder bridge span is being considered for this crossing, to rest on suitable abutments approximately 1 m high, which will mean a distance between the span deck and the bed of the creek of approximately 2.5 m. The span would be swung onto the abutments by crane, and ramps built at each end.

DFO Operational Statements, "Ice Bridges and Snow Fills" and "Clear-Span Bridges", and potentially "Temporary Stream Crossing" for a temporary bridge, will be utilized to guide the construction of crossings. CZN's reference in the DAR of fording some of the crossings along the access road was a misunderstanding. Lower Sundog Creek consists of an outwash fan of coarse gravels, and from late fall onwards, creek flows disappear into the gravels. This section of the road was historically considered an all season road bed, with a poorly defined alignment. What was assumed to be 'dry' ford crossings over this section will in fact be snow fills.

For all crossings and abutments, CZN will ensure that the channel, bed and banks of the stream are protected. For completely frozen conditions, simple snowfill should be adequate most of the time, however, stream banks may still require protection. Bound logs are used for this purpose in some jurisdictions, mats in others. A decision will be made at the time as to whether protection is required and what type. If stream banks are not completely frozen, additional protection may be required to support the weight of trucks and heavy equipment.

ROAD CONSTRUCTION

From the mine, the road bed will already be prepared to Km 22.5. Ramps into and out of a Sundog Creek tributary may need repair, and snowfill for the crossing. The road bed from Km 25 to 27 will require seasonal grading because the road crosses active talus fans. This will be a source of aggregate, as are the talus fans lining the creek to Km 36, especially on the south side near the road alignment. No further road bed preparation other than snow and ice is expected until the Polje re-alignment.

Side-hill cuts are expected in some locations along the Polje re-alignment, especially west of Polje Creek from Km 46.5 to 48.5. The deposits cut are expected to be granular, and the cut material can be re-used for road bed on the approach to Polje Creek (Km 49-51) which may be an area of permafrost and require insulation. The length of road requiring insulation, and the quantity of material required, will be dependent on the conditions encountered. Side-hill cuts are also expected from Km 53 to 55, but permafrost is not suspected.

As note elsewhere, the switchbacks west of Wolverine Pass (Km 96 to 99) will be revised. The ground north and south of the Pass is unstable and will be avoided. The lowest switchback will be eliminated, and the second and third will be combined into one via a wider loop. Drainage will be provided along the upstream edges of these sections. A gravel cap and berm is planned to

insulate potentially underlying permafrost and to provide for safety. The cap and berm are estimated to require 1,750 m^3 of material.

From Km 100 to the Liard River at Km 155, some permafrost may be encountered. A level road bed will be created using dozers with shoes fitted on the bottom of the blades. This will ensure minimal disturbance of the organic layer. The same approach will be used on the other new road sections as much as possible.

Regarding required water quantities for road bed construction, Annex E4 contains a description of ice road construction in the Fort Nelson area. The document provides a description of the approach to road building and gives water quantities. The following information is provided:

- Phase 1: building the subsurface = 30 m^3
- Phase 2: building the ice surface = 100 m^3
- Phase 3: seasonal maintenance = 120 m^3

Total water use for all three phases is about 250 m^3 per kilometre. This is an estimate given for the average conditions observed and worked in the Fort Nelson area for heavy industrial use with traffic flows averaging 100 loaded trucks per day at 85,000 kg per truck. Average loaded speed was variable from 50-60 kmph. Typically, the NWT Department of Transportation designs and maintains snow roads for 64,000 kg loads with an average rate of speed at 35 kmph. Ice bridges are designed for 64,000 kg with a speed limit of 20 kmph. Water is used sparingly, only for snow fills, very rough road sections and ice bridges.

Since the Prairie Creek road will be mostly over frozen ground with minimal ice sections, and for use by lighter traffic at low speeds, water use should be substantially less than 250 m^3 per kilometre.

Regarding water supply, CZN will follow “DFO Protocol for Winter Water Withdrawal from Ice-covered Waterbodies in the Northwest Territories and Nunavut” dated June 21, 2010. From the mine site, the creek at Km 22.5 may represent a water source as seepage has been noted in January. It may be possible to extract water in the Cat Camp area adjacent to Sundog Creek since the gravel outwash is likely very thick and contains a large and easily accessible groundwater resource. Polje Creek is expected to be flowing in winter as it is groundwater fed. As this is a potential location for over-wintering fish, flow rates and water depths will be measured and DFO consulted before extraction occurs. Mosquito Lake is near the road alignment (Km 63), and it appears was accessed previously for water supply. This is a large lake and represents a potentially large water source, but depths are unknown. A survey will be undertaken from the ice cover in order to determine the appropriate volume and location for extraction. The Tetcela and its tributaries, Fishtrap Creek, the wetlands east of the Silent Hills and the Grainger River all represent potential water sources prior to reaching the Liard River. As specified in the water withdrawal protocol, pump intakes will be screened according to the DFO Freshwater Intake End-of-Pipe Fish Screen Guidelines. For stream withdrawals, an assessment of water volume and discharge under the ice may be required to determine the withdrawal that can be made without reducing flows to a point that water levels downstream start to drop.

TABLE E1: ACCESS ROAD STREAM CROSSINGS

Creek	KM Marker	Lattitude	Longitude	Crossing Info.	Crossing Structure
Casket	6.1			Annex A, page 5	Bridge*
Funeral	13.1			Annex A, page 10	Bridge
Sundog	19.9				Snowfill
Sundog trib.	22.5			Annex B, page 4	Snowfill or clear span
Sundog	23.8			Annex A, page 5	Snowfill (span)
Sundog	26.3				Snowfill (span)
Sundog	26.5				Snowfill (span)
Sundog	27.8			Annex C	Snowfill (span)
Sundog	33.4			Annex B, page 2 and Annex C	Snowfill
Sundog	35.0			Annex B, page 2 and Annex C	Snowfill
Sundog trib.	38.0			Annex B, page 2	Snowfill
Sundog trib.	41.6			Annex C	Snowfill
Polje trib.	44.9				Snowfill
Polje trib.	47.4	61°35' 40.20	124°10' 55.70	DAR Appendix 14, PCT1	Snowfill
Polje trib.	48.5	61°36' 07.13	124°10' 11.34	DAR Appendix 14, PCT2	Snowfill
Polje trib.	49.3	61°36' 10.91	124°09' 03.12	DAR Appendix 14, PCT3	Snowfill
Polje	51.2	61°36' 09.10	124°06' 41.23	DAR Appendix 14	Clear span
Polje trib.	52.8	61°35' 57.22	124°05' 10.62	DAR Appendix 14, PCT4	Snowfill
Tetcela trib.	85.6				Snowfill
Tetcela trib.	86.0			Annex C	Snowfill
Tetcela	88.5			Annex C	Snowfill
Fishtrap	93.0			Annex C	Snowfill
Un-named N flowing trib.	102.5	61°24' 53.59	123°33' 49.73	DAR Appendix 14, A1	Snowfill
	104.0	61°23' 58.94	123°33' 37.97	DAR Appendix 14, A2	Snowfill
	105.3	61°23' 07.13	123°32' 51.22	DAR Appendix 14, A3	Snowfill
	106.5	61°22' 31.69	123°32' 27.76	DAR Appendix 14, A4	Snowfill
	108.5	61°21' 31.55	123°30' 53.81	DAR Appendix 14, A5	Snowfill
	111.7	61°21' 22.03	123°30' 41.96	DAR Appendix 14, A6	Snowfill
	113.5	61°20' 44.61	123°29' 40.56	DAR Appendix 14, A7	Snowfill
Grainger	117.5			Annex C	Snowfill
Grainger	118.0			Annex C	Snowfill
Grainger	119-120			Annex C	Snowfill
Grainger	122.0			Annex C	Snowfill
Grainger trib.	124.5			Annex C	Snowfill
Grainger trib.	129.2	61°16' 15.52	123°16' 29.42	DAR Appendix 14, D1	Snowfill
Grainger trib.	129.9	61°15' 52.43	123°16' 21.14	DAR Appendix 14, D2	Snowfill
Grainger trib.	131.1	61°15' 18.09	123°16' 07.14	DAR Appendix 14, D3	Snowfill
Grainger trib.	132.8	61°14' 39.51	123°15' 32.32	DAR Appendix 14, D4	Snowfill
Grainger trib.	134.1	61°13' 49.26	123°15' 04.50	DAR Appendix 14, D5	Snowfill
Grainger trib.	136.3	61°12' 44.63	123°15' 18.68	DAR Appendix 14, D6	Snowfill
Grainger trib.	138.4	61°12' 29.86	123°15' 02.95	DAR Appendix 14, D6a	Snowfill
Liard trib.	139.5	61°11' 27.23	123°13' 37.01	DAR Appendix 14, D7	Snowfill
Liard trib.	142.0	61°10' 20.84	123°14' 08.85	DAR Appendix 14, D8	Snowfill
Liard trib.	144.5	61°08' 08.87	123°14' 50.78	DAR Appendix 14, D9	Snowfill
Liard trib.	146.0	61°07' 31.88	123°14' 34.14	DAR Appendix 14, D10	Snowfill
Liard trib.	147.2	61°07' 12.08	123°14' 44.14	DAR Appendix 14, D11	Snowfill
Liard trib.	149.0	61°07' 07.94	123°14' 46.25	DAR Appendix 14, D12	Snowfill
Liard	154.7				Ice bridge

* Already built

CANADIAN ZINC CORPORATION

Figure 4-1:
Prairie Creek Mine Access Road Redefined Route for Wolverine, Grainger Gap and Front Range Alternative

Scale

0 1 2.5 5 10

Kilometres

Project File Name: DAR Fig 4-1.dwg	
Date: August 2010	Sheet: Nad83 UTM: 95F
Scale: As Shown	Drawn By: C. Reeves

PRAIRIE CREEK MINE SITE

FUNERAL CREEK
CASKET CREEK
ORION CREEK
CADILLAC CREEK
GALENA CREEK
BIG CHIEF CREEK
PRAIRIE CREEK
HARRISON CREEK
SUNDOG CREEK
CAT CAMP
MOSQUITO LAKE
Nahanni National Park Reserve Boundary
MACKENZIE MOUNTAINS
RAM PLATEAU
Tetcela Transfer Facility (TTF)
WOLVERINE PASS
SILENT HILLS
GRAINGER GAP
GRAINGER CAMP
GRAINGER RIVER
NAHANNI RANGE
PRAIRIE CREEK
S. NAHANNI RIVER
ICE BRIDGE
Old Nahanni Logging Road
Nahanni Butte
Liard Transfer Facility (LTF)
LTF to Enterprise ~ 454 km
Liard Highway #7
Lindberg Landing
Blackstone Park
LTF to Fort Nelson Railyard ~ 305 km
LTF to BC Border ~ 131 km

Legend

- 00 Road Markers (km)
- Existing Access Road
- Proposed Alignment Changes
- Surveyed Alignment Changes
- Ice Bridge Crossing
- New Park Boundary
- Previous Park Boundary
- Watercourses
- Claims Boundary
- Transfer Facility

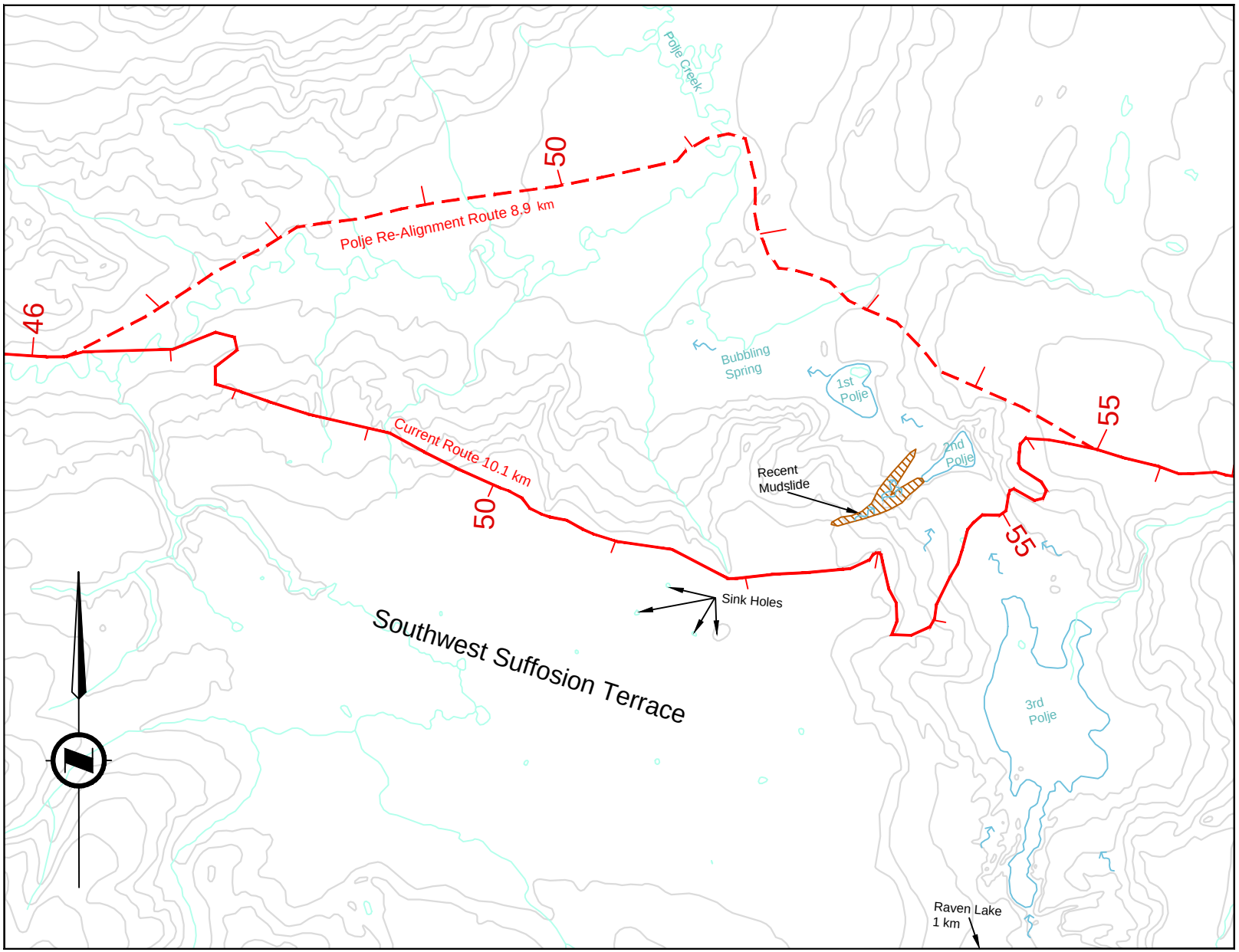


Figure 6-21: Access Road;
Polje By-Pass Alternative

Legend

- 00 Road Markers from Minesite(km)
- Existing Access Road
- Proposed Alignment Changes
- Watercourses
- Contour Interval (100 ft)
- Subsurface Water Flow

Scale

0 0.25 0.5 1

Kilometres

CANADIAN ZINC CORPORATION

Project File Name: DAR Fig 6-21.dwg	
Date: October 2009	Sheet: Nad83 UTM: 95F
Scale: As Shown	Drawn By: C. Reeves

KM 6.2 Casket Creek

KM 13.1 Funeral Creek hairpin

KM 22.5 Existing Sundog Creek crossing

KM 22.5 Possible Sundog Creek span location

KM 23.8 Sundog Creek

KM 26.1 Sundog Creek

KM 27.8 Sundog Creek

KM 28.7 Sundog tributary

KM 29.3 Sundog tributary

KM 29.8 and 30.2 Sundog Creek

KM 32.1 and 32.4 Sundog Creek

KM 33.3 Sundog Creek

KM 35.0 Sundog Creek

KM 35.9 and 36.0 Sundog Creek

KM 38.0 Sundog tributary

KM 41.6 Sundog tributary

KM 51.2 Polje Creek

KM 86.0 Tetcela tributary

KM 88.5 Tetcela River

KM 110.0 Un-named creek tributary

KM 115.0 Un-named creek tributary

KM 120.0 Grainger River at Grainger Gap

Annex E1

TECHNICAL MEMORANDUM

Golder Associates Ltd.
1721 – 8th Street East
Saskatoon, SK, Canada S7H 0T4

Telephone: 306-665-7989
Fax Access: 306-665-3342

TO:	Mr. David Harpley, Canadian Zinc	**DATE:**	25 August 2008
FROM:	J. David Hamilton	**JOB NO:**	08-1365-0081
EMAIL:	**dhamilton@golder.com**		
RE:	**OVERVIEW OF FISH COMPENSATION OPPORTUNITIES**		

1.0 INTRODUCTION

A field investigation was undertaken to assess potential options for developing fish habitat compensation for instream works associated with the upgrades to the Prairie Creek mine winter access road. The field investigation was undertaken during the period of 10 to 13 August 2008. Tasks completed during this period included:

- inspection of instream works in Prairie Creek;
- inspection of habitat conditions at the Casket Creek stream crossing;
- evaluation of habitat conditions in Harrison Creek;
- assessment of habitat at Site S4 on Funeral Creek and at the upper road crossing; and
- fish sampling of Sun Dog Creek at two sites near Cat Camp, downstream of a waterfall and at two sites upstream of the waterfall.

The purpose of this memo is to provide an overview of habitat conditions in the Prairie Creek watershed and to provide preliminary recommendations for fish compensation.

2.0 FISH HABITAT

2.1 Prairie Creek

Prairie Creek is a large mountain stream. The bankfull width can exceed 150 m in width. At the time of the site investigation the wetted width was 30 to 50 m wide. There were areas with large boulder and cobble bars situated between the valley wall and the wetted channel (Photos 1 to 3). The significant difference between wetted width and bankfull width during the late summer is typical of mountain streams. Water depth ranged from approximately 30 cm deep in the riffles to more than a metre deep in the pools.

50 BEST EMPLOYERS IN CANADA 2008

CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

Photo 1 Confluence of Funeral Creek (foreground) and Fast Creek (right hand valley) to form Prairie Creek (valley on left of photograph).

Photo 2 Looking downstream on Prairie Creek, winter road on left downstream side of the valley.

Photo 3 Prairie Creek looking downstream near airstrip.

The majority of Prairie Creek was visually assessed from the air, either when flying into the site or during a low-level helicopter reconnaissance from Funeral Creek to the mine site. The majority of the habitat consisted of long sections of shallow run (R2 or R3), separated by riffles (Photo 3). Water depth was generally less than 30 cm in the reaches accessible from the winter road. Deep water habitat was only present where bedrock constrictions had narrowed the river channel or where very large boulders (i.e., >1.5 m diameter) or bedrock outcroppings had caused scour pools to form. These pools were generally more than a metre deep and 5 to 10 m in length (Photos 4 to 6).

Large woody debris accumulations were absent from the channel. This is likely due to the small size of the trees (diameter of most trees in the riparian areas was less than 30 cm) and the stream power during peak flow events.

Critical habitat appeared to be the deep pools created by bedrock outcroppings and boulders that were approximately 1.5 to 2.0 m on their B-axis, or larger.

2.2 Tributaries to Prairie Creek.

Several tributaries to Prairie Creek were examined, including Casket Creek, Harrison Creek, and Funeral Creek.

Photo 4 **Constriction in a meander bend of Prairie Creek, downstream of the mine.**

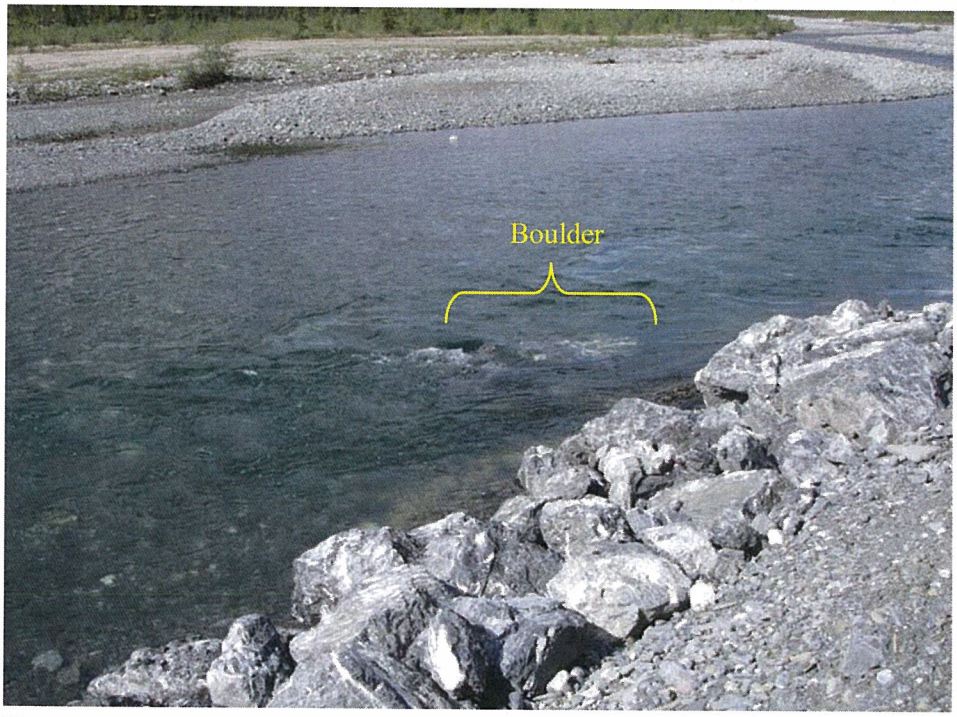


Photo 5 **Pool created by a large boulder at Site B along winter road.**

Photo 6 Looking upstream at a riffle and pool upstream of Winter Road Site D.

2.2.1 Casket Creek

Casket Creek appears to be typical of the smaller tributaries that contribute flows to Prairie Creek. The stream has a short (several hundred metres) low gradient (approximately 2%) reach in an alluvial outwash fan on the Prairie Creek floodplain. Above the outwash fan, the valley narrows and gradient increases. These streams are capable of moving a significant amount of bed material during periods of high flows. At the time of the August field session the wetted width channel was approximately 1.5 m wide and less than 20 cm deep (Photos 7 and 8).

2.3 Harrison Creek

Harrison Creek enters Prairie Creek near the downstream end of the Prairie Creek mine site. Similar to the Casket Creek, the stream is situated in a narrow valley, until it reaches the Prairie Creek floodplain. As with other streams there is very little flow in the late summer and the stream flows subsurface between the tank farm to the road culverts (Photos 9 and 10).

Harrison Creek was extensively modified during the initial period of mine construction in the early 1980's. There is extensive gabion reinforcement of the banks and stream bed to keep the stream channel routed between the mill and tank farm (Photo 11). There is also a set of culverts approximately 10 m upstream of Prairie Creek.

Photo 7 **Looking upstream at Casket Creek channel, near the upstream end of the outwash fan.**

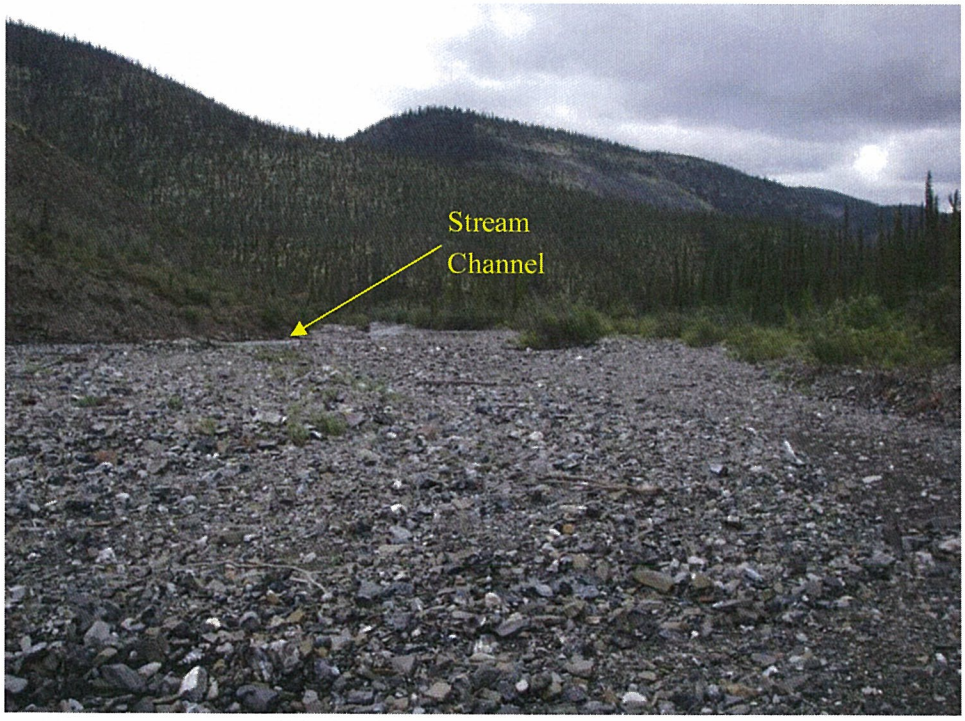


Photo 8 **A portion of Casket Creek outwash fan looking downstream towards the winter access road. The wetted channel is along the toe of the left valley wall.**

Photo 9 **Harrison Creek looking upstream from the road culverts. Water in foreground is mainly discharge from the mine dewatering treatment system.**

Photo 10 **Harrison Creek, looking upstream from behind the mill.**

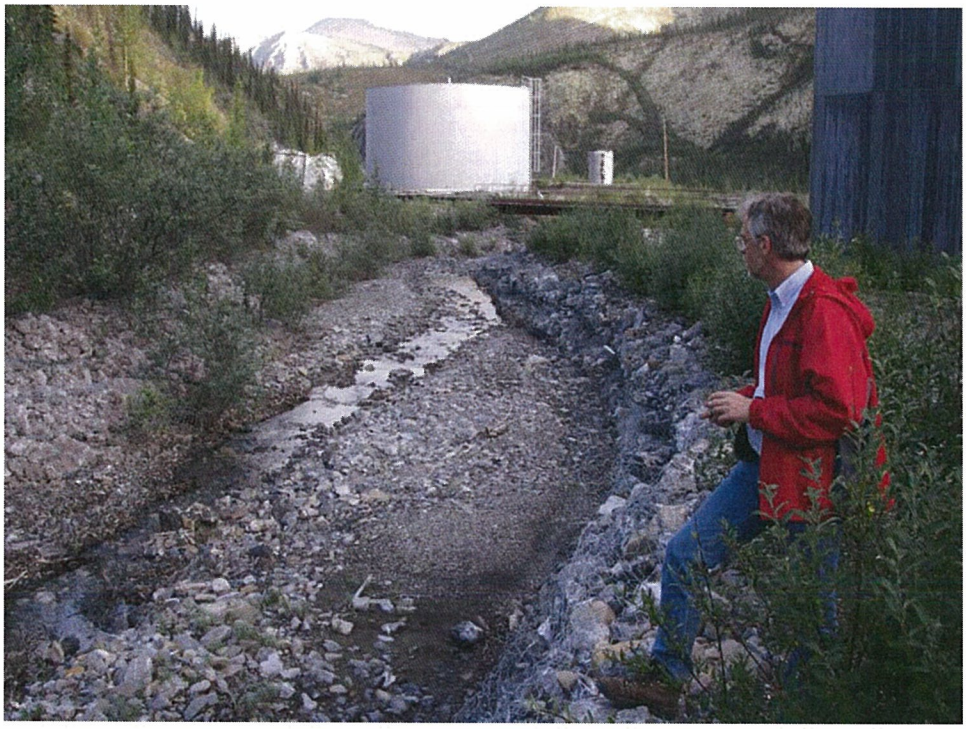


Photo 11 **Looking downstream at modified section of channel between the mill and tank farm. Both banks and stream bed in this reach have been reinforced with gabions.**

2.3.1 Funeral Creek

Site S4 along the winter access road was examined. This is the only site in Funeral Creek where instream works may be required. The bankfull width at this location was 6 to 8 m wide, while the wetted channel width was approximately 2 m at the time of sampling, although the stream widened immediately downstream of S4. The gradient was approximately 5% and the channel morphology was small step-pools separated by short sections of riffle. The small pools created by boulders where approximately 30 to 40 cm deep. Bed material was dominated by boulders and cobbles, with pockets of coarse gravel also present. The stream channel was confined by the valley walls and the right bank in most of S4 was formed by bedrock at the foot of the mountain (Photos 12 and 13).

At the stream crossing located near the head waters of the Funeral Creek, the bankfull width was 4 to 8 m and the wetted channel width was approximately 1 m. Gradient had increased to 12% and the channel featured a step-pool morphology (Photo 14). Based on the size of the rounded boulders, the stream has periodic, high flow events capable of moving boulder sized bed material.

Photo 12 **Funeral Creek at widening of channel, downstream of Site S4.**

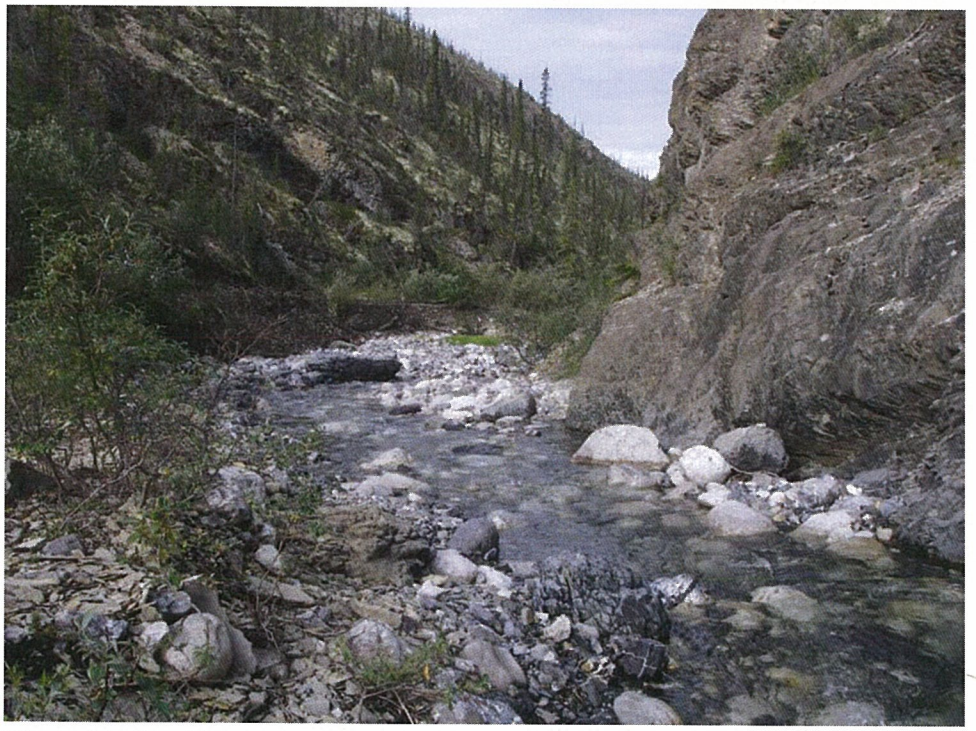


Photo 13 **Looking downstream, at Site S4. Winter access road above left bank in middle of the photograph.**

Photo 14 **Looking downstream from stream crossing in the upper Funeral Creek watershed.**

Low water late in the summer likely limits the distance that fish can move upstream in Funeral Creek. In addition, only a single deep pool (i.e., >1 m), formed by slabs of bedrock in the channel, was observed in the portions of the stream channel visible from the road. As a result it is unlikely that fish could over winter in the middle and upper reaches of Funeral Creek.

3.0 FISH HABITAT COMPENSATION OPPORTUNITIES

Based on the August site inspection, the following conclusions and recommendations are:

- Compensation in small tributaries such as Casket Creek is not recommended. The low water and gradient limit fish habitat. In addition, the large bedload in the outwash fans provides an unstable channel that appears to wander frequently (this is based on the limited vegetation developed on the fan, upstream of the road). In addition, late season low flows would provide very little habitat for bull trout (*Salvelinus confluentus*), which is the target species for the fish habitat compensation.

- In earlier documents it was suggested that the culverts near the mouth of Harrison Creek be removed to improve access to Harrison Creek. By late summer, Harrison Creek flows are subsurface (i.e., flowing through the gravel), which would preclude bull trout from using or moving through the lower portions of Harrison Creek for summer rearing or fall spawning. Note that bull trout can enter tributary streams to stage for spawning as early as the beginning of August (D. Hamilton personal observation). To facilitate the development in Harrison Creek to create fish habitat, the lower portion of the stream channel would have to be naturalized. This would involve the removal of the gabion baskets from the stream bed and

banks, leading to the development of a low flow channel could be created. There would be significant uncertainty as to whether or not a low flow channel would remain wetted in late summer or if flows would continue to go subsurface. Therefore, fish habitat compensation in Harrison Creek would have a high risk of failure. Also, there would be the added risk to the mine infrastructure associated with removal of the gabions in the channel are removed.

- Large woody debris does not play a functional role in creating fish habitat in Prairie Creeks or its tributaries.

- Limiting habitat appears to be the deep pools where fish can rear in the summer and over winter. It is recommended that fish habitat compensation focus on creation of deep pool habitats that can provide refuge areas during low flow periods.

- It is recommended that fish compensation focus on creating deep water habitat features in Prairie Creek where there is a higher likelihood that they would be utilized by bull trout. Options for achieving this include:
  - There is a dewatered side channel on the right downstream bank of a large point bar, across from Site D along the winter access road. This side channel is approximately 250 m long and 10 to 15 m wide (Photo 15). The inlet of this channel could be lowered to divert a portion of the late summer flows into the channel. The habitat in the channel could be modified to create pools similar to the one already present in the channel (Photo 16).
  - Create spurs or groynes off the existing riprap armouring along the road or in areas where the groynes can be tied into the bedrock. These spurs can be constructed to create scour pools, which would mimic the pools created by the large pieces of bedrock in the channel.

- Development of off-channel habitat is another option for fish compensation include creating off channel habitat. This could be done by:
  - removing a culvert crossing along the Funeral Creek portion of the winter road and improving access to a remnant side channel that is approximately 50 m long and 4 to 6 m wide (Photo 17). This channel currently receives some flows from a high gradient first- or second-order tributary, but there is not enough water to support fish in the late summer. Flows could be enhanced by installing a small culvert at the upstream end of the side-channel to divert flows from the mainstem; and
  - enlarging and deepening an existing backwater area on the left downstream bank, near access road Site B (Photo 18).

While the creation of off-channel habitat is feasible, it is unlikely that a bull trout would utilize this type of habitat for a significant portion of the year (i.e., only during high flow periods), and they are not known to inhabit this type of area.

Therefore, it is strongly recommended that fish compensation focus on creating late season pool habitat. It is recommended that a meeting be held with Fisheries and Oceans Canada (DFO) representatives, after the upcoming site visit by the DFO habitat staff, to discuss the conclusions and recommendations outlined in this memo.

Photo 15 **Looking downstream at a dry side channel on the right downstream bank of Prairie Creek, located a cross from Site D of the winter access road.**

Photo 16 **A residual pool associated with bedrock outcropping, in dewatered side channel.**

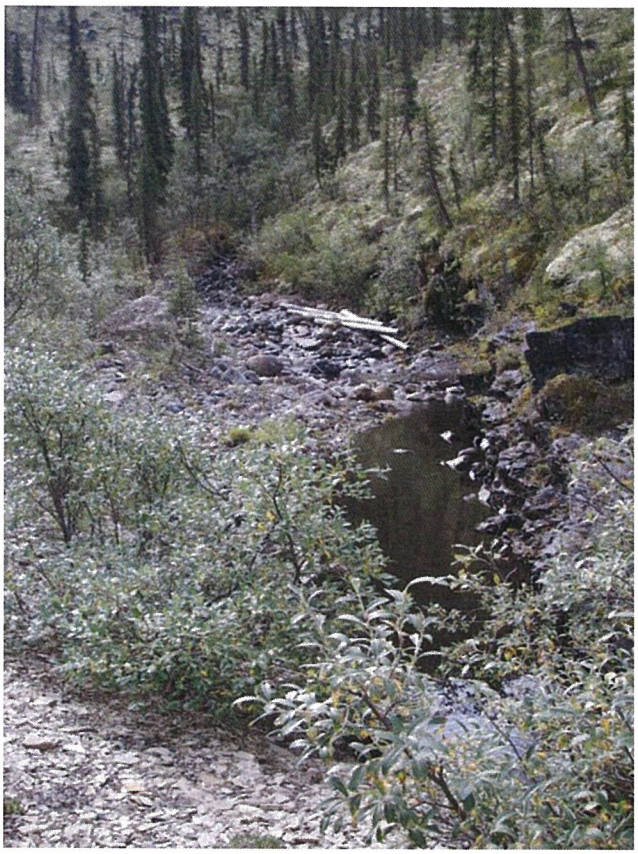


Photo 17 **Looking upstream at remnant side channel along Funeral Creek Road.**

Photo 18 **Backwater area at upstream end of winter access road Site B.**

4.0 CLOSURE

We trust that this meets your immediate needs. We look forward to further discussions with DFO and yourself in regards to the habitat compensation for this project.

J. David Hamilton, M.Sc., R.P. Bio., CPESC
Associate, Senior Aquatic Scientist

JDH/JPO/msd

N:\ACTIVE\2008\1365\08-1365-0081 CANADIAN ZINC PRAIRIE CREEK FISH & FISH HABITAT\CORRESPONDENCE\08-1365-0081 TECHMEMO 22 AUGUST 2008 OPTIONS FOR FISH COMPENSATION.DOC

Annex E2

TECHNICAL MEMORANDUM

Golder Associates Ltd.
1721 – 8th Street East
Saskatoon, SK, Canada S7H 0T4
Telephone: 306-665-7989
Fax Access: 306-665-3342

TO:	Mr. David Harpley, Canadian Zinc	**DATE:**	26 August 2008
FROM:	J. David Hamilton	**JOB NO:**	08-1365-0081
EMAIL:	**dhamilton@golder.com**		
RE:	**OVERVIEW OF FISH COMPENSATION OPPORTUNITIES**		

1.0 INTRODUCTION

During the site inspection of the access road to the Prairie Creek mine, fish sampling and fish habitat assessment was undertaken in Sundog Creek, on 12 August 2008. This memo is intended to provide a brief summary of results.

2.0 FISH AND FISH HABITAT SAMPLING

Sundog Creek (61° 49' 00" N - 124° 14' 06" W) was flown from its headwaters to a point several kilometres downstream of downstream of Cat Camp (this was a construction/maintenance camp for the Prairie Creek Mine access road). The watershed can be divided into upper and lower basins as the upper basin is separated by a waterfall, upstream of the confluence of the two main tributaries to Sundog Creek.

Between the waterfall and Cat Camp Sundog Creek has a wide alluvial floodplain and water would span the floodplain, from valley wall to valley wall, during periods of high flows. There was no surface flow at the time of sampling. Wide expanses of gravel were present, with isolated pockets of water (Photos 1 and 2). Two sample sites were sampled; Station 1 downstream of Cat Camp and Station 2, upstream of Cat Camp (Photos 3 and 4).

Stations 1 and 2 were isolated pools situated along the north valley wall. Station 2 was a series of riffles, runs and pools that was several hundred metres long, before the water went subsurface. Both areas received water flowing through the surficial gravel beds. These pools were 1 to 1.5 m in depth and had clear flowing water. Bed material was gravel and cobble. Fish sampling was conducted at both locations. Numerous Arctic grayling (*Thymallus arcticus*) where capture or observed (Photo 5). The Arctic grayling captured were 185 to 290 mm in length. A suspected bull trout (*Salvelinus confluentus*) was observed at Station 1. This fish had a white leading edge on its pectoral fin, but could not be captured to confirm identification.

50 BEST EMPLOYERS IN CANADA 2008
CANADA'S 50 BEST MANAGED PRIVATE COMPANIES

Photo 1 Sundog Creek below the water looking downstream

Photo 2 Sundog Creek looking downstream near cat camp

Photo 3 Sundog Creek Station 1. Pools and riffles along north valley wall.

Photo 4 Sundog Creek Station 2. Looking downstream at tailout of pool and next riffle

Photo 5 Sundog Creek Station 1. Arctic grayling in pool.

Two sampling stations (Stations 3 and 4) were located upstream of the water fall. Station 3 was immediate above the falls and consisted of shallow cascades/riffles and small pools. Station 4 was located near the upper road crossing and had numerous pools and bedrock chutes. Backpack electrofishing was conducted at both locations. No fish were captured or observed at either location. The waterfall immediate downstream of Station 3 is likely a fish barrier (Photo 6). The results of the sampling in the upper part of the Sundog Creek suggest that the upper reaches of the watershed are non-fish bearing.

3.0 SUMMARY

The lower part of Sundog Creek is fish bearing. Fish habitat in the late summer is limited in the reach, extending from the water fall to east of Cat Camp, due to the lack of surface water flows. Residual pools in this reach are critical habitat features that support fish populations during periods of low flow. Fish access to the upper reaches of the watershed is limited by a set of waterfalls and cascades. The upper portion of the Sundog Creek watershed, above the falls, appears to be non-fish bearing.

Photo 6 Sundog Creek Station 3. Looking upstream at waterfall on Sundog Creek.

4.0 CLOSURE

We trust that this meets your immediate needs. We look forward to further discussions with DFO and yourself in regards to the habitat compensation for this project.

J. David Hamilton, M.Sc., R.P. Bio., CPESC
Associate, Senior Aquatic Scientist

JDH/

N:\ACTIVE\2008\1365\08-1365-0081 CANADIAN ZINC PRAIRIE CREEK FISH & FISH HABITAT\CORRESPONDENCE\08-1365-0081 TECHMEMO 26 AUGUST 2008 SUMMARY OF SUN DOG CREEK SAMPLING.DOC

Annex E3

APPENDIX 1

CANADIAN ZINC PRAIRIE CREEK MINE WINTER ACCESS ROAD LIARD RIVER (KM 175.5) TO PRAIRIE CREEK MINE (KM 0)

FISHERIES AND FISH HABITAT ASSESSMENTS OF WATERCOURSE CROSSINGS AND ROAD REHABILITATION AREAS

SECTION I - INTRODUCTION

At the request of the Department of Fisheries and Oceans (DFO), Canadian Zinc Ltd (CNZ) was asked to complete fisheries and fish habitat assessments to support and obtain fish habitat approval, according to the Fisheries Act and under DFO's "No Net Loss, Net Gain Policy" for the construction and operation of the Prairie Creek Mine Winter Access Road.

To meet DFO's requests, CNZ employed the services of Bathurst Inlet Developments (in conjunction with Dillon Consulting Limited) and Earth Tech Ltd. to complete an assessment (fisheries and Geotechnical) of the proposed watercourse crossings of the Winter Road Alignment (Figure A1) from the Liard River (Road Marking KM 175.5) to the end of the road alignment at the Prairie Creek Mine Site (Road Marking KM 0).

The assessment, and therefore the reporting, of the Winter Road Alignment characteristics and fisheries data, were completed in a manner that considered the alignment as five distinct segments; the Liard River (KM 175.5) to the Grainger Gap (KM 120); Grainger Gap (KM 120) to Sundog Creek (i.e., Cat Camp KM 38), Cat Camp (KM 38) to the headwaters of Funeral Creek (KM 15), and the headwaters of Funeral Creek (KM 15) to Prairie Creek (KM 7); and Prairie/Funeral Creek Confluence to the Prairie Creek Mine Site located adjacent to Prairie Creek at KM 0.

SECTION II - METHODOLOGY

All field assessments were completed using helicopter support and ground assessment by foot and the use of 4-wheeler bikes. An initial fly-over assessment was completed between July 19 and 20, 2006 to document, with air photography, all road alignment watercourse crossings. The assessment habitat biologist from DFO, the senior environmental coordinator for CNZ and one of CNZ's field biologists completed the air assessment over a two-day period starting from the Liard River to the Mine site.

During the initial fly-over, at each of the watercourse crossings, the following data was documented:

- Watercourse number and name (as identified in historic assessment documents);
- Estimated road alignment KM marking from historic road alignment documents);
- UTM Coordinates (Eastings and Northings) from helicopter mounted GPS;
- Watercourse crossing air photos sequentially numbered from Liard River to Prairie Creek Mine; and
- Field comments (i.e., watercourse crossing description, fish habitat characteristics, alignment orientation.

A second field assessment was completed between September 23 and 25, 2006. The field team included two fisheries biologists and a geotechnical engineer. Field assessments were completed by both air and ground reconnaissance.

The road alignment was initially flown by helicopter reassessing each watercourse crossing from the air to confirm information collected during the July assessment. Additionally, by first flying over and along the road alignment (Liard River to the Mine site) the field team had an opportunity to identify key crossings that required detailed ground and in stream assessments, to gather further photographic documentation of each watercourse crossing from low level hovering (time constraints during the initial fly over assessment did not allow for this level of air documentation), and the opportunity to develop a field plan, based on visual inspection, for the completion of an assessment of the entire road alignment.

Data collected during the field assessments of September 2005 included the following:

Air Assessment

- Air photography of each watercourse crossing from at least three aspects (looking upstream, looking downstream and from a hovering position over the crossing centered directly above the road alignment;
- Identification of potential in stream and downstream barriers eliminating or limiting the migration of fish to the road alignment crossing;
- Identification of potential road crossing locations, within close proximity to the existing road alignment crossing that would eliminate or minimize potential impacts to fish habitat, if present;
- The documentation of watercourse crossing locations as identified by GPS coordinates;
- The identification of landing locations in close proximity of the road alignment and watercourse crossing to complete ground assessments; and
- The collection, based on visual assessment, of stream and fish habitat characteristics at watercourse crossing locations where ground access was not possible (i.e., no landing area available in proximity to the watercourse crossing of the road alignment).

Ground Assessment

- Documentation of fish habitat characteristics to include biophysical parameters to be measured/recorded at each crossing location including;
    - bankfull and wetted widths;
    - bankfull and wetted depths;
    - habitat unit composition (pool, riffle, run, flat, boulder garden);
    - substrate composition (generally following established particle size categories: fines/sand (<2mm), gravel/cobble (2-16 mm), pebbles (16 – 64mm), cobble (64-256 mm), and boulder (>256mm);
    - substrate compaction/embeddedness;
    - channel morphology; and
    - disturbance indicators (field indicators of channel degradation and aggredation such as changes in sediment characteristics, areas of recent erosion, debris accumulations, etc.).

- Watercourse cover measurements, to provide information regarding fish habitat quality including:
    - relative amount/distribution of woody debris;
    - presence/relative amount/composition of riparian vegetation;
    - presence/description of undercut banks (UCB);
    - presence of large boulders;
    - presence of pools (for juvenile and/or spawner overwintering/staging);
    - presence of side channels (for juvenile and/or spawner overwintering/staging); and
    - presence of potential barriers (to fish movement).
- Collection of water course crossing velocity and flow measurements using standard mid-point flow method and Swoffer current meter;
- Collection of standard water quality parameters to include, temperature, dissolved oxygen, pH, and conductivity; and
- Ground photography upstream, at and downstream of the stream coarse crossing of the road alignment; and
- Documentation of fish communities within the vicinity of the watercourse crossing using a backpack electrofisher sampling techniques and visual observations.

The assessment also included the documentation of existing road conditions along the Winter Access Road Alignment that runs adjacent to Prairie and Funeral Creeks. Measurements were approximated, most specifically at locations of the road that were noticeably eroded by stream encroachment of the road banks and included existing roadbed widths and road bank elevations adjacent to the creek channels. The characteristics of the road, and most specifically at points of road erosion, were also documented photographically.

The construction of the Prairie Creek Winter Access Road will be completed in such a manner that only clean snow and ice will be used at crossings between the Laird River and the headwaters of Sundog Creek. DFO's operational guidelines and construction methodologies for winter access road creek crossings will be followed. This crossing construction methodology will form the basis from which fish habitat impacts, as a result of crossing construction, will be determined using the information collected from both air and ground assessments.

The assessment of fish habitat impacts, as a result of the winter access road upgrades between the Prairie Creek Mine and the headwaters of Funeral Creek, will also be determine using the fisheries data collected in July and September 2005 in addition to geotechnical information obtained and resulting in the design of road rehabilitation plans. These plans will provide the basis from which the amount (m^2) of fish habitat that will potential be impacted/lost as a result of the road rehabilitation work and thus the calculation of habitat requiring compensation and the development of compensation plans/concepts for approval from DFO.

SECTION III - RESULTS

Initial Fly Over Assessment

An initial fly over of the Prairie Creek Mine Winter Access Road from the Laird River to the Mine site at Prairie Creek was completed between July 19 and 20, 2005. Table A1 provides the data collected and Figures A1, A2 and A3 show the locations and representative photographs of most watercourse crossing of the winter road alignment.

Table A1 – Prairie Creek Winter Access Road Flyover Assessment - July 19 and 20, 2005

Stream Number / Name	Estimated Mile Marker	UTM		Photo Numbers	Comments
		Easting	Northing		
1	94.3	498423	6780538	65, 66	Obvious flow; close to confluence with Grainger River; large woody debris, depth and overhanging veg for cover; breached beaver dam near xing
Grainger River	87.5	498148	6789895	62, 63, 67, 68	Run and riffle boulder garden; good depth and overwintering habitat; left bank appears to be stable and sloping; right bank may be steep and unstable; potential overwintering habitat downstream from crossing
2	84.6	494302	6789949	69	Riffle-Run habitat; substrate appears to be boulder cobble
3	82.8	492137	6790063	70	Run and riffle boulder garden habitat; boulder cobble substrate
4	75.9	482800	6797000	none	Small trib to Grainger River; no photo available
Grainger River at Grainger Pass	72 - 75	-	-	71, 72, 73	Wide flood plain; braided channel; limited habitat for fish, mostly migration.
6	72.1	477165	6798842	74	Small trib flowing through wetland
7	65.3	474318	6703452	75, 76	Headwater trib; wetland with some evidence of a defined channel in areas
8	64.6	472141	6807662	77, 78	Beaver dam upstream from crossing; deep run habitat;
9	63.0	471123	6809131	79	Deep run or glide habitat
10	55.0	465012	6813820	80, 81	UTM coordinates indicate that as-built deviates from proposed by roughly 1-2 kms here; muskeg/wetland with deep slow areas, beaver dams and ponds

Table A1 (con't)

11 (Tetcela River xing 1	51.8	461404	6815740	82	Riffle-Run habitat with evidence of gravel/cobble bars and overwintering areas
12 (Tecela River xing 2	51.2	460432	6813923	83, 84	Riffle-Run habitat with boulders and some large woody debris for cover
Large section of road traverses the silent hills. Steep section with a lot of rock. No watercourse crossings observed from the air, but looks like would be able to quad this section, if it's accessible, to get a closer look.					
13	29.2	436985	6829078	85	Crossing appears to be on and near an unstable and slumping bank; poor crossing location – recommend realignment
14	27.8	434537	6829306	86	Small stream; marginal habitat
15	25.9	431629	6829759	87, 88	Riffle boulder garden and run habitat; crossing on bend, should realign.
Sundog Creek tributary and Prairie Creek	0 - 25	-	-	89	Upstream showing road down center of channel in trib to Sundog
				90	CV crossing with lots of fill on small trib, trib has limited potential for fish (steep gradient and lack of cover)
				91, 92, 93, 94	General photos showing the limited options for alignment of the road through this section
				95, 96	Breached CV crossing, and loss of road bed
				97	Another Breached CV crossing, and loss of road bed

Note:

1. Photos 98-101 karst feature
2. Stream numbers were selected arbitrarily to differentiate photos and comments, these numbers were not used by DFO or the client.
3. All UTM coordinates were read by the pilot during flight and the datum is unknown (e.g. NAD 83).
4. Time was extremely limited during the flight; approximately three hours was spent flying approximately 100 miles of road. This was because the client and DFO had other areas to look at not related to the road, which was outside the scope. No landings were made at any watercourse crossings.

Figures A1, A2 and A3.

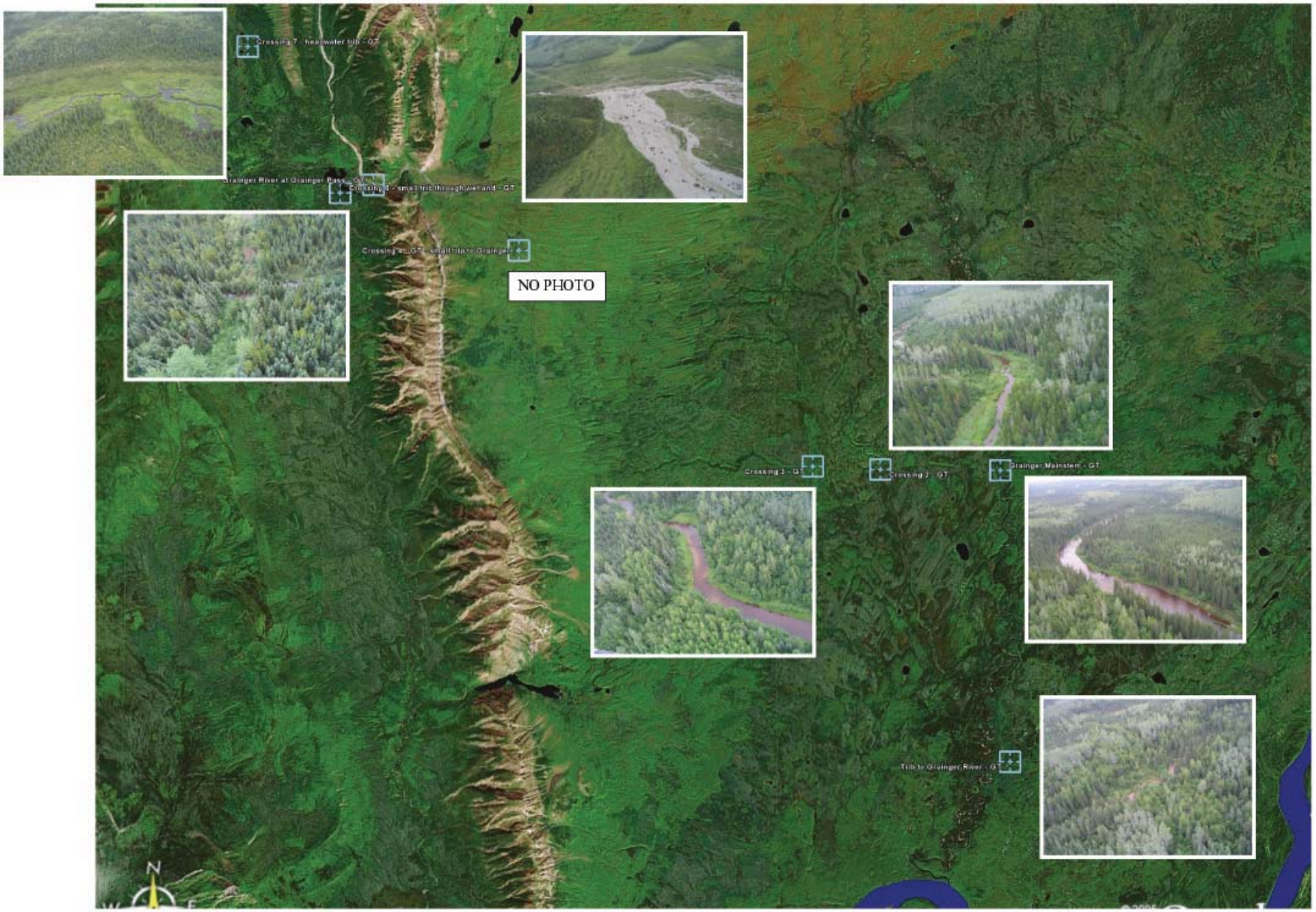


FIGURE A1 - INITIAL FLY OVER ASSESSMENT LOCATIONS JULY 19 AND 20, 2005
Liard River to Grainger Gap

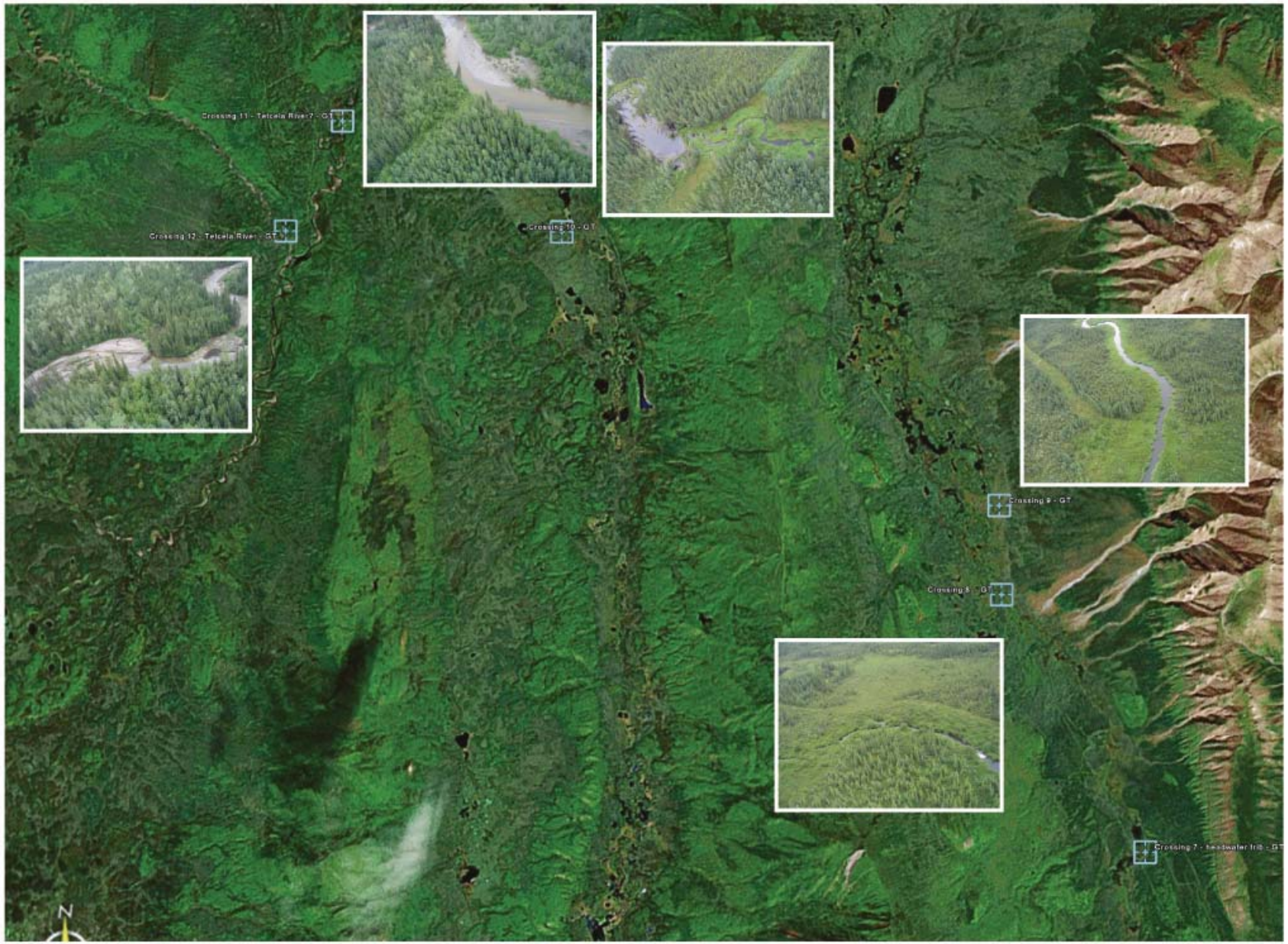


FIGURE A2 - INITIAL FLY OVER ASSESSMENTS LOCATIONS JULY 19 AND 20,2005
Grainger Gap to Tetsela River

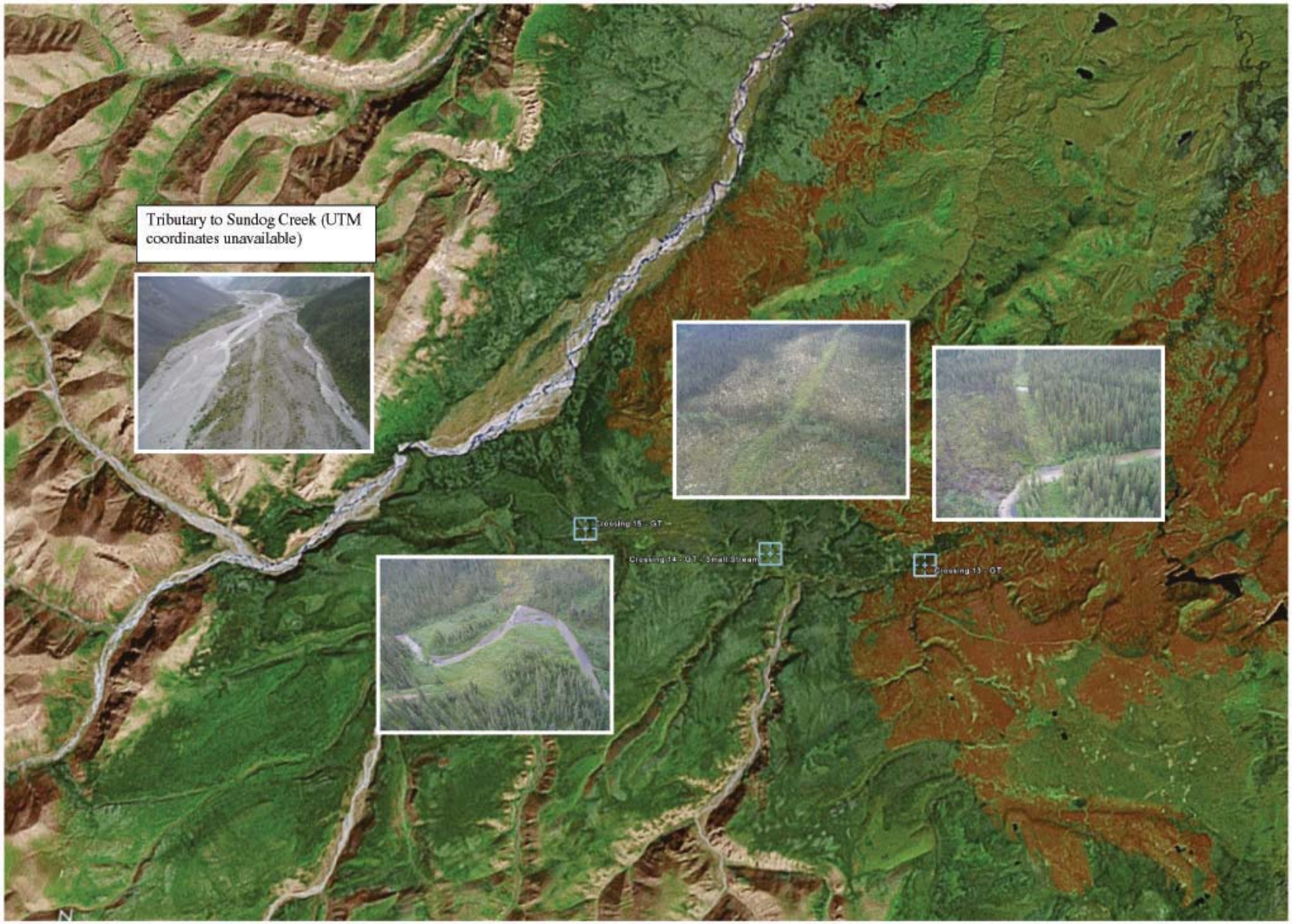


FIGURE A3 - INITIAL FLY OVER ASSESSMENT LOCATIONS JULY 19 AND 20, 2005
Tetsela River (West) to Sundog Creek (Cat Camp)

Air and Ground Field Assessments

Field assessments of the entire length of CNZ's Winter Access Road from the Laird River to the Prairie Creek Mine site was completed between September 25 and 25th, 2005. Results of the fisheries and fish habitat assessments are provided in Table A2.

Table A-2. Habitat Descriptions at Watercourse Crossings - Kilometers 0 – 175.5, Prairie Creek Mine Winter Access Road, September 23-25, 2005.

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
LIARD RIVER (KM 175.5) TO GRAINGER GAP (KM 120) - *See Figure A-4*			
Unnamed west-draining tributary to lower Grainger River	Kilometer 157 (UTM: 498423, 6780538)	– Large woody debris accumulation, numerous beaver dams, possible barrier to fish passage posed by active beaver dams, fish presence possible due to proximity to Grainger River.	
Grainger River	Kilometer 146 (UTM: 498148, 6789895)	– Estimated channel width of approximately 20m at proposed crossing location. – Low velocity run habitat; uniform depth across the channel cross-section; banks appear stable and sloping; boulder cover present at low volumes; only trace LWD observed; substrate composition: cobble (40%), sand (40%), boulder (10%), gravel (10%); black spruce, western larch, sedges comprise riparian vegetation on both banks. – Potential overwintering habitat available in deeper pools within downstream reaches.	Fish surveys by Beak (1982) and Rescan (1994) recorded presence of Arctic grayling and slimy sculpin.
Unnamed south-draining tributary to lower Grainger River	Kilometer 144 (UTM: 494302, 6789949)	– Previously installed CSP culvert observed in place at crossing to the east of a visible airstrip. – Ponding of water visible surrounding the culvert. – Channel wetted width estimated at 5 m. – Beaver activity noted downstream.	

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Unnamed south-draining tributary to lower Grainger River	Kilometer 140 (UTM: 492137, 6790063)	– Small channel located west of airstrip. – Run and riffle habitat, below boulder garden. – Substrate appears composed of large material – boulders, large cobbles	
Unnamed east-draining tributary to lower Grainger River	Kilometer 138 (UTM: not available)	– Small channel, well vegetated and stable banks – Glide habitat over cobble substrate	
Unnamed north-draining tributary to Grainger River	Kilometer 125 (UTM: 482800, 6797000)	– Small tributary channel to Grainger River; no photo available.	
Unnamed south-draining tributary to Grainger River, east of Grainger Gap	Kilometer 122 (UTM: 482648, 6796642)	– Narrow incised channel leading to the Grainger River mainstem – Extensive overhanging and cut banks, with deep (0.6m) scour pools. – Fines comprise channel bank material while boulders line channel bed. – Channel bankfull width is 1.3 m while wetted width is 1.5 m. Bankfull height is 1.3 m. – Excellent cover provided and potential for overwintering habitat. – No barrier to passage observed downstream to Grainger River.	Electrofishing conducted over a 75 m section extending throughout the past crossing location. No fish were collected: Water quality was sampled: Dissolved oxygen – 11.8ppm pH – 8.15 Temperature – 5.0 °C Conductivity – 0.34 uS/cm

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
GRAINGER GAP (KM 120) TO SUNDOG CREEK/CAT CAMP (KM 38) - *See Figure A-4*			
Grainger River at Grainger Gap	Kilometer 119-120 (UTM: 479276, 6799589)	– Braiding channel on a wide floodplain with extensive gravel bars, confined on the right bank by a bedrock outcrop – Channel bankfull width ranges from 60 to 100 m. Average wetted width was 5.2 m and average wetted depth was 0.3 m. – Numerous large gravel bars and several abandoned channels evident. LWD clusters visible on dry gravel bars near present mainstem. Several bars are vegetated willow, birch, and alder. – Extensive riffle sections dominate channel. – Substrate is gravel and cobble. Banks are sloping, vegetated by grasses and shrubs, and also formed of gravel and cobble.	Electrofishing conducted over a 100 m section extending throughout the past crossing location. A total of 6 fish were collected: # Species (length) 2 Arctic grayling (110mm, 130mm) 3 slimy sculpin (60mm, 60mm, 90mm) INSERT DATA FROM FLOW MEASUREMENTS
Wetland area, Grainger River headwaters	Kilometer 118 (UTM: 477165, 6798842)	– Wetland area west of Grainger Gap	
Unnamed tributary, west of Grainger Gap	Kilometer 117 (UTM: not available)	– Small tributary channel leading in to wetland west of Grainger Gap	
Unnamed tributary	Kilometer 110 (UTM: 474318, 6703452)	– Small headwater tributary channel draining from upper slopes into wetland complex. – Channel banks appear stable and well vegetated with sedges and grasses.	

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Unnamed tributary	Kilometer 104 (UTM: 472141, 6807662)	– Small (<2m wide) channel draining from a large marshy wetland area – Deep low gradient, run or glide habitat over smaller substrate (fines largely) – Beaver dams visible upstream – Banks appear stable and well vegetated with grasses and sedges	
Unnamed tributary	Kilometer 103 (UTM: 471123, 6809131)	– Small (<2m wide) channel, with ponds formed behind several beaver dams visible at the crossing, downstream and upstream. – Banks appear stable and well vegetated with grasses and shrubs. – Habitat appears to combine pool-runs through channel modified by beaver	
Fishtrap Creek	Kilometer 93 (UTM: 465012, 6813820)	– Small (<2m wide) channel draining from a large wetland area, exhibits a tortuous meander – Banks appear low in profile; sedges and other wetland vegetation extend through the bankfull channel to the wetted margins of the stream – Channel appears to contain deep run habitat – Beaver dams are visible upstream and downstream	Fish survey by Beak (1982) collected no fish.

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Tetcela River - East Crossing	Kilometer 88 (UTM: 461375, 6815658)	– Channel bankfull width is 30 m and wetted width is 11 m at moderate - low flow conditions. Bankfull height was 1.9m and residual pool depth was 1.0m. – Dominant habitat is characterized as riffle-run and substrate is largely gravel and cobble. – Functional LWD is present instream at the crossing location, upstream, and downstream. Two pools (1.0 m depth) containing LWD are present off the left bank at the past crossing alignment. – Left bank – undercut and vertical bank formed of fines and gravel, vegetated by mixed young forest. – Right bank – sloping bank formed of fines and cobbles, vegetated by mixed pole/sapling forest.	Fish surveys by Beak (1982) and Rescan (1994) recorded presence of Arctic grayling, whitefish, northern pike, lake chub, slimy sculpin, and longnose sucker. INSERT DATA FROM FLOW MEASUREMENTS
Tetcela River – West Crossing	Kilometer 86 (UTM: 460386, 6813946)	– Very dynamic system – movement of larger substrate, braiding of channel, gravel bars, large woody debris and debris jams evident. Gradient is 1.5%. – An abandoned channel is visible along the left bank; downstream portion of this channel is still wetted and fish (Arctic graling) were observed in pools. – Main channel bankfull width is 25 m and wetted width is 7 m at low flow conditions. – Dominant bed substrate material is large cobble and boulder. – Banks are undercut and sloping, formed of finely textured bank material, and vegetated by mixed forest. – Good cover habitat provided throughout the channel by LWD, boulders, cutbanks. – Damage noted to trees along left bank (possible ice jam scarring).	Visual observations noted presence of Arctic grayling juveniles holding in a sidechannel pool. Fish surveys by Beak (1982) and Rescan (1994) recorded presence of Arctic grayling, lake chub, and slimy sculpin. INSERT DATA FROM FLOW MEASUREMENTS

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Unnamed tributary to Sundog Creek off the Ram Plateau	Kilometer 47 (UTM: 436465, 6828647)	– Past road alignment forms a triple crossing spanning a channel meander.	Electrofishing conducted over a 100 m section upstream of the crossing location. No fish were captured or observed. Fish surveys by Beak (1982) recorded presence of Arctic grayling.
North-draining Tributary to Sundog Creek	Kilometer 41 (UTM: 431604, 6829807)	– Meandering unconfined channel with extensive side bars and overhanging banks. – Habitat composition within the area of the crossing was 60% riffle, 20% run, and 20% pool. – At low flow stage, channel bankfull width and wetted width averaged 9.4 m and 2.1 m, respectively. – One pool present downstream of the crossing has a depth of 0.9 m but shallow average depth through most of the surveyed channel section limits over wintering potential. – Substrate at the crossing location was angular gravel and cobble, although exposed bedrock formed the channel bed downstream. – Banks are well vegetated with grasses and shrubs; mixed deciduous/coniferous forest located on the right bank.	Electrofishing conducted over a 40 m section extending from the upstream of the crossing downstream to a bedrock chute and pool. No fish were captured or observed. INSERT DATA FROM FLOW MEASUREMENTS
SUNDOG CREEK/CAT CAMP (KM 38) TO FUNERAL CREEK (KM 15) – *See Figure A-5*			
Sundog Creek	Kilometer 36.5 (UTM: 427157, 6829483)	– Large aggrading braided channel frequently confined within steep/near vertical banks – Multiple channels (2-3) visible; extensive gravel bars – Ground assessment completed, including flow	INSERT DATA FROM FLOW MEASUREMENTS

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Sundog Creek	Kilometer 34 (UTM: 425258, 6829051)	– Approximately 1.5Km long section is dewatered; flow becomes subsurface	
Sundog Creek	Kilometer 28 (UTM: 420622, 6827048)	– Channel narrows, grade increases, confinement from bedrock outcrops and scree slopes – Chutes present; drops of 30-50cm through large boulders; high velocity; potential barrier to fish movement – Substrate largely cobble, boulder	
Sundog Creek	Kilometer 24 (UTM: 417556, 6829067)	– Waterfall, estimated to be ~10m drop into plunge pool	
FUNERAL CREEK (KM 15) TO PRAIRIE CREEK (KM 7) – *See Figure A-6*			
Funeral Creek	Kilometer 8.30 (UTM: 417556, 6829067)	– Upper reaches of Funeral Creek exhibit a channel bankfull width ranging from 3 to 5 m. – Extensive riffle habitat is present. – Substrate is cobble and gravel. – Areas of scour and bank erosion noted at outside bends	

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Funeral Creek	Kilometer 8.20 (UTM: 404450, 6831654)	– Sinuous confined channel with Access road aligned on the left bank. – Extensive riffle habitat is present. Pools (depth 0.3 to 0.4 m) noted downstream where exposed bedrock creates a series of small chutes. – Slope gradient is 4%. – Channel bankfull width is 4m; wetted width varies from 1 to 2 m in low flow conditions. – Left bank – steeply sloping, unvegetated, gravel and cobble bank. – Right bank – near vertical shale bedrock and colluvialmaterial	Electrofishing conducted over a 200m section of channel, including riffle and pool habitat. No fish were collected or observed.
Funeral Creek	Kilometer 7.96 (UTM: 404288, 6831637)	– Extensive riffle habitat is present. – Substrate is cobble and gravel. – Areas of scour and bank erosion noted at outside bends.	
Funeral Creek	Kilometer 7.75 (UTM: 404077, 6831645)	– Riffle, step-pool habitat – Cobble and gravel substrate – Steep (near vertical) shale slope on northern bank, opposite the road	
Funeral Creek	Kilometer 7.22 (UTM: 403563, 6831715)	– Extensive riffle area – Cobble and gravel substrate – Steep grade ~ 5%	

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Funeral Creek	Kilometer 7.15 (UTM: 403405, 6831761)	– Extensive riffle area – Cobble and gravel substrate – Steep grade ~ 5%	
Funeral/Fast Creeks Confluence	Kilometer 7.1 (UTM: 403307, 6831879)	– Extensive riffle area – Cobble and gravel substrate – Steep grade ~ 5% – An area of road erosion is located on the left bank, adjacent to the confluence of Funeral and Fast Creeks.	
FUNERAL CREEK/PRAIRIE CREEK CONFLUENCE (KM 7) TO PRAIRIE CREEK MINE SITE (O KM)			
Prairie Creek	Kilometer 5.50 UTM: 402638, 6830429)	– Small tributary channel to Prairie Creek; wetted width of 2.5m and wetted depth of 0.2m during low flow conditions. – Low gradient run habitat over angular gravel-sized substrate – Tributary channel banks are vegetated with grasses and herbaceous species	
Prairie Creek	Kilometer 5.15 to 5.23 (UTM: 402749, 6830161)	– Prairie Creek is a frequently confined braided channel with multiple channels and large gravel bars. – A small, shallow sidechannel extends along the left bank and joins the mainchannel of Prairie Creek. – Run habitat over cobble substrate. – Bank erosion visible along the left bank of the side channel (~30m) and main channel (~50m) extending along an outside bend.	
Prairie Creek	Kilometer 4.80 (UTM: 402814, 6829710)	– Off-channel seepage area disconnected from main channel is located on the left bank of Prairie Creek. – Deep pools visible but no flow noted. Extensive algal growth visible.	

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Prairie Creek	Kilometer 4.57 to 4.64 (UTM: 402964, 6829538)	– The mainstem channel of Prairie Creek is aligned along the left bank. – Habitat is characterized as riffle-run over cobble substrate. – Erosion is visible along a 70 m section of the left bank. – The left bank is well vegetated and extends away from the channel at a level grade for more than 30 m before being confined by steep bedrock slopes.	
Prairie Creek	Kilometer 3.87 to 3.95 UTM: 403046, 6828952)	– A large sidechannel extends along the left bank of the braided Prairie Creek bankfull channel. – At low flow conditions (late Sept. 2005), wetted width ranged from 3 to 4m and wetted depth was 0.2 to 0.6 m. – Large cobble substrate and occasional boulders comprise the substrate. – Undercutting was visible along the bedrock toe of slope forming the left bank. – Pools are adjacent to bedrock points and boulders along the left bank. – The channel is confined on the left bank by a steep and loose slope (shale), and bedrock.	
Prairie Creek	Kilometer 3.70 to 3.77 UTM: 402990, 6828752)	– A small sidechannel extends along the left bank of Prairie Creek. – At low flow conditions, the wetted width of the channel was 1 m and its wetted depth was 0.1 m. – Channel exhibited riffle habitat over gravel/cobble substrate – Deeper pools (0.4m deep) were visible found around bedrock fingers extending into channel at the downstream end of the sidechannel	

Watercourse	Location[1,2]	Habitat Features	Additional Fisheries Data
Prairie Creek	Kilometer 3.46 to 3.63 UTM: 402980, 6828663)	– A large sidechannel extends along 90 m of the left bank of Prairie Creek along the toe of a steep bank of loose rock. At low flow conditions, wetted width was 14 m and wetted depth was 0.4m. – Substrate is clean cobble and gravel, with bedrock fingers extending from road edge and slope forming the left bank. – Erosion visible along left bank. Shale from the road and upper slope extends 1 to 2 m into the wetted channel margin. – A low flow sidechannel/off-channel section extends for 80 m downstream of the larger sidechannel. At low flow conditions, the wetted width was 10m and the wetted depth was 0.2 m. – Finer substrate (sand, silt) and algal growth visible. – Vegetated gravel bars noted adjacent to this section.	
Prairie Creek	Kilometer 2.70 UTM: 403330, 6827807)	– Mainstem of Prairie Creek is aligned along the left bank below the access road and an area of steep eroding slope. – Natural rockfall extends into the watercourse. – Riffle-run habitat over angular substrate. Bank presently consists of large angular boulders.	

1. Locations (presented as NAD83 - UTM coordinates) are derived from GPS waypoints collected during the September and July site visits.
2. Kilometer references are based on the waypoint locations offset from the road alignment indicated in the AutoCAD base map "winter_roadNS_topo.dwg" provided by Canadian Zinc.

Figures A4, A5, and A6 – Pocket with Folded Maps

Prairie and Funeral Creek Road Rehabilitation Assessment

A field assessment of the Prairie and Funeral Creek road alignment (KM 0 to KM 15) was completed on September 25, 2005 and included both an air and ground assessment of the road. The assessments primarily focused on the constructed road alignment which requires rehabilitation to make the road passable by mine vehicles. Most areas identified for rehabilitation were at locations along the road that have been eroded as a result of creek flows or areas of the road that require rehabilitation due to rock slides and road washouts. Table A3 summarizes the results of the assessment and identifies the road rehabilitation locations and associated road characteristics.

The locations identified in Table A3 were assessed, based on rehabilitation requirements, for the potential to impact fish habitat impacts and the type of habitats that would potentially be lost due to road rehabilitation/stabilization from infilling. Table A4 details the habitat characteristics at each of the rehabilitation areas.

Insert Table A3 and A4 and Figure A7

TABLE A3 - PRAIRIE AND FUNERAL CREEK ROAD REHABILITATION SECTION DETAILS

Section Locations (Fisheries Reference)	Photo Reference Air (Heli) and Ground	KM Distance from Mine Site - Start Location	KM Distance from Mine Site - Finish Location	Section Length (m)	Rehabilitation Length %	Avg. Road Width (m)	Avg. Road Bed Elevation from Water Level (m)	Special Notes
PRAIRIE CREEK								
Section A (3)	1 and A-1	2.837	2.868	31.0	100	4.0	2.0	
Section B1(6)	2, 3, 4 and B1-1to6	3.76	3.956	196.0	33.3	3.5	1.0	
Section B1(6)	2, 3, 4 and B1-1to6			0.0	66.6	2.5	3.0	
Section B2(4)	4, 5,6 and B2-1to3	3.956	4.044	88.0	100	2.0	1.0	
Section B3(5)	6, 7 and B3-1	4.044	4.213	169.0	60	2.5	2.0	
Section B4(2)	7, 8 and B4-1to2	4.213	4.356	143.0	25	2.5	1.5	
Section B4(2)	7, 8 and B4-1to2			143.0	75	n/a	n/a	Road Diversion resulting in no fish habitat issues
Section C1(1)	9 and C-1to2	4.813	4.844	31.0	100		1.5	Road Diversion resulting in no fish habitat issues
Section D1(7)	10, 11,12 13, 14 and D-1to2	5.425	5.625	200.0	33.3	2.5	1.5	
Section D1(7)	10, 11,12 13, 14 and D-1to2	5.425	5.625	200.0	66.6	2.5	3.5	
Section E1(8)	15	5.91	6.05	140.0		5.0	0.3	Road Diversion and creek crossing resulting in no fish habitat issues

Section Locations (Fisheries Reference)	Photo Reference Air (Heli) and Ground	KM Distance from Mine Site - Start Location	KM Distance from Mine Site - Finish Location	Section Length (m)	Rehabilitation Length %	Avg. Road Width (m)	Avg. Road Bed Elevation from Water Level (m)	Special Notes
FUNERAL CREEK								
Section 1	1	7.1	7.115	15.0	100	3.0	1.0	Encrouchment into creek not required with the exception of armouring. Bedrock on road corner can be removed to increase road width.
Section 2	2	7.15	7.165	15.0	100	4.0	1.5	Road width can be increased toward mount slope and away from creek. Road bank armouring required.
Section 3	3	7.22	7.24	20.0	100	3.0	1.5	Widening toward mountain slope required and bank armouring.
Section 4	4	7.75	7.76	10.0	100	2.5	2.0	Widening toward mountain slope required and bank armouring.
Section 5	5	7.96	7.975	15.0	100	3.0	1.5	Widening toward mountain slope required and bank armouring.
Section 6	6	8.3	8.315	15.0	100	2.0	2.0	Widening toward mountain slope required and bank armouring.

Table A4: Anticipated Fish Habitat Impacts Resulting From Road Rehabilitation Between Kilometers 0 and 10, Prairie/Funeral Creeks

Location	Habitat Type	Road Condition	Proposed Works & Potential Impacts
Prairie Creek Kilometer 2.837 to 2.868 ***Road Rehabilitation Section A***	– Main channel – Riffle-run habitat over angular substrate – Bank presently consists of large angular boulders – Ground photo A-1	The road is aligned along the wetted edge of Prairie Creek below an area of steep eroding slope. Natural rockfall that extends into the watercourse comprises the roadbed.	Proposed works include the placement of rock armour along the toe of the left bank of the watercourse to enable road widening, with **no expected loss of wetted habitat.**
Prairie Creek Kilometer 3.76 to 3.956 ***Road Rehabilitation Section B1***	– Large side channel - 70m length - Wetted width of 14m - Wetted depth of 0.4m – Clean cobble and gravel substrate, with bedrock fingers extending from road edge – Shale from road runs 1-2m into wetted channel margin – Ground photos B1-2,-4,-6 – Low flow sidechannel/off-channel section downstream of the larger sidechannel - 130m length - Wetted width of 10m - Wetted depth of 0.2m - Finer substrate and algal growth visible - Ground Photos B1-1,-3,-6	A 200m section of road, aligned along the toe of a steep bank of loose rock, has been narrowed by erosion of the toe of the constructed roadbed. Road width varies from 2.5 to 5m.	Proposed works include the placement of armour rock and widening of the existing road by 2m along the large side channel and by at least 3m along the low flow sidechannel (elevation of the road may be required and this may extend the road prism). Anticipated loss of habitat includes **105m^2** of riffle habitat along the road edge and up to **520m^2** habitat in the low flow channel.

Location	Habitat Type	Road Condition	Proposed Works & Potential Impacts
Prairie Creek Kilometer 3.956 to 4.044 ***Road Rehabilitation Section B2***	– Small sidechannel – Wetted width of 1m – Wetted depth of 0.1m – Riffle habitat with gravel/cobble substrate – Deeper pools (0.4m) found around bedrock fingers extending into channel at the downstream end of the sidechannel – Ground photos B2 -1,-2,-3	A 90m long section of road has been eroded by the formation of a small sidechannel.	Proposed works include bank armouring and back filling to extend the road 4m into the wetted channel with 2m of fish habitat being potentially affected; this would cause the loss of the small sidechannel and result in the loss of **180m^2** of riffle habitat.
Prairie Creek Kilometer 4.044 to 4.213 ***Road Rehabilitation Section B3 (part)***	– Sidechannel – Wetted width of 3 – 4m – Wetted depth of 0.2 – 0.6m – Large cobble substrate with occasional boulders present – Pools adjacent to and undercutting bedrock toe – Ground photo B3-1	A 170m section of road requires bank armouring and widening. The road is below a steep and loose section of slope, and sits on a base of shale-type rock on a bedrock lip. The road is elevated above wetted channel by 1-2m.	Proposed road widening, to extend the road by ~2.5m, would require the infilling of the upstream end of the sidechannel and filling on top of the bedrock toe to widen roadbed, resulting in an anticipated loss of ~ **255m^2** wetted habitat.
Prairie Creek Kilometer 4.213 to 4.356 ***Road Rehabilitation Section B4 (Part)***	– Main channel – Riffle-run habitat – Cobble substrate – Ground photos B4-1,-2	A 143m road section with a 36m section of eroded road needing to be addressed. Opportunity exists to widen the road towards the slope-side.	Proposed road widening, to extend the road by ~3m, would require placement of rock armour along the existing toe of the road resulting in an anticipated loss of ~ **53.6m^2 of** wetted habitat. Diversion of the remaining length of road away from the channel **would permit additional road widening and rehabilitation with no additional loss of wetted habitat.**

Location	Habitat Type	Road Condition	Proposed Works & Potential Impacts
Prairie Creek Kilometer 4.813 to 4.844 ***Road Rehabilitation Section C***	– Main Channel split by gravel/rubble bar – Wide and shallow bank side channel – Riffle-run habitat – limited cover mid-stream or bank Ground photos C- 1,2	A 30m long stretch of road is presently aligned partly adjacent and perpendicular to side-channel. The main flow into the road bank has resulted in road bank erosion	A road diversion can easily be completed moving the road away from the channel. Road rehabilitation will consist of bank larger rock armouring with large rock. **No impacts on fish habitat are expected.**
Prairie Creek Kilometer 5.425 to 5.625 ***Road Rehabilitation Section D***	– Sidechannel/mainchannel – Run habitat over cobble substrate – Shallow and low flow sidechannel extends along the upstream ~30m of the eroded area – Erosion continues ~50m downstream of the sidechannel/mainchannel confluence and extends along an outside bend	A 200m long area of eroded road needs to be repaired and armoured. Road width varies from 1.5m (at downstream end) to 3m (at upstream end). Opportunity exists to widen the road slopeward on the upstream portion of eroded area.	Proposed road improvements would require road widening and the placement of armour rock along 150m of road. Armour placement along the downstream 50m eroded section (where road widening on the slope side is possible) would extend ~2m into the wetted channel, while armoring and widening of the upstream 100m section would extend ~3-4m into the wetted channel and result in a loss of **100m^2** and **600m^2** respectively of wetted habitat.
Prairie Creek Kilometer 5.91 to 6.05 ***Road Rehabilitation Section E***	– Tributary channel crossing – Wetted width of 2.5m – Wetted depth of 0.2m – Low gradient run habitat over angular substrate – Banks are vegetated with grasses and herbaceous species	Existing road alignment crosses both a tributary and sidechannel for a wetted distance of 14m.	No road rehabilitation work required. Proposed realignment of the road would allow one crossing of the tributary channel. Crossing would be constructed with clean snow and ice. **No fish habitat impacts expected.**

Location	Habitat Type	Road Condition	Proposed Works & Potential Impacts
Funeral/Fast Creeks Confluence Kilometer 7.1 ***Road Rehabilitation Section 1***	– Main channel – Extensive riffle area – Cobble and gravel substrate – Steep grade ~ 5%	An area of road erosion is located on the left bank, adjacent to the confluence of Funeral and Fast Creeks.	Bank armouring requires rock placement along toe of slope. Rock scaling may be required to widen road to the slope-side and limit intrusion to the watercourse. **No habitat loss is expected.**
Funeral Creek Kilometer 7.15 ***Funeral Creek Rehabilitation Section 2***	– Main channel – Extensive riffle area – Cobble and gravel substrate – Steep grade ~ 5%	A 15m section of bank has eroded, resulting in narrowing of the road.	Repair of an area of bank erosion requires bank armouring through placement of rock along the toe of existing alignment. Loss of a small area (~**15m^2**) of wetted habitat is anticipated along the channel margin.
Funeral Creek Kilometer 7.22 ***Funeral Creek Rehabilitation Section 3***	– Main channel – Extensive riffle area – Cobble and gravel substrate – Steep grade ~ 5%	A 20m section of bank has eroded and narrowed the road as a result of scour on an outside bend of Funeral Creek.	Repair of an area of bank erosion requires bank armouring through placement of rock along the toe of existing alignment. Loss of a small area (~**20m^2**) of wetted habitat is anticipated along the channel margin.

Location	Habitat Type	Road Condition	Proposed Works & Potential Impacts
Funeral Creek Kilometer 7.75 ***Funeral Creek Road Rehabilitation Section 4***	– Main channel – Riffle, step-pool habitat – Cobble and gravel substrate – Steep (near vertical) shale slope on northern bank, opposite the road	A 10m section of bank has eroded and narrowed the road as a result of scour on an outside bend of Funeral Creek.	Repair of an area of bank erosion requires bank armouring through placement of rock along the toe of existing alignment. Loss of a small portion of the floodplain (~**10m^2**) is anticipated.
Funeral Creek Kilometer 7.96 ***Funeral Creek Road Rehabilitation Section 5***	– Main channel – Riffle habitat – Cobble and gravel substrate	A 15m section of bank has eroded and narrowed the road as a result of scour on an outside bend of Funeral Creek.	Repair of an area of bank erosion requires bank armouring through placement of rock along the toe of existing alignment. Loss of a small area (~**15m^2)** of wetted habitat is anticipated along the channel margin.
Funeral Creek Kilometer 8.30 ***Funeral Creek Road Rehabilitation Section 6***	– Main channel – Riffle habitat – Cobble and gravel substrate	A 15m section of bank has eroded and narrowed the road as a result of scour on an outside bend of Funeral Creek.	Repair of an area of bank erosion requires bank armouring through placement of rock along the toe of existing alignment. Loss of a small area (~**20m^2**) of wetted habitat is anticipated along the channel margin.

1. Locations and lengths of areas of erosion are derived from GPS waypoints collected during the September site visit and scaled measurements from 1994 – 1:50000 Air photography.
2. Kilometer references are based on the waypoint locations offset from the road alignment indicated in the AutoCAD base map "winter_roadNS_topo.dwg" provided by Canadian Zinc and scaled measurements from 1994 – 1:50000 Air photography.

SECTION A – Looking Downstream - Photo A-1

Looking downstream from approx. KM 2.50

PRAIRIE CREEK - UPSTREAM TO DOWNSTREAM - Section A - Photo A-2

Section B1 - Photo B-1

SECTION B1 – Looking Upstream - Photos B-2,3 and 4 (L to R)

Top Left – looking upstream in Section B1 from approx. KM 3.755

Top Right – looking upstream in Section B1 from approx. KM 3.770

Bottom Left – looking upstream from end of Section B1 to section B2 from approx. KM 3.956

SECTION B1 - Looking Downstream - Photos B-5, 6, and 7 (Lto R)

Top Left – looking downstream in Section B1 at approx. KM 3.785

Top Right – looking downstream in Section B1 at approx. KM 3.85

Bottom Left – looking downstream from approx. KM 3.95

Top - Section B1 - Photo B-8
Bottom - Section B1 - Photo B-9

SECTION B2 - Looking Upstream - Photos B-10, 11,and 12 (L to R)

Top Left – looking upstream from Section B1 to start of B2 from approx. KM 3.90

Top Right – looking upstream in Section B1 from approx. KM 3.98

Bottom Left – looking upstream from approx. KM 4.025

Top - Section B2 - Photo B13

Bottom - Section B2 (top) and B3 (bottom) - Photo B-14

SECTION B3 - Looking Upstream - Photos B- 15, 16, and17 (L to R)

Top Left – looking upstream from upstream location of Section B3 to start of Section B4 from approx. KM 4.195

Top Right – looking upstream from Section B3 at start of Section B4 from approx. KM 4.210

SECTION B4 - Looking Downstream

Bottom Left – looking downstream from approx. KM 4.240

SECTION C
Top – Looking downstream from approx. KM 4.835 - Photo C-1
Bottom – Looking upstream from approx. KM 4.810 - Photo C-2

Top - Section C - Photo C-3

Top - Section D - Photo D-1

SECTION D
Top – Looking downstream at Section D from approx. KM 5.575 - Photo D-2
Bottom – Looking upstream at Section D from approx. KM 5.5 - Photo D-3

Top - Section D - Photo D-4

Bottom - Section D - Photo D-5

Top - Section D - Photo D-6

PRAIRIE CREEK LOOKING DOWNSTREAM - Section B-3 (top) to Section D (bottom) - Photo P-1

PRAIRIE CREEK LOOKING DOWNSTREAM - Section D (middle) Section E (bottom) - Photo P-2

Prairie Creek Section F - Photo-F1
FUNERAL CREEK - SECTION 1 -Looking downstream at KM 7.10 - Photo FC-1

SECTION 2 - Looking downstream at KM 7.15 - Photo FC-2

SECTION 3 - Looking at KM 7.22 - Photo FC-3

SECTION 4 - Looking downstream at KM 7.75 - Photo FC-4
SECTION 5 - Looking downstream at KM 7.96 - Photo FC-5

SECTION 6 and 5 - Looking downstream at KM 8.30 - Photo FC-6

CONCLUSIONS

As a result of road rehabilitation requirements to support the reestablishment of Prairie Creek Mine's Winter Access Road from the Mine to the Liard River (specifically road rehabilitation on the between the mine and the headwaters of Funeral Creek – KM 0 to KM 15), fish habitat impacts, and therefore losses, associated with the shorelines of Prairie and Funeral Creek, will result.

The total amount of these potential fish habitat losses and proposed compensation as per Road Rehabilitation Section are provided below.

Prairie Creek

Road Rehabilitation Section A - no expected loss of fish habitat as a result of planned road rehabilitation. Therefore, no fish habitat compensation is required for this Section.

Road Rehabilitation Section B1 - Anticipated loss of habitat includes 105m^2 of riffle habitat along the road edge and up to five locations of 100m^2 each of habitat in the low flow channel and side channel.

Habitat Compensation options could include but not be limited to:

- To compensate for riffle habitat loss along the large side channel, pool habitat will be created due to its scarceness within the Prairie Creek system. This will include the placement of "hard points" or large boulders installed along the armoured toe of the road slope to promote scouring and pool excavation. The construction of this habitat should account for approximately 100m^2 of habitat loss. Additionally, rock deflectors, set perpendicular from the road bank will be constructed to divert water flow and create niche habitat for both adult and juvenile fish; and
- To maintain a portion of the low flow side channel as wetted habitat, bar material at the upstream end of the low flow side channel will be partially excavated to maintain flow to the side channel. Loss of habitat would be expected to be limited to that infilled by the road equaling approximately 400m^2. Boulder clusters will be installed in the low flow channel to provide improved cover and enhance remaining habitat. Back water areas on the downstream edge of the clusters from high flow conditions will allow for scouring and the deposition of finer substrates (sands and silts). These areas will provide cover, habitat for a diversity of aquatic invertebrates and potential spawning areas.

Road Rehabilitation Section B2 – It is anticipated that road rehabilitation in this area would result in the infilling of an extremely small side-channel of Prairie Creek which is adjacent to a gravel bar. Infill to meet the requirements of road rehabilitation would result in the infilling of the side-channel to the gravel/rubble bar. The result of rehabilitation would be a maximum loss of approximately 180m^2 of riffle habitat. Depending on the extent of rehabilitation required at this location this loss me be as little as 90m^2.

Habitat Compensation options could include but not be limited to:

- the creation of pool habitat along the armoured road margin either at B2 and constructed along the outside edge of the gravel/rubble bar or at another suitable location; and
- at the downstream end of the B2 rehabilitation area additional rock structures will be placed to support the pool habitat designs by providing further habitat that will provide "hardpoints" along the toe of the rehabilitate road and to encourage further downstream scour and the development of shallow pool conditions with reduced water velocities.

Road Rehabilitation Section B3 (part) - infilling of the upstream end of a side-channel and filling on top of the bedrock toe to widen the roadbed, it is anticipated that there will be a loss of fish habitat of approximately $255m^2$ in total.

Habitat Compensation options could include but not be limited to:

- Lost riffle habitat will be compensated through the creation of pool habitat along the armoured road margin; and
- Preferred road construction designs will be those limiting impact to existing pools and therefore habitat compensation will focus on the design of rock structures around and in the vicinity of the existing pools to enhance and protect this type of habitat.

Road Rehabilitation Section B4 (Part) - placement of rock armour along the existing toe of the road and the re-establishment of a very small section of the 5m road base will result in an anticipated loss of approximately $53.6m^2$ of fish habitat.

Habitat Compensation options could include but not be limited to:

- The existing road bed and toe in the small section will be removed and completely re-established to duplicate the existing conditions but for a greater length and width of channel; and
- Woody debris, large boulders, and rubble that is currently embedded into the existing road washout will be excavated and reused in the establishment of a riffle/pool/run sequence. The large rock material and some of the larger woody debris (logs) will be used as deflectors perpendicularly set from the bank to create cover and a diversion to the flow along the bank. The remaining woody debris will be used in the creation of a pool on the downstream side of the deflectors and upstream of a run.

Road Rehabilitation Section C - no expected loss of fish habitat as a result of planned road rehabilitation. Therefore, no fish habitat compensation is required for this Section.

Road Rehabilitation Section D – road width expansion and the resulting road bank armouring along several separate sections of this area will result in the loss of approximately $100m^2$ and $600m^2$ of fish habitat respectively.

Habitat Compensation options could include but not be limited to:

- To compensate for run habitat loss along the main channel margin, pool habitat will be created through placement of hard points - large boulders along the armoured toe of the road installed to promote scouring, pool excavation and construction of rock deflectors.

Road Rehabilitation Section E - no expected loss of fish habitat as a result of planned road rehabilitation and diversion within the existing road alignment. Therefore, no fish habitat compensation is required for this Section.

Road Rehabilitation Section F - no expected loss of fish habitat as a result of planned road rehabilitation. Therefore, no fish habitat compensation is required for this Section.

<u>Funeral Creek</u>

Road Rehabilitation Section 1 - no expected loss of fish habitat as a result of planned road rehabilitation. Therefore, no fish habitat compensation is required for this Section.

Funeral Creek Rehabilitation Section 2 - placement of rock armour along the existing toe of the road and the re-establishment of a very small section of the 5m road base will result in an anticipated loss of approximately $15m^2$ of fish habitat.

Habitat Compensation options could include but not be limited to:

- To compensate for the minor habitat impact, manage energy and complex habitat within Funeral Creek, small rock (larger diameter than natural material) deflectors should be placed upstream of the rehabilitation area to enhance cover in the riffle habitat, create downstream scour to expose and protect smaller substrates (sand, gravel, cobble), create diversion of flow mid-stream to add protection to armoured rehabilitation area.

Funeral Creek Rehabilitation Section 3 - bank armouring along the along the channel margin of the existing alignment is required to increase roadbed width and stabilize bank The result of rehabilitation will be a loss of approximately $20m^2$ of fish habitat.

Habitat Compensation options could include but not be limited to:

- small rock deflectors set perpendicular to the stream bank and upstream of the rehabilitation area will assist in the dispersion of water velocities resulting in reduced erosion potential of the stream bank. Increased cover from rock materials larger than native material, scour points to add micro habitats of smaller sized substrates and deeper water; and

- Small rock weirs on the downstream side of the rehabilitation area will create site specific micro habitats with a focus on creating scour pockets within the existing riffle habitat.

Funeral Creek Road Rehabilitation Section 4 - bank armouring along the along the channel margin of the existing alignment is required to increase roadbed width and stabilize bank The result of rehabilitation will be a loss of approximately 20m^2 of fish habitat.

Habitat Compensation options could include but not be limited to:

- small rock deflectors set perpendicular to the stream bank and upstream of the rehabilitation area will assist in the dispersion of water velocities resulting in reduced erosion potential of the stream bank. Increased cover from rock materials larger than native material, scour points to add micro habitats of smaller sized substrates and deeper water; and
- Small rock weirs on the downstream side of the rehabilitation area will create site specific micro habitats with a focus on creating scour pockets within the existing riffle habitat.

Funeral Creek Road Rehabilitation Section 5 - bank armouring along the along the channel margin of the existing alignment is required to increase roadbed width and stabilize bank The result of rehabilitation will be a loss of approximately 15m^2 of fish habitat.

Habitat Compensation options could include but not be limited to:

- small rock deflectors set perpendicular to the stream bank and upstream of the rehabilitation area will assist in the dispersion of water velocities resulting in reduced erosion potential of the stream bank. Increased cover from rock materials larger than native material, scour points to add micro habitats of smaller sized substrates and deeper water; and
- Small rock weirs on the downstream side of the rehabilitation area will create site specific micro habitats with a focus on creating scour pockets within the existing riffle habitat.

Funeral Creek Road Rehabilitation Section 6 - bank armouring along the along the channel margin of the existing alignment is required to increase roadbed width and stabilize bank The result of rehabilitation will be a loss of approximately 15m^2 of fish habitat.

Habitat Compensation options could include but not be limited to:

- small rock deflectors set perpendicular to the stream bank and upstream of the rehabilitation area will assist in the dispersion of water velocities resulting in reduced erosion potential of the stream bank. Increased cover from rock materials larger than native material, scour points to add micro habitats of smaller sized substrates and deeper water; and
- Small rock weirs on the downstream side of the rehabilitation area will create site specific micro habitats with a focus on creating scour pockets within the existing riffle habitat.

Annex E4

Ice Road Construction in Fort Nelson, BC

For many years, the forest industry based in Fort Nelson, B.C. constructed winter ice roads and ice bridges as the predominant access structures for transportation of manufactured logs to the mills. These winter access structures were designed for heavy industrial use and loaded 5-8 axle log haulers could typically reach loads of 85,000 KG. The roads were constructed in November and December, but daily maintenance was required to strengthen and repair the ice surface through to breakup in late March. Drivers were not permitted to use tire chains except on designated grades. The area generally does not contain significant areas of permafrost.

The knowledge and expertise developed by local contractors remains available, but fewer contractors are building ice roads and bridges. Typically, the forest industry roads followed seismic roads and trails where the vegetation had already been removed from the right of way. Low ground pressure dozers (typically a Caterpillar D5 or 6, and more recently a blade equipped Snowcat) would enter onto the right of way in early November to plow the snowfall from the cleared right of way to the edges, maximizing the area available to construct the road. The snow would be stored in windrows at the edge of the road for later use. Skilled equipment operators removed all the snow and herbaceous vegetation cover without removing the root mat or damaging the moss covering.

After the exposed ground was exposed to night time freezing temperatures typically -15^{o} Celsius for 2-3 nights, road construction would begin. Any significant delay beyond 3 days due to warm or cold weather or operational delays could sometimes affect the success of the next phase.

Ice Road Construction in Fort Nelson, BC

In the second phase, water tank trucks with a capacity of $10m^3$ (10,000 litres) were used to carry fresh water from approved borrow pits, ponds and lakes to the road surface. Typically the first loads were ½ the full volume to protect the trucks from breaking through the thin frozen upper layer of root mat and soils. In the first pass, up to 6 loads of water would be applied per kilometre. Usually this first pass was about 11/2 lanes wide for a one way off-highway road with pullouts. One measure of a good road builder and the longevity and strength of his road was how well he could have the water penetrate into the soils. Good absorption and deep penetration of water provided a sound base to build the road surface. *Volume of water used in this phase on average may accumulate to 30 m^3 per kilometre, but can be highly variable depending on ground conditions. Muskeg may require more water while overland forested conditions may require less water.*

Once the base was built, for the third phase, usually one road grader and two water trucks would work together constructing an ice surface. The water truck would apply water and the grader would sweep snow from the plowed windrow onto the freshly watered surface. Mixing of the snow and water would be used to fill in voids and smooth out the road. Typically, day time temperatures of -25^o Celsius made for good freezing conditions and maximizing construction. *Volume of water used in this phase on average may accumulate to 100 m^3, or about 10 full truck loads per kilometre.*

Regular daily maintenance of the ice surface is required to seal ice cracks and fissures and to maintain a smooth travelling surface. Specialized equipment was designed and installed on water trucks whereby a remote controlled blade was attached to the frame to enable drivers to

direct snow to these road defects and apply water in the same pass. Then road traffic compacted the snow and water to repair the surface. Regular application of water and snow throughout the season was required to maintain the strength of the ice surface. *Volume of water used in this phase on average may accumulate to 10 m^3, or about 1 full truck load per kilometre per week over 12 weeks. Total volume of water for road maintenance could amount to 120 m3 per season per kilometre. This estimate is highly variable, depending on seasonal conditions and traffic.*

Total annual water consumption per kilometre:

Phase 1: building the subsurface = 30 m^3

Phase 2: building the ice surface = 100 m^3

Phase 3: seasonal maintenance = 120 m^3

Total water use for all three phases is about 250 m^3 per kilometre. This is an estimate given for the average conditions observed and worked in the Fort Nelson area for heavy industrial use with traffic flows averaging 100 loaded trucks per day at 85,000 kg per truck. Average loaded speed was variable from 50-60 kmph.

Typically, the NWT Department of Transportation designs and maintains snow roads for 64,000 kg loads with an average rate of speed at 35 kmph. Ice bridges are designed for 64,000 kg with a speed limit of 20 kmph. Water is used sparingly, only for snow fills, very rough road sections and ice bridges.

The author acknowledges the expertise, information and assistance provided by Gordie Smith and his employees from G&C Products, a long term road construction contractor in the forestry and oil and gas industry in Fort Nelson.

Paul Davidson, RFT

Health and Safety Coordinator

Kledo Construction, Fort Nelson, BC

Appendix F

APPENDIX F
SPILL CONTINGENCY PLANNING

PREAMBLE

This document is in response to Information Requests from Parks Canada (numbers 14 to 18), Environment Canada (number 15) and the Government of the NWT (number 1). CZN has been in contact with these agencies regarding their requests, and specifically what information is required at this stage. CZN believes that formal spill contingency plans are not necessary at the environmental assessment stage. There is no question that the development of such formal plans is possible, and CZN accepts that it is important that appropriate plans are in place before operations commence. Issues we believe are appropriate for consideration at this stage are:

- commitments by the proponent to produce such plans with an acceptable overall content and agency/third party review; and,

- assessment of the risks of spills occurring and mitigation considerations.

The agencies contacted did not indicate opposition to this approach. Therefore, the remainder of this document focuses on these issues.

COMMITMENTS

CZN commits to producing a spill contingency plan suitable for operations at the Mine and along the access road for all reportable spills. CZN accepts that such a plan must be in place before operations commence. We recommend that this be a condition of operating permits. This condition can include provision for agency and third party review and comment, and necessary approval of a suitable plan by the Mackenzie Valley Land and Water Board before operations can proceed. Following approval, the Plan will be formally circulated to INAC, Parks Canada and the GNWT.

In preparing an appropriate spill contingency plan, CZN will consult and refer to relevant guidelines, such as INAC's 2007 "Guidelines for Spill Contingency Planning", and will note in the plan that this has been done. The plan will address all potentially hazardous substances used at the Mine or transported along the road. The substances considered will include all materials that have the potential to impact the environment or human health, and will include fuel, water treatment chemicals and mineral concentrates. The locations and quantities of all of the substances considered at the mine site, along the access road, and at the transfer stations will be detailed, and locations of storage shown on maps. Particular attention will be paid to substances that occur in liquid form and significant volumes, such as fuel and sulphuric acid, because of the risk of rapid migration and impact. Worst case scenarios will be considered. Material Safety Data Sheets for all substances considered in the plan will be provided in an appendix to the plan.

The Plan will also identify the location of spill kits and materials along the road. Kits will be maintained at the Transfer Facilities and at Cat Camp if it is maintained as a road construction camp. An additional spill kit location will be established approximately mid-distance between the Transfer Facilities so that spill response equipment is available no more than 50 km from any spill site. For a spill on the access road, the plan will define the procedures that should be followed regarding immediate notifications and actions, how equipment and resources would be mobilized to the site of the spill, and what mitigation measures could be adopted in addition to the spill response. Guidance will also be given regarding which components of the spill kit should be used for a given type of spill and spilled substance.

The Plan will include details of spill responses for all types of ground conditions. At the Mine, this will include frozen and non-frozen ground and snow cover. Along the access road, frozen ground with and without snow cover will be considered. Opportunities for the rapid spread of contaminants via surface or sub-surface flow in certain landforms will also be considered, such as in the karst area along the road.

The spill contingency plan will discuss how to manage contaminated media that may result from a spill response. Such media may consist of soil, snow, water or ice. Contaminants are most likely to be either hydrocarbons or metals, although others are possible. Soil contaminated with hydrocarbons can be taken to the bioremediation cell proposed for the Mine site. This may include gravel and rocks rather than attempt to separate these at the spill site. This material would not be included in samples to verify completion of remediation, and would remain on site and be incorporated into the Waste Rock Pile. Soil contaminated with metals could be processed through the Mill, provided the soil does not contain any material that could interfere with the Mill process. Representative samples would be tested to verify the appropriate remedial approach. The plan will also specify the appropriate level of treatment considering future land use. Water contaminated with hydrocarbons can be processed through an activated carbon vessel at the Mine site. Water contaminated with metals can be treated at the Mine site Water Treatment Plant.

Depending on the nature of a spill, it may be necessary to investigate spill impacted areas after a spill response. Procedures will be provided in the Spill Contingency Plan for initial sampling to determine whether further follow-up is necessary. In a worst case, this sampling may indicate a need to conduct a more comprehensive environmental site assessment, and ultimately the development of a remedial action plan

CZN will maintain a trained spill response team at the Mine. The general composition of the team will be detailed in the Plan. Operators stationed at the Transfer Facilities will also receive spill response training. Response training will include spill exercises. These will likely be done at the Mine in a well contained area. However, if any exercises are contemplated within the NNPR, park staff will be notified first and if the plans are approved, invited to observe. Parks staff will also be consulted regarding the rendering of additional resources and assistance for responding to a spill, although CZN would not rely on this.

CZN will ensure that all 3rd party contractors building or using the access road, or working at the Mine site, are provided with a copy of the spill contingency plan, and contracts between CZN and the contractors will stipulate that the contractor must provide a copy of the plan to its site staff on the contract, and ensure the staff read it. Copies of relevant portions of the contracts will be made available for public review. CZN's oversight of road and mine operations will include checks on contractor adherence to the contracts with respect to spill contingency. Details of this oversight will be provided in the plan.

SPILL RISKS/MITIGATION

Design to Minimize Risks

Mine site structures are and will be designed to minimize the risk of spills of stored products. Fuel and acid will be stored within bermed and lined enclosures. Solid products will be stored in defined areas under cover.

CZN has been evaluating the access road with a view to making modifications that promote greater safety and reduce the risk of accidents and, therefore, spills. The focus of evaluations has been the elimination of tight hairpin turns and reduction in road grades. The proposed polje re-alignment will eliminate two hairpins and some steep grades, and will also take the road away from the poljes and associated groundwater sources. Road modifications up to Wolverine Pass are intended to eliminate or relieve tight hairpins. Other more minor changes are being looked at to improve the road design. For the re-alignments, CZN is looking to construct a level bed and avoid a bed sloping to one side, similar to the remainder of the route.

Operational Procedures to Minimize Risks

Operational procedures will be adopted to minimize the risk of spills along the access road and at the Mine. As noted elsewhere, speed limits will be set for all sections of the road. Before the road is opened for traffic, an operations supervisor will drive the road and note appropriate speeds and locations where additional warning is required. Following this, signs will be made and posted along the road. Consideration will be given to sections of the road where the risks from spills are greater. For example, the exposed karst terrain may be more permeable and prone to contamination of groundwater from liquid spills. Specific speed limits may be set for specific types of trucks and loads through sensitive sections. All drivers using the road will be required to have suitable training and experience for the conditions. Drivers will also receive an orientation package describing the road and specific sections/conditions before driving the road for the first time, and they will be required to read it. At the start of each shift, drivers will also receive bulletins on road conditions, problem areas, any observations of wildlife, and any other relevant information. Spill kits will be carried on vehicles appropriate for the loads. Trucks transporting fuel will carry an appropriate quantity of absorbent. Trucks carrying acid will be dedicated trucks with specially trained drivers, and spill kits specific to acid and the volume being transported.

Storage and transfer of fuel and liquid chemicals at the Mine site will adhere to strict protocols. The fuel tanks are in a clay-lined containment with capacity greater than 110% of a single tank volume. The acid tanks will also be in a lined containment with capacity 110% of a single tank volume. Fuel transfer occurs at the Tank Farm where a concrete apron exists and a collection sump. The transfer of acid to the storage tanks will be via a dedicated line. The location of tanker discharge into the line will be a lined pad. Acid transfer and storage will occur within the site containment berm. Any spill evading immediate containment would report to the Catchment Pond. During acid transfer, site staff responsible for the pond will be notified and ready to stop discharge to the environment if necessary.

Impacts from a Spill

For all the substances stored or transported along the access road, at the transfer stations and at the mine site, the biggest risks are posed by liquid substances transported in bulk along the access road. Bulk liquids are stored within containments at the Liard Transfer Facility (fuel) and the mine site (fuel and acid). The risks are greater when these substances are being transported without secondary containment.

Fuel will be transported into the mine in a dedicated tank on each mine-based concentrate trailer. Tank capacity will be 10,000 litres. Most of the road route will consist of frozen muskeg or gravely soil covered by snow. Any spill will likely be absorbed by snow, facilitating recovery. Where snow is absent, spilled fuel should pond on the frozen ground and would be collected. Areas where permeable bedrock is close to surface and not covered by soil are prone to a greater risk from fuel spills. Significant rock exposure occurs in the Ram Plateau. However, the road with the proposed re-alignments traverses karst with varying thicknesses of soil cover. Rock exposures are absent. Therefore, the risk of groundwater contamination from a fuel spill should be effectively mitigated by the frozen conditions. Significant stream crossings would be susceptible to contamination, whether they are frozen or not. The Liard and Tetcela River crossings are prone in this regard. However, these crossings are relatively broad with shallow banks, and the potential for an accident is much less. A span crossing is proposed for Polje Creek. This creek may flow in winter because it is fed by groundwater. Crossing approaches are also shallow and accidents should not occur. Further west, the road runs parallel to Sundog, Funeral and Prairie Creeks. Greater care will need to be taken during travel along these sections, and will be reflected in the speeds and advisories posted. CZN has been making minor modifications along the Prairie Creek part of the route to improve the road, make it safer and move the road further away from the creek.

Sulphuric acid will be transported into the mine by dedicated tanker trucks. Drivers for these trucks are specially trained in driving safety and spill response for this chemical. Although acid spills clearly need to be avoided, such a spill would not introduce a contaminant into the environment. Any spilled acid should be effectively diluted close to the spill source, and after acid neutralization, no contamination will exist. The naturally alkaline surface water and groundwater in the project area renders a higher potential for neutralization of any acid spills.

Appendix G

pHase GEOCHEMISTRY

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September 6, 2010

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V6B 4N9

RE: Draft Responses to Information Requests, Prairie Creek Project

Please find provided here a summary of our draft responses to the Information Requests (IRs) submitted by various stakeholders to the Mackenzie Valley Review Board in response to Canadian Zinc's (CZN's) Development Assessment Report ("DAR") for the Prairie Creek Project.

As directed, only those IRs specified by yourself have been responded to, specifically the IRs from Parks Canada (#20 through 26 and #42) and from the Government of the Northwest Territories (#1-5). Each new response is provided on a new page on the subsequent pages.

If you have any additional concerns or questions, or require further clarification please do not hesitate to contact me.

Regards,
pHase Geochemistry Inc.

original signed

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IR Number: Parks_Canada_20
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Geochemical testing - representative samples
References: DAR 8.2 Waste/Material Characteristics
DAR8.6 Potential Impacts
Appendix 3: Final Humidity Cell Report
Terms of Reference Section: 3.3.2 (3) Key Line of Inquiry: Mine Site Water Quality

Preamble:

A limited number of humidity tests were completed to gain information regarding the geochemical characteristics of the paste backfill, DMS rock, and tailings.

- Paste backfill – 2 samples;
- Tailings – 1 sample for 4-con tailings, 1 sample for 2-con tailings; and,
- DMS – 2 samples.

Further, it is understood that mineralogy of the ore body is heterogeneous. The geochemistry of the tailings, and therefore, paste, may change from that tested if the mineralogy of the mined rock changes. Further details are required in order to understand the confidence of the humidity geochemistry program to represent the characteristics of the paste, and associated leach water characteristics over the duration of mining.

Request:

1. Provide additional details about the humidity geochemistry program, specifically addressing:
   - the limited number of samples tested to date;
   - the heterogeneity of the ore deposit;
   - and, the expected sensitivity of humidity test results if the composition (e.g., material amounts and size, mineralogy, etc.) of the paste changes compared to that initially tested.

2. Describe the geochemical testing program during operation of the mine that will be used to understand the changes and the associated impacts, if any, in paste backfill geochemical characteristics compared to that initially tested. This should include a conceptual understanding of the objectives, sampling frequency, and testing approach that would form the basis of the geochemical testing program.

pHase Response:

1. In the author's experience, the number of samples representing milled products tested for this project is similar to that tested at other projects at a similar stage. The representivity of the samples can be assessed by inference to the variability of the ore deposit itself which is provided here.

   In summary, the Prairie Creek stratigraphy as shown on Figure 4-14 of the DAR and provided again in this letter report consists of (from oldest to youngest) the Sunblood

Formation sandstone, Wittaker Formation dolostones, Road River Formation shales and Cadillac Formation thinly bedded limy shales. Most of the mining activity will occur within the Road River Formation and the Whittaker Formation. The Whittaker Formation is divided into seven (7) units which generally vary by texture and to a lesser extent the amount of chert. The mineralogy of these host units is dominated by dolomite, with lesser amounts of quartz and calcite and trace muscovite-sericite, plagioclase and K-feldspar (Table 4.1; MESH, 2008).

Within this stratigraphic package are two main types of mineralization, the vein mineralization (MQV ore) along structure and the stratabound mineralization (SMS ore) at greater depths and generally at the boundary of units 2 and 3 of the Whittaker Formation. Mineralization resulted in the deposition of galena, sphalerite, pyrite and tennantite-tetrahedrite with rare chalcopyrite and covellite (Table 4.1; MESH, 2008). Geological weathering (oxidation and circulation of meteoric waters) resulted in the mobilization and re-deposition of Zn and Pb as the carbonates smithsonite and cerussite in areas proximal to the vein mineralization. The dominance of these 'secondary phases' is greater in the upper horizons and along structures as shown in Figures 4.14 and 4.15 of the MESH Environmental Characterization Report (MESH, 2008) and provided again in this letter report. In these figures, the warmer colours indicate a higher proportion of Zn and Pb respectively present in carbonate minerals (i.e. in 'oxide' forms). Other oxidation derived minerals identified included iron oxides and oxyhydroxides in trace amounts (Table 4.1; MESH, 2008).

Samples of MQV ore and SMS ore characterized by MESH (MESH, 2008) indicated that both ore types were elevated in Ag, As, Cd, Cr, Cu, Fe, Hg, Pb, Sb, W and Zn compared to the host rock units, and that the MQV ore samples tended to have higher concentrations than the SMS ore samples for all parameters above other than Fe. This would suggest a propensity for higher metals in the upper levels of the proposed mine plan. Based on the current understanding of the distribution of metal carbonates, it is also likely that the upper levels contain a higher proportion of more readily leachable metals associated with these carbonates.

The paste samples characterized and used for the various water quality predictions were produced from ore sourced from both the 930 and the 870 levels (i.e. the upper part of the deposit), roughly from 6 headings on each level (A. Taylor (CZN), pers. comm.). Given the mining methods anticipated (see Section 6.7 of the DAR), it can be generalized that backfilling will occur in tandem with (though off set to) mining such that paste material produced from ore excavated from any one level will likely generally be backfilled in close proximity to where it was originally sourced. While it is accepted that this is a simplification as the mining and backfilling process will be much more complex, this methodology will result in a bulk preservation of the variations with depth that currently occur, i.e. with likely slightly higher and more leachable metals in the backfill in the upper levels.

This also suggests that the paste samples that have been characterized to date are likely to have higher overall metals and a more leachable metal content than paste that will be produced from the deeper levels. Based on this understanding, we believe that while there will in all likelihood be variability in the paste material throughout the life of mine, and that the samples that were obtained for characterization and on which water quality predictions have been based are generally representative, and the results likely conservative with respect to total metal content and leachability.

2. During operations, the current assumptions on paste composition and leaching behaviour will be verified through an operational characterization program. The primary objectives of such a program would be to characterize the mineralogy and metal content (including sulphur and inorganic carbon content) of paste backfill produced on a semi-regular basis. This may take the form of a monthly composite sample every 3 months to start, with the frequency being re-evaluated once a dataset is established, either less frequent if data is generally consistent, or more frequent if great variability is seen. The results will be cross-referenced with a general location placed such that they can be understood in a spatial context as well as a geochemical one. This information can then be evaluated in combination with water quality monitoring at specific levels and/or sumps to assess potential implications to mine water quality, and allow for further verification/re-calibration of the existing characterization and water quality predictions.

IR Number: Parks_Canada_21
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Flush and steady state leaching conditions
References: Appendix 3: Final Humidity Cell Report
Terms of Reference Section: 3.3.2 Key Line of Inquiry: Mine Site Water Quality

Preamble:

The humidity cell tests showed that metals are released from the paste. A flush of metals occurs when water initially passes through the paste, and then with time, a quasi steady state flushing of metals occurs. The humidity cell test results show metal concentrations in the drainage waters spike during flush conditions and then stabilize as quasi steady state conditions occur.

Parks Canada requires further information to understand the effects of groundwater interaction with the paste backfill, and the potential for metal leaching.

Request:

1. Develop a conceptual model of groundwater interaction with the paste backfill and use it to support the following additional requests. If relevant, the reliance of bulkheads installed in the underground voids should be included in the response.

2. Describe the potential for flushing and steady state conditions for metal leaching to occur within the paste backfill during mine operations and post-closure?

3. Water that passes through the backfilled paste may contain elevated metal concentrations. Provide a summary description of interaction of groundwater passing through the backfilled paste. Provide an estimate of groundwater flow leaving entering/leaving the paste backfill and the level of certainty in the estimate.

4. Prepare a detailed summary of the uncertainties with regards to groundwater interaction with the backfill material, and how this uncertainty will be addressed.

5. With regards to the paste backfill in the underground voids, further discuss the impact of flushing and steady state conditions on groundwater quality and how this is considered in predictions of drainage water quality from the paste.

6. If flushing conditions are anticipated to occur within the backfilled paste in the underground voids, discuss the estimated timeframe required to establish quasi steady state conditions.

7. In all responses, provide reference to any hydrogeological testing/analysis results that support the discussion. If there are instances where no hydrogeological testing/analysis results are available to support the discussion, provide additional detail on how to fill the information gap (e.g., confirmatory testing/analysis, monitoring, etc.) and provide confidence to interested parties.

pHase Response:

1. See RGC response (letter dated September 6, 2010)

2. Based on characterization work conducted to date, there are two primary modes of metal release likely associated with many of the materials at Prairie Creek, including the paste backfill. These are (1) release resulting from sulphide oxidation and leaching of those metals mobile in the buffered pH environment and (2) release resulting from the dissolution of carbonate minerals and mobilization of those metals mobile in buffered pH environment.

   Within the backfilled scenario, the metal leaching associated with sulphide oxidation is expected to be generally slow and dominated by chemical oxidation rates, i.e. not anticipated to become acidic where bacterially catalyzed oxidation can increase sulphide oxidation rates. Further, it is anticipated that oxidation will be limited to diffusive mechanisms and hence to the outer surfaces of the paste that is exposed to oxygen. The photo provided below illustrates an example of the anticipated very thin rind of oxidation (as indicated by the iron staining) at the surface of a backfilled level that had been exposed to weathering conditions for a number of years.

Photo 1. Example of backfill showing very limited surface oxidation (as identified by the orange iron staining).

The second mechanism, i.e. the potential metal release resulting from the dissolution of carbonates is dependent on contact with water. The humidity cell test procedure, used as a standard tool in the industry to develop oxidation rates and metal release rates, is not limited by contact with water, indeed the opposite is true in that a substantial amount of water is added during the testwork. For the paste samples, this is on the order of one pore volume per week. In other words, humidity cell leachate is a result of considerably more flushing than would occur in the backfilled stope. The work conducted by RGC (see RGC letter dated September 6, 2010) indicates that there will be very little contact of the paste backfill with groundwater (likely <1% of the groundwater will move through paste

backfill), and that the groundwater that does contact the paste will be again spatially associated with the outer rind or skin of the paste backfill.

Given the conceptualization of groundwater movement during operations and post-closure and more specifically the interaction with the paste backfill, it is anticipated that the bulk volume of the paste will have no interaction with groundwater. The metal leaching contribution from the paste to the mine water will therefore be from the margins, or rind of the backfilled paste. The flushing versus steady state conditions is less easily conceptualized. In a waste pile type environment, flushing is typically seen with the first contact of water following a 'dry period' with a more steady state condition being established during more average but constant conditions of rock:water interaction. Predicting flush concentrations however is difficult as it is dependent on water volume and solubility constraints. In some cases, flush conditions result in dilution and in others they may result in increased concentrations over steady state. Using experience with unsaturated waste piles as an analog, it might be anticipated that during operations while there is a groundwater cone of depression, that any paste:water interaction can be described as a 'flush' mechanism. This is likely however to be very localized, i.e. not all the surfaces will be in contact with water. With an estimated 99% dilution of these flushes with other mine water/groundwater inputs, these flushes may or may not be detectable in the water monitoring data record that will be established. Regardless, the mine water during operations will be collected, re-used and/or treated.

The post closure conditions, once the water table has re-established, are better conceptualized as influenced by steady state release rates (from dissolution but not oxidation) for that portion of the backfill that is below the water table. For the smaller portion of backfill above the water table post closure, the same conceptualization to that during operations is expected.

Over the very long term, it is anticipated that the rind of the paste backfill that is in contact with water will become depleted in both sulphides and metal carbonates and a reduction in the metal leaching associated with the paste will result beyond that currently quantified in the kinetic work conducted (i.e. lower than steady state release rates).

3. See RGC response (letter dated September 6, 2010)

4. See RGC response (letter dated September 6, 2010) for a discussion of the uncertainties related to groundwater interaction with the backfill material. An additional discussion related to the geochemical uncertainties is addressed in the pHase response to Parks Canada IR #26 in this letter report.

5. The processes of flushing and steady state influences from paste backfill on groundwater quality were discussed in concept in the response to item #2 above. It should be noted here, that while the mechanism of flushing the outer surface area of the backfilled paste is considered likely to occur above the water table albeit on a localized scale, that mechanism and the measured flush in the humidity cell are not necessarily analogous. The concentrations of any flush in

the mine setting will be highly dependent on the amount of water 'flushing' a given area or mass of material and the effects of any solubility limits etc. Further, based on RGC's evaluation, it is anticipated that less than 1% of the groundwater will be in contact with the paste backfill. Therefore there will be significant dilution to any 'flush' water.

It is the author's experience that the flush concentrations from humidity cell tests are not relied upon for scale up calculations for water quality predictions. The scale up calculations utilize a depletion rate in terms of a rate of mass removal, mg/kg/wk, demonstrated over a reasonable period of time. The 'flush' phase of a humidity cell test is variable from one cell to another and from one week to another and can be as short in duration as one cycle to as long as 10 cycles or so. The water quality predictions conducted for the Prairie Creek project therefore used the steady state leach rates that can be cast in terms of a more reliable mass depletion rate (i.e. mg/kg/wk). It is also worth noting that the use of the steady state release rates for material that over the long term will be below water are conservative for that proportion of metals that are likely derived by oxidation, i.e. once underwater the oxidation-dependent metal release should cease. A more detailed description of the calculation is provided in the pHase response to Parks Canada IR #25.

6. The kinetic testwork conducted on the paste materials indicated that quasi steady state release rates were established in the lab environment after approximately 6 cycles, or 6 pore volumes (approximately 400 to 600 ml or water was added to the columns each cycle to fill to the top of the column, as described in pHase, 2010).

   It is expected that the equivalent establishment of steady state releases from the paste to any groundwater that might contact the paste will occur within the timeframe of mine reflooding. Further, the water quality during this period will be monitored to establish that this has indeed occurred and can be controlled until such time as steady state conditions are established (also see RGC Response to Parks Canada IR#23, RGC letter dated September 6, 2010.

7. See RGC response (letter dated September 6, 2010)

IR Number: Parks_Canada_22
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Humidity and permeability cell leachate characteristics for paste backfill
References: DAR 8.6.1 Potential Impacts: Mine Operations
Terms of Reference Section: 3.3.2 (2)(a)

Preamble:

Various laboratory analyses were completed to understand the geochemistry of the paste. Humidity cell tests provided information regarding leach rates that were applied to prediction modeling. Permeability cell leachate was also geochemically characterized, and its composition measured concentrations higher than that of the humidity cell leachate. It is likely that the differences in leachate concentrations between the humidity and permeability cells are a result of the testing conditions. The humidity cells resulted in leachate that did not have metal concentrations above Metal Mines Effluent Regulations (MMER); however, the permeability cells did have leachate with select metal concentrations above MMER. It is understood that future water licence limits may or may not be in harmony with MMER limits. It is unclear if, and how, the permeability cell leachate quality testing was utilized in predicting leachate quality from the paste backfill.

Request:

Provide additional discussion on the application of the permeability cell leachate quality results in predicting leachate quality from the paste backfill.

pHase Response:

The permeameter testwork was conducted on the paste samples prior to the same samples being utilized for geochemical kinetic testwork. As the reviewer has indicated, the concentration is dependent on testing conditions (specifically the amount of water added during the testwork) and therefore comparing the concentrations from one test method to another is not necessarily an appropriate comparison. Further, the permeameter testing is not comparable to the steady state humidity cell concentrations, but more akin to the 'flush' concentrations and for reasons similar to those outlined in the response to Parks Canada IR #21, item 5 above, the permeameter water quality results were not used explicitly for scale-up water quality predictions for the paste materials.

It is important to note that while the underground will be completely backfilled with paste, there are more 'sources' that need to be considered, including inflowing groundwater, mine wall rock etc. These sources were incorporated into the predictions of the backfilled underground. Therefore the permeameter results represent contact water with the paste but do not consider the contact water with the other components of the mine water. Recent estimates by RGC indicate that only 1% of the water is likely to contact the paste.

Bearing in mind these qualifiers, Table 1 below has been provided to show a comparison of the pemeameter water quality, the kinetic testing 'flush' (average values), the kinetic testing steady state concentrations and the predicted water quality. In the author's opinion, this information must be compared carefully and to reiterate, the predicted source term for the paste backfilled underground is not akin or directly comparable to the paste samples that were tested by various means (also see the response to Parks Canada IR#25). Predicted underground water quality is similar or slightly better than the permeameter results, as might be expected considering the other inputs to the underground 'system'.

Parameter		MMER Guidelines	Current License Max Grab	Average Concentration from Permeameter Tests on Paste Samples	Average Concentration from first 5 cycles of Kinetic Tests on Paste Samples	Average Concentration from last 5 cycles of Kinetic Tests on Paste Samples	Predicted Source Term for Paste Backfilled Underground
pH	pH Units	6 - 9.5	6 - 9.5	7.8	7.5	7.4	8 to 8.5
Alkalinity, Total as	mg/L			122	26	14	50
Sulfate	mg/L			771	253	61	150
Aluminum (Al)	mg/L			0.03	0.02	0.01	0.05
Antimony (Sb)	mg/L			0.07	0.01	0.00	0.05
Arsenic (As)	mg/L	0.5	0.5	0.003	0.001	0.001	0.01
Barium (Ba)	mg/L			0.05	0.03	0.01	0.02
Cadmium (Cd)	mg/L		0.005	0.07	0.02	0.01	0.01
Calcium (Ca)	mg/L			176	41	19	75
Cobalt (Co)	mg/L			0.001	0.001	0.0003	0.0002
Copper (Cu)	mg/L	0.3	0.1	0.2	0.1	0.01	0.02
Iron (Fe)	mg/L			0.06	0.12	0.04	0.05
Lead (Pb)	mg/L	0.2	0.15	0.3	0.2	0.1	0.05
Magnesium (Mg)	mg/L			39	8	5	15
Manganese (Mn)	mg/L			0.1	0.02	0.01	0.05
Mercury (Hg)	mg/L		0.02	0.02	0.25	0.08	0.05
Molybdenum (Mo)	mg/L			0.03	0.003	0.002	0.005
Nickel (Ni)	mg/L	0.5	0.02	0.03	0.01	0.004	0.005
Potassium (K)	mg/L			28	25	4	2
Selenium (Se)	mg/L			0.02	0.001	0.001	0.005
Silicon (Si)	mg/L			8	12	4	1
Silver (Ag)	mg/L			0.002	0.001	0.00001	0.0005
Sodium (Na)	mg/L			239	68	8	5
Strontium (Sr)	mg/L			0.5	0.2	0.1	0.5
Thallium (Tl)	mg/L			0.0001	0.0001	0.0001	0.0005
Tin (Sn)	mg/L			<0.001	0.0002	0.0005	0.0005
Uranium (U)	mg/L			0.002	0.0002	0.0001	0.0005
Zinc (Zn)	mg/L	0.5	0.5	1.4	0.2	0.2	1

IR Number: Parks_Canada_23
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Discharge of paste backfill leachate to the environment
References: DAR 8.6.1 Potential Impacts: Mine Operations
Terms of Reference Section: 3.3.2.(2)

Preamble:

The geochemical testing and predictions revealed that select metals (e.g., Zn) and pH of the paste backfill leachate may have values that approach or exceed MMER limits. It is understood that future water licence limits may or may not be in harmony with MMER limits. No mechanism to collect paste backfill leachate, if quality exceeds MMER limited, was presented in the DAR.

Request:

Describe and evaluate options to collect and/or treat the leachate, if it exceeds MMER limits.

pHase Response:

The conceptualization of groundwater interaction with paste backfill both during operations and post closure is such that there is anticipated to be very little interaction and therefore minimal leaching from the paste backfill. Further, there is anticipated to be a dilution factor of almost 2 orders of magnitude within the mine workings (See RGC letter dated September 6, 2010). Therefore, there is no basis to assume that continued collection and treatment of mine water will be required after closure. That being said, water quality monitoring of mine water will be an integral part of the operations and whether there is metal leaching from the paste backfill or any other component of the mine, this will be monitored at various sumps and if needed at specific individual levels. Because the metal leaching impact from the materials at Prairie Creek is not driven by pH conditions, i.e. there is no substantial time delay as there would be in a situation where acid generation conditions are anticipated, the water monitoring record that currently exists and the one that will be established during operations is anticipated to provide a robust dataset and understanding of long term metal leaching impacts.

During operations, the mine water will be collected and treated. Post operations, the groundwater table will rebound and will be monitored during this phase.

IR Number: Parks_Canada_24
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Scaling factors to relate laboratory humidity cell leach rates to field scale leach rates for paste

Preamble:

Scaling factors to translate the laboratory humidity cell leach rates to field scale leach rates were presented. The following adjustment factors were utilized to account for the following differences between laboratory and field scales: temperature; particle size/surface area; and contact water flow path. It is unclear if the scaling factors presented in the DAR are valid for the paste.

Request:

1. *Temperature:* A rate reduction factor of 0.3 was applied to account for reductions of chemical oxidation rates due to differences between laboratory and field temperature. The humidity cell tests reported that the paste is non potentially acid generating. It is unclear if metal leaching occurs as a result of oxidation.

Clarify whether the metal release from the paste is a result of oxidation. Further, it is requested that additional information is provided to explain the use of a rate reduction factor, which is based on relations between oxidation rate and temperatures, for the paste material.

2. *Particle size/surface area:* A 0.2 adjustment factor was used to account for the larger surface area of the field material size than that used for laboratory testing. Since the paste contains small size particles, it is unclear if there would be a significant particle size difference for the paste between the laboratory and field conditions. It is requested that CZN compare the size of particles in the paste used in the humidity cell test to the typical size particles anticipated for the paste in the field. It is requested that CZN further explain the selection of the adjustment factor with consideration to the differences in particle size of the paste in the laboratory and field.

3. Contact Water Flow Path: A 0.1 adjustment factor was adopted to account for flow path differences that exist in the laboratory that may not occur at the field scale for the paste. It is requested that CZN compare flow paths through the paste in the laboratory to those in the field. It is requested that CZN further explain the selection for the adjustment factor with consideration to the differences in flow path in the laboratory and that expected in the field.

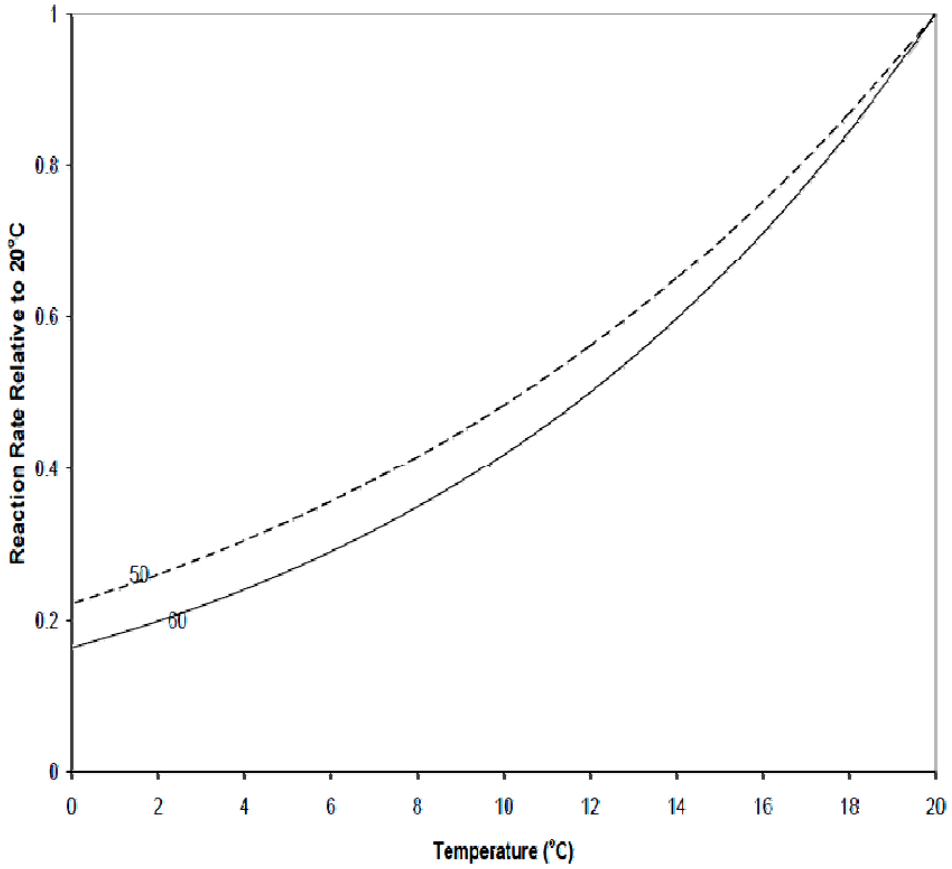
pHase Response:

1. *Temperature*: Metal leaching at Prairie Creek is anticipated to be driven by two primary processes: oxidation and dissolution which are described in detail in the pHase Response to Parks Canada IR#21 above. Note that oxidation of sulphides in neutral pH conditions still occurs though this is typically at a lower

rate than can occur at lower pH. Acidic pH conditions are not required for metal leaching associated with sulphide oxidation. Temperature can affect the kinetics of both of these processes (oxidation and dissolution) but via differing mechanisms. With respect to oxidation of sulphides and the resulting release of metals, lower temperatures tend to slow the rate of chemical oxidation as described by the Arrhenius equation:

$$R_a = R.k_T$$

and illustrated in the graphic below showing the decrease in oxidation rate predicted by the Arrhenius equation for pyrite activation energies of 50 and 60 KJ/mol (see also Figure 2 of pHase 2010c). Temperatures at Prairie Creek nearing freezing are anticipated as an average annual temperature. An adjustment factor of 0.3 corresponds to a temperature of approximately 5°C which is considered conservative for this site.



Cold temperatures may have the opposite effect on the dissolution of carbonates and associated metal leaching. The relationship for temperature and carbonate dissolution in cold temperatures has not been well established or demonstrated in the literature. Theoretically, calculations suggest that carbonate minerals are more soluble under cold conditions as described in the MEND report on Cold Temperature Effects (MEND, 2005). The theory of this effect is such that with decreasing temperatures, the partial pressure of carbon dioxide (PCO_2)

increases, producing carbonic acid and lowering the pH (to values on the order of 5.5). With resulting lowered pH, the dissolution or solubility of carbonate minerals is enhanced. Therefore, the solubility is related specifically to pH rather than to decreasing temperatures. The effect is complicated by a number of variables including the presence of competing cations and other constituents in solution such as $MgOH_2^+$, $CaOH_2^+$ and surface complexation effects.

Existing mine water drainage pH, in water emanating from the levels in the upper zone of the deposit where metal carbonates are in greatest abundance, is typically around or just above 8. At this pH value, carbonic acid is not being produced and therefore enhanced carbonate dissolution as a result of cold temperatures is not a primary process at Prairie Creek. Predicted conditions on closure envisage similar pH conditions and therefore negligible enhanced metal leaching as a result of enhanced solubility. Sensitivity analyses of this parameter have been conducted as described in the pHase response to Parks Canada IR #26 below where it can be seen that if pH were lowered (which is not expected to happen), higher metal leaching rates would be anticipated.

2. *Particle size/surface area*: The proportion of a waste pile or stockpile in the particle size range of approximately 2mm and finer is considered to be the most reactive due to the significantly larger surface area and resulting reactivity (Price, 1997). Humidity cells are typically conducted on that portion of a sample passing the ¼" or <6.3mm. Correction factors used in pHase 2010c were estimated based on particle size distributions reported in MESH, 2008. The particle size distribution for DMS float, which comprises a key component of the paste, suggests that the percentage of material less than 2 mm is <5% (samples Com 930Level HLS Float and Com870Level HLS Float on Figure 3 of pHase 2010c). The tailings, on the other hand, are anticipated to be 100% finer than 2mm (see pHase 2010b, Appendix B). An adjustment factor of 0.2 for this exercise was selected but will require confirmation once field scale paste is produced. Sensitivity analyses of this parameter have been conducted as described in the pHase response to Parks Canada IR #26 below.

3. *Contact Water Flow Path*: It is the author's experience that the adjustment for water flow path, or contact factor, is difficult to predict. An initial factor of 0.1 (10%) was selected based on the conceptual interaction of the underground system (as in pHase 2010c). This has subsequently been refined by RGC (see letter dated September 6, 2010) with current estimates indicating that 0.1 to 0.2% (or 0.001 to 0.002) of groundwater would likely be in contact with the paste backfill and the remaining flow would occur through the fracture zone and bedrock system. On this refined basis, a factor of 0.1 would be conservative with respect to the paste-water contact. Sensitivity analyses of this parameter have been conducted as described in the pHase response to Parks Canada IR #26 below and an addendum to pHase 2010c has been prepared (and attached here).

IR Number: Parks_Canada_25
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Water quality source term predictions for paste

Preamble:

Predicted source term concentrations for the paste were presented. The source term concentrations are likely to be applied to contaminant loading/water balance predictions for the mine site. The source term concentrations were calculated from the humidity cell test results, application of adjustment factors, and calibration of the water quality model. The humidity cell tests for the paste materials measured Zn concentrations in the leachate to be less than 0.5 mg/L; however, the predicted source term Zn concentrations for the paste leachate were about 1.5 to 2.0 mg/L. If the adjustment factors to translate the laboratory results to field scale are reduction factors, it is unclear how the predicted source term concentration is larger than the humidity cell tests.

Request:

Describe the calculation to develop the source term concentration. It is specifically requested that the calculation for predicted source term concentrations for Zn from the paste be presented as an example.

pHase Response:

The humidity cell test procedure uses a lot of water on a weekly basis to flush the solids sample (500 mL water per 1 kg sample per weekly cycle). This is typically substantially more water than would be in contact with the same material in the mine setting. Concentrations are water volume-dependent. Thus, even though there are some reduction factors used in scale-up calculations, there is typically a smaller amount of water which, because it is in the denominator, typically results in an increase in concentrations over that measured in the humidity cell.

The prediction calculations involve a number of steps as follows:

Step 1: Calculate an adjusted anticipated leachable field mass by scaling up rates from humidity cell tests using the equation below.

$$M_{adj} = R \times k_T \times k_{gs} \times k_{rm} \times k_f$$

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

Step 2: Convert adjusted metal leach rates to concentrations by dividing the results from Step 1 by anticipated flow rates using the equation below.

$$C_{adj} = M_{adj} / Q$$

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

Step 3: Speciate and equilibrate the adjusted concentrations using PhreeqC thermodynamic equilibrium software.

Step 4: Compare output concentrations from PhreeqC to appropriate site analogs.

To illustrate the calculation for Zn from the backfilled underground mine:

Consider, that the backfilled underground mine is anticipated to consist not only of paste backfill but of a number of potential 'sources' as follows:

Source (Rock) Type
Paste backfill: 80:20 w 1% cement
Paste backfill: 50:50 w 3% cement
Mine Wall Rock (Unit 5)
Mine Wall Rock (Unit 6)

As described in pHase 2010c, these rock type mixtures (and masses, as described further below) were provided by CZN as reported in their Project Description Report (CZN, 2008). It should be noted here that a simplification for the host rock units was required as humidity cell data was only available for samples from Unit 5 and Unit 6 material. Therefore, the total anticipated host rock mass was partitioned between these two units based on which of them best represented the ARD/ML characteristics of other units for which no kinetic rates are available. This approach on a general scale is considered to be appropriate as the ARD/ML characteristics of the host rock units based on static testing indicated relatively consistent characteristics across the units. The two samples selected for humidity cell testwork represented the two end member cases for which there is non-sulphide hosted metal leaching and sulphide-hosted metal leaching, respectively (see pHase, 2010a).

Calculating R: metal leach rate as observed by humidity cell testing (in mg/kg/wk)

The humidity cell concentrations for each of the above source types were converted to release rates (in units of mg/kg/wk) using the amount of water added in each cycle and the weight of the material in the cell for the estimated steady state period of the test (from pHase 2010c, Appendix A).

Source (Rock) Type	R (mg/kg/wk)
Paste backfill: 80:20 w 1% cement	0.24
Paste backfill: 50:50 w 3% cement	0.08
Mine Wall Rock Unit 5	0.02
Mine Wall Rock Unit 6	0.002

Applying the adjustment factors: k_T ,K_{gs} and K_{rm}

The various adjustment factors to account for variations in the lab testing environment to those in the anticipated field conditions were provided in pHase 2010c, Table 1, and are reproduced below for the backfilled underground scenario.

Source (Rock) Type	k_T	k_{gs}	k_{rm} (kg) *	K_f
Paste backfill: 80:20 w 1% cement	0.3	0.2	1,530,661,500	0.1
Paste backfill: 50:50 w 3% cement			170,073,500	
Mine Wall Rock Unit 5			14,522,130	
Mine Wall Rock Unit 6			33,884,970	

* masses were provided by CZN as reported in their Project Description Report (CZN, 2008). Estimates of reactive rock mass for the underground wall rock were based on surface areas of workings with an assumed 0.5m depth or zone of reactive wall mass. Surface areas for the closed underground were provided by CZN (A. Taylor, pers. comm.).

Multiplying R values by the various adjustment factors (above) results in the adjusted metal leach rates (M_{adj} of 2.3 kg/wk of Zn) from the backfilled underground.

Dividing this value by the amount of water anticipated from the underground (i.e. the flow from Table 2 of pHase 2010c with an average annual estimate of 2.1 L/s) and making the various unit conversions for time, the average annual concentration for Zn is predicted to be 1.8 mg/L.

When speciated with the full predicted chemistry from this scenario, the Zn concentration was not adjusted for solubility limits (i.e. it was not lowered as a result of mineralogical controls).

IR Number: Parks_Canada_26
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Calibration of the water quality prediction model

Preamble:

A calibration of the water quality prediction model was completed for select mine water sources that discharge from the mine site. The calibration was completed to develop adjustment factors to predict field scale water quality from laboratory data. The calibration could not be completed for paste backfill contact water as there are no data to support completion at this time.

Request:

1. Due to the uncertainty associated with using a non-calibrated model to predict paste backfill leachate quality, it is requested that a sensitivity analysis be completed on the predictions of water quality. The analysis should consider varying the adjustment factors, over a reasonable range, to predict the leachate quality of the paste.

2. Further discuss how the calibration of the model to predict leachate quality of the paste will be completed.

3. Provide additional description to further understand model verification (and re-calibration) timing, method, and field data inputs.

4. Further discuss the field testing that is anticipated to be completed during operations of the proposed development to verify if the model adequately depicts site conditions.

pHase Response:

1. As requested, a sensitivity analysis has been conducted and is summarized here. Based on the information requests and the preamble to this request specifically, it is assumed that the concern is predominantly with closure conditions. Therefore the sensitivity analysis conducted here has focused on closed conditions (i.e. the till covered waste rock facility and the backfilled underground) with variation of the adjustment factors for 5 sensitivity runs as detailed in the table below. Note the Base Case has been revised from that in pHase 2010c to better reflect the updated groundwater flux estimates (RGC letter dated September 6, 2010). A complete discussion is provided in Annex A to this letter which is an addendum to pHase 2010c (pHase 2010e).

Run	Facility	Temperature Adjustment Factor (K_T)	Grain Size Adjustment Factor (K_{gs})	Flow Path Adjustment Factor (K_f)
Base Case (revised from pHase 2010c)	Covered Waste Rock Pile - till soil cover	0.2	0.5	0.33
	Backfilled Underground	0.3	0.2	0.01 (paste), 0.99 (wall rock)
Sensitivity Run #1 (no temperature effect, higher flushing)	Covered Waste Rock Pile - till soil cover	1	0.5	0.5
	Backfilled Underground	1	0.2	0.1
Sensitivity Run #2 (no grain size reduction for paste)	Covered Waste Rock Pile - till soil cover	same as Base Case		
	Backfilled Underground	0.3	1	0.1
Sensitivity Run #3 (partial grain size reduction for paste and fully flushed conditions)	Covered Waste Rock Pile - till soil cover	0.2	0.5	1
	Backfilled Underground	0.3	0.5	1
Sensitivity Run #4 (partial grain size reduction of paste, reduced flushing of backfill, all other water through host rock)	Covered Waste Rock Pile - till soil cover	same as Base Case		
	Backfilled Underground	0.3	0.5	0.01 (paste), 0.99 (wall rock)

The results of these sensitivity runs are summarized in the table below for the key parameters of interest, and provided graphically for Zn in particular.

The Base Case analysis has been revised from that in pHase 2010c to better reflect updated evaluations of groundwater/paste interactions as well as a more probably reflection of the anticipated flow path (or flushing) factor for waste rock.

Sensitivity Run #1 considers the effect of no temperature adjustment, i.e that the field release rates would be comparable to 25^{o}C as in the laboratory environment. It also considers slightly higher flushing factors. The results vary from 0% increase for parameters that are strongly controlled by solubility limits (e.g. Al, Ca, Fe) to 86% increases over the base case for parameters with no solubility controls (e.g. Hg, U). Zn increased by 61% over the Base Case for the waste rock and 82% in the underground.

Sensitivity Run #2 considered the effect of no grain size correction for the underground components, i.e. the DMS and tailings that make up the paste and the reactive zone of the wall rock. It also assumed higher flushing (10%), the results show increases over the Base Case again on the order of 0% to 86% (including Cu, Zn) depending on the parameter and associated solubility controls.

Sensitivity Run #3 evaluated a partial grain size reduction for the underground components (paste and wall rock) and fully flushed conditions for both the underground and the waste rock pile, i.e. water in contact with all reactive surfaces. This resulted again in generally similar increases to the preceding runs, with parameters showing increases ranging from 0 to 97%. Predicted concentrations of Zn from the waste rock increased by 73% and from the underground 93%.

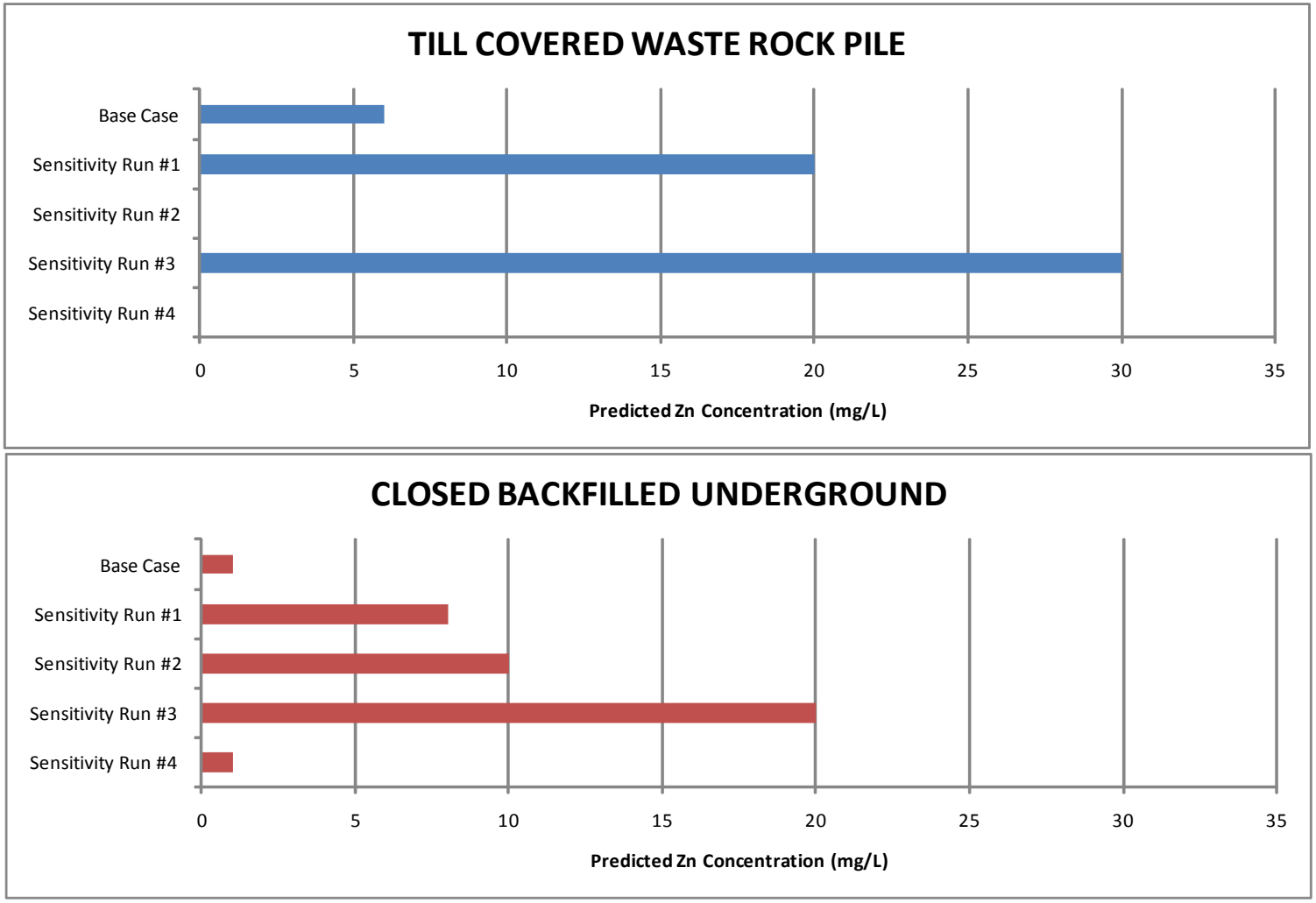
Sensitivity Run #4 is a variant on #3 for the underground, whereby the same partial grain size reduction was assumed, but the anticipated flushing factor refined for the Base Case was maintained. Results were generally similar to the Base Case for most parameters, with the exception of parameters such as Sb and U where no solubility controls have been assumed.

Again using Zn as the example for discussion, the results are interpreted here as indicating that the best professional judgment is that Zn values will <10 mg/L post closure from the waste rock facility and <5 mg/L draining from the underground. Given the level of certainty in these types of predictions, it is possible values could be higher, or seasonally vary to concentrations on the order of 20 mg/L from the waste rock and 10 mg/L from the underground with extreme upper bounds of 30 mg/L possible, though considered unlikely.

Summary of Results of Sensitivity Analyses Conducted in Response to Parks Canada IR #26.

		Base Case		Sensitivity Run #1		Sensitivity Run #2		Sensitivity Run #3		Sensitivity Run #4	
		as in pHase 2010c and addendum to pHase 2010c with revised groundwater flux estimates		no temperature correction, higher flushing		no grain size reduction for paste		partial grain size reduction for paste and fully flushed conditions		partial grain size reduction of paste, reduced flushing of backfill, all other water through host rock	
		TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDER-GROUND	TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDER-GROUND	TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDER-GROUND	TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDER-GROUND	TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDER-GROUND
pH	s.u.	6 to 6.5	~8 to 8.5	6 to 6.5	~8	Not varied in this sensitivity run	~8	6 to 6.5	~7	Not varied in this sensitivity run	~8 to 8.5
SO4	mg/L	~1000 to 1500	~150	>5000	<1000		~1500	~1000 to 1500	~1500 to 2000		~150
Al	mg/L	<0.5	~0.05	<0.5	<0.05		~0.075	<0.5	<0.5		~0.05
Sb	mg/L	~1	~0.05	<5	<0.1		~0.15	<5	~1		~0.1
As	mg/L	<0.1	~0.01	<0.5	<0.01		~0.015	<0.5	~0.05		~0.01
Cd	mg/L	~0.2	~0.01	~0.2	<0.05		<0.05	~0.2	~0.1		~0.01
Ca	mg/L	>500	~75	>500	~350		~500	>500	~400		~75
Cu	mg/L	~0.5	~0.02	<0.75	~0.1		~0.2	<1	<1		~0.02
Fe	mg/L	<0.05	<0.05	<0.05	<0.05		<0.05	<0.05	<0.05		<0.05
Pb	mg/L	~0.05	<0.05	<0.1	<0.1		<0.1	<0.1	<0.1		<0.05
Mg	mg/L	~300	~15	~500	~50		~75	~350	~300		~15
Mn	mg/L	~2	<0.05	~10	<0.1		<0.2	~3	~1		<0.05
Hg	mg/L	~0.05	<0.05	<0.5	<0.1		<0.2	<0.5	<0.5		<0.05
Se	mg/L	~0.2	<0.005	~1.5	<0.02		<0.025	~0.5	<0.2		<0.005
U	mg/L	~0.1	~0.0005	~1	<0.0005		<0.0005	~0.5	<0.005		<0.002
Zn	mg/L	~6	~1	~20	~8		~10	~30	~20		~1

Results of Sensitivity Analyses for Zinc.



2. Calibration of this type of a prediction can only be done during operations when paste backfilling has been initiated and water quality monitoring from the backfilled workings can be implemented.

3. Model verification can be conducted during operations via comparison with water monitoring data. This, in concert with geochemical operational monitoring of paste material produced, will provide data checks and verification of initial predictions. It is important to note again here that the geochemical characteristics of the materials associated with Prairie Creek are such that the weathering and leaching characteristics are not dependent on the development of acidic conditions. This is to say that there is not anticipated to be large variability in the metal leaching concentrations with time. Therefore, the existing monitoring record, and that which will be attained through operations, will provide a robust set of data with which to assess the long term potential for leaching. This, in combination with the water controls during operations (specifically collection and treatment) are considered to constitute best management practices for minimizing potential impacts as a result of mining operations.

4. See response to Parks Canada IR #20 above for anticipated operational characterization program.

IR Number: Parks_Canada_42
Source: Parks Canada Agency
To: Canadian Zinc Corporation
Subject: Waste rock pile drainage water

Preamble:

CZN proposes to cover the waste rock pile as part of the closure strategy for the mine. Based on preliminary analysis, a cover would reduce the net infiltration into the waste rock to 18% to 29% of the precipitation. Additional information will be needed prior to closure to facilitate final cover design, such as: characterization of materials, construction of a long-term climate database, installation of a net radiometer, and completion of annual snow surveys.

The drainage from the waste rock pile post-closure is into Harrison Creek. The waste rock pile drainage waters may be high in metals. It is unclear what monitoring and management/treatment of this water source will occur post-closure.

Request:

1. Provide additional information for a monitoring program with regards to the collection of climatic, engineering, and geochemical data that are necessary to complete final design of the waste rock pile, and to predict water quality of the waste rock pile drainage water.

2. Provide additional details on the proposed monitoring and management/treatment of waste rock pile drainage waters post-closure.

pHase Response:

1. During operations, detailed climate information will be collected for the site. In addition, potential cover material will be identified and fully characterized for geotechnical properties (grain size distributions, in-situ moisture content and temperature etc.) and geochemical properties (e.g. metals content, clay mineralogy etc.) to provide information with which additional cover design and supporting modelling work can be completed. This information, in addition to characterization work on development waste rock and the water monitoring from the waste rock pile seepage, will be used to better predict potential water quality from a covered waste rock facility on closure.

2. During operations, waste rock pile drainage will be captured in a seepage collection pond at the toe of the facility and fed into the mine water management system. This will be monitored on a regular basis and used in concert with the various evaluations on potential covers to help predict water rock pile drainage post closure. Once operations cease, there will be a period of time during reflooding of the mine etc. for which regular monitoring frequencies, and if required treatment of waste rock pile seepage, should it be required, will continue. Ultimately, the intent of cover design for the pile is to ensure that

steady-state drainage does not carry a high metal load which could lead to water quality impacts.

IR Number: GNWT 1-5
Source: Government of the Northwest Territories (ENR)
To: Canadian Zinc Corporation
DAR Section: TOR 3.3.2 Section 8.2
Subject: Geochemical Characteristics of the Paste Backfill

Preamble

CZN plans to use underground paste backfilling as a disposal method for tailings, DMS float, and incinerator ash. It is noted that a series of geochemical characterization tests were conducted on metallurgical samples and paste backfills samples. The tailing samples contain substantial amounts of trace metals, including Cd, Pb and Zn. A proportion of each is present in a readily leachable form, such as carbonates. The DMS float sample also contains notable amounts, however lower than the tailings. Humidity cell test work indicates that most of these parameters will quickly level off to concentrations one quarter of initial flush values, with the exception of Cd, Pb and Zn that tend to show a much less dramatic decay in concentrations and rather relatively consistent and elevated release rates. This information provides preliminary data on the leachability of the paste backfill, however the geochemistry of the paste backfill during operations may reflect different composition scenarios, therefore ongoing geochemical characterization and water quality monitoring should continue.

Request

1. Provide information regarding an operational geochemical monitoring and testing program to determine and confirm the geochemistry of the paste backfill and its subsequent impacts to groundwater.

pHase Response:

1. See response to Parks Canada IR # 20 above for the anticipated operational characterization program.

References:

Canadian Zinc Corporation (2008). Prairie Creek Mine Project Description Report, May 2008.

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ADDENDUM TO

SOURCE TERM WATER QUALITY PREDICTIONS, PRAIRIE CREEK PROJECT, NWT CANADA

Report prepared for:

Canadian Zinc Corporation
1710 - 650 West Georgia Street
Vancouver, BC
Canada, V6B 4N9

Revision 01

September 5, 2010

pHase GEOCHEMISTRY

LIMITATIONS OF REPORT

This addendum report has been prepared by pHase Geochemistry Inc. (pHase) for the account of Canadian Zinc Corporation (CZN). The material in it reflects the judgment of pHase staff in light of the information available to pHase at the time of report preparation. Any use which a Third Party makes of this report or any reliance on decisions to be based on it is the responsibility of such Third Parties. pHase accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report or contents herein.

As a mutual protection to our client, the public, and ourselves, all reports and drawings are submitted for the confidential information of our client for a specific project and authorization for use and/or publication of data, statements, conclusions or abstracts from or regarding our reports and drawings is reserved pending written approval by pHase and CZN. Moreover, any quotation taken from this report must be made in such a manner that the meaning and intent are not materially changed from the meaning and intent as contained herein.

EXECUTIVE SUMMARY

Source term water quality predictions for the Prairie Creek Project have previously been provided in a report by pHase in March, 2010 (pHase 2010c). Those predictions were based on a number of assumptions, with a few key assumptions that have since been revised. This addendum report provides an update of the source term concentrations for closure scenarios, specifically for a till covered waste rock pile and the backfilled underground. The reader is referred to the original report (pHase 2010c) for detailed discussions on source term predictions, only those revisions of note are discussed here, and include:

- A revised estimate of the adjustment factor for flushing through the covered waste rock pile, and
- A revised estimate of the adjustment factor for flushing of the paste backfill in the backfilled underground

The results of these revisions were also provided as the Base Case in the pHase letter dated September 1, 2010 in response to information requests related to CZN's Development Assessment Report (DAR) for the project (pHase, 2010d).

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1.0 INTRODUCTION AND OVERVIEW

The Prairie Creek Project located approximately 550 km west of Yellowknife in the southern Mackenzie Mountains of the Northwest Territories, is a high-grade zinc-lead-silver-copper deposit. The site currently consists of a partially developed underground mine and mill that were fully permitted and constructed in 1982, but never operated. CZN plans to re-permit the operation and bring the Prairie Creek Project into production.

Geochemical characterization testwork on material from the Prairie Creek Project in the NWT has been conducted over the past few years. This test program was initiated by MESH Environmental Inc. (MESH) and, following the suspension of operations of MESH, has been managed by Shannon Shaw of pHase Geochemistry Inc. (pHase), a previous partner of MESH. The program, and results of associated testwork, was last reported by MESH in their report "*Geochemical Characterization Report for the Prairie Creek Project, NWT*" (MESH, 2008). This was augmented by an update of the kinetic testing program by pHase in their report "*Humidity Cell Data Report Update, Prairie Creek Project, NWT Canada*" (pHase, 2010a) and characterization of paste materials in the report "*Geochemical Characterization of Paste and Paste Components, Prairie Creek Project, NWT Canada*" (pHase, 2010b). Source term water quality predictions were derived based in large part on the results and observations of previous studies, and reported in "*Source Term Water Quality Predictions, Prairie Creek Project, NWT Canada*" (pHase 2010c).

In March, 2010, CZN filed its Developers Assessment Report (DAR) for the Environmental Assessment (EA) of the Prairie Creek Mine with the Mackenzie Valley Environmental Impact Review Board. In early July, a number of information requests were submitted by various parties to the EA. As a result of those information requests, some revisions have been made to the assumptions used in the original source term water quality predictions. This addendum provides the results of those updates. The reader is referred to the original source term prediction report (pHase 2010c) for details and context.

2.0 REVISED SOURCE TERM WATER QUALITY PREDICTIONS

The method for completing source term predictions was described in pHase 2010c and detailed further in pHase 2010d. The process involves making a number of assumptions to translate humidity cell leach rates to anticipated field scale leach rates, i.e. scale-up calculations. Assumptions and associated adjustment factors are typically applied for consideration of temperature effects, grain size, rock type mixtures and mass, flow path development, water volume etc. The recent revisions all relate to the assumptions of flow path development, or the degree to which water is in contact with the material of interest. This is also often referred to as the flushing factor.

Rates developed in humidity cell tests and reported in pHase, 2010a represent fully flushed conditions which may or may not reflect field conditions. The development of flow paths in waste piles, stockpiles etc can result in portions of the facility being fully flushed (i.e. in the flow paths) and other areas in which otherwise mobile constituents are stored as secondary minerals within the facility. Typically, the extent to which flow paths develop is a reflection of the height of the facility with lower facilities being more fully flushed than very high facilities. The original source term predictions used an adjustment of 0.5 to represent the waste rock pile, i.e. that 50% of the pile is 'flushed'. For underground wall rock (historic workings and backfilled mine), a factor of 0.1 was assumed to represent the mass which may be flushed from these facilities. Both of these factors have been revised recently based on new data/consideration and are discussed separately below.

2.1 Closed Till-Covered Waste Rock Pile

For a waste rock pile, the flushing factor can also be described as the flow path effect, i.e. infiltration through a rock pile typically is not in contact with all available surfaces, but rather a proportion of the pile. In the author's experience, this value typically varies from approximately 1/3rd to 2/3^{rds} of the pile, or an adjustment factor of ~0.3 to 0.7. The original report used a value of 0.5 and assumed half the contact surfaces were regularly flushed with infiltrating contact water. This has been revised to a lower value of 0.33 with the assumption that the till cover would in effect reduce this flushing compared to the uncovered scenario (which also assumed a value of 0.5).

2.2 Closed Backfilled Underground

Flows used in the original source term predictions were those provided by the hydrogeological investigations conducted by Robertson GeoConsultants Inc. (RGC) (C. Wels, pers comm., email dated March 4th, 2010). Revisions to the hydrogeological conditions anticipated in the closed backfilled underground were provided by RGC in a letter dated July 30, 2010 (RGC, 2010) which addressed information requests on the DAR. These revisions were based on FEFLOW model simulations that were not conducted previously. The simulations indicated that horizontal seepage through the paste backfill component of the closed underground would range from <0.1% to 0.2% of the total groundwater flow, rather than the 10% originally assumed. The remaining flow would occur in the permeable fracture zone and surrounding bedrock mass. Based on these revisions, the source term water quality predictions for the backfilled underground were revised and assumed that 1% of the groundwater flow (still well above that simulated by FEFLOW) would contact the paste and the remaining 99% of flow would occur through the neighbouring fractured rock.

2.3 Updated Source Term Predictions Compared to Original Estimates

The effect of revising the flow path adjustment factor results in a decrease, or lowering of concentrations predicted on closure from both facilities. The results of the original estimates as

well as the revised Base Case are shown together in Table 1, along with the calculated relative percent differences between the two scenarios.

Table 1. Results of Original and Revised Base Case Predictions for the Closed Till-Covered Waste Rock Pile and the Closed Backfilled Underground.

Parameter		Original Base Case		Revised Base Case		Relative Percent Difference	
		as in pHase 2010c		Revised Adjustment Factors for Flushing Effects		Change from Original to Revised Base Case	
		TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDERGROUND	TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDERGROUND	TILL COVERED WASTE ROCK PILE	CLOSED BACKFILLED UNDERGROUND
pH	s.u.	6 to 6.5	~8	6 to 6.5	~8 to 8.5	0%	3%
SO4	mg/L	~1000 to 1500	<500	~1000 to 1500	~150	0%	-108%
Al	mg/L	<0.5	<0.05	<0.5	~0.05	0%	0%
Sb	mg/L	<1	<0.05	~1	~0.05	0%	0%
As	mg/L	<0.1	<0.005	<0.1	~0.01	0%	67%
Cd	mg/L	~0.2	<0.05	~0.2	~0.01	0%	-133%
Ca	mg/L	>500	~100	>500	~75	0%	-29%
Cu	mg/L	<0.75	<0.05	~0.5	~0.02	-40%	-86%
Fe	mg/L	<0.05	<0.05	<0.05	<0.05	0%	0%
Pb	mg/L	<0.1	<0.1	~0.05	<0.05	-67%	-67%
Mg	mg/L	~500	~20	~300	~15	-50%	-29%
Mn	mg/L	~2	<0.05	~2	<0.05	0%	0%
Hg	mg/L	<0.1	<0.05	~0.05	<0.05	-67%	0%
Se	mg/L	~0.3	<0.005	~0.2	<0.005	-40%	0%
U	mg/L	~0.2	<0.0005	~0.1	~0.0005	-67%	0%
Zn	mg/L	~30	~2	~6	~1	-133%	-67%

Many parameters show effectively no difference as a result of this revision. These are parameters for which there are strong mineralogical controls assumed to be effective in both scenarios. Other parameters vary slightly, and have some solubility controls, but more effective in one scenario than in the other. Other parameters that are not limited by solubility in either one or both scenarios show the most substantial reduction in the Revised Base Case. In the waste rock pile, the Revised Base Case results in a significant reduction in the predicted Zn concentration, as

well as Cu, Pb, Mg, Hg, Se and U. For the backfilled underground scenario, the revised base case results in a large reduction in predicted SO4, As, Cd, Cu, Pb and to a lesser extent Ca and Mg concentrations.

3.0 SUMMARY AND CONCLUSIONS

The revisions to the anticipated flushing factors in response to new data/consideration have had the effect of reducing the predicted source term concentrations for the closed till-covered waste rock pile and the closed backfilled underground, summarized in this addendum to pHase 2010c. This reflects the effect of a reduced amount of contact water flushing through the waste rock and paste backfill. The results are best viewed in concert with the original predictions as well as the sensitivity analyses provided in pHase 2010d.

It is noted that CZN will operate a water treatment plant through operations and will be monitoring facilities during that time, as well as during the closure period while the water table rebounds. Refinement of these predictions can be made during operations as necessary to be in a better position to confirm anticipated conditions after closure.

4.0 CLOSURE

pHase Geochemistry Inc. is pleased to submit this addendum to the source term water quality predictions for the Prairie Creek project, NWT. I trust that the contents of this report meet your current requirements and expectation. If you have any queries or concerns, please do not hesitate to contact the undersigned.

Best Regards,

pHase Geochemistry Inc.

per:

Shannon Shaw, M.Sc., P.Geo.(BC)
Senior Geochemist

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Robertson GeoConsultants Inc. (2010). RGC Responses to Information Requests, Prairie Creek Mine, NWT – Rev 0. Letter to Canadian Zinc Corporation, July 30, 2010.

Appendix H

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September 6, 2010
RGC Project No: 148002/4

Canadian Zinc Corporation

Suite 1710 – 650 West Georgia Street
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Attention: Dave Harpley

RE: RGC Responses to Information Requests, Prairie Creek Mine, NWT - REV 1

Dave,

This letter report summarizes our draft responses to the Information Requests (IRs) submitted by various stakeholders to the Mackenzie Valley Review Board in response to Canadian Zinc's Development Assessment Report ("DAR") for the Prairie Creek Mine. As requested, only those IRs directly related to hydrogeological aspects of the proposed development are addressed in this letter report.

1 Information Requests from Parks Canada

1.1 IR_Number: Parks_Canada_21: Flush & steady-state leaching conditions

Request 1. Develop a conceptual model of groundwater interaction with the paste backfill and use it to support the following additional requests. If relevant, the reliance of bulkheads installed in the underground voids should be included in the response.

RGC Response

In general, the interaction of groundwater with the paste backfill will be very limited because of the large difference in permeability (or hydraulic conductivity) between the paste backfill (~4x10-8 m/s) and the MQV and surrounding fracture zone (~5x10-5 m/s). Groundwater will have the tendency to flow through the more permeable fractured bedrock surrounding the paste backfill limiting contact time with, and hence leaching of potential contaminants of concern from, the paste backfill.

The groundwater flow regime differs significantly between active mining and post-closure conditions. As a result, the interaction of groundwater with the paste backfill also differs significantly for those two scenarios and is discussed separately below.

Figure 1 illustrates the conceptual model of groundwater interaction with the paste backfill during active mining. The conceptual model for this situation can be summarized as follows:

- Paste backfill will be placed in a dewatered MQV (drain holes and/or mine access drifts will dewater the MQV ahead of paste backfill); under those circumstances groundwater movement in the MQV/Vein fault will be predominantly vertical (gravity-driven)
- Any vertical recharge and/or lateral (perched) groundwater flow reaching the dewatered Vein Fault/MQV will preferentially percolate down the highly permeable Vein Fault surrounding the backfilled stope with very limited, if any, contact with the paste backfill;
- Continued dewatering of the MQV/Vein Fault of the lowest backfilled stope (by maintaining open access ramps and/or drilling drain holes from the lowest foot wall drift during active mining will minimize the potential for groundwater movement through the lowest backfilled stopes;
- Any groundwater interacting with the paste backfill will be collected as part of routine mine dewatering activities and treated prior to discharge; in other words, the impact of metal leaching from the paste backfill on the receiving environment will be negligible;

For the reasons listed above, seepage from the backfilled stopes during active mining is expected to be very limited. Nevertheless, monitoring of seepage from selected backfilled stopes (flow rates and water quality) could be implemented to verify/update this conceptual model and to improve our predictions of metal leaching from paste backfill.

Figure 2 illustrates the conceptual model of groundwater interaction with the paste backfill for post-closure conditions. The conceptual model for this situation can be summarized as follows:

- After cessation of all mining activity, the underground workings will be allowed to reflood, submerging most of the backfilled stopes. Preliminary modelling suggests that the mine will reflood to about 940 m amsl (assuming sealing of the 870 and 930 adits) which would submerge about 90% of the paste backfill placed underground.

- In the uppermost stope where unsaturated conditions may prevail post-closure, groundwater interaction will be similar to that described above (for active mining), i.e. any groundwater entering the MQV/Vein fault (as direct precipitation and/or lateral recharge) will percolate down the highly permeable fractured bedrock surrounding the low-permeability paste backfill.
- Some vertical recharge may also enter the uppermost stopes and percolate through the backfill. However, the volume of seepage is limited by the (unsaturated) hydraulic conductivity of the paste backfill. Assuming a recharge rate of 100 mm the total (vertical) seepage from the entire paste backfill at the 970 level (3m width by 1,000m length) would only be 0.01 L/s, or about 0.5% of all groundwater flow predicted to flow through the backfilled mine post-closure. In other words, the contribution of vertical seepage through these unsaturated stopes to the total groundwater flow (and associated metal loading) will likely be very small post-closure.
- The majority of backfilled stopes will be submerged permanently below the water table where groundwater flow is predominantly in a horizontal direction, i.e. in a southerly direction towards Prairie Creek valley. The presence of the low-permeability paste backfill represents a barrier to horizontal groundwater flow in the partially backfilled Vein Fault associated with the MQV. Hence groundwater will tend to flow preferentially in the higher-permeable, fractured bedrock surrounding the backfilled stopes.
- The degree of groundwater interaction with the flooded paste backfill will depend on the extent of backfilling of the fracture zone (i.e. Vein Fault) associated with the mineralization. CZN estimates that the mineralized ore zone (to be mined) represents only about 50% of the full width of the fracture zone (Vein fault) (A. Taylor, pers. comm.). In other words, only about 50%-75% of the highly permeable fracture zone will be paste-backfilled during mining.
- Sensitivity analyses using an idealized flow field (simulated in FEFLOW) indicated that horizontal seepage through paste backfill ranged from <0.1% to 0.2% of total groundwater flow depending on the degree of backfilling of the permeable fault zone (see Appendix A). The vast majority (99.8 to >99.9 %) of horizontal groundwater flow would occur in the remaining (non-backfilled), highly permeable fracture zone and (to a lesser extent) in the surrounding bedrock mass.

- Note that our sensitivity analyses did not address the potential presence of any remaining open mine voids. Any horizontal mine workings remaining open after mine closure (e.g. non-backfilled stopes, open drifts etc) would further divert groundwater flow away from the backfilled stopes and further reduce horizontal flow through the low-permeability backfill.

In summary, our conceptual model suggests that groundwater interaction with the paste backfill will continue to be very limited even after flooding of the mine workings post-closure, due to the large contrast in hydraulic conductivity of the fractured bedrock (remaining after mining & backfill) and the paste backfill.

Given the propensity for groundwater to flow through the fractured rock mass rather than the backfill, the need for strategically placed bulkheads to restrict groundwater flow is reduced. A limited number of bulkheads in the main access tunnels to surface would ensure no 'short-circuit' path for mine water.

Water quality predictions suggest that groundwater in contact with the backfilled mine workings after reflooding will be comparable to groundwater quality currently observed in the mineralized MQV, except for slightly elevated cadmium (see response by pHase Geochemistry to information request no. 24 from Parks Canada). Conservative mixing calculations suggest that discharge of this slightly impacted groundwater would not significantly impact Prairie Creek water quality (see Robertson GeoConsultants Inc., 2010).

Note that there is very little, if any, risk of off-site migration of impacted mine water from the backfilled underground workings until the flood level in the mine exceeds the elevation of Prairie Creek (~870m amsl). In other words, there will be ample opportunity to verify these water quality predictions before there would be any impact to Prairie Creek.

Request 3. Water that passes through the backfilled paste may contain elevated metal concentrations. Provide a summary description of interaction of groundwater passing through the backfilled paste. Provide an estimate of groundwater flow leaving (sic) entering/leaving the paste backfill and the level of certainty in the estimate.

RGC Response

See reply by pHase Geochemistry Inc. for first part. Figure A5 of Appendix 1 shows estimates of groundwater flow through the paste backfill for a range of conditions simulated using an idealized flow field (see Appendix 1). The sensitivity analyses

summarized in Figure A5 illustrate the sensitivity of these flow estimates to several parameters, including (i) the degree of backfilling of the Vein Fault, (ii) the hydraulic conductivity (K) of the backfill and (iii) the hydraulic conductivity (K) of the fracture zone. The predicted flow through the backfill is most sensitive to the degree of paste backfill of the fracture zone. The sensitivity analyses presented in Table 1 illustrate the level of uncertainty in this flow estimate (both relative and absolute).

Request 4. Prepare a detailed summary of the uncertainties with regards to groundwater interaction with the backfill material, and how this uncertainty will be addressed.

RGC Response

Table 1 lists the uncertainties in the interaction of groundwater with paste backfill and how these uncertainties will be addressed.

Table 1. List of Uncertainties – Groundwater interaction with paste backfill.

Uncertainty	**How to address**
Hydraulic conductivity of "tight" bedrock and transmissivity (T=width x K) of Vein Fault	Monitor dewatering of Vein Fault (dewatering rates)
Extent of fracturing outside immediate zone of mining (and paste backfilling)	Review of borehole logs (and/or core) of drill holes intercepting Vein Fault Detailed mapping of fracture zone during approach to and mining of MQV
Hydraulic Conductivity of "as placed" paste backfill	Monitor seepage out of select backfilled stopes
Leaching potential of paste backfill during active mining	Monitor seepage water quality from select backfilled stopes

Request 7. In all responses, provide reference to any hydrogeological testing/analysis results that support the discussion. If there are instances where no hydrogeological testing/analysis results are available to support the discussion, provide additional detail on how to fill the information gap (e.g., confirmatory testing/analysis, monitoring, etc.) and provide confidence to interested parties.

RGC Response

Hydraulic testing of the paste backfill was completed by Golder PasteTec in the laboratory and results are provided in Appendix 15C of the DAR.

Estimates of hydraulic conductivity for the "tight" bedrock and the Vein Fault are based on hydraulic testing in the field and calibration of a preliminary groundwater flow model (Appendices 1A & 1B of DAR).

Groundwater flow through paste backfill was estimated using a 3D groundwater flow model with simplified geometry. The model geometry and modelling results are shown in Appendix 1 of this letter report.

As described in previous sections and elsewhere in the DAR, monitoring of groundwater and mine water flow and quality will be conducted prior to, during active mining (and backfilling) and post-closure. This monitoring data will be used to update our conceptual model of groundwater flow and improve/recalibrate the numerical groundwater flow for the Prairie Creek mine site, as required.

1.2 IR_Number: Parks_Canada_23: Flush & steady-state leaching conditions

Request 1. Describe and evaluate options to collect and/or treat the leachate, if it exceeds MMER limits.

RGC Response

During active mining, the MQV/Vein Fault and surrounding bedrock will be dewatered resulting in a cone of depression of the regional groundwater table. This cone of depression will be centered around the MQV/Vein Fault where the paste backfill will be placed. Any leachate from the paste-backfilled stopes will therefore flow by gravity to the nearest drift and from there to the nearest mine water collection point (sump). All mine water collected in the various sumps will then be pumped to the mill area for re-use and/or treatment and discharge. A separate collection of leachate from the paste backfill is not required (as all mine water is either re-used or treated).

After closure of the mine, all mine dewatering will cease and the underground workings will be allowed to reflood. As described in section 1.1 above, leachate from the flooded

paste backfill will be significantly "diluted" with natural groundwater initially flooding and then flowing in the surrounding (fractured) bedrock and any remaining open mine workings. Initial modelling suggests that this dilution is sufficient to reduce the dissolved metal concentrations in the mine water to sufficiently low levels that receiving water impacts will be minimal. Water quality monitoring in the mine workings and/or Vein Fault during reflooding of the mine could be implemented to confirm this prediction.

1.3 IR_Number: Parks_Canada_35: Hydrogeology – zinc concentrations in Prairie Creek Alluvium Aquifer

Request 1. Describe the potential (if any) after closure of the mine, for groundwater to discharge into Harrison Creek, in addition to Prairie Creek.

RGC Response

The preliminary groundwater modelling completed for the DAR suggests that groundwater may be discharging into the alluvial sediments of Harrison Creek (HCAA) in the area between MW09-15 (where the MQV/Vein Fault intercepts the HC valley) and the confluence with Prairie Creek. The increase in groundwater flow from the MQV/Vein fault to HCAA is predicted to be ~3.9 L/s (see Table 1 in Appendix 1C of DAR). Such an increase in groundwater discharge may increase the groundwater levels in the HCAA by about 2.5 to 4.5m.

Visual observations would suggest that Harrison Creek may be a "gaining stream" (i.e. may receive groundwater discharge) in the narrow portion of the valley upstream of the mill (approximately between HC2 and HC3). Hence, it is considered possible that the predicted increase in groundwater discharge and groundwater levels in HCAA post-closure would slightly increase groundwater discharge to Harrison Creek (approaching pre-mine conditions).

Note that groundwater discharge into Harrison Creek can be expected to vary seasonally, with highest groundwater discharge during the spring/summer when groundwater levels are higher and little to no groundwater discharge during the fall/winter period when groundwater levels recede and the stream freezes up.

Note also that Harrison Creek is clearly a "loosing stream" (i.e. is recharging the underlying aquifer) when it crosses the HC alluvial fan (in the mill area). This is most evident in the late fall (September/October) when all stream flow in Harrison Creek disappears into the highly permeable alluvial fan material before reaching Prairie Creek.

Request 2. Provide additional details on proposed monitoring (during mine operations and post-closure) to understand the movement of metals within groundwater in the bedrock, PCAA, and Harrison Creek Alluvial Aquifer.

Table 2 summarizes the proposed groundwater monitoring program for the period of active mining. Figure 1 shows the locations of the various monitoring wells to be used for the proposed groundwater monitoring program. A total of 24 monitoring wells are proposed for routine groundwater monitoring during active mining. Fourteen (14) of these monitoring wells have already been implemented. An additional ten (10) monitoring wells would be completed prior to start of active mining operations.

Table 2. Proposed groundwater monitoring plan – Active Mining Period

Well ID	Screened Lithology	Monitoring Frequency Active Mining	
		Water Level Monitoring	Water Quality Monitoring
Existing Monitoring Wells			
MW08-01	PCAA (shallow)	quarterly	semi-annual
MW08-02	Bedrock	quarterly	annual
MW08-03	Bedrock (Vein Fault)	quarterly	semi-annual
MW08-05	Bedrock (930-level)	quarterly	annual
MW08-06	Bedrock	annual	N/A
MW08-07	Colluvium	quarterly	quarterly
MW08-10	Bedrock	annual	annual
MW09-12	HCAA (shallow)	quarterly	semi-annual
MW09-13	Bedrock	quarterly	annual
MW09-14	HCAA (shallow)	quarterly	semi-annual
MW09-15	MQV/Vein Fault	quarterly	semi-annual
MSW-01	PCAA (shallow)	quarterly	N/A
MSW-03	PCAA (shallow)	quarterly	N/A
STP-2	PCAA (shallow)	quarterly	semi-annual
Proposed Monitoring Wells			
PMW-1	PCAA	annual	annual
PMW-2	PCAA (shallow)	quarterly	quarterly
PMW-3	PCAA (shallow)	quarterly	quarterly
PMW-4S	HCAA/PCAA	quarterly	semi-annual
PMW-4D	Bedrock	quarterly	annual
PMW-5	HCAA/PCAA (deep)	quarterly	annual
PMW-6S	PCAA (shallow)	quarterly	semi-annual
PMW-6D	PCAA (deep)	quarterly	annual
PMW-7	PCAA	quarterly	semi-annual
PMW-8	HCAA	quarterly	semi-annual

Table 2 also summarizes the proposed frequency of groundwater level and groundwater quality monitoring. Baseline monitoring completed to date indicates little seasonal variation in groundwater quality at the Site. We therefore propose semi-annual groundwater quality monitoring (spring and fall) in permeable alluvium and the MQV/Vein Fault and annual monitoring (fall) in bedrock. Quarterly monitoring (winter, spring, summer and fall) is only proposed for those monitoring wells located immediately downgradient of known sources of potential seepage (i.e. water storage pond and waste rock pile).

Field parameters to be measured during water quality sampling include electrical conductivity (EC) and pH. The parameters to be analysed in the laboratory should include total dissolved solids (TDS), alkalinity (if pH> 4), major cations (Ca, Mg, Na, K), major anions (sulphate, bicarbonate) and dissolved metals (aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, nickel, lead, selenium, zinc).

Table 3 summarizes the proposed groundwater monitoring program for post-closure conditions. For purposes of groundwater monitoring, the post-closure period has been subdivided into two periods (i) “early post-closure” and (ii) “steady-state post-closure”. The early post-closure period is characterized by a rebound of the groundwater levels in the mine workings and surrounding bedrock aquifer and associated flushing of residual contamination from the mine workings.

Table 3. Proposed groundwater monitoring plan – Post-closure Period

		Monitoring Frequency Early Post-closure		Monitoring Frequency Steady-state Post-closure	
Well ID	Screened Lithology	Water Level Monitoring	Water Quality Monitoring	Water Level Monitoring	Water Quality Monitoring
Existing Monitoring Wells					
MW08-03	Bedrock (Vein Fault)	semi-annual	annual	annual	annual
MW08-07	Colluvium	semi-annual	semi-annual	annual	annual
MW08-12	HCAA (shallow)	semi-annual	semi-annual	annual	annual
MW09-13	Bedrock	semi-annual	semi-annual	annual	annual
MW09-14	HCAA (shallow)	semi-annual	semi-annual	annual	annual
MW09-15	MQV/Vein Fault	semi-annual	semi-annual	annual	annual
Proposed Monitoring Wells					
PMW-2	PCAA (shallow)	semi-annual	semi-annual	annual	annual
PMW-4S	HCAA/PCAA	semi-annual	semi-annual	annual	annual
PMW-4D	Bedrock	semi-annual	semi-annual	annual	annual
PMW-5	HCAA/PCAA (deep)	semi-annual	annual	annual	annual
PMW-6S	PCAA (shallow)	semi-annual	semi-annual	annual	annual
PMW-6D	PCAA (deep)	semi-annual	annual	annual	annual
PMW-7	PCAA	semi-annual	semi-annual	annual	annual
PMW-8	HCAA	semi-annual	semi-annual	annual	annual

In general, the scope of groundwater monitoring can be gradually reduced once all mine workings are flooded and post-closure steady-state conditions are approached.

It is important to recognize that the scope of post-closure groundwater monitoring proposed in Table 3 is preliminary and should be updated based on groundwater monitoring results during active mining and early post-closure.

1.4 IR_Number: Parks_Canada_36: Hydrogeologic contaminant transport modelling

Request 1. Provide additional details regarding any proposed hydrogeologic investigations to refine the hydrogeologic model and surface water load balance model predictions for pre-mining, mining, and post-closure, including but not limited to: a summary of the primary assumptions applied in the hydrogeologic model and how future hydrogeologic investigation data will support to confirm the assumptions; and, scheduling to complete future hydrogeologic investigations relative to pre-mining, mining, post-closure phases of the project.

RGC Response

Table 4 summarizes the key assumptions of the hydrogeological model and lists the hydrogeological investigations planned to confirm these assumptions. Table 4 also lists a tentative schedule for the various activities.

The emphasis of future hydrogeological work will be on monitoring the response of the fractured bedrock system to the planned dewatering immediately prior to and during active mining. Mine dewatering will act as a very large pumping test which will stress the entire bedrock aquifer system at the appropriate scale (i.e. several kilometers) which cannot be replicated by individual hydraulic testing (e.g. packer testing, pumping tests etc.). This monitoring data will then be used to refine and recalibrate the existing groundwater flow model for the Site to predict (i) future mine dewatering requirements (ii) mine reflooding and (iii) post-closure groundwater flow.

Several additional monitoring wells are proposed to be drilled in the Prairie Creek and Harrison Creek valleys to complement the existing groundwater monitoring network (see Table 3). Drilling logs, hydraulic testing and monitoring data from those new locations will also be used to improve our conceptual model of groundwater flow and assist in future model calibration.

Table 4. Key assumptions, hydrogeological investigations and tentative schedule for hydrogeological model.

Key Assumption	Hydrogeological Investigations	Tentative Schedule
Groundwater Flow Model		
Seasonal recharge to bedrock aquifer (see Table 1 in Appendix 1C of DAR)	Monitor groundwater inflow to mine workings prior to and during active mining Monitor seasonal variations in groundwater levels	ongoing until end of active mining
Hydraulic properties of MQV Vein fault & host bedrock (see Table 2 in Appendix 1C of DAR)	install additional monitoring wells (see table 3 and complete hydraulic testing in selected new wells; complete shut-in tests of exploration and/oir drain holes	prior to start of active mining after start of active mining
Vein Fault is the preferred conduit of groundwater flow in vicinity of the ore body and extends into the HC valley Prairie Creek Alluvial Aquifer receives groundwater recharge (and zinc load) from HCAA and mineralized bedrock	Monitor groundwater levels and groundwater quality prior to and during active mining Refine and recalibrate preliminary groundwater flow model for Prairie Creek mine site	ongoing until end of active mining after start of active mining
Harrison Creek is hydraulically connected to underlying alluvial aquifer (HCAA) and provides a source of groundwater to the mine via the Vein Fault	Monitor groundwater levels in HCAA and flow rates in Harrison Creek before and after start of active mining Monitor occurrence of mine water ingress to workings; complete occasional mine water survey (flow & water quality)	ongoing until end of active mining after start of active mining
Hydraulic properties of paste backfill (see Appendix 15C of DAR)	Monitor seepage rates and water quality from paste backfill	during active mining
Paste backfill seals only about 50-75% of the entire fracture zone associated with the MQV (i.e. Vein fault)	Monitor seepage rates and water quality before and after paste-backfilling of stopes	during active mining

1.5 IR_Number: Parks_Canada_37: Load balance calculations

<u>Request 1</u>. Provide additional details regarding any proposed surface water quality and quantity investigations used to refine the load balance predictions for pre-mining, mining, and post-closure, including, but not limited to: a summary of the primary assumptions applied in the load balance calculations and how future investigation data will support to confirm the assumptions; and, scheduling to complete the investigation relative to pre-mining, mining, post-closure phases of the project.

<u>RGC Response</u>

Table 5 summarizes the key assumptions of the load balance model and lists future investigations planned to confirm these assumptions. Table 5 also lists a tentative schedule for the various activities.

The key assumptions in the load balance model relate to the assumed source concentrations, in particular metal concentrations in seepage from the exposed MQV,

backfilled mine, and from the proposed waste rock pile. To the extent possible, direct sampling of seepage from these contaminant sources will be conducted during active mining to update earlier predictions of contaminant source concentrations.

Other key assumptions for the surface water load balance model are estimated mean monthly flows for the various source waters (e.g. backfilled mine, MQV flow, seepage from WRP) and the receiving surface water (Harrison Creek and Prairie Creek). While the monthly flows for Prairie Creek are based on a 16-year monitoring record of the near-by WSC station, the other monthly flow estimates had to be estimated. We propose that a gauging station be installed in Prairie Creek (at the old WSC gauging station) and a weir-type flow monitoring device in Harrison Creek (upstream of the 930 Portal) to allow routine monitoring of stream flow in both receiving waters. Cover test plots studies should also be initiated during active mining to estimate the rate of infiltration through the waste rock pile after cover placement (for post-closure predictions).

Table 5. Key assumptions, investigations and tentative schedule for surface water contaminant load model.

Key Assumption	**Investigations**	**Tentative Schedule**
Surface Water Contaminant Load Model		
Assumed contaminant concentrations of potential contaminant sources (i.e. MQV, bedrock, portal discharge, ore stockpile) for current conditions	Monitor water quality in mine water and groundwater across the site Repeat synoptic mine water and surface water survey (flow and water quality)	prior to start of active mining
Assumed contaminant concentrations of potential contaminant sources (i.e. actively mined stopes, backfilled stopes, MQV, bedrock, portal discharge, ore stockpile, waste rock pile) during active mining	Monitor water quality in mine water and groundwater across the site Complete synoptic mine water and surface water survey (flow and water quality) during active mining	during active mining
Assumed contaminant concentrations of potential contaminant sources (i.e. flooded U/G workings, MQV, bedrock, waste rock pile) post-closure	Monitor water quality in mine water and groundwater across the site during and following reflooding of mine workings Complete synoptic surface water survey (flow and water quality) after reflooding	after cessation of mine dewatering
Monthly streamflow in Prairie Creek and Harrison Creek	Install gauging stations and monitor streamflow	prior to start of active mining
Net percolation through cover of WRP	Conduct cover test plot studies to determine cover flux	during active mining

In addition, detailed flow and water quality surveys of mine water and surface water will be completed, as required, to better understand the contaminant loads reaching Harrison Creek and Prairie Creek at different stages of mine development. Results of those load surveys will also be used to improve our conceptual model of contaminant loading and assist in updating and recalibrating the current surface water load balance model.

2 Information Requests from Department of Fisheries and Ocean

2.1 IR_Number: DFO_06: Groundwater Discharge to Prairie Creek

Request 1: Identify areas within Prairie Creek, near the mine site, where groundwater discharges to the surface.

RGC Response

Groundwater discharge is possible in the alluvial plain (in the form of springs) or within the stream bed proper ("groundwater upwelling"). Field observations by CZN site personnel suggest that localized groundwater discharge to surface is limited. No springs in the alluvial plain or specific upwellings in Prairie Creek have been noted. The only documented groundwater discharge in the Prairie Creek valley is the localized groundwater discharge in the mill area (i.e. "mill seeps"). These springs are collected in a channel ("mill ditch") and diverted into the catchment pond before being released to Harrison Creek and ultimately Prairie Creek.

In general, mountain streams such as Prairie Creek have a very coarse stream bed which allows good interaction with the underlying alluvial aquifer (i.e. Prairie Creek alluvial aquifer). The amount of groundwater discharge into such streams can vary significantly over short reaches and it is not uncommon to see significant spatial and seasonal variability in stream water gains (i.e. groundwater discharge) and stream water losses (i.e. stream recharging the aquifer) over a scale of several hundred meters.

Note, however, that significant localized groundwater discharge into Prairie Creek (i.e. "upwelling") of groundwater is unlikely to occur along the reach between the water holding pond and upstream of Galena Creek because the Prairie Creek valley widens significantly in this reach. Note also that significant localized groundwater upwelling would delay or potentially prevent winter freeze-up in the stream. No such areas of open water indicating groundwater upwelling have been observed during the winter months by CZN personnel (D. Harpley, pers. comm.).

3 Information Requests from Indian & Northern Affairs – Water Resources Division

3.1 IR_INAC01: Water – Hydrology – Groundwater

Request 1: Since Canadian Zinc Incorporated/Robertson Geotechnical Consulting Limited provided low and high flow rates, what is the most likely average annual flow rate?

RGC Response

Initially, steady-state simulations were computed using the preliminary 3-D groundwater flow model to estimate mine dewatering rates and post-closure flows. Based on initial sensitivity runs "a low flow scenario" and a "high flow scenario" were selected to assess the likely range of groundwater flows. As stated on p. 30 of the Site Hydrogeology Report (Appendix IA of the DAR) the low flow estimate "*is considered more representative of current conditions based on the limited hydraulic testing and observed zinc loading in HCAA and PCAA… [the high flow] Scenario 2 is also plausible and was retained for prediction of past (pre-development) and future (mining and post-closure) conditions to provide an upper limit on past and future groundwater flow (*"*high flow estimate*"*)*".

Subsequently, the preliminary 3-D groundwater flow model was modified to simulate transient (seasonal) groundwater flow at the Prairie Creek site. A preliminary model calibration was achieved by comparing the simulated inflow to the mine workings to the observed monthly discharge from the 870 portal (see Appendix 1C of the DAR for more details).

Table 6 summarizes updated results of this transient modelling. Note that the simulation of active mining (Run NM15Tr) was only recently completed and those results were not available at the time of original submission of the DAR (c. Table 1 in Appendix 1C of DAR).

The mean annual flows predicted with the transient model and summarized in Table 6 represent our best estimate of average annual flow rates at the site. For example, the average annual inflow during mine dewatering is estimated to be 56 L/s.

Table 6. Updated results of transient groundwater flow modeling, Prairie Creek Mine, NWT.

Item	unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL/ Average
A. Model Inputs and Calibration Targets														
Monthly Recharge outside of mine foot print	mm	0	0	0	0	11	45	22	18	6	0	0	0	100
Monthly Recharge over mine foot print	mm	0	0	0	0	21	90	43	35	11	0	0	0	200
Mine Water Discharge from 870 Portal	L/s	3.0	2.5	2.0	2.0	2.0	8.3	11.1	10.5	13.3	10.0	6.5	4.0	6.3
B. Model Predictions for Current Conditions (Run NM10Tr)														
Groundwater Flow into Mine Workings (870 Portal)	L/s	5.1	4.8	4.6	4.4	4.6	9.5	13.6	13.8	10.3	7.8	6.5	5.8	7.6
Groundwater Discharge from MQV/Vein Fault to HCAA	L/s	1.0	0.9	0.9	0.9	0.9	1.2	1.3	1.2	1.2	1.1	1.0	1.0	1.1
C. Model Predictions for Active Mining (Run NM15Tr)														
Groundwater Flow into Mine Workings (870 Portal)	L/s	58.1	45.2	40.1	40.7	41.3	61.7	90.3	74.3	60.5	55.3	57.7	49.4	56.2
D. Model Predictions for Post-Closure Conditions (Run NM12Tr)														
Groundwater Flow through Backfilled Mine Workings	L/s	1.4	1.4	1.3	1.3	1.2	2.1	3.7	4.2	3.4	2.1	1.8	1.6	2.1
Groundwater Discharge from MQV/Vein Fault to HCAA	L/s	4.3	3.7	4.0	3.5	3.8	4.5	6.4	7.3	6.7	6.4	4.2	4.8	5.0

Request 2: What is the level of certainty surrounding the low, high and average annual flow rate (i.e. percentages above or below expected)?

RGC Response

As described above, the "low flow scenario" and "high flow scenario" provide reasonable upper and lower bounds of average annual groundwater flow. In other words, they represent our estimate of the uncertainty in the average flow estimate. For example, the average annual inflow of groundwater into the mine workings during active mining is estimated to be 56 L/s, but may range from as low as 29 L/s to as high as 100 L/s.

Note that the "high flow" estimate of 200 L/s predicted with the steady-state model represents a very conservative upper bound of "seasonal" groundwater inflow to the mine workings. An analysis of the predicted flow field indicated that recharge from HCAA via the Vein Fault would account for 90% of all inflow to the mine workings (i.e. of 16,000 m^3/day or 185 L/s) (see p. 34 of Appendix 1A of DAR). Such a high flow rate cannot be sustained by groundwater flow in the HCAA and would require a large amount of recharge of surface water from Harrison Creek in the overlying stream channel. However, stream flow in Harrison Creek is seasonal and is insufficient to provide such high rates of recharge to the HCAA for much of the year. In fact, the estimated monthly stream flow in Harrison Creek only exceeds 185 L/s for four months of the year (May - August). In

other words, this predicted maximum mine inflow would only be possible during spring runoff conditions.

Note also that recharge represents a relatively small proportion of inflow to the mine workings under this high flow scenario. For example, the mean annual rate of recharge (from snowmelt and precipitation) contributing to the mine inflow was estimated to be only about 6.8 L/s. Hence, even a significant increase in recharge due to a very wet year (say 2 times the average) is unlikely to significantly increase the upper limit of mean annual inflow to the mine.

Considering the factors listed above, we believe that our estimate of 100 L/s represents a more realistic upper limit of mean annual flow into the mine workings (see also p. 34 in Appendix 1A of DAR).

3.2 IR_INAC03: Water – Hydrology – Groundwater

Request 1: What will be the predicted effect of mine dewatering on the HCAA and the PCAA?

RGC Response

The alluvial aquifers in Harrison Creek valley (HCAA) and Prairie Creek valley (PCAA) were not explicitly included in the preliminary 3-D groundwater flow model for the Site. Instead, these alluvial aquifers were represented as constant head boundaries along the contact with the surrounding and underlying bedrock. This approach assumes that the alluvial aquifer has sufficient groundwater flow to supply any recharge to the bedrock during mine dewatering. This approach provides conservative (high) estimates of recharge from the alluvial aquifers to the dewatered underground mine.

In practice, dewatering of the bedrock and in particular the highly permeable MQV/Vein Fault will result in a drawdown of the groundwater table in the alluvial aquifer. This drawdown will induce groundwater flow, primarily from up-valley, plus recharge from the overlying creek (provided the stream is flowing). The extent of drawdown will depend on (i) the magnitude of recharge to the bedrock aquifer (i.e. flow to the mine workings), (ii) the hydraulic conductivity of the alluvial aquifer material (iii) lateral recharge from up-valley and (iv) vertical recharge from the overlying creek.

In general, the 3-D groundwater flow model predicts much higher recharge from the HCAA than from the PCAA, due to the higher elevation (head) and closer proximity of Harrison Creek to the underground workings (i.e. higher gradients). The steady-state model predicts (conservative) recharge rates from the HCAA to the dewatered mine ranging from 20 to 185 L/s (for low flow and high flow scenarios, respectively). In

contrast, the predicted recharge rates from the PCAA to the mine workings are very small (ranging only from 0.2 to 0.6 L/s).

The recharge rates predicted for the HCAA are in excess of the estimated horizontal flow rates of 5-16.5 L/s in the alluvial aquifer (see table 4-4 in Appendix 1A of DAR). In other words, the water table in the alluvial aquifer would likely be drawn down below the creek bed elevation of Harrison Creek. The extent of further drawdown of the groundwater table would depend on the amount of leakage from Harrison Creek. Note that significant drawdown in the HCAA may result in a reduction (or complete disappearance) of the mill seeps.

The predicted direct recharge from the Prairie Creek alluvial aquifer due to mine dewatering (0.2 to 0.6 L/s) represents only a very small fraction of the estimated total flow in the PCAA (15-50 L/s, see table 4-4 in Appendix 1A of DAR). The greatest impact from mine dewatering to PCAA could be a reduction in groundwater inflow from the (partially dewatered) HCAA. Groundwater discharge from HCAA into PCAA is estimated to be about 5-10 L/s. A significant proportion of this flow (up to 6 L/s) discharges to surface ("mill seeps") during summer/fall when the aquifer is "full". A reduction of 5-10 L/s recharge in the mill area is unlikely to cause a significant drawdown in the PCAA.

Request 2: Provide calculations to demonstrate if there is the possibility of reduced flows in Harrison Creek and Prairie Creek?

RGC Response

As discussed above, significant drawdown can be expected to occur in HCAA which would induce leakage from Harrison Creek into the underlying alluvial material. The rate of leakage from Harrison Creek can be estimated using Darcy's law. Assuming free-draining conditions (i.e. vertical gradient = 1), the stream leakage, L, is given by

$$L = Ks * Ls * Ws$$

Where Ks is the hydraulic conductivity of the streambed material and Ls and Ws are the length and average width of the streambed. The stream bed material in Harrison Creek consists predominantly of coarse cobbles, gravel & sand with little fines. Assuming an average hydraulic conductivity of Ks=5*10-4 m/s and an average stream width of 2m, the average leakage would be 1 L/s per meter length of stream bed. Drawdown of the groundwater table in the HCAA will likely be concentrated to the area where the highly permeable MQV/Vein fault crosses the Harrison Creek valley (~ 75m length). Assuming free-draining conditions along a distance of 75 to 100m along Harrison Creek, the total leakage losses from Harrison Creek could be as high as 75 to 100 L/s. Note that these

that these leakage rates are directly proportional to the hydraulic conductivity of the stream bed material which could vary by at least one order of magnitude.

These calculations demonstrate that it is theoretically possible to induce significant leakage from Harrison Creek due to mine dewatering. In fact, stream flow in Harrison Creek may be lost to the underlying alluvial sediments due to mine dewatering during the shoulder seasons (i.e. early spring runoff and/or late summer/early fall), as it is currently during relatively dry periods and in winter.

Since drawdown in the PCAA due to mine dewatering is likely insignificant (see above) leakage losses from Prairie Creek to the underlying alluvium due to mine dewatering are also expected to be insignificant.

4 Closure

We trust that the information provided in this letter report meets your requirements.

Please contact the undersigned if you have any questions regarding the content of this report or require further information.

Best Regards,

ROBERTSON GEOCONSULTANTS INC.

Prepared by:

ORGINAL SIGNED

Dr. Christoph Wels, M.Sc., P.Geo.
Principal and Senior Hydrogeologist

FIGURES

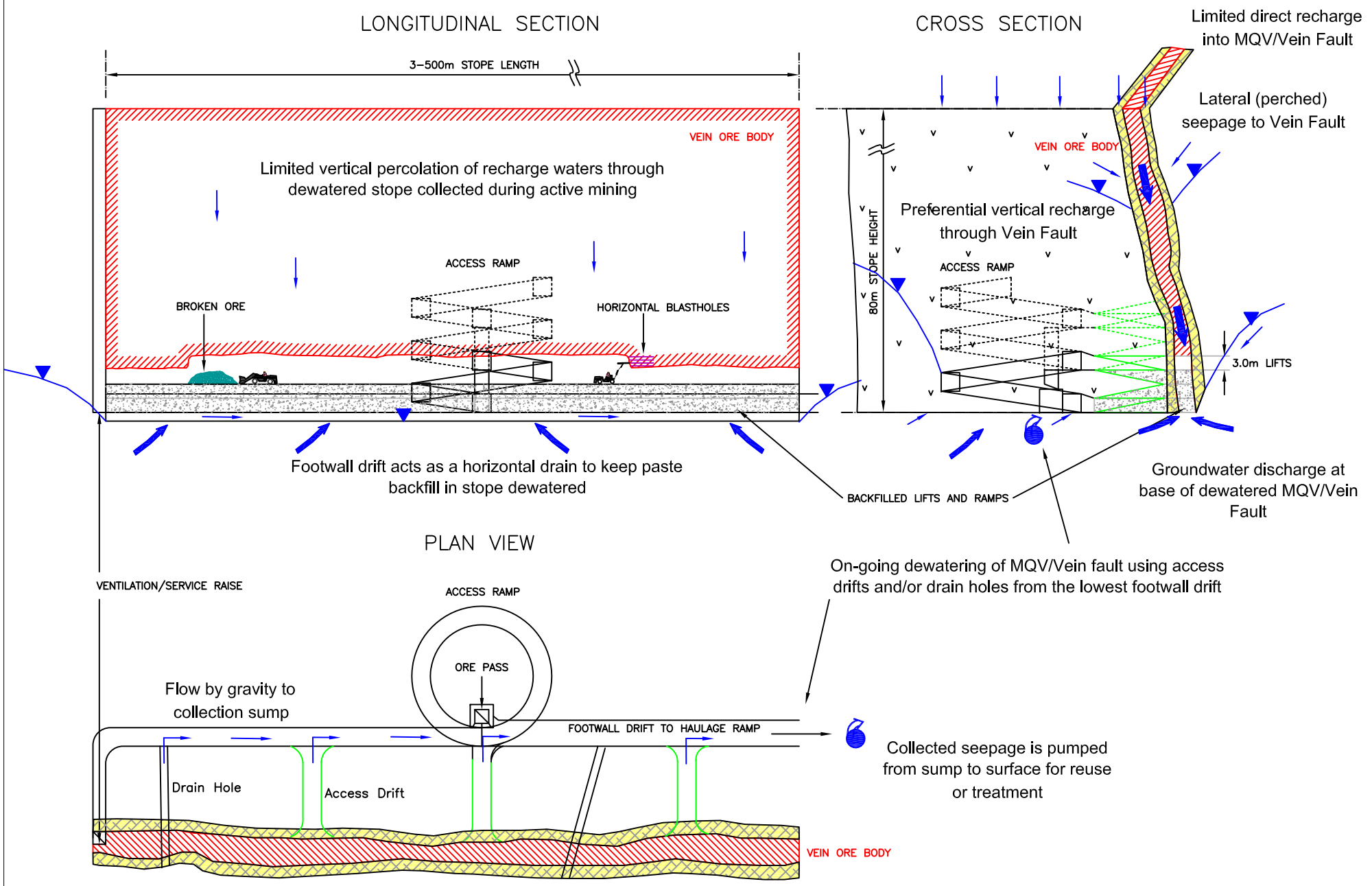

Figure 1: Conceptual model of groundwater interaction with paste backfill - Active Mining

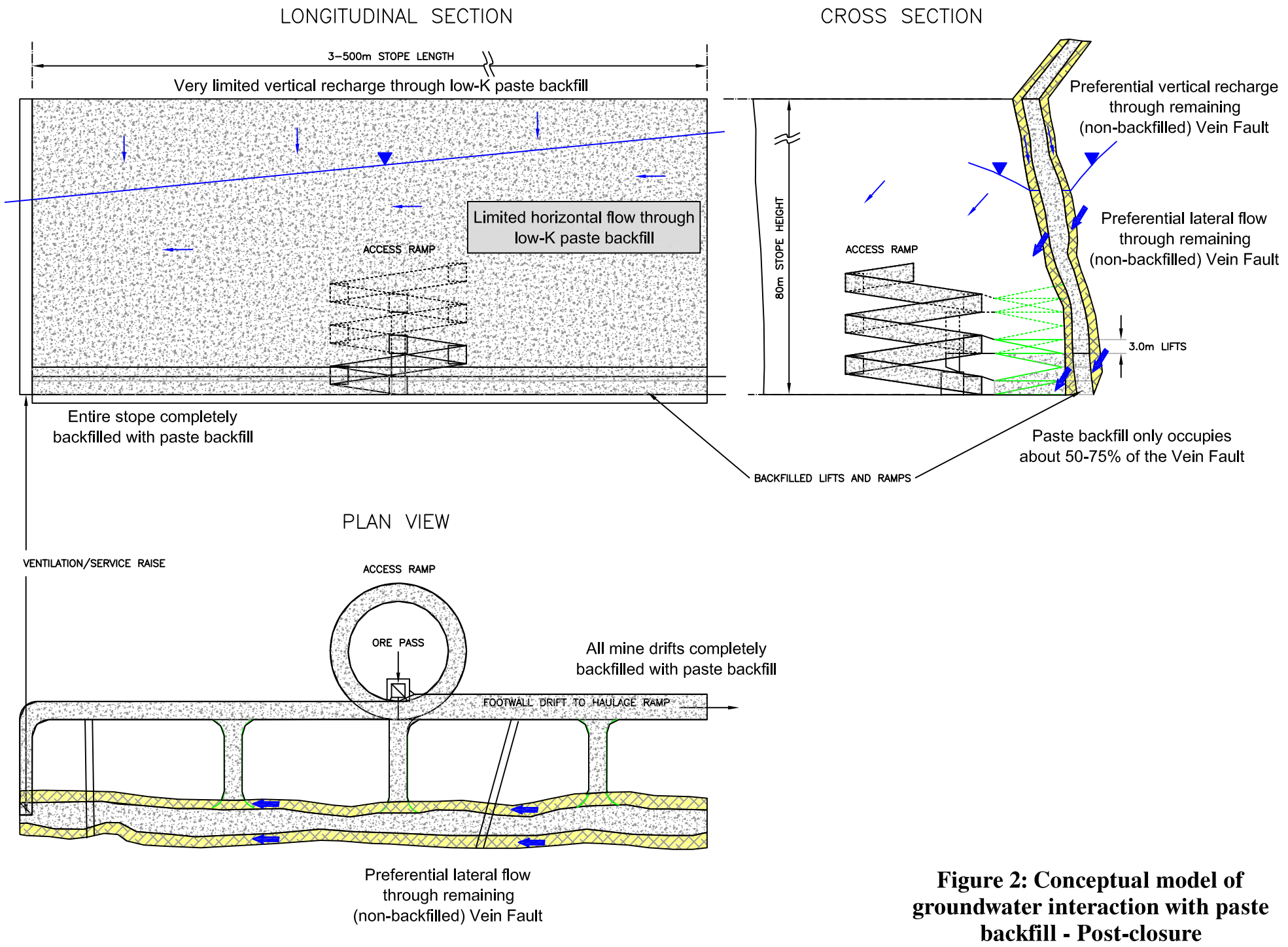

Figure 2: Conceptual model of groundwater interaction with paste backfill - Post-closure

404000

405000

6827000

6826000

6825000

MW08-10

MW08-05

MW08-06

MW08-07

PMW1

PMW8

PMW3

STP2

PMW2

PW-01

PMW4 S/D

MSW-03

MSW-01

MW09-15

MW08-03

MW09-14

MW09-12

MW09-13

PMW5

PMW6 S/D

MW08-01

MW08-02

PMW7

MAIN QUARTZ VEIN (Zone 3)

DISCOVERY VEIN (Zone 5)

Proposed Groundwater Monitoring During Active Mining

Prairie Creek Mine Site

LEGEND

- Stand-Pipe Piezometer
- MSW - Mill Site Well
- Monitoring Well - Bedrock
- Monitoring Well - Alluvium/Unconsolidated
- Proposed Monitoring Well

PROJECTION: UTM
ZONE: 10
DATUM: NAD 83
UNITS: Meters
CONTOUR INTERVAL: 25m

SCALE

0 100 200 300 400 500 Meters

CANADIAN ZINC CORPORATION

ROBERTSON GEOCONSULTANTS INC.
Consulting Geotechnical and Environmental Engineers

CLIENT: Canadian Zinc Corporation
PROJECT: Prairie Creek DAR
PROJECT No: RGC 148002
LOCATION: NT, Canada

FIGURE: 3

DATE:07/27/2010 DRAWN BY:OM FILE:PrairieCr_Proposed_Wells.mxd

APPENDIX 1

Numerical Simulations to Assess Groundwater Interaction with Paste Backfill

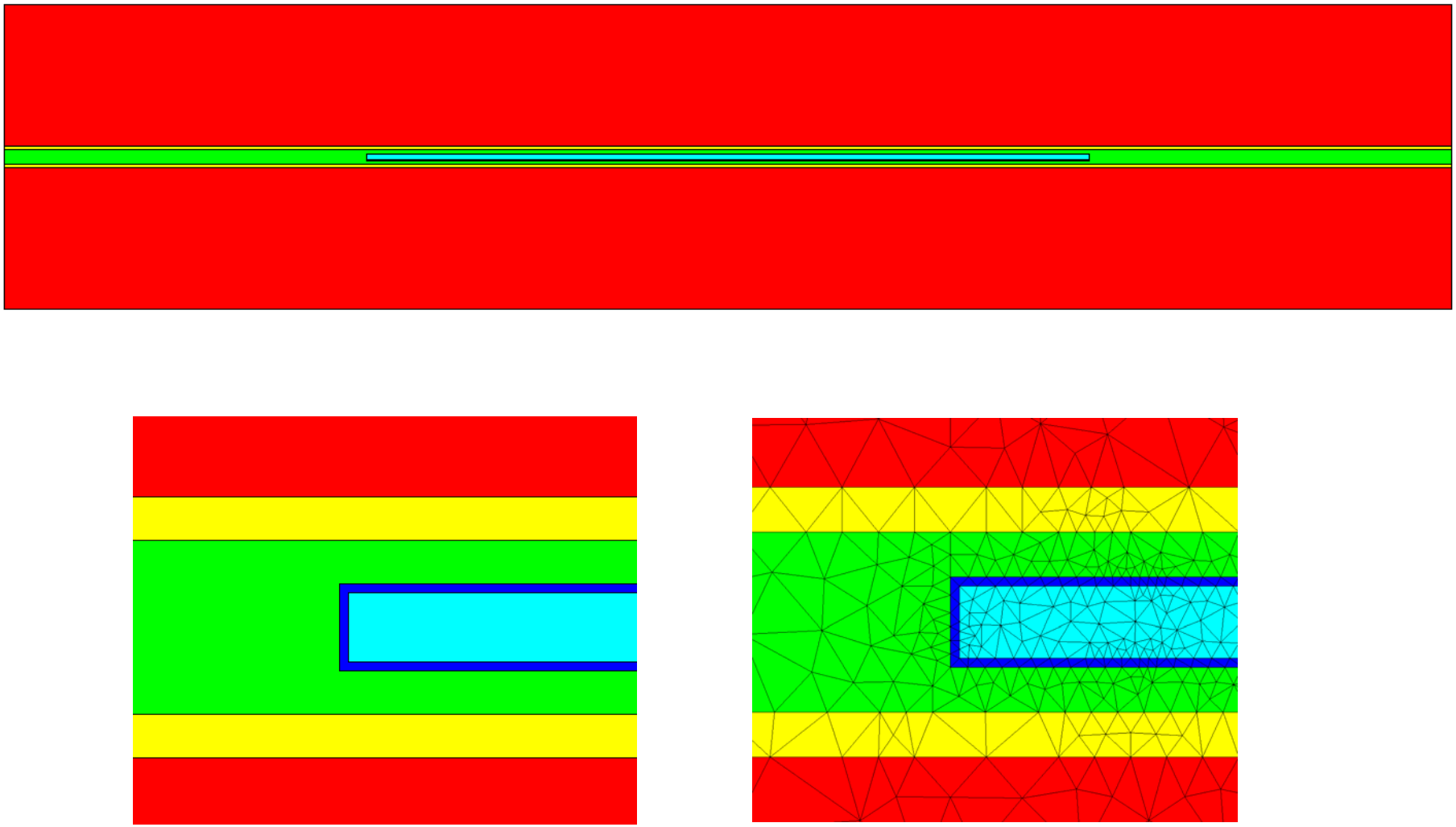

Figure A1. Setup of Idealized Block Model in plan view (blue = paste backfill, green = Fault Zone, yellow&red = bedrock)

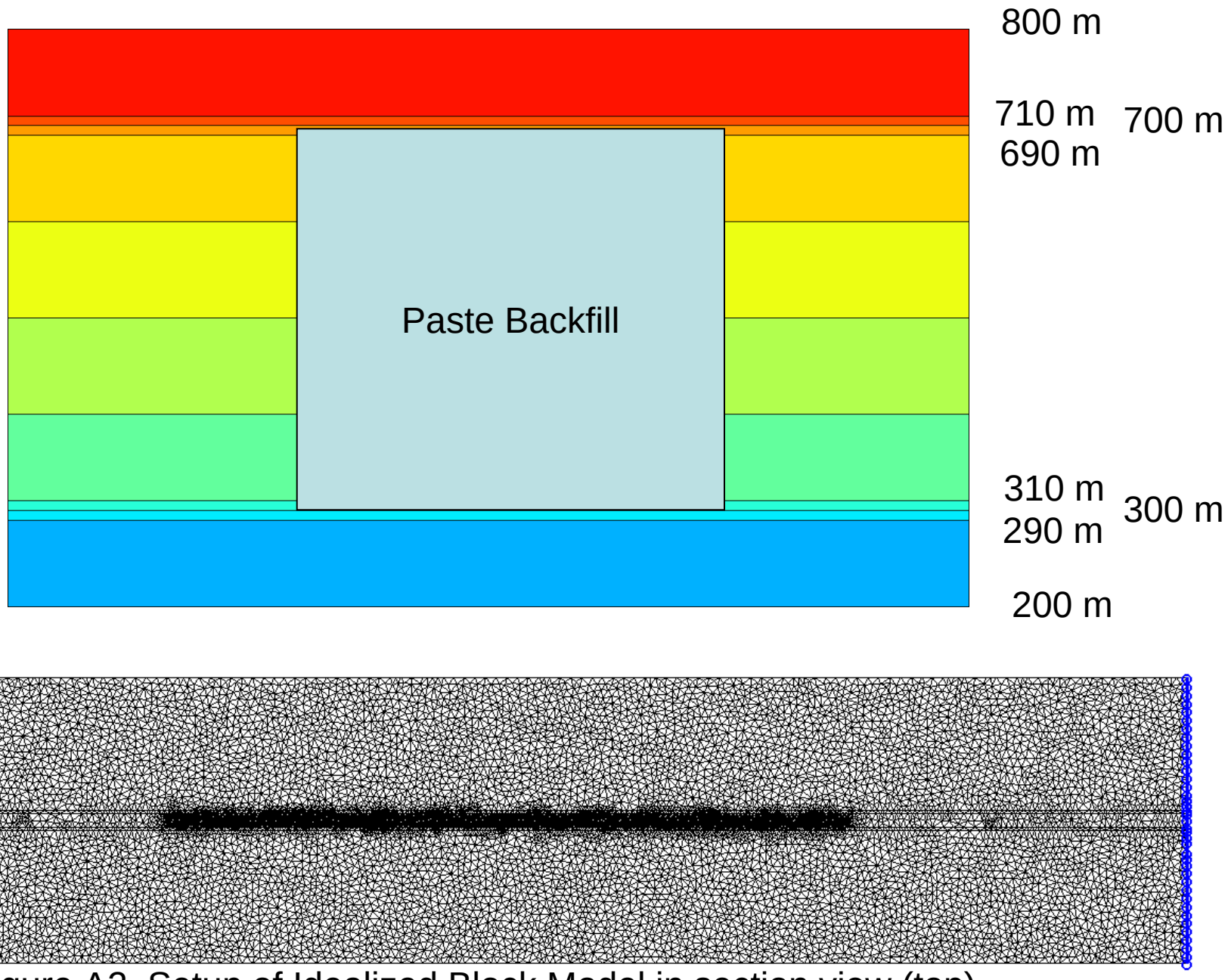

Figure A2. Setup of Idealized Block Model in section view (top) and plan view (bottom)

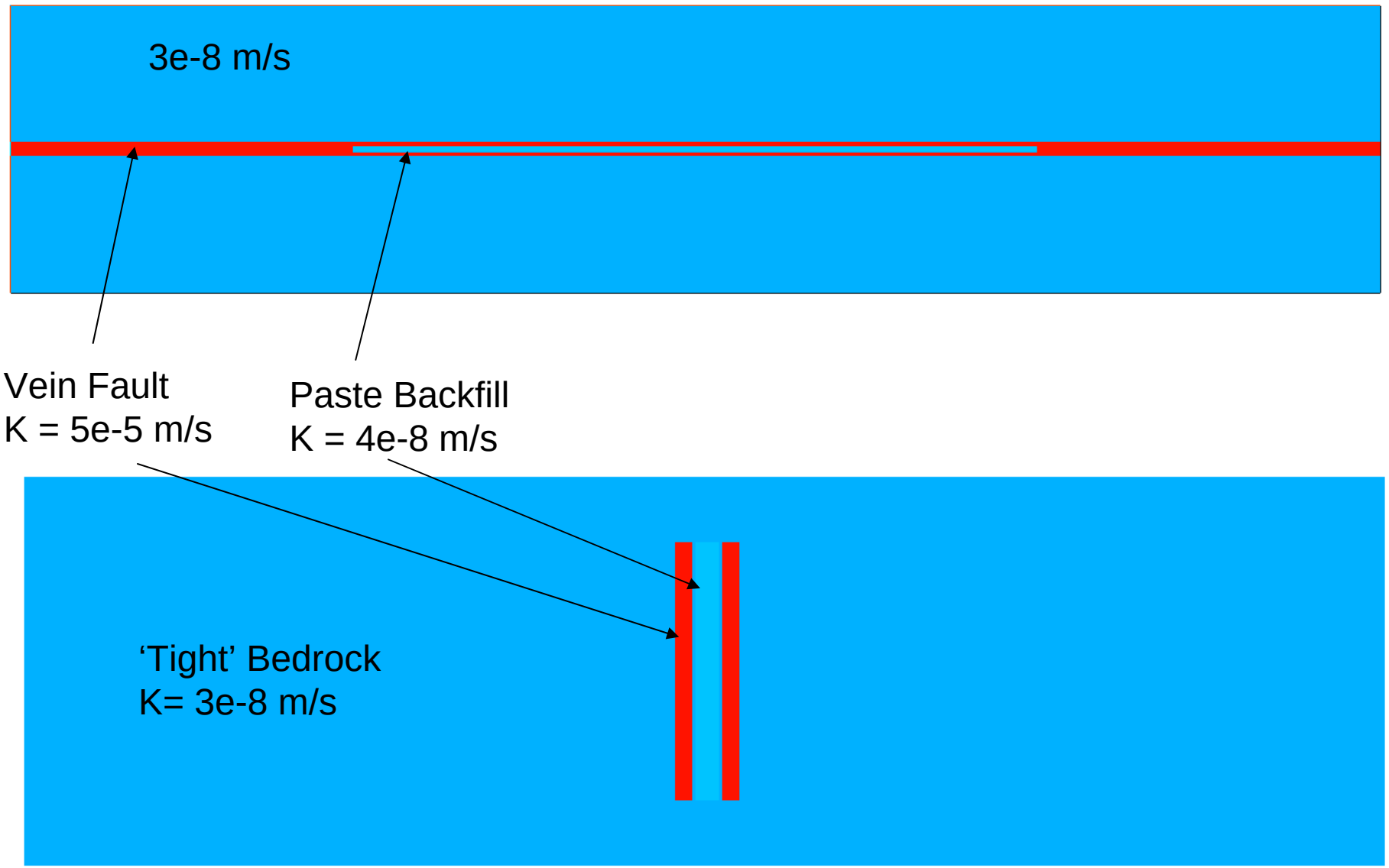

Figure A3. Hydraulic conductivity values used for Idealized Block Model (Base case)

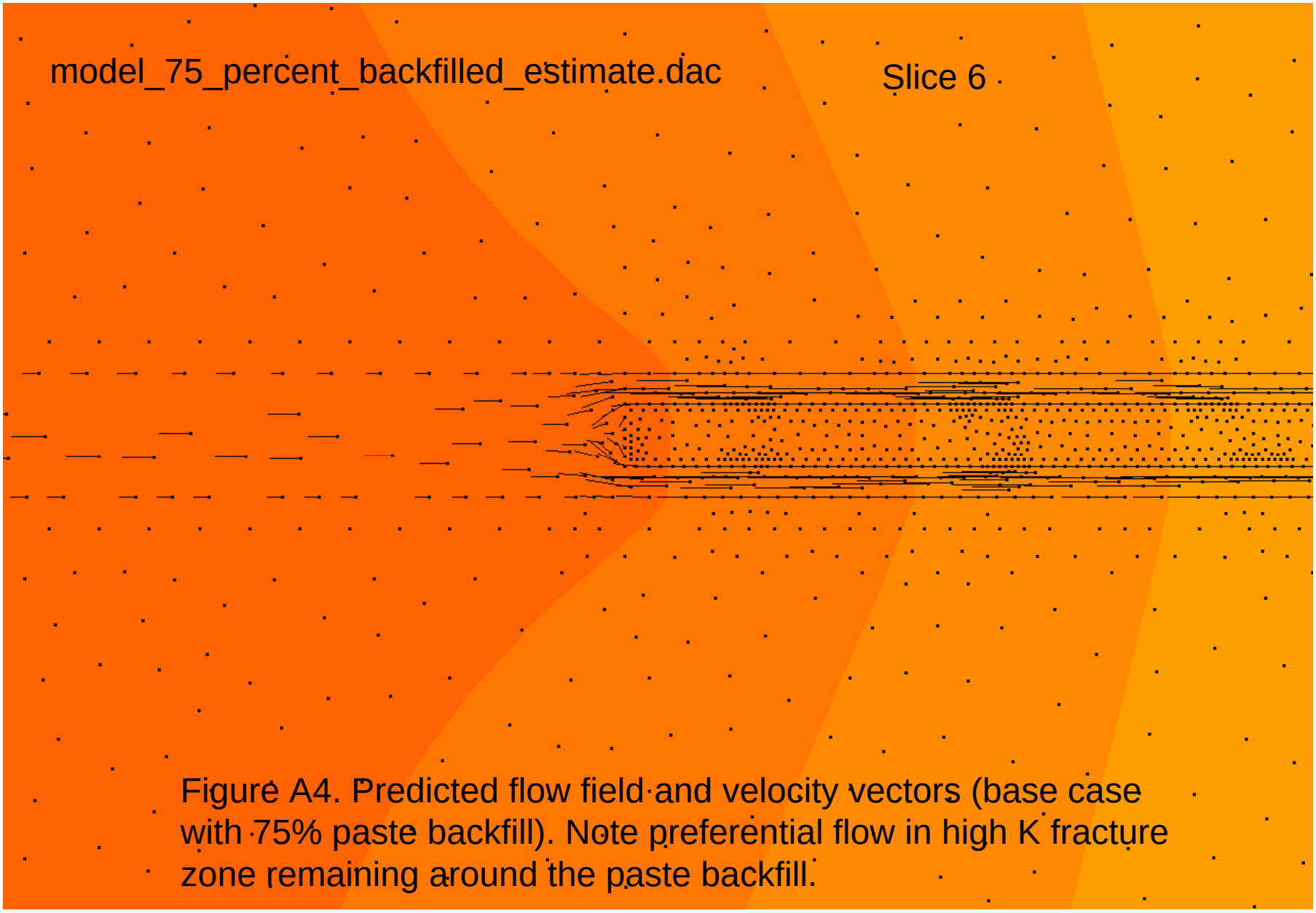

Figure A4. Predicted flow field and velocity vectors (base case with 75% paste backfill). Note preferential flow in high K fracture zone remaining around the paste backfill.

Run	Flow Field	Vein Fault	Backfill	Total	Vein Fault	Backfill	Vein Fault	Backfill	Bedrock
		m/s	m/s	L/s	L/s	L/s	%	%	%
50 % backfilled	constant gradient	5.0E-05	4.0E-08	2.44	2.38	0.001	97.6%	0.04%	2.3%
75 % backfilled	constant gradient	5.0E-05	4.0E-08	2.03	1.97	0.001	96.9%	0.05%	3.1%
100 % backfilled	constant gradient	5.0E-05	4.0E-08	1.47	1.40	0.002	95.3%	0.15%	4.6%
Sensitivity Analysis									
50 % backfilled	constant gradient	5.0E-05	1.0E-08	2.44	2.38	0.000	97.6%	0.01%	2.3%
50 % backfilled	constant gradient	5.0E-05	1.0E-07	2.44	2.38	0.002	97.6%	0.10%	2.3%
50 % backfilled	constant gradient	1.0E-05	4.0E-08	0.52	0.46	0.001	89.0%	0.18%	10.8%

Figure A5. Results of Idealized block model simulations. Note low proportion of flow through low K paste backfill.

Appendix I

MEMORANDUM

MINE PASTE ENGINEERING LTD

TO:	Dave Harpley (Canadian Zinc Corporation)	**DATE:**	August 26, 2010
FR:	Frank Palkovits (Mine Paste Engineering Ltd.)	**JOB NO:**	**01-2010-02**
COPY:	Alan Taylor, Barrie Hancock		
RE:	**REVIEW OF NRCAN, MACKENZIE VALLEY REVIEW BOARD AND PARKS CANADA COMMENTS FOR EA PROCESS, PRAIRE CREEK MINE** **EA PROCESS - FORMAL INFORMATION REQUESTS ON THE PASTE BACKFILL APPLICATION**		

Dear Mr. Harpley:

The following documents have been reviewed in context with Canadian Zinc Corporation's (CZN) submission for approval for the Prairie Creek Mine (PCM):

1. Mackenzie Valley review Board IR Number MVRB 7;
2. Natural Resources Canada (NRCan) IR No. NRCan2, sub-items 1 through 9;
3. Parks Canada Agency IR No.'s 27, 28, 29, 30 and 31 as well as "Information Requests related to Water Management & Treatment at the Prairie Creek Mine Site;
4. Golder Paste Technology Ltd. (PasteTec) Reports:
    a. Pre-Feasibility Engineering Study for Cemented Paste Backfill Plant for the Prairie Creek Project: December 21, 2009;
    b. Laboratory Evaluation of Prairie Creek Mine Backfill: Technical Memorandum, October 21, 2009;
5. Laboratory Evaluation of Canadian Zinc Mine Tailings for Use as Prairie Creek Mine Backfill: November 10, 2009.

1.0 MVRB 7

Request

1. No discussion was provided with regards to the effect of groundwater quality if there is water bleed into the groundwater. What are the allowances or acceptance criteria for the water bleed from the backfilling into the mine groundwater?
2. The water bleed is approximately 15% for 7 in. slump and 20% for 10 in. slump (FTP 2005). However, for FTP 2009 samples, the water bleed is approximately 6%~ for 7 in. slump and 9% for 10 in. slump compared to FTP 2009 samples (Figure 2). Please explain and clarify the differences.
3. The concentrations of As, Cd, Pb, Hg analyses in tailings are of concern. Leach tests on mixtures of paste cement show concentrations in leachate of Cd, Hg, Pb close to, or exceeding, Water Quality limits. For this reason, high bleed rates would result in an environmental risk of groundwater contamination. Risk would be higher above the water table where groundwater may be moving and thus promote more dispersal of bleed water. Please provide clarification on the bleed rates, and how it may affect the ground water quality.

Response

1. Paste backfill testing for moisture bleed is conducted to observe the effect of water bleed on pipeline transport without cement. Paste backfill is always cemented, and excess water is consumed as the cement (or other binders) hydrates. As such, water within the matrix is not available for release. Therefore, significant bleed water is not expected from the backfilled stopes.
2. It is normal to see variations between samples due to changes in mineralogy and process control. However, the samples received in 2005 and 2009 were distinctively different. Note that 2009 samples contained actual DMS rock from PCM following processing of a bulk sample from site. A surrogate sample of dolomite from Manitoulin Island was used as DMS aggregate in 2005 test campaign. Differences in water bleed appear to be controlled more by mineralogy and chemical composition, and to some degree due to particle size distribution. The presence of significant amounts of $ZnCO_3$ and $PbCO_3$ in the latter (2009) sample may suggest oxidation of the sample had occurred.

3. Please refer to Item 1, above. No significant loss of bleed water is expected from backfill in the underground stopes. Should this be the case, and the metal loads in the water pose a problem regarding overall mine water quality, CZN could implement separate collection and management of bleed water.

2.0 NRCAN 2 – REQUEST

Request

1. Plan for UCS testing to incorporate actual DMSA.
2. Chemical and mineralogical compositions for the DMSA should be provided.
3. A plan for long-term UCS testing, up to a minimum of one (1) year should be provided.
4. The details of the UCS testing to be provided including individual sample results, calibration reports of equipment used, as well as details of the materials used in the mix recipes prepare the UCS samples.
5. If addition of flocculants is planned, a plan for incorporating flocculants should be provided.
6. A plan for UCS testing incorporating Prairie Creek process water should be provided.
7. Either a plan for UCS testing incorporating the cement available at the Prairie Creek Mine location, or the details of the cement used showing its characteristics are the same as that available at the Mine location, should be provided. It is further requested that a plan be provided which includes the likelihood of using alternative binder materials (such as slag and fly ash) as well as UCS testing plan incorporating those alternative materials.
8. To conduct a proper optimization of the backfill mix recipe, numerous further tests are required to ensure the proper strength for the excavations will be achieved. It is requested that a detailed plan of the future UCS testing, with the aim of optimizing the binder content and composition, be provided.
9. A plan for particle size analysis of the tailings produced from the full scale plant should be provided. As backfill properties will vary with particle size, it is important to use representative sample of the tailings.

Response

1. Actual Dense Media Separation aggregate (DMS) has been used in the 2009 tailings characterization testing (see PasteTec Report 09-1900-003, Section 2.0, page 2). However, note that the use of paste backfill at PCM is an environmental solution, and not necessary for ground support. Paste strength is an operational parameter in that the paste must be strong enough to support the weight of vehicles underground and where necessary, provide ground support.

2. DMSA chemical and mineralogical testing of actual samples from PCM were conducted in 2009, PasteTec Report 09-1900-003, Section 2.5, page 5. The mineralogy and chemical composition of the Manitoulin samples were not determined as these are not relevant to the future actual operation. For other geochemical data, refer to DAR Appendix 4.

3.

    a. Backfill is a means of both storage and as a platform for working upon (for cut and fill mining). Strictly speaking, underground disposal of backfill does not require backfill to have inherent strength, rather the 'system' for containment of the tailings shall have sufficient strength and safety factors applied to ensure continued safe extraction of remaining reserves. This system typically includes bulkheads and surrounding ground structure or other backfill, in addition to procedures and protocols. Paste backfill requires cement to minimize potential for liquefaction, requiring a nominal strength of 100 kPa.

    b. Backfill shall have a strength necessary to be self-supporting if it will be exposed by future mining where potential failure of that backfill may pose a risk to workers and property (mine, equipment, production sources, etc).

    c. In the case for strict disposal, long-term strength is not applicable.

    d. Where rock mass is sufficiently strong and ground stability studies indicate backfill is not required to maintain stability, consolidation of backfill is not applicable. Furthermore, blended paste backfill using aggregate is not subject to shrinkage due to aggregate-to-aggregate contact in the mix, hence consolidation will also be minimal.

e. During mining processes at PCM (extraction, backfill cycles and sequencing) fresh backfill will be deposited on top of or beside older backfill; voids resulting from consolidation of the old will typically be replaced by fresh backfill. It is only the consolidation voids in the very last stope in a series or sequence of stopes to be mined that will not be replaced or filled with backfill, unless deemed necessary through good engineering practices.

4. Detailed results are attached, Appendix 1

5. UCS testing with flocculant is typically done during commissioning and on-going during operations through a standard quality assurance/quality control (QA/QC) program. Flocculant is not utilized in UCS strength testing as these have been adapted from the ASTM standards for concrete. Historically, use of flocculants has been found to increase strength in cemented hydraulic fill, though good correlation is difficult. For paste backfill, flocculant is typically part of the mix resulting from tailings dewatering (thickening application) where tailings are sourced directly from the mill. Standard procedure for commissioning a mine paste backfill system is to commence backfill planning using laboratory strengths as indicative, with the knowledge that there is industry-wide good correlation to show that laboratory strengths are conservative relative to actual in-situ strengths. As backfilled stopes are exposed by future mining, the ability to possibly reduce binder content, and hence reduce costs, are evaluated by qualitative/observational techniques examining backfill failure as well as dilution within ore, quantitatively using 3-D cavity surveys to calculate backfill losses.

6. As noted above, paste strength is an operational issue. Furthermore, no significant loss of strength is expected from process water use in the backfill mix.

7. As much as possible, locally sourced materials are important for the project economics and to the local economy. At this point, the use of a binder other than Ordinary Portland Cement sourced from Edmonton does not appear to be economic. This type of cement was used in testing.

8. Again, paste strength is an operational issue, and not a safety issue. Therefore, optimizing binder content has financial significance, but no real safety significance. Previous UCS test work identified that a 3 wt% binder mix with 80% tails/20% DMS will provide just under 180 kPa. For the mining methods (Long Hole Stoping, Cut and Fill) and stope sizes currently in design, this is considered sufficient for bulk fill. For trafficability of mobile equipment, a floor will be poured with 3% binder, 50% tails/50% DMS.
9. As per 5 thru 8, laboratory testing of UCS samples using closest representative tailings has been done to develop a realistic relationship of strength, cost and risk. Laboratory test work will be followed up during operations with a QA/QC program to monitor, manage and improve economics and minimize risk.

3.0 PARKS CANADA AGENCY

Request - IR No.27

1. Provide additional information on the likelihood of using cement binder replacement products or admixtures for paste backfill. (Refer also to Information Request NRCan 2(7)).
2. Provide description/technical characteristics of the cement used in the laboratory and that expected for use in the paste backfill plant. (Refer also to Information Request NRCan 2(7)). - If differences exist between the laboratory and the paste backfill plant, it is requested that description is provided with regards to: the expected changes to the strength and geochemistry compared to that reported in the DAR; and, any additional strength and geochemistry testing that is necessary to characterize the paste.
3. Parks Canada assumes that the amount of cement in the paste will be a controlled operational parameter during operation of the paste backfill plant and that QA/QC testing will be completed to ensure the cement content in the paste is within specification tolerance. It is requested that CZN addresses the validity of this assumption.

4. Based on previous experiences in the operation of paste backfill plants at other mines, it is requested that the typical spread in operating range in cement content is detailed. Considering the typical operation spread in cement content, discuss how the cement content may change the geochemistry and leaching characteristics of the paste compared to that presented in the DAR.

Response - IR No.27

1. Typically mine operations will continue to explore means to improve economics while exercising due diligence in minimizing risk exposure to workers and property. Binder falls into this category as suppliers must also manage their product quality. Binder suppliers may change as may the type of binder. Current Ordinary Portland Cement in Canada meets very high guidelines and is generally very uniform across Canada (not so in many other parts of the world). Fly ash and ground iron blast furnace slag (BFS) may be sourced if these products are available and the economics are favourable.
2. Cement used in the laboratory was Ordinary Portland Cement – Type 10 (OPC) as well as fly ash. The fly ash was sourced from Edmonton, Alberta and was a type CI. These are very typical of what may be used at PCM and are being used (or have been used) at other operating mines (HudBay, Louvicourt, etc.). It is not anticipated that these will be significantly different.
3. Cement and/or other binders in addition to the quantity of tailings and aggregate must be carefully and accurately weighed into the final batch recipe to ensure product consistency and product strength. Note that a change in slump from 7-inches (79.5wt% solids) to 10-inches (80.5 wt% solids) requires only 1 wt% water. With such little water variation, strengths and pipeline flow characteristics will change significantly. Batch control, similar to cake recipe, is required.
4. Cement content is expected to range from approximately 2 wt% up to 3 wt% for most mining planned at PCM. There may be exceptions where higher quantities will be required, however these are not expected to be significant (<10%). Cement binders are used to stabilize soils, concrete, backfill, hazardous landfill products, etc, and have not been found to negatively impact or alter overall geochemistry significantly.

Request - IR No.28

1. Provide additional details on the required unconfined compressive strength of the paste to support underground mining operations. Refer also to Information Request NRCan 2(8)
2. Provide additional discussion on the amount of cement necessary to achieve the required unconfined compressive strength. It is requested that CZN provides an opinion on the likelihood that the amount of cement, and its characteristics, will change from the conditions reflected in the completed geochemical testing presented in the DAR. Refer also to Information Request NRCan 2(8).

Response

1. For long-hole stoping and cut and fill mining applications considered at PCM, backfill strengths less than 250 kPa are deemed appropriate. Mining widths will not be great since ore widths are relatively narrow, and this is a key factor in determining backfill strength requirements.
2. The quantity of cement required to reach strengths required for mining purposes is both an economic and operational issue. If strengths are less than required, a greater amount of cement or other binder may be used. The incremental cement addition, should it be required, is not expected to have any significant effect on paste geochemistry.

Request - IR No.29

1. Provide a detailed summary of additional tests and studies that are required to support the design and operations of the paste backfill plant. For each test and study, the summary should address the relative impact of the results on the composition of the paste, and paste geochemistry, compared to that presented in the DAR.

Response

1. Future tests required to address the design of the paste backfill plant to ensure its operability from a process dewatering aspect would consist of duplicating the tests done to date within the reports issued by PasteTec. The testing package has been

instrumental in the successful design and operation of over 30 paste backfill plants globally. It is necessary to repeat the tests to the extent that the samples received in earlier phases of work are representative. Critical tests include thickening, filtering, and UCS. Thickening and filtering are two stages of dewatering necessary to gain control of the interstitial water, while the UCS is required to predict binder consumption needed to ensure safe and economical mining practices. The composition of the paste may vary only to the extent that higher or lower strengths are needed, hence binder content, or an increase in DMS where higher strengths with lower binder content is possible. Increasing paste slump from 7-inch to 10-inch will correspondingly reduce the strength by 20 - 30%; however a reduction in friction loss by up to 2/3rd will facilitate pumping to greater distances at lower pumping costs.

Request - IR No.30

1. Provide additional discussion on the long term mechanical behaviour of the paste backfill. The response must include, but not be limited to, the importance of long-term strength and settlement/consolidation of the paste; and, the potential impact of cavities created in the underground void as a result of post-mine operation settlement of the paste on ground surface settlement, slope stabilities, and groundwater transport. Refer also to Information Request NRCan 2(3).

Response

1. Paste undergoes much less consolidation than hydraulic fill, particularly with aggregate blend (shrinkage limited by aggregate to aggregate contact). Further, tight-filling (to avoid cavities) with paste is far superior to hydraulic fill and rock fill, further limiting shrinkage/consolidation void spaces. With respect to voids created by settlement, for the most part, these will be filled by fresh backfill as mining continues either above or beside the backfill, and is necessary to permit the extraction process. Backfill for mining extraction and for tailings disposal are two essential elements that ensure voids are filled as best as possible. It is in the last stopes at the end of the mine life that any last additional settlement may not be filled; this is very likely to be a non-issue since the mine would essentially be tight filled. As noted above, paste backfill is not required for roof support or slope stability. Ground water transport through voids

is limited by the ability to tight fill with paste. In addition, groundwater studies show that the groundwater will move primarily through the fractured rock mass, not the paste.

Request - IR No.31

1. Provide professional opinion with regards to the likelihood of anticipated challenging dewatering conditions. Describe the potential impacts of the challenging dewater conditions on the operations of the paste backfill plant, proposed paste backfilling operations, and paste backfill geochemistry.

Response

1. Please see IR No. 29, above. Dewatering of the tailings as tested in 2009 suggests that filtration will be more challenging relative to other Zn and Pb operations, however not much different from gold mine tailings. Samples varied significantly between 2005 and 2009, which will require further investigation. In either case, the paste backfill process will be viable, though more expensive to implement. Again, the dewatering issue is one of economics and operations, and has no real significance in terms of geochemistry.

4.0 CLOSURE

Should you have any questions or comment on this report, please do not hesitate to contact us at your convenience.

Sincerely,
MINE PASTE ENGINEERING LTD.

Frank Palkovits, P.Eng.
Director

Attachment: Appendix 1 Details of UCS Testing

Appendix J

APPENDIX J
WATER QUALITY PREDICTIONS

The predictions of receiving water quality in Prairie Creek contained in CZN's Developer's Assessment Report (DAR) have been updated and consolidated in this document. Additional predictions have been made and are also included. Three groups of predictions are presented for the mine operating phase: main metals (cadmium, copper, lead, selenium, zinc); other metals (antimony, arsenic, iron, mercury, silver); and, other parameters (ammonia, nitrate, nitrite, phosphorous, sulphate, conductivity). For each group, four tables of predicted concentrations are presented: at Harrison Creek for average flows; at Harrison Creek for low flows; at the Park boundary for average flows; and, at the Park boundary for low flows. A group of predictions of the main metals is also included for the pre-mine and post-closure periods.

Predictions of operating phase main metals are contained in Tables J1 through J4. These tables reflect a difference in the site-specific guideline and background concentration for zinc. A minor error in the calculation of these was discovered, as explained in Annex J1 to this document.

Predictions of operating phase other metals are contained in Tables J5 through J8. Mercury concentrations for treated water were taken from a revised version of the SGS-CEMI report contained in DAR Appendix 2, attached to this document as Annex J2. Additional site-specific guidelines were also developed, as explained in the report in Annex J3. For average creek flows and low mine flows (29 L/sec), antimony concentrations exceed the site-specific guideline during the winter months. At high mine flows (100 L/sec), both antimony and arsenic exceed their site-specific guidelines during the winter months. However, there is no CCME guideline for the protection of aquatic life for antimony. The predicted arsenic concentrations are generally an order of magnitude less than the CCME guideline (0.005 mg/L). The arsenic concentrations at low creek flows, high mine flows, reach 0.002 mg/L, still well below the guideline. Hence, no significant impacts are expected. These results reflect the basis for not including these metals in the predictions given in the DAR. Treated water concentrations were much less than prevailing, generic water quality guidelines. Mercury concentrations for low creek flows marginally exceed the site-specific guideline in April. As noted in the DAR, CZN would avoid the low flow concentrations by reducing the discharge flow rate at such times.

Predictions of operating phase other parameters are contained in Tables J9 through J12. CZN is planning to use emulsion explosives during mine operations. Emulsions reportedly produce much less residue than ANFO. However, residues of ammonia, nitrate and nitrite are expected. The magnitude of such residues is dependent on blasting practices and other conditions specific to the site. CZN has approximated the magnitude of residues by referring to data available for De Beers' Snap Lake Mine. Predictions of residues for that mine were made by Golder Associates, and results are provided in Annex J4. Note that the predictions were based on Snap's intended use of emulsions for approximately three-quarters of the blasting, with ANFO used for one-quarter. Golder noted that the amount of blasting residues is highly dependent on the quantity of waste explosive entering the drainage system. They note a range of less than 2% to more than 10% waste. A waste rate of 5% was used in their assessment for both emulsion and ANFO explosives. Given that the process of explosive handling and hole charging underground is reportedly much 'cleaner' using emulsions, we believe Golder's assumption of 5% for emulsion

is very conservative. A rate of 1-2% is considered more realistic. The average ammonia loading in Snap's site discharge was predicted by Golder to be 7 mg/L as N, and nitrate 8 mg/L as N, although higher concentration peaks were also expected. A review of Snap's July 2009 SNP report (Annex J5) shows that the predictions were quite good. The monthly average ammonia concentration in the final site discharge (Station 02-17B) was 6 mg/L as N, and nitrate 13.6 mg/L as N. Therefore, the predicted concentrations for Snap were used to select treated mine water concentrations for Prairie Creek.

The Snap concentrations were reduced to approximately 85% of the original values to account for no ANFO use at Prairie Creek. As noted above, emulsions would still be expected to produce residues, but not to the extent of ANFO. The 85% value is still considered to be conservative since the explosive waste rate is expected to be much less than 5%. The 85% values were used in the predictions in Tables J9 through J12. As process water drawn from the Water Storage Pond would consist of 'aged' mine water, oxidation of the residues was assumed in the form of lower ammonia (half) but higher nitrate and nitrite in treated process water.

Predicted ammonia concentrations in Prairie Creek at Harrison Creek exceed the site-specific guideline in all months during average creek flows, and for both low and high mine flows. The CCME ammonia guideline for the protection of aquatic life is pH and temperature dependent. From our SNP sampling, Prairie Creek water consistently has a pH of 8.3. At a temperature of 0^{o}C, the guideline is 1.06 mg/L as N. At 5^{o}C it is 0.74 mg/L as N, and at 10^{o}C it is 0.44 mg/L as N. It is assumed that Prairie Creek water is near zero degrees in winter, in the 5^{o}C range in spring and fall, may reach 10^{o}C in summer. Comparing the predictions to the guidelines for the appropriate temperature, ammonia concentrations during average creek flows and low mine flows are well below the guidelines. At high mine flows, the predicted ammonia concentrations in February and March (1.13 and 1.34 mg/L) would exceed the guideline. All other months are within guidelines. This indicates that further consideration may need to be given to explosives management and the type of explosives used if mine flows approach 100 L/sec, and residues are encountered at the assumed concentrations or higher, to avoid impacts.

During low creek flows, ammonia concentrations would be significantly above CCME guidelines in the winter months for low mine flows (February and March) and high mine flows (December to April). This further underlines the need to monitor creek flows and adjust the discharge flow rate accordingly if flows are lower than average.

The CCME guideline for nitrate is 2.9 mg/L. Predicted nitrate concentrations during average creek flows are well below the guideline for all mine flows. The guideline is exceeded for low creek flows and high mine flows from February to March, but would not occur with reduced site discharge during low flow events.

For average creek flows at Harrison Creek, predicted phosphorous concentrations exceed the site-specific objective in the winter months for high mine flows. Note that these results are due to an assumed treated mine water concentration of 0.17 mg/L, whereas mine water before treatment had a concentration of <0.01 mg/L (Annex J2). Only lime was added in the treatment, therefore it appears the phosphorous detection is a result of interference in the analysis.

Sulphate concentrations marginally exceed the site-specific criterion in February and March at high mine flows. There is no CCME guideline for sulphate. Total dissolved solids (TDS) data is not available for the treated waters. Conductivity was used as a surrogate. The maximum increase in values was 31% in March for average creek flows and high mine flows.

In summary, impacts from site discharges should not occur during operations provided discharge flows are reduced from the planned discharge strategy during low flow periods, and provided the assumed ammonia loads in discharge at high mine flows do not occur.

Source terms for the backfilled mine and covered Waste Rock Pile for the post-closure period were updated by pHase Geochemistry Inc. (see Appendix G). This necessitated a revision of the Prairie Creek water quality predictions by Robertson Geoconsultants. Their revision is provided in Annex J6. Revised predictions of pre-mine and post-closure main metals at Harrison Creek are contained in Table J13, and at the Park boundary in Table J14. No site-specific criteria are exceeded during average flows. At low flows, cadmium, lead and zinc criteria are exceeded February to April. The cadmium and lead exceedences are marginal. Note that the predictions of in-stream water quality are arithmetic, and do include consideration of attenuation effects. While zinc is a relatively conservative metal, cadmium and lead are prone to attenuation, and therefore concentrations of these metals are likely to be well below the predicted values, and therefore impacts are not expected. The predicted zinc concentrations post-closure are less than pre-mine concentrations.

TABLE J1: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF MAIN METALS DURING OPERATIONS AT HARRISON CREEK, AVERAGE FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Cadmium	mg/L	0.00262	0.00001	0.000048	0.000172
Copper	mg/L	0.0021	0.0072	0.00057	0.00253
Lead	mg/L	0.0932	0.0001	0.00023	0.00113
Selenium	mg/L	0.0392	0.0033	0.00116	0.00216
Zinc	mg/L	0.039	0.017	0.00714	0.02265

Note: Treated mine water lead concentration was <0.0002 mg/L, value set at half the detection limit

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.540	0.000	0.019	0.000047	0.000795	0.000226	0.001233	0.007475
Feb	0.388	0.000	0.019	0.000046	0.000879	0.000224	0.001260	0.007600
Mar	0.315	0.000	0.019	0.000046	0.000947	0.000223	0.001282	0.007701
Apr	0.835	0.002	0.019	0.000053	0.000721	0.000444	0.001296	0.007433
May	12.608	0.020	0.019	0.000052	0.000582	0.000377	0.001223	0.007205
Jun	17.587	0.020	0.019	0.000051	0.000579	0.000335	0.001205	0.007187
Jul	12.019	0.020	0.019	0.000052	0.000583	0.000384	0.001226	0.007208
Aug	9.526	0.020	0.019	0.000053	0.000586	0.000424	0.001244	0.007226
Sep	6.446	0.019	0.019	0.000055	0.000594	0.000502	0.001278	0.007262
Oct	2.818	0.007	0.019	0.000054	0.000618	0.000458	0.001268	0.007284
Nov	1.320	0.003	0.019	0.000053	0.000667	0.000436	0.001275	0.007351
Dec	0.855	0.002	0.019	0.000053	0.000717	0.000439	0.001293	0.007427
Mean	5.438	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.540	0.000	0.090	0.000043	0.001517	0.000211	0.001466	0.008548
Feb	0.388	0.000	0.090	0.000041	0.001817	0.000206	0.001563	0.008995
Mar	0.315	0.000	0.090	0.000040	0.002044	0.000201	0.001636	0.009332
Apr	0.835	0.002	0.090	0.000050	0.001217	0.000418	0.001450	0.008166
May	12.608	0.020	0.090	0.000052	0.000619	0.000375	0.001235	0.007260
Jun	17.587	0.020	0.090	0.000051	0.000605	0.000334	0.001214	0.007226
Jul	12.019	0.020	0.090	0.000052	0.000622	0.000382	0.001239	0.007266
Aug	9.526	0.020	0.090	0.000053	0.000635	0.000422	0.001259	0.007298
Sep	6.446	0.019	0.090	0.000055	0.000665	0.000498	0.001300	0.007368
Oct	2.818	0.007	0.090	0.000053	0.000778	0.000449	0.001317	0.007521
Nov	1.320	0.003	0.090	0.000051	0.000996	0.000419	0.001377	0.007836
Dec	0.855	0.002	0.090	0.000050	0.001203	0.000414	0.001444	0.008144
Mean	5.438	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J2: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF MAIN METALS DURING OPERATIONS AT HARRISON CREEK, LOW FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Cadmium	mg/L	0.00262	0.00001	0.000048	0.000172
Copper	mg/L	0.0021	0.0072	0.00057	0.00253
Lead	mg/L	0.0932	0.0001	0.00023	0.00113
Selenium	mg/L	0.0392	0.0033	0.00116	0.00216
Zinc	mg/L	0.039	0.017	0.00714	0.02265

Note: Treated mine water lead concentration was <0.0002 mg/L, value set at half the detection limit

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.148	0.000	0.019	0.000044	0.001325	0.000215	0.001404	0.008262
Feb	0.049	0.000	0.019	0.000037	0.002423	0.000194	0.001758	0.009896
Mar	0.039	0.000	0.019	0.000036	**0.002750**	0.000187	0.001864	0.010383
Apr	0.080	0.002	0.019	0.000092	0.001853	0.002054	**0.002321**	0.009636
May	7.999	0.020	0.019	0.000054	0.000589	0.000461	0.001260	0.007243
Jun	11.019	0.020	0.019	0.000053	0.000584	0.000398	0.001232	0.007215
Jul	6.081	0.020	0.019	0.000056	0.000596	0.000533	0.001291	0.007275
Aug	5.224	0.020	0.019	0.000058	0.000600	0.000583	0.001312	0.007297
Sep	3.734	0.019	0.019	0.000061	0.000611	0.000698	0.001362	0.007350
Oct	1.571	0.007	0.019	0.000059	0.000656	0.000636	0.001352	0.007397
Nov	0.845	0.003	0.019	0.000056	0.000721	0.000549	0.001339	0.007466
Dec	0.259	0.002	0.019	0.000064	0.001031	0.000885	0.001577	0.008036
Mean	3.087	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.148	0.000	0.090	0.000034	**0.003078**	0.000181	0.001969	0.010869
Feb	0.049	0.000	0.090	0.000023	**0.004864**	0.000146	**0.002546**	0.013525
Mar	0.039	0.000	0.090	0.000021	**0.005204**	0.000139	**0.002656**	0.014031
Apr	0.080	0.002	0.090	0.000058	**0.004065**	**0.001245**	**0.002726**	0.012683
May	7.999	0.020	0.090	0.000054	0.000647	0.000458	0.001278	0.007328
Jun	11.019	0.020	0.090	0.000052	0.000626	0.000396	0.001246	0.007277
Jul	6.081	0.020	0.090	0.000056	0.000671	0.000528	0.001314	0.007386
Aug	5.224	0.020	0.090	0.000057	0.000688	0.000576	0.001339	0.007426
Sep	3.734	0.019	0.090	0.000060	0.000733	0.000687	0.001398	0.007528
Oct	1.571	0.007	0.090	0.000057	0.000934	0.000613	0.001435	0.007806
Nov	0.845	0.003	0.090	0.000053	0.001211	0.000515	0.001487	0.008188
Dec	0.259	0.002	0.090	0.000053	0.002278	0.000726	0.001925	0.009849
Mean	3.087	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J3: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF MAIN METALS DURING OPERATIONS AT PARK BOUNDARY, AVERAGE FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Cadmium	mg/L	0.00262	0.00001	0.000048	0.000172
Copper	mg/L	0.0021	0.0072	0.00057	0.00253
Lead	mg/L	0.0932	0.0001	0.00023	0.00113
Selenium	mg/L	0.0392	0.0033	0.00116	0.00216
Zinc	mg/L	0.039	0.017	0.00714	0.02265

Note: Treated mine water lead concentration was <0.0002 mg/L, value set at half the detection limit

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.602	0.000	0.019	0.000047	0.000773	0.000226	0.001226	0.007442
Feb	0.433	0.000	0.019	0.000046	0.000849	0.000225	0.001250	0.007555
Mar	0.351	0.000	0.019	0.000046	0.000911	0.000223	0.001270	0.007647
Apr	0.930	0.002	0.019	0.000053	0.000706	0.000423	0.001283	0.007404
May	14.040	0.020	0.019	0.000052	0.000581	0.000362	0.001217	0.007199
Jun	19.584	0.020	0.019	0.000051	0.000578	0.000325	0.001201	0.007182
Jul	13.384	0.020	0.019	0.000052	0.000582	0.000368	0.001220	0.007201
Aug	10.607	0.020	0.019	0.000053	0.000585	0.000404	0.001235	0.007217
Sep	7.178	0.019	0.019	0.000055	0.000591	0.000474	0.001266	0.007250
Oct	3.138	0.007	0.019	0.000053	0.000613	0.000435	0.001257	0.007270
Nov	1.470	0.003	0.019	0.000053	0.000658	0.000415	0.001264	0.007330
Dec	0.952	0.002	0.019	0.000053	0.000703	0.000419	0.001280	0.007398
Mean	6.056	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.602	0.000	0.090	0.000043	0.001433	0.000213	0.001438	0.008423
Feb	0.433	0.000	0.090	0.000041	0.001712	0.000208	0.001529	0.008838
Mar	0.351	0.000	0.090	0.000040	0.001925	0.000203	0.001597	0.009155
Apr	0.930	0.002	0.090	0.000050	0.001157	0.000400	0.001423	0.008071
May	14.040	0.020	0.090	0.000051	0.000614	0.000361	0.001227	0.007248
Jun	19.584	0.020	0.090	0.000050	0.000602	0.000324	0.001208	0.007217
Jul	13.384	0.020	0.090	0.000052	0.000616	0.000367	0.001231	0.007253
Aug	10.607	0.020	0.090	0.000052	0.000629	0.000402	0.001249	0.007282
Sep	7.178	0.019	0.090	0.000054	0.000656	0.000471	0.001286	0.007345
Oct	3.138	0.007	0.090	0.000053	0.000758	0.000428	0.001302	0.007483
Nov	1.470	0.003	0.090	0.000051	0.000955	0.000401	0.001356	0.007769
Dec	0.952	0.002	0.090	0.000050	0.001144	0.000397	0.001417	0.008051
Mean	6.056	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J4: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF MAIN METALS DURING OPERATIONS AT PARK BOUNDARY, LOW FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Cadmium	mg/L	0.00262	0.00001	0.000048	0.000172
Copper	mg/L	0.0021	0.0072	0.00057	0.00253
Lead	mg/L	0.0932	0.0001	0.00023	0.00113
Selenium	mg/L	0.0392	0.0033	0.00116	0.00216
Zinc	mg/L	0.039	0.017	0.00714	0.02265

Note: Treated mine water lead concentration was <0.0002 mg/L, value set at half the detection limit

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.165	0.000	0.019	0.000044	0.001256	0.000217	0.001381	0.008160
Feb	0.055	0.000	0.019	0.000038	0.002283	0.000196	0.001713	0.009688
Mar	0.043	0.000	0.019	0.000036	**0.002596**	0.000190	0.001814	0.010153
Apr	0.089	0.002	0.019	0.000088	0.001747	0.001904	**0.002225**	0.009430
May	8.908	0.020	0.019	0.000054	0.000588	0.000438	0.001250	0.007232
Jun	12.271	0.020	0.019	0.000052	0.000583	0.000381	0.001225	0.007207
Jul	6.772	0.020	0.019	0.000055	0.000593	0.000503	0.001278	0.007261
Aug	5.817	0.020	0.019	0.000057	0.000597	0.000547	0.001297	0.007281
Sep	4.158	0.019	0.019	0.000059	0.000607	0.000650	0.001342	0.007329
Oct	1.750	0.007	0.019	0.000058	0.000647	0.000595	0.001333	0.007371
Nov	0.941	0.003	0.019	0.000055	0.000706	0.000517	0.001321	0.007434
Dec	0.289	0.002	0.019	0.000062	0.000987	0.000823	0.001537	0.007951
Mean	3.438	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Cadmium	Copper	Lead	Selenium	Zinc
Jan	0.165	0.000	0.090	0.000035	**0.002912**	0.000184	0.001916	0.010624
Feb	0.055	0.000	0.090	0.000024	**0.004698**	0.000149	**0.002493**	0.013280
Mar	0.043	0.000	0.090	0.000022	**0.005051**	0.000142	**0.002606**	0.013803
Apr	0.089	0.002	0.090	0.000058	**0.003891**	**0.001195**	**0.002648**	0.012406
May	8.908	0.020	0.090	0.000053	0.000640	0.000435	0.001266	0.007309
Jun	12.271	0.020	0.090	0.000052	0.000621	0.000379	0.001237	0.007263
Jul	6.772	0.020	0.090	0.000055	0.000661	0.000499	0.001299	0.007362
Aug	5.817	0.020	0.090	0.000056	0.000676	0.000542	0.001321	0.007397
Sep	4.158	0.019	0.090	0.000059	0.000717	0.000641	0.001375	0.007490
Oct	1.750	0.007	0.090	0.000056	0.000899	0.000576	0.001408	0.007741
Nov	0.941	0.003	0.090	0.000052	0.001152	0.000488	0.001457	0.008091
Dec	0.289	0.002	0.090	0.000053	0.002146	0.000688	0.001866	0.009639
Mean	3.438	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J5: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER METALS DURING OPERATIONS AT HARRISON CREEK, AVERAGE FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Antimony	mg/L	0.0112	0.0229	0.000244	0.000605
Arsenic	mg/L	0.0018	0.0028	0.00025	0.00056
Iron	mg/L	0.043	0.0025	0.0486	0.229
Mercury	mg/L	0.00204	0.00001	0.00002	0.000034
Silver	mg/L	0.00004	0.00001	0.000029	0.000103

Note: Treated mine water concentration for iron was <0.005 mg/L and mercury and silver <0.00002. Values set at ha

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.540	0.000	0.019	**0.001014**	0.000337	0.047034	0.000020	0.000028
Feb	0.388	0.000	0.019	**0.001300**	0.000369	0.046450	0.000020	0.000028
Mar	0.315	0.000	0.019	**0.001534**	0.000395	0.045976	0.000019	0.000028
Apr	0.835	0.002	0.019	**0.000772**	0.000310	0.047564	0.000024	0.000029
May	12.608	0.020	0.019	0.000295	0.000256	0.048522	0.000023	0.000029
Jun	17.587	0.020	0.019	0.000281	0.000255	0.048544	0.000022	0.000029
Jul	12.019	0.020	0.019	0.000298	0.000257	0.048518	0.000023	0.000029
Aug	9.526	0.020	0.019	0.000312	0.000258	0.048497	0.000024	0.000029
Sep	6.446	0.019	0.019	0.000342	0.000262	0.048448	0.000026	0.000029
Oct	2.818	0.007	0.019	0.000422	0.000271	0.048278	0.000025	0.000029
Nov	1.320	0.003	0.019	0.000589	0.000290	0.047935	0.000024	0.000029
Dec	0.855	0.002	0.019	**0.000760**	0.000309	0.047588	0.000024	0.000029
Mean	5.438	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.540	0.000	0.090	**0.003479**	**0.000614**	0.042017	0.000019	0.000026
Feb	0.388	0.000	0.090	**0.004505**	**0.000730**	0.039929	0.000018	0.000025
Mar	0.315	0.000	0.090	**0.005282**	**0.000817**	0.038350	0.000018	0.000025
Apr	0.835	0.002	0.090	**0.002467**	0.000501	0.044113	0.000023	0.000027
May	12.608	0.020	0.090	0.000422	0.000270	0.048265	0.000023	0.000029
Jun	17.587	0.020	0.090	0.000372	0.000265	0.048359	0.000022	0.000029
Jul	12.019	0.020	0.090	0.000430	0.000271	0.048249	0.000023	0.000029
Aug	9.526	0.020	0.090	0.000478	0.000277	0.048158	0.000024	0.000029
Sep	6.446	0.019	0.090	0.000587	0.000290	0.047951	0.000026	0.000029
Oct	2.818	0.007	0.090	**0.000970**	0.000332	0.047163	0.000025	0.000028
Nov	1.320	0.003	0.090	**0.001711**	0.000416	0.045651	0.000024	0.000028
Dec	0.855	0.002	0.090	**0.002420**	0.000496	0.044208	0.000023	0.000027
Mean	5.438	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J6: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER METALS DURING OPERATIONS AT HARRISON CREEK, LOW FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Antimony	mg/L	0.0112	0.0229	0.000244	0.000605
Arsenic	mg/L	0.0018	0.0028	0.00025	0.00056
Iron	mg/L	0.043	0.0025	0.0486	0.229
Mercury	mg/L	0.00204	0.00001	0.00002	0.000034
Silver	mg/L	0.00004	0.00001	0.000029	0.000103

Note: Treated mine water concentration for iron was <0.005 mg/L and mercury and silver <0.00002. Values set at ha

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.148	0.000	0.019	**0.002822**	0.000540	0.043353	0.000019	0.000027
Feb	0.049	0.000	0.019	**0.006577**	**0.000963**	0.035714	0.000017	0.000024
Mar	0.039	0.000	0.019	**0.007695**	**0.001089**	0.033439	0.000017	0.000023
Apr	0.080	0.002	0.019	**0.004741**	**0.000763**	0.039781	**0.000058**	0.000026
May	7.999	0.020	0.019	0.000325	0.000260	0.048477	0.000025	0.000029
Jun	11.019	0.020	0.019	0.000303	0.000257	0.048511	0.000024	0.000029
Jul	6.081	0.020	0.019	0.000350	0.000263	0.048439	0.000027	0.000029
Aug	5.224	0.020	0.019	0.000367	0.000265	0.048412	0.000028	0.000029
Sep	3.734	0.019	0.019	0.000413	0.000271	0.048340	0.000030	0.000029
Oct	1.571	0.007	0.019	0.000562	0.000287	0.048027	0.000029	0.000029
Nov	0.845	0.003	0.019	**0.000779**	0.000311	0.047570	0.000027	0.000029
Dec	0.259	0.002	0.019	**0.001859**	0.000434	0.045434	0.000034	0.000028
Mean	3.087	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.148	0.000	0.090	**0.008813**	**0.001215**	0.031163	0.000016	0.000022
Feb	0.049	0.000	0.090	**0.014916**	**0.001901**	0.018746	0.000014	0.000017
Mar	0.039	0.000	0.090	**0.016079**	**0.002032**	0.016380	0.000013	0.000016
Apr	0.080	0.002	0.090	**0.012255**	**0.001606**	0.024354	**0.000038**	0.000019
May	7.999	0.020	0.090	0.000522	0.000282	0.048075	0.000025	0.000029
Jun	11.019	0.020	0.090	0.000447	0.000273	0.048217	0.000024	0.000029
Jul	6.081	0.020	0.090	**0.000609**	0.000292	0.047912	0.000026	0.000029
Aug	5.224	0.020	0.090	**0.000667**	0.000299	0.047801	0.000027	0.000029
Sep	3.734	0.019	0.090	**0.000829**	0.000317	0.047493	0.000030	0.000029
Oct	1.571	0.007	0.090	**0.001512**	0.000394	0.046090	0.000028	0.000028
Nov	0.845	0.003	0.090	**0.002453**	0.000500	0.044158	0.000026	0.000027
Dec	0.259	0.002	0.090	**0.006113**	**0.000912**	0.036753	0.000029	0.000024
Mean	3.087	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J7: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER METALS DURING OPERATIONS AT PARK BOUNDARY, AVERAGE FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Antimony	mg/L	0.0112	0.0229	0.000244	0.000605
Arsenic	mg/L	0.0018	0.0028	0.00025	0.00056
Iron	mg/L	0.043	0.0025	0.0486	0.229
Mercury	mg/L	0.00204	0.00001	0.00002	0.000034
Silver	mg/L	0.00004	0.00001	0.000029	0.000103

Note: Treated mine water concentration for iron was <0.005 mg/L and mercury and silver <0.00002. Values set at ha

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.602	0.000	0.019	**0.000938**	0.000328	0.047189	0.000020	0.000028
Feb	0.433	0.000	0.019	**0.001197**	0.000357	0.046660	0.000020	0.000028
Mar	0.351	0.000	0.019	**0.001409**	0.000381	0.046230	0.000019	0.000028
Apr	0.930	0.002	0.019	**0.000720**	0.000304	0.047667	0.000024	0.000029
May	14.040	0.020	0.019	0.000290	0.000256	0.048530	0.000023	0.000029
Jun	19.584	0.020	0.019	0.000277	0.000254	0.048550	0.000022	0.000029
Jul	13.384	0.020	0.019	0.000292	0.000256	0.048526	0.000023	0.000029
Aug	10.607	0.020	0.019	0.000305	0.000257	0.048507	0.000024	0.000029
Sep	7.178	0.019	0.019	0.000333	0.000261	0.048464	0.000025	0.000029
Oct	3.138	0.007	0.019	0.000404	0.000269	0.048311	0.000024	0.000029
Nov	1.470	0.003	0.019	0.000555	0.000286	0.048002	0.000024	0.000029
Dec	0.952	0.002	0.019	**0.000709**	0.000303	0.047689	0.000024	0.000029
Mean	6.056	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.602	0.000	0.090	**0.003192**	**0.000582**	0.042601	0.000019	0.000027
Feb	0.433	0.000	0.090	**0.004146**	**0.000689**	0.040661	0.000018	0.000026
Mar	0.351	0.000	0.090	**0.004873**	**0.000771**	0.039181	0.000018	0.000025
Apr	0.930	0.002	0.090	**0.002261**	0.000478	0.044529	0.000023	0.000027
May	14.040	0.020	0.090	0.000404	0.000268	0.048299	0.000023	0.000029
Jun	19.584	0.020	0.090	0.000359	0.000263	0.048384	0.000022	0.000029
Jul	13.384	0.020	0.090	0.000411	0.000269	0.048284	0.000023	0.000029
Aug	10.607	0.020	0.090	0.000455	0.000274	0.048202	0.000024	0.000029
Sep	7.178	0.019	0.090	0.000552	0.000286	0.048016	0.000025	0.000029
Oct	3.138	0.007	0.090	**0.000898**	0.000324	0.047306	0.000024	0.000028
Nov	1.470	0.003	0.090	**0.001570**	0.000400	0.045934	0.000023	0.000028
Dec	0.952	0.002	0.090	**0.002218**	0.000473	0.044616	0.000023	0.000027
Mean	6.056	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J8: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER METALS DURING OPERATIONS AT PARK BOUNDARY, LOW FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Antimony	mg/L	0.0112	0.0229	0.000244	0.000605
Arsenic	mg/L	0.0018	0.0028	0.00025	0.00056
Iron	mg/L	0.043	0.0025	0.0486	0.229
Mercury	mg/L	0.00204	0.00001	0.00002	0.000034
Silver	mg/L	0.00004	0.00001	0.000029	0.000103

Note: Treated mine water concentration for iron was <0.005 mg/L and mercury and silver <0.00002. Values set at ha

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.165	0.000	0.019	**0.002587**	0.000514	0.043833	0.000019	0.000027
Feb	0.055	0.000	0.019	**0.006098**	**0.000909**	0.036689	0.000017	0.000024
Mar	0.043	0.000	0.019	**0.007168**	**0.001029**	0.034512	0.000017	0.000023
Apr	0.089	0.002	0.019	**0.004371**	**0.000720**	0.040508	0.000055	0.000026
May	8.908	0.020	0.019	0.000317	0.000259	0.048490	0.000024	0.000029
Jun	12.271	0.020	0.019	0.000297	0.000256	0.048520	0.000023	0.000029
Jul	6.772	0.020	0.019	0.000339	0.000262	0.048455	0.000026	0.000029
Aug	5.817	0.020	0.019	0.000355	0.000264	0.048431	0.000027	0.000029
Sep	4.158	0.019	0.019	0.000396	0.000269	0.048366	0.000029	0.000029
Oct	1.750	0.007	0.019	0.000530	0.000283	0.048085	0.000028	0.000029
Nov	0.941	0.003	0.019	**0.000725**	0.000305	0.047673	0.000026	0.000029
Dec	0.289	0.002	0.019	**0.001705**	0.000417	0.045735	0.000032	0.000028
Mean	3.438	0.0094	0.019					

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)				
Month	PC	Process	Mine	Antimony	Arsenic	Iron	Mercury	Silver
Jan	0.165	0.000	0.090	**0.008248**	**0.001151**	0.032313	0.000016	0.000022
Feb	0.055	0.000	0.090	**0.014352**	**0.001838**	0.019894	0.000014	0.000017
Mar	0.043	0.000	0.090	**0.015555**	**0.001973**	0.017445	0.000013	0.000016
Apr	0.089	0.002	0.090	**0.011654**	**0.001538**	0.025567	**0.000037**	0.000020
May	8.908	0.020	0.090	0.000494	0.000279	0.048127	0.000024	0.000029
Jun	12.271	0.020	0.090	0.000426	0.000271	0.048256	0.000023	0.000029
Jul	6.772	0.020	0.090	0.000572	0.000288	0.047981	0.000026	0.000029
Aug	5.817	0.020	0.090	**0.000625**	0.000294	0.047881	0.000027	0.000029
Sep	4.158	0.019	0.090	**0.000771**	0.000311	0.047603	0.000029	0.000029
Oct	1.750	0.007	0.090	**0.001390**	0.000380	0.046332	0.000027	0.000028
Nov	0.941	0.003	0.090	**0.002248**	0.000477	0.044570	0.000025	0.000027
Dec	0.289	0.002	0.090	**0.005659**	**0.000861**	0.037669	0.000028	0.000025
Mean	3.438	0.0094	0.090					

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J9: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER PARAMETERS DURING OPERATIONS AT HARRISON CREEK, AVERAGE FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Ammonia	mg/L N	3	6	0.005	0.013
Nitrate	mg/L N	10	7	0.12	0.23
Nitrite	mg/L N	1	0.2	0.12	1.03
Phosphorous	mg/L	0.721	0.17	0.007	0.016
Sulphate	mg/L	200	400	67.8	119.3
Conductivity	µS/cm	3250	1200	500	

Note: Concentrations of conductivity and sulphate in treated rocess water based on DAR Table 6-7, and in treated mine water on Tables 3-4 to 3-7 in DAR Appendix 1A. Phosphorous concentrations from DAR Appendix 2.

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.540	0.000	0.019	**0.209**	**0.354**	0.123	0.013	79.1	524
Feb	0.388	0.000	0.019	**0.285**	**0.441**	0.124	0.015	83.3	533
Mar	0.315	0.000	0.019	**0.346**	**0.512**	0.125	0.016	86.7	540
Apr	0.835	0.002	0.019	**0.145**	**0.296**	0.124	0.012	75.5	522
May	12.608	0.020	0.019	**0.019**	0.146	0.122	0.008	68.5	505
Jun	17.587	0.020	0.019	**0.015**	0.139	0.121	0.008	68.3	504
Jul	12.019	0.020	0.019	**0.019**	0.147	0.122	0.008	68.5	506
Aug	9.526	0.020	0.019	**0.023**	0.154	0.122	0.009	68.7	507
Sep	6.446	0.019	0.019	**0.031**	0.169	0.123	0.010	69.2	510
Oct	2.818	0.007	0.019	**0.052**	0.190	0.123	0.010	70.3	511
Nov	1.320	0.003	0.019	**0.097**	**0.240**	0.123	0.011	72.8	516
Dec	0.855	0.002	0.019	**0.142**	**0.292**	0.124	0.012	75.3	521
Mean	5.438	0.0094	0.019						

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.540	0.000	0.090	**0.861**	**1.102**	0.131	**0.030**	115.2	600
Feb	0.388	0.000	0.090	**1.133**	**1.414**	0.135	**0.038**	**130.3**	632
Mar	0.315	0.000	0.090	**1.338**	**1.650**	0.138	**0.043**	**141.7**	656
Apr	0.835	0.002	0.090	**0.593**	**0.809**	0.130	**0.024**	100.3	574
May	12.608	0.020	0.090	**0.052**	0.184	0.122	0.009	70.4	509
Jun	17.587	0.020	0.090	**0.039**	0.166	0.121	0.009	69.6	507
Jul	12.019	0.020	0.090	**0.054**	0.187	0.122	0.009	70.5	510
Aug	9.526	0.020	0.090	**0.067**	0.205	0.123	0.010	71.2	512
Sep	6.446	0.019	0.090	**0.096**	**0.243**	0.124	0.011	72.7	518
Oct	2.818	0.007	0.090	**0.197**	**0.356**	0.125	0.014	78.4	528
Nov	1.320	0.003	0.090	**0.393**	**0.579**	0.127	**0.019**	89.2	550
Dec	0.855	0.002	0.090	**0.581**	**0.795**	0.129	**0.024**	99.6	572
Mean	5.438	0.0094	0.090						

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J10: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER PARAMETERS DURING OPERATIONS AT HARRISON CREEK, LOW FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Ammonia	mg/L N	3	6	0.005	0.013
Nitrate	mg/L N	10	7	0.12	0.23
Nitrite	mg/L N	1	0.2	0.12	1.03
Phosphorous	mg/L	0.721	0.17	0.007	0.016
Sulphate	mg/L	200	400	67.8	119.3
Conductivity	µS/cm	3250	1200	500	

Note: Concentrations of conductivity and sulphate in treated rocess water based on DAR Table 6-7, and in treated mine water on Tables 3-4 to 3-7 in DAR Appendix 1A.

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.148	0.000	0.019	**0.687**	**0.903**	0.129	**0.026**	105.6	580
Feb	0.049	0.000	0.019	**1.681**	**2.043**	0.142	**0.053**	160.7	696
Mar	0.039	0.000	0.019	**1.977**	**2.383**	0.146	**0.061**	177.1	730
Apr	0.080	0.002	0.019	**1.197**	**1.616**	0.153	**0.052**	133.2	687
May	7.999	0.020	0.019	**0.027**	0.161	0.122	0.009	68.9	508
Jun	11.019	0.020	0.019	**0.021**	0.150	0.122	0.009	68.6	506
Jul	6.081	0.020	0.019	**0.033**	0.174	0.123	0.010	69.3	511
Aug	5.224	0.020	0.019	**0.038**	0.182	0.124	0.010	69.5	513
Sep	3.734	0.019	0.019	**0.050**	0.204	0.125	0.011	70.1	517
Oct	1.571	0.007	0.019	**0.089**	**0.245**	0.125	0.012	72.3	520
Nov	0.845	0.003	0.019	**0.147**	**0.305**	0.125	0.013	75.5	525
Dec	0.259	0.002	0.019	**0.433**	**0.657**	0.132	**0.023**	91.3	567
Mean	3.087	0.0094	0.019						

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.148	0.000	0.090	**2.273**	**2.722**	0.150	**0.069**	**193.5**	765
Feb	0.049	0.000	0.090	**3.887**	**4.575**	0.172	**0.113**	**282.9**	953
Mar	0.039	0.000	0.090	**4.195**	**4.929**	0.176	**0.121**	**300.0**	989
Apr	0.080	0.002	0.090	**3.184**	**3.844**	0.172	**0.101**	**243.6**	899
May	7.999	0.020	0.090	**0.079**	0.221	0.123	0.011	71.8	515
Jun	11.019	0.020	0.090	**0.059**	0.193	0.122	0.010	70.7	511
Jul	6.081	0.020	0.090	**0.102**	**0.252**	0.124	0.012	73.1	519
Aug	5.224	0.020	0.090	**0.117**	**0.273**	0.125	0.012	73.9	522
Sep	3.734	0.019	0.090	**0.160**	**0.330**	0.126	0.014	76.2	530
Oct	1.571	0.007	0.090	**0.341**	**0.533**	0.128	**0.019**	86.3	549
Nov	0.845	0.003	0.090	**0.590**	**0.812**	0.130	**0.025**	100.1	576
Dec	0.259	0.002	0.090	**1.559**	**1.940**	0.146	**0.053**	**153.7**	695
Mean	3.087	0.0094	0.090						

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J11: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER PARAMETERS DURING OPERATIONS AT PARK BOUNDARY, AVERAGE FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Ammonia	mg/L N	3	6	0.005	0.013
Nitrate	mg/L N	10	7	0.12	0.23
Nitrite	mg/L N	1	0.2	0.12	1.03
Phosphorous	mg/L	0.721	0.17	0.007	0.016
Sulphate	mg/L	200	400	67.8	119.3
Conductivity	µS/cm	3250	1200	500	

Note: Concentrations of conductivity and sulphate in treated rocess water based on DAR Table 6-7, and in treated mine water on Tables 3-4 to 3-7 in DAR Appendix 1A.

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.602	0.000	0.019	**0.189**	**0.331**	0.122	0.012	78.0	521
Feb	0.433	0.000	0.019	**0.257**	**0.409**	0.123	0.014	81.8	529
Mar	0.351	0.000	0.019	**0.313**	**0.474**	0.124	0.015	84.9	536
Apr	0.930	0.002	0.019	**0.131**	**0.278**	0.123	0.012	74.7	520
May	14.040	0.020	0.019	**0.017**	0.143	0.121	0.008	68.4	505
Jun	19.584	0.020	0.019	**0.014**	0.137	0.121	0.008	68.3	503
Jul	13.384	0.020	0.019	**0.018**	0.144	0.121	0.008	68.5	505
Aug	10.607	0.020	0.019	**0.021**	0.151	0.122	0.009	68.6	506
Sep	7.178	0.019	0.019	**0.029**	0.164	0.123	0.009	69.0	509
Oct	3.138	0.007	0.019	**0.048**	0.183	0.122	0.010	70.1	510
Nov	1.470	0.003	0.019	**0.087**	0.228	0.123	0.011	72.3	514
Dec	0.952	0.002	0.019	**0.128**	**0.275**	0.123	0.012	74.6	519
Mean	6.056	0.0094	0.019						

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.602	0.000	0.090	**0.785**	**1.015**	0.130	**0.028**	111.0	591
Feb	0.433	0.000	0.090	**1.037**	**1.305**	0.134	**0.035**	**125.0**	621
Mar	0.351	0.000	0.090	**1.230**	**1.526**	0.136	**0.040**	**135.7**	643
Apr	0.930	0.002	0.090	**0.539**	**0.745**	0.129	**0.023**	97.3	567
May	14.040	0.020	0.090	**0.047**	0.178	0.122	0.009	70.1	508
Jun	19.584	0.020	0.090	**0.035**	0.161	0.121	0.008	69.5	506
Jul	13.384	0.020	0.090	**0.049**	0.181	0.122	0.009	70.2	509
Aug	10.607	0.020	0.090	**0.061**	0.196	0.122	0.010	70.8	511
Sep	7.178	0.019	0.090	**0.087**	**0.231**	0.123	0.011	72.2	516
Oct	3.138	0.007	0.090	**0.178**	**0.333**	0.124	0.013	77.3	525
Nov	1.470	0.003	0.090	**0.356**	**0.535**	0.126	**0.018**	87.2	546
Dec	0.952	0.002	0.090	**0.527**	**0.732**	0.129	**0.022**	96.7	566
Mean	6.056	0.0094	0.090						

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J12: IN-STREAM PRAIRIE CREEK CONCENTRATIONS OF OTHER PARAMETERS DURING OPERATIONS AT PARK BOUNDARY, LOW FLOWS

		Treated Water		Prairie	In-Stream
		Process	Mine	Creek	Objective
Ammonia	mg/L N	3	6	0.005	0.013
Nitrate	mg/L N	10	7	0.12	0.23
Nitrite	mg/L N	1	0.2	0.12	1.03
Phosphorous	mg/L	0.721	0.17	0.007	0.016
Sulphate	mg/L	200	400	67.8	119.3
Conductivity	µS/cm	3250	1200	500	

Note: Concentrations of conductivity and sulphate in treated rocess water based on DAR Table 6-7, and in treated mine water on Tables 3-4 to 3-7 in DAR Appendix 1A.

Mine Drainage Flow 29 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.165	0.000	0.019	**0.624**	**0.830**	0.128	**0.024**	102.1	572
Feb	0.055	0.000	0.019	**1.544**	**1.886**	0.141	**0.049**	153.1	680
Mar	0.043	0.000	0.019	**1.842**	**2.228**	0.145	**0.057**	169.6	715
Apr	0.089	0.002	0.019	**1.095**	**1.488**	0.150	**0.048**	127.6	671
May	8.908	0.020	0.019	**0.024**	0.157	0.122	0.009	68.8	508
Jun	12.271	0.020	0.019	**0.019**	0.147	0.122	0.008	68.5	506
Jul	6.772	0.020	0.019	**0.031**	0.168	0.123	0.010	69.1	510
Aug	5.817	0.020	0.019	**0.035**	0.176	0.123	0.010	69.3	512
Sep	4.158	0.019	0.019	**0.046**	0.196	0.124	0.011	69.9	516
Oct	1.750	0.007	0.019	**0.081**	**0.233**	0.124	0.012	71.9	518
Nov	0.941	0.003	0.019	**0.133**	**0.287**	0.124	0.012	74.8	522
Dec	0.289	0.002	0.019	**0.392**	**0.605**	0.131	**0.022**	89.0	561
Mean	3.438	0.0094	0.019						

Mine Drainage Flow 100 L/sec

	Flows (m^3/sec)			In-Stream Concentrations (mg/L)					
Month	PC	Process	Mine	Ammonia	Nitrate	Nitrite	Phosphorous	Sulphate	Cond.
Jan	0.165	0.000	0.090	**2.121**	**2.548**	0.148	**0.065**	**185.0**	747
Feb	0.055	0.000	0.090	**3.726**	**4.390**	0.170	**0.108**	**274.0**	934
Mar	0.043	0.000	0.090	**4.062**	**4.776**	0.174	**0.117**	**292.6**	974
Apr	0.089	0.002	0.090	**3.019**	**3.650**	0.170	**0.096**	**234.4**	878
May	8.908	0.020	0.090	**0.071**	0.211	0.123	0.010	71.4	513
Jun	12.271	0.020	0.090	**0.053**	0.186	0.122	0.009	70.4	510
Jul	6.772	0.020	0.090	**0.092**	**0.239**	0.124	0.011	72.5	517
Aug	5.817	0.020	0.090	**0.106**	**0.258**	0.124	0.012	73.3	520
Sep	4.158	0.019	0.090	**0.145**	**0.309**	0.126	0.014	75.4	527
Oct	1.750	0.007	0.090	**0.308**	**0.493**	0.127	**0.018**	84.5	545
Nov	0.941	0.003	0.090	**0.535**	**0.748**	0.130	**0.023**	97.1	569
Dec	0.289	0.002	0.090	**1.437**	**1.797**	0.144	**0.049**	**147.0**	680
Mean	3.438	0.0094	0.090						

Bold = Value exceeds site specific objective

Note: Mine water flow for treatment is approximately 10 L/sec less than total mine drainage flow

TABLE J13: PREDICTED IN-STREAM CONCENTRATIONS OF MAIN METALS POST-MINE CLOSURE AND PRE-MINE
PRAIRIE CREEK AT HARRISON CREEK

	Post-Mine Closure						Pre-Mine					
Month	Cadmium	Copper	Lead	Selenium	Zinc	SO_4	Cadmium	Copper	Lead	Selenium	Zinc	SO_4
	Mean Prairie Creek Flows						**Mean Prairie Creek Flows**					
Jan	0.077	0.62	0.46	1.19	15.33	93	0.052	0.57	0.35	1.19	16.56	93
Feb	0.087	0.64	0.51	1.20	17.00	97	0.053	0.57	0.36	1.19	18.40	97
Mar	0.094	0.65	0.55	1.20	20.50	100	0.055	0.58	0.38	1.19	22.01	100
Apr	0.065	0.60	0.38	1.19	11.08	81	0.051	0.57	0.32	1.18	12.12	81
May	0.058	0.59	0.30	1.19	7.01	36	0.049	0.56	0.29	1.18	7.53	36
Jun	0.055	0.58	0.30	1.19	6.87	46	0.049	0.56	0.29	1.18	7.48	46
Jul	0.055	0.58	0.31	1.19	7.09	54	0.049	0.57	0.29	1.18	7.80	55
Aug	0.056	0.58	0.31	1.19	7.34	60	0.049	0.57	0.29	1.18	8.08	60
Sep	0.058	0.58	0.32	1.19	7.66	63	0.049	0.57	0.30	1.18	8.40	63
Oct	0.074	0.62	0.34	1.20	9.47	85	0.050	0.57	0.31	1.18	9.85	85
Nov	0.066	0.60	0.37	1.19	10.04	87	0.050	0.57	0.31	1.18	10.95	88
Dec	0.069	0.60	0.41	1.19	12.69	92	0.051	0.57	0.33	1.19	13.78	92
	Low Prairie Creek Flows						**Low Prairie Creek Flows**					
Jan	0.100	0.67	0.59	1.20	22.58	94	0.056	0.58	0.39	1.19	**24.20**	94
Feb	**0.196**	0.85	**1.14**	1.25	**47.22**	100	0.067	0.60	0.55	1.20	**50.48**	101
Mar	**0.225**	0.91	**1.33**	1.26	**61.45**	104	0.073	0.61	0.64	1.20	**65.14**	105
Apr	**0.133**	0.73	0.78	1.22	**30.46**	83	0.059	0.59	0.44	1.19	**32.63**	84
May	0.056	0.58	0.30	1.19	6.88	36	0.049	0.56	0.29	1.18	7.45	36
Jun	0.054	0.58	0.30	1.19	6.78	46	0.049	0.56	0.29	1.18	7.42	46
Jul	0.055	0.58	0.31	1.19	7.08	54	0.049	0.57	0.29	1.18	7.80	54
Aug	0.055	0.58	0.31	1.19	7.26	60	0.049	0.57	0.29	1.18	8.00	60
Sep	0.056	0.58	0.32	1.19	7.49	63	0.049	0.57	0.30	1.18	8.23	63
Oct	0.071	0.62	0.34	1.20	9.15	85	0.049	0.57	0.30	1.18	9.58	85
Nov	0.062	0.59	0.35	1.19	9.25	87	0.050	0.57	0.31	1.18	10.13	87
Dec	0.081	0.63	0.48	1.20	16.73	93	0.053	0.57	0.36	1.19	18.04	93
SRC objectives	**0.172**	**2.53**	**1.13**	**2.16**	**22.65**	**n/a**	**0.172**	**2.53**	**1.13**	**2.16**	**22.65**	**n/a**

Bold = Value exceeds site specific objective

Concentrations in µg/L

TABLE J14: PREDICTED IN-STREAM CONCENTRATIONS OF MAIN METALS POST-MINE CLOSURE AND PRE-MINE
PRAIRIE CREEK AT PARK BOUNDARY

	Post-Mine Closure						Pre-Mine					
Month	Cadmium	Copper	Lead	Selenium	Zinc	SO_4	Cadmium	Copper	Lead	Selenium	Zinc	SO_4
	Mean Prairie Creek Flows						**Mean Prairie Creek Flows**					
Jan	0.074	0.62	0.43	1.19	15.18	93	0.052	0.57	0.33	1.18	15.61	93
Feb	0.083	0.63	0.48	1.19	16.67	96	0.053	0.57	0.34	1.18	17.26	97
Mar	0.089	0.64	0.52	1.20	19.82	99	0.054	0.58	0.36	1.19	20.51	100
Apr	0.063	0.59	0.37	1.19	11.36	80	0.050	0.57	0.31	1.18	11.61	81
May	0.057	0.59	0.29	1.19	7.70	36	0.049	0.57	0.29	1.18	7.49	36
Jun	0.054	0.58	0.29	1.19	7.57	46	0.049	0.57	0.28	1.18	7.44	46
Jul	0.054	0.58	0.30	1.18	7.77	54	0.049	0.57	0.29	1.18	7.74	54
Aug	0.055	0.58	0.31	1.18	7.99	60	0.049	0.57	0.29	1.18	7.98	60
Sep	0.057	0.58	0.31	1.19	8.29	63	0.049	0.57	0.29	1.18	8.27	63
Oct	0.071	0.62	0.33	1.20	9.91	85	0.049	0.57	0.30	1.18	9.58	85
Nov	0.064	0.60	0.36	1.19	10.42	87	0.050	0.57	0.30	1.18	10.57	87
Dec	0.066	0.60	0.39	1.19	12.81	92	0.051	0.57	0.32	1.18	13.11	92
	Low Prairie Creek Flows						**Low Prairie Creek Flows**					
Jan	0.095	0.66	0.56	1.20	21.70	94	0.055	0.58	0.38	1.19	22.48	94
Feb	**0.182**	0.83	1.05	1.24	**43.92**	99	0.065	0.60	0.52	1.19	**46.20**	100
Mar	**0.208**	0.88	1.22	1.25	**56.81**	103	0.071	0.61	0.60	1.20	**59.49**	105
Apr	**0.124**	0.71	0.72	1.21	**28.79**	83	0.058	0.58	0.42	1.19	**30.09**	83
May	0.055	0.58	0.29	1.19	7.59	36	0.048	0.57	0.28	1.18	7.42	36
Jun	0.053	0.58	0.29	1.18	7.49	46	0.048	0.57	0.28	1.18	7.39	46
Jul	0.054	0.58	0.30	1.18	7.76	54	0.049	0.57	0.29	1.18	7.73	54
Aug	0.055	0.58	0.30	1.18	7.92	60	0.049	0.57	0.29	1.18	7.91	60
Sep	0.055	0.58	0.31	1.18	8.13	63	0.049	0.57	0.29	1.18	8.12	63
Oct	0.069	0.61	0.33	1.20	9.63	85	0.049	0.57	0.30	1.18	9.33	85
Nov	0.061	0.59	0.34	1.19	9.71	87	0.050	0.57	0.30	1.18	9.82	87
Dec	0.078	0.62	0.46	1.19	16.44	92	0.053	0.57	0.34	1.18	16.94	93
SRC objectives	**0.172**	**2.53**	**1.13**	**2.16**	**22.65**	**n/a**	**0.172**	**2.53**	**1.13**	**2.16**	**22.65**	**n/a**

Bold = Value exceeds site specific objective

Concentrations in µg/L

Annex J1

Memo

Date: September 1, 2010

To: David Harpley, VP Environment and Permitting Affairs, Canadian Zinc Corp.

From: Andrew Harwood, Lead Research Scientist, Saskatchewan Research Council (SRC)

Re: Update to Site-Specific Water Quality Objective for Zinc in Prairie Creek, NWT

Dear David,

As I mentioned in earlier correspondence, while I was deriving new site-specific water quality objectives for antimony, arsenic, iron, silver, sulphate, ammonia, nitrate, nitrite, phosphorus, and total dissolved solids, I noticed that some of the values used to calculate the zinc objective were included in the calculations in the wrong units (mg/L instead of µg/L). The zinc site-specific objective derived in our report to you dated March 2010 (SRC Publication No. 10432-1E10) should therefore be updated from 21.95 µg/L to 22.65 µg/L. Background concentrations of zinc in Prairie Creek should also be revised for load modeling purposes. The background concentration for zinc used for the March 2010 report was 6.37 µg/L, but the load modeling should instead use a background concentration of 7.14 µg/L.

Table 1 shows the zinc concentrations updated since the March 2010 report (highlighted in grey), along with the revised average background concentration in Prairie Creek (7.14 µg/L) and the revised site-specific objective based on the mean + 2 standard deviations (22.65 µg/L). This revised site-specific objective is still below the existing CCME guideline for zinc (30.00 µg/L). If the site-specific objectives are to be adopted, 22.65 µg/L of zinc should be used instead of 21.95 µg/L.

Tables 2 and 3 show the revised estimated in-stream metal concentrations given the updated background concentration of zinc in Prairie Creek and based on water samples following batch treatment simulations and samples sent for toxicity testing, respectively. These tables show the revised load modeling for Prairie Creek and replace Tables 4 and 7 from the March 2010 report. While estimated in-stream zinc concentrations are higher than originally reported given the higher background concentration used in the model, there are still no exceedances of the site-specific objective for zinc.

Table 1: Prairie Creek sampling points from upstream of the mine site and the adjacent sub-basin, with the updated values for zinc.

Data Source	Station	Sample Date	Hardness (mg/L as CaCO3)	Total Cl (mg/L)	Total Cd (µg/L)	Total Cu (µg/L)	Total Pb (µg/L)	Total Hg (µg/L)	Total Se (µg/L)	Total Zn (µg/L)
2008 SNP Results (Canadian Zinc)	3-10 PCU	2-Jul-2008	226		0.03	0.60	0.30	0.01	1.10	5.00
		30-Jul-2008	259		0.04	0.60	0.70	0.01	1.20	11.00
		25-Nov-2008	327		0.02	0.30	0.10	0.01	1.30	5.00
		1-Oct-2008	341		0.01	0.30	0.20	0.01	1.50	6.00
		3-Sep-2008	297		0.03	0.40	0.40	0.01	1.10	10.00
2008 SNP Results (Canadian Zinc)	3-11 PCD	2-Jul-2008	229		0.03	0.60	0.30	0.01	1.00	15.00
		30-Jul-2008	284		0.04	0.40	0.40	0.01	1.40	13.00
		11-Nov-2008	318		0.11	1.00	0.50	0.01	1.50	19.00
		25-Nov-2008	333		0.04	0.40	0.20	0.01	1.20	8.00
		1-Oct-2008	350		0.03	0.40	0.40	0.01	1.60	10.00
		3-Sep-2008	302		0.05	0.40	0.40	0.01	1.10	11.00
A953718-R_10-56-10_N001 (Canadian Zinc)	FAST CREEK	9-Oct-2009			0.03	0.30	0.10	0.04	1.20	2.50
	FUNERAL CREEK	9-Oct-2009			0.08	0.50	0.30	0.02	1.10	38.00
	PRAIRIE CREEK	9-Oct-2009			0.03	0.40	0.10	0.03	1.40	20.00
Canadian Zinc	Funeral Creek	30-Aug-2005	250		0.05		0.25	0.025	0.50	6.00
		29-May-2005	150		0.05		0.25	0.025	0.50	7.00
		18-Oct-2005	250		0.05		0.25	0.025	0.50	32.00
	Prairie Creek above Airstrip	30-Aug-2005	260		0.05		0.25	0.025	1.00	2.50
		22-Jun-2004	156		0.5					4.00
		29-May-2005	160		0.05		0.25	0.025	0.50	2.50
		18-Oct-2005	300		0.05		0.25	0.025	1.00	2.50
	Prairie Creek above Galena	30-Aug-2005	270		0.05		0.80	0.025	0.50	11.00
		29-May-2005	170		0.05		0.25	0.025	0.50	6.00
		18-Oct-2005	300		0.05		0.25	0.025	0.50	16.00
	Prairie Creek above Quartz	30-Aug-2005	270		0.05		0.80	0.025	1.00	9.00
		18-Oct-2005	300		0.05		0.25	0.025	1.00	15.00
	Prairie Creek below Harrison	22-Jun-2004	194			0.50				14.00
		29-May-2005	190		0.1		2.30	0.025	0.50	39.00
	Prairie Creek above Funeral	30-Aug-2005	270		0.05		0.25	0.025	2.00	2.50
		29-May-2005	160		0.2		2.80	0.025	0.50	11.00
		18-Oct-2005	290		0.05		0.25	0.025	0.50	2.50
Environment Canada	Prairie Creek above Cadillac Mine	3-Jul-2003	223	0.32	0.014	0.26	0.020		0.81	3.13
		3-Jul-2003	226	0.32	0.015	0.24	0.015		1.15	3.14
		3-Jul-2003	224	0.32	0.015	0.28	0.018		1.09	3.10
		25-Sep-2003	256	0.25	0.003	0.16	0.005		1.13	3.38
		16-Jun-2004	200	0.12	0.019	0.25	0.016		0.75	2.61
		21-Sep-2004	172	0.14	0.022	0.21	0.014		0.98	3.88
		23-Feb-2005	332	0.7	0.031	0.04	0.005		1.73	5.73
		20-Jun-2005	221	0.42	0.031	0.25	0.010		0.89	3.28
		26-Sep-2005	255	0.44	0.026	0.22	0.007		1.26	4.36
		16-Mar-2006			0.051	0.14	0.005		1.79	8.54
		12-Sep-2006	245	0.19	0.026	0.28	0.012		1.14	3.86
		6-Mar-2007	312	0.4	0.03	0.82	0.013		1.72	7.35
		11-Jun-2007	194	0.13	0.024	0.38	0.045		0.97	3.28
		10-Oct-2007	285	0.21	0.03	0.19	0.014		1.38	4.58
		31-Mar-2008	332	0.7	0.034	0.15	0.012		1.84	6.48
		16-Jun-2008	191	0.15	0.026	0.36	0.067		0.94	4.15
		7-Oct-2008	274	0.24	0.027	0.22	0.024		1.25	4.81
		17-Feb-2009	325	0.34	0.027	0.06	0.005		1.87	5.32

Table 1: Prairie Creek sampling points from upstream of the mine site and the adjacent sub-basin, with the updated values for zinc (cont.).

Data Source	Station	Sample Date	Hardness (mg/L as CaCO3)	Total Cl (mg/L)	Total Cd (µg/L)	Total Cu (µg/L)	Total Pb (µg/L)	Total Hg (µg/L)	Total Se (µg/L)	Total Zn (µg/L)
Parks Canada	NNP-55-08	11-Aug-2008			0.04	0.32	0.07		0.74	2.74
	NNP-56-08	11-Aug-2008			0.017	0.54	0.04		1.25	1.14
	NNP-57-08	12-Aug-2008			0.014	0.15	0.03		0.48	1.32
	NNP-59-08	12-Aug-2008			0.012	0.41	0.02		1.17	0.68
	NNP-60-08	12-Aug-2008			0.012	0.50	0.04		1.06	1.52
	NNP-61-08	12-Aug-2008			0.012	0.25	0.01		0.79	0.63
	NNP-62-08	12-Aug-2008			0.023	0.25	0.01		1.10	2.68
	NNP-63-08	12-Aug-2008			0.034	0.23	0.01		1.21	4.72
	NNP-64-08	12-Aug-2008			0.033	0.23	0.01		1.22	3.90
	NNP-71-08	13-Aug-2008			0.03	0.53	0.02		1.23	3.43
	NNP-72-08	13-Aug-2008			0.026	0.26	0.01		1.23	3.25
	NNP-73-08	13-Aug-2008			0.023	0.24	0.01		1.18	2.95
U of S (Dube)	PU1-EEM	26-Aug-2006	265	0.7	0.05	0.30	0.10	0.02	1.30	2.40
	PU1-RCA	26-Aug-2006	266	0.7	0.05	0.70	0.10	0.02	1.30	2.40
	PU1-RCAD	26-Aug-2006	267	0.7	0.05	0.60	0.10	0.02	1.20	2.50
	PN2	25-Aug-2006	429	0.70	0.05	0.60	0.10	0.02	2.80	1.30
	PN3	25-Aug-2006	279	0.70	0.1	1.70	0.40	0.02	2.00	17.00
	PN4	25-Aug-2006	169	0.70	0.05	0.40	0.10	0.02	0.60	0.40
	PN5	24-Aug-2006	243	0.70	0.05		0.20	0.02	1.10	2.80
	PU2	24-Aug-2006	202	0.70	0.05	3.70	0.10	0.02	1.80	1.80
	PU3	24-Aug-2006	268	0.70	0.1		0.40	0.02	3.00	10.00
	PU4	23-Aug-2006	197	0.70	0.05	6.50	0.10	0.02	0.60	0.40
Summary	**Number of Samples**		**55**	**27**	**70**	**53**	**69**	**39**	**69**	**71**
	Mean		**256**	**0.46**	**0.048**	**0.57**	**0.23**	**0.020**	**1.16**	**7.14**
	Standard Deviation		**59**	**0.23**	**0.062**	**0.98**	**0.45**	**0.007**	**0.50**	**7.75**
	Mean + 2 Standard Deviations		**374**	**0.93**	**0.172**	**2.53**	**1.13**	**0.034**	**2.16**	**22.65**
	CCME Guideline: Freshwater Aquatic Life		**NG**	**NG**	**0.017**	**4.0***	**7.0***	**0.026**	**1.00**	**30.00**

***CCME guidelines for Cu and Pb are hardness dependent. Values presented here are based on background hardness levels in Prairie Creek**

Table 2: Treatment Scenario #1 – Revised estimated in-stream metal concentrations based on 0.09 m^3/s flow of mine water and metal concentrations from water samples following batch treatment simulations.

Month	Flows (m^3/s)			Estimated In-Stream Concentrations					
	Prairie Creek	Process Water	Mine Water	Cadmium (µg/L)	Copper (µg/L)	Lead (µg/L)	Mercury (µg/L)	Selenium (µg/L)	Zinc (µg/L)
Jan	0.540	0.000	0.090	0.044	1.49	0.23	0.019	1.49	14.97
Feb	0.388	0.000	0.090	0.043	1.78	0.22	0.018	1.60	17.46
Mar	0.315	0.000	0.090	0.042	2.00	0.22	0.018	1.68	19.34
Apr	0.835	0.007	0.090	0.065	1.20	0.93	0.019	1.67	12.68
May	12.608	0.014	0.090	0.051	0.62	0.33	0.020	1.22	7.56
Jun	17.587	0.014	0.090	0.050	0.60	0.30	0.020	1.20	7.44
Jul	12.019	0.014	0.090	0.051	0.62	0.34	0.020	1.22	7.58
Aug	9.526	0.014	0.090	0.051	0.63	0.36	0.020	1.24	7.70
Sep	6.446	0.014	0.090	0.053	0.66	0.43	0.020	1.27	7.96
Oct	2.818	0.014	0.090	0.059	0.78	0.67	0.020	1.41	8.98
Nov	1.320	0.009	0.090	0.063	0.99	0.85	0.019	1.56	10.83
Dec	0.855	0.007	0.090	0.064	1.19	0.91	0.019	1.66	12.56
Mean	**5.438**	**0.009**	**0.090**						
CCME Guideline: Freshwater Aquatic Life				0.017	4.00	7.00	0.026	1.00	30.00
RCA: Mean + 2 Standard Deviations				0.172	2.53	1.13	0.034	2.16	22.65

Table 3: Treatment Scenario #2 – Revised estimated in-stream metal concentrations based on 0.09 m^3/s flow of mine water and metal concentrations from water samples sent for toxicity testing.

Month	Flows (m^3/s)			Estimated In-Stream Concentrations				
	Prairie Creek	Process Water	Mine Water	Cadmium (µg/L)	Copper (µg/L)	Lead (µg/L)	Selenium (µg/L)	Zinc (µg/L)
Jan	0.540	0.000	0.090	0.073	0.73	1.94	1.39	15.40
Feb	0.388	0.000	0.090	0.080	0.78	2.48	1.47	18.02
Mar	0.315	0.000	0.090	0.086	0.82	2.89	1.52	20.01
Apr	0.835	0.007	0.090	0.073	0.68	2.34	1.56	14.93
May	12.608	0.014	0.090	0.050	0.58	0.45	1.21	7.87
Jun	17.587	0.014	0.090	0.050	0.58	0.39	1.19	7.67
Jul	12.019	0.014	0.090	0.051	0.58	0.47	1.21	7.91
Aug	9.526	0.014	0.090	0.051	0.58	0.53	1.22	8.11
Sep	6.446	0.014	0.090	0.053	0.59	0.67	1.25	8.56
Oct	2.818	0.014	0.090	0.058	0.61	1.21	1.36	10.32
Nov	1.320	0.009	0.090	0.066	0.65	1.83	1.48	12.76
Dec	0.855	0.007	0.090	0.072	0.68	2.29	1.55	14.76
Mean	**5.438**	**0.009**	**0.090**					
CCME Guideline: Freshwater Aquatic Life				0.017	4.00	7.00	1.00	30.00
RCA: Mean + 2 Standard Deviations				0.172	2.53	1.13	2.16	22.65

Shaded values represent exceedances of the site-specific guideline of mean + 2SDs of the reference condition.

If you have any questions regarding this revision of the site-specific objective for zinc, please do not hesitate to contact me.

Sincerely,

Andrew Harwood, Ph.D.
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Annex J2

Prairie Creek Water Treatment Testing

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Appendix A. Relevant Toxicity Results

1.0 INTRODUCTION

1.1 The Project

Canadian Zinc Corporation (CZN) is preparing the Prairie Creek Mine for operations. Water management will include treating mine water and process water from the mill to remove metals. Representative water samples were provided to SGS-CEMI for treatment testing. The mine water sample was a combination of water from vein stopes and from a new decline driven from the main adit, while the process water was received from SGS Lakefield after lock-cycle metallurgical tests on mineralized samples.

The scope of this water treatment study is to confirm appropriate water treatment processes for the mine water and process water expected during operations. The following report provides the test work results and recommendations to optimize reagent addition.

1.2 Background

SGS-CEMI previously conducted bench scale testing of mine water for zinc removal in 2006 in support of existing exploration-scale water treatment. Based on the test results, CZN switched from soda ash to using sodium sulphide in mid-September 2006 which met with an immediate improvement. However, while dissolved zinc was being removed, suspended solids persisted. This was mainly due to the nature of precipitate as a result of sulphide treatment which produces fine sediments that are difficult to settle. SGS-CEMI conducted further testing to optimize reagent dosage and determine proper settling aids to address the TSS (Total Suspended solids) issue that results in higher zinc concentrations. The results from these tests indicated that a combination of sulphide followed by ferric addition (coagulant) and minimum 120 minute retention was sufficient to remove the suspended solids. Previous bench scale tests also confirmed that lime would be a suitable treatment agent, however, the dosage required and weight limitations considering CZN currently has to fly-in all supplies to site made lime use impractical.

2.0 EXPERIMENTAL OUTLINE

2.1 Precipitation using Hydrated Lime (Mine Water Only)

The following samples were prepared and tested:

Test 1A: 1L sample of mine water treated to pH 8.5

Test 1B: 1L sample of mine water treated to pH 8.8

Test 1C: 1L sample of mine water treated to pH 9.0

Test 1D: 1L sample of mine water treated to pH 9.3

Test 1E: 1L sample of mine water treated to pH 9.6

Use an initial volume of 1L of sample water. Create a 10% Lime solution, add lime to sample water to desired pH, agitate for 60 minutes and take a sample of water. The target pH's used for this test were: 8.5, 8.8, 9.0, 9.3 and 9.6.

Observations

Maintaining the pH at 8.8 was difficult as this seemed to be an inflection point for the water.

2.2 Precipitation using Hydrated Lime (Mine & Process Water Blend)

As per discussions with CZN and SNC Lavalin, the following blends of mine and process water were prepared and tested:

Test 2: 1L of 100% process water

Test 3: 1L of 80% process water and 20% mine water

Test 4: 1L of 60% process water and 40% mine water

Create a 10% Lime solution; add lime to sample water to target pH, 9.5. Agitate for 60 minutes, maintaining pH at 9.5 and take a sample of water.

Observations

The mixture water looked the same as the process water, there was no visible difference.

2.3 Precipitation using Hydrated Lime and Ferric (Process Water Only)

The following samples were prepared and tested:

Test 5: 1L of 100% process water + 10mg/L Fe

Test 6: 1L of 100% process water + 20mg/L Fe

Test 7: 1L of 100% process water + 20mg/L Fe

Test 8: 1L of 100% process water + 30mg/L Fe

Test 9: 1L of 100% process water + 40mg/L Fe

Use an initial volume of 1L of sample water. Add the specified volume of Fe to the solution. Create a 10% Lime solution; add lime to sample water to desired pH. Maintain the pH for 60 minutes and remove a sample.

Observations

Flocculation and settling happened fairly quickly for all tests

2.4 Precipitation using Sulphide and Ferric (Process Water Only)

The following samples were prepared and tested. The dosage was based on the optimum results from the 2006 bench scale testing study.

Test 10: 1L of 100% process water + 9mg/L S^{2-} + 2mg/L Fe

Test 11: 1L of 100% process water + 15mg/L S^{2-} + 5mg/L Fe

Use an initial volume of 1L of sample water. Add the specified volume of Sulphide to the solution. Agitate for 30 minutes then add the volume of Iron to the solution. Create a 5% Lime solution; add lime to sample water to desired pH. Maintain the pH for 30 minutes and remove a sample.

2.5 Precipitation using Sulphide and Ferric at lower pH (Process Water Only)

The following samples were prepared and tested:

Test 12: 1L of 100% process water + 40mg/L S^{2-} + 100mg/L Fe
Test 13: 1L of 100% process water + 40mg/L S^{2-} + 100mg/L Fe
Test 14: 1L of 100% process water + 40mg/L S^{2-} + 100mg/L Fe
Test 15: 1L of 100% process water + 40mg/L S^{2-} + 100mg/L Fe

Analysis results from previous tests indicated that other metals specifically As, Cd, Pb, Sb, Se may need treatment to meet MMER regulations. Use an initial volume of 1L of sample water.

Acidify using H_2SO_4 to target pH (3.0, 3.3, 3.6, and 4.0). Add 40 mg/L S^{2-} to solution, agitate for 30 minutes and remove a sample. Next add 100mg/L Fe and increase and maintain the pH at 9.5 using a 10% Lime solution. Finally, after 30 minutes remove a sample for analysis.

Observations

The pH was fairly steady between 3.0-4.0 and easily maintained without fluctuations.

2.6 pH Optimization for Sulphide and Ferric Addition (Process Water Only)

After reviewing the results from previous tests, it was decided to optimize operating pH. The following samples were prepared and tested:

Test 16: 1L of 100% Process Water + 40mg/L S^{2-} + 100mg/L Fe
Test 17: 1L of 100% Process Water + 40mg/L S^{2-} + 100mg/L Fe

Use an initial volume of 1L of sample water. Acidify using H_2SO_4 to target pH (4.5 and 5.0). Add 40 mg/L S^{2-} to solution, agitate for 30 minutes and remove a sample. Next add 100mg/L Fe and increase and maintain the pH at 8.5 using a 10% Lime solution. Finally, after 30 minutes remove a sample for analysis.

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3.0 RESULTS & DISCUSSION

3.1 Precipitation Using Hydrated Lime (Mine Water Only)

3.1.1 Lime Consumption

Table 1 below summarizes the lime consumption up to desired pH for 1L sample.

Table 1. Lime Consumption for Mine Water

Test #	Initial pH	Target pH	Final pH	Lime Consumption (mL)	Lime Consumption (g/L)
1A	7.6	8.5	8.54	1.14	0.11
1B		8.8	8.81	1.2	0.12
1C		9.0	9.02	1.35	0.14
1D		9.3	9.28	1.56	0.17
1E		9.6	9.57	2.13	0.21

As shown in the table above, lime demand was 0.213 g/L of $Ca(OH)_2$ for pH 9.6.

3.1.2 Water Quality Analysis

The mine water received from the site was tested using hydrated lime by increasing the pH to precipitate metals. As shown in the Table 2 below, the main metal of concern is zinc with dissolved concentration of 4.25 mg/L and a slightly elevated concentration of Cd at 20.8 µg /L.

Table 2. Water Quality for Mine Water at various pH

	Units	Feed	Test 1A	Test 1B	Test 1C	Test 1D	Test 1E
pH		**7.6**	**8.54**	**8.81**	**9.02**	**9.28**	**9.57**
Aluminium (Al)	mg/L	<0.001	0.041	0.013	0.013	0.015	0.022
Antimony (Sb)	mg/L	0.0238	0.0226	0.0226	0.0226	0.0229	0.0222
Arsenic (As)	mg/L	0.0009	0.0026	0.003	0.0031	0.0028	0.0028
Cadmium (Cd)	mg/L	0.0208	0.00005	0.00002	0.00002	0.00001	<0.00001
Chromium (Cr)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Co)	mg/L	0.0018	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Copper (Cu)	mg/L	0.0128	0.0144	0.007	0.0084	0.0072	0.0053
Iron (Fe)	mg/L	0.014	0.039	0.007	<0.005	<0.005	<0.005
Lead (Pb)	mg/L	0.0006	0.0004	<0.0002	<0.0002	<0.0002	<0.0002
Magnesium (Mg)	mg/L	105	112	113	111	110	110
Manganese (Mn)	mg/L	0.052	0.003	<0.001	<0.001	<0.001	<0.001
Mercury (Hg)	mg/L	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Molybdenum (Mo)	mg/L	0.003	0.004	0.004	0.004	0.004	0.004
Nickel (Ni)	mg/L	0.018	0.009	0.008	0.007	0.007	0.006
Phosphorous (P)	mg/L	<0.01	0.725	0.585	0.317	0.17	0.17
Potassium (K)	mg/L	3.13	5.16	5.37	5.29	5.33	5.57
Selenium (Se)	mg/L	0.0028	0.0037	0.0035	0.0033	0.0033	0.0032
Sodium (Na)	mg/L	2.03	2.78	2.72	2.63	2.65	2.74
Strontium (Sr)	mg/L	0.941	0.865	0.865	0.87	0.716	0.645
Uranium (U)	mg/L	0.0341	0.0246	0.0244	0.0247	0.0228	0.019
Zinc (Zn)	mg/L	4.25	0.878	0.062	0.015	0.017	0.019

The tests were conducted using hydrated lime and as indicated in Figure 1 below, zinc was below 0.1 mg/L after pH 8.8 while Cadmium was also removed to less than 0.05 µg/L. The recommended target pH for full-scale treatment is 9.3 (Test 1D). Some metal concentrations fluctuate somewhat between the different pH test ranges. In full-scale (operations) treatment, contact (reaction) time is expected to be greater and filtration will remove suspended sediment. Therefore, the above results should be considered a 'worst-case', and treated water quality during operations should be superior.

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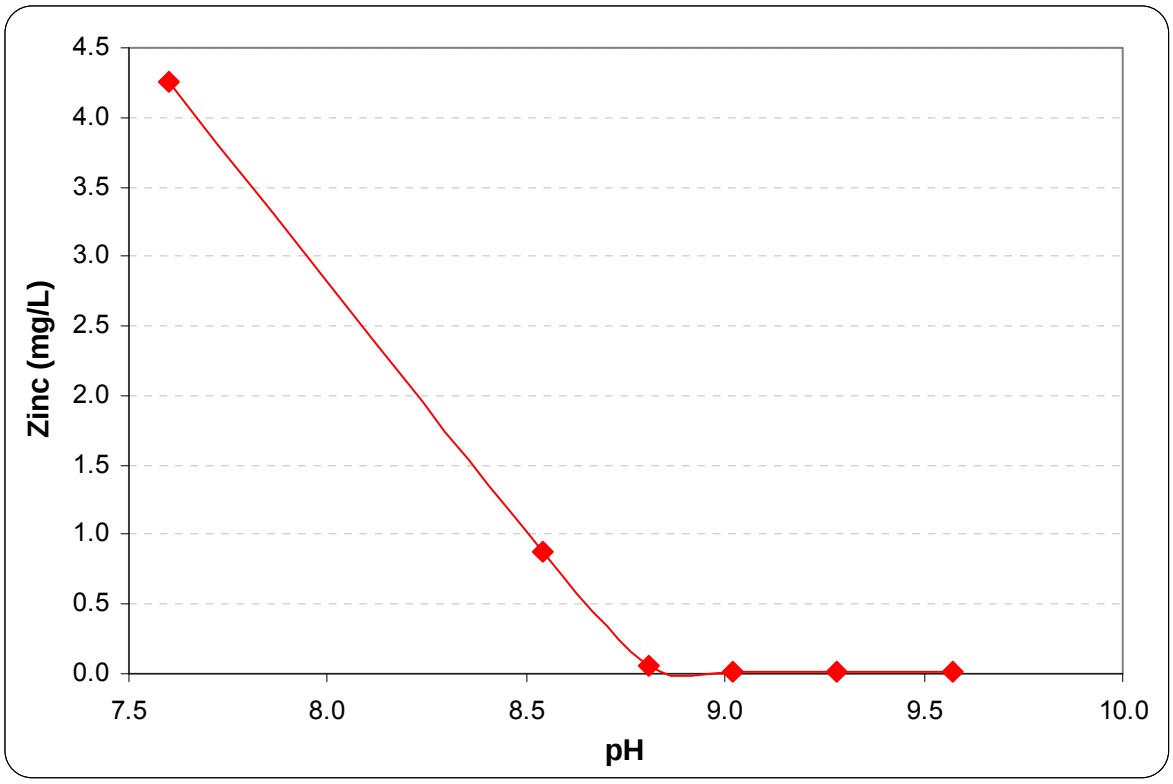

Figure 1. Zinc Concentration with pH for Mine Water

3.2 Precipitation Using Hydrated Lime (Mine & Process Water Blend)

3.2.1 Lime Consumption

As recommended, three different blends were tested and

Table 3 below shows the lime demand for each sample. The blends included:

Test 2: 1L of 100% process water

Test 3: 1L of 80% process water and 20% mine water

Test 4: 1L of 60% process water and 40% mine water

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Table 3. Lime Consumption for Process & Mine water blends

Test #	% Process Water	% Mine Water	Initial pH	Target pH	Final pH	Lime Consumption (mL)	Lime Consumption (g/L)
2	100	0	9.10	9.5	9.47	0.45	0.02
3	80	20	9.00	9.5	9.46	1.2	0.06
4	60	40	8.70	9.5	9.51	1.65	0.08

Due to the alkalinity from the process water with initial pH of 9.1, the lime demand was relatively low at 0.0825 mg/L to achieve final pH 9.5 compared to the mine water alone.

3.2.2 Water Quality Analysis

The process water received from SGS Lakefield was blended with the Mine Water and tested using hydrated lime by increasing the pH to precipitate metals. As shown in the Table 4 below, the main metal of concern in the process included arsenic at 0.51 mg/L, lead at 5.3 mg/L and zinc at 3.4 mg/L.

Table 4. Water Quality for Process and Mine water blends at various pH

	Units	Mine Water	Process Water	Test 2	Test 3	Test 4
Blends (PW:MW)		-	-	100:0	80:20	60:40
pH		**7.6**	**9.10**	**9.47**	**9.46**	**9.51**
Aluminium (Al)	mg/L	<0.001	0.017	0.029	0.023	0.025
Antimony (Sb)	mg/L	0.0238	0.273	0.256	0.255	0.226
Arsenic (As)	mg/L	0.0009	0.509	0.531	0.415	0.31
Cadmium (Cd)	mg/L	0.0208	0.0825	0.0823	0.0676	0.051
Chromium (Cr)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt (Co)	mg/L	0.0018	<0.0005	<0.0005	<0.0005	<0.0005
Copper (Cu)	mg/L	0.0128	0.0032	0.0026	0.0025	0.001
Iron (Fe)	mg/L	0.014	0.147	0.159	0.133	0.086
Lead (Pb)	mg/L	0.0006	5.26	5.1	4.2	3.36
Magnesium (Mg)	mg/L	105	10.3	11.2	28.1	43.7
Manganese (Mn)	mg/L	0.052	0.015	0.022	0.162	0.032
Mercury (Hg)	mg/L	<0.00002	0.00168	0.00197	0.00155	0.00256
Molybdenum (Mo)	mg/L	0.003	0.073	0.073	0.06	0.051
Nickel (Ni)	mg/L	0.018	0.008	0.011	0.009	0.009
Phosphorous (P)	mg/L	<0.01	1.09	1.11	0.877	0.401
Potassium (K)	mg/L	3.13	13	13.4	11.2	9.03
Selenium (Se)	mg/L	0.0028	0.104	0.0954	0.0795	0.0548
Sodium (Na)	mg/L	2.03	1130	1220	955	727
Strontium (Sr)	mg/L	0.941	0.037	0.137	0.253	0.37
Uranium (U)	mg/L	0.0341	0.0162	0.0163	0.0195	0.022
Zinc (Zn)	mg/L	4.25	3.42	3.44	2.8	2.09

Simple lime neutralization was not successful in achieving low metals concentrations in the effluent. A lowest zinc concentration of 2.09 mg/L was achieved with a higher proportion of mine water to process water (60:40). Since lime neutralization was sufficient in removing zinc from the mine water only, it is evident that zinc and other metals removal in the process water needs further optimization. Concentration reduction in this test is mainly due to dilution by mine water.

3.3 Precipitation Using Hydrated Lime and Ferric (Process Water Only)

3.3.1 Lime Consumption

Due to poor dissolved metals removal in the previous test, mainly due to the process water, all subsequent tests were focused on optimizing metals removal for process water only. The next series of tests were conducted at higher pH (for zinc optimization) and higher iron to zinc ratio.

Higher iron concentration in the feed is known to enhance metals removal due to co-precipitation; therefore, iron was added as ferric sulphate to increase the iron to zinc ratio.

Table 5. Lime Consumption for Process water with High Iron Addition

Test #	% Process Water	% Mine Water	Initial pH	Fe Addition (mg/L)	Final pH	Lime Consumption (mL)	Lime Consumption (g/L)
5	100	0	9.10	10	9.89	6.7	0.34
6	100	0		20	9.55	3.43	0.17
7	100	0		20	10.07	7.6	0.38
8	100	0		30	9.62	3.81	0.19
9	100	0		40	9.47		

As expected, due to increased iron concentration in the feed, the lime demand also increased to 0.191 g/L at pH 9.5.

3.3.2 Water Quality Analysis

As shown in Table 6 below, zinc removal was slightly improved with high iron concentration in the feed compared to simple lime neutralization with the lowest zinc concentration of 0.145 mg/L achieved with 40 mg/L iron addition.

Table 6. Water Quality with increasing Iron to Zinc Ratio

	Units	Process Water	Test 5	Test 6	Test 7	Test 8	Test 9
Fe Addition	mg/L	-	10	20	20	30	40
pH		**9.10**	**9.89**	**9.55**	**10.07**	**9.62**	**9.47**
Aluminium (Al)	mg/L	0.017	0.015	0.008	0.012		
Antimony (Sb)	mg/L	0.273	0.315	0.123	0.318		
Arsenic (As)	mg/L	0.509	0.369	0.087	0.31		
Cadmium (Cd)	mg/L	0.0825	0.075	0.0781	0.0743		
Chromium (Cr)	mg/L	<0.001	<0.001	<0.001	<0.001		
Cobalt (Co)	mg/L	<0.0005	0.0007	<0.0005	0.0008		
Copper (Cu)	mg/L	0.0032	0.0006	0.0019	0.0006		
Iron (Fe)	mg/L	0.147	0.2	0.0013	0.212		
Lead (Pb)	mg/L	5.26	4.13	0.58	4.15		
Magnesium (Mg)	mg/L	10.3	8.75	10.7	8.67		
Manganese (Mn)	mg/L	0.015	0.017	0.02	0.006		
Mercury (Hg)	mg/L	0.00168	0.00308	-	0.00278		
Molybdenum (Mo)	mg/L	0.073	0.077	0.071	0.079		
Nickel (Ni)	mg/L	0.008	0.026	0.004	0.025		
Phosphorous (P)	mg/L	1.09	0.801	1.12	0.698		
Potassium (K)	mg/L	13	15.9	13.2	14.5		
Selenium (Se)	mg/L	0.104	0.0894	0.09	0.0875		
Sodium (Na)	mg/L	1130	1160	1289	1160		
Strontium (Sr)	mg/L	0.037	0.052	0.043	0.045		
Uranium (U)	mg/L	0.0162	0.0159	0.016	0.0158		
Zinc (Zn)	mg/L	3.42	2.99	0.74	3.1	0.314	0.145

Since the tests were preliminary tests and the primary focus was zinc removal, only zinc analysis was conducted for Test 8 and Test 9.

3.4 Precipitation Using Sulphide and Ferric (Process Water Only)

Due to poor zinc removal with lime neutralization, SGS-CEMI reviewed the 2007 bench scale testing study conducted on mine water to remove zinc using sulphide precipitation. The optimum conditions and reagent dosage were used on the process water. Table 7 below contains the solution data from the feed (process water) and two test solutions. Test 10 was treated with 9 mg/L S^{2-} and 2 mg/L Fe addition (optimum condition from 2007 study), Test 11 was treated with 15 mg/L S^{2-} and 5 mg/L Fe addition (increased dosage).

Table 7. Water Quality using optimum Sulphide dosages from 2007 Bench-Scale Testing Study

	Units	Process Water	Test 10	Test 11
Sulphide Addition	mg/L	-	9.0	15.0
Fe Addition	mg/L	-	2.0	5.0
Aluminium (Al)	Mg/L	0.017	0.037	0.022
Antimony (Sb)	mg/L	0.273	0.208	0.317
Arsenic (As)	mg/L	0.509	0.545	0.454
Cadmium (Cd)	mg/L	0.0825	0.0678	0.0751
Chromium (Cr)	mg/L	<0.001	0.002	<0.001
Cobalt (Co)	mg/L	<0.0005	0.002	<0.0005
Copper (Cu)	mg/L	0.0032	0.0014	0.001
Iron (Fe)	mg/L	0.147	6.44	0.165
Lead (Pb)	mg/L	5.26	5.11	4.27
Magnesium (Mg)	mg/L	10.3	11.4	9.07
Manganese (Mn)	mg/L	0.015	0.105	0.021
Mercury (Hg)	mg/L	0.00168	0.00428	0.00321
Molybdenum (Mo)	mg/L	0.073	0.077	0.073
Nickel (Ni)	mg/L	0.008	0.064	0.012
Phosphorous (P)	mg/L	1.09	1.49	0.555
Potassium (K)	mg/L	13	15.4	13.4
Selenium (Se)	mg/L	0.104	0.0603	0.0684
Sodium (Na)	mg/L	1130	1230	1170
Strontium (Sr)	mg/L	0.037	0.05	0.052
Uranium (U)	mg/L	0.0162	0.0167	0.0158
Zinc (Zn)	mg/L	3.42	3.76	3.08

As indicated in the table above, the zinc removal efficiency was better than lime neutralization; however, the zinc concentration was still above 0.3 mg/L with 15 mg/L of sulphide addition. All previous tests were focused on zinc removal; however, after a thorough review of the analytical results, other metals including cadmium, lead, arsenic, antimony, uranium, and selenium were observed to be elevated.

Based on our past experience with cadmium and lead removal, further tests were planned to treat process water using sulphide at low pH followed by pH increase to precipitate zinc and other heavy metals as metal hydroxides.

3.5 Precipitation Using Sulphide and Ferric at lower pH (Process Water Only)

As mentioned, the test was planned to remove Cd and Pb at lower pH followed by iron addition

to remove Zn and As at higher pH. 1N sulphuric acid solution was added to the process water to adjust the pH from 9.0 to below 4.0 followed by sulphide addition and 30 minutes of mixing and iron and lime addition to increase the pH to 9.3.

3.5.1 Acid Consumption

Since the pH of the process was 9.10, sulphuric acid was added to decrease the pH for Cd and Pb removal.

Table 8. Acid Consumption for Sulphide/Ferric Test at pH below 4.0

Test #	Initial pH	Target pH	1N H_2SO_4 Addition (mL)
12A	9.10	3.0	20.6
13A		3.3	19.0
14A		3.6	18.7
15A		4.0	17.2

3.5.2 Sulphide Addition

No pH adjustments were made after sulphide addition because as expected, the pH increased by 2.0 pH units for each test.

Table 9. Solution pH after Sulphide Addition for Sulphide/Ferric Test at pH below 4.0

Test #	S^{2-} Added (mg/L)	Initial pH	Final pH
12B	40	3.0	5.24
13B	40	3.3	5.37
14B	40	3.6	5.71
15B	40	4.0	6.31

3.5.3 Water Quality Analysis after Sulphide Addition for Sulphide/Ferric Test

As mentioned, 40 mg/L of sulphide was added and the solution agitated for 30 minutes. Following 30 minutes, the sample was taken and filtered using a 0.45 micron membrane filter.

Table 10. Water Quality after Sulphide Addition for Sulphide/Ferric Test at pH below 4.0

	Units	Process Water	Test 12B	Test 13B	Test 14B	Test 15B
Sulphide Addition	mg/L	-	40	40	40	40
pH		**9.10**	**5.24**	**5.37**	**5.71**	**6.31**
Aluminium (Al)	mg/L	0.017	0.036	0.045	0.038	0.063
Antimony (Sb)	mg/L	0.273	0.577	0.565	0.614	0.596
Arsenic (As)	mg/L	0.509	0.465	0.437	0.503	0.473
Cadmium (Cd)	mg/L	0.0825	0.0203	0.0195	0.0458	0.0396
Chromium (Cr)	mg/L	<0.001	0.003	0.005	0.003	0.002
Cobalt (Co)	mg/L	<0.0005	0.0006	0.0005	0.0005	0.0005
Copper (Cu)	mg/L	0.0032	0.031	0.0122	0.0217	0.0118
Iron (Fe)	mg/L	0.147	0.243	0.327	0.265	0.261
Lead (Pb)	mg/L	5.26	4.83	5.13	5.55	5.11
Magnesium (Mg)	mg/L	10.3	10.8	10.7	11.5	11.1
Manganese (Mn)	mg/L	0.015	0.035	0.074	0.066	0.028
Mercury (Hg)	mg/L	0.00168	0.00339	0.00225	0.00386	0.00211
Molybdenum (Mo)	mg/L	0.073	0.071	0.066	0.074	0.074
Nickel (Ni)	mg/L	0.008	0.02	0.023	0.02	0.026
Phosphorous (P)	mg/L	1.09	4.78	2.95	4.49	2.84
Potassium (K)	mg/L	13	16.4	13.8	16.5	14.4
Selenium (Se)	mg/L	0.104	0.0484	0.039	0.0483	0.0384
Sodium (Na)	mg/L	1130	1180	1140	1250	1230
Strontium (Sr)	mg/L	0.037	0.057	0.042	0.041	0.041
Uranium (U)	mg/L	0.0162	0.0136	0.0117	0.0132	0.0121
Zinc (Zn)	mg/L	3.42	3.09	2.45	3.52	2.81

As shown in Table 10 above, lowering the pH and adding sulphide did not enhance metals removal at this stage of the tests particularly for cadmium and lead. The tests were then continued with ferric addition and pH adjustment as detailed below.

3.5.4 Ferric Addition

Following the sulphide addition, iron as ferric sulphate was added at 100 mg/L to enhance iron to zinc ratio and improve zinc removal. Hydrated lime was added to increase the pH to about 9.3 for metal precipitation.

Table 11. Solution pH after Iron Addition for Sulphide/Ferric Test

Test #	Fe Added (mg/L)	Initial pH	Final pH
12C	100	5.24	9.28
13C	100	5.37	9.41
14C	100	5.71	9.39
15C	100	6.31	9.35

3.5.5 Water Quality Analysis after Iron Addition for Sulphide/Ferric Test

As mentioned, 100 mg/L of iron as ferric sulphate was added and the solution agitated for 30 minutes at pH 9.3. Following 30 minutes, sample was filtered using a 0.45 micron membrane filter. The results after sulphide addition indicate 52% removal for Cd and 3% removal for Pb. However, the samples taken after ferric addition shown below in

Table 12, greater than 95% removal for both was achieved. Since the CdS precipitates are very fine, we believe that Cd and Pb were precipitated at lower pH but due to the fine particulate nature of the precipitate the solids were not removed even after 0.45 micron filter while after iron and lime addition which acts as a coagulant, the fine particles were settled with the ferric sludge.

It seems that ferric was reduced to ferrous which resulted in higher iron concentrations for some of the tests. Fe concentrations can be further lowered by increasing the retention time to 45 min and addition of air for oxidation.

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Table 12. Water Quality after Iron Addition for Sulphide/Ferric Test at lower pH below 4.0

	Units	Process Water	Test 12C	Test 13C	Test 14C	Test 15C
Fe Addition	mg/L	-	100	100	100	100
pH		**9.10**	**9.28**	**9.41**	**9.39**	**9.35**
Aluminium (Al)	mg/L	0.017	0.011	0.013	0.013	0.019
Antimony (Sb)	mg/L	0.273	0.0126	0.0131	0.0136	0.0127
Arsenic (As)	mg/L	0.509	0.0007	0.0008	0.0008	0.0012
Cadmium (Cd)	mg/L	0.0825	0.00327	0.0048	0.00362	0.0033
Chromium (Cr)	mg/L	<0.001	0.002	0.002	0.001	0.001
Cobalt (Co)	mg/L	<0.0005	<0.0005	0.0007	0.0006	0.0007
Copper (Cu)	mg/L	0.0032	0.0031	0.0071	0.0044	0.0043
Iron (Fe)	mg/L	0.147	1.26	0.516	2.44	0.088
Lead (Pb)	mg/L	5.26	0.0741	0.0571	0.0887	0.0493
Magnesium (Mg)	mg/L	10.3	8.13	7.76	9.66	7.05
Manganese (Mn)	mg/L	0.015	0.002	0.003	0.004	0.001
Mercury (Hg)	mg/L	0.00168	0.00105	0.00112	0.001	0.0005
Molybdenum (Mo)	mg/L	0.073	0.033	0.034	0.033	0.036
Nickel (Ni)	mg/L	0.008	0.012	0.01	0.013	0.012
Phosphorous (P)	mg/L	1.09	0.464	0.436	0.513	0.489
Potassium (K)	mg/L	13	13	13	12.6	12
Selenium (Se)	mg/L	0.104	0.0283	0.0307	0.0294	0.0239
Sodium (Na)	mg/L	1130	912	969	1020	1020
Strontium (Sr)	mg/L	0.037	0.642	0.617	0.694	0.639
Uranium (U)	mg/L	0.0162	0.0009	0.0005	0.0016	0.0002
Zinc (Zn)	mg/L	3.42	0.063	0.098	0.089	0.07

The results show that ferric treatment after sulphide treatment greatly enhanced metal removal as illustrated in Figure 2 below. It is assumed that metals such as Cd and Pb were precipitated with sulphide but due to the nature of the precipitate (particle size smaller than 0.45 micron) the precipitates were not removed during filtration, thus resulting in higher dissolved metals concentration. In the subsequent tests, ferric addition enhanced particle settling resulting in the finer particle being adsorbed onto the ferric hydroxide particles.

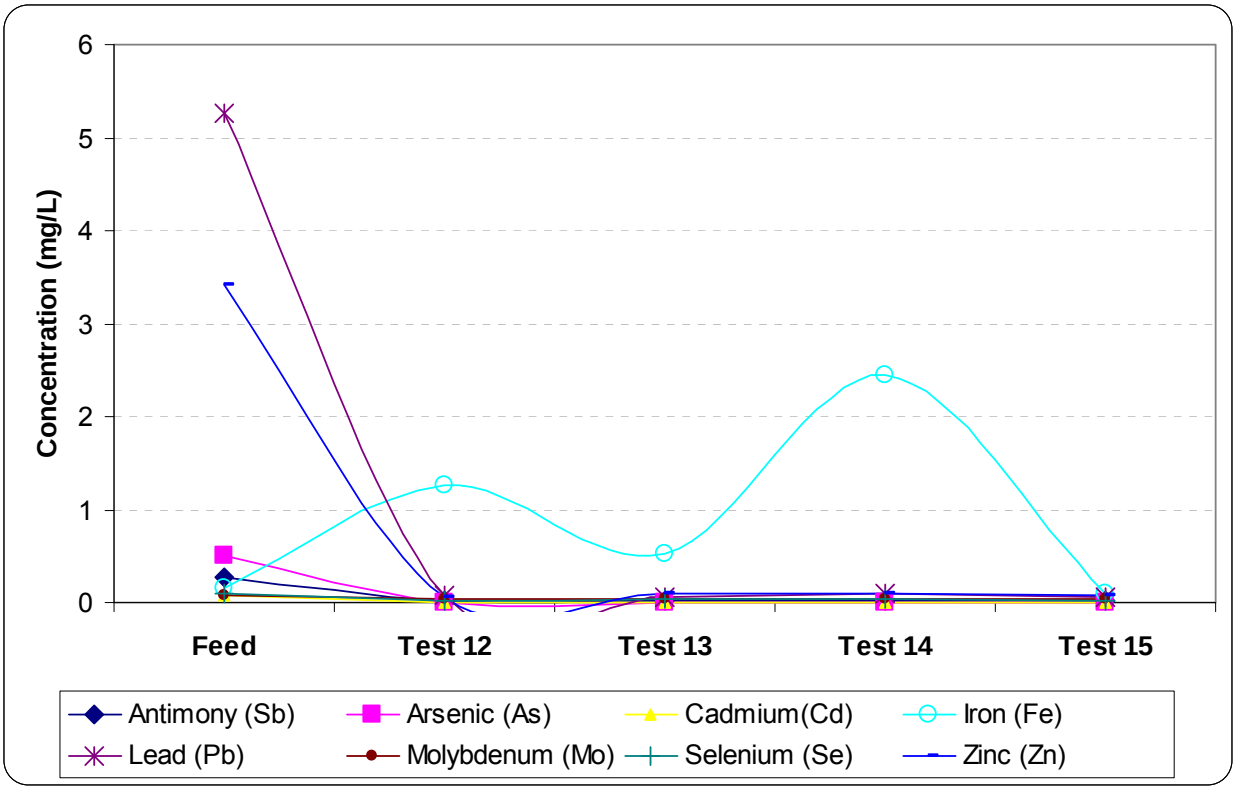

Figure 2. Metals Concentration for Sulphide/Ferric Test

3.6 pH Optimization for Sulphide and Ferric Addition Test

The previous test was planned to remove Cd and Pb at lower pH followed by iron addition to remove Zn and As at higher pH. 1N sulphuric acid solution was added to the process water to adjust the pH from 9.0 to below 4.0 followed by sulphide addition and 30 minute of mixing and iron and lime addition to increase the pH to 9.3. After reviewing the results, further tests were planned to optimize the pH and test pH above 4.0.

3.6.1 Acid Consumption

Similar to previous tests sulphuric acid was added to decrease the pH for Cd and Pb removal. Table 13 below shows the total acid consumption for the test and as shown the target pH was above 4.0.

Table 13. Acid Consumption for Sulphide/Ferric Test at pH above 4.0

Test #	Initial pH	Target pH	1N H_2SO_4 Addition (mL)
16A	9.10	4.5	16.4
17A		5.0	15.1

3.6.2 Sulphide Addition

No pH adjustments were made after sulphide addition because as expected, the pH increased by about 1.5 pH units for each test.

Table 14. Solution pH after Sulphide Addition for Sulphide/Ferric Test at pH below 4.0

Test #	S^{2-} Added (mg/L)	Initial pH	Final pH
16B	40	4.5	5.04
17B	40	5.0	5.47

3.6.3 Ferric Addition

Following the sulphide addition, iron as ferric sulphate was added at 100 mg/L to enhance iron to zinc ratio and improve zinc removal. Hydrated lime was added to increase the pH to about 8.5 for metal precipitation.

Table 15. Solution pH after Iron Addition for Sulphide/Ferric Test

Test #	Fe Added (mg/L)	Initial pH	Final pH
16C	100	5.04	8.38
17C	100	5.47	8.51

3.6.4 Water Quality Analysis after Iron Addition for Sulphide/Ferric Test

Following the sulphide addition, the solution was allowed to mix for 30 minutes and after 30 minutes, iron as ferric sulphate was added and pH increased to 8.5 with lime. The results summarized in Table 16 showed improvement for molybdenum and iron removal while selenium removal was slightly reduced to 60%. All other metals had similar removal efficiency above 95%. This indicates that the solution can be acidified to pH 5.0 followed by sulphide treatment, and iron addition at pH 8.5 can achieve higher metal removal.

Table 16. Water Quality after Iron Addition for Sulphide/Ferric Test at lower pH above 4.0

	Units	Process Water	Test 16C	Test 17C
Fe Addition	mg/L	-	100	100
pH		**9.10**	**8.38**	**8.51**
Aluminium (Al)	mg/L	0.017	0.008	0.011
Antimony (Sb)	mg/L	0.273	0.0112	0.0117
Arsenic (As)	mg/L	0.509	0.0018	0.0021
Cadmium (Cd)	mg/L	0.0825	0.00262	0.0043
Chromium (Cr)	mg/L	<0.001	<0.001	<0.001
Cobalt (Co)	mg/L	<0.0005	<0.0005	0.0006
Copper (Cu)	mg/L	0.0032	0.0021	0.0016
Iron (Fe)	mg/L	0.147	0.043	0.037
Lead (Pb)	mg/L	5.26	0.0932	0.0829
Magnesium (Mg)	mg/L	10.3	9.71	8.55
Manganese (Mn)	mg/L	0.015	0.008	0.007
Molybdenum (Mo)	mg/L	0.073	0.023	0.014
Nickel (Ni)	mg/L	0.008	0.004	0.006
Phosphorous (P)	mg/L	1.09	0.721	0.532
Potassium (K)	mg/L	13	12.2	12.7
Selenium (Se)	mg/L	0.104	0.0392	0.0412
Sodium (Na)	mg/L	1130	1044	1072
Strontium (Sr)	mg/L	0.037	0.172	0.336
Uranium (U)	mg/L	0.0162	0.0002	0.0003
Zinc (Zn)	mg/L	3.42	0.039	0.045

The recommended treatment approach is acidification to pH 5, and after treatment pH increase to pH 8.5. Therefore, test 16C above is considered most representative of final effluent quality, although the pH increase was only to pH 8.3. Full-scale treatment should produce better water quality (as for mine water treatment explained above).

4.0 TOXICITY TESTWORK

Following the testwork, it was concluded that minewater and process water would be treated separately due to the different process designs. Batches of both minewater and process water were treated and submitted for acute and chronic toxicity testwork. The relevant results of the toxicity testwork are provided in Appendix A.

4.1 Mine Water

A 100L sample of the mine water was treated with lime to pH 9.3 and 60 minute retention time. After treatment, the sample was acidified to pH 8.5 using 1N sulphuric acid solution and submitted for toxicity analysis. As indicated in the table below, all metals of concern were below the MMER targets after treatment. However, the lead concentration was artificially elevated in the effluent as the concentration was not present in the feed. Therefore, the effluent results in

Table 17 are considered appropriate for review of toxicity results, but the results in Table 2 (1D) are considered more representative of full-scale treated minewater quality.

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Table 17. Toxicity Analysis for Mine Water

	Units	Feed	Effluent
Aluminium (Al)	mg/L	<0.001	0.008
Antimony (Sb)	mg/L	0.0238	0.0117
Arsenic (As)	mg/L	0.0009	0.002
Barium (Ba)	mg/L	0.019	0.002
Beryllium (Be)	mg/L	<0.0001	<0.0001
Bismuth (Bi)	mg/L	<0.001	<0.001
Boron (B)	mg/L	<0.05	<0.05
Cadmium (Cd)	mg/L	0.0208	0.00022
Chromium (Cr)	mg/L	<0.001	<0.001
Cobalt (Co)	mg/L	0.0018	<0.0005
Copper (Cu)	mg/L	0.0128	0.0017
Iron (Fe)	mg/L	0.014	0.011
Lead (Pb)	mg/L	0.0006	0.0122
Magnesium (Mg)	mg/L	105	83.2
Manganese (Mn)	mg/L	0.052	<0.001
Molybdenum (Mo)	mg/L	0.003	0.002
Nickel (Ni)	mg/L	0.018	0.003
Phosphorus (P)	mg/L	<0.01	0.012
Potassium (K)	mg/L	3.13	2.75
Selenium (Se)	mg/L	0.0028	0.0028
Silicon (Si)	mg/L	3.04	1.59
Silver (Ag)	mg/L	<0.00002	<0.00002
Sodium (Na)	mg/L	2.03	3.99
Strontium (Sr)	mg/L	0.941	0.284
Thallium (Tl)	mg/L	0.00033	0.00011
Tin (Sn)	mg/L	<0.005	<0.005
Titanium (Ti)	mg/L	<0.005	<0.005
Uranium (U)	mg/L	0.0341	0.0016
Vanadium (V)	mg/L	<0.005	<0.005
Zinc (Zn)	mg/L	4.25	0.065
Zirconium (Zr)	mg/L	<0.0005	<0.0005

The sample passed both 96-h Rainbow trout and 48-h Daphnia Magna with no mortalities. Results are summarized in the

Table 18 below.

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Table 18. Toxicity Results Summary for Mine Water

Test	IC25 or EC25 (%v/v)	LC 50 (%v/v)
Rainbow Trout		>100
Daphnia Magna		>100
Fathead minnow Growth & Survival	>100	>100
Ceriodaphnia dubia Reproduction and Survival	68.1	>100
Pseudokirchneriella subcapitata	>90.91	-
Lemna minor – Frond Increase	>97	-
Lemna minor – Dry Weight	>97	-

4.2 Process Water

A 100L sample of the process water was treated using the sulphide/ferric treatment process. The sample was acidified to pH 4.5 using sulphuric acid and sulphide was added at 40 mg/L concentration. The mixture was reacted for 30 minutes followed by iron addition and pH increase to 9.3. After treatment, flocculant at 2 mg/L was added to assist in settling the precipitates and clear overflow was decanted from the top. The sample was acidified to pH 8.5 and submitted for toxicity analysis.

Table 19. Toxicity Analysis for Process Water

	Units	Feed	Effluent-1 May 2009	Effluent-2 June 2009
Aluminium (Al)	mg/L	0.019	0.007	0.004
Antimony (Sb)	mg/L	0.35	0.34	0.425
Arsenic (As)	mg/L	0.529	0.0927	0.106
Barium (Ba)	mg/L	0.012	0.009	0.008
Beryllium (Be)	mg/L	<0.0001	<0.0001	<0.0001
Bismuth (Bi)	mg/L	<0.001	<0.001	<0.001
Boron (B)	mg/L	0.077	0.068	<0.1
Cadmium (Cd)	mg/L	0.0873	0.00079	0.00113
Chromium (Cr)	mg/L	<0.001	<0.001	<0.002
Cobalt (Co)	mg/L	0.0007	0.0007	<0.001
Copper (Cu)	mg/L	0.0054	0.0012	0.0013
Iron (Fe)	mg/L	0.132	0.9	1.04
Lead (Pb)	mg/L	5.12	1.87	0.127
Magnesium (Mg)	mg/L	9.55	8.93	10
Manganese (Mn)	mg/L	0.009	0.006	0.006
Mercury (Hg)	mg/L	0.00168	-	0.00204
Molybdenum (Mo)	mg/L	0.063	0.043	0.052
Nickel (Ni)	mg/L	0.02	0.012	0.008
Phosphorus (P)	mg/L	0.501	0.341	0.661
Potassium (K)	mg/L	11.5	10.5	11.6
Selenium (Se)	mg/L	0.117	0.0333	0.0331
Silicon (Si)	mg/L	35.6	26.7	25.9
Silver (Ag)	mg/L	0.00043	0.00004	<0.00004
Sodium (Na)	mg/L	1100	1010	1130
Strontium (Sr)	mg/L	0.035	0.092	0.13
Thallium (Tl)	mg/L	0.00053	0.00018	<0.0001
Tin (Sn)	mg/L	<0.005	<0.005	<0.005
Titanium (Ti)	mg/L	0.006	<0.005	<0.01
Uranium (U)	mg/L	0.018	0.0096	0.001
Vanadium (V)	mg/L	0.014	0.005	<0.01
Zinc (Zn)	mg/L	3.7	0.64	0.8
Zirconium (Zr)	mg/L	0.0013	<0.0005	<0.001

The sample was sent for 96-h Rainbow trout and 48-h Daphnia Magna and the results are summarized below. Based on the acute testing results, chronic testing was not completed.

Table 20. Toxicity Results Summary for Mine Water

Test	LC 50 (%v/v)
Rainbow Trout	70.71
Daphnia Magna	<10

The effluent quality showed high concentrations of iron and antimony which may have caused poor results for the toxicity testing. The results for toxicity tests also showed significantly high conductivity (mainly due to high TDS). In addition, the sulphide precipitates are very fine compared to hydroxide precipitate (lime treatment) and tend to stay suspended in solution even after flocculation as well as pass through a 0.45 micron membrane filter. Although Cd and Cu concentrations were lower that in previous tests (Table 16, Test 16C), but Zn was higher. As noted above, the results should be better in the industrial plant since settling is enhanced in a proper clarifier and by providing a proper sulphide sludge recycle for coagulation and flocculation. However, as for minewater, the effluent results in Table 17 are considered appropriate for review of toxicity results, but the results in Table 16 (16C) are considered more representative of full-scale treated process water quality.

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Annex J3

Memo

Date: September 1, 2010

To: David Harpley, VP Environment and Permitting Affairs, Canadian Zinc Corp.

From: Andrew Harwood, Lead Research Scientist, Saskatchewan Research Council (SRC)

Re: Additional Site-Specific Water Quality Objectives for Prairie Creek, NWT

Dear David,

Further to your request for additional site-specific water quality objectives for Prairie Creek, please find enclosed objectives for antimony (Sb), arsenic (As), iron (Fe), silver (Ag), sulphate, ammonia, nitrate, nitrite, phosphorus, and total dissolved solids. These site-specific objectives were derived using data from the same sites and dates, and using the same background concentration approach, that were used to derive site-specific objectives for cadmium, copper, lead, mercury, selenium and zinc and described in a report prepared by SRC for Canadian Zinc dated March 2010 (SRC Publication No. 10432-1E10).

Table 1 lists the data used to derive the site-specific objectives, along with the objectives which are based on the mean + 2 standard deviations (SDs), and the corresponding federal guideline derived by the Canadian Council of Ministers of the Environment (CCME). The mean + 2SDs approach was used as this is the site-specific method listed in the Canadian Environmental Sustainability Indicators (CESI, 2008) report for use in lotic systems in the Northwest Territories (NWT). This approach is specifically listed for the determination of site-specific objectives for As, Fe, ammonia, nitrite, and phosphorus in the NWT. While the other parameters are not listed in the CESI (2008) report, the same approach was adopted for consistency. As in the earlier report, any values that were reported as being below detection limits were taken as half the detection limit for the calculation of means and standard deviations.

Calculated site-specific objectives were higher than CCME guidelines for nitrite (site-specific: 0.80 mg/L versus CCME: 0.06 mg/L) and phosphorus (site-specific: 0.016 mg/L versus CCME: 0.010 µg/L). However, the site-specific objective for nitrite was overly influenced by one high value on June 16, 2008, with all other nitrite values being below or close to the detection limit. The other parameters measured on June 16 were within the range of values reported for the same site on other dates, suggesting that the sample was not contaminated. Nevertheless, the legitimacy of the nitrite objective is questionable due to the influence of this one value.

Table 1: Prairie Creek sampling points from upstream of the mine site and the adjacent sub-basin, with site-specific derived water quality guidelines.

Data Source	Station	Sample Date	Total Fe (µg/L)	Total As (µg/L)	Total Ag (µg/L)	Total Sb (µg/L)	Dissolved Sulphate (mg/L)	Total Ammonia-N (mg/L)	Nitrate-Nitrogen (mg/L)	Nitrite-Nitrogen (mg/L)	Phosphorus (mg/L)	TDS (mg/L)
2008 SNP Results (Canadian Zinc)	3-10 PCU	2-Jul-2008	24	0.1	0.01	0.25		0.0025				
		30-Jul-2008	14	0.2	0.01	0.25		0.0025				
		25-Nov-2008		0.2				0.0025				
		1-Oct-2008	8	0.3	0.01	0.25		0.008				
		3-Sep-2008	21	0.2	0.01	0.25		0.0025				
2008 SNP Results (Canadian Zinc)	3-11 PCD	2-Jul-2008	86	0.2	0.01	0.25		0.0025				
		30-Jul-2008	29	0.3	0.01	0.25		0.0025				
		11-Nov-2008		0.3								
		25-Nov-2008		0.2				0.0025				
		1-Oct-2008	13	0.4	0.01	0.25		0.007				
		3-Sep-2008	10	0.3	0.01	0.25		0.0025				
A953718-R_10-56-10_N001 (Canadian Zinc)	FAST CREEK	9-Oct-2009	10	0.05	0.01	0.25	72	0.0025	0.187	0.001		
	FUNERAL CREEK	9-Oct-2009	8	0.50	0.01	0.25	50	0.0025	0.164	0.001		
	PRAIRIE CREEK	9-Oct-2009	10	0.05	0.01	0.25	69	0.0025	0.154	0.001		
Canadian Zinc	Funeral Creek	30-Aug-2005	8	0.5	0.05	0.5	64.6	0.0025	0.15	0.005		
		29-May-2005	146	0.5	0.05	0.5						
		18-Oct-2005	2.5	0.5	0.05	0.5	65.7	0.005	0.19	0.0025		
	Prairie Creek above Airstrip	30-Aug-2005	2.5	0.5	0.05	0.5	69.8	0.024	0.15	0.005		
		22-Jun-2004	2.5									
		29-May-2005	99	0.5	0.05	0.5	27.6					
		18-Oct-2005	18	0.5	0.05	0.5	82.8	0.012	0.17	0.0025		
	Prairie Creek above Galena	30-Aug-2005	12	0.5	0.05	0.5	67.1	0.0025	0.14	0.0025		
		29-May-2005	180	0.5	0.05	0.5	29.3					
		18-Oct-2005	13	0.5	0.1	1.0	83.9	0.008	0.19	0.0025		
	Prairie Creek above Quartz	30-Aug-2005	28	0.5	0.05	0.5	67.8	0.0025	0.14	0.005		
		18-Oct-2005	47	0.5	0.05	0.5	84.8	0.01	0.18	0.0025		
	Prairie Creek below Harrison	22-Jun-2004	6									
		29-May-2005	73	0.5	0.05	0.5	41.5					
	Prairie Creek above Funeral	30-Aug-2005	2.5	0.5	0.05	0.5	82.2	0.0025	0.15	0.005		
		29-May-2005	131	0.5	0.05	0.5						
		18-Oct-2005	2.5	0.5	0.05	0.5	71.9	0.005	0.18	0.0025		
Environment Canada	Prairie Creek above Cadillac Mine	3-Jul-2003	12.4	0.13	0.003	0.140	54.3	0.0025			0.004	238
		3-Jul-2003	12.6	0.12	0.001	0.128	54.5	0.0025			0.004	240
		3-Jul-2003	14.4	0.14	0.002	0.145	54.4	0.0025			0.004	239
		25-Sep-2003	1.8	0.12	0.001	0.120	57.0	0.008			0.004	
		16-Jun-2004	18.4	0.11	0.001	0.101	41.2	0.0025			0.01	
		21-Sep-2004	4.8	0.13	0.001	0.127	58.6	0.0025				
		23-Feb-2005	0.5	0.08	0.001	0.122	87.0	0.0025				
		20-Jun-2005	8.8	0.11	0.001	0.111	52.2	0.0025			0.01	235
		26-Sep-2005	2.5	0.10	0.001	0.105	68.6	0.0025			0.01	274
		16-Mar-2006	1.3	0.11	0.001	0.139		0.0025			0.01	
		12-Sep-2006	9.2	0.14	0.001	0.105	67.9	0.0025			0.01	265
		6-Mar-2007	4.4	0.11	0.005	0.140	94.3	0.020			0.01	343
		11-Jun-2007	60.1	0.12	0.001	0.102	42.5	0.0025	0.10	0.01	0.01	201
		10-Oct-2007	9.6	0.11	0.001	0.108	85.8		0.06	0.01		
		31-Mar-2008	2.4	0.10	0.001	0.145	102.0		0.12	0.01	0.01	359
		16-Jun-2008	81.9	0.12	0.001	0.098	46.7	0.0025	0.24	1.89	0.02	206
		7-Oct-2008	5.7	0.13	0.001	0.123	84.2					
		17-Feb-2009	3.9	0.12	0.001	0.149	104.0					

Table 1: Prairie Creek sampling points from upstream of the mine site and the adjacent sub-basin, with site-specific derived water quality guidelines (cont.).

Data Source	Station	Sample Date	Total Fe (µg/L)	Total As (µg/L)	Total Ag (µg/L)	Total Sb (µg/L)	Dissolved Sulphate (mg/L)	Total Ammonia-N (mg/L)	Nitrate-Nitrogen (mg/L)	Nitrite-Nitrogen (mg/L)	Phosphorus (mg/L)	TDS (mg/L)
Parks Canada	NNP-55-08	11-Aug-2008	96.9	0.15	0.001	0.149		0.006			0.0034	
	NNP-56-08	11-Aug-2008	50.4	0.19	0.002	0.131		0.005			0.0034	
	NNP-57-08	12-Aug-2008	44.0	0.07	0.0005	0.110		0.005			0.0032	
	NNP-59-08	12-Aug-2008	19.6	0.16	0.002	0.126		0.005			0.0017	
	NNP-60-08	12-Aug-2008	55.2	0.16	0.001	0.112		0.007			0.0026	
	NNP-61-08	12-Aug-2008	6.8	0.10	0.0005	0.072		0.006			0.0023	
	NNP-62-08	12-Aug-2008	4.8	0.11	0.0005	0.116		0.005			0.0011	
	NNP-63-08	12-Aug-2008	8.1	0.10	0.0005	0.126		0.0025			0.0010	
	NNP-64-08	12-Aug-2008	6.7	0.12	0.0005	0.131		0.005			0.0022	
	NNP-71-08	13-Aug-2008	3.8	0.14	0.0005	0.124		0.0025			0.0016	
	NNP-72-08	13-Aug-2008	3.9	0.14	0.0005	0.128		0.0025			0.0014	
	NNP-73-08	13-Aug-2008	3.6	0.14	0.0005	0.125		0.005			0.0010	
U of S (Dube)	PU1-EEM	26-Aug-2006	89	0.2	0.1	0.1	68	0.005	0.09	0.01	0.01	282
	PU1-RCA	26-Aug-2006	86	0.2	0.1	0.1	68	0.005	0.08	0.01	0.01	286
	PU1-RCAD	26-Aug-2006	86	0.2	0.1	0.1	68	0.005	0.08	0.01	0.01	282
	PN2	25-Aug-2006	136	0.3	0.1	0.4	177	0.005	0.20	0.01	0.01	492
	PN3	25-Aug-2006	586	0.4	0.1	0.3	82	0.005	0.07	0.01	0.01	312
	PN4	25-Aug-2006	64	0.2	0.1	0.1	25	0.005	0.08	0.01	0.01	186
	PN5	24-Aug-2006	112	0.2	0.1	0.1	46	0.005	0.11	0.01	0.01	278
	PU2	24-Aug-2006	100	0.2	0.1	0.1	52	0.005	0.10	0.01	0.01	230
	PU3	24-Aug-2006	399	0.3	0.1	0.3	95	0.005	0.15	0.01	0.01	318
	PU4	23-Aug-2006	79	0.2	0.1	0.1	49	0.005	0.12	0.01	0.01	222
Summary	Number of Samples		69	70	67	67	44	59	28	28	36	21
	Mean		48.6	0.24	0.029	0.244	67.8	0.005	0.14	0.08	0.007	274
	Standard Deviation		90.2	0.16	0.037	0.181	25.7	0.004	0.05	0.36	0.004	69
	Mean + 2 Standard Deviations		229.0	0.56	0.103	0.605	119.3	0.013	0.23	0.80	0.016	413
	CME Guideline: Freshwater Aquatic Life		300	5.0	0.10	NG	NG	Variable[a]	2.9[b]	0.06[c]	0.010[d]	NG

[a]The guideline for total ammonia-N is pH and temperature dependent.

[b]Guideline is expressed as mg nitrate-nitrogen/L.

[c]Guideline is expressed as mg nitrite-nitrogen/L.

[d]CCME guidance framework recommends no greater than a 50% increase in phosphorus concentrations above the baseline level.

Site-specific objectives were lower than CCME guidelines for Fe, As, ammonia and nitrate, and effectively the same for Ag (site-specific: 0.103 µg/L versus CCME: 0.10 µg/L). No CCME guidelines currently exist for Sb, sulphate and total dissolved solids. The CCME guideline for ammonia is pH and temperature dependent; however, the site-specific guideline is considerably lower than the most conservative CCME guideline over the pH and temperature range existing in Prairie Creek. This is due to the low background concentrations of ammonia in Prairie Creek.

For contaminant load modelling purposes, the mean concentrations of the parameters in Prairie Creek, as derived in Table 1, should be used as the background concentration. These are reproduced in Table 2.

Table 2: Prairie Creek background concentrations for use when modelling contaminant loads.

Parameter	Units	Prairie Creek background
Iron	µg/L	48.6
Arsenic	µg/L	0.24
Silver	µg/L	0.029
Antimony	µg/L	0.244
Sulphate	mg/L	67.8
Ammonia	mg/L	0.005
Nitrate	mg/L	0.14
Nitrite	mg/L	0.08
Phosphorus	mg/L	0.007
Total Dissolved Solids	mg/L	274

If you have any questions regarding these site-specific objectives, please do not hesitate to contact me.

Sincerely,

Andrew Harwood, Ph.D.
Lead Research Scientist
Water Sciences Team, Ecosystems
Saskatchewan Research Council

Annex J4

MEMORANDUM

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Golder Associates

Golder Associates Ltd.
Telephone No.: 403-299-5600
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DATE: February 14, 2008 07-1334-0026/8000

TO: Mr. John Bartlett
De Beers Canada Inc.

FROM: Ken DeVos and Mark Digel

CC: Lasha Young and Kristin Salzsauler

RE: Snap Lake Mine: Nitrate and Ammonia Concentration and Loading Estimates Relative to Environmental Assessment Report Predictions for Additional Explosives Use

1. INTRODUCTION

The site water quality model for the De Beers Snap Lake Mine was developed for the 2002 Snap Lake Environmental Assessment Report (Appendix IX.1, De Beers 2002). The memorandum herein presents the results of an evaluation of the potential effects of doubling the use of explosives at the Snap Lake on ammonia and nitrate concentrations and loads discharged from the site to Snap Lake. As requested by De Beers Canada Inc. (De Beers), the modelling uses all of the same assumptions, source terms and limitations as those described in Appendix IX.1 of the Environmental Assessment Report (EAR) with the exception of the doubling of the explosive use rates over the duration of mining.

The scope of work as requested and presented includes only an update of results for nitrate and ammonia at the final discharge from the treatment system to Snap Lake (relative to those used in the EAR), for the condition of doubling the explosives use rate in the mine. Other changes in site conditions will have an influence on observed water quality; however, they are not considered in this model.

A brief summary of the overall model structure and overall model limitations is provided in Section 2.0 and Section 2.1. The assumptions, source terms, and limitations as they relate to explosives loading rates both in the original EAR model and as currently modelled are provided in Section 2.2; however, due to the overall model complexity the reader is referred to

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Appendix IX.1 of the EAR for a detailed description of the model structure and for a description of all source loading terms other than for explosives.

2. THE SNAP LAKE MINE SITE WATER QUALITY MODEL

The Snap Lake Mine site consists of several inter-related components that contribute to flow and/ or mass loading on site water quality. The existing model combines water balance and mass balance considerations for each site component. A recirculation loop is incorporated in the model structure that iteratively accounts for water seeping from the lake to the mine, which is pumped through the treatment system and back to the lake.

Explosives are primarily used underground and will contribute mass load to the mine water. Other influencing factors with respect to the overall discharge water quality include: groundwater inflow to the mine; North Pile runoff; site runoff; and, treatment. In addition to these factors, mixing in Snap Lake and seepage of water from Snap Lake, through the groundwater and back to the mine can significantly influence the resulting predicted water quality. In the EAR predictions, and in the current predictions, all water reporting to the working areas of the mine were assigned an incremental loading to account for observed values in the underground exploration program. Each of these factors, in addition to explosives use, can influence the concentrations and loadings of ammonia and nitrate from the Snap Lake Mine.

Water quality estimates are provided for a forty-year period, beginning in January 2000. For the purposes of modelling, it is assumed that the mine was flooded at the end of August 2001 and remained flooded until 2003. A pre-development phase was assumed from 2003 to 2005, followed by an operational phase from 2005 through 2027. Closure was assumed to occur at the end of December 2027. A full explanation of the assumptions, source terms and limitations can be found in Appendix IX.1 of the EAR (De Beers 2002).

2.1 Model Limitations

Key limitations of the GoldSim model include:

- Changes to the Snap Lake Project or site conditions – The project description and site conditions as identified in the EAR are the basis for the model. The current changes to site conditions represent significant deviations from those used in the EAR predictions, especially with respect to predicted mine water inflow values (HCI 2005; De Beers 2006). Changes in project or site conditions have not been incorporated into the model and will change water quality predictions.
- System complexity – For the Snap Lake Mine, care was taken to incorporate all known processes as understood during model development at the time of EAR preparation. However; even the best models incorporate simplified representations of the processes occurring in a natural system and results will vary from operational

monitoring data. Incorporation of the existing monitoring data will help in refining water quality estimates. As indicated in the Appendix IX.1 of the EAR, the occasional re-assessment of potential impact predictions and/or remedial measures will be required as part of an adaptive management strategy.

2.2 Mass Load Due to Explosives Use

Explosives use will primarily influence concentrations and mass loading for total ammonia (NH_3) and nitrate (NO_3). The modelled nitrate and ammonia loadings are also influenced by the incremental load added to the mine water from groundwater entering the working face of the mine. The incremental load added was based on observations during the exploration program for the mine and may change based on operational data; however, these possible changes were not included in this update.

In developing estimates of mass load due to explosive use, the following factors were considered:

- the type of explosives used;
- the schedule of explosives use (AMEC 2001); and,
- the explosives handling considerations (i.e., spillage/unreacted explosives).

The explosive material usage schedule as derived in the EAR (Figure 1) was used to help develop the mass load rates. For the purpose of the model runs the amount of explosives released was doubled, which accounts for an assumed doubling of the explosives used, under the assumption that the waste rate of explosives remains constant. The mass released was added to the calculated mine water flow rate to develop estimates of concentration over time for these parameters.

Geochemical reactions and attenuation mechanisms for the nitrogen species were not included in the model; however, they have the potential to reduce observed concentrations along the flow system. Mass is lost from the system only through discharge from the Snap Lake outlet, with concentrations and loading rates stabilizing once mass discharged from the system via the Snap Lake outlet is equal to the mass added through explosives use and other sources.

At present, it is estimated that the primary type of explosive used during operations will be an emulsion type explosive (emulsion), with ammonium nitrate/fuel oil (ANFO) being used for footwall development. A minor amount of packaged explosive and detonator cord will also be used. The bulk compositions of the emulsion and ANFO are provided in Table 1. For the purposes of the mass loading estimates, all types of packaged explosives and other explosive products (excluding emulsion) were conservatively assigned the chemical composition of ANFO since ANFO has a higher proportion of NH_4 and NO_3 relative to emulsion.

Table 1 Explosive Composition (based on data from manufacturers)

Components	Ammonium Nitrate/Fuel Oil	Emulsion (non-aluminized)
NH_4NO_3	94 %	63 %
$NaNO_3$	0 %	18 %
H_2O	0 %	9 %
fuel Oil	6 %	6 %
microballoons (glass)	0 %	4 %
aluminum	0 %	0 %

Notes: See unit and acronym list for definitions.

The amount of waste explosive that will dissolve and enter the flow system can range from less than 2% to greater than 10% depending on the handling procedures for a given mine. Under the assumption that reasonable handling practices will be employed at Snap Lake, an explosives waste rate of 5% was used to calculate mass load in the model. It was further assumed that all wasted explosives would dissolve entirely. Figure 1 shows the anticipated emulsion and ANFO use incorporated in the model (AMEC 2001).

3. RESULTS

Results are presented for nitrate and ammonia at the final discharge from the treatment system to Snap Lake (relative to those used in the EAR), for the condition of doubling the explosives use rate in the mine. Results are presented in Attachment 1 and Figures 2 and 3 present the concentrations and mass load rates respectively for nitrate and ammonia at the final discharge. Doubling the input mass of explosives in the mine results in the following estimates of changes in ammonia and nitrate concentrations and loading in the final mine water discharge to Snap Lake:

Ammonia Discharged

- Peak total ammonia concentrations (expressed as nitrogen [N]) of about 23 mg/L-N in the overall site discharge compared to EAR predicted peak values of about 15 mg/L-N.
- Long term (average predicted concentration from year 10 to year 20) ammonia concentrations of about 7 mg/L-N in the overall site discharge compared to EAR predicted long term values of values of about 5.5 mg/L-N.
- Mass load rates at the discharge point increase over the first few years of mining and stabilizing at values ranging from about 150 kg-N/d to 190 kg-N/d compared to EAR long term values ranging from about 115 kg-N/d to 145 kg-N/d.

Nitrate Discharge

- Peak nitrate concentrations of about 25 mg/L-N (expressed as nitrogen [N]) in the overall site discharge compared to EAR predicted peak values of about 16 mg/L-N.
- Long term nitrate concentrations of about 8 mg/L-N in the overall site discharge compared to EAR predicted long term values of about 6 mg/L-N.
- Mass load rates at the discharge point increasing over the first few years of mining stabilizing at values ranging from about 160 kg-N/d to 290 kg-N/d compared to EAR long term values ranging from about 120 kg-N/d to 240 kg-N/d.

4. DISCUSSION AND RECOMMENDATIONS

For a 100% increase in the rate of explosive use, the corresponding modelled increase in both concentration and long term loading rate the lake is approximately 25%. A 100% increase in the results in a lower percent increase in concentrations and loadings of ammonia and nitrate to Snap Lake because explosives provides only a portion of the total loadings contributed by mining activities. This illustrates that for the parameters NH_4, and NO_3, variability is governed not only by explosives use, but by groundwater inflow, and the overall Snap Lake hydrologic system. With current monitoring data and mine development it should be possible to review the current nitrate and ammonia loading reporting from mine-water inflow, independent of explosives use in the mine to determine if the incremental loading factor for nitrate and ammonia as determined from the exploration data remains appropriate.

It is recommended that the overall model be updated to reflect changes in predicted mine water inflows by HCI, as well as to reflect current observations related to mine water quality, surface water quality, surface layout, and changes related to processing and storage of waste materials.

5. REFERENCES

AMEC. 2001. Expected explosive use rate for the Snap Lake Mine. Table from K. Durston, Project Engineer. Unpublished. July 2001.

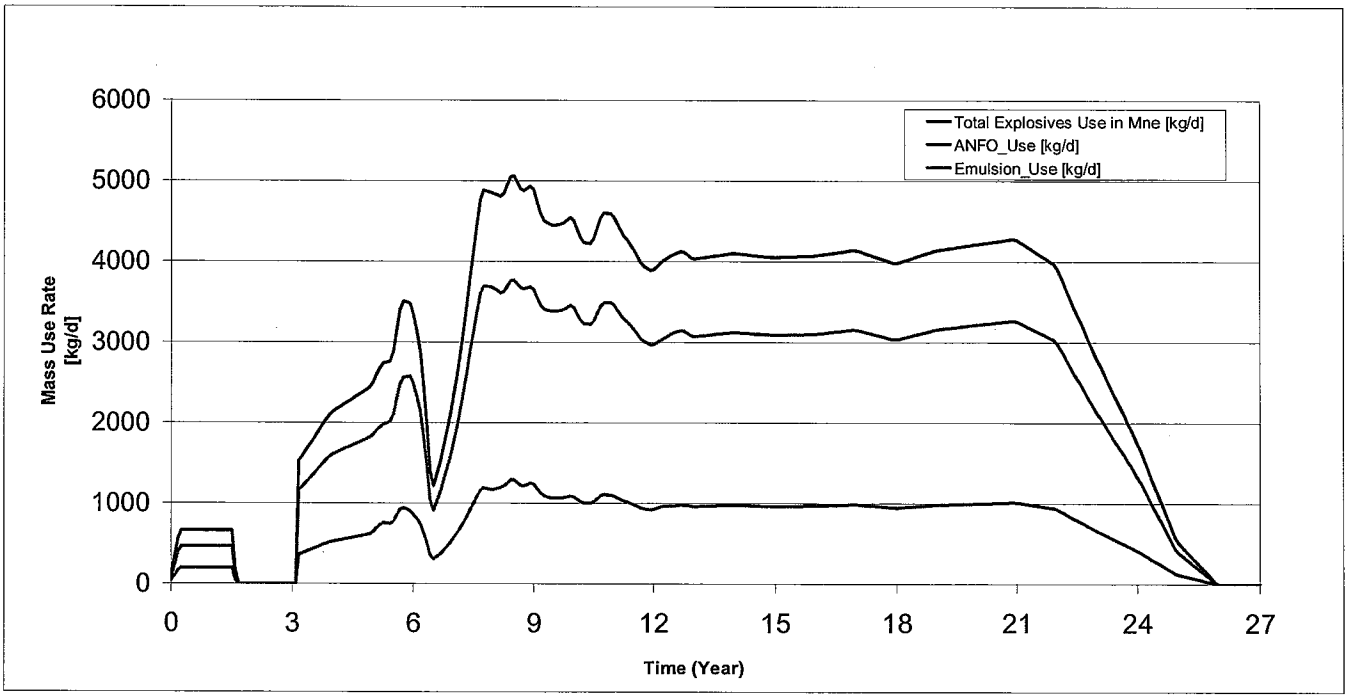
De Beers Canada Inc. (De Beers). 2002. Snap Lake Diamond Project Environmental Assessment. February 2002. Document submitted to Mackenzie Valley Environmental Impact Review Board. February 2002.

De Beers Canada Inc. (De Beers). 2006. 2005 Annual Report, Type A Water License MV2001L2-0002. Prepared for the Mackenzie Valley Land and Water Board. March 2006.

HCI (Hydrologic Consultants, Inc. of Colorado). 2005. Hydrogeologic Framework of Snap Lake Project Area and Predicted Inflow to Proposed Mine. September 2005 updated based on Data from P1PP. Prepared by Hydrologic Consultants Inc. of Colorado, an HCItaska Company. September, 2005. HCI 1780.

Explosive Use Rate for Environmental Assessment Report Predictions

Figure 1



Note: Rates shown were used in EAR predictions, a 100% increase (or doubling of the explosives shown in the graph) was used for the current model.

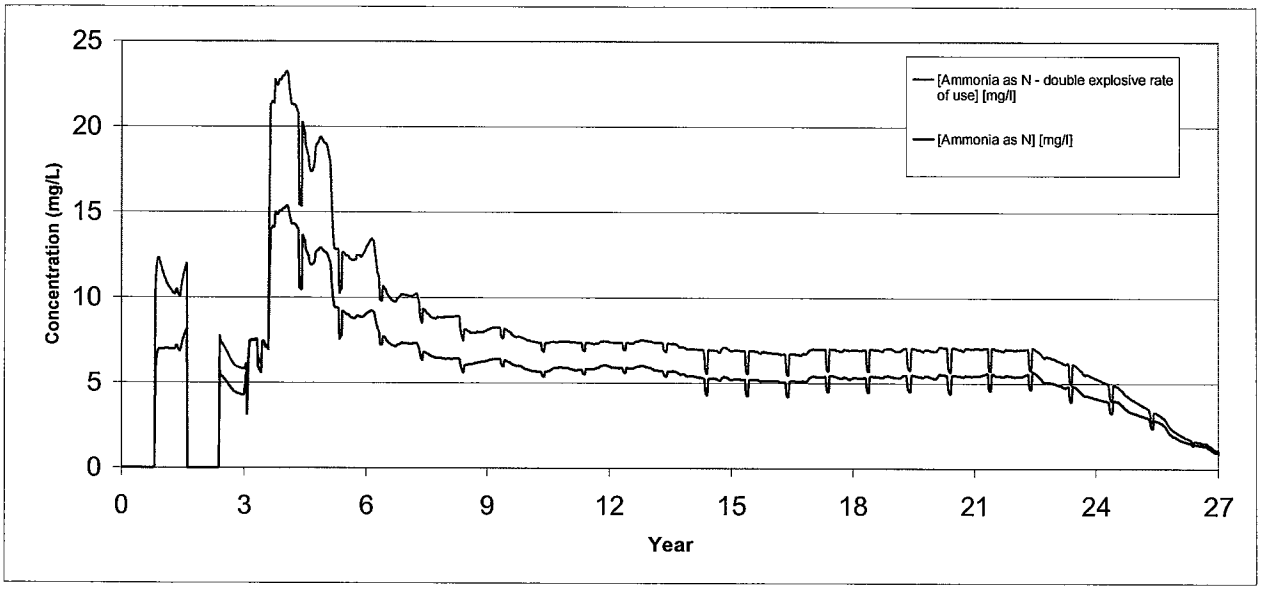
Date: January, 2008
Project: 07-1334-0026 / 9000

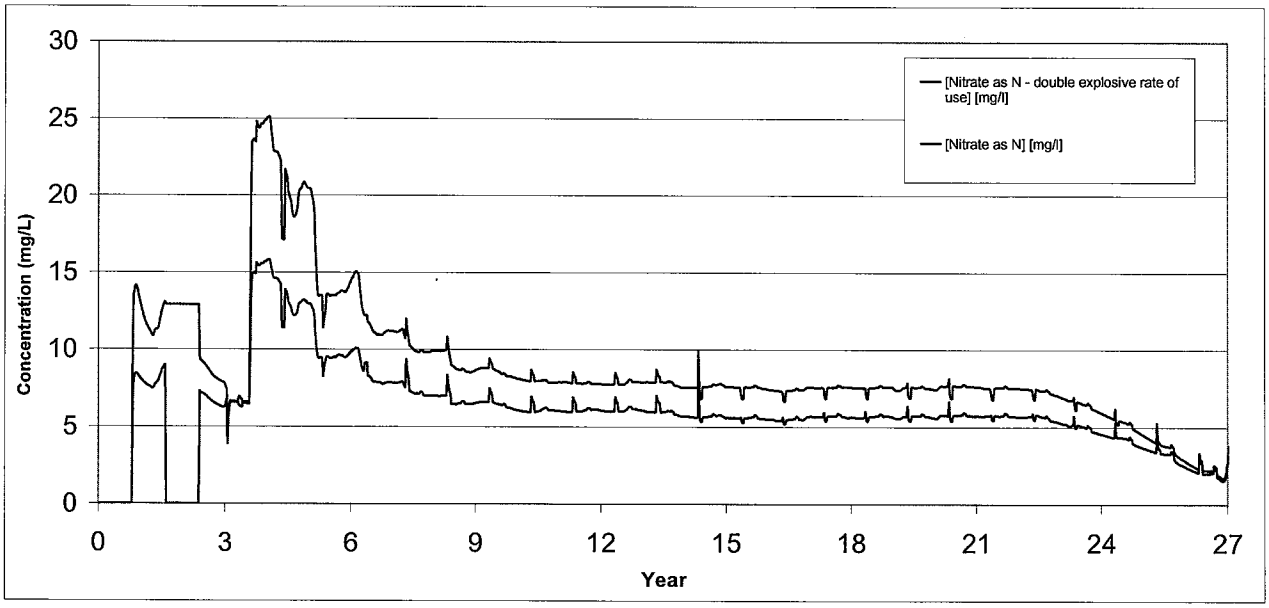
Drawn CMC
Chkd KJD

Golder Associates

Concentrations of Nitrate and Ammonia
Final Discharge to Snap Lake

Figure 2





Date: January, 2008
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Chkd KJD

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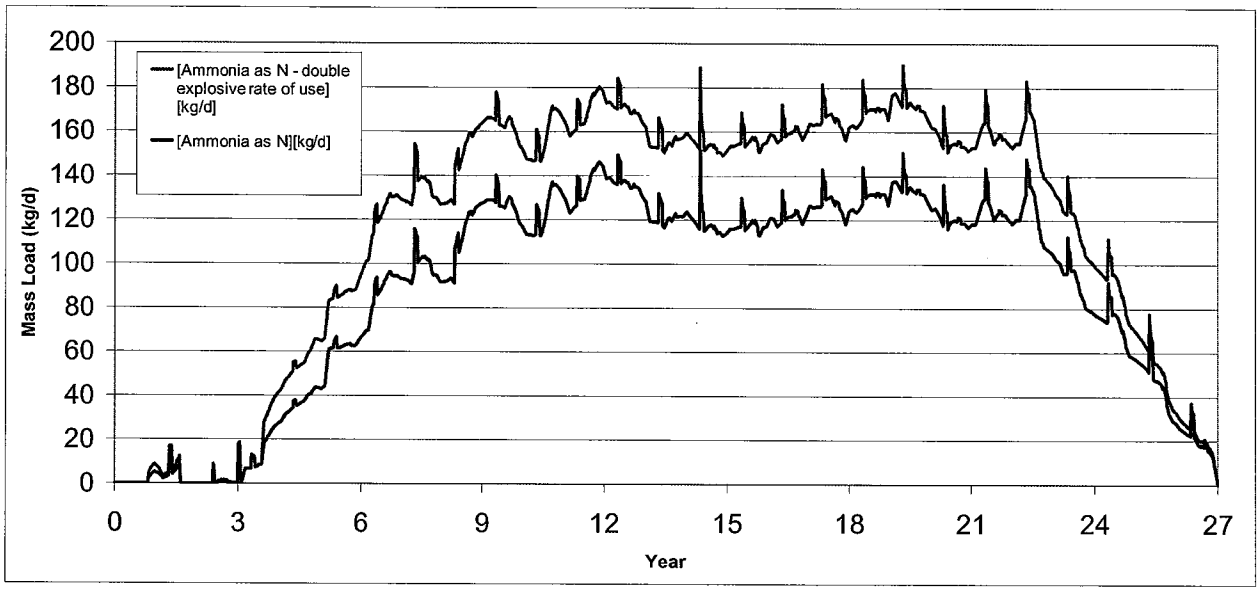
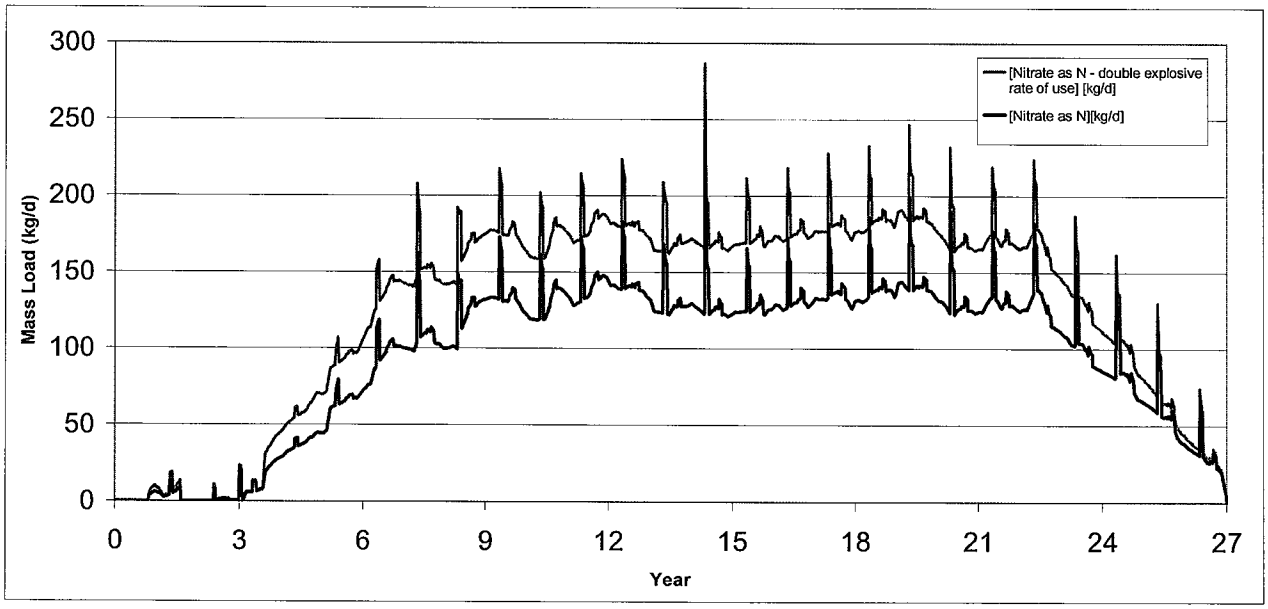
Mass Load Rate of Nitrate and Ammonia
Final Discharge to Snap Lake

Figure 3





Date: January, 2008
Project: 07-1334-0026 / 9000

Drawn CMC
Chkd KJD

Golder Associates

Annex J5

DE BEERS
CANADA
SNAP LAKE MINE

August 31, 2009

File: L020

Willard Hagen, Chair
Mackenzie Valley Land and Water Board
PO Box 2130
Yellowknife, Northwest Territories
X1A 2P6

Dear: Mr. Hagen:

Re: Snap Lake Mine
Monthly Water License Report: July 2009
Land Use Permit #MV2001C0012 / Water License #MV2001L2-0002

Monthly Surveillance Network Program (SNP) samples were collected during July from eleven (11) stations at the De Beers Canada Inc. Snap Lake Mine site. SNP Station 02-03 was not sampled due to obstruction by the relocation of the ore storage pile to facilitate the construction of the permanent accommodations complex. To comply with the directive from INAC, De Beers will be submitting a formal request to the MVLWB to modify Condition 4 of the Surveillance Network Programme for SNP Station 02-03.

Details for the samples collected during the month are presented in the attached tables along with the Quality Assurance/Quality Control (QA/QC) analyses. Data validation is ongoing and revised data are updated in subsequent SNP reports.

To harmonize with the Aquatics Effects Monitoring Program, calculated Total Dissolved Solids (TDS) as opposed to measured values will be reported.

The following table illustrates the sampling status of the various SNP stations for the reporting period (Table 1). SNP Stations 02-22 and 02-23 sampling was discontinued after the diffuser and effluent pipeline construction in Snap Lake was completed September 2005.

#300 – 5102 50th AVENUE
YELLOWKNIFE NT X1A 3S8 CANADA
TEL (867) 766-7300 FAX (867) 766-7347

TABLE 1: SNP SAMPLING STATUS JULY 2009

SNP STATION	DESCRIPTION	STATUS
02-01	Final mine water collection sump	Active
02-02	North Pile drainage collection ditch	Active
02-03	Core Facilities area collection ditch near Water Management Pond	In-active
02-04	Uncontrolled surface runoff at culvert by airstrip	Active
02-05	Uncontrolled surface runoff at Bulk Sample Mine Rock Pad	Active
02-06	Uncontrolled surface runoff at Quarry Site	Active
02-07	Uncontrolled surface runoff at Road to Bulk Emulsion Plant	Active
02-08	Uncontrolled surface runoff at Winter Access Road	Active
02-09	Uncontrolled surface runoff at Emulsion Plant Area	Active
02-10	Any other points where observable flow to Snap Lake or IL5 is observed	Active
02-11	Seepage well down gradient from Dam 1 near Snap Lake shoreline	Active
02-12	Seepage well down gradient from Dam 1 at Water Management Pond	Active
02-13	Seepage well down gradient from Dam 2 at Water Management Pond	Active
02-14	Water Management Pond (stilling well near pump house)	Active
02-15	Water Intake from Snap Lake	Active
02-16	Sewage Discharge from Sewage Treatment Plant prior to mixing with Water Treatment Plant Effluent	Active
02-17	Final Combined Water Treatment Plant and Sewage Treatment Plant Effluent	Active
02-18	Whole Lake Total Dissolved Solids, Calcium, and Chloride (several sites with the main lake basin of Snap Lake	AEMP
02-19	SNP Station Removed effective November 16th 2007	In-active
02-20	Snap Lake on the edge of the mixing zone around the diffuser (2 stations located in a radius of 120 degrees at 200 meters from diffuser)	AEMP
02-21	Outlet from Snap Lake flowing into the Lockhart System	AEMP
02-22	Diffuser Construction – completed September 2005	In-active
02-23	Intake Construction – completed September 2005	In-active

WATER MANAGEMENT

SNP Station 02-02 (Table 3): turbidity analysis was missed on July 19 and 26 by the laboratory due to login errors.

SNP Station 02-16i (Table 6): The monthly average for all parameters at STP2 was compliant for July.

STP1 was decommissioned when dorms in the old camp were shut down April 11, 2009. MBR 3 was decommissioned June 26, 2009 and MBR 2 was taken out of service July 4, 2009. Graphical profiles are provided in Figures 1 to 3.

SNP Station 02-17 (Table 7): The Water Treatment (WTP) operated for 31 days during the month and discharged a volume of 597,067 cubic meters. The monthly average for all parameters met compliance for July. Graphical profiles are provided in Figures 4 to 16.

All flows from the Water Management Pond are directed to the permanent Water Treatment Plant for processing. A cap was removed from an additional port to accommodate an increase in flow from the underground.

Field Blank (June SNP Table 19): questionable data results were received for the field blank for June. An investigation is being undertaken with the laboratory to determine the cause.

WATER CONSUMPTION

The quantity of water extracted from Snap Lake for camp operations, site services, construction and commissioning purposes are tabulated in Table 11. A total volume of approximately 3,089 cubic meters (m^3) of water was consumed during the month.

GENERAL WASTE

All domestic camp/kitchen wastes generated were incinerated except grease from the kitchen grease traps. The grease is shipped off-site. Waste wood products are burned in the authorized pit as per the Land Use Permit. Audits of the waste management area are conducted weekly to ensure unsuitable wastes are controlled and managed.

SPILL REPORTING

There were no reportable spills in July. All other spills reported during the month are included in Table 12.

REGULATORY

One routine regulatory inspection was conducted in July for site. No major issues were identified.

ENVIRONMENTAL STUDIES/SURVEYS

Regular monitoring of Snap Lake included the following:

- Site water monitoring activities;
- Monthly Profiles and Water Quality around diffuser;
- Plankton / Benthic Survey;
- Fish Health Survey;
- Fish Population Survey;

- Raptor Fledgling Count; and
- Air Quality.

CONSTRUCTION ACTIVITIES

Earthworks were ongoing for the construction of a 4 meter lift on the Starter Cell berms to elevation 482 meters. The modification request to raise the height of the Starter Cell to 486 meters was approved by the Board.

Foundations, footings and grounding for footings were worked on at the Ammonium Nitrate Bulk Storage Facility.

GEO-TECHNICAL ACTIVITIES

The Water Management Pond (WMP) water elevation and North Pile sump monitoring is ongoing (Table 13).

PROCESSING PLANT ACTIVITIES

With the finalization of Phase I Pre-Production Mining in 2005, the Bulk Sample Plant was mothballed in July 2005. The plant was re-commissioned with the first material processed through the plant February 21, 2008. The plant was shut down on February 1, 2009 and will re-open when the mine returns to full production.

The Process Plant processed a total of 12,102 tonnes of kimberlite. Approximately 10,620 tonnes of coarse reject and 10,157 m^3 of slimes were deposited in the North Pile Starter Cell in July. Preparations were initiated in preparation for the summer slowdown July 15 – September 2, 2009 as per Sections 5.1.2 and 5.1.3 of the Closure and Reclamation Plan.

MINING ACTIVITIES

Underground de-watering continued throughout the month. A total volume of 545,133 m^3 was directed to the Water Treatment Plant.

FUEL STORAGE/ TANK FARM ACTIVITIES

Ongoing inspections of the tank farms and distribution systems continued for the month.

AIR STRIP

Regular monitoring and strip maintenance was carried out during the month.

CONTAINMENT DAMS

Weekly inspections of Dams # 1 and 2 continued during the month with no unusual occurrences noted. The annual inspection of the Water Management Pond dams was completed and the summary report submitted to the Board.

Should you have any questions, comments or require further clarification, please don't hesitate to contact me at 767-8763 or e-mail me at the following address: Gail.Seto@ca.debeersgroup.com).

Sincerely,
DE BEERS CANADA MINING INC.

Gail Seto
Sr. Environmental Coordinator
Snap Lake Mine

Copied to: J. Ash, V. Meeres (MVLWB)
T. Covey (INAC)
D. White & Z. Liu (SLEMA)
B. Corrigan, D. McCallum, & D. Vokey (DBCM)
File

TABLE 2: FINAL MINEWATER COLLECTION SUMP
(SNP Station 02-01)
LICENSE # MV2001L2-0002
Month - July 2009

Surveillance Network Program Results for the Snap Lake Mine	UNITS	05-Jul-09		12-Jul-09		19-Jul-09		26-Jul-09	
Sample Control Number		2009-1565		2009-1584		2009-1596		2009-1623	
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
pH	pH	7.82		7.88		7.81		7.82	
Specific Conductivity	µS/cm	1040		1140		1140		1040	
Alkalinity	mg/L	53.8		52.7		53.4		50.3	
Hardness	mg/L	287		362		349		330	
Total Suspended Solids	mg/L	641		1060		1070		76.0	
Total Dissolved Solids(calc)	mg/L	486		571		569		532	
Turbidity	NTC	345		560		612		40.0	
NUTRIENTS	UNITS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Ammonia-N	mg/L	1.06	n/a	2.52	n/a	1.91	n/a	0.423	n/a
Nitrate-N	mg/L	2.91	n/a	4.98	n/a	4.26	n/a	1.33	n/a
Nitrite-N	mg/L	0.108	n/a	0.223	n/a	0.365	n/a	0.0562	n/a
Total Kjeldahl Nitrogen	mg/L	1.61	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Phosphorus	mg/L	1.42	0.0026	n/a	n/a	n/a	n/a	n/a	n/a
Ortho-phosphate	mg/L	0.0027	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Organic Carbon	mg/L	2.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MAJOR IONS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
Bicarbonate	mg/L	33.3		37.4		34.8		61.4	
Calcium	mg/L	101		126		124		118	
Carbonate	mg/L	< 5.0		< 5.0		< 5.0		< 5.0	
Chloride	mg/L	244		273		282		274	
Fluoride	mg/L	0.363		0.369		0.393		0.344	
Magnesium	mg/L	8.48		11.4		9.62		8.55	
Potassium	mg/L	2.92		3.98		3.70		2.98	
Sodium	mg/L	49.9		64.6		62.1		57.3	
Sulphate	mg/L	33.3		37.4		34.8		34.2	
ORGANICS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
Oil & Grease	mg/L	< 1.0		n/a		n/a		n/a	
Benzene	mg/L	< 0.00050		n/a		n/a		n/a	
Ethylbenzene	mg/L	< 0.00050		n/a		n/a		n/a	
Toluene	mg/L	< 0.00050		n/a		n/a		n/a	
Xylene	mg/L	< 0.00050		n/a		n/a		n/a	
F1 (C6-C10)	mg/L	< 0.10		n/a		n/a		n/a	
F2 (> C10 C-16)	mg/L	< 0.25		n/a		n/a		n/a	
ULTRA LOW METALS	UNITS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Aluminum	µg/L	9700	< 40	n/a	n/a	n/a	n/a	n/a	n/a
Antimony	µg/L	< 20	< 3.2	n/a	n/a	n/a	n/a	n/a	n/a
Arsenic	µg/L	< 4.0	< 1.6	n/a	n/a	n/a	n/a	n/a	n/a
Barium	µg/L	441	27.5	n/a	n/a	n/a	n/a	n/a	n/a
Beryllium	µg/L	< 4.0	< 2.0	n/a	n/a	n/a	n/a	n/a	n/a
Bismuth	µg/L	< 0.40	< 0.20	n/a	n/a	n/a	n/a	n/a	n/a
Boron	µg/L	111	91.1	n/a	n/a	n/a	n/a	n/a	n/a
Cadmium	µg/L	< 0.80	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Cesium	µg/L	< 200	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Chromium	µg/L	177	< 1.6	n/a	n/a	n/a	n/a	n/a	n/a
Cobalt	µg/L	21.4	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Copper	µg/L	15.2	< 2.4	n/a	n/a	n/a	n/a	n/a	n/a
Iron	µg/L	20.7	< 5.0	n/a	n/a	n/a	n/a	n/a	n/a
Lead	µg/L	13.3	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Lithium	µg/L	63	19.5	n/a	n/a	n/a	n/a	n/a	n/a
Manganese	µg/L	428	32.2	n/a	n/a	n/a	n/a	n/a	n/a
Mercury	µg/L	< 0.020	< 0.020	n/a	n/a	n/a	n/a	n/a	n/a
Molybdenum	µg/L	3.87	3.32	n/a	n/a	n/a	n/a	n/a	n/a
Nickel	µg/L	297	9.24	n/a	n/a	n/a	n/a	n/a	n/a
Rubidium	µg/L	< 200	< 200	n/a	n/a	n/a	n/a	n/a	n/a
Selenium	µg/L	< 0.40	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Silver	µg/L	2.2	< 0.80	n/a	n/a	n/a	n/a	n/a	n/a
Strontium	µg/L	1720	1590	n/a	n/a	n/a	n/a	n/a	n/a
Thallium	µg/L	< 0.40	XD	n/a	n/a	n/a	n/a	n/a	n/a
Tin	µg/L	< 1.6	< 0.80	n/a	n/a	n/a	n/a	n/a	n/a
Titanium	µg/L	580	< 1.2	n/a	n/a	n/a	n/a	n/a	n/a
Uranium	µg/L	2.54	0.72	n/a	n/a	n/a	n/a	n/a	n/a
Vanadium	µg/L	25.9	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Zinc	µg/L	71.0	< 8.0	n/a	n/a	n/a	n/a	n/a	n/a
Field Parameters	UNITS								
pH	pH	7.69		8.24		7.75		7.43	
Specific Conductivity	µS/cm	970		1075		1040		1004	
Water Temperature	°C	11.2		7.1		11.9		9.4	

General Notes: Parameters in addition to those requested by the water license were analyzed. This data will be used in water quality modelling for the mine.
Shaded values are under investigation for lab QA/QC reasons.
R - Result adjusted for method blank XD = Invalid result based on internal review - dissolved metals exceeded total metals

TABLE 3: NORTH PILE COLLECTION DITCH
(SNP Station 02-02)
LICENSE # MV2001L2-0002
Month - July 2009

Surveillance Network Program Results for the Snap Lake Mine	UNITS	05-Jul-09		12-Jul-09		19-Jul-09		26-Jul-09	
Sample Control Number		2009-1566		2009-1585		2009-1597		2009-1624	
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
pH	pH	7.82		n/a		n/a		n/a	
Specific Conductivity	µS/cm	2280		n/a		n/a		n/a	
Alkalinity	mg/L	71.5		n/a		n/a		n/a	
Hardness	mg/L	688		n/a		n/a		n/a	
Total Suspended Solids	mg/L	8		7		13		4410	
Total Dissolved Solids (calc)	mg/L	1360		n/a		n/a		n/a	
Turbidity	NTC	5.16		8.08		lab login error		lab login error	
NUTRIENTS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Ammonia-N	mg/L	18.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nitrate-N	mg/L	116	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nitrite-N	mg/L	1.50	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total Kjeldahl Nitrogen	mg/L	16.9	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Phosphorous	mg/L	0.0128	0.0057	n/a	n/a	n/a	n/a	n/a	n/a
Ortho-phosphate	mg/L	< 0.0010	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Organic Carbon	mg/L	3.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MAJOR IONS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
Bicarbonate	mg/L	142		n/a		n/a		n/a	
Calcium	mg/L	148		n/a		n/a		n/a	
Carbonate	mg/L	< 5.0		n/a		n/a		n/a	
Chloride	mg/L	304		n/a		n/a		n/a	
Fluoride	mg/L	0.724		n/a		n/a		n/a	
Magnesium	mg/L	68.5		n/a		n/a		n/a	
Potassium	mg/L	30.6		n/a		n/a		n/a	
Sodium	mg/L	111		n/a		n/a		n/a	
Sulphate	mg/L	142		n/a		n/a		n/a	
ORGANICS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
Benzene	mg/L	< 0.00050		n/a		n/a		n/a	
Ethylbenzene	mg/L	< 0.00050		n/a		n/a		n/a	
Toluene	mg/L	< 0.00050		n/a		n/a		n/a	
Xylene	mg/L	< 0.00050		n/a		n/a		n/a	
TEH (C11 - C30)	mg/L	n/a		n/a		n/a		n/a	
F1 C6-C10 (mg/L)	mg/L	< 0.10		n/a		n/a		n/a	
F2 (> C10 C-16)	mg/L	< 0.25		n/a		n/a		n/a	
ULTRA LOW METALS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Aluminum	µg/L	127	< 40	n/a	n/a	n/a	n/a	n/a	n/a
Antimony	µg/L	< 20	< 3.2	n/a	n/a	n/a	n/a	n/a	n/a
Arsenic	µg/L	< 4.0	< 1.6	n/a	n/a	n/a	n/a	n/a	n/a
Barium	µg/L	163	147	n/a	n/a	n/a	n/a	n/a	n/a
Beryllium	µg/L	< 4.0	< 2.0	n/a	n/a	n/a	n/a	n/a	n/a
Bismuth	µg/L	< 0.40	< 0.20	n/a	n/a	n/a	n/a	n/a	n/a
Boron	µg/L	860	812	n/a	n/a	n/a	n/a	n/a	n/a
Cadmium	µg/L	< 0.80	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Cesium	µg/L	< 200	0.82	n/a	n/a	n/a	n/a	n/a	n/a
Chromium	µg/L	< 3.2	XD	n/a	n/a	n/a	n/a	n/a	n/a
Cobalt	µg/L	2.1	1.76	n/a	n/a	n/a	n/a	n/a	n/a
Copper	µg/L	< 4.0	< 2.4	n/a	n/a	n/a	n/a	n/a	n/a
Iron	µg/L	0.614	XD	n/a	n/a	n/a	n/a	n/a	n/a
Lead	µg/L	< 0.40	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Lithium	µg/L	27	17.3	n/a	n/a	n/a	n/a	n/a	n/a
Manganese	µg/L	122	108	n/a	n/a	n/a	n/a	n/a	n/a
Mercury	µg/L	< 0.020	< 0.020	n/a	n/a	n/a	n/a	n/a	n/a
Molybdenum	µg/L	34.7	36.4	n/a	n/a	n/a	n/a	n/a	n/a
Nickel	µg/L	47.9	45.4	n/a	n/a	n/a	n/a	n/a	n/a
Rubidium	µg/L	< 200	< 200	n/a	n/a	n/a	n/a	n/a	n/a
Selenium	µg/L	< 0.40	< 0.40	n/a	n/a	n/a	n/a	n/a	n/a
Silver	µg/L	< 1.6	< 0.80	n/a	n/a	n/a	n/a	n/a	n/a
Strontium	µg/L	1620	1670	n/a	n/a	n/a	n/a	n/a	n/a
Thallium	µg/L	< 0.40	< 0.20	n/a	n/a	n/a	n/a	n/a	n/a
Tin	µg/L	< 1.6	< 0.80	n/a	n/a	n/a	n/a	n/a	n/a
Titanium	µg/L	< 20	< 1.2	n/a	n/a	n/a	n/a	n/a	n/a
Uranium	µg/L	2.99	2.74	n/a	n/a	n/a	n/a	n/a	n/a
Vanadium	µg/L	2.01	< 2.0	n/a	n/a	n/a	n/a	n/a	n/a
Zinc	µg/L	< 16	< 8.0	n/a	n/a	n/a	n/a	n/a	n/a
FIELD PARAMETERS	UNITS								
pH	pH	7.9		7.56		7.82		7.74	
Specific Conductivity	µS/cm	2074		2054		1731		1808	
Water Temperature	°C	14.5		12.3		15.7		15.5	

General Notes: Parameters in addition to those requested by the water license were analyzed. This data will be used in water quality modelling for the mine.
Shaded values are under investigation for lab QA/QC reasons.
R - Result adjusted for method blank XD = Invalid result based on internal review - dissolved metals exceeded total metals

TABLE 4: WATER MANAGEMENT POND
(STILLING WELL NEAR THE PUMPHOUSE)
SNP Station 02-14
LICENSE # MV2001L2-0002
Month - July 2009

Surveillance Network Program Results for the Snap Lake Mine	UNITS	05-Jul-09		12-Jul-09		20-Jul-09		26-Jul-09	
Sample Control Number		2009-1567		2009-1586		2009-1598		2009-1625	
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
pH	pH	7.72		7.71		7.77		7.64	
Specific Conductivity	µS/cm	1870		1910		1930		1860	
Alkalinity	mg/L	45.9		50		49.9		47	
Hardness	mg/L	412		490		469		553	
Total Suspended Solids	mg/L	4		3		85		5.0	
Total Dissolved Solids (calc)	mg/L	1040		1100		1070		1130	
Turbidity	NTC	2.45		2.43		3.21		5	
NUTRIENTS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Ammonia-N	mg/L	39.4	n/a	38.1	n/a	31.3	n/a	26.5	n/a
Nitrate-N	mg/L	97.5	n/a	99.4	n/a	91.5	n/a	87.8	n/a
Nitrite-N	mg/L	0.741	n/a	1.08	n/a	1.45	n/a	1.83	n/a
Total Kjeldahl Nitrogen	mg/L	35.3	n/a	35.3	n/a	27.1	n/a	17.5	n/a
Phosphorous	mg/L	0.0154	0.0066	0.0123	0.0031	1.27	0.0039	0.0100	0.0024
Ortho-phosphate	mg/L	< 0.0010	n/a	< 0.0010	n/a	< 0.0010	n/a	< 0.0010	n/a
Organic Carbon	mg/L	2.9	n/a	3.3	n/a	3.5	n/a	3.1	n/a
MAJOR IONS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
Bicarbonate	mg/L	115		60.6		122		57.2	
Calcium	mg/L	111		122		109		133	
Carbonate	mg/L	< 5.0		< 5.0		< 5.0		< 5.0	
Chloride	mg/L	230		238		245		268	
Fluoride	mg/L	0.742		0.745		0.796		0.806	
Magnesium	mg/L	40.9		45.1		47.8		53.6	
Potassium	mg/L	20.9		23.7		21.7		23.3	
Sodium	mg/L	79.3		91.5		81.1		87.9	
Sulphate	mg/L	115		127.0		122		135	
ORGANICS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL	
Benzene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050	
Ethylbenzene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050	
Toluene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050	
Xylene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050	
F1 C6-C10 (mg/L)	mg/L	< 0.10		< 0.10		< 0.10		< 0.10	
F2 (> C10 C-16)	mg/L	< 0.25		< 0.25		< 0.25		< 0.25	
ULTRA LOW METALS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Aluminum	µg/L	87	21	65.5	6.55	714	< 10	< 80	< 40
Antimony	µg/L	< 20	1.0	0.793	0.816	< 5.0	0.81	< 20	< 3.2
Arsenic	µg/L	< 4.0	0.98	0.755	0.768	1.6	1.26	< 4.0	2.1
Barium	µg/L	105	103	101	98.3	137	102	119	107
Beryllium	µg/L	< 4.0	< 0.50	< 0.20	< 0.20	< 1.0	< 0.50	< 4.0	< 2.0
Bismuth	µg/L	< 0.40	< 0.050	< 0.030	< 0.030	< 0.20	< 0.050	< 0.80	< 0.20
Boron	µg/L	500	467	382	317	532	460	631	574
Cadmium	µg/L	< 0.80	0.1	< 0.050	< 0.050	< 0.20	< 0.10	< 0.80	< 0.40
Cesium	µg/L	< 200	0.46	0.43	0.42	< 50	0.44	< 200	0.46
Chromium	µg/L	< 3.2	XD	1.34	< 0.060	41.3	< 2.0	< 16	< 8.0
Cobalt	µg/L	1.04	0.9	1.22	0.95	8.94	0.75	1.22	0.84
Copper	µg/L	< 4.0	1.8	1.32	1.12	3.8	4.89	< 4.0	3.5
Iron	µg/L	0.177	XD	150	9.6	2800	< 10	759	720
Lead	µg/L	< 0.40	0.1	0.138	0.066	3.26	< 0.10	< 0.40	< 0.40
Lithium	µg/L	< 24	XD	22.2	20.8	29.7	23.2	30.0	23.9
Manganese	µg/L	58.7	39.6	74.0	65.0	262	30.8	90.9	96.9
Mercury	µg/L	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Molybdenum	µg/L	31.4	32.6	33.6	32.8	28.3	35.2	34.2	33.2
Nickel	µg/L	34.1	30.2	41.2	36.7	121.0	40.0	45.6	40.3
Rubidium	µg/L	< 200	< 50	39.6	38.9	< 50	< 50	< 200	< 200
Selenium	µg/L	< 0.40	< 0.40	< 0.40	< 0.40	8.90	0.60	< 0.40	< 0.40
Silver	µg/L	< 1.6	< 0.20	< 0.10	< 0.10	< 0.40	< 0.20	< 1.6	< 0.80
Strontium	µg/L	1290	1280	1370	1330	1480	1510	1550	1440
Thallium	µg/L	< 0.40	0.16	0.095	0.092	0.35	0.120	< 0.40	< 0.20
Tin	µg/L	< 1.6	< 0.20	n/a	n/a	< 0.40	< 0.20	< 1.6	< 0.80
Titanium	µg/L	< 20	1.04	6.89	1.83	38.1	< 0.30	< 20	< 1.2
Uranium	µg/L	2.06	2.04	2.15	2.13	3.06	1.91	2.07	1.88
Vanadium	µg/L	1.47	< 2.0	0.617	0.364	5.98	0.5	< 10	< 2.0
Zinc	µg/L	< 16	6.0	14.2	13.3	31.0	10.8	17.0	11.1
FIELD PARAMETERS	UNITS								
pH	pH	7.80		7.86		7.80		7.44	
Specific Conductivity	µS/cm	1817		1820		1844		1821	
Water Temperature	°C	16.0		12.5		16.5		16.5	

General Notes: Parameters in addition to those requested by the water license were analyzed. This data will be used in water quality modelling for the mine.
Shaded values are under investigation for lab QA/QC reasons.
R - Result adjusted for method blank XD = Invalid result based on internal review - dissolved metals exceeded total metals

TABLE 5: WATER INTAKE FROM SNAP LAKE
(SNP Station 02-15)
LICENSE # MV2001L2-0002
Month - July 2009

Surveillance Network Program Results for the Snap Lake Mine	UNITS	02-May-09		07-Jun-09		05-Jul-09		05-Jul-09 Duplicate		05-Jul-09 Multi-Agency Triplicate	
Sample Control Number				2009-1450		2009-1568		2009-1569		2009-1570	
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
pH	pH	n/a		6.83		7.07		7.02		n/a	
Specific Conductivity	µS/cm	missed in error		130		82.4		81.9		78.6	
Alkalinity	mg/L	n/a		11.8		7.7		7.1		6.6	
Hardness	mg/L	n/a		39.7		26.2		25.9		30.1	
Total Suspended Solids	mg/L	n/a		n/a		n/a		n/a		n/a	
Total Dissolved Solids (calc)	mg/L	n/a		65.0		39.2		38.6		30	
Turbidity	NTC	n/a		n/a		n/a		n/a		n/a	
NUTRIENTS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Ammonia-N	mg/L	n/a	n/a	0.0876	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Nitrate-N	mg/L	n/a	n/a	0.291	n/a	0.166	n/a	0.173	n/a	0.13	n/a
Nitrite-N	mg/L	n/a	n/a	< 0.0020	n/a	< 0.0020	n/a	< 0.0020	n/a	< 0.01	n/a
Total Kjeldahl Nitrogen	mg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Phosphorous	mg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ortho-phosphate	mg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Organic Carbon	mg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
MAJOR IONS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
Bicarbonate	mg/L	n/a		6.16		3.83		3.78		6.6	
Calcium	mg/L	n/a		12.2		8.01		7.93		9.6	
Carbonate	mg/L	n/a		< 5.0		< 5.0		< 5.0		n/a	
Chloride	mg/L	n/a		27.7		16.1		15.9		16.8	
Fluoride	mg/L	n/a		0.072		0.051		< 0.050		0.1	
Magnesium	mg/L	n/a		2.25		1.5		1.47		1.5	
Potassium	mg/L	n/a		1.16		0.83		0.85		0.8	
Sodium	mg/L	n/a		7.10		3.5		3.6		4.6	
Sulphate	mg/L	n/a		6.16		3.83		3.78		4	
MICROBIOLOGY	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
E. coli	CFU/100ml	n/a		< 1.0		< 1.0		< 1.0		< 1.0	
Crytosporidium	oocyst/100mL	n/a		n/a		0		n/a		n/a	
Giarida	cysts/10L	n/a		n/a		0		n/a		n/a	
Heterotrophic Plate Count	CFU/100ml	n/a		n/a		134		n/a		n/a	
FIELD PARAMETERS	UNITS										
pH	pH	n/a		6.21		5.97		n/a		n/a	
Specific Conductivity	µS/cm	n/a		131.3		88.3		n/a		n/a	
Water Temperature	°C	n/a		18.9		13.4		n/a		n/a	

General Notes: Parameters in addition to those requested by the water license were analyzed. This data will be used in water quality modelling for the mine. Shaded values are under investigation for lab QA/QC reasons.

R - Result adjusted for method blank XD = Invalid result based on internal review - dissolved metals exceeded total metals

TABLE 6: SEWAGE DISCHARGED FROM SEWAGE TREATMENT PLANTS PRIOR TO MIXING WITH WATER TREATMENT PLANT EFFLUENT (SNP 02-16i STP2)

LICENCE #MV2001L2-2001

Month - July 2009

Surveillance Network Program Results for the Snap Lake Mine	UNITS	06-Jul-09		12-Jul-09		21-Jul-09		28-Jul-09		Monthly Average
Sample Control Number		2009-1576		2009-1581		2009-1621		2009-1626		
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		AVE
pH	pH	6.70		6.93		7.02		7.05		6.93
Total Suspended Solids	mg/L	< 3		< 3		8		10		5
NUTRIENTS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	AVE
BOD (5-day)	mg/L	< 2	n/a	< 2	n/a	< 2	n/a	3	n/a	2
Ammonia-N	mg/L	0.02	n/a	0.02	n/a	0.03	n/a	0.02	n/a	0.02
Total Kjeldahl Nitrogen	mg/L	0.14	n/a	0.75	n/a	0.43	n/a	0.64	n/a	0.49
Phosphorous	mg/L	0.38	0.09	0.13	0.07	1.54	0.49	1.38	0.74	0.86
Ortho-phosphate	mg/L	0.017	n/a	0.008	n/a	0.200	n/a	0.508	n/a	0.183
Organic Carbon	mg/L	8.3	n/a	8.0	n/a	10.4	n/a	8.0	n/a	8.7
MAJOR IONS										AVE
Nitrate-N	mg/L	8.40		6.90		4.48		5.80		6.40
Nitrite-N	mg/L	0.15		0.15		0.10		0.07		0.12
MICROBIOLOGICAL	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		AVE
E. Coli	mpn/100ml	< 1.0 F		< 1.0		3.1		i		1.4
Faecal Coliforms	cfu/100ml	< 1 F		< 1		4 AB		i		1
ORGANICS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		AVE
Hexane Extractable Material	mg/L	< 2.0		< 2.0		< 2.0		< 2.0		< 2.0
FIELD PARAMETERS	UNITS									
pH	pH	6.31		6.82		6.64		6.72		6.62
Specific Conductivity	µS/cm	686		724		711		700		705
Water Temperature	°C	23.5		23.0		25.7		23.5		23.9

E = Suspect Result: Sample stored above recommended temperature
AB = Possible matrix interference, reported result uncertain
F = Suspect Result: Sample received frozen.

TABLE 7: WATER TREATMENT PLANT EFFLUENT
(SNP Station 02-17B)
LICENSE # MV2001L2-0002
Month - July 2009

Surveillance Network Program Results for the Snap Lake Mine	UNITS	02-Jul-09		07-Jul-09		13-Jul-09		19-Jul-09		25-Jul-09		Monthly Average
Sample Control Number		2009-1561		2009-1578		2009-1583		2009-1599		2009-1622		
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL		AVE
pH	pH	7.77		7.59		7.44		7.57		7.48		7.57
Specific Conductivity	µS/cm	1110		1270		1250		1290		1230		1230
Alkalinity	mg/L	50.9		38.0		30.9		36.0		35.3		38.2
Hardness	mg/L	340		364		377		388		368		367
Total Suspended Solids	mg/L	4.0		< 3.0		< 3.0		< 3.0		5.0		3
Total Dissolved Solids (calc)	mg/L	543		653		657		590		576		604
Turbidity	NTU	0.88		2.73		0.90		0.47		0.44		1.08
NUTRIENTS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	AVE
Biochemical Oxygen Demand	mg/L	n/a	n/a	n/a	n/a	< 2.0	n/a	n/a	n/a	n/a	n/a	< 2.0
Ammonia-N	mg/L	1.16	n/a	7.05	n/a	8.85	n/a	7.46	n/a	5.50	n/a	6.00
Nitrate-N	mg/L	3.63	n/a	19.3	n/a	21.8	n/a	21.7	n/a	1.43	n/a	13.57
Nitrite-N	mg/L	0.078	n/a	0.247	n/a	0.280	n/a	0.299	n/a	0.287	n/a	0.238
Total Kjeldahl Nitrogen	mg/L	1.34	n/a	6.94	n/a	9.08	n/a	5.12	n/a	3.90	n/a	5.28
Phosphorous	mg/L	0.0028	< 0.0010	0.0040	< 0.0010	0.0077	0.0022	0.0041	0.0019	0.0045	< 0.0010	0.0046
Ortho-phosphate	mg/L	< 0.0010	n/a	< 0.0010	n/a	< 0.0010	n/a	< 0.0010	n/a	< 0.0010	n/a	< 0.0010
Organic Carbon	mg/L	1.7	n/a	2.3	n/a	2.7	n/a	2.1	n/a	2.2	n/a	2.2
MAJOR IONS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL		AVE
Bicarbonate	mg/L	38.7		64.5		67.7		72.6		43.1		57.3
Calcium	mg/L	120		119		124		127		119		122
Carbonate	mg/L	< 5.0		< 5.0		< 5.0		< 5.0		< 5.0		< 5.0
Chloride	mg/L	263		268		259		277		272		268
Fluoride	mg/L	0.358		0.425		0.438		0.482		0.443		0.43
Magnesium	mg/L	9.68		16.2		16.3		17.3		17.2		15.3
Potassium	mg/L	3.2		7.05		6.98		7.00		7.19		6.28
Sodium	mg/L	60.7		68.7		66.3		67.9		63.2		65.4
Sulphate	mg/L	38.7		64.5		67.7		72.6		68.1		62.3
ORGANICS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL		AVE
Oil & Grease	mg/L	n/a		n/a		< 1.0		n/a		n/a		< 1.0
Benzene	mg/L	n/a		n/a		< 0.00050		n/a		n/a		< 0.00050
Ethylbenzene	mg/L	n/a		n/a		< 0.00050		n/a		n/a		< 0.00050
Toluene	mg/L	n/a		n/a		< 0.00050		n/a		n/a		< 0.00050
Xylene	mg/L	n/a		n/a		< 0.00050		n/a		n/a		< 0.00050
F1 (C6-C10)	mg/L	n/a		n/a		< 0.10		n/a		n/a		< 0.10
F2 (>C10-C16)	mg/L	n/a		n/a		< 0.25		n/a		n/a		< 0.050
MICROBIOLOGY	UNITS											AVE
E. Coli	cfu/100ml	n/a		n/a		< 1.0		n/a		n/a		< 1.0
Faecal Coliform	cfu/100ml	n/a		n/a		< 1		n/a		n/a		< 1
ULTRA / LOW METALS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	AVE
Aluminum	µg/L	n/a	n/a	n/a	n/a	24.1	7.65	n/a	n/a	n/a	n/a	24.1
Antimony	µg/L	n/a	n/a	n/a	n/a	0.332	0.334	n/a	n/a	n/a	n/a	0.332
Arsenic	µg/L	n/a	n/a	n/a	n/a	0.74	0.642	n/a	n/a	n/a	n/a	0.74
Barium	µg/L	n/a	n/a	n/a	n/a	35.3	34.1	n/a	n/a	n/a	n/a	35.3
Beryllium	µg/L	n/a	n/a	n/a	n/a	< 0.20	< 0.20	n/a	n/a	n/a	n/a	< 0.20
Bismuth	µg/L	n/a	n/a	n/a	n/a	< 0.030	< 0.030	n/a	n/a	n/a	n/a	< 0.030
Boron	µg/L	n/a	n/a	n/a	n/a	141	135	n/a	n/a	n/a	n/a	141
Cadmium	µg/L	n/a	n/a	n/a	n/a	< 0.050	< 0.050	n/a	n/a	n/a	n/a	< 0.050
Cesium	µg/L	n/a	n/a	n/a	n/a	0.15	0.15	n/a	n/a	n/a	n/a	0.15
Chromium	µg/L	n/a	n/a	n/a	n/a	1.61	1.51	n/a	n/a	n/a	n/a	1.61
Cobalt	µg/L	n/a	n/a	n/a	n/a	0.24	0.2	n/a	n/a	n/a	n/a	0.24
Copper	µg/L	n/a	n/a	n/a	n/a	1.19	XD	n/a	n/a	n/a	n/a	1.19
Iron	µg/L	n/a	n/a	n/a	n/a	49	13.3	n/a	n/a	n/a	n/a	49
Lead	µg/L	n/a	n/a	n/a	n/a	0.129	0.125	n/a	n/a	n/a	n/a	0.129
Lithium	µg/L	n/a	n/a	n/a	n/a	23.7	23.8	n/a	n/a	n/a	n/a	23.7
Manganese	µg/L	n/a	n/a	n/a	n/a	33.0	31.7	n/a	n/a	n/a	n/a	33
Mercury	µg/L	n/a	n/a	n/a	n/a	< 0.020	< 0.02	n/a	n/a	n/a	n/a	< 0.020
Molybdenum	µg/L	n/a	n/a	n/a	n/a	9.09	8.98	n/a	n/a	n/a	n/a	9.09
Nickel	µg/L	n/a	n/a	n/a	n/a	8.35	7.99	n/a	n/a	n/a	n/a	8.35
Rubidium	µg/L	n/a	n/a	n/a	n/a	10.0	9.9	n/a	n/a	n/a	n/a	10
Selenium	µg/L	n/a	n/a	n/a	n/a	< 0.40	< 0.4	n/a	n/a	n/a	n/a	< 0.40
Silver	µg/L	n/a	n/a	n/a	n/a	< 0.10	< 0.10	n/a	n/a	n/a	n/a	< 0.10
Strontium	µg/L	n/a	n/a	n/a	n/a	1630	1600	n/a	n/a	n/a	n/a	1630
Thallium	µg/L	n/a	n/a	n/a	n/a	< 0.030	< 0.030	n/a	n/a	n/a	n/a	< 0.030
Tin	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Titanium	µg/L	n/a	n/a	n/a	n/a	2.04	1.12	n/a	n/a	n/a	n/a	2.04
Uranium	µg/L	n/a	n/a	n/a	n/a	1.07	1.02	n/a	n/a	n/a	n/a	1.07
Vanadium	µg/L	n/a	n/a	n/a	n/a	0.256	0.055	n/a	n/a	n/a	n/a	0.256
Zinc	µg/L	n/a	n/a	n/a	n/a	1.58	XD	n/a	n/a	n/a	n/a	1.58
FIELD PARAMETERS	UNITS											AVE
pH	pH	7.05		6.26		6.58		6.73		6.71		6.67
Specific Conductivity	µS/cm	1043		1354		1172		1163		1177		1182
Water Temperature	°C	9.5		12.9		9.5		11.1		12.1		11.0

General Notes: Parameters in addition to those requested by the water license were analyzed. This data will be used in water quality modelling for the mine.
Shaded values are under investigation for lab QA/QC reasons.
R - Result adjusted for method blank XD = Invalid result based on internal review - dissolved metals exceeded total metals

TABLE 8: TRAVEL BLANKS

LICENSE #MV2001L2-0002

Month - July 2009

Surveillance Network Program Results for the Snap Lake Mine	UNITS	01-Feb-09		03-Mar-09		02-Apr-09		01-Jun-09		05-Jul-09	
Sample Control Number		2009-0087		2009-1161		2009-1271		2009-1394		2009-1572	
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
pH	pH	5.6		5.5		5.81		5.12		5.58	
Specific Conductivity	µS/cm	0.5		1.0		0.88		0.30		< 0.20	
Alkalinity	mg/L	< 5.0		< 5.0		< 5.0		< 5.0		< 5.0	
Hardness	mg/L	< 1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Total Suspended Solids	mg/L	< 3.0		< 3.0		< 3.0		< 3.0		< 3.0	
Total Dissolved Solids (calc)	mg/L	< 1.0		< 1.0		< 1.0		< 1.0		< 1.0	
Turbidity	NTU	< 0.10		< 0.10		< 0.10		< 0.10		< 0.10	
NUTRIENTS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Biochemical Oxygen Demand	mg/L	< 2	n/a	< 2	n/a	< 2	n/a	< 2.0	n/a	< 2.0	n/a
Ammonia-N	mg/L	< 0.005	n/a	< 0.005	n/a	< 0.0050	n/a	< 0.0050	n/a	< 0.0050	n/a
Nitrate-N	mg/L	< 0.006	n/a	< 0.006	n/a	< 0.0060	n/a	< 0.0060	n/a	< 0.0060	n/a
Nitrite-N	mg/L	< 0.002	n/a	< 0.002	n/a	< 0.0020	n/a	< 0.0020	n/a	< 0.0020	n/a
Total Kjeldahl Nitrogen	mg/L	< 0.05	n/a	< 0.05	n/a	< 0.050	n/a	< 0.050	n/a	< 0.050	n/a
Phosphorous	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.0010	< 0.001	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ortho-phosphate	mg/L	< 0.001	n/a	< 0.001	n/a	< 0.0010	n/a	< 0.0010	n/a	< 0.0010	n/a
Organic Carbon	mg/L	< 1	n/a	< 1	n/a	< 1.0	n/a	< 1.0	n/a	< 1.0	n/a
MAJOR IONS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
Bicarbonate	mg/L	< 0.05		< 0.05		< 0.050		< 0.050		< 0.050	
Calcium	mg/L	< 0.5		< 0.5		< 0.50		< 0.50		< 0.50	
Carbonate	mg/L	< 5		< 5		< 5.0		< 5.0		< 5.0	
Chloride	mg/L	< 1		< 1		< 0.50		< 0.50		< 0.50	
Fluoride	mg/L	< 0.05		< 0.05		< 0.050		< 0.050		< 0.050	
Magnesium	mg/L	< 0.1		< 0.1		< 0.10		< 0.10		< 0.10	
Potassium	mg/L	< 0.1		< 0.1		< 0.10		< 0.10		< 0.10	
Sodium	mg/L	< 1		< 1		< 1.0		< 1.0		< 1.0	
Sulphate	mg/L	< 0.05		< 0.05		< 0.050		< 0.050		< 0.050	
ORGANICS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
Oil & Grease	mg/L	< 1		< 1		< 1		< 1.0		< 1.0	
Benzene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050		< 0.00050	
Ethylbenzene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050		< 0.00050	
Toluene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050		< 0.00050	
Xylene	mg/L	< 0.00050		< 0.00050		< 0.00050		< 0.00050		< 0.00050	
TEH (C11 - C30)	mg/L	< 0.05		< 0.05		< 0.050		n/a		n/a	
F1 C6-C10 (mg/L)	mg/L	< 0.10		< 0.10		< 0.10		< 0.10		< 0.10	
F2 (>C10-C16)	mg/L	< 0.05		< 0.05		< 0.050		< 0.050		< 0.25	
MICROBIOLOGY	UNITS										
E. Coli	cfu/100ml	< 1		< 1		7		< 1		< 1	
Faecal Coliform	cfu/100ml	< 1		< 1		9		< 1		< 1	
ULTRA LOW METALS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
Aluminum	µg/L	< 0.3	< 0.3	< 0.3	< 0.3	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30
Antimony	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030
Arsenic	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030
Barium	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Beryllium	µg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Bismuth	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030
Boron	µg/L	< 1	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Cadmium	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Cesium	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Chromium	µg/L	< 0.06	< 0.06	< 0.06	< 0.06	< 0.060	< 0.060	< 0.060	< 0.060	< 0.060	< 0.060
Cobalt	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Copper	µg/L	< 0.6	< 0.6	< 0.6	< 0.6	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60	< 0.60
Iron	µg/L	< 5	< 5	< 5	< 5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Lead	µg/L	0.13	0.13	0.13	0.12	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Lithium	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Manganese	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Mercury	µg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020	< 0.020
Molybdenum	µg/L	< 0.06	< 0.06	< 0.06	< 0.06	< 0.060	< 0.060	< 0.060	< 0.060	< 0.060	< 0.060
Nickel	µg/L	< 0.06	< 0.06	< 0.06	< 0.06	< 0.060	< 0.060	< 0.060	< 0.060	< 0.060	< 0.060
Rubidium	µg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0	< 1.0
Selenium	µg/L	< 0.4	< 0.4	< 0.4	< 0.4	0.4	XD	< 0.4	< 0.4	< 0.40	< 0.40
Silver	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Strontium	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Thallium	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030
Tin	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Titanium	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Uranium	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Vanadium	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050	< 0.050
Zinc	µg/L	< 0.8	< 0.8	< 0.8	< 0.8	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80

General Notes: Parameters in addition to those requested by the water license were analyzed. This data will be used in water quality modelling for the mine. Shaded values are under investigation for lab QA/QC reasons.

R - Result adjusted for method blank XD = Invalid result based on internal review - dissolved metals exceeded total metals

TABLE 9: FIELD BLANKS

LICENSE #MV2001L2-0002

Month - July 2009

Program Results for the Snap Lake Project	UNITS	01-Feb-09		03-Mar-09		08-Apr-09		05-Jul-09	
Sample Control Number		2009-0088		2009-1160		2009-1289		2009-1571	
ROUTINE	**UNITS**	**TOTAL**		**TOTAL**		**TOTAL**		**TOTAL**	
pH	pH	6.2		6.1		6.42		5.73	
Specific Conductivity	µS/cm	1.9		2.2		1.69		< 0.20	
Alkalinity	mg/L	< 5		< 5		< 5.0		< 5.0	
Hardness	mg/L	< 1		< 1		< 1.0		< 1.0	
Total Suspended Solids	mg/L	< 3		< 3		< 3.0		< 3.0	
Total Dissolved Solids (calc)	mg/L	< 1		< 1		< 1.0		< 1.0	
Turbidity	NTU	< 0.1		< 0.1		< 0.10		< 0.10	
NUTRIENTS		**TOTAL**	**DISS**	**TOTAL**	**DISS**	**TOTAL**	**DISS**	**TOTAL**	**DISS**
Biochemical Oxygen Demand	mg/L	< 2	n/a	< 2	n/a	< 2	n/a	< 2.0	n/a
Ammonia-N	mg/L	0.007	n/a	< 0.005	n/a	< 0.0050	n/a	< 0.0050	n/a
Nitrate-N	mg/L	< 0.006	n/a	< 0.006	n/a	< 0.0060	n/a	< 0.0060	n/a
Nitrite-N	mg/L	< 0.002	n/a	< 0.002	n/a	< 0.0020	n/a	< 0.0020	n/a
Total Kjeldahl Nitrogen	mg/L	< 0.05	n/a	< 0.05	n/a	< 0.050	n/a	< 0.050	n/a
Phosphorous	mg/L	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Ortho-phosphate	mg/L	< 0.001	n/a	< 0.001	n/a	< 0.0010	n/a	< 0.0010	n/a
Organic Carbon	mg/L	< 1	n/a	< 1	n/a	< 1.0	n/a	< 1.0	n/a
MAJOR IONS	**UNITS**		**TOTAL**		**TOTAL**		**TOTAL**		**TOTAL**
Bicarbonate	mg/L		< 0.05		< 0.05		< 0.050		< 0.050
Calcium	mg/L		< 0.5		< 0.5		< 0.50		< 0.50
Carbonate	mg/L		< 5		< 5		< 5.0		< 5.0
Chloride	mg/L		< 1		< 1		< 0.50		< 0.50
Fluoride	mg/L		< 0.05		< 0.05		< 0.050		< 0.050
Magnesium	mg/L		< 0.1		< 0.1		< 0.10		< 0.10
Potassium	mg/L		< 0.1		< 0.1		< 0.10		< 0.10
Sodium	mg/L		< 1		< 1		< 1.0		< 1.0
Sulphate	mg/L		< 0.05		< 0.05		< 0.050		< 0.050
ORGANICS	**UNITS**		**TOTAL**		**TOTAL**		**TOTAL**		**TOTAL**
Oil & Grease	mg/L		< 1		< 1		< 1.0		< 1.0
Benzene	mg/L		< 0.00050		< 0.00050		< 0.00050		< 0.00050
Ethylbenzene	mg/L		< 0.00050		< 0.00050		< 0.00050		< 0.00050
Toluene	mg/L		< 0.00050		< 0.00050		< 0.00050		< 0.00050
Xylene	mg/L		< 0.00050		< 0.00050		< 0.00050		< 0.00050
TEH (C11 - C30)	mg/L		< 0.05		< 0.05		< 0.050		n/a
F1-BTEX	mg/L		< 0.1		< 0.1		< 0.10		< 0.10
F2 (>C10-C16)	mg/L		< 0.05		< 0.05		< 0.050		< 0.25
MICROBIOLOGY	**UNITS**								
E. Coli	cfu/100ml		< 1.0		< 1.0		< 1		< 1
Faecal Coliform	cfu/100ml		< 1		< 1		< 1		< 1
ULTRA LOW METALS		**TOTAL**	**DISS**	**TOTAL**	**DISS**	**TOTAL**	**DISS**	**TOTAL**	**DISS**
Aluminum	µg/L	4.7	XD	< 0.3	< 0.3	0.4	< 0.30	< 0.30	< 0.30
Antimony	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030
Arsenic	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030
Barium	µg/L	0.14	XD	< 0.05	XD	0.052	< 0.050	< 0.050	< 0.050
Beryllium	µg/L	< 0.2	< 0.2	< 0.2	< 0.2	< 0.20	< 0.20	< 0.20	< 0.20
Bismuth	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030
Boron	µg/L	< 1	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0	< 1.0
Cadmium	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050	< 0.050
Cesium	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Chromium	µg/L	< 0.06	XD	< 0.06	< 0.06	< 0.060	< 0.060	< 0.060	XD
Cobalt	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Copper	µg/L	< 0.6	< 0.6	< 0.6	< 0.6	< 0.60	< 0.60	< 0.60	< 0.60
Iron	µg/L	12	XD	< 5	< 5	< 5.0	< 5.0	< 5.0	< 5.0
Lead	µg/L	0.07	0.08	0.05	0.05	< 0.050	0.055	< 0.050	XD
Lithium	µg/L	< 0.1	0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Manganese	µg/L	0.3	0.5	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Mercury	µg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.020	< 0.020	< 0.020	< 0.020
Molybdenum	µg/L	< 0.06	< 0.06	< 0.06	< 0.06	< 0.060	< 0.060	< 0.060	< 0.060
Nickel	µg/L	0.07	XD	< 0.06	< 0.06	< 0.060	< 0.060	< 0.060	< 0.060
Rubidium	µg/L	< 1	< 1	< 1	< 1	< 1.0	< 1.0	< 1.0	< 1.0
Selenium	µg/L	< 0.40	< 0.40	< 0.40	< 0.40	< 0.40	< 0.40	< 0.40	< 0.40
Silver	µg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Strontium	µg/L	0.2	XD	< 0.1	XD	< 0.10	< 0.10	< 0.10	< 0.10
Thallium	µg/L	< 0.03	< 0.03	< 0.03	< 0.03	< 0.030	< 0.030	< 0.030	< 0.030
Tin	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Titanium	µg/L	0.4	0.3	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Uranium	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050	< 0.050
Vanadium	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.050	< 0.050	< 0.050	< 0.050
Zinc	µg/L	1.3	< 0.8	< 0.8	< 0.8	< 0.80	< 0.80	< 0.80	< 0.80

General Notes: Parameters in addition to those requested by the water license were analyzed. This data will be used in water quality modelling for the mine. Shaded values are under investigation for lab QA/QC reasons.

R - Result adjusted for method blank XD = Invalid result based on internal review - dissolved metals exceeded total metals

TABLE 10: FIELD BLANKS (SEWAGE)

LICENSE #MV2001L2-0002

Month - July 2009

Surveillance Network Program Results for the Snap Lake Project	STATION	06-Feb-09		03-Mar-09		07-Apr-09		06-Jun-09		06-Jul-09	
Sample Control Number		2009-0098		2009-1167		2009-1285		2009-1448		2009-1577	
ROUTINE	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
pH	pH	6.31		6.37		6.41		6.44		5.98	
Total Suspended Solids	mg/L	< 3		< 3		< 3		< 3		< 3	
NUTRIENTS		TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS	TOTAL	DISS
BOD (5-day)	mg/L	i	n/a	< 2	n/a	< 2	n/a	< 2	n/a	< 2	n/a
Ammonia-N	mg/L	0.008	n/a	< 0.005	n/a	< 0.01	n/a	< 0.01	n/a	< 0.01	n/a
Total Kjeldahl Nitrogen	mg/L	0.09	n/a	0.06	n/a	< 0.06	n/a	< 0.06	n/a	< 0.06	n/a
Phosphorous	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ortho-phosphate	mg/L	0.003	n/a	< 0.002	n/a	< 0.002	n/a	< 0.002	n/a	< 0.002	n/a
Organic Carbon	mg/L	0.9	n/a	< 0.5	n/a	< 0.5	n/a	< 0.5	n/a	< 0.5	n/a
MAJOR IONS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
Nitrate-N	mg/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
Nitrite-N	mg/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
ORGANICS	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
Hexand Extractable Material	mg/L	2.2		< 2.0		< 2.0		< 2.0		< 2.0	
MICROBIOLOGY	UNITS	TOTAL		TOTAL		TOTAL		TOTAL		TOTAL	
E. Coli	cfu/100ml	i		< 1.0		< 1.0		i		< 1.0	
Faecal Coliform	cfu/100ml	i		< 1		< 1		i		< 1	

i= hold time exceeded upon receipt at lab

TABLE 11: MONTHLY AND YEAR-TO-DATE WATER BALANCE SUMMARY

Date	Pumphouse Volume Pumped	Water Volume Trucked	Sewage Volume Disposed	Recycled Water	Minewater	TWTP Discharge to Snap Lake	WTP Discharge to Snap Lake
	(m^3)						
JAN	4,617	0	4,617	23,949	475,944	0	448,657
FEB	4,403	0	4,403	18,923	427,948	0	393,937
MAR	3,680	0	3,680	14,733	494,693	0	464,194
APR	3,099	0	3,099	6,088	495,492	0	458,220
MAY	3,210	0	3,210	7,213	518,086	0	478,480
JUN	3,199	0	3,199	7,055	512,721	0	545,771
JUL	2,645	0	2,645	1,427	545,133	0	597,067
AUG							
SEP							
OCT							
NOV							
DEC							
Totals	**24,853**	**0**	**24,853**	**79,388**	**3,470,017**	**0**	**3,386,326**

Table 12: SPILLS SUMMARY

Month	Day	PRODUCT	VOLUME	Units	LOCATION	EQUIPMENT / COMMENTS
Jul	1	hydraulic oil	5	L	5190N	JD-204 Jumbo
Jul	3	hydraulic oil	49	L	TDA	TC-401 Truck
Jul	3	hydraulic oil	10	L	510 170A	JD-202 Jumbo
Jul	3	hydraulic oil	4	L	TDA	LV-211 Toyota
Jul	11	diesel	10	L	Spur road to AN site	Spill on AN run from a loose hose
Jul	12	hydraulic oil	89	L	505 490 Ramp	DL-101 Solo
Jul	14	hydraulic oil	49	L	505 118A	DL-101 Solo

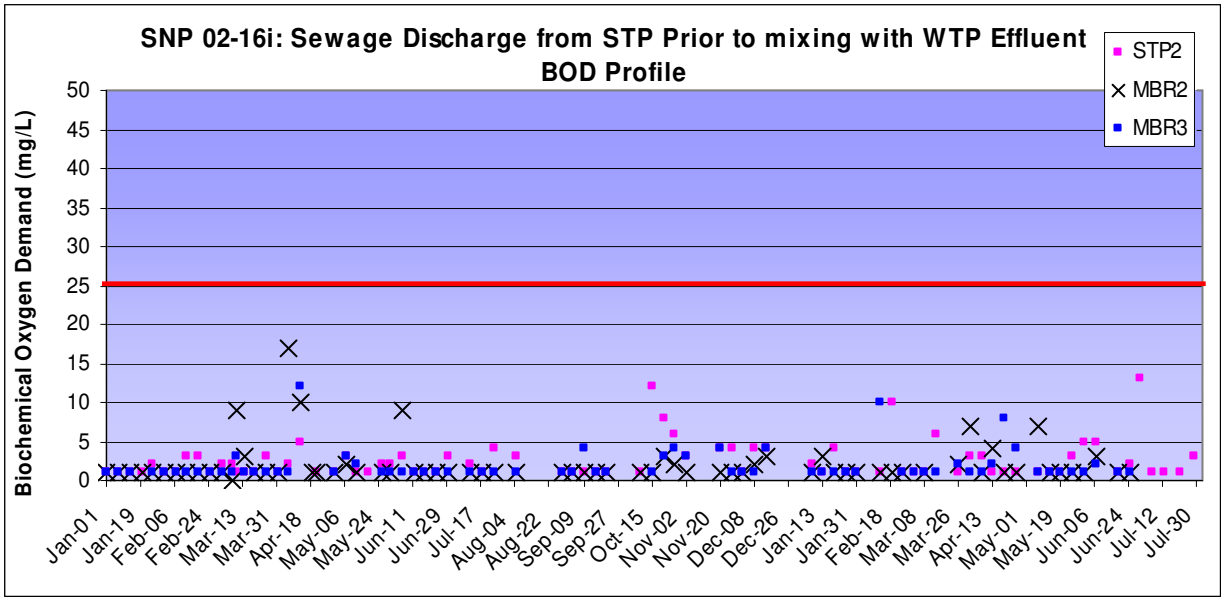
Table 13: RUNOFF WATER PUMPED / TRUCKED TO WATER MANAGEMENT POND

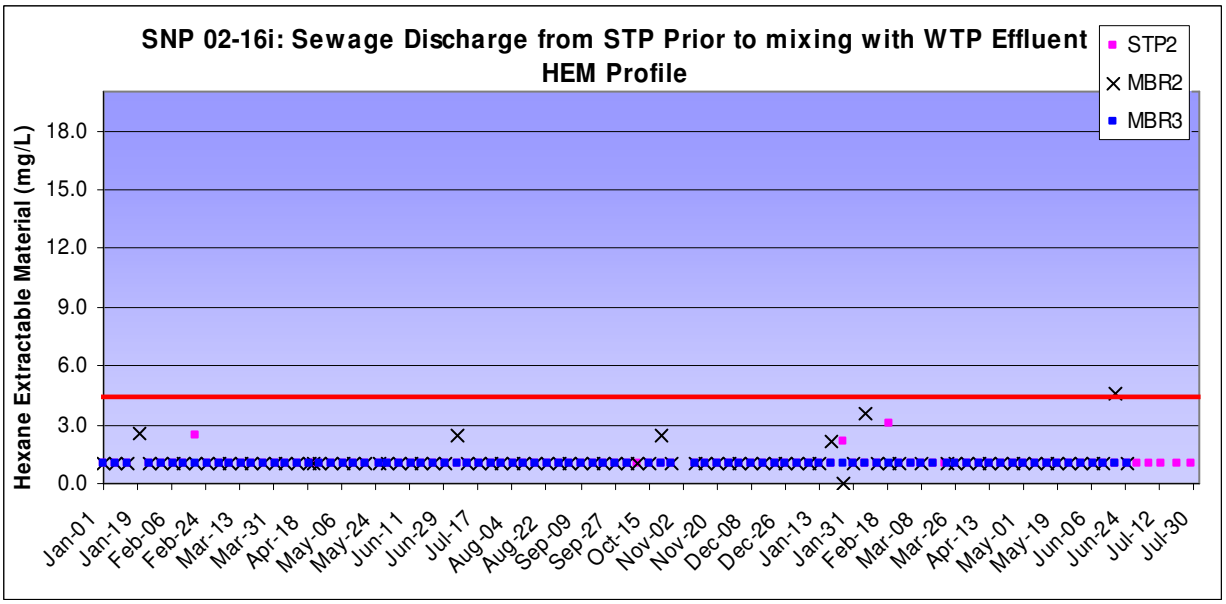
Month	Temporary & Perimeter Sumps	South Pit *	Airport Deicing Sump	Ammonium Nitrate Sump	Fuel Berms	Other	Total
Jan	12,308	0	0	0	0	0	12,308
Feb	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0
Apr	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
Jun	20,551	0	0	0	0	0	20,551
Jul	31,742	1,643	0	0	0	0	33,385
Aug							0
Sep							0
Oct							0
Nov							0
Dec							0
TOTAL	**52,293**	**1,643**	**0**	**0**	**0**	**0**	**66,244**

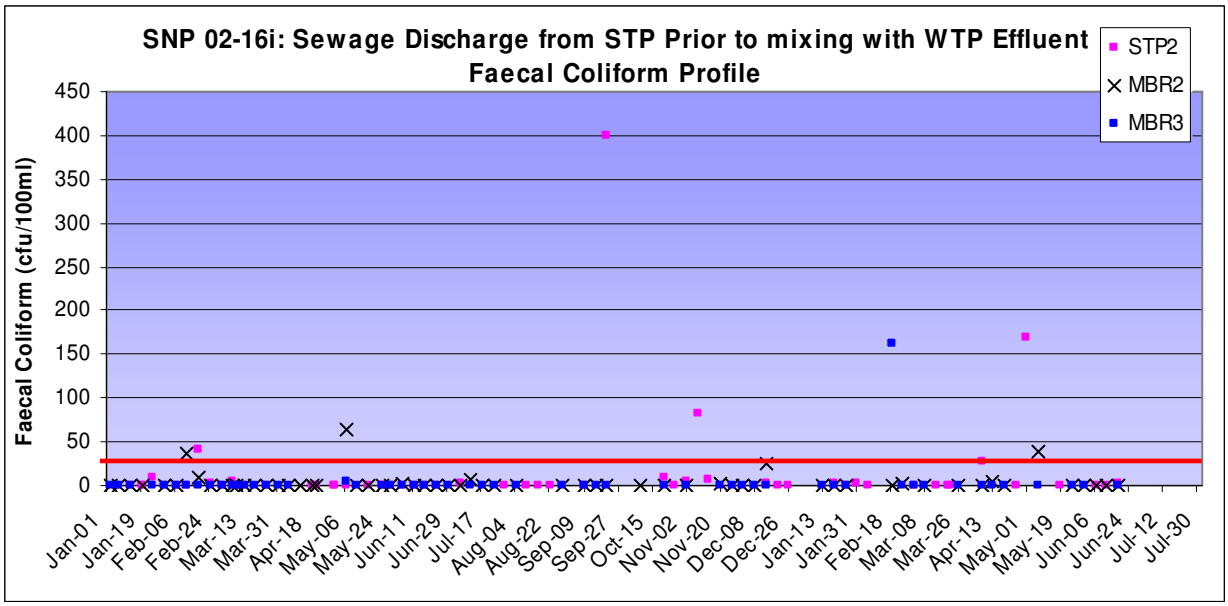
Estimate only

* Pumped to Water Treatment Plant

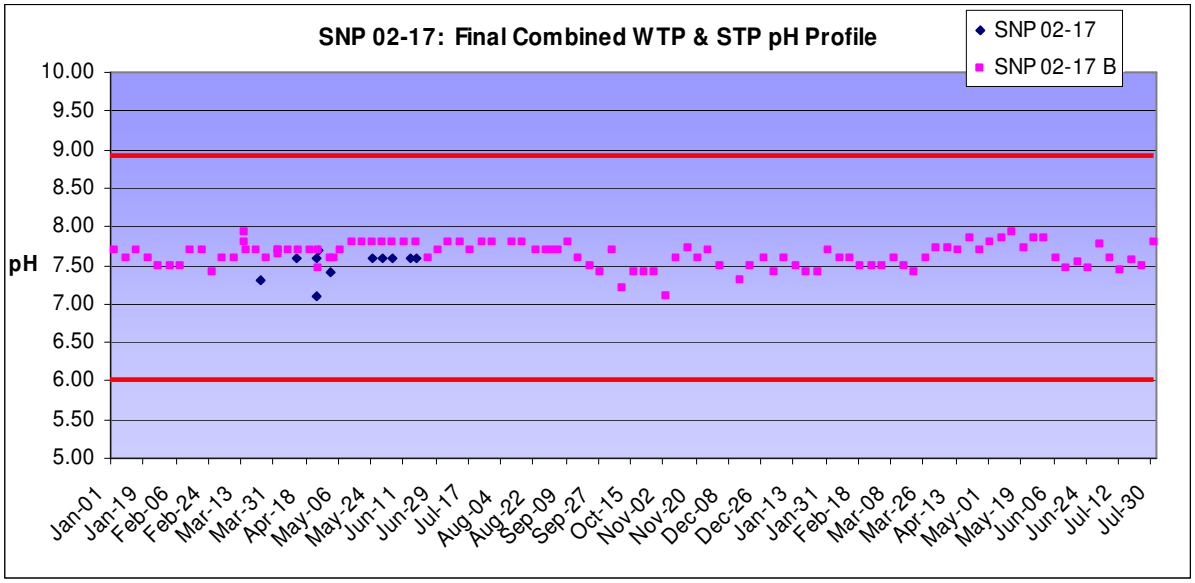
FIGURES 1- 3

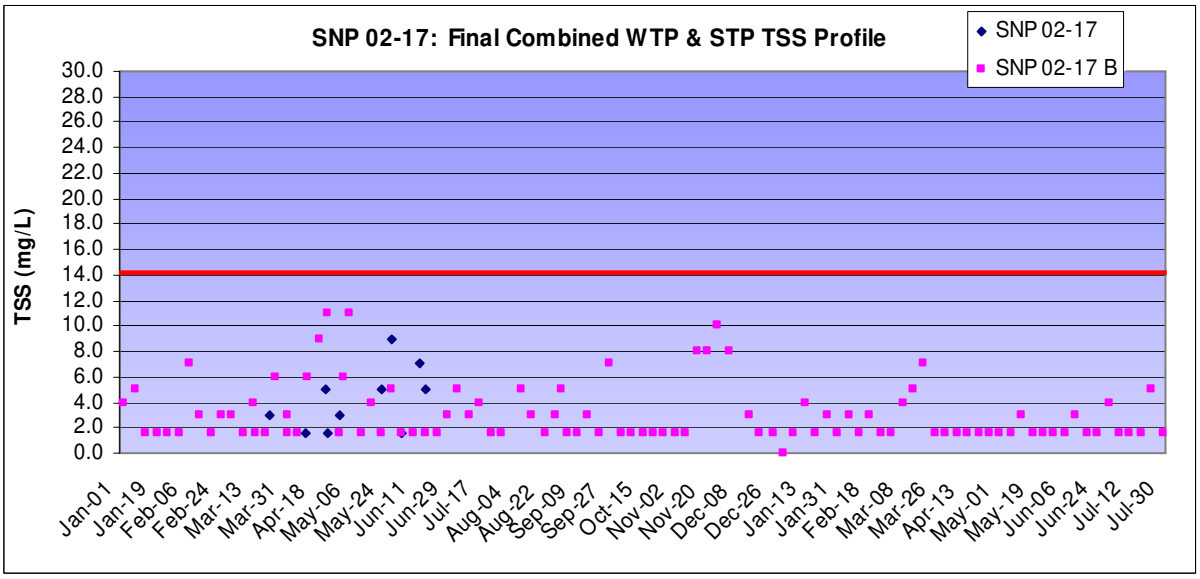

SNP 02-16i: Sewage Discharge from STP Prior to mixing with WTP Effluent
BOD Profile
Biochemical Oxygen Demand (mg/L)
STP2
MBR2
MBR3
50
45
40
35
30
25
20
15
10
5
0
Jan-01
Jan-19
Feb-06
Feb-24
Mar-13
Mar-31
Apr-18
May-06
May-24
Jun-11
Jun-29
Jul-17
Aug-04
Aug-22
Sep-09
Sep-27
Oct-15
Nov-02
Nov-20
Dec-08
Dec-26
Jan-13
Jan-31
Feb-18
Mar-08
Mar-26
Apr-13
May-01
May-19
Jun-06
Jun-24
Jul-12
Jul-30

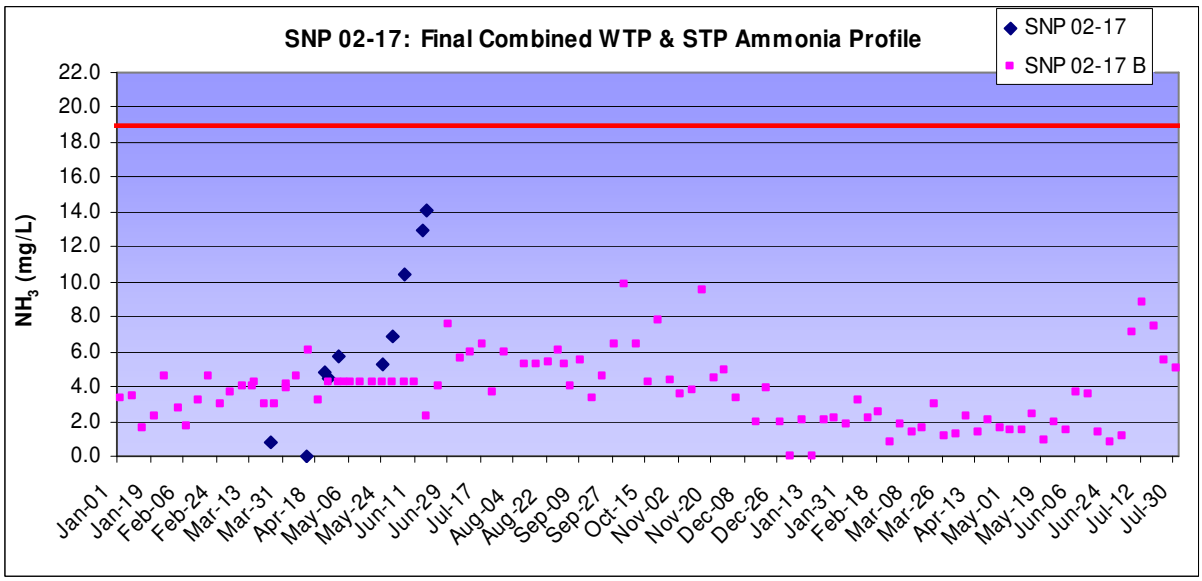

SNP 02-16i: Sewage Discharge from STP Prior to mixing with WTP Effluent
HEM Profile
Hexane Extractable Material (mg/L)
STP2
MBR2
MBR3
18.0
15.0
12.0
9.0
6.0
3.0
0.0
Jan-01
Jan-19
Feb-06
Feb-24
Mar-13
Mar-31
Apr-18
May-06
May-24
Jun-11
Jun-29
Jul-17
Aug-04
Aug-22
Sep-09
Sep-27
Oct-15
Nov-02
Nov-20
Dec-08
Dec-26
Jan-13
Jan-31
Feb-18
Mar-08
Mar-26
Apr-13
May-01
May-19
Jun-06
Jun-24
Jul-12
Jul-30


SNP 02-16i: Sewage Discharge from STP Prior to mixing with WTP Effluent
Faecal Coliform Profile
Faecal Coliform (cfu/100ml)
STP2
MBR2
MBR3
450
400
350
300
250
200
150
100
50
0
Jan-01
Jan-19
Feb-06
Feb-24
Mar-13
Mar-31
Apr-18
May-06
May-24
Jun-11
Jun-29
Jul-17
Aug-04
Aug-22
Sep-09
Sep-27
Oct-15
Nov-02
Nov-20
Dec-08
Dec-26
Jan-13
Jan-31
Feb-18
Mar-08
Mar-26
Apr-13
May-01
May-19
Jun-06
Jun-24
Jul-12
Jul-30

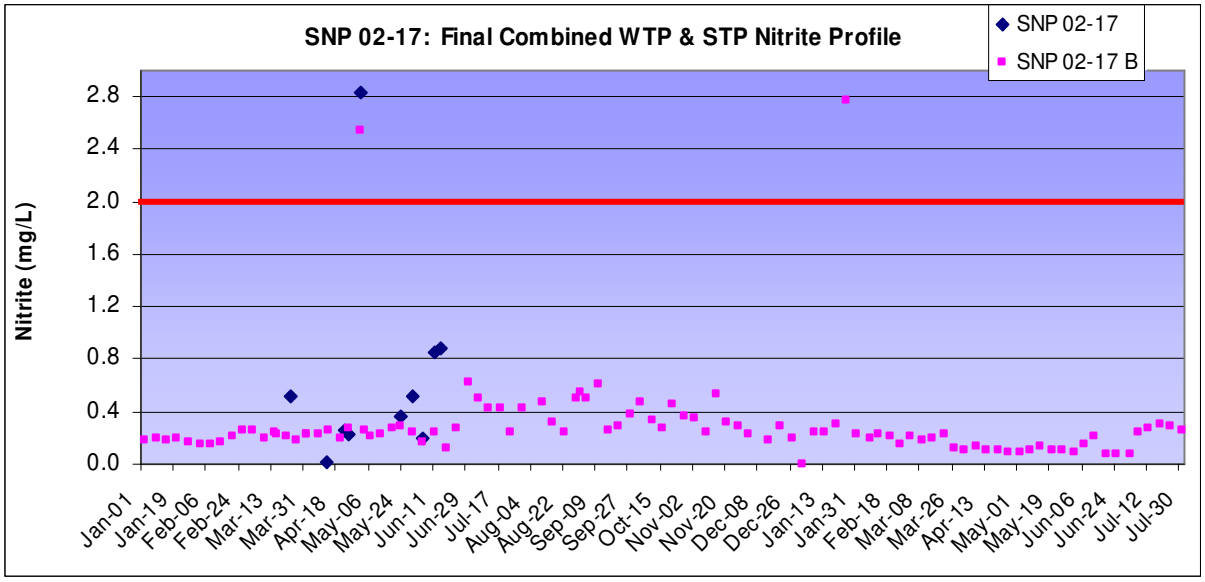
FIGURES 4 - 6

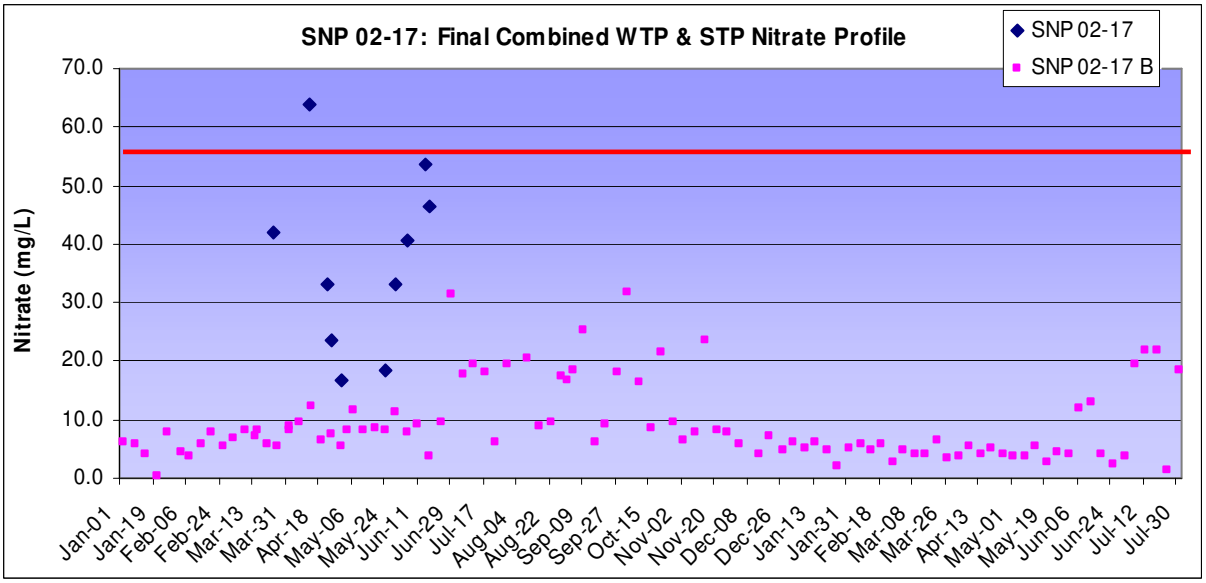

SNP 02-17: Final Combined WTP & STP pH Profile
SNP 02-17
SNP 02-17 B
pH
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
Jan-01 Jan-19 Feb-06 Feb-24 Mar-13 Mar-31 Apr-18 May-06 May-24 Jun-11 Jun-29 Jul-17 Aug-04 Aug-22 Sep-09 Sep-27 Oct-15 Nov-02 Nov-20 Dec-08 Dec-26 Jan-13 Jan-31 Feb-18 Mar-08 Mar-26 Apr-13 May-01 May-19 Jun-06 Jun-24 Jul-12 Jul-30

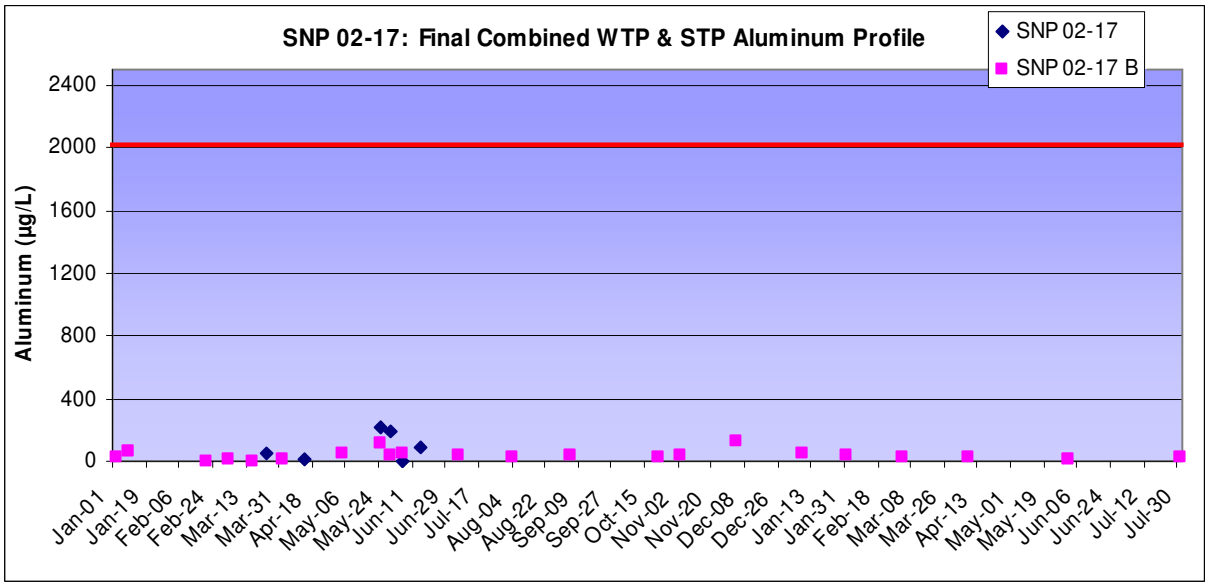

SNP 02-17: Final Combined WTP & STP TSS Profile
SNP 02-17
SNP 02-17 B
TSS (mg/L)
30.0
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Jan-01 Jan-19 Feb-06 Feb-24 Mar-13 Mar-31 Apr-18 May-06 May-24 Jun-11 Jun-29 Jul-17 Aug-04 Aug-22 Sep-09 Sep-27 Oct-15 Nov-02 Nov-20 Dec-08 Dec-26 Jan-13 Jan-31 Feb-18 Mar-08 Mar-26 Apr-13 May-01 May-19 Jun-06 Jun-24 Jul-12 Jul-30


SNP 02-17: Final Combined WTP & STP Ammonia Profile
SNP 02-17
SNP 02-17 B
NH3 (mg/L)
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Jan-01 Jan-19 Feb-06 Feb-24 Mar-13 Mar-31 Apr-18 May-06 May-24 Jun-11 Jun-29 Jul-17 Aug-04 Aug-22 Sep-09 Sep-27 Oct-15 Nov-02 Nov-20 Dec-08 Dec-26 Jan-13 Jan-31 Feb-18 Mar-08 Mar-26 Apr-13 May-01 May-19 Jun-06 Jun-24 Jul-12 Jul-30

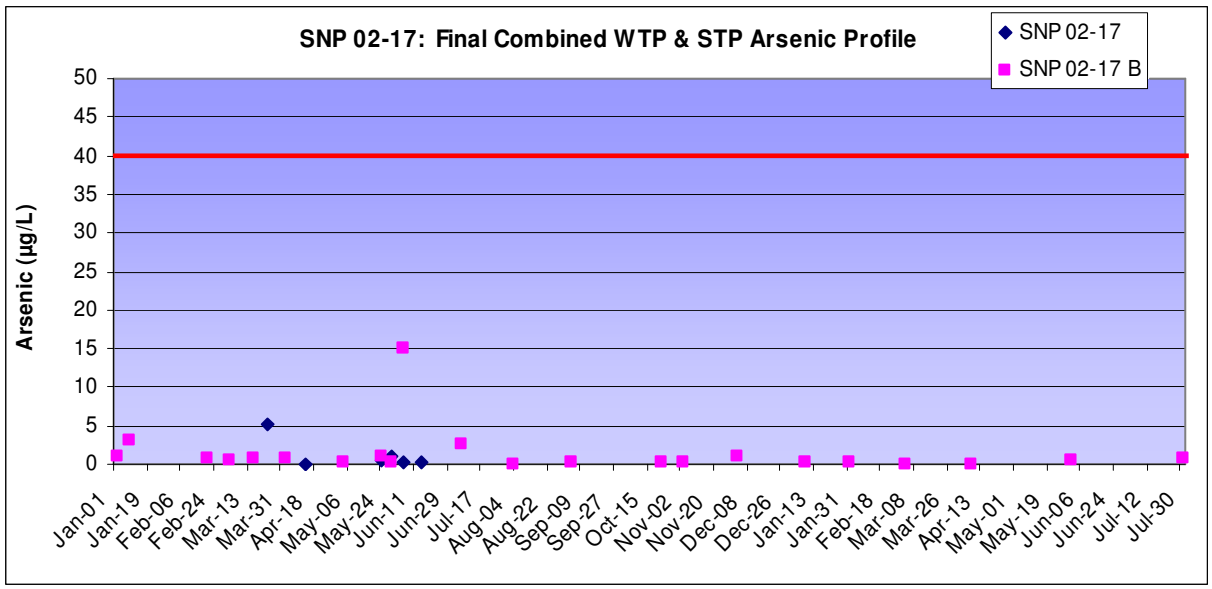
FIGURES 7 – 9

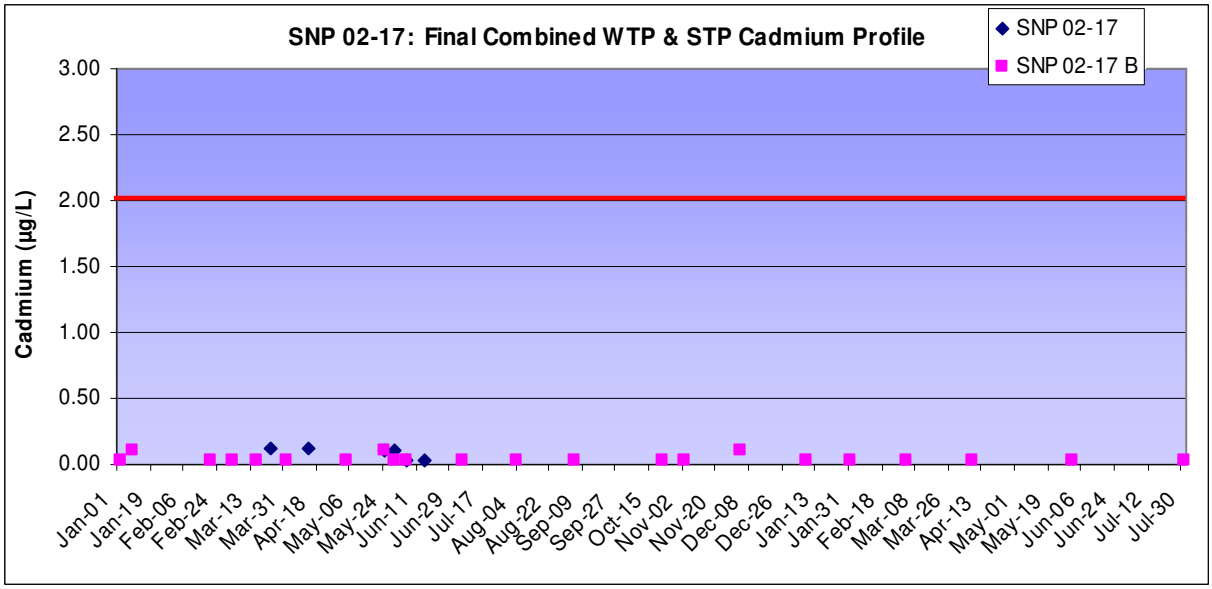

SNP 02-17: Final Combined WTP & STP Nitrite Profile
SNP 02-17
SNP 02-17 B
Nitrite (mg/L)
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
Jan-01 Jan-19 Feb-06 Feb-24 Mar-13 Mar-31 Apr-18 May-06 May-24 Jun-11 Jun-29 Jul-17 Aug-04 Aug-22 Sep-09 Sep-27 Oct-15 Nov-02 Nov-20 Dec-08 Dec-26 Jan-13 Jan-31 Feb-18 Mar-08 Mar-26 Apr-13 May-01 May-19 Jun-06 Jun-24 Jul-12 Jul-30

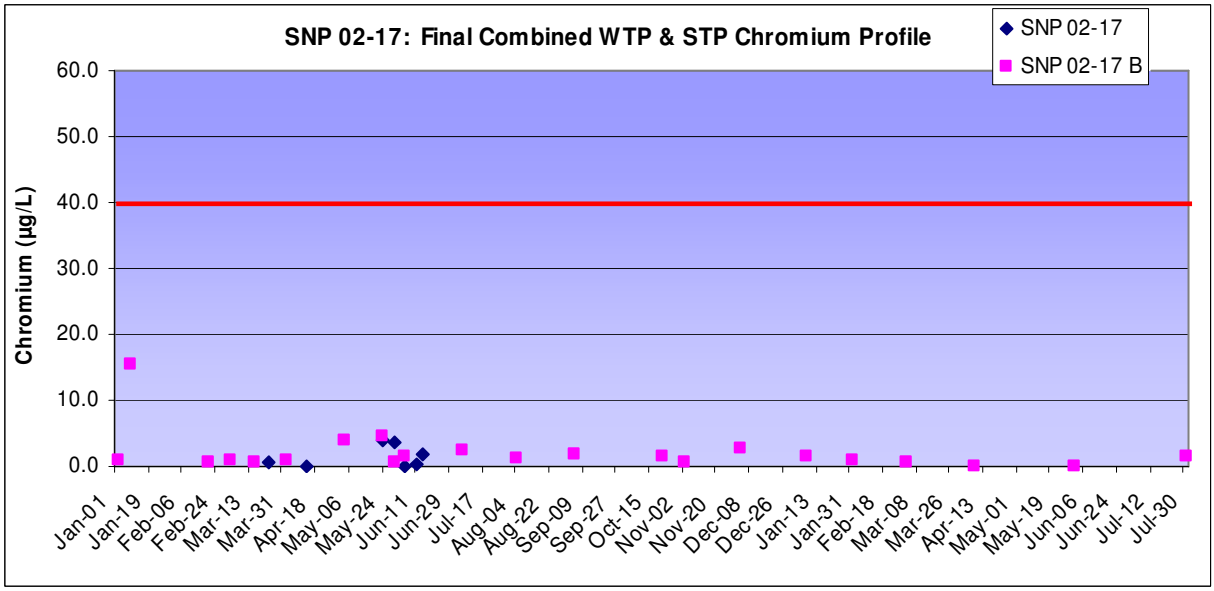

SNP 02-17: Final Combined WTP & STP Nitrate Profile
SNP 02-17
SNP 02-17 B
Nitrate (mg/L)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Jan-01 Jan-19 Feb-06 Feb-24 Mar-13 Mar-31 Apr-18 May-06 May-24 Jun-11 Jun-29 Jul-17 Aug-04 Aug-22 Sep-09 Sep-27 Oct-15 Nov-02 Nov-20 Dec-08 Dec-26 Jan-13 Jan-31 Feb-18 Mar-08 Mar-26 Apr-13 May-01 May-19 Jun-06 Jun-24 Jul-12 Jul-30


SNP 02-17: Final Combined WTP & STP Aluminum Profile
SNP 02-17
SNP 02-17 B
Aluminum (µg/L)
2400
2000
1600
1200
800
400
0
Jan-01 Jan-19 Feb-06 Feb-24 Mar-13 Mar-31 Apr-18 May-06 May-24 Jun-11 Jun-29 Jul-17 Aug-04 Aug-22 Sep-09 Sep-27 Oct-15 Nov-02 Nov-20 Dec-08 Dec-26 Jan-13 Jan-31 Feb-18 Mar-08 Mar-26 Apr-13 May-01 May-19 Jun-06 Jun-24 Jul-12 Jul-30

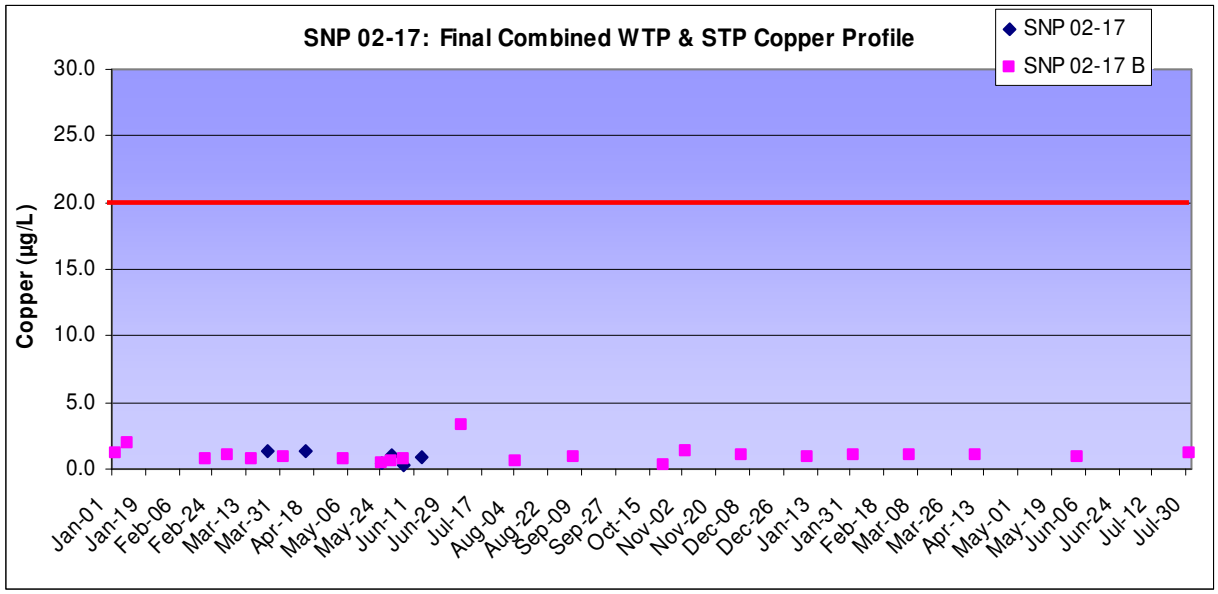
FIGURES 10 – 12

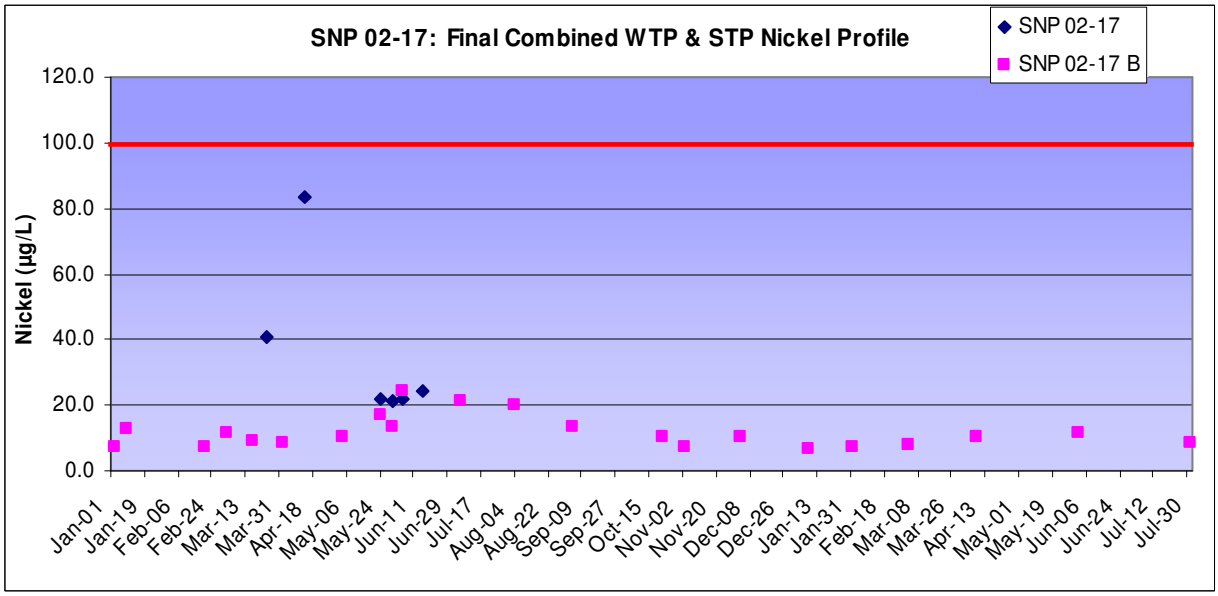






FIGURES 13 – 15





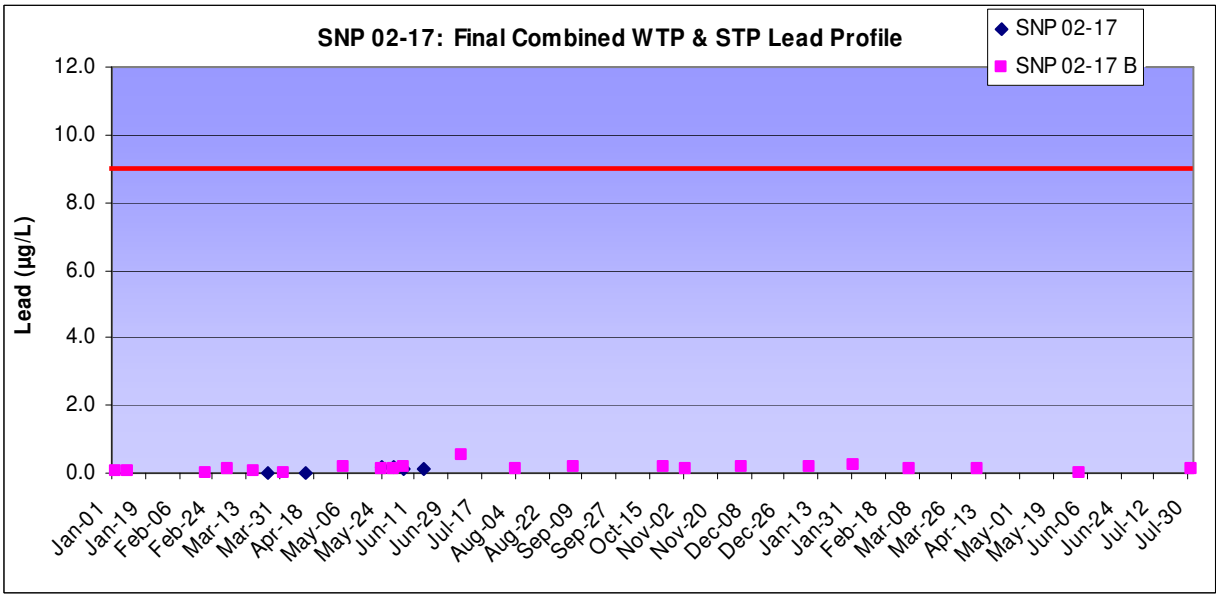
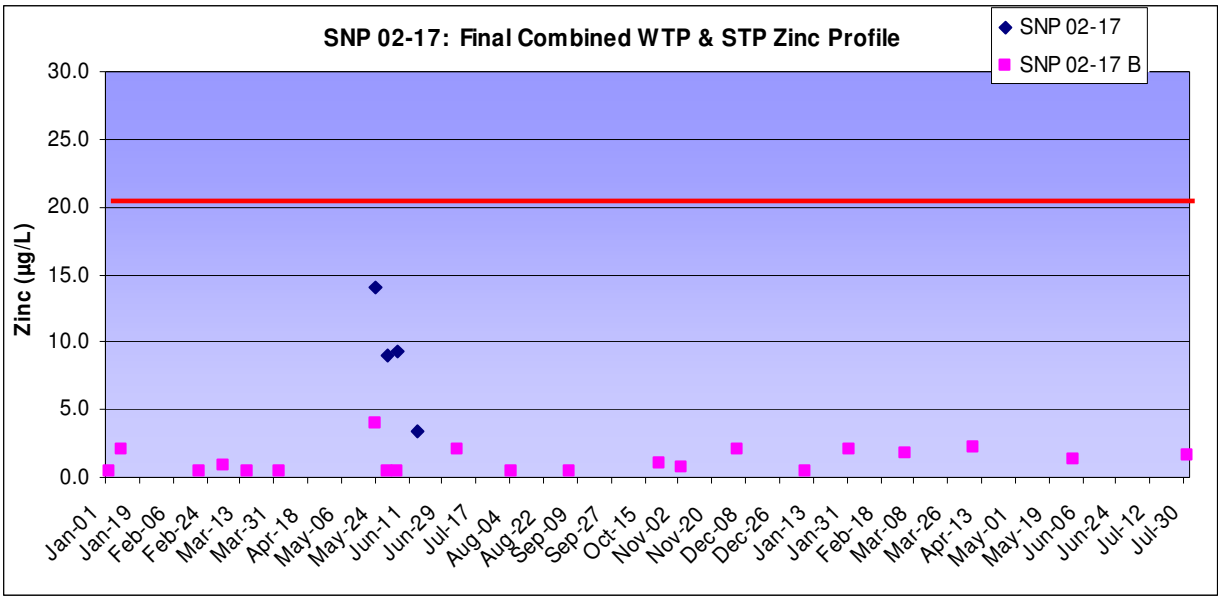


FIGURE 16


SNP 02-17: Final Combined WTP & STP Zinc Profile
SNP 02-17
SNP 02-17 B
Zinc (µg/L)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Jan-01
Jan-19
Feb-06
Feb-24
Mar-13
Mar-31
Apr-18
May-06
May-24
Jun-11
Jun-29
Jul-17
Aug-04
Aug-22
Sep-09
Sep-27
Oct-15
Nov-02
Nov-20
Dec-08
Dec-26
Jan-13
Jan-31
Feb-18
Mar-08
Mar-26
Apr-13
May-01
May-19
Jun-06
Jun-24
Jul-12
Jul-30

Annex J6

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September 6, 2010
RGC Project No: 148002

Canadian Zinc Corporation
Suite 1710 – 650 West Georgia Street
Vancouver, B.C.
V6B 4N9

Attention: Dave Harpley

RE: Updated Predictions of Post-Closure Water Quality in Prairie Creek, Prairie Creek mine, NWT REV0

Dave,

The purpose of this memo is to update the predictions of post-closure water quality conditions in Prairie Creek from RGC (2010a) by incorporating refined source term predictions from pHase Geochemistry Inc.

1 Updated Predictions of Post-Closure Water Quality

CZN has proposed to backfill the mine workings and tunnels with a mixture of cemented tailings and rock and include strategically-placed bulkheads to allow re-flooding of the mine above the 870-level. Groundwater flow modelling of those post-closure conditions suggests that the primary metal load to Prairie Creek from the re-flooded mine workings will occur via groundwater flow along the MQV/Vein Fault system (which discharges into Harrison Creek alluvium and/or Harrison Creek itself and then Prairie Creek), whereas seepage from the waste rock pile (to be placed in a side valley of Harrison Creek) represents a secondary load.

1.1 Source terms

In RGC (2010a), five mixing components were assumed for post-closure conditions:

- Prairie Creek water;
- Harrison Creek water;
- Seepage from backfilled & re-flooded mine workings

- Groundwater flow from Vein Fault/MQV system (not impacted by mine backfill)
- Seepage from waste rock pile (WRP)

Details regarding how flow estimates for the various components were estimated are provided in RGC (2010a) and are not repeated in this memo. Table 1-1 summarizes these flows though and shows assumed concentrations for sulphate (in mg/L) and selected metals of concern (Cd, Cu, Pb, Se and Zn in ug/L) in the five mixing components that define post-closure conditions. As per RGC (2010a), all metals concentrations were assumed to be constant whereas sulphate in surface water was assumed to vary in time (based on field observation).

The sulphate and metals concentrations for seepage from the mine backfill and till-covered WRP are based on geochemical predictions of source terms initially developed in pHG (2010a) and recently updated in pHG (2010b) (i.e. see response to information request no. 24 from Parks Canada) and the reader is referred to those reports for more detail on source terms predictions. Note that for the purpose of our mixing calculations we used concentrations from sensitivity run 4 from pHG (2010b), which assumes partial grain size reduction of paste and reduced flushing of backfill by groundwater (i.e. most water moves through host rock) relative to the 'base case' scenario for closed backfill underground.

Groundwater discharging from the Vein Fault/MQV system (but by-passing the backfilled mine workings) was assumed to be the same as that assumed for pre-mining conditions. In other words, a 2:1 mixture of groundwater in the less mineralized Vein Fault (represented by MW08-03) and groundwater observed in the mineralized MQV (represented by MW09-15) was assumed (see RGC, 2010a). Note, however, that the relative proportion of those two groundwater types discharging into HCAA is uncertain and hence the influence of this ratio on predicted post-closure water quality in Prairie Creek was assessed by way of sensitivity analysis (see sub-sections below).

1.2 Post-Closure Water Quality for Mean Monthly Flows

Table 1-2 shows the results of the post-closure mixing calculations assuming mean monthly flow conditions. The monthly flows of seepage from the backfilled mine workings and un-impacted groundwater discharging along the Vein Fault/MQV system into HCAA were estimated using a transient groundwater flow model for post-closure conditions (RGC, 2010b). Predicted monthly seepage rates through the backfilled mine workings range from 1.2 L/s in May to 4.2 L/s in August (Table 1-1). Numerical methods and modelling assumptions for this transient groundwater flow model as well as

modelling results are described in more detail in RGC (2010b). Note that the site-specific in-stream criteria proposed by the Saskatchewan Research Council (SRC) for Prairie Creek are also shown for comparison in Table 1-2 (see SRC, 2010).

The monthly seepage rates from the WRP were taken from preliminary modelling of cover performance completed by O'Kane Consultants Inc. According to that study, monthly seepage rates for a 2-m thick till cover over the WRP would range from a maximum of 0.53 L/s in May to 0.02 L/s in November with no seepage during the remainder of the year (O'Kane Consultants, 2010).

The predicted post-closure concentrations in Prairie Creek (at SPN3-11) meet the proposed site-specific in-stream criteria for cadmium, copper, lead, selenium and zinc throughout the year assuming mean monthly flows. Note that the predicted post-closure concentrations for copper, lead, selenium, zinc and sulphate are very similar to those predicted for pre-mining conditions. Only cadmium is predicted to show significantly higher post-closure concentrations in Prairie Creek during the winter low-flow period. The higher post-closure cadmium concentrations are a result of the assumed cadmium concentrations in mine backfill which are higher than the assumed background concentrations in the MQV/Vein fault.

Note that the predicted post-closure concentrations of zinc in Prairie Creek are very sensitive to the assumed contribution of unimpacted (but mineralized) groundwater from the MQV. Table 1-2b shows the predicted cadmium and zinc concentrations in Prairie Creek for higher contributions of mineralized groundwater from the MQV. These sensitivity runs indicate that the SRC in-stream criterion for zinc (but not for cadmium) could potentially be marginally exceeded during winter base flow conditions (in February and March).

At the present time, insufficient data is available to determine the natural zinc load contributing via the Vein Fault/MQV system with a high degree of accuracy. We recommend that our preliminary loading estimates be updated once additional monitoring data become available.

1.3 Post-Closure Water Quality for Minimum Flows

Post-closure water quality in Prairie Creek was also predicted for minimum flows reported for Prairie Creek. As described in RGC (2010a), these loading estimates represent an "extreme-case" scenario because the in-stream dilution of metal loading (from groundwater at the site) would be at a minimum.

Table 1-3 shows the results of the post-closure mixing calculations for minimum flows. The minimum flows assumed for post-closure conditions in Prairie Creek (and Harrison Creek) were identical to those used for pre-mining. Using the same rationale as described for pre-mining, the groundwater flow through the backfilled mine and the MQV/Vein fault system was also assumed to be reduced by 50% of the predicted mean monthly flow during these extreme dry conditions. Similarly, monthly seepage rates from the WRP were also assumed to be reduced by 50% compared to estimates for average recharge conditions.

Assuming minimum flows in Prairie Creek, post-closure concentrations for copper, lead and selenium in Prairie Creek are predicted to meet the proposed in-stream criteria even under those extreme low-flow conditions. However, post-closure concentrations of cadmium and zinc are predicted to exceed their respective SRC criterion during the winter months (January to April). Note that the predicted post-closure concentrations for zinc are very close to those predicted for pre-mining conditions. Again, the only metal predicted to show significantly higher post-closure concentrations is cadmium.

Note that the predicted post-closure water quality in Prairie Creek is significantly influenced by the assumed reduction in groundwater flow during such an extreme period of minimum flows. Table 1-4 shows the predicted cadmium, lead and zinc concentrations in Prairie Creek for a range of groundwater flows. These sensitivity runs indicate that SRC in-stream criteria for most months (all except February and March) might be met if groundwater flow decreases to less than 25% of mean monthly flows during a dry period. In contrast, in-stream criteria for cadmium, lead and zinc could potentially be exceeded during the winter months if groundwater flow remained at mean monthly flows during an extreme low-flow period.

At the present time, insufficient data is available to determine the likely groundwater flow via the Vein Fault/MQV system during an extreme dry period. Again, it is recommended that our preliminary loading estimates be updated once additional monitoring data become available.

2 Summary & Conclusions

Post-closure water quality conditions (after sealing and complete re-flooding of the underground workings) can be summarized as follows:

- Assuming average flow conditions the post-closure concentrations of all metals of concern (cadmium, copper, lead, selenium and zinc) in Prairie Creek are predicted to meet the proposed in-stream criteria year-round;

- However, the predicted post-closure water quality (in particular zinc concentrations) is very sensitive to the assumed proportion of groundwater from the highly-mineralized portion of the Vein Fault/MQV system. Post-closure water quality in Prairie Creek is predicted to marginally exceed the zinc criterion during winter base flow (February & March), provided groundwater flow along the MQV contributes more than 30% of the total flow along the Vein Fault/MQV system.
- Assuming minimum flow in Prairie Creek, the post-closure concentrations of cadmium and zinc in Prairie Creek may exceed their respective in-stream criteria during the winter low flow period (January to April);
- Stream water quality in Prairie Creek is generally predicted to recover to pre-mining conditions after closure of the Prairie Creek Mine. The only significant increase in metal loading to Prairie Creek after mine closure (relative to pre-mining) is predicted for cadmium (due to assumed leaching of this metal from the mine backfill);
- The predicted pre-mining and post-closure concentrations for Prairie Creek (at SPN3-11) are preliminary in nature and should be updated once additional monitoring data and/or analyses become available

3 Closure

We trust that the information provided in this memo meets your requirements.

Please contact the undersigned if you have any questions regarding the content of this report or require further information.

Best Regards,

ROBERTSON GEOCONSULTANTS INC.

ORIGINAL SIGNED

Dr. Paul R. Ferguson
Senior Geochemist

ORIGINAL SIGNED

Dr. Christoph Wels, M.Sc., P.Geo.
Principal and Senior Hydrogeologist

4 References

MESH Environmental Inc. (2008), Geochemical Characterization Report for the Prairie Creek mine, NWT, April 2008.

O'Kane Consultants Inc., Results of Preliminary Numerical Modelling Program of WRSF Cover System Alternatives at Prairie Creek, Memorandum prepared for Canadian Zinc, February 19 2010.

Phase Geochemistry (2010a), Source Term Water Quality Predictions, Prairie Creek Project, NWT, Canada, Report prepared for Canadian Zinc, March 2010.

Phase Geochemistry (2010b), Draft Responses to Information Requests, Prairie Creek project, September 6, 2010.

Robertson GeoConsultants Inc. (2010a), Load Balance Calculations for Mine Water and Surface Water, Prairie Creek mine, NWT, Letter Report submitted to Canadian Zinc, March 17, 2010.

Robertson GeoConsultants Inc. (2010b), Addendum to Site Hydrogeology Report - Results of Transient Groundwater Modeling, Prairie Creek Mine, Letter Report submitted to Canadian Zinc, March 8, 2010.

Saskatchewan Research Council (2010), Development of Site-Specific Water Quality Guidelines for Prairie Creek, NWT, SRC Publication No. 10432-1C10 prepared for Canadian Zinc, February 2010.

TABLES

Table 1-1. Predicted Post-closure Water Quality for Prairie Creek - Average Flows

Source Concentrations (assumed constant)

		End-member Concentration				
Parameter	**Unit**	**PC above Mine (SPN 3-10)**	**Harrison Creek (HC-2)**	**Backfilled Mine (from pHG, 2010b)**	**MQV/Vein Fault**	**WRP (from pHG, 2010b)**
SO4	mg/L	74	160	150	244	1,500
Cadmium	ug/L	0.05	0.07	10	0.55	200
Copper	ug/L	0.57	0.30	20	1.55	500
Lead	ug/L	0.23	3.20	50	7.46	50
Selenium	ug/L	1.16	2.30	5	1.62	200
Zinc	ug/L	6.4	9.0	1,000	1,185	6,000

	MW09-15	**MW08-03**
SO4	360	190
Cadmium	0.72	0.47
Copper	0.70	2
Lead	1.80	10.4
Selenium	0.30	2.3
Zinc	2,120	735

	SO4 mg/L	**Mean Monthly Flows (L/s)**		**Predicted Flows (L/s)**		
Month	**PC & HC**	**PC above Mine (SPN 3-10)**	**Harrison Creek**	**Backfilled Mine (Tr12)**	**MQV/Vein fault (Tr12)**	**WRP (Table 2, pHG)**
Jan	92	530	11	1.4	2.9	0.00
Feb	96	381	8	1.4	2.3	0.00
Mar	98	309	6	1.3	2.7	0.00
Apr	80	819	17	1.3	2.2	0.00
May	36	12,358	251	1.2	2.5	0.53
Jun	46	17,237	350	2.1	2.4	0.48
Jul	54	11,780	239	3.7	2.7	0.19
Aug	60	9,336	190	4.2	3.1	0.15
Sep	63	6,318	128	3.4	3.3	0.12
Oct	85	2,762	56	2.1	4.3	0.24
Nov	87	1,294	26	1.8	2.4	0.02
Dec	90	838	17	1.6	3.3	0.00
Mean	***74***	***5,330***	***108***	***2.1***	***2.9***	***0.14***

In-Stream Criteria		
Parameter	**mg/L**	**ug/L**
Cadmium	0.000172	0.172
Copper	0.00253	2.53
Lead	0.00113	1.13
Selenium	0.00216	2.16
Zinc	0.02265	22.65

	SPN 3-11 - In-Stream Concentrations (ug/L)					
	Cadmium	**Copper**	**Lead**	**Selenium**	**Zinc**	**SO4**
Month	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**mg/L**
SRC criteria	***0.172***	***2.53***	***1.13***	***2.16***	***22.65***	***n/a***
Jan	0.077	0.62	0.46	1.19	15.3	93
Feb	0.087	0.64	0.51	1.20	17.0	97
Mar	0.094	0.65	0.55	1.20	20.5	100
Apr	0.065	0.60	0.38	1.19	11.1	81
May	0.058	0.59	0.30	1.19	7.0	36
Jun	0.055	0.58	0.30	1.19	6.9	46
Jul	0.055	0.58	0.31	1.19	7.1	54
Aug	0.056	0.58	0.31	1.19	7.3	60
Sep	0.058	0.58	0.32	1.19	7.7	63
Oct	0.074	0.62	0.34	1.20	9.5	85
Nov	0.066	0.60	0.37	1.19	10.0	87
Dec	0.069	0.60	0.41	1.19	12.7	92
Mean	***0.068***	***0.60***	***0.38***	***1.19***	***11.0***	***75***

Note: bold values exceed the in-stream criterion proposed by SRC

Table 1-2. Sensitivity of Predicted Post-closure WQ in Prairie Creek on MQV/Vein Fault Source Concentrations

A) Source Concentrations (assumed constant)

		MQV	Vein Fault
Parameter	**Unit**	**MW09-15**	**MW08-03**
SO4	mg/L	360	190
Cadmium	ug/L	0.72	0.47
Copper	ug/L	0.70	2.00
Lead	ug/L	1.80	10.4
Selenium	ug/L	0.30	2.3
Zinc	ug/L	2,120	735

B) Predicted Water Quality in Prairie Creek

	SPN 3-11 - In-Stream Concentrations (ug/L)							
	Base Case 66% Vein Fault - 33% MQV		Sensitivity 1 50% Vein Fault - 50% MQV		Sensitivity 2 33% Vein Fault - 66% MQV		Sensitivity 3 0% Vein Fault - 100% MQV	
	Cadmium	Zinc	Cadmium	Zinc	Cadmium	Zinc	Cadmium	Zinc
Month	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**	**ug/L**
SRC criteria	***0.172***	***22.65***	***0.172***	***22.65***	***0.172***	***22.65***	***0.172***	***22.65***
Jan	0.097	15.93	0.097	17.20	0.097	18.33	0.098	20.84
Feb	0.114	17.84	0.114	19.26	0.114	20.52	0.115	**23.32**
Mar	0.125	21.44	0.126	**23.46**	0.126	**25.24**	0.127	**29.21**
Apr	0.076	11.44	0.077	12.08	0.077	12.64	0.077	13.90
May	0.058	8.01	0.058	8.06	0.058	8.10	0.059	8.20
Jun	0.056	7.53	0.056	7.57	0.056	7.59	0.056	7.66
Jul	0.057	7.53	0.057	7.59	0.057	7.64	0.057	7.74
Aug	0.059	7.82	0.059	7.90	0.059	7.96	0.059	8.12
Sep	0.061	8.23	0.062	8.35	0.062	8.46	0.062	8.70
Oct	0.079	11.63	0.079	11.99	0.079	12.31	0.079	13.02
Nov	0.076	10.73	0.076	11.16	0.077	11.55	0.077	12.41
Dec	0.082	13.11	0.083	14.01	0.083	14.80	0.083	16.58
Mean	***0.079***	***11.77***	***0.079***	***12.39***	***0.079***	***12.93***	***0.079***	***14.14***

Note: bold values exceed the in-stream criterion proposed by SRC

Table 1-3. Predicted Post-closure Water Quality for Prairie Creek - Minimum Flows

Source Concentrations (assumed constant)

		End-member Concentration				
Parameter	Unit	PC above Mine (SPN 3-10)	Harrison Creek (HC-2)	Backfilled Mine (from pHG, 2010b)	MQV/Vein Fault	WRP (from pHG, 2010b)
SO4	mg/L	74	160	150	244	1,500
Cadmium	ug/L	0.05	0.07	10	0.55	200
Copper	ug/L	0.57	0.30	20	1.55	500
Lead	ug/L	0.23	3.20	50	7.46	50
Selenium	ug/L	1.16	2.30	5	1.62	200
Zinc	ug/L	6.4	9.0	1,000	1,185	6,000

	MW09-15	MW08-03
SO4	360	190
Cadmium	0.72	0.47
Copper	0.70	2
Lead	1.80	10.4
Selenium	0.30	2.3
Zinc	2,120	735

	SO4 mg/L	Minimum Flows (L/s)		Estimated Minimum Flows (L/s)		
Month	PC & HC	PC above Mine (SPN 3-10)	Harrison Creek	Backfilled Mine (Tr12)	MQV/Vein Fault (Tr12)	WRP (Table 2, pHG)
Jan	92	145	3	0.7	1.5	0.00
Feb	96	48	1	0.7	1.2	0.00
Mar	98	38	1	0.7	1.4	0.00
Apr	80	78	2	0.6	1.1	0.00
May	36	7,840	159	0.6	1.3	0.27
Jun	46	10,800	219	1.1	1.2	0.24
Jul	54	5,960	121	1.8	1.4	0.10
Aug	60	5,120	104	2.1	1.6	0.08
Sep	63	3,660	74	1.7	1.7	0.06
Oct	85	1,540	31	1.1	2.1	0.12
Nov	87	828	17	0.9	1.2	0.01
Dec	90	254	5	0.8	1.6	0.00
Mean	**74**	**3,026**	**61**	**1.1**	**1.4**	**0.07**

In-Stream Criteria		
Parameter	mg/L	ug/L
Cadmium	0.000172	0.172
Copper	0.00253	2.53
Lead	0.00113	1.13
Selenium	0.00216	2.16
Zinc	0.02265	22.65

	SPN 3-11 - In-Stream Concentrations (ug/L)					
	Cadmium	Copper	Lead	Selenium	Zinc	SO4
Month	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L
SRC criteria	***0.172***	***2.53***	***1.13***	***2.16***	***22.65***	***n/a***
Jan	0.100	0.67	0.59	1.20	22.6	94
Feb	**0.196**	0.85	1.14	1.25	**47.2**	100
Mar	**0.225**	0.91	1.33	1.26	**61.5**	104
Apr	0.133	0.73	0.78	1.22	**30.5**	83
May	0.056	0.58	0.30	1.19	6.9	36
Jun	0.054	0.58	0.30	1.19	6.8	46
Jul	0.055	0.58	0.31	1.19	7.1	54
Aug	0.055	0.58	0.31	1.19	7.3	60
Sep	0.056	0.58	0.32	1.19	7.5	63
Oct	0.071	0.62	0.34	1.20	9.2	85
Nov	0.062	0.59	0.35	1.19	9.2	87
Dec	0.081	0.63	0.48	1.20	16.7	93
Mean	0.095	0.66	0.54	1.20	19.4	75

Note: bold values exceed the in-stream criterion proposed by SRC

Table 1-4. Sensitivity of Predicted Post-closure WQ in Prairie Creek on Groundwater Baseflow

A) Assumed Groundwater Flow & WRP Seepage during Minimum Flow Periods

Month	Upper Estimate Mean Monthly Flows			Best Estimate 50% of Mean Monthly Flows			Lower Estimate 25% of Mean Monthly Flows		
	Backfilled Mine (Tr12)	MQV/Vein Fault (Tr12)	WRP (Table 2, pHG)	Backfilled Mine	MQV/Vein Fault	WRP	Backfilled Mine	MQV/Vein Fault	WRP
Jan	1.4	2.9	0.00	0.7	1.5	0.00	0.4	0.7	0.00
Feb	1.4	2.3	0.00	0.7	1.2	0.00	0.3	0.6	0.00
Mar	1.3	2.7	0.00	0.7	1.4	0.00	0.3	0.7	0.00
Apr	1.3	2.2	0.00	0.6	1.1	0.00	0.3	0.6	0.00
May	1.2	2.5	0.53	0.6	1.3	0.27	0.3	0.6	0.13
Jun	2.1	2.4	0.48	1.1	1.2	0.24	0.5	0.6	0.12
Jul	3.7	2.7	0.19	1.8	1.4	0.10	0.9	0.7	0.05
Aug	4.2	3.1	0.15	2.1	1.6	0.08	1.0	0.8	0.04
Sep	3.4	3.3	0.12	1.7	1.7	0.06	0.8	0.8	0.03
Oct	2.1	4.3	0.24	1.1	2.1	0.12	0.5	1.1	0.06
Nov	1.8	2.4	0.02	0.9	1.2	0.01	0.5	0.6	0.01
Dec	1.6	3.3	0.00	0.8	1.6	0.00	0.4	0.8	0.00
Mean	**2.1**	**2.9**	**0.14**	**1.1**	**1.4**	**0.07**	**0.5**	**0.7**	**0.04**

B) Predicted Water Quality in Prairie Creek

Month	SPN 3-11 - In-Stream Concentrations (ug/L)								
	Upper Estimate Mean Monthly Flows			Best Estimate 50% of Mean Monthly Flows			Lower Estimate 25% of Mean Monthly Flows		
	Cadmium	Lead	Zinc	Cadmium	Lead	Zinc	Cadmium	Lead	Zinc
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
SRC criteria	***0.172***	***1.13***	***22.65***	***0.172***	***1.13***	***22.65***	***0.172***	***1.13***	***22.65***
Jan	**0.226**	0.70	**41.08**	0.138	0.50	**24.00**	0.094	0.395	15.28
Feb	**0.545**	**1.39**	**93.05**	**0.306**	0.86	**51.33**	**0.180**	0.581	**29.30**
Mar	**0.631**	**1.65**	**120.53**	**0.354**	1.01	**66.28**	**0.205**	0.656	**37.11**
Apr	**0.336**	0.94	**58.05**	**0.195**	0.62	**32.80**	0.123	0.456	19.75
May	0.065	0.30	8.98	0.057	0.29	7.70	0.052	0.292	7.06
Jun	0.061	0.30	8.23	0.055	0.29	7.33	0.052	0.291	6.88
Jul	0.066	0.31	8.66	0.057	0.30	7.54	0.053	0.295	6.98
Aug	0.069	0.32	9.02	0.059	0.30	7.72	0.054	0.296	7.07
Sep	0.071	0.32	9.60	0.060	0.31	8.01	0.054	0.298	7.22
Oct	0.105	0.36	15.93	0.077	0.32	11.19	0.063	0.306	8.81
Nov	0.093	0.37	13.27	0.071	0.33	9.85	0.060	0.310	8.14
Dec	0.162	0.55	**28.65**	0.106	0.42	17.64	0.077	0.356	12.06
Mean	0.202	0.63	***34.59***	***0.128***	***0.46***	***20.95***	***0.089***	***0.378***	***13.80***

Note: bold values exceed the in-stream criterion proposed by SRC

Appendix K

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nhc
northwest hydraulic consultants

Ref. No. 16987

September 9, 2010

Canadian Zinc Corporation
Suite 1710 - 650 West Georgia Street
Vancouver, BC
V6B 4N9

Attention: David Harpley

Via email: david@canadianzinc.com

Re: Conceptual design for mine site outfall to Prairie Creek

Dear Mr. Harpley:

1.0 INTRODUCTION

The water management plan proposed by Canadian Zinc Corporation (CZN) for operation of the Prairie Creek mine involves treatment of mine drainage water and mill process water to reduce metal concentrations, then discharging excess treated water to Prairie Creek. CZN had indicated that the outfall would use a diffuser in a single, deep channel in Prairie Creek to ensure complete mixing with receiving water. In addition, a variable discharge would be used so that process water treatment would be managed according to the magnitude of seasonal flows in Prairie Creek. Details of the proposed water management plan and commitments to minimize potential for impacts to fish or aquatic habitat are presented in CZN's "Prairie Creek Mine Developer's Assessment Report" submitted to the Mackenzie Valley Review Board in March 2010.

This report has been prepared at the request of CZN to develop a design for a diffuser outfall for the treated mine drainage and mill process water. Following an assessment of channel hydraulics and design constraints in the reach where the outfall is required, the scope of the work was expanded to assess a range of outfall alternatives.

2.0 DESIGN CONSIDERATIONS

Prairie Creek is a high-energy, gravel-bed stream which originates within the southern Mackenzie Mountains of the Northwest Territories. The low water channel flows within a gravel floodplain which is up to 300 m wide, often bounded by mountains on either side. The channel gradient may be controlled in part by intermittent bedrock outcrops. At normal open water flows, the wetted channel in the alluvial (not bedrock) reaches is generally shallow (less than 1.5 m deep), about 20 to 40 m wide and bordered by gravel bars on one or both sides. The Prairie Creek mine site was constructed in the left floodplain of the creek, and flood protection berms for the site have reduced the active floodplain in the vicinity of the proposed outfall to about 50 m. With the relatively narrow active floodplain, the position of the wetted channel at low flows is relatively stable and more predictable than at other locations.

Outfall design should meet the following objectives:

- be durable and able to withstand flood flow conditions including bed load;
- discharge to a location where water is flowing at low flow conditions;
- discharge below the bottom of winter ice;
- promote mixing with the receiving water; and
- minimize construction disturbances.

The outfall will be located near the downstream end of the plant site, upstream from the confluence of Prairie and Harrison Creeks, and will drain a catchment pond located inside the site flood protection berms. Following an initial review of channel geometry and hydraulics in the vicinity of the catchment pond, it became apparent that there are trade-offs between the degree of initial mixing and amount of construction disturbance. Due to the significant construction disturbances associated with an outfall in a single deep channel as originally proposed, a range of alternatives was assessed.

Figure 1 and Photo 1 show the locations of four alternative outfalls. Alternative A is the existing outfall to Harrison Creek just upstream from the confluence with Prairie Creek. Alternative B is a simple pipe discharging to Prairie Creek from the channel left bank just upstream from Harrison Creek. Alternative C is an exfiltration trench that would release effluent to the channel bed from a perforated pipe installed beneath the bottom of channel. Alternative D is a diffuser outlet that would be trenched into a relatively deep section of channel bed, with dispersion risers to release effluent at mid-depth flow above the channel bottom.

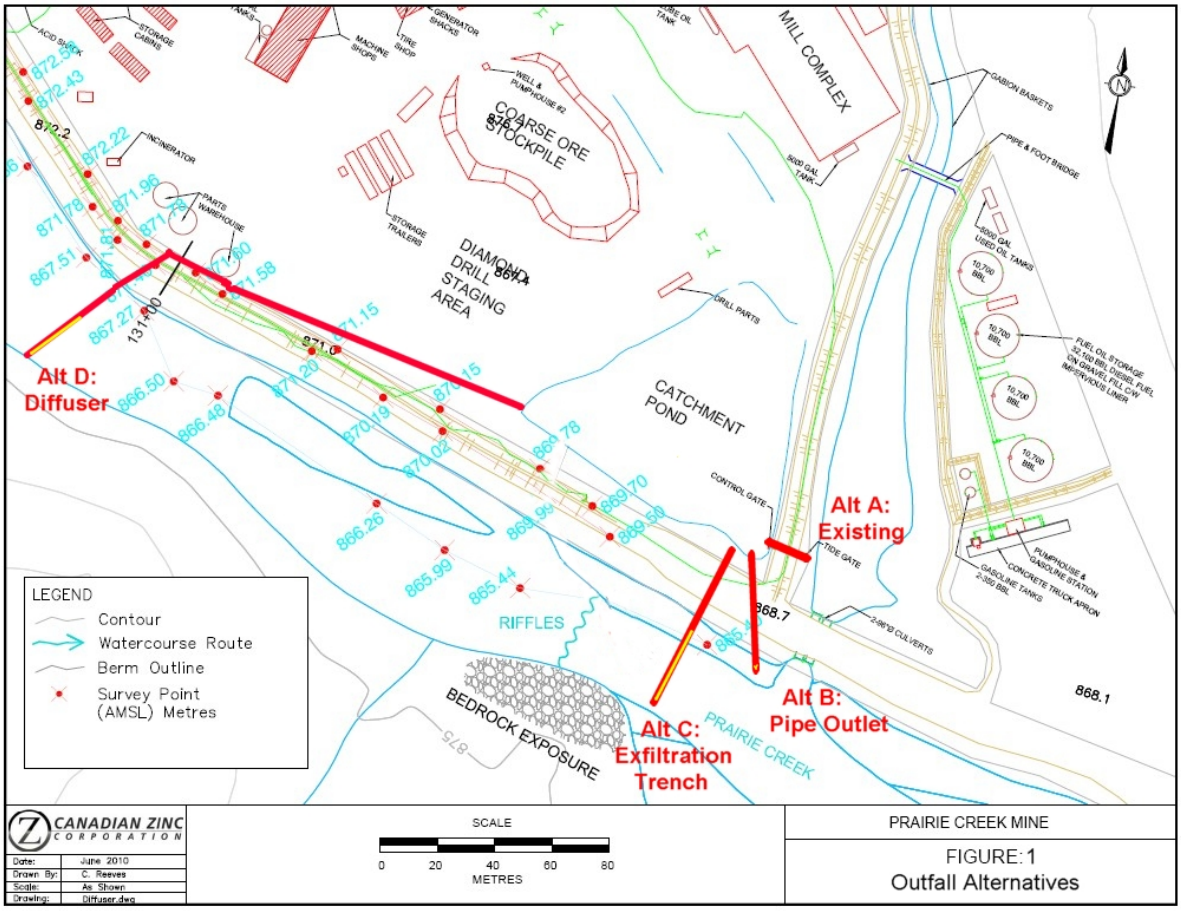


Photo 1, Outfall Alternatives. Photo taken August 9, 2010, viewing downstream. Discharge is approximately 12 m^3/s representing an average August flow.

3.0 FLOWS AND WATER LEVELS

Flows and water levels for the outfall design were reviewed using available streamflow and channel geometry information. Water Survey of Canada (WSC) stream gauge 10EC002, Prairie Creek at Cadillac Mine, was operated continuously from October 1974 through December 1990, and provides flows for the outfall location. Channel cross section and profile surveys of the stream which encompass the proposed outfall location were made in August 1980, and provide a basis for relating the streamflows to corresponding widths and depths. Channel geometry information was obtained from the attached figure "Prairie Creek Profile, Cross Sections and Estimated Flood Levels" prepared in 1980 by Ker, Priestman & Associates. The 1980 geometry information was digitized and modelled with the HEC-RAS hydraulic model to assess the channel hydraulics. Outfall alternatives A, B, and C are all located in the vicinity of the existing confluence of Harrison and Prairie Creek near station 139+50 (ft) on the 1980 drawings. The confluence shown on the 1980s drawings at station 148+00 is for an old alignment prior to channel modifications along Harrison Creek.

Table 1 presents the WSC summary of flows for Prairie Creek. Low flows will be a limiting factor for the outfall design and are the subject of discussion here. The lowest monthly flow in any particular year most often occurs in March, but in some years the flows are lowest in February or April. For the 15 years of recorded flows for these months, the lowest average flow is 0.309 m^3/s in March. The minimum monthly flow reported for a particular month was 0.038 m^3/s in March 1985. The minimum recorded daily flow was 0.029 m^3/s on Mar 10, 1980. Although these flows are very low, there is no evidence to indicate that the creek is likely to freeze up completely in the study ready. In developing an outfall design for such low flows, the possibility exists that outflow may need to be curtailed, and water stored on-site, below some flow threshold. For purposes of the present assessment, channel hydraulics were modeled for a design low flow of 0.30 m^3/s, recognizing that lower monthly flows will occur in about half of all years. Hydraulics were also assessed for an extreme low flow of 0.03 m^3/s at which outflow discharges may not be possible.

Table 1
PRAIRIE CREEK AT CADILLAC MINE (10EC002)
Monthly Mean Discharge (m^3/s)

Archived hydrometric data from Canada's HYDAT database.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1974	-	-	-	-	-	-	-	-	-	2.77	1.61	0.790	-
1975	0.438	0.264	0.122	0.516	16.4	19.4	14.9	12.8	7.45	3.10	1.33	0.934	6.52
1976	0.781	0.660	0.550	1.10	18.4	23.0	19.7	8.52	5.85	2.43	1.04	0.504	6.91
1977	0.279	0.269	0.263	0.596	14.9	34.2	14.5	10.7	7.47	2.78	0.828	0.254	7.27
1978	0.230	0.170	0.167	0.376	7.84	11.9	10.6	6.27	3.66	1.57	0.851	0.629	3.71
1979	0.375	0.241	0.237	0.325	10.4	24.4	14.2	8.89	5.08	2.04	1.07	0.556	5.67
1980	0.319	0.162	0.061	1.05	8.64	7.26	9.62	7.95	6.83	5.61	1.30	1.04	4.17
1981	0.528	0.357	0.310	0.363	13.7	13.4	5.96	5.12	8.06	2.75	1.62	1.30	4.47
1982	0.773	0.387	0.240	0.536	9.73	19.2	7.51	8.27	6.44	2.32	1.25	1.05	4.82
1983	0.792	0.550	0.397	0.272	7.86	15.8	9.23	16.9	6.03	1.54	0.859	0.460	5.09
1984	0.145	0.048	0.064	0.861	8.52	13.6	13.8	8.88	5.48	2.69	0.903	0.535	4.65
1985	0.206	0.070	0.038	0.078	13.1	12.7	11.5	7.22	5.43	2.84	2.32	1.84	4.81
1986	1.23	0.868	0.661	0.526	15.0	24.4	16.1	10.3	6.75	3.93	1.32	1.04	6.87
1987	0.865	0.703	0.489	0.377	8.43	13.2	8.99	9.99	8.30	2.66	0.939	0.770	4.66
1988	0.603	0.454	0.292	0.845	15.1	37.4	16.8	8.08	9.08	3.73	1.34	0.791	7.87
1989	0.269	0.294	0.468	4.34	15.9	10.8	5.98	5.19	4.09	2.56	1.72	0.944	4.41
1990	0.639	0.595	0.577	0.935	13.8	12.1	9.09	14.3	5.08	1.64	1.69	0.812	5.15
Mean	0.530	0.381	0.309	0.819	12.4	18.3	11.8	9.34	6.32	2.76	1.29	0.838	5.44
Max	1.23	0.868	0.661	4.34	18.4	37.4	19.7	16.9	9.08	5.61	2.32	1.84	7.87
Min	0.145	0.048	0.038	0.078	7.84	7.26	5.96	5.12	3.66	1.54	0.828	0.254	3.71

Low flows occur during late winter when an ice cover will be present. Channel hydraulics were modelled with a Manning's roughness of 0.035 for the channel bed and 0.025 for the ice cover. An ice thickness of 1.0 m was assumed; thickness affects the hydrostatic water level but has little or no effect on the depth of flow beneath the ice cover.

Results of the hydraulic modelling were that, at section 131+00 representing the outfall reach in the vicinity of Alternatives B and C, a design flow of 0.30 m^3/s under ice would have a flow area approximately 4.6 m wide and 0.08 m deep. At extreme low flow, the flow area would be approximately 2.8 m wide and 0.05 m deep.

In reviewing the low flow channel hydraulics, it must be recognized that the precise position of a low flow channel in a gravel bed stream is not fixed, and that shifting can occur any time that flow is sufficiently high to move the bed materials. Several of the channel cross sections surveyed in 1980 show multiple low points in the cross sections which appear to represent active and abandoned low flow channels. The alignments of the Prairie Creek outfall alternatives shown in Figure 1 and Photo 1 are at locations where the low flow channel is expected to be reasonably stable. This stability is the result of the river training effect of the flood protection berm along the channel left bank, and bedrock outcrops on the right bank. No evidence of significant vertical movement of the channel was observed on Prairie Creek at the Harrison Creek confluence, where the outlet culverts were installed about 30 years ago to match the vertical position of the channel at that time.

4.0 OUTFALL CONCEPTUAL DESIGN

The original concept for the outfall design was to use a multi-port diffuser which would maximize the horizontal and vertical mixing of effluent with the receiving water at the point of release. In a typical river application, an outlet pipe would be trenched (anchored) into the channel bed, with risers extending above bed level to release effluent into the flow. Nozzles or spreaders at the ends of the diffuser risers can aid in the mixing process.

Photo 2. Example of effluent diffuser from Tideflex® brochure, available online at www.tideflex.com.

Photo 2 is from a Tideflex® brochure and shows a diffuser designed to discharge to a shallow river using 6 " patented diffuser valves with integral three foot-long rubber risers. Diffuser valves can be custom-designed to maximize outfall mixing performance based on jet velocity, open area and the hydraulic head limitations.

The very shallow depth of flow below the Prairie Creek winter ice cover presents a significant challenge for using a conventional multi-port diffuser system as illustrated above. The risers would be constructed with fixed outlet points which would need to intersect with under-ice shallow flow only 0.05 to 0.08 m deep during late winter conditions. Although the horizontal position of the low-flow channel is expected to be reasonably static where outlets are proposed, the mixing performance would be highly sensitive to the channel vertical stability. Even slight variation in the bed elevation of the low flow channel could cause water to be released at either the top or the bottom of the water column, compromising the mixing performance.

An alternative approach to deal with the very shallow winter flow would be to construct an exfiltration trench system in the channel bed. Conceptually, this would be a durable pipe that is perforated with suitable screened openings, placed in a trench below the streambed and backfilled with washed coarse alluvial material. The inlet to the system would be screened to prevent the entry of materials which could clog the outlet, and there should be some ability to connect a pump which would apply pressure flow to flush accumulated fines from the trench backfill material if necessary. With this design, effluent would enter the flowing water at upward seepage from the channel bed, and vertical mixing would not be as rapid as with ports that discharge mid-depth into the flow.

Other alternatives for the outfall include a simple pipe outlet to the Prairie Creek low flow channel, or the continued use of the existing outlet which releases to Harrison Creek. Pros and cons of each of the identified alternatives are considered below.

Alternative A: Existing Outfall

Alternative A is the continuing use of the existing catchment pond outlet to Harrison Creek. The primary advantage to this alternative is that there would be no construction disturbance. However, mixing with Prairie Creek flow would be the slowest of all alternatives being considered. Also, the flow passes through culverts before reaching Prairie Creek, and winter ice problems are likely.

Alternative B: Pipe Outlet

Alternative B is a simple pipe outlet discharging from the left bank of Prairie Creek about three to five metres upstream from the Harrison Creek confluence. Field surveys conducted in August 2010 confirmed that the channel minimum bed (maximum depth) at this location is about 10 m wide, starting about 1.5 m from the edge of vegetated bank. Construction would involve excavating a trench through the left bank at a level which intersects the channel bottom about 1.5 m from the left bank, placing the pipe to extend a short distance into the flow, and armouring the trench backfill with light riprap. Sediment control for the work could likely be completed with silt fencing around the work site in a manner similar to the sediment control measures used during bank armouring work for access road repairs.

Advantages to the pipe outlet alternative include:

- minimal construction disturbance;
- effluent is released to water below the winter ice level, allowing for winter operation;

- gravity outflow should be feasible (no pumping required); and
- minimal maintenance needs and easy access for repair if necessary.

The disadvantage to the pipe outlet alternative is that effluent will not be fully mixed with the receiving water at the point of release. A mixing zone analysis is planned to be performed to quantify the reach length required for the effluent to be diluted to acceptable target levels.

Photo 3, Prairie Creek in vicinity of Outfall Alternatives A, B, and C. Photo taken August 9, 2010. Flow is left to right.

Alternative C: Exfiltration Trench

Alternative C is an exfiltration trench across a portion of the bed of Prairie Creek about 20 m upstream from the Harrison Creek confluence. Photo 3 shows the channel conditions in this reach. Construction would involve excavating a trench through the left bank to a depth about one metre below the minimum bed level, with the trench extending approximately 5 metres into the channel from the left bank. The design would not extend across the entire channel. To avoid introducing an effluent plume across the entire channel bottom, potentially interfering with the passage of aquatic organisms, the outer extent of exfiltration trench would be stopped at about the midpoint of the low flow channel segment. Sediment control during exfiltration trench construction would most likely require diverting the main flow to the far side of the channel while work is in progress. Aqua Dams® (water-filled water barriers) could be used for the diversion activity to minimize secondary disturbance to the channel.

Advantages to the exfiltration trench include:

- design which is resilient to changes in the elevation or location of the low flow channel; and
- effluent initial mixing is improved over a simple pipe outlet.

Disadvantages include:

- a moderate construction impact due to excavation into the channel bed, and
- the system could be difficult to service if the outlet pipe perforations became plugged by unexpected solids in the wastewater or by siltation of the trench backfill material.

An exfiltration trench system at this location should be designed with a pump to ensure adequate performance given the small available gravity head and uncertain head losses through the exfiltration media.

Alternative D: Deep Channel Diffuser

Alternative D is a diffuser outfall constructed in a deep channel segment of Prairie Creek located approximately 250 m upstream from the confluence with Harrison Creek. The deep water at this site is the result of scour action when flood flows impinge against bedrock at the right side of channel. Field surveys in August 2010 determined that the maximum water depth at this location is about 1.8 m; this is one metre deeper than the deepest part of channel in the vicinity of the Harrison Creek confluence. Additional surveys and hydraulic modelling would be required to determine the expected flow depth at winter low flow conditions, but it is likely that the water would be sufficiently deep to accommodate a conventional multiport diffuser with risers. Outflow would need to be pumped to the diffuser because the stream water level at this location is higher than at the catchment pond.

A complication to implementation of Alternative D is that the suitable deep water is located on the far side of the channel, opposite from the mine site. Construction would involve excavating a trench across the entire width of channel, about 25 to 30 m in total, to a depth at least one metre below the minimum bottom elevation at the deep part of channel on the far side. A diffuser section about 10 m long with risers would be installed in the bed at the deep portion of channel. Connecting pipe would be installed at a similar deep elevation across the gravel bar segment. Construction would occur in two segments with flow isolation. During construction in the deep channel segment, the stream would need to be temporarily diverted from the deep channel on the right to the gravel bar on the left. Aqua Dams® could be used for the diversion. The reach where the diversion would need to occur can be seen on Photo 1. There is a risk that a new primary channel could cut into the gravel bar while the diversion is in place. A final design for this alternative will need to give further thought to constructability issues and risks.

Alternative D has the advantage of ensuring complete mixing with receiving water. The disadvantage is that there could be significant disturbance to the channel during construction. Trenching into the channel bed for this alternative is more extensive (deeper and longer) than for the other alternatives, due to the need to be below the deep water section on the far side of the channel. Also, there are construction risks associated with having equipment isolated on a mid-channel gravel bar while the streamflow is diverted back and forth between the right and left sides of channel.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Normal low flows during late winter conditions are a limiting factor for the outfall design. In an alluvial reach without bedrock effects, an average March flow of 0.30 m^3/s under the ice would have a flow area approximately 4.6 m wide and 0.08 m deep. At the lowest recorded flow, the flow area would be approximately 2.8 m wide and 0.05 m deep. The position of the low flow channel may shift following bed-mobilizing flood events.

Ideally, the outfall would be situated in water that is deeper than in a typical channel section at low flow. A suitable deep water section was identified where flood flows impinge against bedrock, and where a conventional diffuser outfall could be installed with multiple ports to maximize horizontal and vertical mixing at the point of release. However, this deep water section is located along the far bank which is difficult to access from the mine site and construction at this location would require relatively deep trenching (up to three metres) across the entire width of channel, plus a temporary total diversion of the stream flow around the deep water section while the work is in progress. Because of the difficulty of construction and the extent of channel disturbance, it is recommended that consideration be given to other alternatives.

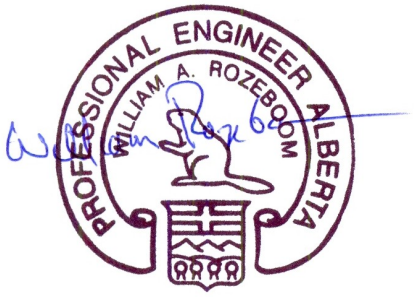
Consideration was given to: A) continued use of the existing outfall to Harrison Creek, B) a simple pipe outlet at the bank of Prairie Creek, and C) an exfiltration trench constructed in the Prairie Creek channel bed. The recommended alternative, considering operational performance, maintenance needs and construction impacts, is for a simple pipe outlet from the bank of Prairie Creek. A mixing zone analysis is planned to be performed to quantify the reach length required with this alternative for the effluent to be diluted to acceptable target levels.

Additional design details for the recommended outlet will be prepared upon completion of the mixing zone analysis and confirmation of design flows. Tentatively, the outfall will consist of a durable steel pipe, about 20 to 40 mm diameter, discharging at the channel bottom about 2.0 m from the existing edge of bank. A check valve would be installed at the end of pipe to prevent reverse flow and to promote mixing.

We trust that the above assessment meets your immediate needs; please do not hesitate to call if there are any questions.

Respectfully submitted,

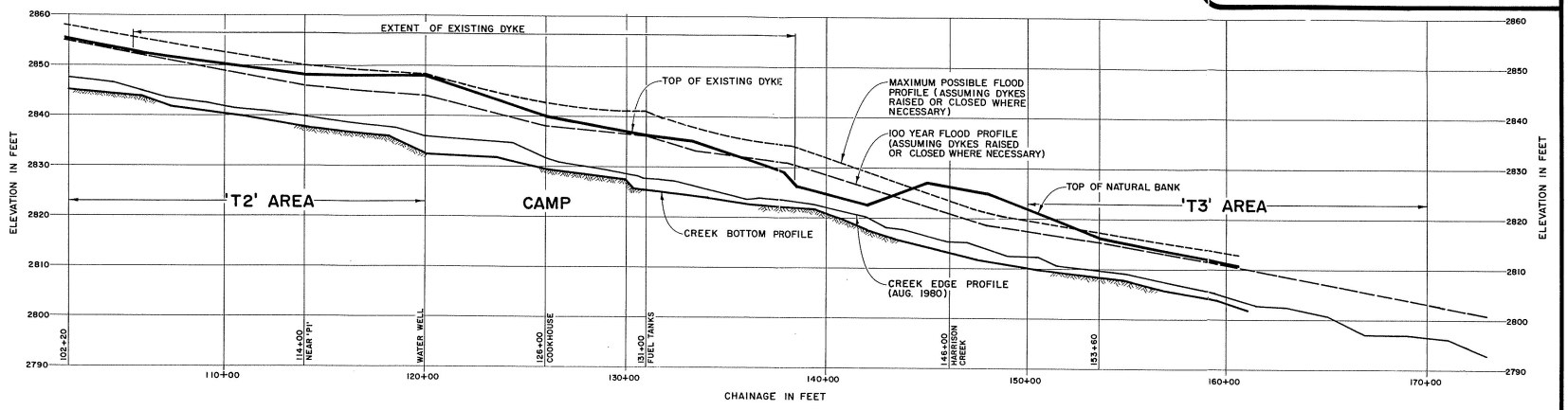
northwest hydraulic consultants



W.A. (Bill) Rozeboom, M.B.A., P.Eng.
Senior Hydrologist

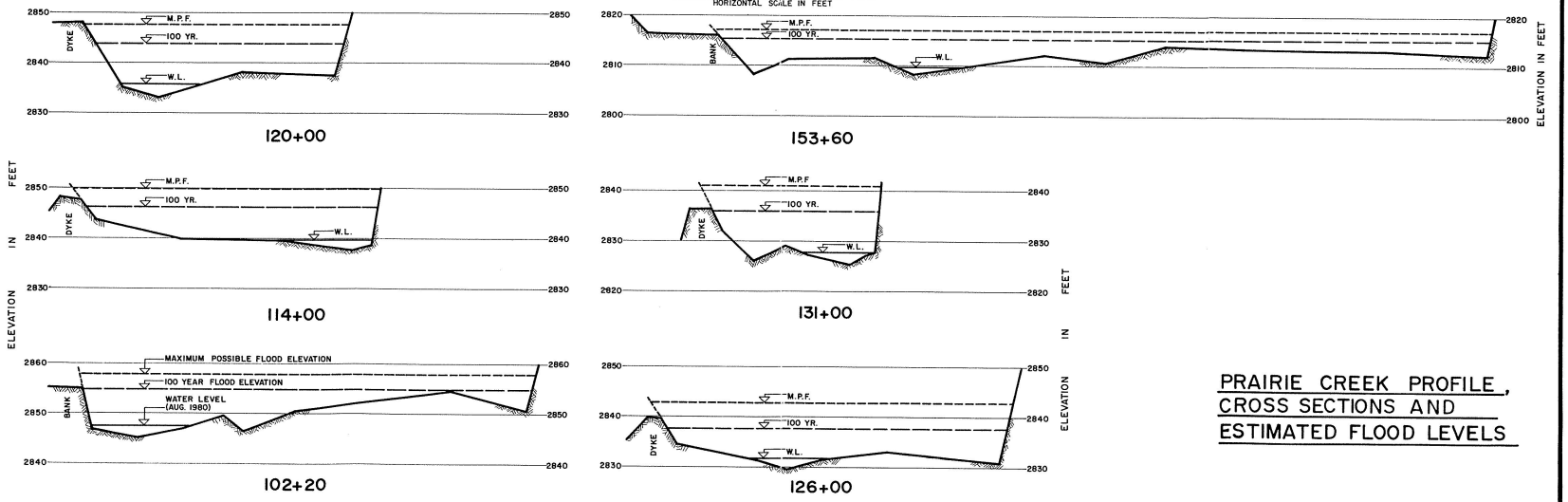
Gary Van Der Vinne, P.Eng
Principal

CADILLAC EXPLORATIONS LIMITED



PROFILE - PRAIRIE CREEK

0 500 1000
HORIZONTAL SCALE IN FEET



CROSS SECTIONS

0 50 100 150
HORIZONTAL SCALE IN FEET

PRAIRIE CREEK PROFILE, CROSS SECTIONS AND ESTIMATED FLOOD LEVELS

FIGURE 18

KER, PRIESTMAN & ASSOCIATES LTD.

Appendix L

APPENDIX L
WATER DISCHARGE COMPLIANCE APPROACH

INTRODUCTION

CZN's strategy for discharging water to the receiving environment was explained in the DAR in Section 6.16.7 and Appendix 9. The strategy includes maximizing treatment rates and discharge during periods of high flows in Prairie Creek, and reducing rates in low flow months. For process water, water will be stored during months when creek flows are typically lowest, and no process water will be treated and discharged. Treatment and discharge rates will be adjusted according to receiving water flows.

The traditional manner of discharge regulation (by the Mackenzie Valley Land and Water Board) is to set 'end of pipe' discharge limits for flow rate and parameter concentrations, also known as effluent discharge criteria. The limits in conjunction effectively restrict concentration loadings entering the receiving environment. However, in the absence of seasonal variations in discharge limits, concentration loadings remain constant year round irrespective of the ability of the receiving environment to absorb them. This means that receiving water concentrations after mixing of upstream flows with the discharge will also vary seasonally. From the perspective of the aquatic environment, impacts will be minimized when downstream concentrations remain within an acceptable range and do not fluctuate substantially on a seasonal basis. It is clear that the traditional manner of discharge regulation is not suited to CZN's proposed discharge strategy. Inflexible limits on discharge rates would mean an inability to modify rates in tandem with variations in receiving water flows, and a consequent variation in downstream receiving water quality. A modified regulatory instrument is required.

EFFLUENT QUALITY CRITERIA

The Land and Water Boards of the Mackenzie Valley recently issued a final draft "Water & Effluent Quality Management Policy" (April 29, 2010). Most of the following commentary was extracted from this document.

The Water Boards set discharge limits, also called effluent quality criteria (EQC), in the conditions of a water licence. EQC's define the maximum allowable concentrations or amounts (i.e., loadings) of each contaminant in the waste and the proponent must ensure that the waste discharged stays within these limits in order to remain in compliance with the water licence. Typically, an EQC value will be developed for any contaminant that is predicted to be in the waste at a concentration that may adversely affect downstream water quality. The EQC will be established on a project-specific basis to ensure that:

1. Water quality in the downstream environment is protected,

2. Contaminant loadings to the environment are minimized, and

3. The proponent can reasonably and consistently achieve the EQC

The Water Boards believe that EQC for a project must be set such that the water quality standards established for the receiving environment will not be exceeded. No such standards have been established for water bodies in the NWT; instead, the level of water quality to be maintained in the receiving environment has been, and will continue to be, decided on a project-specific basis by the Boards, and EQC set accordingly.

In their water licence applications, proponents must provide the information necessary to establish water quality standards for contaminants of concern and may, based on that information, propose appropriate water quality standards for the receiving environment of their project. This is what CZN has done with the derivation of site-specific water quality objectives (DAR Appendix 7).

Proponents are expected to minimize and, where technically and economically possible, to prevent waste from entering water. To this end, the Water Boards expect proponents to demonstrate how their planning processes have considered the following waste prevention/minimization hierarchy of preferred options:

1. Source control – waste should be prevented or reduced at the source whenever feasible;

2. Reuse/recycle – waste that cannot be prevented should be reused or recycled in an environmentally safe manner whenever feasible;

3. Treatment based on best available technology – waste that cannot be prevented or recycled/reused should be treated in an environmentally safe manner whenever feasible; and,

4. Discharge based on limits – discharge of waste to the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

While CZN is limited in its ability to adopt Option 1, Option 2 has been employed with the recycle of mine and mill water for mill feed. For Option 3, CZN will use conventional lime treatment for mine water, and a multi-step process for mill water with pH adjustment, sulphide, lime and coagulant addition. Option 4 is the subject of this document.

The final determination of EQC requires that the proponent submits the following:

- technically feasible predictions of the concentration and quantities of contaminants that it proposes to discharge after all proposed waste prevention measures have been employed, and,

- predictions of how the effluent, once discharged, will mix and disperse in the receiving environment.

This information will enable the Water Boards to set EQC that are reasonably and consistently achievable by the proponent, while still ensuring that the receiving environment is protected. The

establishment of an initial dilution zone (IDZ) will be considered by the Water Boards on a case-by-case basis such that the water quality standards for the receiving environment will need to be met outside of the IDZ.

REGULATION PROPOSAL

CZN proposes that there be dual EQC, one set would consist of 'end-of-pipe' limits, and a second would consist of the calculation of loadings with the intent of meeting site-specific objectives in receiving waters.

Table L1 provides different sets of end of pipe concentrations. The first set consists of the limits in CZN's existing Water Licence. The second set contains the Metal Mine Effluent Regulation (MMER) limits. The third set presents proposed limits for a Water Licence for mine operations. The limits in this last set are based on MMER concentrations, with existing Water Licence values where no MMER values exist. The exception is cadmium. The existing Water Licence values for cadmium are arbitrarily low, and while these are not problematic for current site discharges, they could be for future discharges that include a treated process water component. The intent of the proposed limits is to avoid the discharge of water that could be acutely toxic to aquatic life, maintain operational flexibility and ensure that the EQC can reasonably and consistently be achieved.

In Section 8.5 of the DAR, treated water quality was compared to generic water quality objectives. The comparison indicated that the metals cadmium, copper, lead, mercury, selenium and zinc could exceed an objective. Site specific objectives were then developed for these metals, and in addition, background upstream concentrations in Prairie Creek were defined. For a given metal, the load that can be discharged from the mine without exceeding the objective can be computed. This is done by multiplying the difference in concentration between the objective and the background value by the receiving water flow rate. Therefore, acceptable loads for discharge will vary in tandem with creek flows. Creek flows vary significantly on a seasonal basis, and are also prone to significant variation in a matter of hours in response to intense rainfall events. An approach is required that provides operational flexibility, but at the same time is subject to adequate regulatory control and reporting.

It is proposed that the site-specific objectives and background concentrations for cadmium, copper, lead, mercury, selenium and zinc from DAR Appendix 7 be written into a Water Licence for operations. Ammonia could be added, but its objective would need to be the CCME guideline for the protection of aquatic life. CZN intends to re-establish a permanent, automated flow monitoring station on Prairie Creek. Flows would be monitored continuously, with data relayed to the Water Treatment Plant (WTP) in real time. Records would be kept on at least an hourly interval and would be provided with monthly Surveillance Network Program (SNP) reports. Based on the fixed site-specific objectives and background concentrations, and the hourly creek flow rate, the WTP operator would determine the allowable loads for discharge (this calculation would likely also be automated). Simultaneously, the operator would also be receiving data on WTP treatment rate and would have recent treated water quality data, allowing calculation of treated water loads. The operator would adjust treatment rates to maintain treated loads at or just below the allowable loads for discharge. This would be done by automatically opening or closing

valves controlling the inflow of mine and mill water. This would divert more or less water to the Water Storage Pond. Treatment rates and water quality data would also be provided with monthly SNP reports.

The intent of opening or closing valves to adjust treatment rates is to instantaneously alter the loads being discharged to the environment. The point of discharge to the environment will be the outlet from the Catchment Pond. This pond receives site runoff which will tend to dilute treated water. However, in order to effect an instantaneous change on discharge water quality, the treatment plant discharge into the Catchment Pond will need to be located close to the pond outlet. During the open water season, treated water would blend with site runoff. In winter, the treatment plant discharge pipe would be closed to the Catchment Pond as there would be no runoff, and connected directly to the pond outlet. This would be necessary to avoid icing.

The receiving water EQC would consist of the metals 'screened' as being of interest based on comparison with generic water quality guidelines. Similar to the 'end of pipe' EQC, maximum average load calculations would be specified in the Water Licence based on the procedure described above, with some relaxation of these limits for maximum grab samples to allow for variances of short-duration.

The effectiveness of the impact reduction techniques described above would be subject to review based on the SNP program and reports, and on a suitable Aquatic Effects Monitoring Program (AEMP) which would include an Environmental Effects Monitoring (EEM) program. It is suggested that this review be done annually after completion of annual reports, and adaptive management actions be considered at that time. Necessary changes to the Water Licence would occur with renewal every 5 years.

TABLE L1: END OF PIPE CONCENTRATIONS

Parameter	Existing Water Licence		MMER			Proposed Water Licence	
	Max. Average	Max. Grab	Monthly	Composite	Grab	Max. Average	Max. Grab
Total Ammonia	5	10				5	10
Total Arsenic	0.5	1	0.5	0.75	1.0	0.5	1
Total Cadmium	0.005	0.01				0.02	0.04
Total Chromium	0.15	0.3				0.15	0.3
Total Copper	0.1	0.2	0.3	0.45	0.6	0.3	0.6
Total Lead	0.15	0.3	0.2	0.3	0.4	0.2	0.4
Total Mercury	0.02	0.04				0.02	0.04
Total Nickel	0.2	0.4	0.5	0.75	1.0	0.5	1.0
Total Zinc	0.3	0.6	0.5	0.75	1.0	0.5	1.0
Total Suspended Solids	15	30	15	22.5	30	15	30
Total Petroleum Hydrocarbons	5	10				5	10
pH	6-9.5		6-9.5			6-9.5	

All concentrations mg/L except pH

Appendix M

TECHNICAL MEMORANDUM

DATE August 23, 2010 **DOCUMENT No.** 09-1112-0610

TO David Harpley
Canadian Zinc Corporation

CC

FROM Martin Rawlings and Chris Madland **EMAIL**

PRAIRIE CREEK MINE – AIR QUALITY RESPONSES

IR Number: EC-3

Source: EC/ENR

To: Canadian Zinc Corporation

Subject: Air Quality Modelling Input and Output Data

Preamble:

The quality of model predictions is dependant on the quality of the input data used in the model. The selection of model options and the configuration of model domains and grids can also affect the quality of predictions.

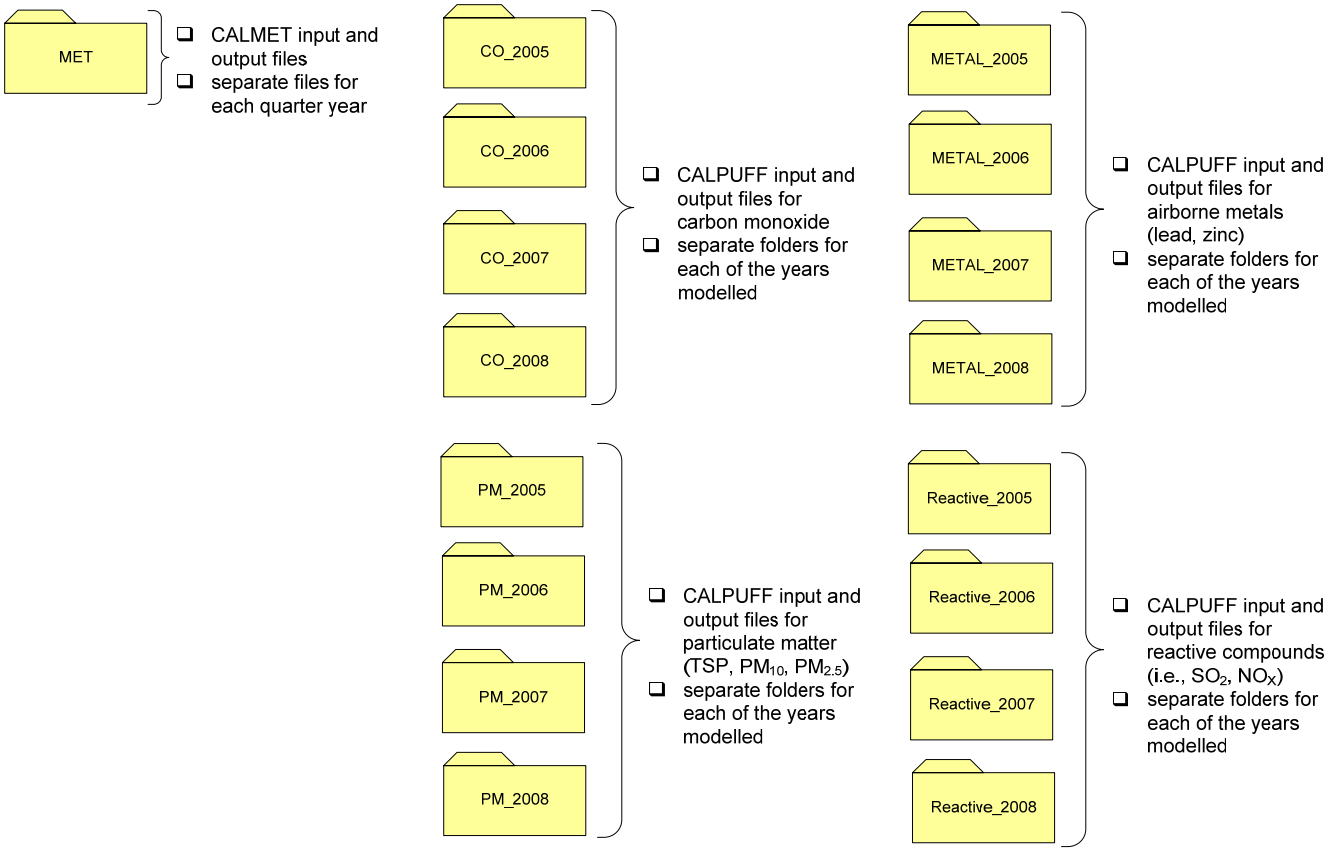
To provide confidence in the air quality model predictions provided in the DAR, all input data and selected model options and configurations must be reviewed.

Requests:

EC/ENR requests that the proponent provide all input and control files used in the CALPUFF model to generate the air quality predictions presented in the DAR. All files should be in a format that can be used directly into CALPUFF. Please include all output files in the raw CALPUFF format.

Response:

An external hard drive with the requested input and output files has been provided for consideration by the regulators. Due to the size of the meteorological input files, the modelling was done on a year-by-year basis, with four separate meteorological data files prepared and used for modelling each year. The following figure illustrates the structure of the data on the provided media.



IR Number: EC-4

Source: EC/ENR

To: Canadian Zinc Corporation

Subject: Air Quality Modelling Results

Preamble:

The proponent introduces a novel concept of a buffer zone, which extends 200 m around the surface mine lease (Air Quality Assessment, Section 2.4). There is no discussion of the significance or the justification of employing the buffer zone in regards to air quality impacts from the mine emissions. EC/ENR notes that the section of Prairie Creek (stream) which runs along the mine site is captured within the buffer zone. This stream could be an important receptor, particularly to the deposition of lead and zinc.

The proponent provides predicted maximum ambient concentrations and deposition rates based on CALPUFF modelling for receptors within the mine lease, receptors on the surface lease boundary, receptors within the buffer zone, receptors on the buffer zone boundary and receptors outside of the buffer zone (Air Quality Assessment, Tables 14, 15, and 16). The model predictions are further discussed in Section 4.2.3, and Section 4.2.4. Spatial plots of the predicted concentration isopleths were not provided. Spatial concentration isopleth plots are commonly included in air quality assessments and are essential to understanding the extent and

severity of potential impacts as well as locating appropriate monitoring sites. Other jurisdictions, such as Alberta (Alberta, Air Quality Model Guideline, 2009), require spatial concentration isopleth plots of model predictions to be provided with air quality assessments.

Request:

EC/ENR requests that the proponent discuss the significance and justification of using a buffer zone in the air quality assessment.

EC requests that the proponent provide spatial isopleth plots of predicted maximum ambient concentration and deposition rates for each species modelled.

Reference:

Government of Alberta, 2009, Air Quality Model Guideline. http://environment.alberta.ca/01004.html

Response

Dispersion modelling results presented in the Air Quality Assessment included predictions within, and beyond the surface lease. In order to aid the reader in understanding the extent of these predictions, the predictions within the area immediately adjacent to the lease were also identified. This area was referred to as a "buffer zone", and included the area within 200 m of the lease boundary.

This concept was useful, for example, in understanding that while the maximum 24-TSP concentrations were predicted to exceed the GNWT standards within the lease, they drop to 55% of the standard within a distance of 200 m (Table 14 of the Air Quality Assessment shows maximum predicted 24-TSP of 66.1 µg/m^3 on the buffer site boundary). In addition to the tabular results, Appendix C to the Air Quality Assessment provides representations of the areas where the maximum concentrations were predicted to occur.

The extents for the predicted concentrations could also be shown using concentration isopleths. While these figures are familiar to regulators and air quality practitioners, they are often confusing to lay-readers. For example, a lay-reader may wish to know which hour resulted in isopleths shown in a figure of the maximum 1-hour SO_2 concentrations. In fact, the results in isopleths showing the maximum 1-hour SO_2 concentrations do no come from a single hour, but from the combination of all of the hours (i.e. 35,064) modelled.

To aid the regulators in their review, we have prepared a series of isopleth figures that illustrate the extent of predicted concentrations in excess of the relevant criteria (i.e., >100% of criteria). In many cases, the maximum predicted concentrations do not exceed the relevant criteria and therefore, the figures do not show any areas of shading.

IR Number: EC-5

Source: EC/ENR

To: Canadian Zinc Corporation

Subject: Air Quality Monitoring Plan

Preamble:

In the outline of the of air quality monitoring plan, the proponent has identified the parameters to be measured, frequency and location of the monitoring and project phase in which the monitoring will occur (Air Quality Assessment, Table 24). Information on the types of monitoring was not provided. It would appear from the monitoring frequency that TSP, PM_{10}, and $PM_{2.5}$ will be measured using integrated monitors such as a dichotomous sampler, SO_2 and NO_2 will be measured using passive monitors, and lead and zinc will be measured using dustfall samplers. EC/ENR requests that the proponent confirm the types of monitors being proposed in the monitoring plan.

The number of monitors is unclear. The Red Dog Mine has established a network of 25 dustfall monitors at the main mine site, along the haul road and at each transfer site. The Prairie Creek Mine should implement an adequate monitoring program to ensure that fugitive dust mitigation is effective and that dust containing metals are not contaminating areas around the active mine site, haul road and transfer sites. Deposition of lead, zinc, and other contaminants into Prairie Creek is of particular concern.

Obtaining spatial isopleth plots of predicted ambient concentrations and deposition rates is essential to determining the number and location of monitoring sites.

Request:

EC/ENR requests that the proponent provide additional information regarding the air quality monitoring plan. Please provide the type of monitoring planned for each parameter and the number and location of the monitoring sites.

Response:

EC/ENR is correct in assuming that the type of air quality monitoring proposed for the Prairie Creek Mine would likely include sampling for TSP, PM_{10} and $PM_{2.5}$ at a minimum of one location on the project boundary (perhaps adjacent to the creek). Passive monitoring stations for SO_2 and NO_2 would also be proposed, likely to be co-located with the particulate monitoring station(s). In addition to the particulate and passive monitoring proposed, a dustfall monitoring program on the project boundary and adjacent (offsite) to significant material handling locations would also be proposed.

All of the monitoring stations would be sited in accordance with a slightly modified version of the Alberta Monitoring Directive. The modification will be the inclusion of site accessibility and electrical service accessibility in the algorithm used to identify suitable locations for monitoring. We note that the Prairie Creek operation will be significantly smaller than the Red Dog Mine, and road operations will be winter only as opposed to all season as at Red Dog. This has a significant bearing on the focus and intensity of monitoring requirements. The number of dustfall stations that will be proposed (~5) will reflect this and will be designed to generate adequate data on dustfall deposition and metals. The program will also be designed to be responsive to changing conditions, i.e., it will be a “living program”.

The detailed siting assessment will be conducted in consultation with EC/ENR.

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 120 µg/m^3 Concentration Threshold
- River
- Waterbody

24-Hour TSP (µg/m^3)

- 120 - 240
- 240 - 360
- > 360

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 24-HOUR TSP CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

FIGURE: 1

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\Fig23_ReceptorGridUsedForCalpuffModelling.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 80 µg/m^3 Concentration Threshold
- River
- Waterbody

Annual TSP (µg/m^3)

- 80 - 160
- 160 - 240
- > 240

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED ANNUAL TSP CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
GIS	PP	12 Jul. 2010		
CHECK	AF	12 Jul. 2010		
REVIEW		12 Jul. 2010		

FIGURE: 2

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig2_AnnTSP.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 50 µg/m^3 Concentration Threshold
- River
- Waterbody

24-Hour PM_{10} (µg/m^3)

- 50 - 100
- 100 - 150
- > 150

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 24-HOUR PM_{10} CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
GIS	PP	12 Jul. 2010		
CHECK	AF	12 Jul. 2010		
REVIEW		12 Jul. 2010		

FIGURE: 3

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig3_24PM10.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 80 µg/m^3 Concentration Threshold
- River
- Waterbody

1-Hour $PM_{2.5}$ (µg/m^3)

- 80 - 160
- 160 - 240
- > 240

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 1-HOUR $PM_{2.5}$ CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
GIS	PP	12 Jul. 2010		
CHECK	AF	12 Jul. 2010		
REVIEW		12 Jul. 2010		

FIGURE: 4

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig4_1PM25.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 30 µg/m^3 Concentration Threshold
- River
- Waterbody

24-Hour $PM_{2.5}$ (µg/m^3)

- 30 - 60
- 60 - 90
- > 90

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 24-HOUR $PM_{2.5}$ CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
GIS	PP	12 Jul. 2010		
CHECK	AF	12 Jul. 2010		
REVIEW		12 Jul. 2010		

FIGURE: 5

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig5_24PM25.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 450 µg/m^3 Concentration Threshold
- River
- Waterbody

1-Hour SO_2 (µg/m^3)

- 450 - 900
- 900 - 1350
- > 1350

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 1-HOUR SO_2 CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
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FIGURE: 6

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig6_1SO2.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 150 µg/m^3 Concentration Threshold
- River
- Waterbody

24-Hour SO_2 (µg/m^3)

- 150 - 300
- 300 - 450
- > 450

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 24-HOUR SO_2 CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
GIS	PP	13 Jul. 2010		
CHECK	AF	13 Jul. 2010		
REVIEW		13 Jul. 2010		

FIGURE: 7

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig7_24SO2.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 30 µg/m^3 Concentration Threshold
- River
- Waterbody

Annual SO_2 (µg/m^3)

- 30 - 60
- 60 - 90
- > 90

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED ANNUAL SO_2 CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
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CHECK	AF	13 Jul. 2010		
REVIEW		13 Jul. 2010		

FIGURE: 8

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig8_AnnSO2.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 400 µg/m^3 Concentration Threshold
- River
- Waterbody

1-Hour NO_2 (µg/m^3)

- 400 - 800
- 800 - 1200
- > 1200

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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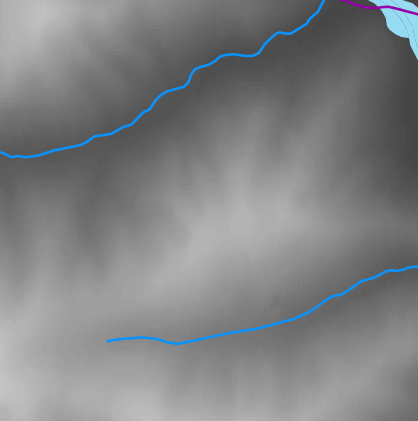
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10



PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 1-HOUR NO_2 CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
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FIGURE: 9

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig9_1NO2.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 200 µg/m^3 Concentration Threshold
- River
- Waterbody

24-Hour NO_2 (µg/m^3)

- 200 - 400
- 400 - 600
- > 600

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 24-HOUR NO_2 CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
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FIGURE: 10

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig10_24NO2.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 60 µg/m^3 Concentration Threshold
- River
- Waterbody

Annual NO_2 (µg/m^3)

- 60 - 120
- 120 - 180
- > 180

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED ANNUAL NO_2 CONCENTRATIONS

Golder Associates
Mississauga, Ontario

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DESIGN	PP	12 Feb. 2010		
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FIGURE: 11

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig11_AnnNO2.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- River
- Waterbody

1-Hour NO_x ($\mu g/m^3$)

- 800 - 1600
- 1600 - 2400
- > 2400

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 1-HOUR NO_x CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
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FIGURE: 12

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig12_1NOX.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- River
- Waterbody

24-Hour NO_x ($\mu g/m^3$)

- 400 - 800
- 800 - 1200
- > 1200

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 24-HOUR NO_x CONCENTRATIONS

Golder Associates
Mississauga, Ontario

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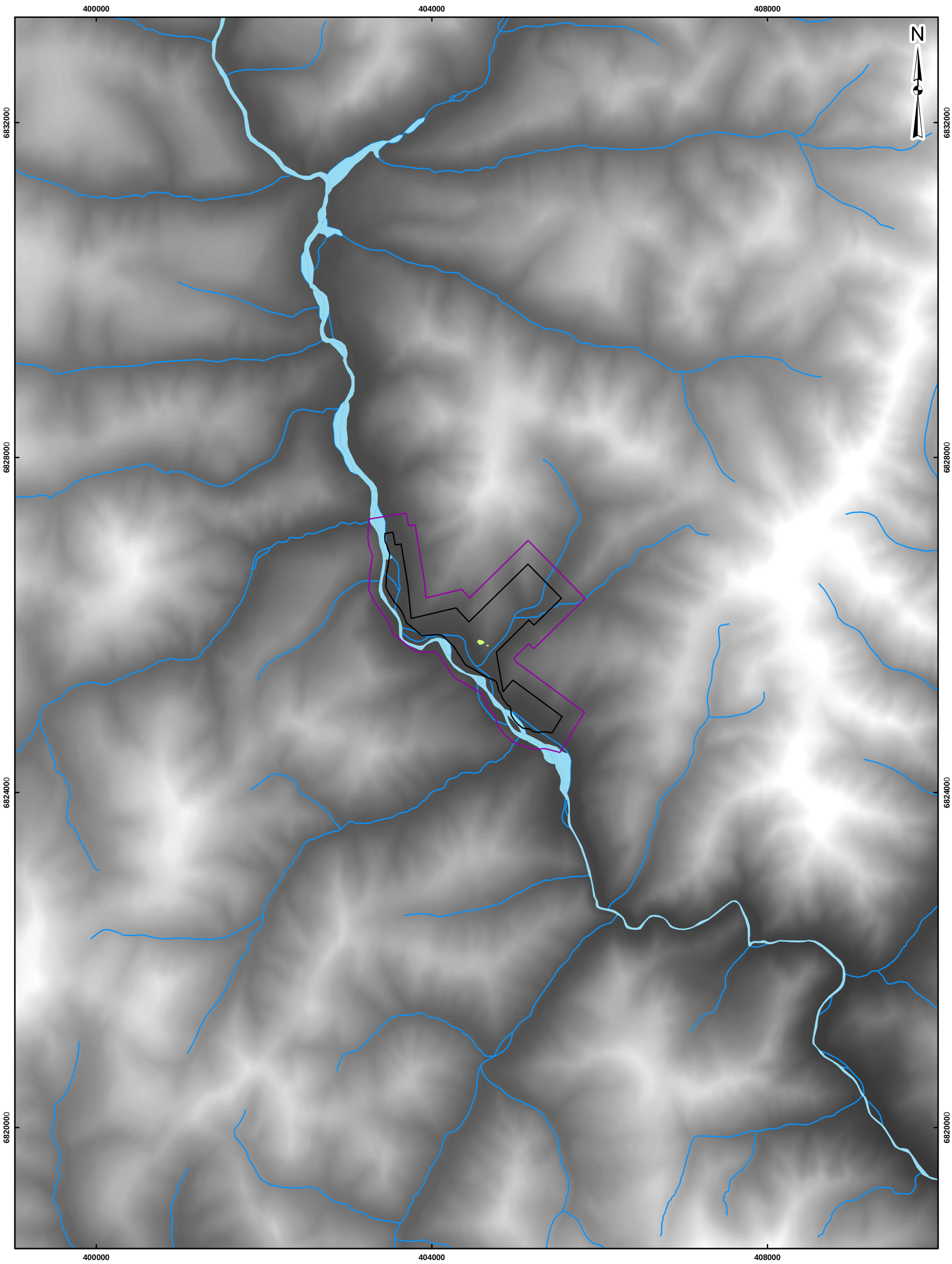
CHECK	AF	13 Jul. 2010		
REVIEW		13 Jul. 2010		

FIGURE: 13

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig13_24NOX.mxd



LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- River
- Waterbody

Annual NO_x ($\mu g/m^3$)

- 120 - 240
- 240 - 360
- > 360

500 250 0 500 1,000 1,500
SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED ANNUAL NO_x CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
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REVIEW		13 Jul. 2010		

FIGURE: 14

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig14_AnnNOX.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

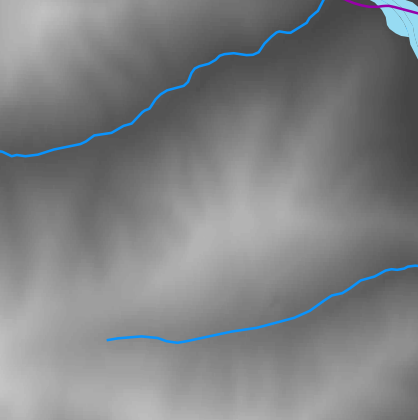
- Site Boundary
- Site Boudnary 200m Offset
- 15000 µg/m^3 Concentration Threshold
- River
- Waterbody

1-Hour CO (µg/m^3)

- 15000 - 30000
- 30000 - 45000
- > 45000

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES



REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 1-HOUR CO CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
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REVIEW		13 Jul. 2010		

FIGURE: 15

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig15_1CO.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

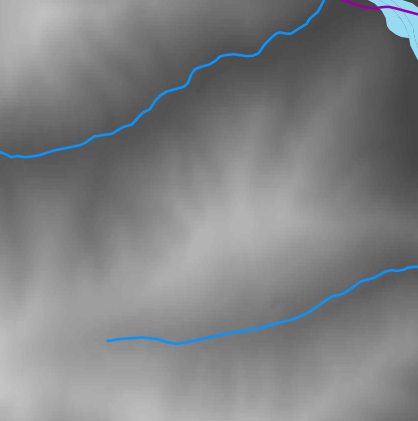
- Site Boundary
- Site Boudnary 200m Offset
- 6000 µg/m^3 Concentration Threshold
- River
- Waterbody

8-Hour CO (µg/m^3)

- 6000 - 12000
- 12000 - 18000
- > 18000

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES



REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 8-HOUR CO CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
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REVIEW		13 Jul. 2010		

FIGURE: 16

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig16_8CO.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- 1.5 µg/m^3 Concentration Threshold
- River
- Waterbody

1-Hour Lead (µg/m^3)

- 1.5 - 3.0
- 3.0 - 4.5
- > 4.5

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 1-HOUR LEAD CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010		
GIS	PP	13 Jul. 2010		
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FIGURE: 17

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig17_1Lead.mxd

400000 404000 408000

6832000 6828000 6824000 6820000

N

LEGEND

- Site Boundary
- Site Boudnary 200m Offset
- River
- Waterbody

1-Hour Zinc (µg/m^3)

- 1.5 - 3.0
- 3.0 - 4.5
- > 4.5

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

MAXIMUM PREDICTED 1-HOUR ZINC CONCENTRATIONS

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
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FIGURE: 18

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\ConcentrationIsopleths\Fig18_1Zinc.mxd

Appendix N

SNC·LAVALIN

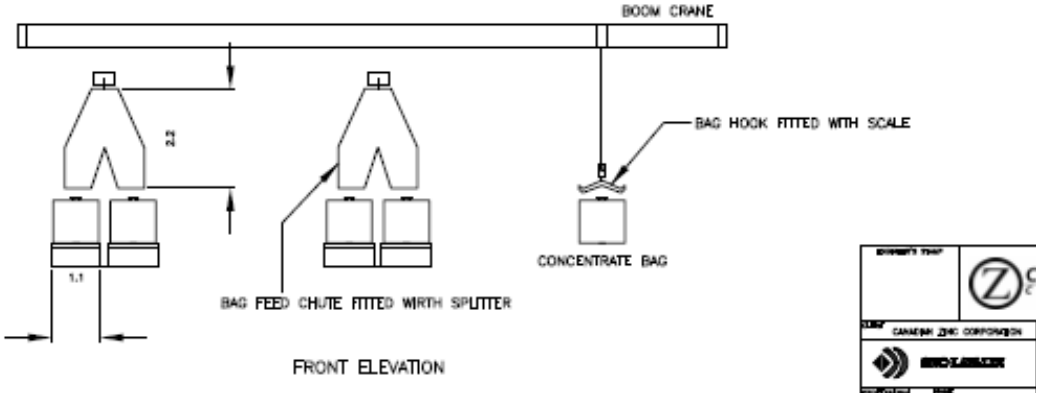
(604) 662-3555

TO:	David Harpley	**Date:**	July 28, 2010
C.C.:	Alan Taylor, Tony Wachmann		
FROM:	Byard MacLean		
Subject:	Prairie Creek Mine - Bagging Plant Description		

The Concentrate Bagging Section - Concentrate Bagging

Both lead and zinc concentrates are filtered to 8-10% moisture using dedicated Larox pressure filters. The filtered concentrate discharges onto belt conveyors that feed the concentrate bagging section. The filtrate solution is recycled back into the process plant.

Each of the filtered concentrate conveyors discharge into pant-leg chute fitted with a flop gate which allows the filtered concentrate to be directed to either side of the pant-leg. The pant-leg chute discharges directly into concentrate bags which are supported by a bag rack which supports an open bag. When a bag has been filled the flop gate directs the filtered concentrate to the next empty bag.



Full bags are closed with ties (see Figure 4) and lifted off the bag rack (see Figure 1) with an overhead crane fitted with a weigh scale and moved to a temporary storage area within the Bagging Section. Although it is not expected, if any concentrate is deposited on the outside of the closed bag, it will be removed by either compressed air or water while still in the Bagging Section.

Figure 1 - Partially filled bag on bag rack. Note roller conveyor to move full bag to where it can be accessed by the overhead crane fitted with a lifting hook and weigh scale.

Figure 2 - View of lifting hook and weigh scale fitted to an overhead crane in the Bagging Section.

The Concentrate Storage Section - Movement of Bagged Concentrate to the Storage Area

Bagged concentrate is relocated from the Bagging Section to the Concentrate Storage Section using a front-end loader fitted with a lifting hook. To eliminate concentrate track out from the Bagging Section to the Concentrate Storage Section, the loader, and more importantly its wheels, do not enter the Bagging Section.

Figure 3 - Note four lifting lugs on each bag and that loader wheels are outside the Bagging Section.

Figure 4 – Concentrate bag showing sealing method

Figure 5 – Stacking of bags in Storage Area

The Concentrate Loading Section - Loading the Concentrate Haul Trucks

Bagged concentrate is loaded from the Concentrate Storage Section to the Concentrate Haulage Trucks using a front-end loader fitted with a lifting hook. To eliminate concentrate track out from the Concentrate Storage Section by the Concentrate Haulage Trucks, the loading bay is partitioned so that the trucks do not enter the storage area where the loader operates.

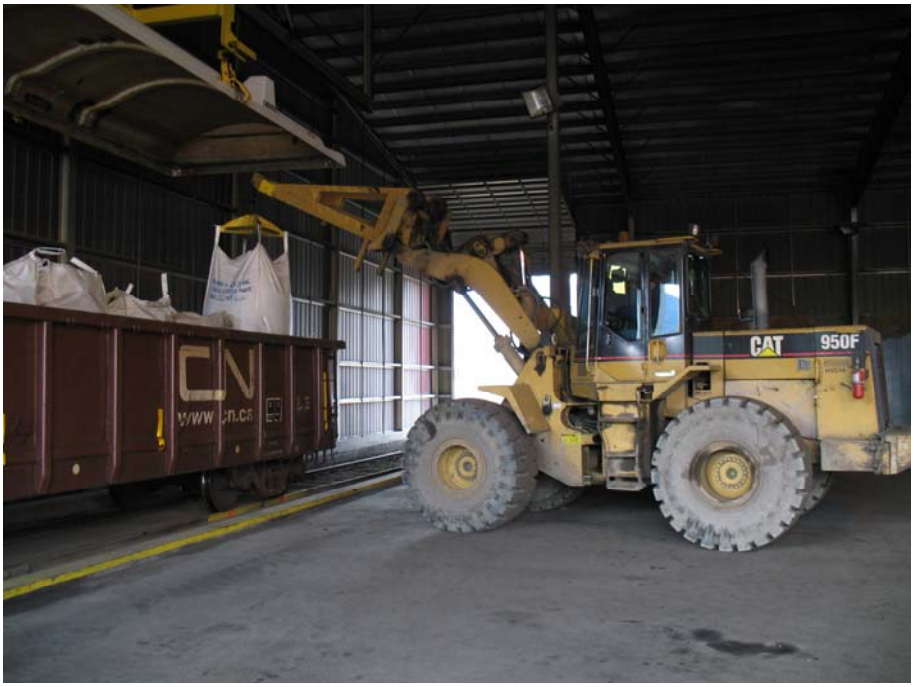


Figure 6 – At Prairie Creek, the setup would be different in that the loader would be loading trucks from the edge of the building, but similar in that the trucks would not enter the concentrate storage area where wheel contamination could potentially take place.

Appendix O

REPORT
PREPARED FOR THE
CANADIAN ZINC CORPORATION
VANCOUVER, BC

PRAIRIE CREEK MINE, NT
BULK FUEL STORAGE FACILITIES

CODE COMPLIANCE REPORT

Project No. 10-CZ-02

Prepared by:
Roosdahl Engineering Enterprises
September 6, 2010

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Appendix III	Photos

CANADIAN ZINC CORPORATION
Prairie Creek Mine, NT

Bulk Fuel Storage Facility
Code Compliance Report
September 6, 2010

1.0 Background

The Prairie Creek Mine, owned by Canadian Zinc Corporation (CZN) is a base metal mine developed and constructed to near completion in the early 1980's. Due to a sharp drop in the price of silver at that time, the mine did not begin commercial operations. The mine infrastructure has been in use since then to support advanced exploration. CZN is now continuing to advance the project to production and has applied for operating permits.

The Prairie Creek Mine is located in the Northwest Territories at 61º 34' N, 124º 49' W. The Prairie Creek Mine site is located approximately 600 air km (230 air miles) N of Fort Nelson, BC, in the Nahanni River watershed,

The Bulk Fuel Storage Compound at the Prairie Creek mine site includes the following diesel fuel tank systems:

- Diesel Fuel Storage Tank No.1 1 700 m3 (10 700 BBL)
- Diesel Fuel Storage Tank No.2 1 700 m3 (10 700 BBL)
- Diesel Fuel Storage Tank No.3 1 700 m3 (10 700 BBL)
- Diesel Fuel Storage Tank No.4 1 700 m3 (10 700 BBL)

As detailed in the following drawings (provided in Appendix I), the diesel fuel and gasoline storage compounds are constructed with a 300 mm (1') thick impervious clay seal, protected by a 900 mm (3') thick sand and gravel cover:

- Canadian Zinc *Corporation, Prairie Creek Mine, Drawing dated April 2005, Fuel Storage Area As-Built Diagram*;
- *Kilborn Engineering Drawing No. 150-17-001, dated Sept. 8, 1981, Prairie Creek Project, Fuel Oil Storage Tank Farm, General Arrangement;*
- *Kilborn Engineering Drawing No. 100-17-016, dated March 16, 1982, Prairie Creek Project, Diesel Fuel Storage & Gasolene Storage, P & I Diagram; and*
- *Golder Associates Drawing No. 802-1073, Fig 10, dated Sept. 1980 Fuel Tank Farm, Spill Control Works*.

Inspection of the containment area shows, by a relatively high tide mark on the tanks and on the dike wall, that the clay seal is effective. Survey elevations and dike containment volume calculations show that the required containment capacity of the largest tank plus 10% of the capacity of the other three tanks (2 212 m3) can be adequately contained by the dike, as constructed.

A separate gasoline storage compound is constructed within the 300 mm (1') thick impervious clay seal protected area. However, the existing two 55 m3 gasoline tanks do not meet Code requirements.

Roosdahl Engineering Enterprises was requested, to conduct a compliance review of the Prairie Creek Mine aboveground fuel storage tank systems, with respect to the new regulations enacted on June 12, 2008, *Storage Tank Systems for Petroleum Products and Allied Petroleum Regulations,* governing design and operation of aboveground fuel storage tank systems in the Northwest Territories.

2.0 Existing Facilities

The existing aboveground fuel storage tank systems located at the Prairie Creek Mine, are owned and operated by the Canadian Zinc Corporation (CZN). A condition inspection of the Fuel Storage Facilities at the Prairie Creek Mine Site, NT, was carried out by Larrie Roosdahl, P.Eng., on July 21-22, 2005, in response to a request, by the Canadian Zinc Corporation.

A set of Prairie Creek Mine Reference Documents were received from Canadian Zinc Corporation, including copies of the following fuel storage system drawings for the mine:

- Canadian Zinc Corporation Drawing, dated Apr. 2005 Fuel Storage Area, As Built Diagram
- KILBORN Drawing No. 150-17-001 Rev.04 Prairie Creek, Fuel Oil Storage Tank Farm, General Arrangement
- KILBORN Drawing No. 100-17-016 Rev.02 Prairie Creek, Fuel Storage and Gasolene Storage, P&ID Diagram
- Golder Associates Drawing No. 802-1073, Fig.10 Fuel Tank Farm, Spill Control Works

These Reference Documents are printed and available in Appendix I:

2.1 Location

The Prairie Creek Mine, is located in the Northwest Territories at 61º 34' N, 124º 49' W, and is approximately 600 air km North of Fort Nelson, BC. The elevation at the Prairie Creek Mine, at the airstrip, is approximately 3 000' (915m) above sea level. The Prairie Creek Mine site is located in the Nahanni watershed, at the junction of the Harrison and Prairie Creeks, on a low gravel beach in a mountainous area enclosed on two sides by high hills.

The nearest base for chartered aircraft is either, Fort Nelson, BC or Fort Simpson, NT. Transportation for fuel and heavy equipment is currently by winter Cat train although construction of an all weather road is being investigated.

2.2 Climate

The average climate conditions at Prairie Creek are as follows:

July Temperatures:	Mean high	25.6º C
	Mean low	12.2º C
January Temperatures:	Mean high	-25.6º C
	Mean low	-32.7º C
Precipitation:		
	Rainfall	381.0 mm
	Snowfall	1 549.0 mm
	Total Precipitation	533.0 mm

2.3 Prairie Creek Mine Fuel Storage System

2.3.1 Diesel Fuel Tanks

The diesel fuel tanks and general layout of the bulk fuel storage compound is shown in Photos # 1 and #4 in Appendix III. The following nameplate data was recorded for the four diesel fuel tanks:

Diesel Fuel Tank No.1 *Name Plate Data*:

Gem Steel Enterprises Ltd. Edmonton, Alberta
Type: Fuel Storage Serial Number: 81-112-3
Work Order No: 112 Date: API 650
Design Specific Gravity: 0.88 Corrosion Allowance: None
Diameter: 49' 0" Height: 32' 0" Material: C40.21 38T
Shell: .250 .188 Floor: .250 Roof: .188
Customer: Cadillac Exp. Ltd.
Inside Diameter: 14 930 mm Height: 9 750 mm
Capacity: 1 700 m3 (1 700 000 litres)

Diesel Fuel Tank No.2 *Name Plate Data*:

Gem Steel Enterprises Ltd. Edmonton, Alberta
Type: Fuel Storage Serial Number: 81-112-1
Work Order No: 112 Date: API 650
Design Specific Gravity: 0.88 Corrosion Allowance: None
Diameter: 49' 0" Height: 32' 0" Material: C40.21 38T
Shell: .250 .188 Floor: .250 Roof: .188
Customer: Cadillac Exp. Ltd.
Inside Diameter: 14 930 mm Height: 9 750 mm
Capacity: 1 700 m3 (1 700 000 litres

Diesel Fuel Tank No.3 *Name Plate Data*:

Gem Steel Enterprises Ltd. Edmonton, Alberta
Type: Fuel Storage Serial Number: 81-112-2
Work Order No: 112 Date: API 650
Design Specific Gravity: 0.88 Corrosion Allowance: None

Diameter: 49' 0" Height: 32' 0" Material: C40.21 38T
Shell: .250 .188 Floor: .250 Roof: .188
Customer: Cadillac Exp. Ltd.
Inside Diameter: 14 930 mm Height: 9 750 mm
Capacity: 1 700 m3 (1 700 000 litres)

Diesel Fuel Tank No.4 *Name Plate Data*:

API Standard 650

Year Completed: '82
Nominal Diameter: 49' Nominal Height: 32'
Nominal Capacity: 10 700 BBL
Fabricated by: Bird Oil Equipment Ltd. Erected by: Bird Oil Equipment Ltd.
Inside Diameter: 14 930 mm Height: 9 750 mm
Capacity: 1 700 m3 (1 700 000 litres)

The tanks were fabricated and erected to *API Standard 650, Welded Steel Tanks for Oil Storage*, and the exterior of Tank No.1 was painted with 2 coats of Devoe Bar Rust 236 epoxy in 2006. The three remaining tanks are not painted and are rusted although approximately 50% of the mill scale is still intact. There is no significant metal loss. These tanks need to be painted.

The tanks meet the new Federal Guidelines, are considered to have good structural integrity, and are in very good condition.

API 653 inspections, of the aboveground fuel storage tank systems, were carried out at the Prairie Creek Mine Site, NT, in 2008, in accordance with *API Standard 653, Tank Inspection, Repair, Alteration, and Reconstruction,* by Larrie Roosdahl, P.Eng., API 653 Tank Inspector Certificate #21606. The API 653 Out-of-Service (internal) Inspections were conducted on September 21, 2008 to compliment the previous In-Service (external) API 653 Inspections carried out in July 2005.

Based on API 653 analyses of the tabulated results of the inspections provided in individual *Diesel Fuel Storage Tank, API Out-of-Service Inspection Reports, dated September 20, 2008*, the four diesel fuel tanks located in the CZN Mine Fuel Storage Facility at Prairie Creek, NT have been certified for continued service, with regular maintenance and inspection, as follows:

- Tank No. 1 can be certified for up to 32 years;
- Tank No. 2 can be certified for up to 43 years;
- Tank No. 3 can be certified for up to 19 years;
- Tank No. 4 can be certified for up to 24 years;

However, *API 653 Clause 6.4.2* states:…*The actual inspection interval shall be set for each tank, to ensure that the bottom plate minimum thickness at the next inspection is not less than the value listed in Table 6-1 (0.050" if the tanks are located in an impervious secondary containment). In no case shall the internal inspection interval exceed 20 years,* with the *Authority Having Jurisdiction (Office of the Fire Marshal)* approval.

API 653 Clause 6.3.1 requires that routine in-service inspections of the fuel storage facility be carried out by the owner's operator who is familiar with the facility, the tank, and the characteristics of the product being stored. Depending on the circumstances, daily or weekly inspection should be carried out, "*but the interval shall not exceed one month. This routine in-service inspection shall include a visual inspection of the tank's exterior surfaces. Evidence of leaks; shell distortions; signs of settlement; corrosion; and the condition of the foundation, paint coatings, insulation systems, and appurtenances should be documented for follow-up action by an authorized inspector."*

2.3.2 Gasoline Tanks

The two existing gasoline tanks are located in a separate diked containment area included in the security of the secondary containment for the diesel fuel tanks, as shown in Kilborn Engineering Drawing No. 150-17-001, in Appendix I. The two 350 BBL (55 m3) riveted gasoline tanks are badly dented, are not labelled and are not expected to be worth inspecting, repairing and testing. It is recommended that tanks be replaced with new tanks or other suitable ULC or API Labelled tank(s) located on site. One of the existing diesel fuel tanks could be used as an interim gasoline storage tank and can be temporarily connected to the gasoline dispenser system, until new gasoline tanks can be installed.

2.3.3 Bulk Fuel Storage Secondary Containment

As shown on Drawings: CZC, Dwg., dated April, 2005 and Cadillac Explorations – Golder Associates Dwg. 802-1073, Fig.10, the storage compound is constructed with a 1' thick impervious clay seal, protected by a 3' thick sand and gravel cover. Inspection of the containment area shows by a relatively high tide mark on the tanks and on the dike, as shown on Photo #2, that the clay seal is effective.

The survey elevations and diked Fuel Oil Containment volume calculations, shown on CZC Dwg., dated April, 2005, show that the required containment capacity of the largest tank plus 10% of the capacity of the other tanks (2 212 m3) can be adequately contained by the dike, as constructed.

The diked containment is graded to a sump located in the southwest corner, where the water is tested before being pumped out.

2.4 Fuel Transfer Area and Pump House

2.4.1 Fuel Resupply Operation

All fuels will be brought in by tanker trucks over the winter road during the months of January through March. Supplies will be marshaled at Fort Nelson and transported approximately 300 km north on the Liard Highway, to the Liard River crossing, which is 30 km northeast of Nahanni Butte. From there, the winter road, originally built by Cadillac Exploration, will be re-opened to traverse 160 km west to the mine site.

Properly equipped and serviced tanker trucks belonging to the fuel suppliers will be used to transport the fuel. Spill contingency plans for transporting the fuel will be in place, by the fuel suppliers, and will be approved by the Department of Environment and Natural Resources of the Government of the Northwest Territories.

All vehicles traversing the winter road will be required to have radios, such that movement between checkpoints is strictly controlled to prevent accidents.

2.4.2 Bulk Fuel Storage System

A fuel resupply and dispensing area has been designed, as shown in Photo #3, with the following facilities:

- Bulk Fuel Storage Compound with Secondary Containment
- Diesel Fuel/Gasoline Pump House
- Diesel Fuel/Gasoline Loading Rack and Gasoline Dispenser
- Truck Unloading Manifolds with Spill Preventers
- Truck Fuelling Apron

The details of the fuel storage compounds, fuel pump house, loading platform, piping, resupply manifolds with spill preventers, and concrete truck apron are shown on CZC Dwg., dated April 2005 and KILBORN, Dwg. No. 150-17-001 Rev.04, dated November 19, 1981. The Process and Instrumentation Diagram for the fuel systems is provided in KILBORN, Dwg. No. 100-17-016 Rev.02, dated March 16, 1982. The drawings are provided in Appendix I, for reference.

The diesel fuel and gasoline is designed to be stored in the diked containment area, provided with an impervious clay liner. Fuel delivery tanker trucks are unloaded through connections provided with spill preventers, through the fuel pumps to the storage tanks. Diesel fuel and gasoline are dispensed through the pump house, a meter and an overhead loading rack.

The fuel transfer pump house is set up to handle, P-40 diesel fuel and gasoline. Gasoline will be stored in two new gasoline storage tanks, in a separate diked containment area. Gasoline would then be dispensed through the existing pump house and a Gas Boy Dispenser Cabinet and ¾” fueling hose. Diesel fuel will be dispensed through an existing loading rack.

2.4.3 Diesel Fuel/Gasoline Loading Rack and Dispenser

The tanker truck resupply and fuel dispensing area, in front of the Pump House and Loading Platform, shown in Photo #3, is provided with a concrete vehicle loading apron, approximately 4 m wide x 36.7 m long. The apron includes a pad around the Loading Platform, see Photo #7, and drain channels to a sump located on each end of the Pump House to contain any spillage that may occur on the fuelling apron. Spill preventers are

provided at each resupply manifold to further minimize any fuel spillage during fuelling operations. The apron and spill containment systems are in excellent condition.

2.4.4 Fuel Pump House

The fuel pump house shown in Photo #3, is an insulated metal clad steel frame building approximately 4 500 mm (15') x 6 700 mm (22') x 2 400 mm (8') high with a peaked roof and a concrete floor. The building is provided with explosion proof wiring, lights and fire alarm system. Fire extinguishers (20 lb. dry chemical) are provided in the Pump House and at the resupply manifold locations.

The pumps are mounted on concrete pads and include two 3" x 2" pumps for double diesel fuel tanker truck unloading. The pumps, shown in Photo #5, are also piped for mine vehicle fuelling through the loading rack.

There is also a 3" x 2" gasoline tanker truck unloading pump, shown in Photo #6. Gasoline dispensing is by gravity through a Gas Boy dispenser pump, shown in Photo #7.

Each meter piping run has a set of strainers and block valves. The details of the strainers, meters and valves are shown on CZC Dwg., dated April 2005 and KILBORN, Dwg. No. 150-17-001 Rev.04, dated November 19, 1981. The Process and Instrumentation Diagram for the fuel systems is provided in KILBORN, Dwg. No. 100-17-016 Rev.02, dated March 16, 1982. The drawings are provided in Appendix I, for reference.

2.4.5 Diesel Fuel Piping

The piping within the diesel fuel storage compound, is insulated 6" schedule 40 pipe with 6" x 150# flanges and 6" x 150# steel gate valves. Electric heat tracing is provided for winter operations, for the P-40 diesel fuel supplied for diesel engine operations. Each tank is separated by a 3 way Nordstrom plug valve, to allow control of diesel fuel for resupply and vehicle loading operations, and for periodic transfer of diesel fuel to the mine operations day tank, as shown in Photo #2.

3.0 Code Compliance

The above inspections and report discussions confirm that the bulk fuel storage system at the Canadian Zinc Corporation, Prairie Creek Mine was designed and constructed in compliance with the Technical new *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations*.

3.1 Federal Regulations

The purpose of the new *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (Regulations)* is to reduce the risk of contaminating soil and groundwater due to spills and leaks. These *Regulations* are made on June 12, 2008, under *Part 9* of the *Canadian Environmental Protection Act, 1999 (CEPA 1999).* The

former *Regulations* applied to aboveground storage tanks (AST) systems with a total capacity of more than 4 000 litres that contain petroleum products; the new *Regulations* do not apply to AST in which the aggregate capacity of the tanks is less than 2 500 litres and are connected to a heating appliance or emergency generator.

The new *Regulations* set forth the requirements that govern the design, upgrading and installation of a new or existing storage tank system, or any component of a new or existing system. These requirements are either directly incorporated from or are based on the requirements of the *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (Code)* developed by the Canadian Council of Ministers of the Environment (CCME), and referred to as the *Technical Guidelines*. The *Code* presents a model set of technical requirements designed to protect the environment from existing, new, or proposed storage tank systems that contain petroleum and allied petroleum products. The former Regulations did not require compliance with the *Technical Guidelines*; only for owners to self assess their storage tank systems to the *Technical Guidelines*. In this regard, diligent owners and engineering companies tended to design fuel storage facilities, in accordance with the current *Technical Guidelines* and *Code* Requirements, on a voluntary basis.

The new *Regulations* were selected as the best option to achieve, within the shortest time frame possible, the environmental and health objectives of reducing the risk of contaminating soil and groundwater due to spills and leaks of petroleum products from storage tank systems. These *Regulations* require that storage tank systems be designed, installed and removed from service in an environmentally responsible manner. Leaking storage tank systems are withdrawn from service, and systems that are considered to be a high-risk to the environment are permanently withdrawn from service and are removed.

3.2 Major Regulatory Requirements

The purpose of the new *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (Regulations)* is to reduce the risk of contaminating soil and groundwater, due to spills and leaks, from existing and new fuel storage tank systems. Some of the major regulatory requirements affected by the *Regulations* include:

3.2.1 Withdrawal of leaking storage tank systems from service;

Leaking storage tanks systems are required to be temporarily withdrawn from service, repaired, and pass a leak detection test before being returned to service.

3.2.2 Removal of high-risk storage tanks systems;

The following storage tanks systems are considered by Environment Canada to be at a high risk for contaminating soil and groundwater, and have to be permanently withdrawn from service and removed within four years (2012):

a) storage tank systems with tanks designed to be installed aboveground but installed below grade.
b) storage tank systems with tanks designed to be installed underground but installed above grade.
c) storage tank systems with partly buried tanks.
d) single-walled underground storage tank systems that do not have pre-existing corrosion protection and leak detection.
e) single-walled underground piping that does not have pre-existing corrosion protection and leak detection.

3.2.3 Completion of leak detection testing;

The owner/operator of a storage tank system installed before 2008 has to perform prescribed leak detection testing at a specified frequency, or continuous monitoring on single-walled underground equipment and single-walled aboveground equipment that does not have secondary containment.

3.2.4 Requirements for product transfer area;

The area around the connection point between a fuel delivery truck and a storage tank system with a capacity of more than 2 500 litres needs to be designed to contain spills that could occur during the product transfer process.

3.2.5 Petroleum products truck delivery driver duties;

Petroleum products truck delivery drivers are prohibited from transferring petroleum products into any storage tank, unless the storage tank system identification number is visible, and they are required to record the storage tank system identification number when delivering product. They are also required to notify the operator of any spill that occurs and of any evidence of a leak from the storage tank system.

3.2.6 Regulation Code;

The *Regulations* set forth the requirements that govern the design, upgrading and installation of a new or existing storage tank system, or any component of a new or existing system. These requirements are either directly incorporated from or are based on the requirements of the *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products (Code)* developed by the Canadian Council of Ministers of the Environment (CCME).

3.2.7 Tank Identification Number;

The *Regulations* also require the owner/operator to identify their storage tank systems and obtain, from the Minister of the Environment (Minister), an identification

number for their tanks. The identification number shall be clearly displayed on the storage tank.

3.2.8 Emergency Plan

The *Regulations* require that the owner/operator is required to prepare an Emergency Plan that takes into consideration all elements required to protect the environment and human health.

3.2.9 Product Spill Report

In the event of a spill over 100 litres, the *Regulations* outline the details to be provided in a Spill Report to be submitted to the Minister under paragraph 212(1)(a) of CEPA 1999. The report includes the date when the spill occurred, a description of the circumstances and any mitigating measures taken.

3.2.10 Fuel Storage System records

Records respecting the design and installation of the storage tank systems shall be kept for the life of the storage tank system. Other operating and maintenance records shall be kept for five years.

3.3 Technical Requirements

3.3.1 API 653 Inspection Upgrades

Based on the API Out-of Service inspection reports, dated September 20, 2008, confirmation is required that the identified Maintenance Recommendations have been addressed (see Appendix II for complete list), including:

- 3.3.1.1 construct a compacted granular tank foundation pad under Tank #4
- 3.3.1.2 upgrade the transfer piping to the mill
- 3.3.1.3 upgrade the tank grounding system and install static electricity bonding over all pipe flanges and valves
- 3.3.1.4 paint all tanks with a corrosion resistant coating – Tank #1 was painted in 2006
- 3.3.1.5 reseal the water draw-off valve threaded connections
- 3.3.1.6 set and calibrate the Level Gauge Boards
- 3.3.1.7 install (with diesel fuel resistant adhesive) a Buna N seal in the Clay & Bailey gauge hatch cover
- 3.3.1.8 replace the pressure relief valves on the piping system with by-pass pressure relief valves around all valves, to allow excess thermal expansion pressure in the piping to relieve back to the tanks.

3.3.2 Environmental Requirements

To meet the new *Regulations* the following technical upgrades are recommended:

3.3.2.1 an overfill alarm system needs to be installed on each tank to prevent over filling the tanks during truck fuel transfers

3.3.2.2 an emergency vent manway lift-off cover (ULC-S630, Figure E1) needs to be fabricated and installed in place of the existing manway cover on all four tanks to provide the required emergency venting in case of a fire

3.3.2.3 a leak detection test needs to be completed before filling the tanks.

3.3.2.4 the piping in the pump house needs to be painted, colour coded and labeled to Canadian Petroleum Products Institute (CPPI) standards

3.3.2.5 the tanks need to be registered and provided with an identification number

3.3.2.6 an Emergency Plan needs to be prepared and submitted to the Minister

3.3.2.7 Storage Tank System records need to be kept for the life of the system and operation and maintenance records need to be kept for five years.

4.0 Conclusions

4.1 It is evident that the diesel fuel bulk fuel storage and dispensing facilities have been designed and constructed to meet all the requirements of the *National Fire Code*; the *Canadian Electrical Code*; and *American Petroleum Institute (API), Underwriters' Laboratories of Canada (ULC)* and *Canadian Standards Association (CSA)* Codes and Standards and, based on the API 653 inspections conducted in 2005 and 2008, the facilities are considered to be safe and environmentally secure for continued operation.

4.2 The *Canadian Council of Ministers of the Environment (CCME), Environmental Code of Practice for Aboveground Storage Tank Systems Containing Petroleum Products*, is based on the design and construction of facilities to the above codes and standards, thus the facilities also meet the intent of the *CCME Environmental Code of Practice.*

4.3 Based on the API 653 tank inspections conducted on September 20, 2008, the structural integrity of the diesel fuel bulk storage and dispensing facilities is considered to be good and suitable for continued operation, with routine inspection and maintenance, for the next 19 to 20 years, with the Authority Having Jurisdiction approval.

4.4 With the replacement of the existing gasoline tanks, the gasoline storage and dispensing facility is also considered to be suitable for commissioning and future use.

5.0 Recommendations

To be compliant with the new *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations (Regulations),* it is recommended that:

1) the work listed in the API Inspection Upgrade Work List be completed and confirmed;
2) an overfill alarm system be installed on each tank to prevent over filling the tanks during truck fuel transfers;
3) an emergency vent manway lift-off cover (ULC-S630, Figure E1) be fabricated and installed in place of the existing manway cover on all four tanks to provide the required emergency venting in case of a fire;
4) a leak detection test be completed on all four tanks before filling the tanks;
5) the piping in the pump house be painted, colour coded and labeled to Canadian Petroleum Products Institute (CPPI) standards;
6) the tanks be registered and provided with an identification number;
7) an Emergency Plan be prepared and submitted to the Minister and
8) Storage Tank System records be kept for the life of the system, and operation and maintenance records need to be kept for five years.

Appendix I

Drawings:

- Canadian Zinc Corporation, Drawing No. — Fuel Storage Area, As Built Diagram
- Golder Associates, Dwg. No. 802-1073, Fig.10 — Fuel Tank Farm, Spill Control Works
- KILBORN, Drawing No. 150-17-001, Rev.04 — Prairie Creek, Fuel Oil Storage Tank Farm, General Arrangement
- KILBORN, Drawing No. 100-17-016, Rev.02 — Prairie Creek, Fuel Storage and Gasolene Storage, P&ID Diagram

Appendix II

- **API Inspection Upgrade Work List**

API Inspection Upgrade Work List
September 7, 2010

General Diesel Fuel Tank Containment Area - Work List:

1. Grade the entire containment area bottom evenly toward the sump, to provide a tank pad under Tank #4, which will allow water to be drained and kept away from the tank bottom, or construct a new API 650 granular tank foundation a minimum of 12" above the existing containment elevation. Pump out the containment area regularly to keep the water away from the tanks.

Diesel Fuel Piping - Work List:

2. Remove or redesign the piping across the pipe bridge to the plant. The flexible connector needs to be replaced and installed in the horizontal position.
3. Remove the open pressure relief valves on the piping and install Thermal Pressure Relief Valves (PRV) at all valves and check valves that isolate sections of piping with a PRV by-pass, as shown in attached Detail Drawings, NT-P05, NT-P06 or NT-P08.
4. Provide static electricity bonding around all flanges and valve assemblies as shown on Details NT-E15, NT-E16, NT-E17 or NT-E18.

Diesel Fuel Tank #1 - Work List:

5. Reinstall the tank grounding cable and ensure that it is securely connected to a ground rod bonded to the piping and other tanks. See Details NT-E19, NT-E24 and NT-E15
6. Replace the manway and pipe gaskets.
7. Remove, inspect and pressure test the Shand & Jurs water drain valve and reseal the threaded connection (with gasoline/diesel fuel resistant Gasoila Thread Sealant).
8. Check and adjust the level gauge board and set it to an actual dip reading.
9. Check, clean and lubricate the 6" Pressure Vacuum Vent.

Diesel Fuel Tank #2 - Work List:

10. Check and tighten the tank grounding cable and ensure that it is securely connected to a ground rod bonded to the piping and other tanks.
11. Replace the manway and pipe gaskets.
12. Remove, inspect and pressure test the leaking Shand & Jurs water drain valve and reseal the threaded connection (with gasoline/diesel fuel resistant Gasoila Thread Sealant). Install plug.
13. Check and adjust the level gauge board and set it to an actual dip reading.
14. Check and install a new seal in the 8" Clay & Bailey gauge hatch.
15. Clean, prepare and paint the tank exterior to prevent further corrosion.

Diesel Fuel Tank #3 - Work List:

16. Check and tighten the tank grounding cable and ensure that it is securely connected to a ground rod bonded to the piping and other tanks.
17. Replace the manway and pipe gaskets.
18. Remove, inspect and pressure test the Shand & Jurs water drain valve and reseal the threaded connection (with gasoline/diesel fuel resistant Gasoila Thread Sealant).
19. Check and adjust the level gauge board and set it to an actual dip reading.
20. Check and install a new seal in the 8” Clay & Bailey gauge hatch.
21. Clean, prepare and paint the tank exterior to prevent further corrosion.

Diesel Fuel Tank #4 - Work List:

22. Clean off the tank bottom rim (covered with gravel about 4” deep) and construct a tank pad, providing a 4’ wide apron and a 2:1 slope to the containment bottom. This tank has no pad. If possible the containment area should be graded about 10” lower to form a 6” high granular pad. Do not cut into the clay liner. The tank may have to be lifted and a new 12’ high gravel pad constructed in the future.
23. Check and tighten the tank grounding cable and ensure that it is securely connected to a ground rod bonded to the piping and other tanks.
24. Replace the manway and pipe gaskets.
25. Remove, inspect and pressure test the Shand & Jurs water drain valve and reseal the threaded connection (with gasoline/diesel fuel resistant Gasoila Thread Sealant).
26. Check and adjust the level gauge board and set it to an actual dip reading.
27. Check and install a new seal in the 8” Clay & Bailey gauge hatch.
28. Clean, prepare and paint the tank exterior to prevent further corrosion.

Diesel Fuel/Gasoline Pump House Area - Work List:

29. Remove all timber pipe supports and install new fabricated steel pipe supports, spaced appropriately
30. Install Thermal Pressure Relief Valves (PRV) at all valves and check valves that isolate sections of piping with a PRV by-pass, as shown in attached Detail Drawings, NT-P05 or NT-P06.
31. Provide static electricity bonding around all flanges and valve assemblies as shown on Details NT-E16, NT-E17 or NT-E18.
32. Check and service all electrical circuits and breakers.
33. Check and service or replace the Fire Alarm System.
34. Service and calibrate or replace the Gasboy gasoline dispensing pump.
35. Service and calibrate or replace the Truck Fill meter.
36. Install a gas detector, alarm and ventilation system in the pump house.
37. Clean, prepare and paint the piping and structural steel.

Appendix III

Photos

Photo #1	General Bulk Fuel Storage Compound Location
Photo #2	Diesel Fuel Compound Showing Impermeability of Clay Liner
Photo #3	View of Pump House and Dispensing Area
Photo #4	North Side of Diesel fuel Compound Showing Diesel Fuel Tanks
Photo #5	Diesel Fuel Piping in the Pump House
Photo #6	Gasoline Piping in the Pump House
Photo #7	Loading Rack Area

Appendix P

Project No. M004-001

Geochemical Characterization Report for the Prairie Creek Project, NWT

Prepared for:

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April 2008

Table 4.4. Metals by Aqua-Regia Digestion with ICP Finish

| General Sample Information | | |

Table 4.4. Metals by Aqua-Regia Digestion with ICP Finish

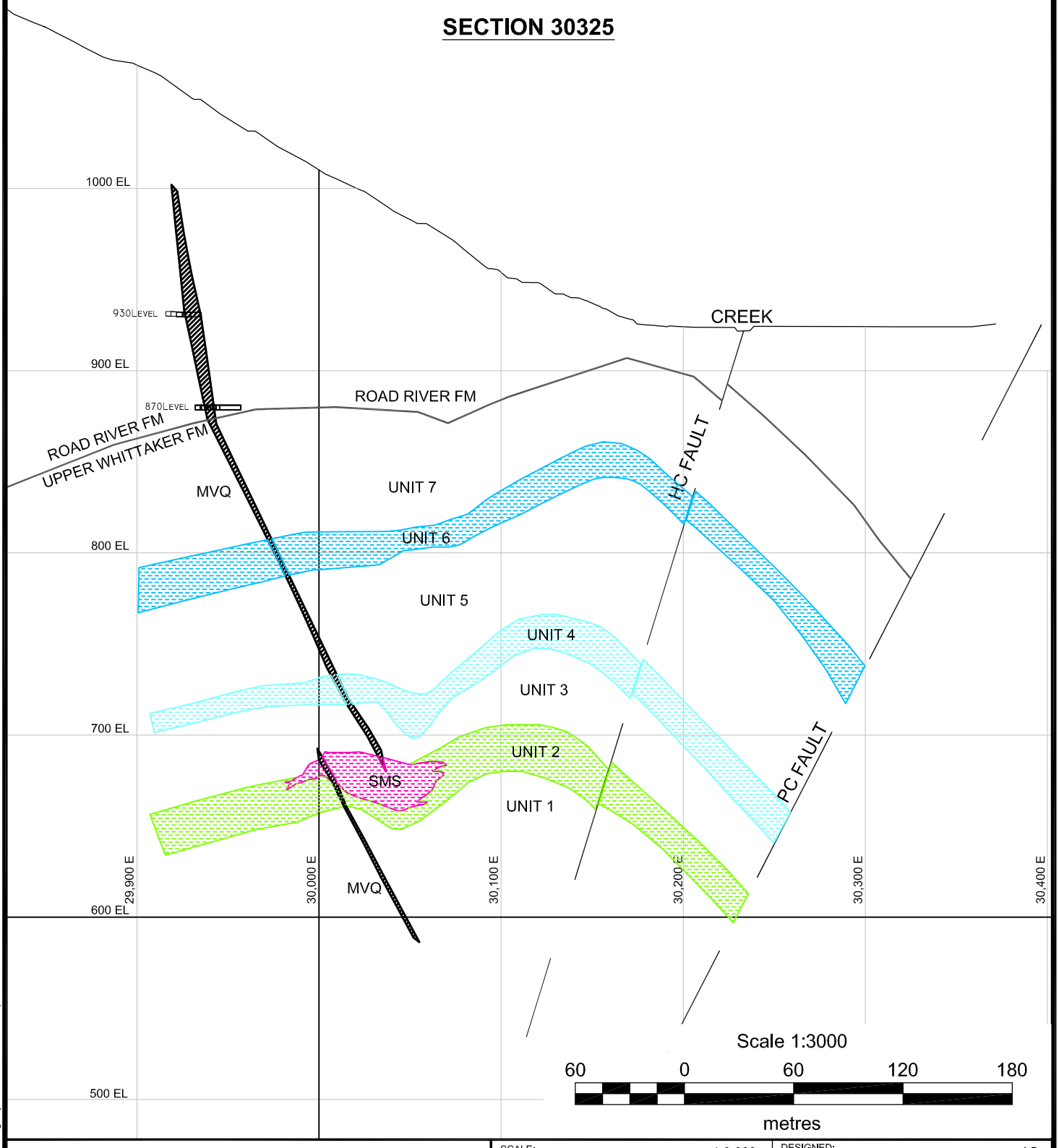
General Sample Information									Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Hg [3]	K	Mg	Mn	Mo	Na	Ni	P	Pb	Sb	Sc	Sn	Sr	Th	Ti	Tl	U	V	W	Y	Zn	Zr
Material	Unit	Sample Year	Sample ID	Location	From-	To-	Length	Unit	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppb	%	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Typical Element Distribution - Carbonate[1]:					Typical			0.0x	0.42	1	10	0.x		30.23	0.035	0.1	11	4	0.38	40	0.27	4.7	1100	0.4	0.04	20	400	9	0.2	1	0.x	610	1.7	0.04	0.0x	2.2	20	0.6	40	20	19
						10x threshold			0.x	4.2	10	100	x		302.3	0.35	1	110	40	3.8	400	2.7	47	11000	4	0.4	200	4000	90	2	10	x	6100	17	0.4	0.x	22	200	6	400	200	190
Host Rock	Unit 3	1994	Unit 3-1	DH 94-063	428.7		0.15-0.30	m	<0.5	1.39	<20	30	<0.5		15.05	<0.5	<1	42	6	0.65	0.14	0.48	12.7	135	1	0.63	5		21					113		0.03			29			4	
		1994	Unit 3-2	DH 94-063	468.3		0.15-0.30	m	0.5	0.04	<20	<10	<0.5		6.88	5.5	<1	40	7	2.89	1.3	0.09	11.3	350	<1	0.3	5		86					43		0.005			11			1070	
		1994	Unit 3-3	DH 94-061A	517.1		0.15-0.30	m	<0.5	0.26	<20	<10	<0.5		10.85	<0.5	<1	25	1	0.17	0.16	0.21	7.38	165	<1	0.25	3	210	28					44		0.005			14			8	
		2005	PC-05-02	DH 93-050	397.6	399.1	1.5	m	0.3	0.11	<5	45	<0.5	<5	17.6	2	<1	69	6	0.34		0.07	10.83	219	<2	0.04	9	285	63	<5	1	<10	86		<0.01			4	<10	4	705	2
		2005	PC-13-01	DH 92-013	258.3	259.6	1.3	m	0.8	0.08	<5	37	<0.5	<5	18.2	3	<1	58	16	0.39		0.05	11.56	539	<2	0.03	5	239	668	<5	1	<10	84		<0.01			4	<10	4	489	2
		2005	PC-13-03	DH 92-013	272.2	273.2	1.0	m	28	0.09	<5	37	<0.5	<5	19.3	8	<1	28	45	0.91		0.05	11.57	667	<2	0.04	5	1324	28900	41	<1	<10	88		<0.01			5	<10	5	921	2
		2005	PC-63-25	DH 94-063	428.7	430.2	1.5	m	<0.2	0.09	<5	39	<0.5	<5	17.2	<1	<1	38	3	0.44		0.07	10.71	109	<2	0.03	6	240	48	<5	1	<10	82		<0.01			4	<10	4	<1	2
		2006	009-1-4 Comp	DH 92-009	1	4	3	m	3.6	0.05	<5	41	<0.5	<5	16	5	<1	32	96	0.34	1000	0.05	8.86	496	<2	0.03	6	231	1098	37	1		97		<0.01			5	16		816	2
		2006	009-4-7 Comp	DH 92-009	4	7	3	m	1	0.08	<5	<10	<0.5	<5	15	3	<1	34	20	0.34	<1000	0.07	8.72	375	<2	0.03	6	372	486	7	1		115		<0.01			5	<10		504	2
		2006	009-7-8	DH 92-009	7	8	1	m	1.8	0.08	<5	<10	<0.5	<5	15.5	68	<1	29	14	0.34	22000	0.07	9.6	400	<2	0.02	7	287	360	<5	1		101		<0.01			6	95		10800	2
		2006	009-8-9	DH 92-009	8	9	1	m	0.4	0.07	<5	<10	<0.5	<5	16.4	1	<1	41	3	0.31	<1000	0.06	9.44	260	<2	0.02	6	294	15	<5	1		96		<0.01			4	<10		196	2
		2006	009-9-10	DH 92-009	9	10	1	m	0.6	0.07	<5	<10	<0.5	<5	15.7	11	<1	42	16	0.25	<1000	0.06	9.44	280	<2	0.03	5	262	385	7	1		86		<0.01			5	<10		1583	2
		2006	009-7-10 Comp	DH 92-009	7	10	3	m	1	0.07	<5	<10	<0.5	<5	15.7	33	<1	41	14	0.3	9000	0.06	9.19	304	<2	0.02	6	264	175	<5	1		91		<0.01			5	40		5148	2
		2006	140-0-1	DH 04-140	0	1	1	m	0.9	0.06	<5	<10	<0.5	<5	14.8	11	<1	46	27	0.29	<1000	0.05	9.27	313	<2	0.02	5	406	189	20	1		95		<0.01			5	<10		1160	2
		2006	140-1-4 Comp	DH 04-140	1	4	3	m	0.7	0.06	<5	<10	<0.5	<5	16.3	6	<1	59	20	0.29	<1000	0.05	9.57	188	<2	0.02	5	274	153	13	1		75		<0.01			5	<10		504	2
		2006	140-4-7 Comp	DH 04-140	4	7	3	m	0.4	0.07	<5	<10	<0.5	<5	15.6	6	<1	63	19	0.32	<1000	0.05	9.57	125	<2	0.02	5	278	82	18	1		81		<0.01			4	<10		309	2
		2006	140-7-8	DH 04-140	7	8	1	m	0.5	0.07	<5	<10	<0.5	<5	16.3	4	<1	35	12	0.29	<1000	0.06	9.65	108	<2	0.02	4	264	61	12	1		78		<0.01			4	<10		277	2
		2006	140-8-9	DH 04-140	8	9	1	m	0.3	0.07	<5	<10	<0.5	<5	15.3	6	<1	44	19	0.35	<1000	0.05	9.39	92	<2	0.02	5	231	75	19	1		81		<0.01			4	<10		287	2
		2006	140-9-10	DH 04-140	9	10	1	m	0.5	0.08	<5	<10	<0.5	<5	15.5	4	<1	32	11	0.3	<1000	0.06	9.82	90	<2	0.02	5	289	59	13	1		88		<0.01			4	<10		339	2
		2006	140-7-10 Comp	DH 04-140	7	10	3	m	0.4	0.07	<5	<10	<0.5	<5	16	5	<1	35	16	0.32	<1000	0.06	9.6	100	<2	0.02	5	264	74	17	1		83		<0.01			4	<10		320	2
	Unit 2	1994	Unit 2-1	DH 94-063	459.1		0.15-0.30	m	<0.5	0.23	<20	<10	<0.5		12.75	0.5	<1	62	5	0.16	0.08	0.08	8.19	145	<1	0.3	2	390	26					51		0.005			10			8	
		1994	Unit 2-2	DH 94-061A	556.7		0.15-0.30	m	<0.5	0.23	<20	10	<0.5		21.1	<0.5	<1	60	1	0.2	0.12	0.06	11.8	205	1	0.63	1		57					63		0.005			12			56	
		2005	PC-67-01	DH 94-067	436.7	437.7	1.0	m	0.7	0.14	<5	45	<0.5	<5	20.2	2	<1	19	2	1	5160	0.1	12.97	1303	<2	0.04	14	722	253	<5	2	<10	133		<0.01			8	<10	5	304	3
		2005	PC-67-03	DH 94-067	439.4	440.9	1.5	m	0.8	0.03	<5	40	<0.5	<5	17.7	3	<1	63	3	0.71	1807	0.02	11.33	635	<2	0.03	6	250	348	<5	<1	<10	76		<0.01			2	<10	2	555	1
		2005	PC-67-04	DH 94-067	448.5	450.0	1.5	m	0.9	0.03	<5	77	<0.5	<5	20	1	<1	14	7	2.83	569	0.02	12.14	317	<2	0.03	10	462	365	<5	<1	<10	95		<0.01			3	<10	3	271	2
		2005	PC-63-28	DH 94-063	459.2	460.1	0.9	m	0.9	0.03	<5	36	<0.5	<5	17.3	3	<1	49	13	0.26		0.02	11.35	185	<2	0.03	4	378	714	<5	<1	<10	72		<0.01			2	<10	2	307	<1
	Unit 1	1994	Unit 1-1	DH 94-063	346.0		0.15-0.30	m	5.5	0.47	140	<10	<0.5		20.1	3	<1	23	271	0.66	5	0.25	11.25	1190	1	0.64	1		438					182		0.005			15			400	
		1994	Unit 1-2	DH 93-041	372.5		0.15-0.30	m	0.5	0.49	<20	10	<0.5		2.64	0.5	<1	160	10	0.46	0.5	0.23	3.62	75	<1	0.12	6	3760	89					23		0.01			11			66	
		2005	PC-13-08	DH 92-013	297.2	297.8	0.6	m	1.6	0.04	<5	33	<0.5	<5	15.1	14	<1	89	13	0.8		0.02	9.74	929	<2	0.03	8	365	1101	<5	<1	<10	83		<0.01			3	<10	3	3370	1
		2005	PC-12-21	DH 92-012	370.4	371.9	1.5	m	<0.2	0.09	<5	38	<0.5	<5	19	3	<1	15	5	0.9		0.06	11.68	268	<2	0.03	6	1628	105	<5	1	<10	80		<0.01			7	<10	9	589	2
		2005	PC-27-04	DH 93-027	243.4	244.9	1.5	m	<0.2	0.07	<5	37	<0.5	<5	19.8	<1	<1	9	2	0.51		0.04	12.35	372	<2	0.03	4	399	55	<5	<1	<10	96		<0.01			5	<10	3	87	2
	Waste Rock	1980s	Waste rock																																							
		1994	PC-1	930 L pad					3	1.71	<20	30	<0.5		13.7	39.5	<1	63	86	0.76	11.8	0.73	8.69	350	3	0.4	13	100	2550					135		0.02			81			4900	
		1994	PC-2	930 L portal					8.5	0.33	50	10	<0.5		8.29	175	<1	46	248	0.59	95.8	0.22	6.27	220	1	0.19	6	150	4420					58		0.005			30			10000	
		1994	PC-4	Talus rock					<0.5	0.87	<20	170	<0.5		23.8	1	2	9	8	0.36	0.6	0.59	2.31	65	4	0.45	10	90	46					236		0.02			62			132	
		1994	PC-5	868 L pad					<0.5	0.78	<20	10	<0.5		13.6	3.5	<1	14	15	0.51	1	0.4	11	190	2	0.49	6		80					53		0.01			61			432	
		1994	PC-6	869 L pad					<0.5	0.75	<20	<10	<0.5		11.7	7.5	<1	23	13	0.39	0.6	0.39	9.95	145	2	0.41	6		87					56		0.02			85			612	
		2005	WR-TP4-01	870 L pad TP4	0.00	0.20	0.20	m	3.8	0.07	<5	43	<0.5	<5	18.2	30	<1	<1	128	0.63		0.06	10.58	252	<2	0.03	14	502	2968	<5	2	<10	105		<0.01			32	41	11	5502	4
		2005	WR-TP4-02	870 L pad TP4	0.20	0.80	0.60	m	8.8	0.13	34	40	<0.5	<5	14.6	17	<1	75	260	0.55		0.09	9.16	203	<2	0.04	19	821	2148	86	2	<10	69		<0.01			11	14	11	2689	4
		2005	WR-TP5-01	870 L pad TP5	0.00	0.15	0.15	m	2.2	0.18	17	51	<0.5	<5	17.1	8	<1	48	53	0.74		0.13	8.32	113	<2	0.03	19	616	1254	9	2	<10	154		<0.01			33	<10	12	1204	6
		2005	WR-TP5-02	870 L pad TP5	0.15	0.40	0.25	m	<0.2	0.29	6	87	<0.5	<5	22.8	<1	<1	29	8	0.75		0.1	5.18	172	<2	0.03	12	271	63	<5	2	<10	593		<0.01			15	<10	7	158	3
		2005	WR-TP5-03	870 L pad TP5	0.40	0.70	0.30	m	19.5	0.29	44	114	<0.5	<5	17.8	40	<1	41	238	1.09		0.11	6.02	244	<2	0.03	20	329	17500	87	2	<10	347		<0.01			24	28	9	4378	5
		2005	WR-TP5-04	870 L pad TP5	0.70	0.80	0.10	m	0.7	0.1	<5	45	<0.5	<5	17.7	6	<1	52	22	0.51		0.07	10.48	122	<2	0.03	7	185	198	<5	1	<10	96		<0.01			7	<10	5	1109	3
		2006	1-1	870 L WR pile					25.4	0.2	87	122	<0.5	<5	>15.0	153	1	35	517	0.54	97000	0.11	9.06	344	7	0.03	13	233	**10000**	177	1		76	5	<0.01	<10	122	46	<10		**10000**	6
		2006	1-2	870 L WR pile					16.6	0.16	81	65	<0.5	<5	>15.0	136	2	18	503	0.61	70000	0.09	9.48	189	8	0.02	14	205	6806	176	1		70	<5	<0.01	<10	122	45	<10		**10000**	6
		2006	1-3	870 L WR pile					3.3	0.14	30	52	<0.5	<5	>15.0	32	2	12	78	0.64	13000	0.08	9.66	276	11	0.02	12	209	2071	34	1		76	5	<0.01	<10	133	36	<10		4223	6
		2006	1-4	870 L WR pile					0.5	0.14	17	36	<0.5	<5	>15.0	7	2	10	5	0.67	3000	0.09	10.22	320	11	0.02	13	164	402	9	1		72	9	<0.01	<10	139	39	<10		841	6
		2006	# 2-1	870 L WR pile					1.2	0.13	19	45	<0.5	<5	>15.0	11	2	11	50	0.62	2000	0.09	5.04	202	10	0.01	12	221	741	14	1		269	8	<0.01	<10	132	23	<10		1347	5
		2006	# 2-3	870 L WR pile					3.2	0.16	24	54	<0.5	<5	>15.0	29	2	27	101	0.71	9000	0.1	5.6	170	9	0.02	19	577	1756	28	2		209	9	<0.01	<10	118	20	<10		4032	6
		2006	# 2-4	870 L WR pile					3.4	0.15	25	37	<0.5	<5	>15.0	18	3	18	82	0.68	7000	0.1	8.03	166	9	0.02	18	803	2198	28	2		125	9	<0.01	<10	118	18	<10		2371	7
		2006	# 2-5	870 L WR pile					<0.2	0.14	14	21	<0.5	<5	>15.0	3	2	21	19	0.54	<1000	0.1	8.28	125	8	0.02	15	1048	132	<5	1		117	7	<0.01	<10	112	9	<10		379	5
		2006	# 2-21	870 L WR pile					2.3	0.16	15	45	<0.5	<5	>15.0	13	3	16	47	0.65	4000	0.12	2.55	104	9	0.02	25	298	1490	9	2		277	12	<0.01	<10	137	26	<10		1861	6
		2006	# 2-22	870 L WR pile					1.4	0.15	12	38	<0.5	<5	>15.0	9	2	13	43	0.61	1000	0.11	2.61	98	10	0.01	14	613	1158	12	2		272	11	<0.01	<10	135	26	<10		1088	6
		2006	3-1	870 L WR pile					0.6	0.14	15	131	<0.5	<5	>15.0	6	2	47	42	0.63	2000	0.1	8.42	134	8	0.02	17	1299	318	8	2		96	8	<0.01	<10	85	9	<10		693	6
		2006	3-2	870 L WR pile					<0.2	0.16	20	35	0.5	<5	>15.0	3	2	58	34	0.48	1000	0.1	8.93	78	7	0.02	30	2070	58	<5	1		101	7	<0.01	<10	78	9	<10		235	4
		2006	3-3	870 L WR pile					<0.2	0.17	20	74	0.5	<5	14.4	1	2	79	25	0.5	<1000	0.11	8.4	76	8	0.02	31	1986	32	<5	2		98	6	<0.01	<10	74	9	<10		142	4
		2006	3-4	870 L WR pile					<0.2	0.16	22	43	0.5	<5	14.91	3	2	64	29	0.48	<1000	0.1	8.68	74	7	0.02	30	2091	61	<5	2		100	6	<0.01	<10	75	9	<10		271	5
		2006	4-1	870 L WR pile					0.6	0.18	<5	56	<0.5	<5	>15.0	6	1	45	32	0.8	4000	0.13	2.59	86	4	0.02	19	765	349	12	2		265	<5	<0.01	12	<10	29	<10		722	7
		2006	4-2	870 L WR pile					0.8	0.19	<5	50	<0.5	<5	>15.0	7	1	41	33	0.79	2000	0.14	2.6	90	4	0.02	20	683	361	14	2		283	<5	<0.01	12	<10	31	<10		817	7
		2006	4-3	870 L WR pile					0.4	0.15	<5	37	<0.5	<5	>15.0	3	<1	39	16	0.79	<1000	0.11	2.28	81	4	0.01	17	738	133	11	2		279	<5	<0.01	10	<10	28	<10		325	7
		2006	4-4	870 L WR pile					0.5	0.14	<5	47	<0.5	<5	>15.0	4	<1	36	19	0.75	2000	0.11	2.38	80	4	0.01	17	758	206	6	2		269	<5	<0.01	10	<10	26	<10		435	7
		2006	4-4A	870 L WR pile					<0.2	0.15	<5	49	<0.5	<5	>15.0	3	<1	47	22	0.82	2000	0.11	2.56	86	4	0.02	18	694	189	10	2		275	<5	<0.01	<10	<10	27	<10		391	7
		2007	5-1	870 L WR pile					<0.2	0.07	14	59	<0.5	<5	>15	2	2	7	<1	0.61	<1000	0.06	1.85	87	2	0.01	13	211	92	<5	2		396	7	<0.01	<10	69	19	<10		186	5
		2007	5-2	870 L WR pile					0.2	0.07	13	165	<0.5	<5	>15	2	2	8	<1	0.57	<1000	0.05	1.76	83	2	0.01	21	189	143	<5	1		405	7	<0.01	<10	69	20	<10		209	5
		2007	5-3	870 L WR pile					0.2	0.06	14	88	<0.5	<5	>15	4	2	8	<1	0.54	1000	0.05	1.47	74	2	0.01	12	294	106	<5	1		381	5	<0.01	<10	71	19	<10		276	5
		2007	5-5	870 L WR pile					0.7	0.07	13	60	<0.5	<5	>15	5	1	11	<1	0.56	1000	0.05	2.36	82	2	0.01	13	327	262	5	2		315	6	<0.01	<10	64	20	<10		521	5
		2007	6-1	870 L WR pile					0.4	0.05	4.7	55	<1	<0.1	>10	1.3	2.7	7	9.3	0.44	400	0.04	2.12	104	3.9	0.01	23	150	74	1.4	1.8		406	1.9	0.022	<0.1	1.5	17	<0.1		136	5
		2007	6-2	870 L WR pile					0.5	0.07	5.1	44	<1	<0.1	>10	1.9	2.8	6	11.2	0.42	700	0.05	3.35	119	3.7	0.01	22	300	86	2.3	1.7		343	1.8	0.017	<0.1	1.6	23	0.1		186	5.6
		2007	6-3	870 L WR pile					0.6	0.07	6.7	44	<1	0.1	>10	2.5	2.7	8	13.7	0.45	900	0.05	4.93	151	4.1	0.01	20	100	138	3.3	1.6		236	1.7	0.014	0.1	1.7	20	0.1		282	5.7
		2007	6-4	870 L WR pile					1.1	0.08	11	197	<1	0.1	>10	6.9	2.8	10	23.5	0.45	290	0.06	3.43	106	3.6	0.01	22	220	310	6.5	1.7		277	2	0.016	<0.1	1.7	21	0.5		781	6
Ore	MQV	1980s	Ore																																						
		2005	UG-Face 1-03	930 L					96	0.03	264	11	<0.5	<5	<0.01	90	<1	474	563	1.96	90000	0.01	<0.01	28	13	0.02	13	48	104000	376	<1	<10	9		<0.01			6	219	<1	12400	2
		2005	UG-Face 2-04	930 L					175.1	0.01	417	15	<0.5	<5	2.04	1760	<1	171	2286	0.46		0.01	2.24	978	<2	0.02	6	95	126000	1140	<1	<10	27		<0.01			6	7163	4	285000	1
		2005	UG-Face 3-02	930 L					169.9	0.02	669	14	<0.5	<5	0.07	1050	2	333	4250	1.61	580000	0.01	0.05	43	3	0.02	16	107	122000	1680	<1	<10	7		<0.01			4	3653	<1	151000	2
		2005	PC-05-09	DH 93-050	319.8	325.5	5.7	m	246	0.03	1190	27	<0.5	<5	3.61	510	11	190	6729	6.19		0.02	2.17	860	<2	0.02	90	159	131000	3383	<1	<10	57		<0.01			7	1994	1	81200	4
		2005	PC-05-08	DH 93-050	325.5	327.6	2.1	m	512	<0.01	2286	<10	<0.5	<5	0.04	2570	<1	43	11600	0.56		<0.01	0.03	20	<2	0.03	<1	206	238000	6887	<1	48	5		<0.01			1	9858	<1	394000	<1

See notes on last page.

Table 4.4. Metals by Aqua-Regia Digestion with ICP Finish

| General Sample Information | | |

SECTION 30325



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SCALE:	1:3,000	DESIGNED:	AS
DATE:	APR 2008	CHECKED:	AS
DRAWN:	WKL	APPROVED:	PM

MESH Environmental Inc.

PROJECT: PRAIRIE CREEK PROJECT

TITLE: TYPICAL CROSS SECTION OF THE PRAIRIE CREEK DEPOSIT

CLIENT: CANADIAN ZINC CORPORATION

PROJECT No.:	DWG No.:	REV.:
0440-004	2.5	0

DWG TO BE READ WITH MESH REPORT TITLED "GEOCHEMICAL CHARACTERIZATION REPORT FOR THE PRAIRIE CREEK PROJECT, NWT." DATED APRIL 2008

X:\Projects\0440\004\dwg\0440-004-01 Typical Cross-Section.dwg Layout: 1-2000 Plot Date Apr 23 08 Time: 6:08 PM

Formation	Code	Thickness (m)	Description	
Cadillac Formation	SDC	300 to 350	**Siltstone/Shale** (grey, thinly banded siltstone/shale)	
Road River Formation	SDR	230 to 280	**Argillaceous Dolomite** (mid-dark grey graphitic argillaceous bioclastic dolomite)	
Whittaker Formation	OSW3-7	50 to 55	Unit 7	**Interbedded Chert-Dolomite** (well-bedded, black to mid-gray cherts interbedded with dolomite)
	OSW3-6	11 to 25	Unit 6	**Upper Spar Unit** (massive, bioclastic, mid-grey, fine grained dolomite with white spar-filled cavities)
	OSW3-5	55 to 100	Unit 5	**Upper Chert Nodule-Dolomite Unit** (massive to poorly bedded weakly bioclastic, fine- to medium- grained dolomite with mid-grey to black chert nodules)
	OSW3-4	9 to 24	Unit 4	**Lower Spar Unit** (similar to Upper Spar Unit)
	OSW3-3	40 to 60	Unit 3	**Lower Chert-Dolomite Unit** (similar to Upper Chert Nodule-Dolomite unit)
	OSW3-2	20 to 30	Unit 2	**Mottled Dolomite Unit** (fine grained dolomite with spheroidal mottled texture and chert; unit host to stratabound massive sulphide deposits)
	OSW3-1	20 to 30	Unit 1	**Massive Dolomite Unit** (grey massive dolomite with minor chert nodules)

(Based on Minefill, 2007)

CANADIAN ZINC CORPORATION

MESH Environmental Inc.

Geochemical Assessment for the Prairie Creek Project

Main Zone Stratigraphy and Rock Descriptions | **Fig. 2.6**

Appendix Q

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nhc
northwest hydraulic consultants

File: 1-6987

September 9, 2010

Canadian Zinc Corporation
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PO Box 11644
Vancouver, British Columbia
V6B 4N9

Attention: Mr. David Harpley, P. Geo.
V.P. Environment and Permitting Affairs

Subject: **Prairie Creek Mine Berm Inspection, 2010**

Dear Mr. Harpley:

1.0 INTRODUCTION

This letter report is provided as a record of findings and recommendations from our August 2010 site visit to the Prairie Creek mine site. The focus of the work described here was the integrity of the berm face adjacent to the Prairie Creek channel where there has been some loss of riprap and associated steepening of the lower part of berm adjacent to the channel. This is the second documented inspection of the berm by Northwest Hydraulic Consultants (NHC). The first inspection is described in a memorandum dated August 14, 2009, which included recommendations for: (1) repairs at four locations along the berm and (2) ongoing monitoring of berm face integrity. Figure 1 shows the locations of the repair sections and monitoring sites.

The entire length of berm shown in Figure 1 was inspected by ground observations in August 2010. The upstream part of the embankment berm and the downstream part of the flood protection dyke were observed to be intact and showed no signs of any erosion. Erosion at the toe of slope was visually evident along about 450 metres of the central part of the berm and dyke, but the amount appeared unchanged from conditions observed in the prior 2009 inspection. All of the observed changes from 2009 to 2010 were associated with repair activities.

2.0 BERM DESCRIPTION

The berm was originally completed sometime in the early 1980s and is comprised of two distinct segments which were designed separately. The upstream portion of the berm is approximately 590 m long and was designed as a storage embankment. It has a top elevation about 8 metres above the normal creek water level. It was originally intended for storage of mine tailings but present plans are for a water storage pond that is supplied from mine and mill water. The embankment berm is armoured with heavy riprap along its entire length from the toe of slope to a height about 3 metres above normal creek water level. Design drawings for the berm specified heavy rock bank protection with an average rock size of 2.5 ft (0.8 m) diameter and minimum layer thickness of 5 ft (1.5 m). It is difficult from surface observations to confirm the average rock size and layer thickness actually installed. The maximum rock size appears to be about 2 m based on large material which is exposed at the toe of slope near Repair Site D.

The downstream portion of the berm is approximately 560 m long and was designed as a flood protection dyke for the mine camp. It has a top elevation about 4 metres above the normal creek water level. Except for a short 25 m reach at the upstream end previously identified as Repair Site C, the berm is fully armoured from toe to top of berm with heavy riprap. Design drawings for the dyke specified heavy rock protection with an average rock size of 1.5 ft (0.5 m) diameter and minimum layer thickness of 3 ft (0.9 m).

Loss of riprap along the toe and lower slope of the berm has occurred along approximately 450 m of berm, starting just upstream from Repair Site D where the stream first impinges on the berm, and continuing until just downstream of Repair Site A. Over the upstream 300 metres of this reach from Repair Site D to Monitoring Site 4, unweathered rock is exposed to a consistent height of about 2.0 to 2.5 m above the late summer water level, indicating loss of material to this height. Over the downstream remaining 150 m of the reach ending just downstream of Repair Site A, there is progressively less and less material loss. The changing pattern of material loss from the upstream to downstream portions of eroded berm is believed to be due to the changing pattern of the approach flow. The upstream portion of the berm is exposed to impinging streamflow whereas the downstream portion experiences relatively uniform flow parallel to the berm.

3.0 2006 FLOOD EVENT

From a review of photos and other available information, it is believed that a flood which occurred on June 17, 2006, was responsible for much of the riprap displacement which has occurred along the berm. The 2006 event followed a heavy 24-hour rainfall and produced high water conditions which were videotaped by Canadian Zinc from the upstream part of the pond embankment. Considering this information in combination with Water Survey of Canada (WSC) 1975 to 1990 streamflow records for this location, the 2006 event was the largest flow in Prairie Creek in the past 30 years since 1978.

The water level during the 2006 flood was about 2.0 to 2.5 m higher than the normal August level, based on close examination of the video and subsequent field observations. Along the downstream portion of the embankment berm and upstream portion of the flood protection berm, the flood water level corresponds to the transition from weathered (darker) upper bank riprap and the steepened lower slope where unweathered rock is exposed. Review of WSC rating curves for the Prairie Creek gauge, plus hydraulic modelling of the reach adjacent to the mine site, indicates that the flood high water level would be associated with a discharge in the range of 200 to 400 m^3/s. The flow is at least comparable to the maximum discharge reported by the WSC for Prairie Creek, 187 m^3/s on June 1977, when the water level at the gauge was about 2.8 m higher than the normal August level. The higher flow estimate is based on HEC-RAS hydraulic modelling without calibration to the WSC rating curve, which is for a channel constriction upstream from the surveyed channel cross sections used in the hydraulic modelling.

From the HEC-RAS model and assuming the higher (400 m^3/s) discharge, the flow velocity at the toe of the embankment berm would be about 3.4 m/s where the main channel is against the berm. Downstream, the flow velocity at the toe of flood protection dyke would be about 1.2 m where the flow is parallel to the dyke. The riprap specified in the original design should withstand these velocities if the flow is parallel to (and not impinging on) the protected slope.

4.0 INSPECTION AND MONITORING RESULTS

Five monitoring sites were established along the flood protection berm in July 2009 to document the status of riprap displacement and to provide a baseline condition for tracking future movement. The

purpose of this monitoring is to determine whether rock continues to be lost during “normal” flow events or only during episodic major floods. While the current significant displacement appears to be the result of a one-time major event in 2006, the armour may have lost some of its original resistance to typical annual peak flows now that the outer edge has been steepened. Monitoring activities include photographic documentation and measurement of the distance from fixed control points at the top of berm to the edge of eroded bank at each site.

The locations of the monitoring sites are shown on Figure 1. Each of the sites has a rebar pin with a hooked top (so as not to create a tire hazard) that is driven flush into the flat (stable) top of berm to serve as a fixed reference point for measurements. A second rebar pin extending about 0.3 m above the ground is installed on the camp-side edge of berm to help in locating the sites. The tops of both pieces of rebar are painted orange and are flagged with survey tape. In 2010, additional flagging was added to each of the reference point pins. The edge-of-berm pin at Site 3 was missing, and was replaced with flagging in a bush at about the original location. Both pins at Site 5 had been removed (or buried) during berm repair work and the pins were not replaced.

Repair activities along the berm, which included continuous smoothing of the upper berm surface between Repair Sites A and C, resulted in alterations to all of the monitoring sites. The smoothness and visual appearance of the upper berm though this segment is now generally improved. However, the repairs disturbed some of the transition between weathered and exposed rock which was being monitored to quantify the amount and rate of berm erosion. Of the five monitoring sites which had been established in 2009, Sites 4 and 5 will be continued only for visual observation because the transition between the weathered (intact) and eroded rock was lost during the berm smoothing work.

Table 1 summarizes the relative locations of the measurement sites, measured in an upstream direction from the berm deflection point at the downstream end of the eroded reach. The berm deflection point is approximately 48 m upstream from survey benchmark 870-1B located in the berm crest.

Table 1
Monitoring Site Locations
Distance Upstream from Berm Deflection Point

Feature	Distance along crest (m)
Berm Deflection Point	0
Monitoring Site 1	65
Monitoring Site 2	104
Monitoring Site 3	167
Monitoring Site 4	200
Monitoring Site 5	226

Measurements at each site were made perpendicular to the berm slope, with a tape measure laid on the ground surface from the fixed reference pin at the top of berm. Measurements ended at the transition from weathered to unweathered (recently exposed) riprap as it was hazardous to extend the line down the steeply eroded slope. Vertical deflections were not recorded but may be inferred from companion photographs. Tables 2a and 2b summarize the measurements made at the sites on 30 July 2009 and on 11 August 2010.

Table 2a
Monitoring Site Measurements, 30 July 2009
Distances (m) measured along ground surface

Feature	Monitoring Site				
	1	2	3	4	5
Rebar at inner edge top of berm	-1.5	-2.4	-1.8	-2.2	-2.3
Reference Point (Rebar Pin)	0	0	0	0	0
Outer edge top of berm	2.7	1.5	2.1	3.3	3.4
Original (now slumped) edge of berm	n/a	3.6	n/a	n/a	5.4
Start of level riprap (weathered)	4.4	3.6	n/a	n/a	n/a
Start of riprap slope (weathered)	6.1	5.7	2.8	4.6	5.8
Start of fresh (exposed) riprap	12.8	11.4	8.9	8.6	8.5

Table 2b
Monitoring Site Measurements, 11 August 2010
Distances (m) measured along ground surface

Feature (see note at bottom of table)	Monitoring Site				
	1	2	3	4	5
Rebar at inner edge top of berm	-1.5	-2.4	lost	-2.2	lost
Reference Point (Rebar Pin)	0	0	0	0	lost
Outer edge top of berm	2.8	1.6	2.3	3.3	n/a
Original (now slumped) edge of berm*	n/a	n/a	n/a	n/a	n/a
Start of level riprap (weathered)*	2.8	1.6	2.3	3.7	n/a
Start of riprap slope (weathered)*	3.8	2.7	3.1	4.5	n/a
Start of fresh (exposed) lower slope riprap	13.0	11.0	9.2	n/a	n/a

* Top of slope features including the slumped edge of berm, start of level riprap, and start of riprap slope are no longer relevant following the upper slope repairs made in late 2009. The slumped edges have been repaired, and all of the riprap at the top of slope now has a fresh (exposed) appearance.

Measurements from the reference pin to the start of fresh (exposed) lower slope riprap were reviewed to quantify the lateral stability of the eroded edge of flood protection berm. A comparison of measurements from 2009 and 2010 does not indicate any loss of berm material. The data suggest possible movement of 0.4 m at Monitoring Site 2, but this is attributed to the shortening of the berm surface length which occurred when the upper portion of berm slope was smoothed to take out a slump and to remove bulging at Repair B.

Photo pairs 1a through 5b show the lower berm at each of the monitoring sites in 2009 and 2010. Slope stability was assessed by comparing photos to see if there had been any movement of identifiable rocks, or additional exposure of the roots of vegetation along the steep lower portion of the berm slope. Full resolution versions of the photos used for this assessment, not limited to those reproduced in this report, are available on request. The conclusion from the photo interpretation is that berm toe of slope remained stable over the 2009-2010 monitoring period.

5.0 STATUS OF RECOMMENDED REPAIRS

Our repair recommendations following the 2009 assessment were for: (1) smoothing of the upper bank at Repair Sites A and B where slumping of the upper slope had occurred, (2) armouring of an unprotected segment at Repair Site C at the transition between the embankment berm and flood protection dyke, and (3) adding additional large rock at Repair Site D where the stream impinges directly onto the berm.

Repairs at Sites A and B were observed in the 2010 inspections to have been satisfactorily completed. Photos 6a and 6b show the 2009 and 2010 condition of the upper berm at Site B, viewing downstream towards Site A. These sites are visually no different now than adjacent sections of the dyke, and are not discussed further.

At Repair Site C, heavy riprap was placed at the toe of slope as had been recommended and lighter rock was placed behind the toe to rebuild the lower portion of previously exposed berm. Photos 7 and 8 show aerial and ground views of the completed repair; before-and-after conditions can be seen in Photos 5a and 5b taken from Monitoring Site 5. The repair at Site C provides satisfactory protection and no additional work at this location is needed at this time.

Repairs at Site D were only partially completed, and additional work is needed to achieve the original recommendations for repair of a segment approximately 30 m long where the surface is relatively rough and there was some exposure of underlying material. Photos 9 and 10 show aerial and ground views of the present condition of the site. The repair recommendation is to use the largest available material, not to exceed 1.5 m diameter, to construct a new toe of slope that is secured by strategic placement against the existing very large rock at the water edge. The slope would then be re-built on approximately a 1.5:1 (H:V) or flatter slope that provides a smooth transition to existing riprap at the upstream and downstream extents of repair. Once the larger rock with an average diameter of 0.5 to 0.6 meters is placed, smaller rock should be added to fill the voids and chink the new material into place.

6.0 CLOSURE

Berm repair work has improved the berm appearance and integrity relative to the conditions observed in July 2009. There was no evidence of additional erosion or loss of rip along the approximately 450 m long reach where material had previously been lost from the toe of slope, apparently during a major flood which occurred in June 2006. Additional work is needed to complete the repairs recommended in 2009 for Repair Site D where the stream impinges most directly and persistently on the berm.

The peak discharge of the 2006 flood is estimated to have been in the range of 200 to 400 m^3/s based on a videotaped high water level, subsequent hydraulic modeling, and consideration of the Water Survey of Canada rating curve for the upstream Prairie Creek streamflow station. The flow caused observable erosion of the berm toe where the flow impinged against the berm, but similar erosion was not observed in other reaches where the flow was relatively uniform and parallel to the berm. Where erosion has occurred, the loss of material has caused the berm to be overly steep near the water edge, and possibly vulnerable to further erosion at discharges less than that which occurred in 2006.

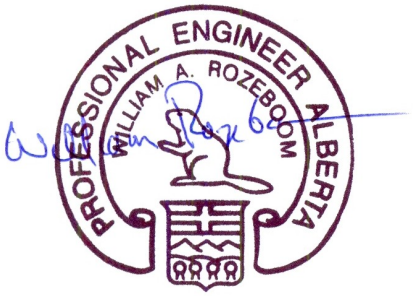
Continued annual monitoring to track and detect the possible progressive loss of berm material is recommended. This would consist of visual and quantitative documentation of the five sites established in 2009, plus a general inspection of the full length of berm. Future evidence of significant additional loss of bank armour and/or further slumping of the berm slope may trigger a recommendation for additional repairs. For continuity, we recommend that NHC senior engineering

staff or other persons similarly qualified in bank protection works participate in the annual inspections and the subjective interpretation of results.

Thank you for your attention to this matter and for your consideration of the above recommendations. Please do not hesitate to call if there are any questions.

Respectfully submitted,

northwest hydraulic consultants



W.A. (Bill) Rozeboom, M.B.A., P.Eng.
Senior Hydrologist

Gary Van Der Vinne, P.Eng
Principal

Figure 1
Location Plan

Photo 1a. Monitoring Site 1. View downstream, July 2009.

Photo 1b. Monitoring Site 1. View downstream, August 2010. No change in condition of vegetation or position of identifiable rocks near toe of slope.

Photo 2a. Monitoring Site 2. View upstream, July 2009.

Photo 2b. Monitoring Site 2. View upstream, August 2010. No change in condition of vegetation or position of identifiable rocks near toe of slope.

Photo 3a. Monitoring Site 3. View upstream, July 2009.

Photo 3b. Monitoring Site 3. View upstream, August 2010. No change in condition of exposed roots on steep lower slope. Little or no change in position of identifiable rocks near toe of slope.

Photo 4a. Monitoring Site 4. View upstream, July 2009.

Photo 4b. Monitoring Site 4. View upstream, August 2010. Transition from weathered to unweathered rock was graded out. Root exposure at lower slope vegetation same as in 2009.

Photo 5a. Monitoring Site 5. View upstream, July 2009.

Photo 5b. Monitoring Site 5. View upstream, August 2010. Transition from weathered to unweathered rock was graded out.. The slope work is presumed to be responsible for covering some of the large rocks visible on the lower slope in 2009.

Photo 6a. View downstream from Repair Site B towards Repair Site A, July 2009.

Photo 6b. View downstream from Repair Site B towards Repair Site A, August 2010.

Photo 7. Repair Site C. View upstream, August 2010.

Photo 8. Repair Site C. View upstream, August 2010.

Photo 9. Repair Site D, August 2010. Flow is left to right.

Photo 10. Repair Site D. View downstream, August 2010.