YESAB
Yukon Environmental and
Socio-economic Assessment Board

Designated Office Evaluation Report

Phase V/VI Expansion of Mining and Milling, Minto Mine

Project Number: 2013-0100

Proponent: Capstone Mining Corp.

Assessment Completion Date: April 25, 2014

Mayo Designated Office

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Mayo Designated Office Evaluation Report

Phase V/VI Expansion of Mining and Milling, Minto Mine – 2013-0100

Summary

The Proponent, Capstone Mining Corp. (Capstone) operates the Minto Mine, a high-grade copper mine located on Selkirk First Nation Category A Settlement Land, approximately 240 kilometres (km) northwest of Whitehorse, Yukon Territory. The Minto Mine is located in the Minto Creek watershed on the west side of the Yukon River, approximately 41 km southwest of the community of Pelly Crossing. Operations currently include the Main Pit, Area 2 Pit, Area 118 Pit, Minto South Portal, waste dumps and ore stockpile areas, an ore processing facility with a mill water pond, a concentrate storage shed, a dry stack tailings storage facility (DSTSF), a water retention dam with associated Water Storage Pond, administrative offices, an airstrip and a camp.

The Mayo Designated Office, under the Yukon Environmental and Socio-economic Assessment Act (YESAA), has completed several evaluations of proposals concerning operations at the Minto Mine. The first report, issued in May of 2008, resulted in the Government of Yukon amending Yukon Quartz Mining License QML-0001 to reflect the increased milling rate of 3,200 tpd. The second report, issued in March of 2010, further increased the mill rate to 3,600 tpd and revised the Water Management Plan (WMP). The third proposal, for Phase IV operations, increased the mill rate to 4,200 tpd. The fourth proposal was for an amendment to the Air Emissions Permit 60-30 in relation to the operation of the diesel generators used to power the mine. The most recent evaluation, 2010-0198, included an expansion of mining areas, new open pits, implementation of underground mining, shifting from dry-stack to in-pit slurry tailings deposition and expansion of waste dumps and camp.

The current proposal, for the Phase V/VI expansion, requires amendments to the Proponent's existing licences (QML-0001 and WUL QZ96-006) and increases the surface mining life to mid-2017 and underground mining to late 2019. Milling will continue to mid-2022. Reclamation and closure activities are proposed to be complete by the end of 2023 with post-closure monitoring beginning in 2024. The amendments associated with the planned activities that are assessable under YESAA include:

- Mining of three new open pits and the expansion of one existing open pit, including an expanded network of site access and haul roads to accommodate the mining activities;
- Expansion of underground mining to include two additional reserves and two new portals and associated infrastructure;
- Expansion and modification of waste rock dumps to increase existing dump sites and establish new dump sites;
- Expansion and modification of slurry tailings storage facility including a new tailings storage dam to increase storage capacity in the Main Pit;
- Changes to water management including new conveyance structures and new water quality standards for certain contaminants;
- Progressive reclamation following completion of mine components; and
- Final reclamation and closure following completion of Phase V/VI mining and milling.

Capstone submitted the project proposal to the Mayo Designated Office of the Yukon Environmental and Socio-economic Assessment Board in accordance with Paragraph 50(1)(b) of YESAA on July 5, 2013. The Project underwent an adequacy review that resulted in an information request on August 7,

2013 with the response from Capstone received on September 7, 2013. A second information request was issued September 23, 2013 with the corresponding response on October 30, 2013. The proposal was subsequently deemed adequate and the period for seeking views and information began December 4, 2013. The Mayo Designated Office sought views and information on the Phase V/VI proposal between December 4, 2013 and January 8, 2014.Two information requests were issued during the seeking views and information period on January 14 and March 3, 2014 with partial responses at various times in January through March. On March 21, 2014, the Mayo Designated Office began preparing the Evaluation Report.

Reviewers who submitted comments throughout the assessment included: Natural Resources Canada, Environment Canada, White River First Nation, Yukon Government, Yukon Conservation Society and Selkirk First Nation. Primary concerns related to water management, water quality and infrastructure stability.

Based on the comments received during seeking views and information, along with other relevant considerations, five valued environmental and socio-economic components (VESEC) were identified:

- Health and Safety
- Aquatic Resources
- Selkirk First Nation Settlement Land
- Environmental Quality
- Wildlife and Wildlife Habitat

The Mayo Designated Office determined that the Project will have significant adverse effects on all of the above VESECs such that further mitigation is required.

The Decision Bodies, Government of Yukon, Department of Energy, Mines and Resources – Minerals and Selkirk First Nation, will review the Recommendation and the accompanying reasons described in this Evaluation Report. The Decision Bodies will issue a Decision Document(s) within 30 days, as prescribed under s. 2 of the *Decision Body Time Periods and Consultation Regulations*, that will either a) accept the recommendation, b) vary the recommendation, or c) reject the recommendation.

Assessment Outcome

Under s. 56(1)(b) of *the Yukon Environmental and Socio-economic Assessment Act*, the Mayo Designated Office recommends to the Decision Bodies that the Project be allowed to proceed, subject to specified terms and conditions. The Designated Office determined that the Project will have significant adverse environmental and socio-economic effects in or outside Yukon that can be mitigated by those terms and conditions.

The terms and conditions of the recommendations are as follows:

1. The full buttress of the Main Pit Dump shall be built and displacement of the Main Pit south wall arrested prior to any further construction of the Main Pit Dump.

Rationale: *Adding load without adding resistance (e.g. fully constructed buttress, or filling the main pit with tailings) presents a heightened risk of structural instability.*

2. In situ monitoring devices shall be installed, such as inclinometers, surface monitoring points, and vibrating wire piezometers to aid in determination of the cause

of fissures observed at the surface of the in-pit dump and to monitor the changes in geometry or pore pressures in the in-pit dump area.

3. Additional analyses shall be conducted to clarify the assumptions of the Main Pit Dump stability analyses and to indicate what the limiting case is (e.g. waste rock dump fully constructed, but tailings not yet up to Elev. 804 m) to determine the short-term factors of safety.

4. Given the inherent uncertainty in the foundation conditions for the dam and the potential loading the dam must resist in the long term (in perpetuity), the final design of the Main Pit Dam shall conform to the minimum factors of safety as indicated by the Proponent in the information response (shown within Tables 1 and 2 in Information Request (B) Response, YOR 2013-0100-167-1).

Rationale: *If there is a significant departure from the approach and geometry provided in the Main Pit Dam Conceptual Design Report and Proponent responses to Information Requests, or a departure from the factors of safety provided in the Proponent's response, then the conclusions supporting this recommendation may no longer be valid and the dam design may need to be re-assessed.*

5. The Proponent shall provide regulators a Quantitative Risk Assessment for the Main Pit Dam as indicated in Part 6 of the Canadian Dam Safety Guidelines (CDA 2007).

6. In order to mitigate or reduce risk, further detailed geotechnical investigations are recommended to be undertaken to better refine the subsurface model, and detailed geotechnical laboratory testing is recommended for the foundation and dam fill materials to better define the range of geotechnical properties to be used in design. The results of these investigations shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.

7. Given the site wide instabilities and potential for foundation instabilities (e.g. paleochannel, long-term slope movement, etc.), a sensitivity analysis on all the geotechnical parameters shall be undertaken to understand the implications (size, volumes, slope angles, costs) on the design configuration, on the factors of safety and on the risk assessment. The results of the sensitivity analysis shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.

8. To mitigate the potential for differential settlement of the dam foundation due to thawing permafrost and consolidation of unfrozen overburden soils, detailed geotechnical investigation, laboratory testing and analyses shall be undertaken to better define the range of geotechnical properties to be used in settlement analyses. The results of these investigations shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.

9. To mitigate long-term risk to the Main Pit Dam, the models used in developing Main Pit Dam designs shall maintain the phreatic surface at Elev. 804 m, as a conservative approach.

Rationale: *The Proponent indicated that the phreatic surface in the impoundment is expected to be at Elev. 804 m and the Proponent indicates that it may lower over time. However, since the phreatic surface is such a sensitive factor in stability calculations, the models should maintain a conservative phreatic surface.*

10. The inflow design flood shall be conservatively set at the Probable Maximum Flood level. The earth dam and the spillway designs should take into consideration the effects of the Probable Maximum Flood.

Considering the expected design life (in perpetuity) and significant uncertainty regarding the magnitude of future weather events, the precautionary approach must be applied.

11. The Proponent shall submit plans to the regulator(s) for their tailings depositions strategy (over the life of the impoundment) to provide assurance that a minimum tailings beach width of 100 m will be achieved.

Rationale: *Tailings beaches are important for seepage control, lowering the phreatic surface/hydraulic gradient, keeping ponded water away from the crest and for dam stability. The Proponent indicated that the tailings deposition strategy will create a tailings beach with a minimum width of at least 100 m on the upstream side of the dam. However, the Proponent also noted that ice lenses, which could account for up to 20% of the capacity of the MPTMF could "hinder proper tailings beach development." Current CDA guidelines do not contemplate the concept of a tailings beach (although, the Draft CDA Technical Bulletin for Mining Dams does include information regarding tailings beaches and their implications for tailings dams). Since the proposed tailings beach is so integral to the overall design and function of the MPTMF, it is important that the Proponent provide assurances at the design stage that the tailings deposition strategy is conducive to adequate tailings beach width (particularly in light of challenging site conditions, i.e. ice lens development).*

12. Yukon Government shall engage Selkirk First Nation in determining the acceptability of the final plans for the Main Pit Dam that include and take into account the results of a Quantitative Risk Assessment. The determination should be made on the basis of consensus.

Rationale: *Given that SFN, as the landowner, must accept a level of risk of dam failure, this condition will ensure social acceptability of that risk. As discussed in this report, a failure of the Main Pit Dam would have significant adverse effects to SFN's citizens and their Category A settlement land. Although the rights to administer mining activities on the Minto Mine Property are retained by Yukon Government, adverse effects from a failure of the Main Pit Dam would extend well beyond the mine site in terms of both loss of life for SFN citizens and environmental degradation. A decision* *to approve the Main Pit Dam in opposition to SFN's position would equate to imposing unwanted risk to the group that would be most affected by a dam failure.*

13. As part of a detailed maintenance and monitoring plan for the Main Pit Dam, the Proponent shall provide regulators and Selkirk First Nation with a comprehensive evaluation of expected monitoring and maintenance costs, as well as costs associated with a dam failure, through the design life of the dam. In addition to the money currently held, Yukon Government shall ensure that sufficient security is provided by the Proponent to cover the costs of ongoing maintenance and monitoring requirements, as well as costs associated with a failure of the Main Pit Dam.

14. The Proponent shall adequately monitor potential effects to groundwater flows and quality from the Project. Within the Minto Creek drainage, these should include new multilevel monitoring wells up-gradient and downgradient of Mine activities and increased sampling frequency. These include installation of boreholes and multi-level monitoring wells between current monitoring wells MW12-07 and MW12-06 and downstream of well MW12-05. Longitudinal flow paths shall be evaluated using non-toxic tracer testing to provide a more robust understanding of groundwater movements in support of the development of a numerical groundwater model.

15. The Proponent shall develop a numerical groundwater model for the Minto Creek watershed, informed by additional monitoring, to develop a comprehensive understanding of flow and solute transport with a focus on the closure period. This model shall consider the effects of property geology and potential interaction of the various hydrogeologic and hydrologic domains.

16. The Proponent shall not release additional mass loadings of contaminants of potential concern that are elevated above the site-specific water quality objectives in the receiving environment.

17. The changes to SSWQOs for Al, Fe and Cr proposed by the Proponent will likely result in significant adverse effects to aquatic life. As such, the current SSWQOs should remain for all COPCs. For Fe, the SSWQOs should remain unchanged, but the regulators may wish to consider the merit of removing Fe from the effluent criteria as it is sufficiently controlled by the current restrictions on TSS. Should the Proponent need to relax the SSWQO for Cr, they should provide regulators with an analysis of total Cr in mine releases and Minto Creek background that is Cr(III) and Cr(VI). CCME provides guidelines for appropriate WQOs based on Chromium speciation.

18. The downstream compliance point at W2 can be removed provided the end-of-pipe discharge quality and quantity criteria are based on:

a. The objective is to ensure protection of the downstream receiving environment. The 2010 WUL defines Lower Minto Creek at W2 as the receiving environment and identifies Chinook salmon as the target species of greatest concern. Protection of the receiving environment must include protection of the most sensitive species in that system to ensure that the system can sustain use by Chinook salmon.

b. The SSWQO as the basis to derive end-of-pipe discharge limits and for comparison to water quality monitoring data to demonstrate environmental protection.

c. Ensuring the mass loadings of COPCs do not cause an increase in downstream concentrations beyond the defined SSWQOs.

i. Mine water releases that have COPC concentrations below the SSWQOs for the receiving environment can be released without control on quantity.

d. Monitoring water quality in the downstream receiving environment at W2 and applying SSWQOs to the downstream receiving environment at W2.

19. If the Water Use Licence is amended to include the removal of the W2 compliance point, it should include end-of-pipe quality and quantity criteria. We recommend a more restrictive quantity criterion and or more restrictive quality criteria than proposed by the Proponent to achieve the desired SSWQO in the receiving environment.

20. If the Proponent is permitted to discharge RO treated water without restriction on discharge rate, the quality of the discharge water must comply with the SSWQOs at the point of release and the release of such water must not result in erosion of the stream banks or alteration to the habitat in Minto Creek.

21. The Proponent shall update their Adaptive Management Plan to, at a minimum:

a. Establish water concentrations for the Water Storage Pond that trigger changes to release quantity;

b. Include flow measurements taken at an appropriate location to represent the receiving environment prior to and during periods of release from the WSP;

c. Include measures to adjust flows from the WSP to the appropriate mixing ratio;

d. Establish clear procedures for investigating the cause of COPC concentrations that become elevated in the receiving environment. Establish corrective actions to address elevated COPC concentrations that characterize mine effluent. Triggers to begin investigation of elevated COPC concentrations should be set at a value below the SSWQOs to allow for corrective action (where possible) prior to causing effects to aquatic resources.

22. In addition to annual Water Balance and Water Quality model reports, the Proponent shall provide regulators with an annual report outlining the accuracy of the Water Balance and Water Quality model. The report shall at a minimum:

a. Provide a comparison of waste rock and tailings produced during the course of Phase V/VI production to historical geochemical and water quality monitoring data collected from pre-existing Minto Mine Operations;

b. Undertake monitoring of pit walls for all open pit operations over the course of mining operations to better define source terms for post-closure modeling;

c. Identify any discrepancies between model predictions at water quality stations and the exiting monitoring data;

i. Discuss the origin and implication of such discrepancies if they exist;

d. Guide the evolution of existing monitoring programs as appropriate; and

e. Identify follow-up programs to reduce uncertainty associated with the model assumptions.

23. The Proponent shall develop and implement a monitoring program (quantity and quality) of all contact waters including pit-walls, in-situ and down-gradient tailings, and waste rock pore waters during operations. This includes monitoring of the existing DSTF. The results of this program shall be compared to the source terms used in the Water Quality Model and provided to regulators annually as part of the Accuracy of the Water Balance and Water Quality Model Report prescribed by mitigation # 22.

24. As part of the final design for the Main Pit Dam, the Proponent shall include a collection sump to capture, monitor and treat seepage from the Main Pit Tailings Management Facility through the Main Pit Dam. Seepage from the Main Pit Dam must be included in the annual updates to the water quality model and shall be assumed to continue in perpetuity if any uncertainty as to the total duration of seepage exists at the time of model updates.

25. Additional passive and semi-passive treatment systems are required for the closure period to ensure the protection of aquatic resources in lower Minto Creek. Mitigation # 25 from the Decision Document for project 2010-0198 has not resulted in the timely development of a statistically robust evaluation of: 1) in-situ water behaviour (quantity and quality) through different soil covers on selected reclaimed areas and 2) laboratory and scaled experimental passive treatment of wetlands. This mitigation shall be amended to include the following:

a. No later than 90 days following the issuance of the Decision Document for evaluation 2013-0100, the Proponent shall provide the other members of the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) with a detailed study design to evaluate the site performance of the proposed cover systems in a full scale trial at the site. At a minimum, the study shall be designed to provide a statistically robust review of the following:

i. Infiltration rates measured at randomly selected locations across the waste facility to adequately capture the variability in cover thickness and slopes;

ii. Rates of erosion across the site and a percentage of the site affected by cover breakthrough;

iii. Contaminant loads from the cover system; and

iv. Any other matters recommended by the advisory committee.

b. Within 30 days of the issuance of the study design report referred to in 'a', the members of the Advisory Committee shall provide the Proponent with suggested changes and feedback on their proposed design.

c. The study design shall be finalized within 180 days of the issuance of the Decision Document for this assessment (2013-0100).

d. No later than 60 days following the issuance of the Decision Document for evaluation 2013-0100, the Proponent shall provide the other members of the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) with a detailed study design to evaluate the site performance of the proposed wetland in a demonstration-scale trial at the site. The study design shall include all necessary components to provide a statistically robust and defensible evaluation of the year round performance of the wetland for treating water at the site. The study shall also incorporate measures to monitor metal loads in the wetland to develop a long-term maintenance and monitoring plan.

e. A demonstration-scale wetland shall be constructed on site beginning in 2014 as outlined by the Proponent in YOR 2013-0100-253-1.

26. The Proponent shall provide to the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) a report detailing all reasonable and practical mitigations for the closure period. When determining what constitutes "reasonable" and "practical", members of the advisory committee shall consider the following:

a. The expected or actual site performance of a given mitigation;

b. The cost of the mitigation (both initial cost and long-term maintenance cost) compared to the expected contaminant reductions.

27. The Proponent shall implement all reasonable and practical passive and semi-passive mitigations developed from mitigation # 26.

28. The Proponent shall provide regulator(s) with a fully costed monitoring and maintenance plan for all site components at closure. Moreover, the Regulator(s) shall consider this report when determining the appropriate security to be provided to YG by the Proponent.

29. The Proponent shall maintain a fully functioning water treatment plant on site until such time that they can demonstrate full protection of aquatic life at the receiving environment in Minto Creek through mitigations applied during closure.

30. The Proponent shall immediately begin reclamation of all disturbed areas that are no longer subject to ongoing operations and that will be unaffected by Phase V/VI developments.

31. The Proponent shall update their mine development plans to account for the full construction of the Mill Valley Fill Extension Stage 2.
32. To ensure adequate performance of the Mill Valley Fill buttress, the design and construction program shall include all recommendations detailed on page five of the report prepared by Norwest Corporation (YOR 2013-0100-219-1).
33. Non-degradation (compared to historical background quality) of Minto Creek water quality shall provide the basis for the development of water quality objectives for the closure period. However, if non-degradation cannot be achieved using reasonable and practical passive treatment mitigations (as outlined in mitigation # 29), then the closure objective shall be guided by what can be practically achieved (as long as the objectives are below the effects levels for aquatic resources with sufficient contingency).
34. In the event that that COPC concentrations remain elevated in Minto Creek compared to historical background levels during closure, the Yukon Water Board shall consider whether the remaining assimilative capacity preserves sufficient opportunity for SFN on their Settlement Land and fulfills the spirit and intent of s.14.8.1 of SFNs Final Agreement. The Yukon Water Board should consider whether additional corrective action (i.e. further mitigation or compensation to SFN) is warranted in the event that they decide SFN will experience significant loss of future opportunity as a result of the loss of assimilative capacity in Minto Creek.
35. The Proponent shall familiarize themselves and their contractors with Yukon invasive species and how to manage them by referring to the document "Why Should I Care About Invasive Species?" available from http://www.yukoninvasives.com/pdf_docs/WhyshouldIcare2011_sm.pdf.
36. The Proponent shall remove foreign soil and plant material from equipment prior to moving it to the project site.
37. The Proponent shall report the presence of any invasive plants that are listed on the Yukon Invasive Species Council website (http://www.yukoninvasives.com/pdf_docs/plants_all_invasives.pdf) to Yukon Government by e-mail (invasives@gov.yk.ca) or to the Northern Tutchone Regional Biologist (867-996-2162).
38. Wherever practicable, vegetation clearing for this Project shall occur after July 31st. In the event that land clearing activities occur during the core-breeding period of May 1st to July 31st, prior to clearing the Proponent must plan to avoid disturbing or destroying nests of birds listed under the *Migratory Birds Convention Act*. Contact the Canadian Wildlife Service (Whitehorse) for information on considerations related to determining the presence of nests.

39. If active nests of birds listed under the *Migratory Birds Convention Act* are discovered, the Proponent shall postpone activities in the nesting area until nesting is completed (i.e. the young have left the vicinity of the nest).

Section 110 Recommendations:

As outlined in Section 4.4 of this report, the Designated Office makes the following Section 110 recommendations under the *Yukon Environmental and Socio-economic Act*:

- A project-specific socio-economic and socio-cultural effects monitoring program shall be implemented and shall result in an annual report. The first report should include all the data available at the time of writing and preferably all project phases (construction, operation and closure) and be submitted to the parties of the tripartite working group by December 31, 2014. The development of the monitoring program should consider currently known effects but should also remain flexible so that unforeseen effects can be incorporated. The following list of indicators of direct and indirect socio-economic and socio-cultural effects is provided for illustrative purposes; it should not be considered definitive: Employment and income data and information for Minto Mine; Contracting and business expenditures and distribution; Workforce development data and information; Cultural and community well-being; and Cumulative summaries for all project phases and years; and
- A cumulative effects assessment and monitoring framework shall be developed and implemented by the tripartite working group for submission to the parties by March 31, 2015. This working group is expected to develop an integrated comprehensive cumulative effects program that will include ecological, socio-economic and socio-cultural components. The working group should define the monitoring program so that specific categories are directly quantifiable and that these variables will measure change over time. Information gathered under the project specific monitoring program should be provided for inclusion in the cumulative effects monitoring program.

Report prepared by:

Adam Wrench & Chris Evans

For more information, please contact:

Name: Adam Wrench

Title: Manager, Designated Office

Mayo Designated Office

Table of Contents

Acronyms and commonly used terms

A2PTMF – Area 2 Pit Tailings Management Facility

ANFO – Ammonium Nitrate Fuel Oil

AP – Acid potential

ARD – Acid rock drainage

Asl – Above sea level

BCM – bank cubic metre

CCME - Canadian Council of Ministers of the Environment

CDA – Canadian Dam Association

COC – Contaminant of concern

COPC – Contaminants of potential concern

COSEWIC - Committee on the Status of Endangered Wildlife in Canada

CWQG - Canadian Water Quality Guidelines

DSTSF - Dry Stack Tailings Storage Facility

EEM – Environmental effects monitoring

EEM - Environmental Effects Monitoring program

FOS – Factor of safety

ICOLD – International Commission on Large Dams

ISQG - Interim sediment quality guideline

JCS – Juvenile Chinook Salmon

LOM – Life of Mine

MMER - Metal Mining Effluent Regulations

MPTMF – Main Pit Tailings Management Facility

MVF – Mill Valley Fill

NAG – Non-acid generating

NP – Neutralizing potential

PAG – Potentially acid-generating

PEL – Probable effects level

PPCF – Post-pillar cut-and-fill

QML - Quartz Mining Licence

RAP – Room and pillar

RO – Reverse osmosis

SARA – Species at Risk Act

SFN – Selkirk First Nation

SSWQO - Site Specific Water Quality Objective

SV & I – Seeking views and information

SW Waste Dump – Southwest Waste Dump

TDS – Total dissolved solids

TMF – Tailings management facility

Tpd – Tonnes per day

TSS – Total suspended solids

WMP - Water Management Plan

WSP - Water Storage Pond

WUL - Water Use Licence

YESAA - Yukon Environmental and Socio-economic Assessment Act

YESAB - Yukon Environmental and Socio-economic Assessment Board

BACKGROUND

Part A provides the context and background information required for the assessment of the Project. Section 1.0 identifies the requirement for an assessment under the *Yukon Environmental and Socio-economic Assessment Act*, while Sections 2.0 and 3.0 provide information and baseline data for the Project and Project area. Section 4.0 identifies the scope of the assessment, including matters that were considered in evaluating the significance of potential effects of the Project

1.0 REQUIREMENT FOR AN ASSESSMENT

The purpose of the proposed Project is to mine and mill copper-gold deposits to produce metals concentrates for sale in the global commodities markets. While several activities are likely to be undertaken in conjunction with this Project, under s. 47 of the *Yukon Environmental and Socio-economic Assessment Act,* the Project is subject to an assessment by the Mayo Designated Office due to the following circumstances:

- The proposed activity is listed in column 1 of Schedule 1 of the *Assessable Activities, Exceptions and Executive Committee Projects Regulations* (Activity Regulations); and not listed in column 2 as excepted. The proponent proposes to undertake activities listed in Part 1, item 3 and Part 9, item 12 of the Activity Regulations. The specific activity is listed as:

  "*On other than an Indian reserve, construction, operation, modification, decommissioning or abandonment of or other activity in relation to, a mine*"; and

  "*Other than for an electrical power undertaking, the deposit of waste into water or in any other place under conditions in which the waste, or any other waste that results from the deposit, may enter water".*
- Is proposed to be undertaken in the Yukon; and
- An authorization or the grant of an interest in land by a government agency, independent regulatory agency, municipal government, or First Nation is required for the activity to be undertaken.

Table 1: The Decision Body and the triggering authorizations required for the Project. This information is based on the project proposal and other information submitted to the Designated Office during the assessment.

Decision Body	Authorization Required	Act or Regulation
YG Energy Mines and Resources – Minerals Resources Branch	Quartz Mining License – Amendment	*Quartz Mining Act*
	Type A Water Use License – Amendment	*Waters Act* (Yukon) *Waters Regulations*
Selkirk First Nation		*Selkirk First Nation Final Agreement* *Selkirk First Nation Self Government Agreement*

2.0 PROJECT DESCRIPTION

2.1 Proponent Information

The Proponent for this project is Capstone Mining Corporation (Capstone). The primary contact person for this Project is Martin Haefele, Permitting Manager, Capstone. The alternate contact person for this project is Scott Keesey, Senior Environmental Manager, Access Consulting Group. Mr. Haefele and Mr. Keesey can be contacted at:

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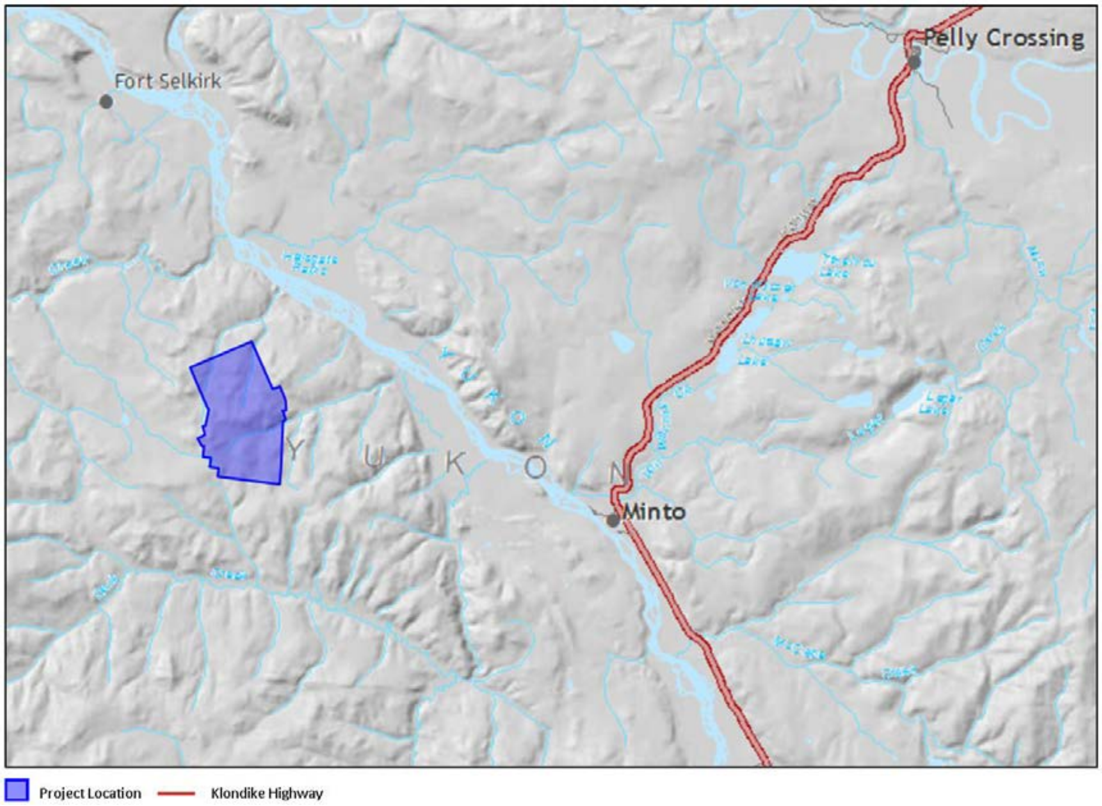
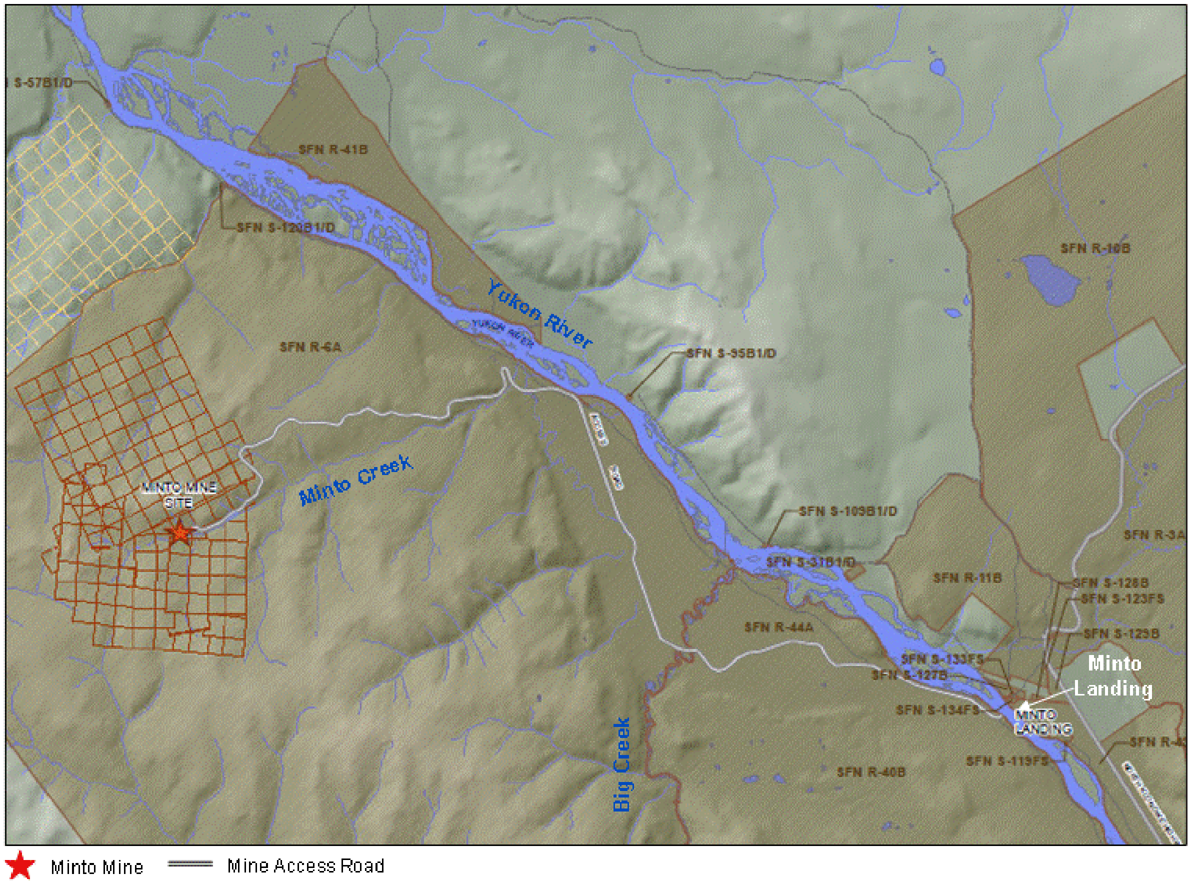
Canada

2.2 Geographical Context

The Minto Mine is located approximately 240 km northwest of Whitehorse and 41 km southwest of Pelly Crossing (Table 2). The Minto Mine area consists of 164 claims on the west side of the Yukon River within Selkirk First Nation (SFN) Category A Settlement Land Parcel R-6A (Survey 2000-0112LTO Plan 83638 CSR). The North Klondike Highway is located on the east side of the Yukon River and the mine-site is accessed by crossing the Yukon River at Minto Landing. After crossing the Yukon River, either by summer barge or winter ice-bridge, access to the mine-site is via a 29 km access road up the Minto Creek drainage. Crews and supplies are transported by air during the spring thaw and fall freeze- up.

Table 2: Project location, coordinates and geographical parameters





Project Coordinates:	**UTM**
Map Sheet: 115I11	Zone 8
	NW 381562E 6948449N
	NE 384750E 6949975N
	SW 382423E 6943670N
	SE 386586E 6942352N
	Degrees, Minutes, Seconds
	NW 62˚ 38′ 51″ N 137˚ 18′ 39″ W
	NE 62˚ 39′ 44″ N 137˚ 14′ 59″ W
	SW 62˚ 36′ 18″ N 137˚ 17′ 26.52″ W

	SE 62˚ 35′ 40.2″ N 137˚ 12′ 32″ W **Decimal Degrees** NW 62.6476˚ N 137.3108˚W NE 62.6623˚ N 137.2497˚W SW 62.605˚ N 137.2907˚W SE 62.5945˚ N 137.2088˚W
First Nation Traditional Territories Involved:	Selkirk First Nation
Drainage Region:	*Major Drainage Area*: Yukon *Sub Drainage Area*: Headwaters Yukon *Sub-sub Drainage Area*: Headwaters Yukon - Nordenskiold
Nearby Watercourses or Waterbodies:	Minto Creek

2.3 Project History

The Minto Mine, operated by Capstone, is an existing and fully operational copper and gold mine. The property has been explored since the initial workings on the claims in 1971. In 2005, Sherwood Copper (the predecessor of Capstone Mining Corp.) acquired the property and focussed on confirming the resource in the Main Pit while they completed construction of the mine infrastructure. The Minto Mine has been producing concentrate under various licences and permits since 2007.

The Minto Mine operation currently includes:

- The Main Pit, Area 2 Pit, Area 118 pit and Minto South Portal;
- Waste dumps, overburden dumps and ore stockpile areas;
- An ore processing facility with a mill water pond;
- A concentrate storage shed;
- A tailings filter building and dry stack tailings storage facility (DSTSF);
- A water retention dam with associated Water Storage Pond (WSP); and
- Administrative offices, camp and airstrip.

With the completion of the currently permitted phase IV operations, the Minto Mine is expected to produce an estimated total of 7.4 million tonnes (Mt) of ore and 14.5 M m^3 of waste. Minto Mine is currently authorized to mine up to 2.5 Mt per year and mill up to 4 200 tonnes per day (tpd) of ore.

The Mayo Designated Office, under the *Yukon Environmental and Socio-economic Assessment Act* (YESAA), has completed four evaluations of proposals concerning operations at the Minto Mine. The first report, issued in May of 2008, resulted in the Government of Yukon amending Yukon Quartz Mining License QML-0001 to reflect the increased milling rate of 3 200 tpd. The second report, issued in March of 2010, further increased the mill rate to 3 600 tpd and revised the Water Management Plan (WMP). The third proposal, for Phase IV operations, increased the mill rate to 4 200 tpd. The fourth proposal was for an amendment to the Air Emissions Permit 60-30 in relation to the operation of the diesel generators used to power the mine.

Since commercial production began in 2007, it has become apparent that the Minto Creek watershed environment is very different from the modeled environment that formed the basis of the original WMP. Due to large amounts of un-anticipated precipitation, the Proponent required three separate discharges of water under the emergency provisions in the *Waters Act* (up to 350 000 m^3 of water was discharged in August 2008; 300 000 m^3 in June 2009 and 705 000 m^3 in August 2009). The current WMP for the site is regulated by Water Use License (WUL) QZ96-006 and includes both an end of pipe discharge standard and a receiving environment compliance point.

Current mining activities are expected to finish by early 2014. Activities in this proposal increase the mining life by approximately 5 years and the milling life by approximately 6 years by adding three new open pits, expanding the Area 2 pit and increasing underground mining. The additional mining will be done under amendments to the current licenses, which expire June 16, 2016. Reclamation and closure activities are proposed to finish in 2023 with post-closure monitoring beginning in 2024.

2.4 Project Details

Capstone proposes amendments to its Quartz Mining License QML-0001 and Type A Water Use License QZ96-006 in order to expand its current mining operations at the Minto Mine. The following sections outline the activities, which collectively comprise the Project.

2.4.1 Surface mining

Phase V/VI surface mining will include three new open pits (Minto North, Ridgetop North and Ridgetop South) and an expansion of the existing Area 2 Pit (Area 2 Stage 3). These additional pits will extend surface mining to 2017.

Mining will begin with the Minto North pit. Following completion of the Minto North pit, the Area 2 Stage 3 will be mined to provide additional storage volume for tailings deposition. Mining will then proceed to the Ridgetop South pit and conclude with the Ridgetop North pit.

The mining rate will proceed at a rate of 12 800 bank cubic metres (BCM)/day until the completion of the Area 2 Stage 3 pit. This rate is set to provide timely completion of the Area 2 pit so it can transition into a tailings storage facility. Following the completion of the Area 2 Stage 3 pit, the mining rate will decrease to 7 200 BCM/day through to completion of surface mining (Ridgetop North & South).

Open pit mining will be conducted as a conventional truck/excavator operation using diesel-powered excavators, trucks, drills and auxiliary equipment. Overburden will be stripped using dozers and rock will be drilled and blasted. Material will be loaded onto trucks using excavators and hauled to the various facilities depending on material composition. Mining equipment requirements will be commensurate with the mining rate and will decrease following the completion of the Area 2 Stage 3 pit.

Overburden will be segregated from the other material for use in reclamation (see Section 2.4.4). Overburden volumes will exceed what is required for reclamation; as such, a portion of overburden will be co-disposed with rock in the waste dumps. Segregation of the waste rock and ore will be determined from sampling of drill cuttings from blast holes prior to excavation.

2.4.2 Underground mining and exploration

Phase V/VI includes development of three additional underground reserves known as Minto East, Copper Keel and Wildfire. Minto East and Copper Keel form the East Keel Underground complex and will be accessed through the Highwall Portal located east of the Main Pit (Figure 1). The wildfire underground will be accessed through a new portal called Wildfire located west of the airstrip (Figure 1). These additional underground reserves will increase the total underground reserves by approximately 135% compared to those presented in the phase IV development.

Depending on the thickness of the mineralized zone, room and pillar (RAP) mining methods (for use where mineralized thickness less than 10 m) or post-pillar cut-and-fill (PPCF; for use where mineralized thickness is greater than 10 m) mining methods may be used. Total production from underground developments will be 2 000 tonnes of ore per day; this is unchanged from phase IV production.

2.4.2.1 East Keel Underground

Access to the East Keel Underground will be via a single 5.0 x 5.0 m decline. In addition to the network of underground mine workings, three raises will be constructed (one ventilation raise and two exhaust raises). The East Keel Underground is expected to be in production for approximately 5.5 years. Full production from these underground workings is expected in 2014.

2.4.2.2 Wildfire Underground

Access to the Wildfire Underground will be via a single 5.0 x 5.0 m decline. In the Wildfire workings, the decline will also serve as the exhaust airway. A ventilation raise will be constructed to provide fresh air and secondary egress. The wildfire Underground will be developed over a six month period.

2.4.2.3 Mining Equipment

Production mucking will use rubber –tired load-haul-dump units with ~7.6 m^3 buckets, loading 40 tonne underground haul trucks. Drilling will be done with two-boom electric-hydraulic jumbo drills propelled by diesel engines. Ground support equipment includes mechanized rockbolters, and manual rockbolting conducted from scissor lift platforms.

2.4.2.4 Health & Safety

Ground support will include the use of bolts, welded wire mesh and shotcrete as needed. Ground support standards for underground workings will be established under supervision of Minto’s engineering staff and engineering consultants where needed.

During initial development of the underground workings, the decline will provide the only point of entrance/egress to the mine workings. The ventilation raises, once developed, will be used as secondary egress points for underground mining. Ladders and platforms will allow miners to escape underground workings if the main decline becomes obstructed.

Exhaust gases produced by mining equipment will be diluted by fresh air forced underground by large ventilation fans. Adequate ventilation was calculated by based on a need for fresh air exchange of 0.064 m^3/s per installed kW of diesel engine power operating underground. The kW rating of each piece of equipment was multiplied by a utilization factor to determine the amount of air required. In addition, all mobile equipment will be equipped with exhaust scrubbers. The East Keel Underground will require three ventilation raises, while the Wildfire Underground will require one.

2.4.3 Explosives

Ammonium nitrate fuel oil (ANFO) will be used as the major explosive for mine development. Consumption of explosives for development and stoping is estimated to be 0.6 to 0.9 kg/tonne of broken rock. Initially bulk explosives will be stored in Minto's existing magazines alongside the products used for surface mining and transported underground as needed. As ore production begins and the number of working faces increases, explosives magazines will be constructed underground.

2.4.4 Overburden & Waste Rock Management

Expanded surface mining will produce approximately10.2 Mm^3 of waste rock and approximately 4.8 Mm^3 of overburden. Expanded underground workings will produce approximately 133,000 m^3 of waste rock. Up to six new waste dump facilities will be constructed to dispose of the additional waste rock. In addition, the existing reclamation dumps will be expanded to accommodate additional overburden from surface mining.

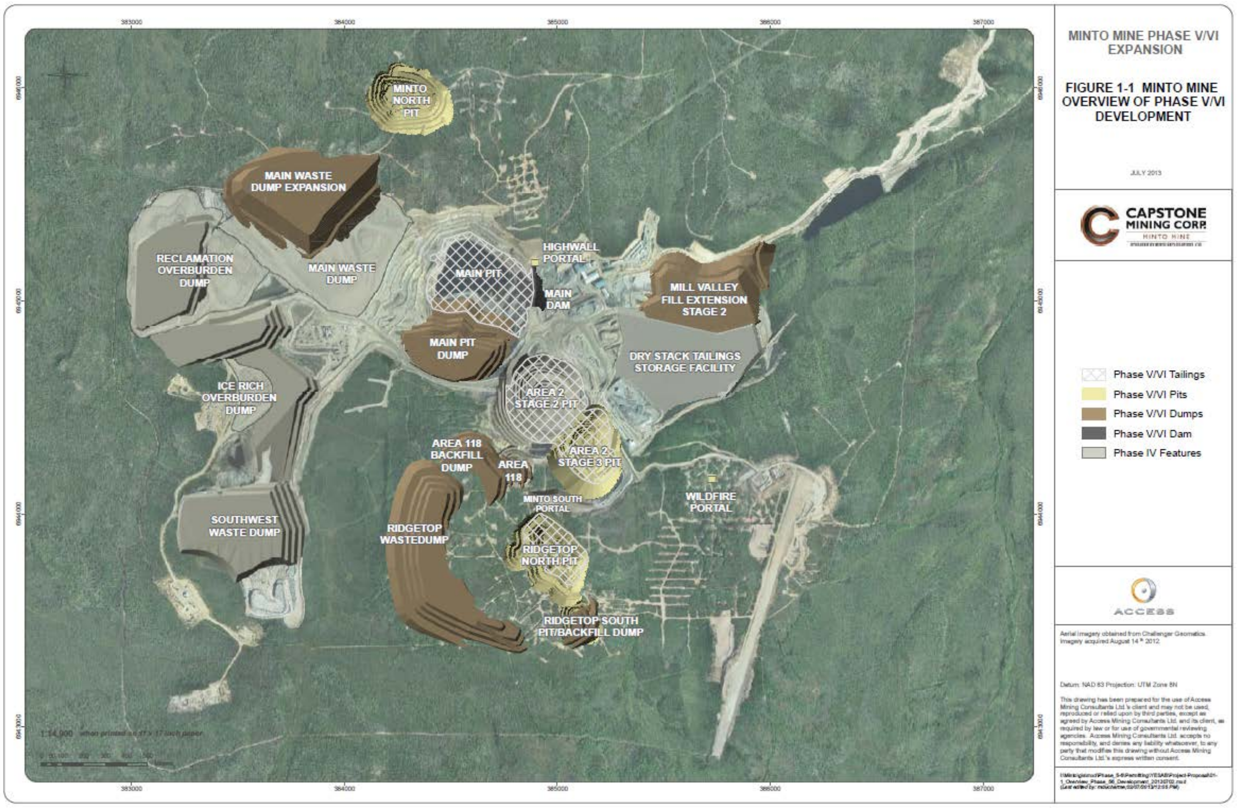


Figure 1: Proponent map showing overview of Phase V/VI development. Sourced from YOR 2013-0100- 005-1

Waste rock will be segregated based on potential for metal leaching determined from on-site testing of drill core samples. Non-acid generating (NAG) waste rock will be segregated from potentially acid generating (PAG) waste rock. PAG waste rock is defined as material having a ratio of neutralization potential (NP) to acid potential (AP) less than 3 (NP:AP<3). In order to prevent environmental contamination from metal acid rock drainage (ARD), waste rock with a NP:AP<3 ratio will be disposed of sub-aqueously in the Main Pit along with tailings.

Pre-project sampling indicated that no NP:AP<3 waste rock is present in the Minto North Pit. A portion (13-17%) of the waste rock from the Minto South pits (Area 2 Stage 3, Ridgetop North and Ridgetop South) is predicted to be PAG (NP:AP<3). As such, the Proponent has planned for saturated disposal of up to 20% of the waste rock from the Minto South pits post-closure. The additional storage of PAG waste rock beyond the predicted volumes (i.e. 3%) is to allow for uncertainty in the estimates. The total PAG (NP:AP<3) waste rock estimated from surface mining is approximately 1.2 Mm^3. PAG waste rock will be disposed in both the Main Pit and Area 2 pit tailings storage facilities below the final water table elevation.

2.4.5 Ore Processing

The current permitted mill rate of 4,200 tpd will not change with phase V/VI production. Besides the temporal scope of processing, no material changes are proposed to the ore processing as a result of phase V/VI mining.

This current proposal will extend ore processing to approximately year 2022. Ore is processed by crushing and milling. Crushing consists of a two-stage crushing circuit where ore is screened by rock size to separate rocks too large for the crusher to be broken up further before crushing. The crusher produces uniform material to that is fed into the mill. The mill plant consists of the following main unit operations:

- Two-stage grinding circuit comprised of a single semi-autogenous grinding (SAG) mill and two ball mills;
- Bulk flotation in rougher and scavenger stages, followed by cleaner flotation;
- Centrifugal gravity concentration of coarse gold;
- Concentrate thickening and pumping;
- Concentrate filtration;
- Concentrate storage (on-site);
- Tailings thickening and pumping to an in-pit deposition location; and
- Water reclamation.

The result of ore processing is a metal concentrate and tailings. The metals concentrate is stored on site before it is hauled of site for further processing. Currently up to 18,000 tonnes of concentrate can be stored on site at any given time.

2.4.6 Tailings Disposal

Slurry tailings from the mill will be directed to four separate tailings management facilities (TMF) (Main Pit, Area 2 Pit, Area 2 Stage 3 Pit and Ridgetop North pit). A small portion of tailings may be disposed underground as paste backfill in areas where additional support is required to accommodate underground mining. Total storage volume required for disposal of tailings and NP:AP<3 waste rock is approximately 16.4 Mm^3. Insufficient natural storage capacity exists at the project site for storage of tailings. As such, Phase V/VI includes the construction of a tailings dam to increase the storage capacity; the Main Pit Dam will be located along the eastern edge of the Main Pit TMF.

2.4.7 Main Pit Dam

The natural storage capacity of the Main Pit is 4.9 Mm^3. Before construction of the Main Pit Dam, an overall storage deficit of 1.7 Mm^3 exists for storage of Phase V/VI waste. Construction of the Main Pit Dam will increase the storage capacity of the Main Pit by approximately 1.7 Mm^3.

The Main Pit Dam will increase the spill elevation of the Main Pit from approximately 791 m above sea level (asl) to 806 m asl. The Full Supply Level of the dam will be 804 m asl, allowing for a total of 2 m freeboard. The Main Pit Dam will be roughly 300 m long with a maximum crest height of 23 m. The average height of the dam will be roughly 10 m.

The Main Pit Dam will be constructed using waste rock and overburden from the development of the Area 2 Stage 3 pit. The Main Pit Dam will be constructed by encapsulating a low permeability core of fine-grained overburden within a waste rock shell.

During mine operations, the Main Pit Dam will retain both tailings solids and free water. Following mine closure the Main Pit Dam will not retain free water. Surface flows through the Main Pit TMF post closure will be directed by engineered conveyance structures to the Area 2 Pit TMF. Further details on water conveyance are provided in Section 2.4.5.

A conceptual level of design details are provided for the Main Pit Dam as part of this assessment; assumptions exist with this design and are discussed in Section 5 – Health and Safety. The Proponent notes that a substantial amount of work remains to advance this project component to the build stage. This work will include:

- Detailed foundation characterization;
- Borrow identification and characterization;
- Tailings confirmation characterization; and
- Geotechnical and hydro-technical engineering analysis.

2.4.8 Water Conveyance & Management

An extensive network of water collection and conveyance infrastructure exists throughout the project site currently (Figure 2). The water conveyance network at the mine site consists of diversion ditches, culverts, sumps, pumps and pipelines. These water conveyance structures are intended to segregate clean runoff and mine impacted water. Clean water is conveyed to the Water Storage Pond (WSP) while mine-impacted water is currently directed to the Main Pit. The segregation of clean water from mine-impacted water is a key principle of Capstone’s water management plan at the site.

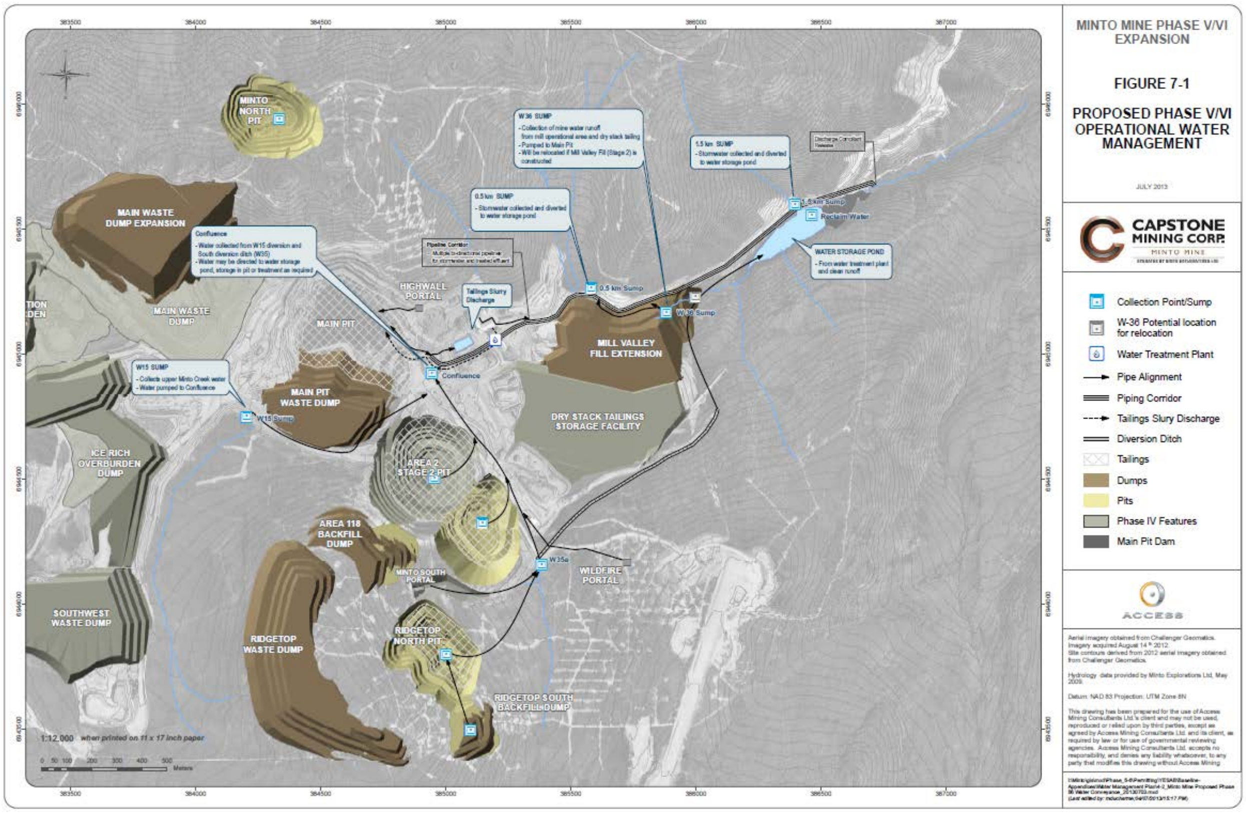


Figure 2: Proposed Phase V/VI Operational Water Management. Sourced from YOR 2013-0100-011-1.

Phase V/VI operations will require changes to the current water management infrastructure at the site. These changes include:

- Further development of the Main Pit into a tailings management facility (the MPTMF), and as a reservoir for storage of mine water;
- Development of the Area 2 Pit into a tailings management facility (the A2PTMF) and as a reservoir for storage of mine water;
- Addition of mine water sumps and mine water pipelines to dewater the Ridgetop North and South Pits, and a sump for the Minto North Pit;
- Additional pipelines to dewater the underground workings at portal locations;
- Addition of tailings slurry and reclaim lines from the mill to the A2PTMF and the Ridgetop North TMF;
- Modification of the tailings diversion ditch to increase capacity, and to include piping of runoff from the eastern edge of the ditch to the water storage pond (WSP); and

- Decommissioning of the south diversion ditch and modification to the W35A collection point to allow for conveyance of several features.[1]

The proposed water management infrastructure for the Phase V/VI developments are intended to separate mine-impacted water from un-impacted water by allowing mine operators flexibility with water conveyance.

Under the current water licence (QZ96-006) the Proponent is bound to two compliance points. The first is located below the WSP downstream of the project site and is the last point of control for mine affected water. The second is at W2 in the receiving environment, a short distance upstream from the confluence of Minto Creek with the Yukon River. The WSP is intended to hold “clean” water that meets or exceeds the effluent release criteria. When background water meets the criteria set for W2 or during the freshet period, compliant water can be released from the WSP, the water treatment plant or both. Elevated metals from background water at W2 have prevented the Proponent from releasing water compliant with the upstream licence criteria, creating a water management challenge at the site. This situation has led to emergency releases of non-compliant water to Minto creek on several occasions. To avoid emergency releases of water, the Proponent has been depositing excess water in the Main Pit when necessary.

2.4.9 Water Treatment

Water treatment on site is comprised of a two-stage process. The first stage of the process uses a ballasted lamella clarifier unit to remove total suspended solids (TSS), total metals and dissolved copper. The second stage of treatment is a reverse osmosis (RO) treatment system that removes 95-99% of all constituents. The RO system is required to remove nitrate and selenium to levels that meet the Water Use Licence (WUL) criteria. The RO system concentrates the constituents into a brine solution containing approximately 25% of the feed water and 95-99% of the constituents. The brine is then pumped to the Main Pit for disposal and the clean water is released either to the WSP or directly to Minto Creek.

Although the WSP is intended to hold clean water prior to release, this water will be treated if it does not meet the WUL discharge criteria. If water needs to be released from the Main Pit or Area 2 Pit, this water will be treated before release to the WSP or Minto Creek.

2.4.10 Water Balance & Modelling

A stochastic water balance model built on Phase IV modelling work incorporates historical water balance data and produces predictions of the range of future precipitation and surface runoff events for the proposed development through closure. The water balance model divides the site and surrounding area into catchments and sub-catchments with an additional sub-catchment for the new Minto North pit in the McGinty watershed. Each sub-catchment is classified as undisturbed, partially developed or developed, and the area for each sub-catchment is calculated and input to the model. Details of the load source terms for the model are presented in Appendix K-B of the proposal.[2]

The water balance predicts that approximately 70% of the precipitation that falls on the project site leaves as evapotranspiration, sublimation and groundwater re-charge. Only 30% of precipitation leaves the site

[1] YOR 2013-0100-011-1
[2] YOR 2013-0100-044-1 to 049-1

as runoff. In an average year, the project will have an operational water surplus of roughly 28% of the total runoff. In contrast, a 1 in 100-year drought would see an operational water deficit of 36% where a 1 in 200-year wet year would produce a 56% surplus. The site wide water management will vary considerably depending on the precipitation received at the site.

Using the GoldSim software package, a water and load balance model was produced to develop predictions of annual flow and quality of water within and downstream of the Minto Mine site. Loadings were incorporated into the model by calculating the associated loading source terms and the corresponding water flows or mine components in the following ways:

- Concentration based source terms were applied as constant values to monthly runoff volumes from corresponding sub-catchments.
- Loading-based source terms were incorporated into the model as a “dry” load either to runoff or to water reservoirs. For example, loadings from tailings solids were applied to the water in the reservoir where tailings were deposited.[3]

From the corresponding loads the model produced “expected case” and “reasonable worst-case” predicted concentrations for key parameters at the WSP and lower Minto Creek during open water periods during operations and post closure. These predictions are presented in Tables 7-5 through 7-8 of the proposal.[4]

In the model, during the operational period, mine water destined for release from the Main Pit or Area 2 Pit was modelled as if it were treated by the RO treatment system on site, as this would be the normal procedure. The RO treatment was accounted for in the model by removing 95% of the loadings from the feed water from the two pits.

2.4.11 Proposed Effluent Criteria and Water Quality Standards During Operations

The phase V/VI proposal includes significant changes to effluent management at the project site. These changes include:

- The removal of the compliance point in the receiving environment at W2;
- Changes to the effluent limits for the Nitrite, Nitrate, Selenium, Ammonium and Cadmium; and
- A paced effluent release from the WSP that maintains a 3:1 dilution ratio with the background flows in Minto Creek.

2.4.11.1 Removal of W2 Compliance Point

Due to elevated background metals over the past couple of years, the mine has been unable to release water as some contaminant of concern (COC) concentrations at W2 are regularly elevated above the licence criteria for that station. Much of these elevated concentrations appear to originate in two tributaries below the mine site and the water quality of these tributaries is assessed at stations C-10 and C-4. As such, the Proponent has requested that the compliance point at W2 be removed.

[3] YOR 2013-0100-011-1
[4] *Ibid*

2.4.11.2 Proposed Changes to Effluent Release Criteria

As part of this proposal, the Proponent initiated an effects assessment of releasing water with parameter concentrations greater than the effluent quality limits prescribed in their current WUL. The Proponent first identified COCs that exceeded the release criteria or nearly exceeded the release criteria in water at the WSP. These COCs were:

- Nitrite ($N\text{-}NO_2$) – effluent limit 0.15 mg/L;
- Nitrate ($N\text{-}NO_3$) – effluent limit 7.65 mg/L;
- Selenium (Se) – effluent limit 0.003 mg/L.
- Ammonia (NH_4) – effluent limit 0.89 mg/L; and
- Cadmium (Cd) – effluent limit 0.00015 mg/L.

The Proponent then assessed and proposed alternative discharge criteria based on their assessment of effects to the receiving environment in lower Minto Creek at W2. These alternative discharge criteria were set based on modifying factors (geochemical, physiological, and biological) in the receiving environment. Specifically, the Proponent's water quality team considered the:

- Aquatic environment character: erosional system, naturally elevated contaminant concentrations, marginal habitat, limited productivity, etc.;
- Modifying factors to toxicity: hardness, pH, temperature, dissolved organic carbon, and chloride; and
- Resource Use: duration and nature of use, species distribution, and life stage, etc.

From this assessment, the following changes are proposed to the effluent release criteria, outlined in Table 3 below.

Table 3: Comparison of Existing and Proposed Effluent Quality Limits in Water Use Licence QZ96-006. Sourced from YOR 2013-0100-011-1

		Water Use Licence QZ96-006 Amendment 8				Proposed Water Use Licence Limits		
		Water Treatment Plant Effluent Discharge to Minto Creek	**Freshet[A] at W50 and W17**	**Non-Freshet at W50 and W17**	**Non-Freshet at W2**	**All Discharge from Site (Freshet)**	**All Discharge from Site (Non-Freshet)**	**Proposed WUL Limits for Non-Freshet at W2**
pH	units	6.5 to 9.0	6.5 to 9.0	6.5 to 9.0	6.5 to 9.0	No Change	No Change	**No Standard**
Ammonia	mg/L	0.89	0.89	0.89	0.35	**1.5**	**1.5**	**No Standard**
N-NO2	mg/L	0.15	0.15	0.15	0.06	**0.7**	**0.7**	**No Standard**
N-NO3	mg/L	7.65	7.65	7.65	2.9	**30**	**30**	**No Standard**
Oil and Grease		none visible	none visible	none visible	none visible	No Change	No Change	**No Standard**
Total Suspended Solids	mg/L	15	30	15	-	No Change	No Change	**No Standard**
Phosphorus (total)	mg/L	-	-	-	0.02	No Change	No Change	**No Standard**
Aluminum (total)	mg/L	2.7	2.7	2.7	0.62	No Change	No Change	**No Standard**
Arsenic (total)	mg/L	-	-	-	0.005	No Change	No Change	**No Standard**
Cadmium (total)	mg/L	0.00015	0.00015	0.00015	0.00004	**0.0003**	**0.0003**	**No Standard**
Chromium (total)	mg/L	0.008	0.008	0.008	0.002	No Change	No Change	**No Standard**
Copper (total)	mg/L	0.05	0.08	0.05	0.013	No Change	No Change	**No Standard**
Iron (total)	mg/L	3.5	3.5	3.5	1.1	No Change	No Change	**No Standard**
Lead (total)	mg/L	0.02	0.02	0.02	0.004	No Change	No Change	**No Standard**
Molybdenum (total)	mg/L	0.4	0.4	0.4	0.073	No Change	No Change	**No Standard**
Nickel (total)	mg/L	0.5	0.5	0.5	0.11	No Change	No Change	**No Standard**
Selenium (total)	mg/L	0.003	0.003	0.003	0.001	**0.02**	**0.02**	**No Standard**
Zinc (total)	mg/L	0.15	0.15	0.15	0.03	No Change	No Change	**No Standard**

Notes:

[A]April 1 to May 31

2.4.11.3 Paced Effluent Release from the WSP

During the review of the proposal, YESAB and other reviewers noted the possibility for the Proponent to release large volumes (compared to background flows) of effluent containing metals concentrations at or near the licenced discharge criteria. This situation was not fully contemplated in the modelling work provided in support of the application. A 3:1 dilution ratio between background flows and effluent release was used to screen COCs for the modelling work, but effluent release was not initially proposed to be regulated according to dilution ratio. Following questions of dilution, the Proponent updated their proposal to include paced effluent release. The Proponent's response to the second information request during adequacy review of the proposal outlines their proposed strategy:

Table 4: Proposed Mine Discharge Strategy for Operational Period. Sourced from YOR 2013-0100-167-1.

Period	Effluent quality limits	Limit of discharge rate
November through May	Proposed Ph. V/VI effluent quality limits	None
June through October	Proposed Ph. V/VI effluent quality limits	Discharge paced to flows in lower Minto Creek*

*Discharge pacing intended to limit untreated discharge from the mine site

The Proponent provided the following three-step effluent release strategy to maintain a minimum 3:1 dilution ratio during operations:

1. Monitoring of flow volumes at an appropriate location in lower Minto Creek.
    a. Provisionally, the existing flow monitoring station MC1 is thought to be a suitable location.
    b. At a minimum, daily flow measurements will be collected manually. Minto will evaluate the merits and the feasibility of remote monitoring; the datalogger at the flow monitoring station at MC1 could be equipped with a radio or satellite modem, which would allow remote monitoring of flows.
2. Measurement of daily rates of water treated through the RO treatment plant.
3. Daily adjustment of volume of untreated water from site to meet the following condition:

$$1/3(Q_{MC1} + Q_{RO}) \geq Q_{WSP}$$

where:
Q_{MC1} = daily flow volume in lower Minto Creek (provisionally represented by station MC1);
Q_{RO} = daily volume processed through the RO treatment plant;
Q_{WSP} = daily volume of untreated water discharge from mine site (represented by Water Storage Pond (WSP) discharge).[5]

As illustrated by the Proponent's equation, the discharge pacing will apply only to untreated water released from the WSP. Water released from the RO treatment plant will be released in unlimited volumes and will be used to dilute water from the WSP when the 1:3 dilution ratio cannot be met due to low background flows.

2.4.12 Reclamation and Closure

The Phase V/VI closure plan builds upon the Phase IV closure plan and uses the same principles and strategies. Progressive reclamation will be employed where possible throughout mine construction and operations. Slopes will be re-contoured and re-vegetated by compacting, scarifying and seeding. The following three strategies will be employed to reduce adverse effects to water during closure:

- Source control methods;
- Passive and semi-passive treatment systems; and

[5] YOR 2013-0100-0167-1

- Contingency water treatment.

Reclamation and closure activities are scheduled to begin in 2014. Final reclamation and closure work will be complete by 2024 with transition to monitoring and maintenance. Reclamation will begin with the Southwest Waste Dump cover placement and re-vegetation this year. Reclamation will end with the construction of the final diversions and water storage pond dam deconstruction.

2.4.12.1 Source Control

Source controls measures for Phase V/VI operations will consist primarily of:

- Operational characterization of wastes (i.e. PAG vs. Non-PAG material);
- Materials segregation;
- Sub-aqueous disposal; and
- Isolating covers over waste dumps to reduce water infiltration and atmospheric exposure.

Operational characterization, materials segregation and sub-aqueous disposal are described in Sections 2.4.4, 2.4.6 and 2.4.7 respectively.

Isolating soil covers are the Proponent's preferred cover option as they are the simplest and least expensive of the cover systems evaluated. Soil covers are expected to achieve reductions of approximately 20-30% of mean annual precipitation with periods of significant breakthrough that may reduce performance. Soil covers returned acceptable reductions of metal loadings when included in the modelling runs. All waste facilities will be covered by soil covers post closure. Figure 3 outlines proposed reclamation measures following Phase V/VI development.

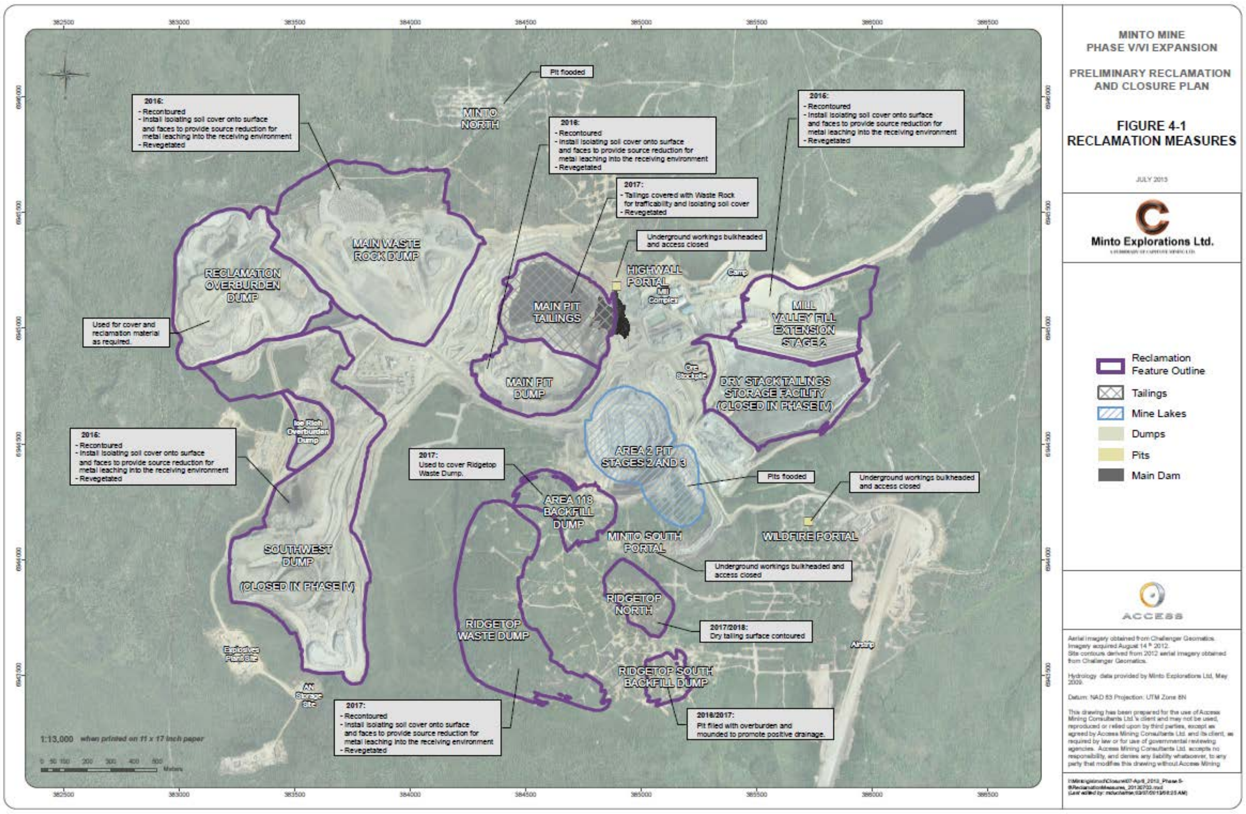


Figure 3: Proposed reclamation measures for Phase V/VI components. Sourced from YOR 2013-0100-008-1.

2.4.12.2 Passive and Semi-Passive Treatment Systems

Passive and semi-passive treatment systems proposed for advancement at this site include settling ponds, wetlands and bioreactors. These systems were found to be integral to achieving protection of aquatic life during past closure planning efforts. Recent work has noted that water treatment of any kind following successful reclamation and cover placement may not be necessary. However, passive and semi-passive treatment systems are still proposed as key mitigation measures to deal with periods of cover break through and unexpected poor reclamation performance. The feasibility of these treatment systems is still largely unknown for this site as the metal loads and extreme climate may limit their use. Figure 4 shows the likely placement of key treatment systems to reduce loadings during closure.

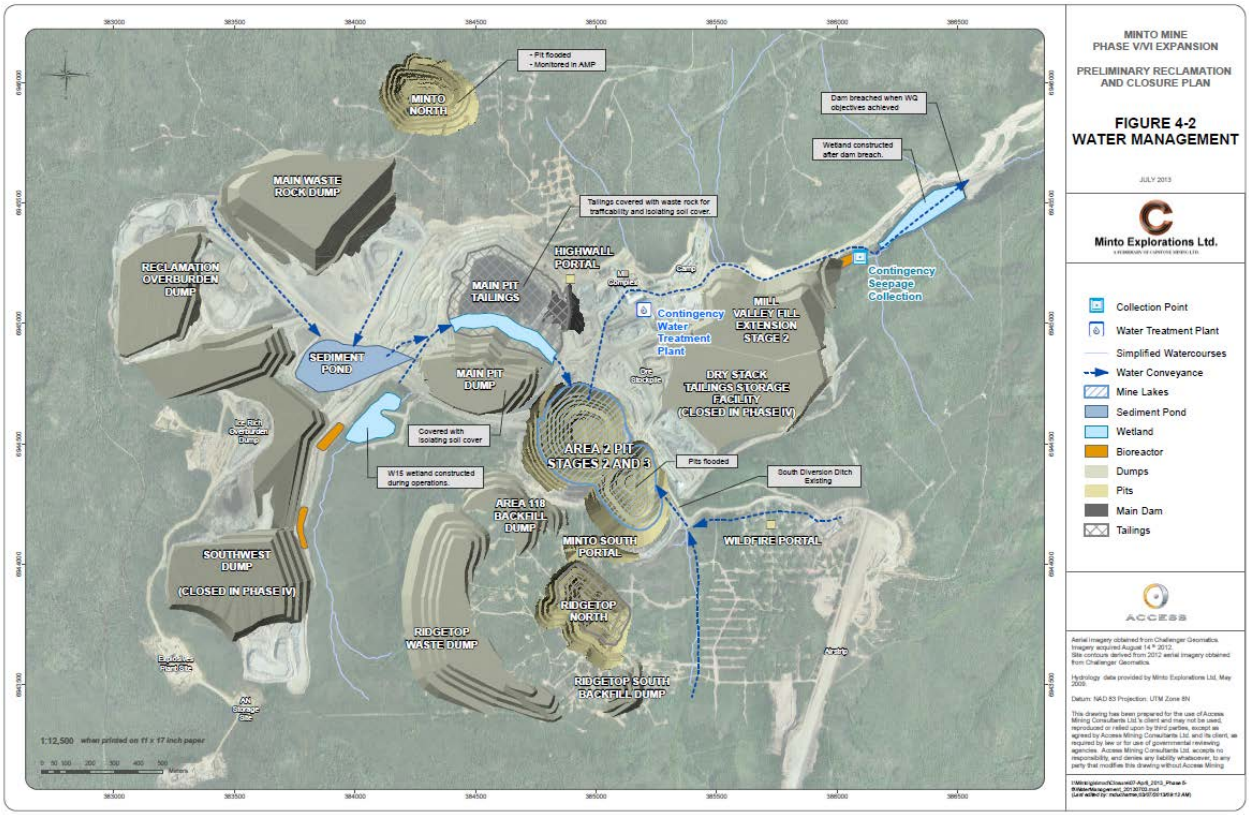


Figure 4: Phase V/VI water management infrastructure for post-closure. Sourced from YOR 2013-0100-008-1.

2.4.12.3 Contingency Water Treatment

Although modelling results did not predict the need for active water treatment during closure, the period when vegetation is re-establishing on the site and tertiary water treatment systems are stabilizing may include elevated contaminant loads and necessitate the use of active water treatment. If active water treatment is necessary it is expected to be required during the transition between operations and closure. The existing water treatment facility located in the Mill Complex will be used to achieve water treatment requirements.

2.5 Project Scope

Capstone is proposing the expansion of mining activities at their existing Minto Mine (copper/gold mine) in central Yukon. Minto Explorations Ltd. (a wholly owned subsidiary of Capstone) operates the Minto Mine, located approximately 41 km southwest of Pelly Crossing on the west side of the Yukon River. Minto Explorations Ltd. is currently permitted to operate under Quartz Mining Licence (QML-0001) and Type A Water Licence (QZ96-006) to conduct both open pit and underground mining and associated processing. The Phase V/VI expansion will require amendments to their existing licences and will increase the surface mining life to mid-2017 and underground mining to late-2019. Milling will continue to mid-2022. Reclamation and closure activities are proposed to be complete by the end of 2023 with post-closure monitoring beginning in 2024.

Project Activities (see project proposal for a complete description of project activities)

- Mining of three new open pits and the expansion of one existing open pit, including an expanded network of site access and haul roads to accommodate the mining activities
- Expansion of underground mining to include two additional reserves and two new portals and associated infrastructure
- Expansion and modification of waste rock dumps to increase existing dump sites and establish new dump sites
- Expansion and modification of slurry tailings storage facility including a new tailings storage dam to increase storage capacity in the Main Pit
- Changes to water management including new conveyance structures and new water quality standards for certain contaminants
- Progressive reclamation following completion of mine components
- Final reclamation and closure following completion of Phase V/VI mining and milling

3.0 ENVIRONMENTAL AND SOCIO-ECONOMIC SETTING

The following sections provide brief summaries of the environmental and socio-economic conditions of the Project area. These summaries are largely sourced from material submitted by the Proponent, which includes a comprehensive collection of data, reports and studies. For a detailed account of any particular environmental and/or socio-economic aspect, the reader is encouraged to visit the Project file on the YOR. To ease navigation of the proposal documents, the Proponent has provided a Table of Contents document that includes a listing of proposal sections as well as associated appendices.[6]

3.1 Physical Environment

The Minto Mine is located on the west side of the Yukon River within Selkirk First Nation Category A Settlement Land Parcel R-6A, approximately 240 km northwest of Whitehorse and 41 km southwest of Pelly Crossing. Highway 2 (North Klondike Highway) is located on the east side of the Yukon River. The mine can be accessed in the summer by barge crossing or in winter by the ice bridge crossing at Minto Landing.

The mine property lies in the eastern portion of the Dawson Range, which is part of the Klondike Plateau Physiographic Region, an uplifted surface that has been dissected by erosion. The area was largely unglaciated during the last ice age and topography consists of deep and narrow valleys, rounded rolling hills, and ridges with relief of up to 600 m. Elevations within the property range between 460 and 975 m above sea level.

The mine is located in a subarctic climate and estimated mean annual precipitation (rainfall and snowfall) is 329 mm. Mean annual temperature in the area is -2° C (winter temperatures range between -10 to -30° C and summer temperatures range between 10 - 20° C).

[6] YOR 2013-0100-004-1

3.1.1 Geology

The Minto property is located in the north-northwest trending Carmacks Copper Belt, located along the eastern margin of the Yukon-Tanana Composite Terrain, which is comprised of several metamorphic assemblages of batholiths. The Minto property and surrounding area is underlain by plutonic rocks of the Granite Mountain Batholith that have intruded into the Yukon-Tanana Composite Terrain. These plutonic rocks vary from quartz diorite and granodiorite to quartz manzonite.[7]

The deposits are hypogene sulphide mineralization consisting of chalcopyrite, bornite, euhedral chalcocite, and minor pyrite. Testing also indicated the presence of covellite, although this species has never been positively logged macroscopically. The host rock to the Minto deposits are moderately oxidized magma with widespread iron oxide (magnetite and Hematite) mineralization. There are very strong structural controls on ore mineral emplacement and there is no apparent genetic link to a specific phase of intrusion.[8]

There is very little exposure of the Minto deposits or the rock surrounding those deposits. Because the Minto property was not glaciated during the last ice age event, any exposed sections of the deposits and surrounding rock have experienced deep weathering and oxidation.[9] The deep weathering and oxidation of surface materials at this site is an important factor in understanding how these materials will react once disturbed.

3.1.2 Minto Creek

3.1.2.1 Surface Water Hydrology

Minto Creek is approximately 17 km in length and is composed of two distinct reaches divided by a steep canyon. The canyon has a grade of 21% and is situated approximately 1.5 km upstream of the confluence with the Yukon River. Minto Creek is between 2 to 3 meters in width and approximately 0.5 to 1.5 meters in depth during medium flow conditions. The creek is generally deeper and wider near the confluence with the Yukon River with a grade of 1.5 to 2%, which increases to 6% at the base of the canyon. The mouth of Minto Creek at the confluence with the Yukon River has a silt and sand substrate. Minto Creek has peak flows during spring freshet and low flows in the summer. The creek freezes to the bottom in the winter. Minto Creek is responsive to precipitation events that result in high flood conditions during heavy rainfall events. On occasion, surface flow in the lower reach is interrupted during low flow conditions.

For the purpose of water management, Minto Creek is divided into two distinct watersheds. Upper Minto, which includes the Minto Creek headwaters and the mining operation, is approximately 1,000 hectares (ha). All surface water that collects in Upper Minto currently reports to the water storage pond (WSP) prior to discharge into Lower Minto. Lower Minto includes the main stem of Minto Creek and its tributaries from the outflow of the WSP to the confluence with the Yukon River. It also includes the downstream section of the upper reach and canyon described above. Lower Minto is approximately 3,000 ha or 75% of the Minto Creek drainage area.

[7] YOR 2013-0100-072-1
[8] *Ibid*
[9] *Ibid*

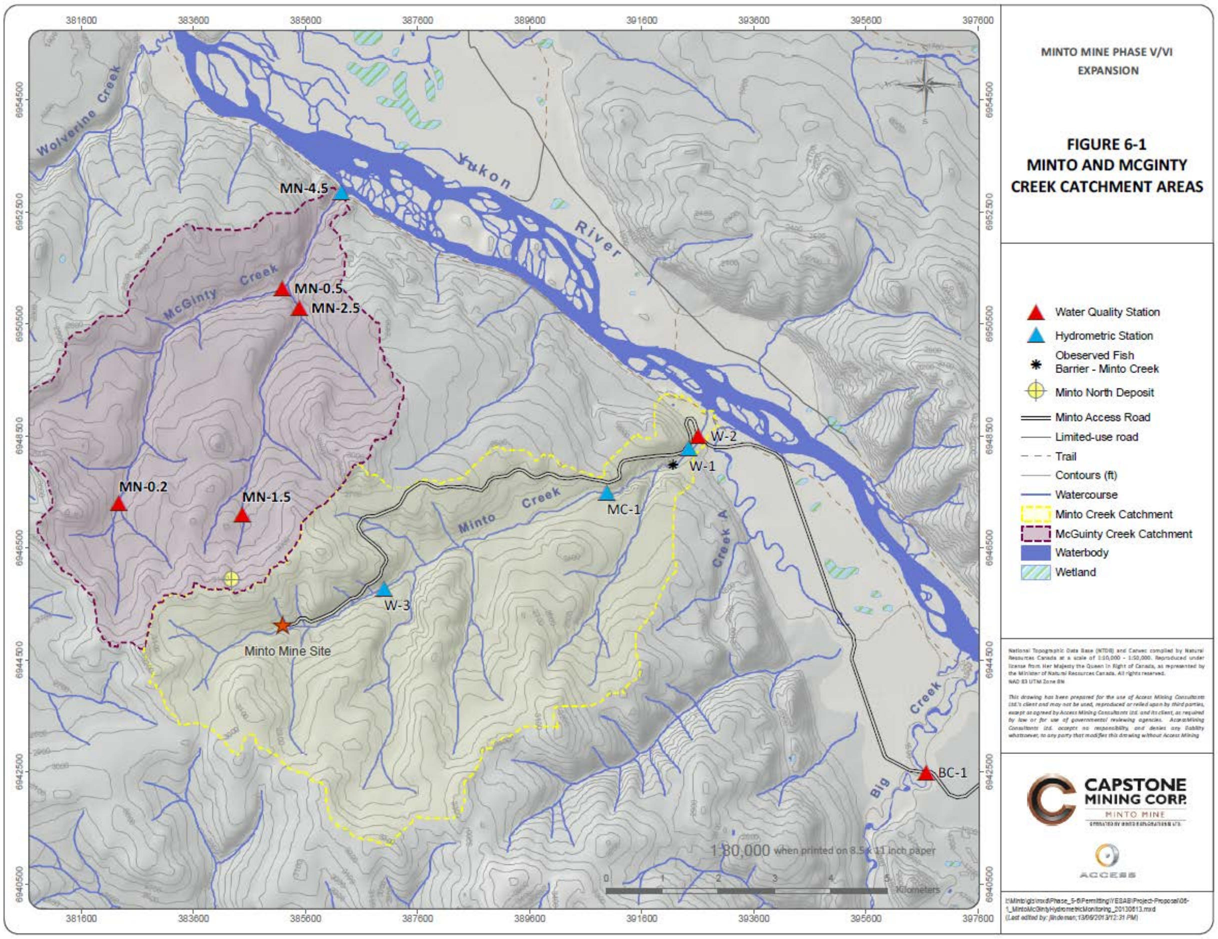


Figure 5: Proponent map showing Minto and McGinty Creek catchment areas along with key water sampling stations. Sourced from YOR 2013-0100-010-1.

Table 5: Mean Monthly Discharge (m3/s) on Minto Creek at Station W1.[10]

Mean	April	May	June	July	August	September	October
Pre-mine 1993 to 2006	-[4]	0.433	0.049	0.129	0.093	0.128	0.083
Mining period 2007 to 2012	-[4]	0.283	0.126	0.115	0.119	0.088	0.055
All data 1993 to 2012	-[4]	0.380	0.091	0.122	0.105	0.106	0.064

Table 6: Mean Monthly Discharge (m3/s) on Minto Creek at Station W3.[11]

Mean	April	May	June	July	August	September	October
Pre-mine 1993 to 2006	-[4]	0.167	0.02	0.032	0.015	0.023	0.013
Mining period 2007 to 2012	-[4]	0.012	0.010	0.031	0.047	0.068	0.047
All data 1993 to 2012	-[4]	0.115	0.014	0.031	0.030	0.043	0.032

[1]Monthly flows calculated by averaging all available flow data for a given month. Average flow in months with only a single spot flow measurement assumed equal to the spot flow measurement.

[2]Flows impacted by storage within and emergency releases from the Water Storage Pond in August and September 2008 and in June through October 2009.

[3]2010-2012 flows impacted by storage and/or release from the Water Storage Pond as evidenced by the discharge record at W3.
[4]Insufficient data for calculation.

3.1.2.2 Surface water quality

Minto Creek catchment water quality analyses are divided into three phases:

- Pre-mine operation:
  - January 2005 to March 31, 2006;
- Operational phase with no mine discharge to Minto Creek:
  - April 1, 2006 to August 25, 2008;
  - October 1, 2008 to June 25, 2009;
  - August 7 to August 12, 2009;
  - October 31, 2009 to July 13, 2010;
  - October 28, 2010 to April 15, 2012;
- Operational phase with mine discharge to Minto Creek:
  - August 26 to September 30, 2008;
  - June 26 to August 6, 2009;
  - August 13 to October 30, 2009;
  - July 14 to October 27, 2010;
  - April 16 to May 11, 2012.

[10] YOR 2013-0100-010-1
[11] *Ibid*

- May 12 to December 31, 2012.[12]

Parameters examined include aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, molybdenum, nickel, selenium, silver, thallium, zinc, pH, nitrate, nitrite, ammonia, fluoride, and phosphorus (phosphorus analysis as part of metals analysis). Total suspended solids (TSS) and total dissolved solids (TDS) concentrations have also been considered.[13] Generally speaking, during the pre-mine operation phase, aluminum, cadmium, chromium, copper and iron showed exceedances of the Canadian Water Quality Guidelines (CWQGs) associated with natural mineralization and/or elevated TSS concentrations.[14]

TSS levels in lower Minto Creek increased at stations MC1 and W2 in 2011 due to slumping in a tributary downstream of the mine. This increase in TSS had a leveraging effect upon metal concentrations, which have also been observed to increase in the lower stations of Minto Creek. In order to account for these loadings in water quality model predictions, the Proponent applied the background data set developed in 2012 to catchments in lower Minto Creek while the data set developed in 2009 was used to represent background conditions in Upper Minto Creek.[15]

The dataset for the operations with no discharge phase also shows exceedances of the CWQGs for the same parameters as during pre-operations: aluminum, cadmium, chromium, copper, and iron.[16]

During the operations phase with mine discharge, average parameter concentrations were found to exceed the CWQG for aluminum (89%), copper (95%), iron (22%), mercury (55%), selenium (86%), fluoride (100%), nitrite (81%), and nitrate (82%). Exceedances at W3 for average concentrations of parameters compared to W2 limits, during operations with mine discharge, include cadmium (37%), copper (29%), selenium (86%), nitrite (81%), nitrate (82%), and phosphorus (87%).[17]

At station W2, the following observations are made of the water quality between the discharge and non-discharge phases, as compared to the W2 non-freshet water licence limits:

- Exceedances of the aluminum limit are highest during the operations with no discharge phase; in particular, the limit was exceeded more often than not during 2011 and 2012.
- Cadmium exceedances at W2 compared to the non-freshet limit are higher during mine discharge periods.
- Copper exceedances at W2 compared to the non-freshet limit appear to remain the same between the discharge and non-discharge periods.
- Frequency of iron exceedances is highest during the non-discharge periods.
- Selenium and nitrate frequency of exceedance is substantially higher during periods of mine discharge.

[12] YOR 2013-0100-031-1
[13] *Ibid*
[14] YOR 2013-0100-010-1
[15] YOR 2013-0100-046-1
[16] YOR 2013-0100-010-1
[17] YOR 2013-0100-031-1

- The total phosphorus limit is exceeded for most of the samples.[18]

The Proponent's water quality predictions anticipate that some metals, metalloids, and nutrients may become elevated in Minto Creek due to mine effluent discharge during Phase V/VI operational and closure conditions. The scenarios modeled include the expected case typical and upper limits as well as the reasonable worst-case typical and upper limits, for both the operational and post closure periods. The parameters of concern under one or more scenarios include nitrogen compounds (nitrite, nitrate, and ammonia), selenium, copper, cadmium and fluoride.[19]

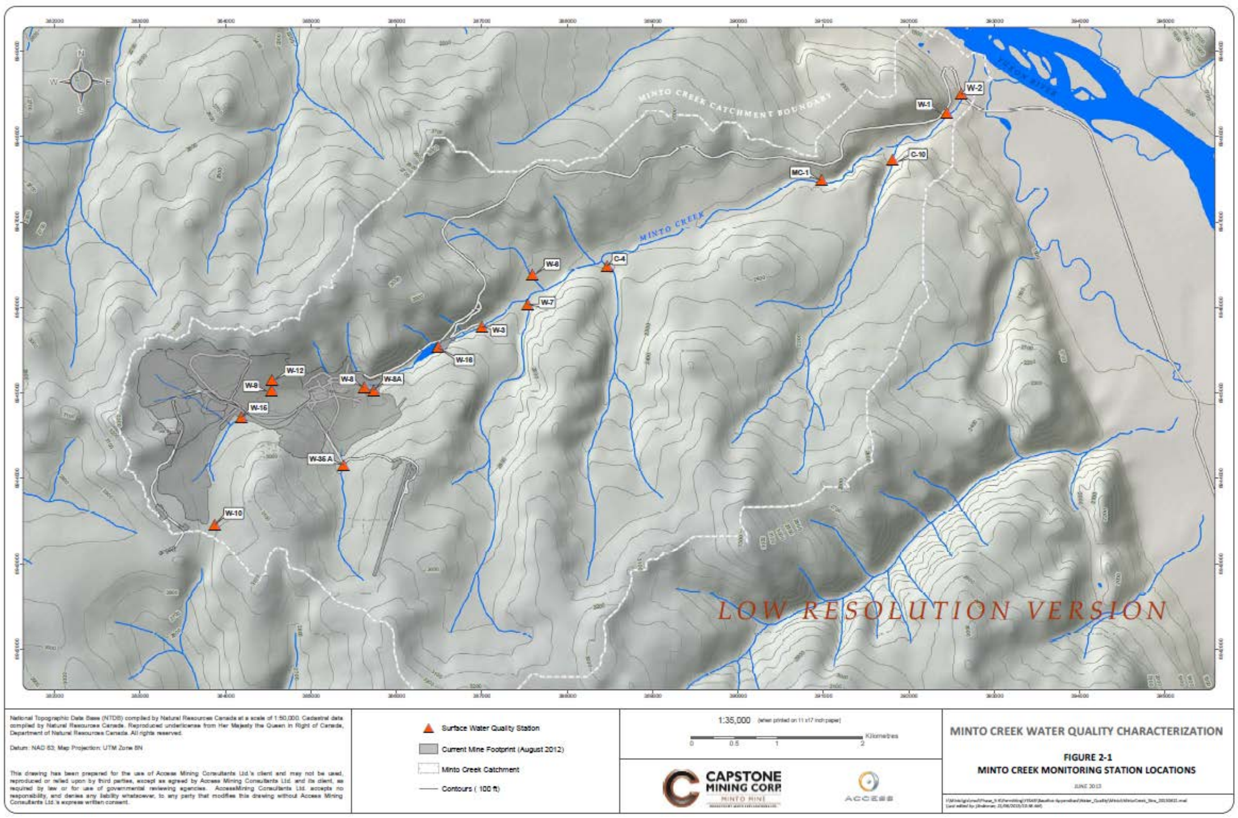


Figure 6: Proponent map showing Minto Creek catchment area and water sampling stations. Sourced from YOR 2013-0100-031-1.

Taking into account water quality data during Minto Mine operations, concentrations of aluminum, cadmium, chromium, copper, iron, molybdenum, lead, selenium, zinc, nitrite and nitrate at the receiving environment station (W2) in Lower Minto Creek have generally increased between pre-operation and operation periods, and between operation periods with no discharge to operation periods with discharge.20 This is concurrent with higher concentrations of these same parameters measured in

[18] YOR 2013-0100-010-1
[19] YOR 2013-0100-011-1
[20] YOR 2010-0198-075-1

effluent (W3), and demonstrates the effect of mine operations on water quality within the receiving environment.[21]

3.1.2.3 Sediments

Baseline sediments were characterized in 1994 (Table 6), and have been sampled annually since 2006. Sample locations included two sites exposed to mine effluent in Minto Creek (W2 and W3) as well as two reference sites. Prior to the commencement of mine operations, sediments in Minto creek were composed mostly of sand, with some gravel and minimal fractions of silt and clay.

Results from sampling show that concentrations of arsenic, copper and occasionally chromium exceeded the interim sediment quality guideline (ISQG) levels over the years, but not greater than the probable effect level (PEL).[22] Copper was the only metal to exceed guideline levels every year, including during baseline sampling in 1994. Arsenic was above the ISQG in most sampling years, except during baseline sampling, 2007 and 2009.

[21] YOR 2010-0198-139-1
[22] Probable effect level defines the level above which adverse effects are expected to occur frequently ((CCME 2001).

Table 7: Baseline Stream Sediment Results[23]

Analysis	Guideline Levels		Sampling Location			
	ISQG	PEL	S1 (W9) Average	S2 (W3) Average	S3 (~100m d/s W6) Average	S4 (W2) Average
Physical Tests:						
Moisture %	-	-	25.2	21.7	24.1	18.5
Total Metals*:						
Antimony	-	-	0.36	0.42	0.44	0.29
Arsenic	5.9	17	4.1	4.4	4.2	4.4
Cadmium	0.6	3.5	0.07	0.13	< 0.10	< 0.10
Chromium	-	-	17.2	22.1	23.3	14.0
Copper	35.7	197	103	48	40	14
Lead	35	91.3	3.4	3.9	3.8	1.6
Mercury	0.17	0.486	0.02	0.01	0.01	0.01
Molybdenum	-	-	< 4.0	< 4.0	< 4.0	< 4.0
Silver	-	-	< 2.0	< 2.0	< 2.0	< 2.0
Zinc	123	315	35.7	47.8	48.5	29.4
Particle Size:						
Gravel – % (>2.00 mm)	-	-	9.2	4.9	1.8	28.8
Sand – % (2.00 – 0.063 mm)	-	-	72.2	75.2	77.9	62.6
Silt – % (0.063 mm – 4 µm)	-	-	14.1	13.9	14.1	6.6
Clay – % (<4 µm)	-	-	4.6	6.0	6.3	1.9

*Note: *Results are expressed as milligram per dry kilogram*
Adapted from Table 5.9 in HKP 1994

3.1.2.4 Groundwater

The conceptual model suggests that the overall groundwater flow generally follows site topography, with all groundwater in the Minto Creek basin reporting to a central point near the WSP (Figure 7). Shallow groundwater is reportedly controlled by permafrost, with groundwater surfacing up-gradient from the WSP. Similarly, the model suggests that deeper groundwater flow will not be highly influenced by the mine components due to the confining actions of the permafrost.

The implications of the geology (overburden, lithology, and permafrost conditions) found at the Minto site and the past monitoring events are:

Permafrost:

- Will dominate groundwater flow system below active zone to depths of up to 45 m; and
- Conventional “standpipe” monitoring wells installed through the permafrost into the underlying unfrozen ground will be inoperable as the piezometric levels will be near surface; therefore, the resulting water in them will freeze.

[23] YOR 2013-0100-050-1

Shallow flow:

- will be dominated by permafrost conditions;
- will occur in the seasonally thawed layer; and
- will be controlled by overburden composition in the unfrozen areas.

Deeper flow:

- will occur below the permafrost within the bedrock;
- will concentrate in the shallow, weathered zone if unfrozen; and
- standpipe monitoring wells will not be an effective means of monitoring the deep groundwater system.[24]

Groundwater quality sampling indicates that the baseline groundwater chemistry is not significantly different than the baseline surface water chemistry on the site.[25] Generally, baseline groundwater quality is consistent in quality throughout the site and similar to the surface water quality mean annual concentrations.

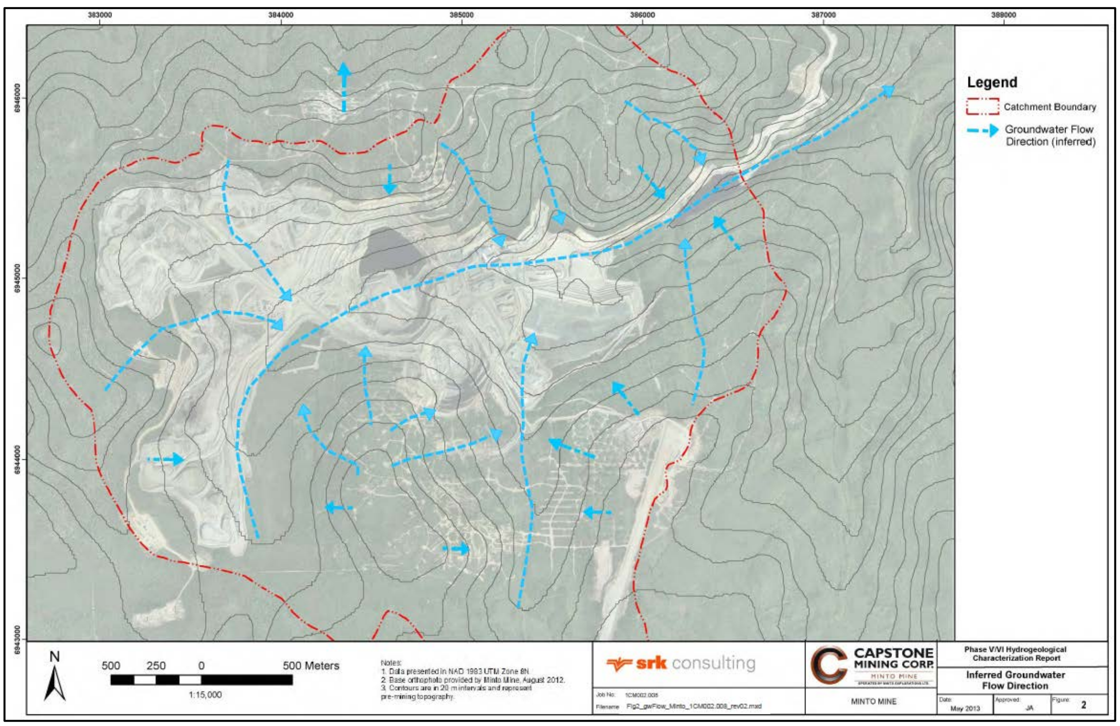


Figure 7: Inferred groundwater flow directions. Sourced from YOR 2013-0100-034-1.

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24 YOR 2013-0100-033-1
25 *Ibid*

3.1.2.5 Permafrost conditions

Figure 8 shows the current understanding of the spatial distribution of permafrost within the Minto Creek watershed. Data from drilling at several locations has shown permafrost ranging from within 1 m of ground surface to depths of up to 10 m.[26]

> Permafrost plays a significant role in the groundwater flow system on the site as it forms a confining layer (or aquiclude) for flow below the frozen ground and inhibits infiltration from the overlying active layer. The lack of permafrost in the bed and adjacent areas of Minto Creek indicates that groundwater and surface water can interact along the axis of the creek and that by-pass of surface and/or shallow groundwater monitoring points below a permafrost layer is unlikely.[27]

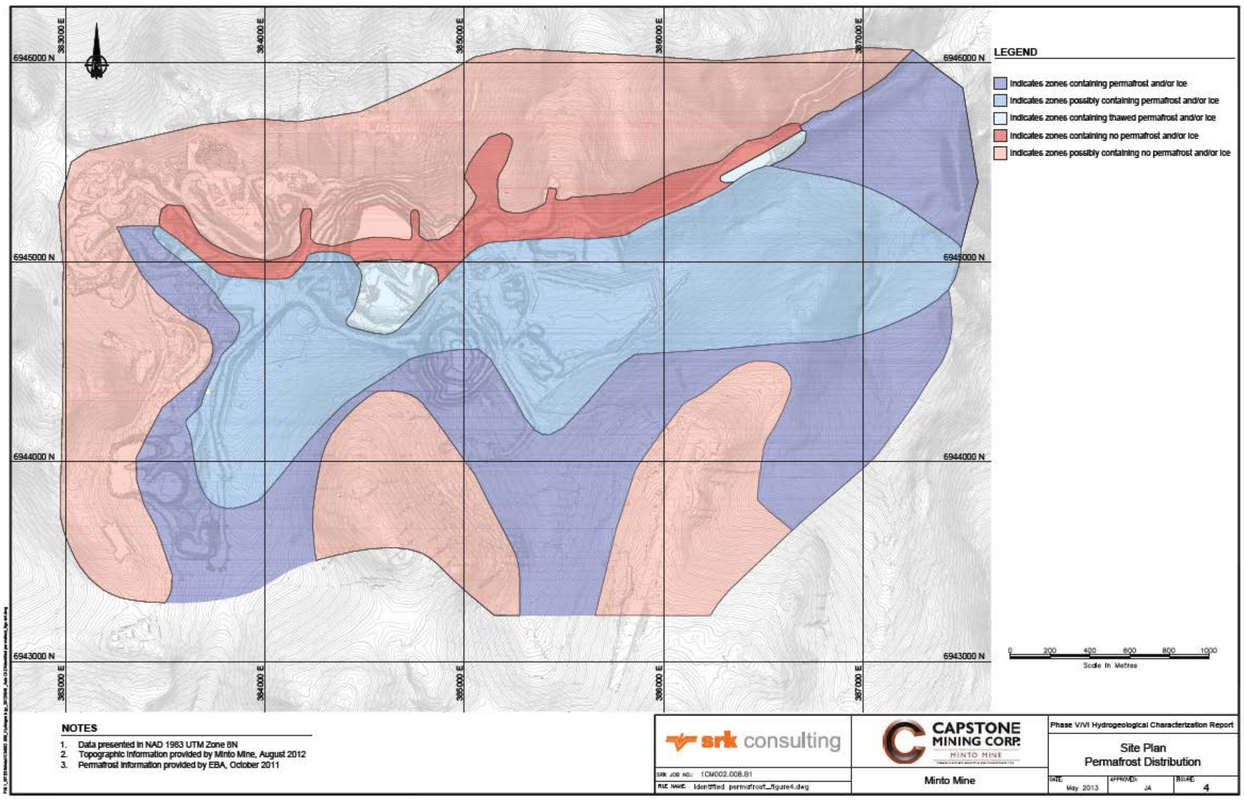

Figure 8: Extent of permafrost at the Minto Mine-site. Sourced from YOR 2013-0100-034-1.

3.1.3 2.1.3 McGinty Creek

Compared to the amount of baseline information for aquatic resources for Minto Creek, there is a relative lack of the same type of information for McGinty Creek. The Designated Office acknowledges that this is

[26] YOR 2013-0100-033-1
[27] YOR 2013-0100-022-1

a result of development focused in the Minto Creek drainage to date and that, as the Project progresses, further detailed information for McGinty Creek will be collected. Nevertheless, a lack of baseline data for hydrology, permafrost and hydrogeology presents challenges in developing appropriate and realistic baseline conditions.

3.1.3.1 Surface Water Hydrology

McGinty Creek is located to the north of Minto Creek and flows north-northeast nearly 9.5 km to the Yukon River confluence, and includes a catchment area of approximately 34 km^2. The average wetted width ranges from 2 – 2.5 m and the gradient ranges from 3 – 4.5 %.[28]

Table 8: Mean Monthly Discharge (m3/s) Calculated from Continuous Discharge Records on McGinty Creek, at Station MN-4.5.[29]

	Month						
	April	May	June	July	August	September	October
2009		0.018	0.033	0.019	0.031	0.016	0.013
2010		0.028	0.051	0.079	0.047	0.034	
2011		0.482	0.096	0.13	0.138	0.068	
2012	0.224	0.245	0.189	0.082	0.052	0.173	
Mean	0.224	0.193	0.092	0.077	0.067	0.073	0.013

Grey values computed with partial data

3.1.3.2 Surface water quality

Water quality data for McGinty Creek has been collected since May 2009. Parameters reviewed include the total metals aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, molybdenum, nickel, selenium, silver, thallium, zinc, pH, nitrate, nitrite, ammonia and fluoride. TSS concentrations and the relationship with parameters of were also considered.[30]

Baseline water quality sampling showed regular exceedances of the CWQG's for total aluminum, cadmium, chromium, copper, iron, lead, zinc and fluoride. Parameters that have infrequently exceeded the CWQG include arsenic, mercury, silver, ammonia and pH. Many parameters show spikes in concentrations in the summers of 2010 (August), 2011 (July) and 2012 (June). These spikes in parameters correspond to spikes in TSS associated with heavy precipitation events.[31]

[28] YOR 2013-0100-050-1
[29] YOR 2013-0100-010-1
[30] YOR 2013-0100-032-1
[31] YOR 2013-0100-010-1

Table 9: Water Quality Modelling Results for McGinty Creek at Mouth[32]

Parameter*/ Unit		Baseline Conditions		After Mining at Minto North	
				Worst Case	
		Average	Max	Average	Max
Ammonia	mg/L	0.0355	0.27	not predicted- expect no change	
F	mg/L	0.20	0.43	0.23	0.43
$N\text{-}NO_2$	mg/L	0.0064	0.025	not predicted- expect no change	
$N\text{-}NO_3$	mg/L	0.073	0.3	not predicted- expect no change	
Sulphate	mg/L	3.1	9.1	3.2	9.1
Al	mg/L	0.55	3.3	0.55	3.3
As	mg/L	0.00062	0.0022	0.00065	0.0022
Cd	mg/L	0.000031	0.000095	0.000032	0.000095
Cr	mg/L	0.0011	0.0063	0.0012	0.0063
Cu	mg/L	0.0035	0.012	0.0036	0.012
Fe	mg/L	1.0	5.4	1.00	5.4
Pb	mg/L	0.00043	0.0021	0.00044	0.0021
Mn	mg/L	0.052	0.20	0.053	0.20
Hg	mg/L	0.0000042	0.000012	0.0000047	0.000012
Mo	mg/L	0.00069	0.0016	0.00085	0.0016
Ni	mg/L	0.0021	0.0074	0.0021	0.0074
Se	mg/L	0.00014	0.00031	0.00015	0.00031
Ag	mg/L	0.0000073	0.000029	0.0000084	0.000029
Tl	mg/L	0.0000049	0.000026	0.0000054	0.000026
Zn	mg/L	0.0067	0.033	0.0067	0.033

Source: Source: \\VAN-SVR0\Projects\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\01_Project_Phases\07_Phase_5_6\Results\Minto_North\[1CM002-003_MintoNorth_WQ_Prediction_2013-06-26.xlsx]
*: all concentrations are total concentrations

3.1.3.3 Sediments

In 2010 to 2012, 'Reference 1' monitoring site (W6) was changed to upper McGinty Creek. Results from sampling showed elevated levels of copper and arsenic (including exceedances of ISCGs), although not above PEL.[33]

[32] YOR 2013-0100-049-1

3.1.3.4 Groundwater

Currently, there is only one groundwater monitoring well in the McGinty Creek watershed (MW09-03), which was installed in 2009. MW09-03 was installed just outside the footprint of the proposed Minto North pit to a depth of approximately 50 m. The well drill log for MW09-03 showed no permafrost in the core.[34] The Proponent expects that, similar to the Minto Creek catchment, topography within the McGinty Creek catchment will control groundwater flow. However, there is limited groundwater quality information reported for McGinty Creek to verify this assumption.

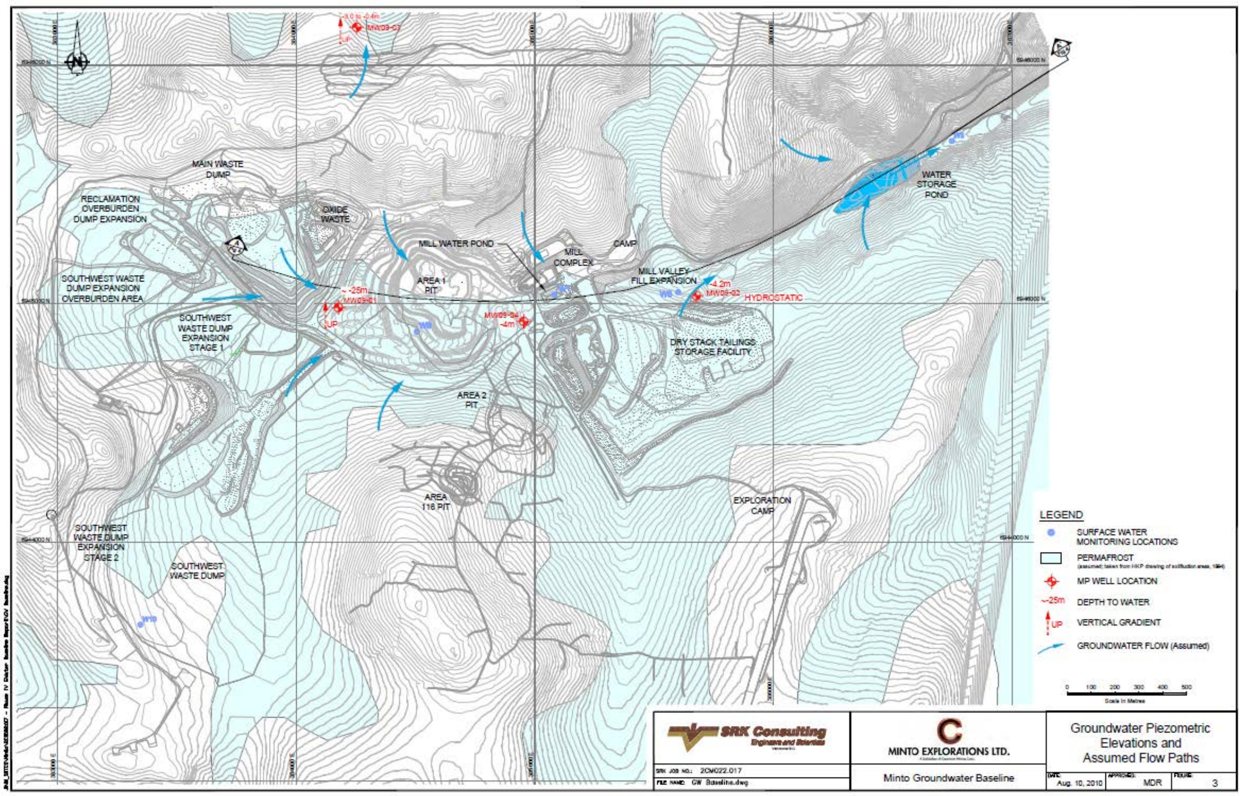

Figure 9: Groundwater piezometric elevations and assumed flow paths. Sourced from YOR 2013-0100-033-1.

3.1.3.5 Permafrost conditions

Due to McGinty Creek's close proximity, the watershed likely has a similar permafrost regime as the Minto Creek watershed. However, the proposal contains limited information on the extent and/or distribution of permafrost in the watershed. The well log for GW09-03 (situated on the northern rim of the proposed Minto North pit) showed no permafrost in the core (well constructed to an approximate depth of 50 m).[35]

[33] YOR 2013-0100-050-1
[34] YOR 2013-0100-033-1
[35] *Ibid*

3.2 Biological Environment

3.2.1 Aquatic biology

3.2.1.1 Fish and fish habitat

Minto Creek

Minto Creek discharges into the Yukon River, which is a major drainage for much of the Yukon Territory, originating in south central Yukon and flowing to the northwest to Alaska. Previous studies on the Yukon River within the vicinity of the Minto Mine have identified both spawning and rearing areas for salmon. Spawning shoals are present in the Ingersoll Islands (downstream of the project area) as well as around islands upstream of Minto Creek, near Big Creek. These offer an extensive network of side channels and sloughs that provide good spawning gravel. Fish species present in the Yukon River include chinook, coho, and chum salmon, rainbow trout, lake trout, least cisco, bering cisco, round whitefish, lake whitefish, inconnu, arctic grayling, northern pike, burbot, longnose sucker and slimy sculpin.

In terms of fish habitat, Minto Creek is a small erosional creek, with no natural upstream water storage. A natural fish barrier (i.e. steep canyon) is located about 1.2 km upstream from the Yukon River; no fish samples have been obtained upstream of the barrier during any sampling event. The silt and sand substrate that characterizes the creek mouth area is not suitable spawning habitat for Chinook salmon. The creek freezes to ground during the winter and therefore does not provide over-wintering habitat or viable spawning habitat for fall spawning species. Water temperature and high flows in Minto Creek are potential limitations to fish use during the spring season.

Baseline fish studies were conducted in 1994 and annually since 2006. Species captured include slimy sculpin, arctic grayling, round whitefish, burbot and Chinook salmon. Chinook salmon, though only in the young of year and juvenile life stages, is the most dominant species observed in Minto Creek. Generally, fish are present in low numbers in Minto Creek and were only captured during sampling later than June and mid-July. Flows within the Minto Creek are variable on a yearly basis, with intermittent flows an extensive ice build-up during winter that limits the potential for overwintering habitat for fish.[36]

> During the summer of 2009, there was a marked increase in Chinook salmon captures which coincided with an emergency release of water from the Minto Mine tailings dam (catch per unit effort (CPUE) of at least three times the previous highest catch records). Similarly, high numbers of JCS were captured in 2010, when the mine was discharging water into Minto Creek. It is believed that the stable, elevated flow and warmer, more consistent temperature regime (i.e. a narrower diurnal temperature fluctuation) associated with the release may have attracted JCS into the system from the Yukon River.[37]

The Proponent's Environmental Effects Monitoring (EEM) for Minto Creek consists of an integrated assessment of effluent sub-lethal toxicity, water quality, benthic invertebrate community condition and fish health. Overall, the Cycle 2 EEM (2009-2011) documented an influence of the mine on the water quality

[36] YOR 2013-0100-050-1
[37] *Ibid*

of Minto Creek even in the absence of discharge. However, mine effluent did not cause any sub-lethal toxicity.[38]

McGinty Creek

McGinty Creek's gradient, discharge volume, depth, configuration and absence of an upstream reservoir limit its wintering habitat potential. Similar to Minto Creek, it experiences minimal to no flows during the winter.[39]

Arctic grayling and slimy sculpin were captured in McGinty Creek during baseline studies in 1994 (electrofishing and minnow trapping). However, due to substantial deadfall caused by a forest fire changed creek conditions, only minnow trapping was used in 2009–2011, which yielded very low numbers of slimy sculpin. 2009-2011 results were similar to those in 1994, whereby fish were only captured in close proximity to the Yukon River confluence.[40]

3.2.1.2 Benthic community

Minto Creek

Baseline sampling was undertaken in Minto Creek in 1994, and follow-up studies as required by the Proponent's WUL and the Metal Mining Effluent Regulations (MMER) EEM program were conducted in Minto Creek annually from 2006 through 2012 (except 2009).

The results from these surveys show that lower Minto Creek supports a healthy erosional benthic invertebrate community, with a greater taxon richness/diversity and a lower dominance by chironomids when compared to Wolverine Creek (control site). In general, the EEM results indicate that Minto Creek supports a healthy benthic community, which doesn't seem to have been significantly affected by the mine activities to date.41

McGinty Creek

Results from EEM in McGinty Creek revealed a significantly lower number of taxa, Bray-Curtis Index and proportion of chironomids (midges), and significantly higher Simpson's Evenness and proportion of EPT taxa (mayflies, stoneflies and caddisflies), compared to Minto Creek.

> This appeared to be caused, at least partly, by colder water temperatures compared to Minto Creek. Water temperature data collected at station MN-4.5 between 2009 and 2012 indeed show that the mean monthly water temperature in McGinty Creek is on average 2.0°C colder than in lower Minto Creek (for periods of non-discharge of mine water) during the summer period (June–September, inclusive.).[42]

[38] YOR 2013-0100-017-1
[39] YOR 2013-0100-008-1
[40] YOR 2013-0100-050-1
[41] YOR 2013-0100-008-1
[42] *Ibid*

3.2.1.3 Periphyton

Minto Creek

Periphyton is the assemblage of algae, bacteria, fungi, and meiofauna attached to submerged substrate in freshwaters. Based on sampling events in 1994, 2011 and 2012, the periphyton community of lower Minto Creek relative to lower Wolverine Creek had lower density and taxon richness.[43] Periphyton communities of lower Minto Creek and lower Wolverine Creek in 2011 both differed from the community documented at lower Minto Creek in 1994.

> Concentration of chlorophyll a was lower at lower Minto Creek than at lower Wolverine Creek but the difference was not statistically significant…The production of both creeks could be considered low (oligotrophic)… This differs from the classification based on only total phosphorus which would define both areas as mesotrophic. The lower concentrations of chlorophyll a despite relatively high phosphorus may be due to environmental factors associated with a northern system such as low water temperatures and a short growing season.[44]

McGinty Creek

The proposal did not include any information pertaining to periphyton sampling events or results for McGinty Creek.[45]

3.2.2 Wildlife

The diversity of vegetative communities and successional stages around the Minto Mine provides a variety of habitat niches that support approximately 46 species of mammal (insectivores, bats, lagomorphs, rodents, carnivores, and ungulates), 60 species of birds, and one species of amphibian, the wood frog (*Rana sylvatica*). Different species utilize the project area at different times of the year, some year-round and others seasonally.

Baseline wildlife conditions for the Minto Mine area were collected in 1994 and several studies and surveys have been conducted in the area since that time (Table 9). The following sections provide brief summaries of identified key species and their presence in the project area.

[43] YOR 2013-0100-008-1
[44] YOR 2013-0100-052-1
[45] YOR 2013-0100-052-1

Table 10: Wildlife Surveys and Studies Undertaken in the Minto Project Area. Sourced from YOR 2013-0100-056-1.

Dates	Type of Survey	Conducted By
Jan-March 2012	Late Winter Ungulate Studies	Environmental Dynamics Inc (EDI), Environment Yukon
Fall 2012	Klaza Caribou Herd Study	Environment Yukon
March 2011	Late Winter Ungulate Study	Environment Yukon and EDI (on behalf of Casino Mining Corporation)
July 2010	Baseline Ecosystems and Vegetation Report	Access Consulting Group
February 2010	Late Winter Moose Survey (Aerial)	Access Consulting Group
December 2009	Post-rut Moose Survey (Aerial)	Access Consulting Group
June 2009	Dall Sheep Survey (Aerial)	Environment Yukon
2007	Moose Survey	Environment Yukon
2003	Klaza Caribou Herd Survey	Environment Yukon
1994	Spring Wildlife Survey Spring Dall Sheep Survey Summer Raptor Survey Summer Wildlife Ground Pellet Survey	Hallam Knight Piesold Ltd.

3.2.2.1 Moose

Although the project area does not provide key moose habitat, such as late winter range, moose do use the surrounding areas at all times of the year. Areas downstream of the Minto Creek confluence with the Yukon River are known to be spring calving grounds and are used for rearing during the summer months; moose also use the Yukon River banks and wetland areas in these areas. The Minto Creek valley burn provides good summer and winter habitat and moose and signs of moose have been observed in the upper Minto Creek watershed.

The frequent and often large fires that have occurred around the Minto Mine have created prime habitat for moose. The numerous moose sightings and sign found in the area indicate that it is attractive and well-used by resident moose. Local aerial surveys completed in early and late winter in 2009 and 2010 respectively, indicates that the population is below territorial average and recruitment may be low. However, the population has increased since the initial local survey was done in 1994. Then, the population was estimated at 40 moose per 1,000 km^2 during a government-supported count, which is considered below average. Winter surveys in 2007 indicated a population of 125 per 1,000 km2.[46] The Proponent noted that recent aerial surveys were conducted in 2011 and 2012, although at the time of project submission, results were not yet available.

3.2.2.2 Caribou

Caribou have not been recorded to occur in the immediate Project area, but key winter range habitat has been identified for the Klaza herd in the headwaters of Big Creek, approximately 15 km west of the Project. The Klaza caribou herd, a woodland caribou herd protected under the *Species at Risk Act*

[46] YOR 2013-0100-056-1

(SARA) as a species of special concern (Environment Canada 2012), has range approximately 15 km to the west of the Project. The Klaza caribou herd was last surveyed in 2012, and is estimated at 1,180 caribou with an increasing population trend (Yukon Government 2012). A review of habitat maps reveals that the herd‘s range does not overlap with the Minto Project.

The Tatchun Caribou Herd, also a woodland caribou protected under SARA, has key winter range east of the Yukon River, approximately 16 km from the Project area. The herd was last surveyed in 2000 with an estimated population of 500.[47]

3.2.2.3 Thinhorn Sheep

Dall’s sheep are known to inhabit the general project area, particularly the Minto Bluffs along the east side of Yukon River. However, although the access road to the Minto Mine passes near sheep habitat, the project area itself hosts limited habitat, and sheep are not expected to occur in the Project area for any extended length of time.[48]

3.2.2.4 Bears

Both black bears and grizzly bears are present at times within the Project area. Sightings and tracks were documented in a 2010 baseline report and sightings by mine personnel have also been recorded. Although the Project area does not contain any identified key habitat, both species have been observed on site on many occasions.

The Project has measures in place to manage wildlife attractants on site in order to reduce conflicts. Although these measures have been successful for the most part, there were four bear fatalities reported (1 in 2010 and 3 in 2011).

3.2.2.5 Birds

Several species of birds are found in the area including grouse, ptarmigan, numerous songbirds and migratory waterfowl. Although raptors such as nighthawk and red-tailed hawk have been noted at the mine-site, the Minto Mine site does not provide key habitat for these birds. The Yukon River main valley provides exceptional riparian cliff habitat for birds of prey. Key breeding habitat for peregrine falcons is located approximately 3 km north of the Project along the Yukon River corridor.

Migratory bird species, designated as threatened and protected under the *Migratory Birds Convention Act* (MCBA) that may be expected in the project area include:

- Common Nighthawk and Olive-sided Flycatcher (Threatened);
- Peregrine Falcon (*anatum/tundrius*), Short-eared Owl and Rusty Blackbird (Special Concern: Species at Risk Public Registry 2012); and
- Barn Swallow has been recommended as Threatened, and Horned Grebe (western population) has been recommended as Special Concern by the Committee on the Status of Endangered Wildlife in

[47] *Ibid*
[48] YOR 2013-0100-056-1

Canada (COSEWIC 2012), but they have not yet been listed under SARA (Environment Canada 2013).

Seasonally, the project area may be used during migration and breeding seasons. Several species—Canada goose, mallard duck, pintail duck, green-winged teal and American widgeon— pass through the area on their way further north to Arctic breeding grounds. Waterfowl are not known to use the Minto Mine area for extended periods.

3.2.2.6 Species at Risk

Although some SARA listed species may pass through the project area, the Project does not overlap critical habitat for any rare or endangered species in Yukon.

3.2.3 Vegetation

The Minto Mine lies within the Pelly River Ecoregion. Black and white spruces are the most common types of trees with paper birch occuring on cooler sites and aspen and balsam poplar occupying disturbed areas. Lodgepole pine frequently invades burnt areas, often in competition with deciduous trees on moist to wet sites. The tree line occurs at elevations of 1,350 to 1,500 m. Feathermoss dominates the understory vegetation of nearly closed coniferous stands, but as the trees thin, willows and ericaceous shrubs become prevalent. Sedge or sphagnum tussocks are common in wetlands and under black spruce. Sagewort grasslands, with several forbs, and sometimes aspen, occur on steep south facing slopes. Shrub birch and willow occur in the subalpine and extend well above the treeline. Ericaceous shrubs and prostrate willows dominate the alpine vegetation, except on rocky terrain, where lichens are more prevalent.

Baseline vegetation conditions for the Minto Mine area were collected in 1994. This baseline information was supplemented with a 2010 vegetative study which encompassed a total of 3,626 ha (3 km radius around the Mine footprint). The Proponent has also developed an ecosystem map to be used as a land management and planning tool.[49] As Phase V/VI activities evolve, the map will provide a quick assessment of the type of vegetation and the quantity of area that will be directly disturbed.

The Minto Project area has been burned by several forest fires over the last 40 years. Consequently, much of the vegetation in this region is in varying stages of regenerative growth. In 1980, a wildfire burnt 4,550 ha, including the top of the Minto Creek drainage and a fire in 2010 burnt 5,260 ha along the southwest flank of the Yukon River.

The Proponent noted that, although no rare plants were found in their site investigations "That does not mean that the rare species do not exist within the study area, only that they were not located in the areas or in the season that the fieldwork was undertaken.[50]

3.3 Socio-economic Environment

The Minto Mine is entirely within Selkirk First Nation (SFN) Category A Settlement Lands (Parcel R-6A). The mine access road is within SFN Parcel R-6A and Parcel R-44A while the east barge landing access

[49] YOR 2013-0100-012-1
[50] *Ibid*

point is within Parcel R-43B. The mine has been operational since October 2007 and the site includes bunkhouses, a cafeteria, recreation facilities and other infrastructure to support an approximate 200-person camp. A camp upgrade, approved under the Phase IV permitting, is currently underway to increase camp capacity to 248.

Although the Minto Mine area is within SFN Settlement Lands, the claims associated with the mine area were staked three years prior to the start of land claims negotiations. Under the SFN Final Agreement and the SFN Self Government Agreement, certain rights are reserved, such as:

- All rights to mines (opened and unopened) and minerals (including precious and base metals) within settlement land are ceded to the Crown except on Category A lands, where mines and minerals are owned fee simple by SFN excepting pre-existing rights such as those that form the Minto property;
- Where pre-existing rights lie within Category A land, such as the Minto Mineral claims, the government will continue to administer those rights as though they were still Crown Land (SFN Final Agreement, Chapter 5.6.2) except that any royalties collected from those mineral rights will be paid to;
- A 30m right of way within land parcels R-6A, R-40B and R-44A covering the existing access road from Minto Landing to the project, with the right to construct, maintain, upgrade and use the right of way and road for as long as MintoEx holds its mineral rights; and
- The right of YTG to grant a surface lease over the mineral rights, subject to the consent of SFN, not to be unreasonably withheld (Minister of Public Works and Government Services Canada 1998).

On September 16, 1997, MintoEx and SFN entered a Cooperation Agreement concerning the Minto Project with respect to the development of the Minto Mine. The Cooperation Agreement was amended on November 4, 2009. In addition to establishing cooperation with respect to permitting and environmental monitoring, the confidential agreement deals with other economic and social measures and communication between SFN and MintoEx.

SFN continues to use the Minto Mine area for various traditional uses. The Proponent has indicated that, through interviews with SFN elders and citizens, they have determined that SFN members use the area for subsistence and other cultural activities and desire that the area remain a site of continued cultural land use.

Several Registered Trapping Concessions are held in the Project area. These include RTC #136: Heinz Sauer, RTC#139: Danny Joe, RTC #142: OPEN, RTC #143: Johnny Sam, RTC #145: Glen and Jim Bullied, RTC #146: Geo and Ken McGinty, RTC #147: Kathleen Sam. Only RTC #145 and #146 are located within the immediate mine area. Trapper access to the Minto Mine area has been identified and will be maintained in accordance with the Cooperation Agreement. Compensation agreements have been negotiated with the RTC #146 & #147 trap line holders of the trapping areas impacted by the mine and access road. Only two outfitting concessions fall within the Project area, Registered Outfitting Concessions #13 – Held by Tim Mervyn (Mervyn Outfitting) and #14 – Held by the Sandulak family (Trophy Stone Outfitting).

Annual salmon fishing occurs at Minto Landing and other sites along the Yukon River. The Minto Landing area is used for various cultural activities throughout the year, including SFN's General Assembly, berry picking, trapping, hunting, and spiritual activities.

The Yukon River, near Minto Landing and the Minto Mine access route, currently hosts recreational activities, such as fishing, hunting, hiking and canoeing/rafting. The nearby Minto Resorts, owned by SFN, provides camping and other outdoor adventure excursions for visitors to the area. Minto Landing is a starting point for tourist excursions down-river to historic Fort Selkirk. The Yukon River is also used as a transportation corridor for freight and other cargo. Land use on the western shores of the Yukon River is limited, as vehicle access to the western shore is available only in winter over river ice, or during open water by barge.

4.0 SCOPE OF THE ASSESSMENT

4.1 Introduction

The following sections highlight a summary of the Designated Office's considerations for developing the scope for the assessment of the Project. Within these considerations are the assumption that relevant terms and conditions from Phase IV authorizations will be carried forward into amendments for Phase V/VI licensing. That is, existing mitigating factors within Capstone's existing licenses will continue to be requirements for Phase V/VI operations and activities. Similarly, the Designated Office also assumes that relevant terms and conditions listed within the Decision Document for Phase IV[51] will also be complied with and enforced.

4.2 Views and Information Submitted

The Mayo Designated Office solicited comments during both the Adequacy Review (AR) stage and the Seeking Views and Information (SV&I) stage. The information provided during these comment periods collectively shaped the evaluation of the Phase V/VI project. As such, details of specific comments are highlighted throughout the report. The following is a description of the comment processes along with a brief summary of the comments provided during the SV&I period.

During AR, we contacted governments and key technical advisors to submit comments regarding the technical adequacy of the information provided in the Phase V/VI proposal. These parties were engaged to advise YESAB of any technical deficiencies that would prevent reviewers from conducting the evaluation of the Phase V/VI proposal and concluding potential effects. These comments were considered and, where appropriate, incorporated into subsequent information requests to the Proponent. Through this process, further details of the project were provided and the proposal was modified in certain areas. The comments, information requests and proposal changes can be tracked on the YOR. At the request of our office, the Proponent provided a reference table that highlighted the changes to the Proposal as a result of the AR process.[52] Key modifications to the project proposal are highlighted in Section 2.4 of this report.

[51] YOR 2010-0198-139-1
[52] YOR 2013-0100-196-1

The Mayo Designated Office sought views and information on the Phase V/VI proposal between December 4, 2013 and January 8, 2014. A SV&I period of 35 days is the maximum allowed by the Rules for Evaluations Conducted by Designated Offices. The following is a summary of the comments submitted during the SV&I period. As the Mayo DO received relevant comments following the SV&I period, these comments are included in this summary as well. The comments are summarized in the order that they were received.

Department of Fisheries and Oceans Canada (YOR 2013-0100-197-1)

The Department of Fisheries and Oceans Canada (DFO) participated in the technical working group during AR. The Proponent provided additional project details in relation to questions posed by DFO during AR. Following receipt of this information, DFO determined that the Proponent does not require an authorization from the Fisheries Protection Program, issued under the *Fisheries Act*, to proceed with the project as proposed. DFO referred the proponent to their guidance documents available on their website. These comments are not considered further.

Natural Resources Canada (YOR 2013-0100-200-1)

Natural Resources Canada (NRCan) provided comments regarding their regulatory responsibilities for explosives manufacture and storage. NRCan noted that the Proponent has an existing licence (F72384) authorizing the manufacture and storage of explosives and that this licence will remain valid for the Phase V/VI expansion. These comments are not considered further.

Selkirk First Nation (YOR 2013-0100-201-1; 2013-0100-215-1–230-1; 2013-0100-245-1; 2013-0100-261-2)

Selkirk First Nation provided substantial comments during the assessment process. Their first comment submission was a request for an extension to the SV & I period. As the SV & I period had already been extended to the full 35 days, this request could not be accommodated. Following SV & I, on January 24, 2014 SFN submitted their evaluation comments. SFN's comments focused primarily on:

- Water quality and aquatic life
- The stability of Mine works from a geotechnical perspective
- The closure plan
- Socio-economic effects

Following their main comment submission on January 24, 2014, SFN submitted additional comments in response to information submitted by other reviewers including YESAB's technical team. SFN's final submission on April 1, 2014 provided an excellent summary of the comments submitted and their technical team's perspective and critique of those other comment submissions. SFN's extensive comments are considered throughout this report. Specific excerpts are highlighted in the particular value to which they apply.

Environment Canada (2013-0100-202-1; 2013-0100-206-1)

Environment Canada's (EC) first comment submission was a request for additional time to provide comments. As with SFN's request, our rules did not allow for additional time as we had reached the maximum time allowed for the SV&I period. EC did submit their full comments before the close of the SV&I period. EC's comments focused on:

- Proposed Changes to Effluent and Quality Standards
- Characterization of Groundwater and Implications for Effects
- Aquatic Environment and Habitat
- Water Quality Modelling
- Geologic & Hydrologic Conditions
- ML/ARD Assessment
- Water and Load Balance Model Report
- Effects to Aquatic Environment

In summary, EC raised concerns with the Proponent's derivation of source terms, the Proponent's description and integration of flow paths, and how these may potentially impact the receiving environment. These comments are considered primarily in Section 6.0 of this report.

White River First Nation (2013-0100-203-1)

White River First Nation (WRFN) submitted comments stating that the Project exists in WRFN's traditional territory. WRFN stated that the Project is likely to have adverse impacts on WRFN's ability to exercise their Aboriginal rights by adversely affecting habitat and animal populations in the area as well as other resources that WRFN citizens rely upon to exercise their Aboriginal rights. WRFN noted the cumulative impacts of the project in combination with other projects in their traditional territory to their Aboriginal rights.

WRFN stated that the project area was used historically by members of WRFN and may still be used today for hunting, fishing, trapping and gathering activities or other cultural activities. WRFN noted that the disturbance of the land from this project may affect their ability to exercise their rights in the future.

WRFN outlined their expectation that traditional land use information specific to the project area will be collected and integrated into the application. WRFN noted that they feel that without this information specific to WRFN YESAB will not have full and accurate information necessary to assess the impacts of the proposed activities on WRFN Aboriginal rights and culture.

Significant effects to animal and fish populations are not expected as result of this Project, following application of all non-discretionary legislation and the mitigations in this report. As such, adverse effects are not expected to WRFN's aboriginal rights as a result of impacts to fish and wildlife from the Project. The project site is an existing active mine site with controlled access for safety. WRFN citizens cannot be using the project site for hunting, fishing or gathering at this time. The Phase V/VI expansion of Minto mine will be predominantly contained within the existing mine footprint and will not affect any previously undisturbed areas. No significant effects are expected from impacts to current traditional activities at the project site.

In terms of traditional land use information, we have concluded that because the Phase V/VI expansion is contained predominantly within the existing Minto mine footprint and entirely on SFN Category A Settlement Land, traditional land use information specific to WRFN is not necessary to conduct our assessment of effects for this project. The Minto Phase V/VI expansion is not expected to result in adverse effects to WRFN traditional land use values.

Yukon Government [YG] (2013-0100-204-1)

The Mineral Resources Branch of Energy Mines and Resources and the Water Resources Brand of Environment Yukon retained SLR Consulting Canada (SLR) to review aspect of the Phase V/VI project related to water quality, water management and closure. These findings were summarized in a joint letter submitted as part of YG's comment submission. In addition, Environment Yukon provide comments specific to air quality related to the project highlighting permits currently held by the proponent.

In general, YG concluded that the outstanding issues highlighted in their comment submission will be address in the regulatory phase of the project evaluation. Notwithstanding this conclusion, we considered the issues highlighted in both the YG letter submission and the attached SLR report. Applicable comments are discussed in Section 6.0 of this report.

Yukon Conservation Society [YCS] (2013-0100-205-1)

YCS highlighted concerns related to:

- The Main Pit Dam
- Underground Storage of Waste Rock
- Water Quality
- Bonding for Closure
- Preliminary Reclamation and Closure Plan

YCS concluded that there is not enough detailed technical information available for the assessment and noted their general concern with YESAB deferring technical issues to the regulatory process rather than addressing them in the evaluation. YCS noted their disagreement with the proposal to relax SSWQO in the receiving environment and highlighted the lack of conservatism in the proposal to address uncertainty, noting unforeseen environmental issues from past mining at other sites in the territory. YCS concluded their submission with a concern that YG should evaluate the risk of an early mine closure at this site an ensure that they have sufficient bonding to clean up the site.

Potential effects from the Main Pit Dam are discussed in Section 5.0 of this report. Potential effects to aquatic resources are discussed in Section 6.0.

Capstone Mining Corp. (the Proponent)

The Proponent played an active role during the assessment by responding to comments submitted and providing additional information to us in a timely manner. The additional information submitted by the Proponent is considered throughout this report in the sections where it applies.

4.3 Consideration of YESAB's technical consultant's reports

YESAB retained EcoMetrix Incorporated to provide focused technical support during the evaluation of the Minto Phase V/VI proposal. We asked EcoMetrix to provide technical support on:

- Geotechnical aspects of mine components;
- Geochemical aspects of mine waste management;
- Hydrogeology and implications for containment movement; and
- Water quantity, quality and affects to aquatic life.

EcoMetrix provided analysis of the adequacy of the proposal followed by an evaluation of the potential effects to environmental quality and aquatic resources. In addition, we directed EcoMetrix to review selected technical concerns raised by other reviewers during the process. EcoMetrix produced three primary reports during the evaluation: an evaluation report (YOR 2013-0100-240-1); a focused report on the closure period of the mine and associated effects (YOR 2013-0100-243-2); and an evaluation of the use of the bio-ligand model in the determination of effects to aquatic life and implications of previous recommendations for water management and monitoring (YOR 2013-0100-246-2).

In determining the effects of the project, EcoMetrix's recommendations were considered along with comments received and the Proponent's responses. Specific sections of EcoMetrix's reports are highlighted throughout Sections 5.0 and 6.0 of this report.

4.4 Consideration of previous assessments

Prior to the enactment of YESAA, there were several activities at the Minto site that were assessed under previous assessment regimes, including a 1997 Screening conducted under the Government of Canada's Environmental Assessment and Review Process Guidelines Order (EARPGO) and a 2005 Screening under Yukon's now defunct *Environmental Assessment Act*.

The Mayo Designated Office has also completed four evaluations of proposals concerning operations at the Minto Mine. The first report, issued in May of 2008, resulted in the Government of Yukon amending Yukon Quartz Mining License QML-0001 to reflect the increased milling rate of 3 200 tonnes per day (tpd). The second report, issued in March of 2010, further increased the mill rate to 3 600 tpd and revised the Water Management Plan (WMP). The third proposal, for Phase IV operations, increased the mill rate to 4 200 tpd and included a commencement of underground operations at Minto. The fourth proposal was for an amendment to the Air Emissions Permit 60-30 in relation to the operation of the diesel generators used to power the mine. The most recent evaluation, 2010-0198, included an expansion of mining areas, new open pits, implementation of underground mining, shifting from dry-stack to in-pit slurry tailings deposition and expansion of waste dumps and camp.

Several of the activities assessed under these previous assessments are still authorized under existing licenses, which are summarized in Table 11. Existing activities that are currently licensed and are not proposed to change in Phase V/VI will not be considered further in this assessment.[53] Phase V/VI

[53] With the possible exceptions of residual effects from existing activities that may be relevant to cumulative effects assessment sections of the report.

represents a temporal extension to several activities and, in some instances, there are proposed changes to currently licensed activities (e.g. removal of compliance point at W2 for water quality). These new and/or altered activities will be considered.

Table 11: Existing licensed activities and applicable authorizations.[54]

Activity	Licencing Parameters – Currently Licenced Activities	Applicable Authorization(s)
Access	Construction, operation, and maintenance of a road and power network.	QML-0001
Airstrip	This is currently licenced.	QML-0001
Camp	Construction of a 300-person camp with roads, office space, and wastewater deposit.	QML-0001 WUL QZ96-006
Ore stockpiles	This activity is currently licenced.	QML-0001
Fuel containment facility	This activity is currently licenced.	QML-0001
Storage and use of explosives	This activity is currently licenced.	QML-0001
Development of Area 2 (Stages 1 and 2) and Area 118	This activity is currently licenced.	QML-0001
Development of the MSU portal area	This activity is currently licenced.	QML-0001
Milling	Milling rate of up to 4,200 tpd.	QML-0001 WUL QZ96-006
Mill Water Treatment Plant	This activity is currently licenced.	QML-0001
Water storage dam	This activity is currently licenced.	QML-0001
Production	Mining rate of up to 2.5 million tonnes per year.	QML-0001
Concentrate	Production, storage, and transport off the site.	QML-0001
Waste rock and overburden facilities	Main waste dump (MWD), Southwest dump (SWD), Reclamation overburden dump (ROD), ice-rich overburden dump (IROD).	QML-0001
Dry stack tailings facility	Total volume of tailings not to exceed 5.9 million tonnes in Main Pit and Area 2 Pit.	QML-0001 WUL QZ96-006
O&M of bridge, culvert, barge landings and flood control structures	Big Creek Bridge, Minto Creek culvert, Yukon River barge landing.	WUL MS04-227
Water use	Obtain maximum of 1,000 m^3/day from Yukon River, Minto Creek and groundwater (includes well water for camp).	WUL QZ96-006
Deposit overburden	From A2, 118 and portal areas.	QML-0001
Deposit waste rock	From A2, 118 and underground workings.	QML-0001
Deposit slurry tailings	In Main Pit and Area 2 Pit.	QML-0001
Water storage	In Water storage pond, Mill water pond and Area 2 Pit.	WUL QZ96-006
Water diversion	Minto Creek and its tributaries.	WUL QZ96-006
Deposit effluent	Into Minto Creek.	WUL QZ96-006
Water treatment plant	Operation of water treatment plant.	WUL QZ96-006

NOTES:

WUL QZ96-006, WUL MS04-227, and QML-0001 expire on June 16, 2016
WUL QZ96-006 is Amendment 8 of WUL QZ96-006.

As shown in the summarized assessment history above, the Minto project has been assessed in phases. It is important that mitigating terms and conditions from previous assessments and authorizations that are still relevant to current operations continue to be implemented and enforced. This was recognized in Mitigation #7 listed in the Evaluation Report for Phase IV, which states:

[54] YOR 2013-0100-004-1

> MintoEx shall apply recommendations 1 to 27, inclusively, as stated in the Joint Yukon Government-Selkirk First Nation Decision Document of March 29, 2010, for the Minto Mine Water Management and Milling Rate Amendments (YOR document # 2009-0206-087-1).
>
> Rationale: This current evaluation strongly supports the recommendations stated in the Joint Yukon Government-Selkirk First Nation Decision Document as the most effective measure to ensure that there are no significant adverse effects to aquatic resources in the receiving environment of Minto Creek.[55]

Just as the Project is developed in phases that build on previous phases, so too does the assessment build on previous assessments. Therefore, it is important that previous mitigating terms and conditions from past assessments are carried forward into the requested amendments for Phase V/VI authorizations. The Designated Office recommends that all relevant terms and conditions listed in the Decision Document for Phase IV[56] be carried forward into the amended licenses for Phase V/VI.

The Designated Office makes this recommendation in light of issues raised during the current assessment. Notably, SFN had concerns that terms and conditions accepted in the Decision Document for Phase IV have not yet been implemented. Specifically, under Section 110 of YESAA, the Designated Office recommended that:

- A project specific monitoring program: the project-specific socio-economic and socio-cultural effects monitoring program shall result in an annual report. Ideally the first report would include all the data available at the time of writing and preferably all project phases (construction, operation and closure). The development of the monitoring program should consider what are currently known effects but should also remain flexible so that unforeseen effects can be incorporated. The following list of indicators of direct and indirect socio-economic and socio-cultural effects is provided for illustrative purposes; it should not be considered definitive: Employment and income data and information for Minto Mine; Contracting and business expenditures and distribution; Workforce development data and information; Cultural and community well-being; and Cumulative summaries for all project phases and years; and
- Cumulative Effects Monitoring: It is recommended that a cumulative effects assessment and monitoring framework be developed and implemented by the tripartite working group referred to in YOR document # 2010-0198-137-1. This working group is expected to develop an integrated comprehensive cumulative effects program that will include ecological, socio-economic and socio-cultural components. The working group should define the monitoring program so that specific categories are directly quantifiable and that these variables will measure change over time. Information gathered under the project specific monitoring program should be provided for inclusion in the cumulative effects monitoring program.[57]

These two conditions were intended to reduce uncertainty and to allow for the development of monitoring programs to evaluate the Project's impacts over time and to adapt mitigations to address any unforeseen

[55] YOR 2010-0198-139-1
[56] YOR 2010-0198-141-1
[57] YOR 2010-0198-141-1

issues that may arise. The Designated Office acknowledges that, at least in the case of recommendation 1 above, a socio-economic monitoring framework has been developed by the Tripartite Working Group (TWG).[58] Additionally, as highlighted in SFN's comments, the Proponent has committed to:

> (a) implement a project-specific socio-economic monitoring program for the life of the project as provided for in SFN and YG *2010-0198 YESAA Decision Documents* and as committed to by MEL in the Proposal (p. 198, 204) and Appendix T (p. 18, 21-22).
>
> (b) Develop a cumulative effects assessment and monitoring framework for managing project-related cumulative effects as provided for in SFN and YG *2010-0198 YESAA Decision Documents* and as committed to by MEL in Appendix T (p.21-22).
>
> (c) participate in a tripartite working group of YG, SFN and MEL to develop and implement (a) and (b) as committed to by MEL in YOR document # 2010-0198-137-1 and reaffirmed in the Proposal (p. 198, 204) and Appendix T (p. 6, 18, 21-22).[59]

However, the monitoring frameworks are not yet in place. As such, much of the uncertainty that was present at the end of the Phase IV assessment remains, and in some ways, may have increased due to the additional complexities associated with Phase V/VI. The Designated Office has reviewed the Draft Minto Mine Socio-Economic Monitoring Program,[60] and it is a comprehensive framework, which, if it had been implemented, would have provided meaningful information for the current assessment. However, since it has not yet been implemented (years after the recommended deadline), the data has not been collected nor reported and the current assessment is left to consider socio-economic effects of the mine in the absence of this valuable information, once again.

The Designated Office has considered the value in re-recommending the Section 110 terms and conditions. However, due to the fact that this approach was ineffective for Phase IV, there is a question as to whether or not it will be effective for Phase V/VI. This view is reinforced by the fact that there have been several years of missed opportunity for gathering/monitoring data. The Proponent noted that:

> The key to confirming and adaptively managing effects and enhancing benefits will be to adapt proposed and future mitigations to respond to potential issues and opportunities identified by the socio-economic monitoring program. This program will be undertaken by the tri-partite socio-economic working group. Although a formal monitoring program is not currently in place, Minto and SFN have been working together during Phase IV to mitigate Project-related effects and enhance benefits.[61]

This approach is reasonable; however, without actual monitoring data, its ultimate effectiveness is unknown. Due to the amount of time lost already, there is an increasing urgency to implement these monitoring programs as soon as possible given that, as SFN has noted, "the end of mine life is now in

[58] YOR 2013-0100-220-1
[59] YOR 2013-0100-228-1
[60] YOR 2013-0100-220-1
[61] YOR 2013-0100-012-1

sight.[62] The Designated Office has updated the Section 110 recommendations accepted in the Decision Document for Phase IV to include specific implementation dates, as follows:

Section 110 Recommendations:

- A project-specific socio-economic and socio-cultural effects monitoring program shall be implemented and shall result in an annual report. The first report should include all the data available at the time of writing and preferably all project phases (construction, operation and closure) and be submitted to the parties of the tripartite working group by December 31, 2014. The development of the monitoring program should consider currently known effects but should also remain flexible so that unforeseen effects can be incorporated. The following list of indicators of direct and indirect socio-economic and socio-cultural effects is provided for illustrative purposes; it should not be considered definitive: Employment and income data and information for Minto Mine; Contracting and business expenditures and distribution; Workforce development data and information; Cultural and community well-being; and Cumulative summaries for all project phases and years; and
- A cumulative effects assessment and monitoring framework shall be developed and implemented by the tripartite working group for submission to the parties by March 31, 2015. This working group is expected to develop an integrated comprehensive cumulative effects program that will include ecological, socio-economic and socio-cultural components. The working group should define the monitoring program so that specific categories are directly quantifiable and that these variables will measure change over time. Information gathered under the project specific monitoring program should be provided for inclusion in the cumulative effects monitoring program.

4.5 Consideration of Accessory and Ongoing Licenced Activities

The Phase V/VI proposal builds upon previous mining activities that have collectively created the present landscape of the mine property. Numerous previously authorized or currently licenced activities will interact with and/or support those activities proposed as part of the Phase V/VI development. Although many of these activities will not be considered as part of the current proposal, they will be considered in relation to Phase V/VI either through the cumulative effects analysis or as far as they have altered the landscape and influenced the condition of the site with implications for closure. For example, although the DSTF is existing and was previously authorized, the ongoing issues with stability are considered here in terms of the ability of Capstone to successfully close Minto Mine.

4.5.1 Consideration of 'M' Zone

During the assessment, the Designated Office became aware of an amendment to the Proponent's Underground Mine Development and Operations Plan (UMDOP) "to authorize a change in the mining sequence for the Area 2 portion of the Phase IV underground operation" (Yukon Government 2014).

[62] YOR 2013-0100-215-1

> The area, known as the M-zone, was previously scheduled as one of the last elements for the Area 2 portion of the Phase IV underground operation. Instead, the Licensee now proposes a portal near the bottom of the Area 2 pit and to develop this high-grade deposit earlier in order to avoid any risk associated with mining in close proximity to the tailings/water deposit slated for Area 2 (Yukon Government 2014).

The Designated Office considered the potential for this change in operations/scheduling to affect, or be affected, by the proposed Phase V/VI operations. The 'M' Zone will be physically separated from other underground operations and, as noted above, will be mined earlier than proposed to avoid risks associated with tailings/water placement in the Area 2 pit. The approved amendment to the UMDOP may affect the scheduling for tailings placement, but the Designated Office is satisfied that the change in portal location to access the 'M' Zone will not significantly affect Phase V/VI operations.

4.6 Consideration of Project Effects to Health and Safety from Mining Methods

Phase V/VI developments consist of both open pit and underground mining. Open pit mining has been occurring at Minto Mine since the beginning of mining operations. Current authorizations and applicable non-discretionary legislation have proven effective at managing risks to health and safety. As such, open pit mining methods as they pertain to worker's health and safety will not be considered further in this report.

Underground mining was introduced to Minto Mine as part of Phase IV developments. Substantially more underground development is proposed as part of Phase V/VI. Although Phase V/VI development includes a new underground mining method (PPCF), the most likely effects to worker's health and safety remain the same as for Phase IV underground mining. The Phase IV evaluation assessed project effects to health and safety, including:

- Reduced air quality;
- Working underground and adit failure;
- Risks from explosives;
- Exposure to chemicals; and
- Emergencies, accidents and malfunctions.

In addition to the extensive Proponent commitments and the non-discretionary legislation, the YESAB evaluation of Phase IV activities (2010-0198) included a mitigation to reduce or eliminate the residual significant adverse effects to workers' health and safety from underground mining. The Mayo Designated Office has determined that successful implementation of the Proponent's commitments, non-discretionary legislation and the mitigation (number 6; accepted by YG) from YESAB assessment 2010-0198 will successfully eliminate, reduce or control significant adverse effects to mine employees from underground operations. The effects of underground mining to health and safety are not discussed further in this assessment.

4.7 Consideration of Heritage Resources

The Project is an expansion of an existing mine, which will require clearing an additional 82.04 ha. Proposed activities include the use of heavy equipment to clear land and move earth, which may potentially affect heritage resources.

The Proponent has commissioned several archaeological studies to acquire an understanding of the heritage and historic resources in the Project area. Most recently in 2011, Matrix Research Limited completed a heritage resource overview assessment (HROA) and subsequent heritage resource impact assessment (HRIA). Figure 10 shows areas of high potential for the presence of heritage resources as identified in the HROA.

As highlighted in Figure 10, several Phase V/VI components overlap areas of high potential for the presence of heritage resources, including: the Minto North Pit, Mill Valley Fill Extension (Stage 2), Ridgetop Waste Dump, Ridgetop North Pit, Main Waste Dump Expansion and Area 118 Backfill Dump.

In addition to non-discretionary compliance with existing legislation, including the *Yukon Historic Resources Act*, *Archaeological Sites Regulation* and the Selkirk First Nation Final Agreement, the Proponent has also committed to implementing their Heritage Protection Plan (Minto Explorations Ltd. 2011). This plan is comprehensive and site-specific and outlines procedures and protocol for all employees and contractors. The Proponent has also committed to the following mitigating measures regarding heritage and historic resources:

- Adherence to Minto's Heritage Protection Plan;
- Minto will conduct a HRIA where Phase V/VI activities overlap with areas identified as having high heritage resources potential, as per Matrix's *Heritage Resource Overview Assessment*;
- Minto commits to ongoing community consultations and communication to ensure awareness of the Project extent and operations, with opportunity for public discussion or raising of concerns; and
- All discoveries of heritage and paleontological resources will be reported to SFN government's heritage department and YG heritage branch.

During SV&I, there were no direct heritage resource concerns raised. In consideration of the existing legislative requirements and Proponent commitments above, the Designated Office is satisfied that the Project will not result in significant adverse effects to heritage resources. As such, heritage resources will not be considered further in this assessment.

Figure 10: Areas of high heritage resource potential in the Minto area. Sourced from YOR 2013-0100-013-1.

4.8 Consideration of Effects to Wildlife and Wildlife Habitat

The Phase V/VI developments will occur in previously disturbed areas, with some additional clearing (~82 ha). Phase V/VI also includes disturbance in a new drainage (McGinty Creek), but this area does not overlap with any key wildlife habitat.

Project operations are likely resulting in displacement of some wildlife species from the project area, but this displacement does not affect key wildlife habitat and is not expected to result in significant effects. The most likely effects to wildlife come in the form of direct mortality as a result habituation of bears and collisions with wildlife and vehicles servicing the mine.

During the Minto Phase IV evaluation (2010-0198), Yukon Government Department of Environment noted that human-bear conflicts in 2010 and 2011 resulted in the destruction of a four bears at the Minto camp. Because of this information, YESAB recommended five mitigation measures aimed at reducing or eliminating the adverse effects from human bear interactions. These mitigations focused on both reducing attractants at the site and excluding bears from mine site areas (e.g. installation of electric fencing). For the Phase IV project, the Proponent also provided several mitigations to reduce the likelihood of vehicle-wildlife collisions.

The Designated Office assumes that existing license conditions will continue to be requirements for Phase V/VI operations and is satisfied that existing mitigations and legislative requirements are sufficient to ensure that adverse effects associated with Phase V/VI activities are not significant. However, the assessment for Phase IV did not include mitigations to reduce, control or eliminate adverse effects to migratory birds. Since there will be additional clearing activities (~82 ha) that may overlap with migratory bird presence in the area, this assessment will consider adverse effects to migratory birds in Section 9 – Wildlife and Wildlife Habitat.

4.9 Consideration of Invasive Species

The Project will require the disturbance of an additional 82 ha of land. Activities including land clearing, road construction and use of heavy equipment will result in the direct loss of vegetation. The Proponent has included several measures to mitigate the loss of vegetation associated with newly disturbed areas (see Section 11.2.1.1 of the proposal[63]). Most of these measures deal with minimizing the extent of clearing as much as possible and implementing progressive reclamation techniques to encourage revegetation.

The Proponent also recognized that effects associated with the proposed disturbance could lead to a "reduction in ecosystem integrity and displacement of native plant species due to the introduction of invasive plant species."[64] However, there were no mitigations provided to deal with invasive species, specifically. Potential effects associated with the introduction and/or facilitation of invasive species will therefore be considered in Section 8 – Environmental Quality.

4.10 Consideration of Main Pit Dam

A failure of the Main Pit Dam has the potential to adversely affect multiple VESECs. For instance, a dam breach and subsequent release of tailings and supernatant water could impact the health and safety of individuals within the inundation zone (e.g. death), fish and fish habitat (e.g. smothering substrate), water quality (e.g. increased contaminant loading), environmental quality (e.g. increased erosion and scouring) and wildlife (e.g. flooding of habitat). The magnitude of potential effects could vary depending on the size of the breach, amount of tailings released as well as the timing and stage of failure (e.g. operations vs. post-closure).

The primary effects characterization of a Main Pit Dam failure is considered in Section 5 – Health and Safety. This effects characterization is heavily dependent on the modelled inundation flooding scenarios that could follow a dam breach. Section 5 includes a significance determination as well as recommended mitigations to eliminate, control or reduce the potential adverse effects to Health and Safety.

Sections 6 – Aquatic Resources and 8 – Environmental Quality also consider the impacts of a dam failure to their respective VESECs. However, these sections rely on the primary effects characterization in Section 5 – Health and Safety. Similarly, mitigating terms and conditions recommended in earlier sections are considered in the significance determinations of subsequent sections (e.g. terms and conditions recommended to mitigate adverse effects to Health and Safety are considered in the significance determination regarding potential effects to Aquatic Resources). The intent of this approach is to reduce

[63] YOR 2013-0100-012-1
[64] *Ibid*

redundancies within the report and to recognize that a mitigation strategy can be effective for more than one VESEC (e.g. a more stringent design standard can reduce the probability of failure, which in turn would reduce the likelihood of adverse effects to all potentially affected VESECs).

Where there are potential effects of the Main Pit Dam that are not addressed in a preceding VESEC section that are relevant to a subsequent VESEC, then those issues are dealt with separately. For example, the potential adverse effects related to seepage from the dam (e.g. contamination of downstream water quality) are not addressed in Section 5– Health and Safety; however, there is consideration of these effects in Section 6– Aquatic Resources. Similarly, if there are residual effects that remain after mitigating for potential adverse effects to a particular VESEC, then those residual effects will be considered in subsequent VESEC sections.

4.11 Consideration of Significance

In order to mitigate a potential adverse effect, the Designated Office must first find significance. In addressing what may constitute a "significant" adverse effect, the Designated Office considered the following factors:

Magnitude: This refers to the magnitude of the effect. Low magnitude effects may have no impact, while high magnitude effects do have an impact.

Probability: The likelihood that an adverse effect will occur.

Geographic Extent: This refers to the extent of change over the geographic area of a project. The geographic extent of effects can be local or regional. Local effects may have a lower impact than regional effects.

Duration and Frequency: This refers to the length of time the effect lasts and how often the effect occurs. The duration of an effect can be short term or long term. The frequency of an effect can be frequent or infrequent. Short term and/or infrequent effects may have a lower impact than long term and/or frequent effects.

Reversibility: This refers to the degree to which the effect is reversible. Effects can be reversible or permanent. Reversible effects may have lower impact than irreversible or permanent effects.

Context: This refers to the ability of the environment to accept change. For example, the effects of a project may have an impact if they occur in areas that are ecologically sensitive, with little resilience to imposed stresses.

4.12 Consideration of Cumulative Effects

With regards to cumulative effects, subsection 42(1)(d) of the Yukon Environmental and Socio-economic Assessment Act (YESAA) instructs Designated Offices to consider:

42(1)(d) the significance of any adverse cumulative environmental or socio-economic effects that have occurred or might occur in connection with the project or existing project in combination with the effects of

i. Other existing projects for which proposals have been submitted under subsection 50(1), or

ii. Other existing or proposed activities in or outside Yukon that are known to the designated office, executive committee or panel of the Board from information provided to it or obtained by it under the Act.

A cumulative effect occurs when the residual effects of the proposed project interact with the residual effects of other projects[65] to produce an effect larger than the residual effect in isolation. This combination of residual effects can create a significant cumulative effect. In this assessment, cumulative effects are evaluated to the extent possible with the information available for each valued component as identified in Part B of this report. The spatial scale used to determine the presence of a significant cumulative effect is determined based on the relevance to a particular valued component. For example, cumulative effects to water quality at a certain location within a stream may be assessed by evaluating impacts associated with all upstream activities and/or natural phenomena that contribute loadings to the watercourse. In this report, where necessary, a cumulative effects assessment is included following the assessment of project effects for each valued component.

In the situation where the Designated Office determined that there would be no residual effects of the proposed Project on a specific value, then a cumulative effects assessment for that value was not necessary.

4.13 Valued Environmental and Socio-economic Components (VESEC)

The following valued environmental and socio-economic components (VESEC) are the specific values that have been identified by the Mayo Designated Office as being adversely affected by the project:

- Health and Safety (Section 5.0)
- Aquatic Resources (Section 6.0)
- Environmental Quality (Section 7.0)
- Selkirk First Nation Treaty Rights (Section 8.0)
- Wildlife and Wildlife Habitat (Section 9.0)

[65] For the current assessment, residual effects from previous phases of Minto (e.g. Phase IV), ongoing operations and existing activities will also be considered in the cumulative effects sections for each identified VESEC, where appropriate.

WILDLIFE AND WILDLIFE HABITAT (SECTION 8.0) ASSESSMENT AND REASONS FOR RECOMMENDATION

Part B of this evaluation report presents the effects assessment of the Project on valued components identified in Section 4.0. For each valued component, an overview of the value is provided followed by the effects characterization analysis. Where relevant, measures to reduce significant adverse effects of the Project on the valued component are identified. The effects characterization ends with a conclusion on the key findings of the assessment.

5.0 HEALTH AND SAFETY

5.1 Overview

Several activities associated with mining can present hazards to human health and safety. However, as noted in Section 4, the assessment will focus on adverse effects associated with a potential failure of the Main Pit Dam. The Main Pit Dam will be designed and constructed to retain waste rock, tailings and supernatant water with an engineered soil cover in post closure.

The Main Pit Dam must remain functional and intact in perpetuity and there are several potential dam failure scenarios that could have a spectrum of effects, depending on the magnitude of the breach, amount of material released, rate and extent of inundation and stage of mine development. However, in order to be conservative and provide a robust assessment and appropriate mitigation, the Designated Office will consider the ‘worst case’ scenarios as presented in the dam break analysis summary below (ss 5.3.1.5).

A failure of the Main Pit Dam could release retained materials into an inundation zone downstream in an area that contains key mine infrastructure. A ‘worst case’ failure during the operational period of the mine could result in the death of up to 90 people at the site. The Designated Office has determined that the Project may result in significant adverse effects to health and safety from a Main Pit Dam failure. As such, the following effects have been considered:

- Multiple casualties (injuries and/or death) to individuals within the inundation zone downstream of the Main Pit Dam.

The Designated Office acknowledges that there is no way to eliminate the possibility of a dam failure. However, Proponent commitments, regulatory requirements, proposed design standards, best practices and mitigations listed within this report will work to reduce the likelihood and/or severity of the adverse effects. The Designated Office is of the opinion that the residual risk of a dam failure is not significant considering the mitigative framework that will be implemented. With this in mind, however, the Proponent, regulators, Selkirk First Nation (SFN) and society in general, must accept the fact that the Main Pit Dam needs to function and remain in place in perpetuity. There is no ‘walk away’ solution and long-term monitoring and maintenance, in addition to adequate resources (i.e. financial security) to conduct these activities, will be required in perpetuity.

The Designated Office acknowledges that there is much work to be done to further characterize the site conditions and to further develop advanced engineering designs for the Main Pit Dam. This work will contribute to a better understanding of final design requirements and will further reduce existing uncertainties. The Proponent has completed appropriate, high-quality characterization work to date and the Designated Office is confident that this will continue.

As this work progresses and final decisions are made regarding the development of the Main Pit Dam, it is imperative that SFN play a key role in those decisions. The SFN Final Agreement requires the consent of SFN not to be unreasonably withheld when Government of Yukon grants a surface lease over the mineral right for Minto (Minister of Public Works and Government Services Canada 1998). Those that would be most affected by the consequences of a failure (i.e. SFN) must be fully aware, and be willing to accept, the ongoing risk. In other words, SFN must be a partner in the decision that determines whether the Main Pit Dam presents a 'tolerable' risk to their Category A Settlement Land.

5.2 Main Pit Dam Description

The following section summarizes the proposed Main Pit Dam, conceptual design as described in the proposal and outlines some unique features of tailings dams. This section is not intended to provide a comprehensive characterization of the Main Pit Dam. For a more comprehensive description of the dam design, site characteristics and associated information, please refer to the proposal and supporting documents of the Project file on YESAB's Online Registry.

5.2.1 Main Pit Dam Conceptual Design

The Project includes the construction of a containment dam on the east rim of the Main Pit in order to increase the storage capacity for tailings and potentially acid-generating (PAG) waste rock. The Main Pit Dam will be constructed with locally available materials and will be approximately 300 m long with a maximum crest height of 23 m and crest width of 15 m. The dam will have a full supply level (FSL) of 804 m and a total freeboard of 2 m (final crest elevation of 806 m).

The dam will be constructed at the lowest point of the Main Pit wall, which currently has a natural spill elevation of 791 m. Both tailings solids and free water will be retained during the dam's operational phase. At closure, the dam will not retain free water, although surface run-off facilities (e.g. conveyance structures and passive treatment facilities) will remain in place. The Main Pit Dam will increase the storage capacity of the Main Pit Tailings Management Facility (MPTMF) by 1.7 Mm^3.

The Project also includes the construction of a permanent spillway south of the Main Pit Dam that will direct water toward the Area 2 Pit. The spillway will be a large swale with a 25 m base and 10H:1V side slopes. The spillway inlet elevation will be at 804 m (FSL of the MPTMF) and the outlet will be at 803 m (0.5% grade).

The Main Pit Dam will be built to Canadian Dam Association's (CDA) Dam Safety Guidelines with a design life of 200 years (operational design life of 20 years). Based on the Proponent's preliminary dam hazard classification of 'Very High,' the annual exceedance earthquake design will be at least the 1/5000 year event and the Inflow Design Flood will be 2/3 between the 1/1000 year and probable Maximum Flood (PMF).

Tailings deposition for Phase V/VI will continue Phase IV's strategy of hydraulically placed in-pit tailings (i.e. slurry deposition of low solids content; 50-60% by weight). This tailings deposition strategy is expected to improve seepage performance through the creation of a 'beach' that will separate ponded water from the upstream slope of the dam by at least 100 m.

The Main Pit Dam will be an 'earthen-filled' embankment[66] constructed of locally-sourced materials. Core material will be clayey-silt overburden, transition will be crushed rock and the shell will be run-of-mine waste rock and riprap. The upstream slope will be 2H:1V and the downstream slope will be 3H:1V.

Initial foundation characterization presented in the proposal contained several assumptions and corresponding uncertainties. In light of these unknowns and the historic instabilities at the mine site, the Designated Office requested further details regarding the foundation conditions. In response, the Proponent conducted field investigations and submitted the results to the assessment.[67] "In general, the findings of the geotechnical investigation indicate that the assumptions made in the Main Pit Dam Conceptual Design report are consistent with or more conservative than the results of the geotechnical investigation.[68]

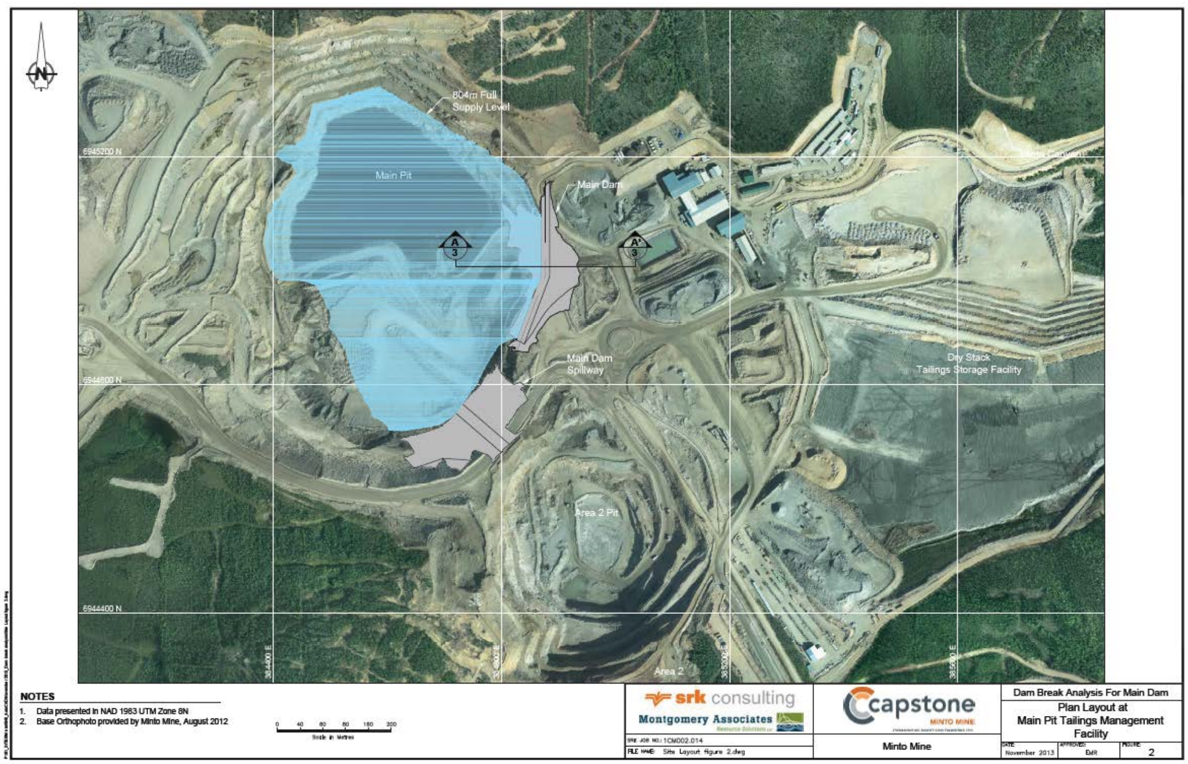

Figure 11: Plan layout for Main Pit Tailings Management Facility. Sourced from YOR 2013-0100-173-1.

[66] Throughout the proposal and supporting documents, the Main Pit Dam is often referred to as a 'tailings dam.' In many cases, 'tailings dams' refer to dams that are constructed, at least partially, out of tailings material. For clarity's sake, the Designated Office notes that the proposed Main Pit Dam will not be constructed from tailings material but will, rather, retain tailings. This report will follow the convention set out in the proposal (i.e. 'tailings dams' will imply 'tailings retention dams').

[67] YOR 2013-0100-231-1 through -235-1

[68] YOR 2013-0100-266-1

5.2.2 Unique Considerations of Tailings Dams

YESAB's Dam Guide defines tailings dams as "structures built for the purpose of storing mine waste and water from the milling process. The design of a tailings dam depends on the type of tailings involved, where they will be stored, and the life expectancy of the dam" (YESAB and Yukon Environment 2012).

Tailings dams are unique engineered structures that differ from conventional water retention dams in several ways. Most notably, tailings dams must often remain in perpetuity whereas most water retention dams have a finite lifespan and associated decommissioning. As such, the design, construction, operation and closure of tailings dams have some fundamental differences and associated challenges compared to water storage dams. Furthermore, there are several characteristics of tailings dams that make them more vulnerable than other retention structures, including:

- Embankments are constructed using locally collected fills (soil, coarse waste, overburden from mining operations);
- There is a lack of regulations on specific design criteria; and
- There is a high cost for maintenance works for tailings dams after closure of mining activities (Rico, et al. 2008).

Tailings dams can undergo environmental as well as physical failure, unlike conventional water-retaining dams that can only undergo physical failure (Martin and Davies 2002). As such, there are design implications for ensuring that the Main Pit Dam is physically stable and has measures in place to address potential environmental concerns. These concerns will be addressed further in Section 6 – Aquatic Resources.

Because tailings dams must remain intact and function in perpetuity, the closure phase is substantially longer than the production phase. This unique characteristic makes the application of conventional dam safety criteria to address the tailings dam closure condition largely inappropriate and potentially unsafe. Szymanski and Davies (2004) suggested that "the majority of currently available dam safety guidelines do not account well for the specifics of tailings dams."

> This simply is a result of much longer exposure period (design interval) applicable to the closure phase… There seems to be no dam safety guidelines commonly used in Canada that address this critical while unique tailings dam design aspect. As this aspect of tailings dams is so fundamental to their very nature, this omission alone challenges the use of commonly available guidelines for appropriate assessment of tailings dams at closure (Szymanski and Davies 2004).

The current CDA Guidelines do provide some consideration of tailings dams and there are technical bulletins for mining dams currently under development to help address this lack of specific guidance.[69] However, a review of tailings dam literature reveals that there is a need for more specific consideration of the unique nature of tailings dams and their long-term presence once built.

[69] The Canadian Dam Association is currently developing guidelines specifically for tailings dams.

> The design approach and safety requirements for tailings dams, including dam surveillance programs, are often adapted from the practice of conventional dam engineering. In many respects this is appropriate, but tailings dams have many unique features and operating requirements, which demand specific consideration and do not allow unquestioned adoption of conventional dam engineering practice (Martin and Davies 2002).

The unique nature of tailings dams, which includes the requirement to remain stable in perpetuity, results in an ongoing risk of failure and subsequent consequences in the downstream environment. The following sections will provide a characterization of a Main Pit Dam failure and the potential adverse effects to health and safety.

5.3 Project Effects – Main Pit Dam Failure

The following section summarizes the proposed Main Pit Dam break analysis. Additionally, this section presents a review of tailings dams' failure modes, risk factors for the proposed Main Pit Dam, a summary of the regulatory environment as well as a discussion of risk/uncertainty and associated limitations of the assessment.

5.3.1 Effects Characterization

5.3.1.1 Introduction

A breach of the Main Pit Dam, regardless of the initiating event(s) and/or failure mode, could have severe adverse effects to individuals within the inundation zone downstream. As shown in Figure 11, key mine infrastructure (e.g. Mill Complex and main access road), are situated directly down gradient from the proposed Main Pit Dam where there is potential for many mine employees to be present. The Proponent provided a Main Pit Dam break analysis and corresponding inundation zone mapping, which show that these mine areas could be flooded rapidly after a dam failure. The results of this analysis played a key role in understanding the extent and magnitude of adverse effects resulting from a dam failure.

The following sections provide a summary of potential failure modes, risk factors associated with the proposed Main Pit Dam and break analysis in the context of potential human casualties (injuries and/or loss of life) due to dam failure. The intent of this approach is to mitigate for the worst possible outcome, recognizing that these mitigations will also be effective for less severe failure scenarios.

5.3.1.2 Potential Failure Modes of Tailings Dams

There are several causes of tailings dam failures worldwide; however, a major cause is due to extreme meteorological events (e.g. unusual rainfall). Another important cause is related to poor management. In many instances, however, dam failures result from a combination of factors, for example:

> Failures attributed to meteorological causes (intense rainfall, hurricanes, rapid snowmelt, ice accumulation in the tailings dam, etc.) may also be associated with overflow/overtopping, seepage, foundation failure or bad impoundment management (Rico, et al. 2008).

The following sections provide brief summaries for several types of tailings dam failure modes as identified in a technical report issued by the United States Environmental Protection Agency (U.S. Environmental Protection Agency 1994).

Rotational Sliding

Rotational sliding may result in slope failures (local sloughing to massive arc slides) due to shear stress along a potential failure surface equalling or exceeding shear strength. Causes of rotational failure include changes to the water table, changes in the permeability of foundation materials, disturbances to the embankment (e.g. vibration or impact loading) and settlement of foundation materials.

Foundation Failure

Movement along a failure plane will occur if loading produces stress in excess of shear strength of the soil in weak layers beneath the structure. Such movement could result in local deformations or complete dam failure.

Overtopping

Overtopping is one of the most common failure modes and results when run-on water exceeds the capacity of the impoundment (due to improper diversion of surface water, excessive storm water flows, inadequate design, etc). Tailings dams are constructed of erodible material and a rapid flow over the embankment crest can erode a gulley, which allows for more flow and can result in a major failure within a short period of time. Large storm water inflow can also increase pore pressure, which can lead to liquefaction of tailings.

Erosion

Tailings dams are constructed of erodible material and, as such, are susceptible to erosion. Extreme precipitation events and/or poor construction/maintenance can lead to gullying which, if not addressed could lead to dam failure.

Piping

Piping refers to internal erosion that can occur along seepage pathways within or beneath a dam. This erosion can lead to the formation of low-pressure conduits that allow concentrated flow and progressive erosion, which could lead to local and/or a general dam failure.

Liquefaction

Liquefaction is another common cause of failure in tailings dams and occurs when tailings behave like a viscous fluid. Because tailings are typically unconsolidated, saturated deposits of similarly sized grains, they are susceptible to suspension in water and can flow considerable distances through narrow openings. There are several factors that affect the liquefaction potential of tailings, including:

- Soil type - Uniform grain size materials, mostly in the fine sand sizes (the typical gradation of a tailings material), are the most susceptible to liquefaction.
- Relative density or compactness - For a given material, the more compact or dense it is the more resistant it will be to liquefaction.

- Initial confining pressure at the time subjected to dynamic stress - This offers an opportunity in certain areas to prevent liquefaction by applying overloads to loose deposits.
- Intensity and duration of the ground shaking - Liquefaction may occur due to an intensive earthquake, or due to prolonged earth movement.
- Location of the water table - A high water able is detrimental. Consequently, a tailings deposit constructed on a pervious foundation or a dam with a phreatic line kept low by providing adequate internal drainage features may have a greatly reduced potential for liquefaction.

The proposed Main Pit Dam at the Minto Mine is subject to several risk factors that increase its susceptibility to these failure modes. The next section details some of these risk factors as well as some of the uncertainty surrounding site characteristics.

5.3.1.3 Main Pit Dam Risk Factors

The Proponent has acknowledged that the Main Pit Dam will be constructed upon challenging foundations and that the site must be further characterized to better understand the feasibility of the conceptual design. As noted above, the Proponent has initiated detailed foundation characterization work and the results of recent work indicate that foundation conditions are more favourable than anticipated in the original proposal documents and Main Pit Dam Conceptual Design Report. However, challenging foundation conditions remain and there are several known risk factors associated with the Main Pit Dam location.

Foundation

Drill logs from within the dam's footprint and surrounding area indicate overburden depths from 0 m up to 60 m as well as the presence of ice lenses and permafrost (massive ice may be present). Overburden at the site is

> colluvium primarily comprised of granite-based sand from weathering of the granitic bedrock in the area and is generally thin but pervasive. Deeper deposits, especially the in-filled, pre-glacial channel (or paleochannel) approximately in the center of the property, include fine-grained silts and clays with sporadic inclusion of ice lenses and zones of massive ice.[70]

The results from the August 2013 drill program indicate that the bedrock is generally higher than assumed in the Main Pit Dam Conceptual Design Report and "the results of the strength and consolidation testing indicated generally competent foundation soils."[71] Nevertheless, the Main Pit Dam will be constructed in close proximity to a 'paleochannel' that, as a component of the overburden conditions, has contributed to three significant mass ground movements on site, namely:

- Creep displacement of the Dry Stack Tailings Storage Facility;
- The Main Pit south wall failure; and
- Foundation movements of the southwest waste dump foundation.

[70] YOR 2013-0100-025-1
[71] YOR 2013-0100-266-1

Field characterization attributes the DSTF's movement to a "shear surface occurring within a deep (26 to 64 m bgs), very ice rich clay layer located approximately 7 m from the bedrock contact."[72] The south wall failure in the Main Pit is also associated with this ice-rich, plastic clay layer within the lower paleochannel materials (i.e. same foundation conditions as the DSFT); however, investigations suggest that "displacements of the Main Pit south wall and the southwest dump foundation are believed to have been initiated primarily by excavation of the Main Pit, which simply created a void for the ice-rich overburden soils to move towards due to gravitational forces."[73]

The site characterization that has taken place to date, as well as the Main Pit Dam's close proximity to these mass ground movements, suggest that the dam may be susceptible, and/or may contribute to, further movement within the paleochannel. "It is these foundation soils that have caused failure conditions under the Dry Stack Tailings Storage Facility (DSTSF) and the Area I (Main) Pit slope."[74] Such failure conditions within the dam foundation could impact the integrity of the dam in many ways including differential settlement, crest settlement, rotational sliding, cracking of the core and slope failures. In turn, there could be localized failures requiring repair or a complete failure with a release of retained materials, including significant tailings release depending upon their liquefaction potential (which would depend on the operational status of the MPTSF, phreatic surface, as well as the saturation of the tailings).

Other risks associated with the existing foundation materials include potential settling from the mass of the dam and melting permafrost/ice lenses, which could lead to local deformations or mass movement and subsequent dam failure.

Main Pit Dump

In 2011, prior to completion of mining within the Main Pit, the south wall of the pit failed:

> The south wall initially showed signs of instability in April 2009 and has continued to move since that time. At the end of April 2011 a block of frozen material [approximately 20 m thick, 175 m long (parallel to face) and 85 m wide (perpendicular to face) bounded at the back by a tension crack] failed into the pit.[75]

The cause of the failure and foundation movement were "linked and are associated with an ice-rich, plastic clay layer(s) generally within the lower portion of the paleochannel materials."[76] In order to arrest further movement into the pit, the South Wall buttress and Main Pit Dump were designed and, to date, have been partially constructed.

Since a failure of the dump and/or buttress may impact the integrity of the Main Pit Dam, it is important that outstanding issues associated with these components are resolved. Notably, Terraprobe recommended in their review that there is a need to determine "whether the surface cracks observed in

[72] YOR 2013-0100-025-1
[73] *Ibid*
[74] YOR 2013-0100-225-1
[75] YOR 2013-0100-168-1
[76] YOR 2013-0100-168-1

the field [i.e. on the surface of the in-pit dump] are related to movement of the pit wall, or due to self-weight consolidation, instability of the in-pit dump, or construction methodology."[77]

The full buttress as designed had not been fully constructed as of June 2013. So, although the partially-constructed buttress has slowed the creep failure, the movement has not been arrested. As such, adding further load prior to completion of the buttress is not appropriate.

There is also uncertainty within models provided regarding the material contained within the pit, during modelling:

> At some point, there will be water, followed by tailings in the pit to certain elevations. It is assumed that the SRK models used tailings within the pit to below the elevations 786 m (Phase IV) and 804 (Phase V/VI), but it is not clear… Furthermore, the final condition with tailings in the pit is not necessarily the limiting case.[78]

Additional analyses will be required to indicate what the limiting case is to determine the short-term factors of safety.

Faults

There are three known faults that intercept the Main Pit. The DEF fault is at the northern end of the pit and strikes east-west and dips north-northeast. The Minto Creek fault strikes east-west and is believed to be north dipping. The third fault lies south of the other two faults, strikes south-east to north-west, possibly intersects the other faults and is believed to dip north-northeast.

The extent of these faults, and other potential faults, under the Main Pit Dam's foundation is unknown. Additionally, the potential for faults to impact the Main Pit Dam's integrity is also unknown. Faults could provide preferential seepage pathways and contribute to local movement and settlement of the dam through either gradual 'creep' or abrupt displacement associated with an earthquake.

Water Balance/ Water Management

Lack of control over the hydrological regime is a common cause of failure, which can lead to overtopping, slope instability, seepage and erosion from a lack of control of water balance within impoundments (Chambers and Higman 2011).

The Proponent's Water Use Licence requires that Minto Mine has the capacity to store 0.975 Mm^3 of water in the Main Pit every October 31. It is assumed that this requirement will remain in place for Phase V/VI; although, the Proponent has indicated that this surge capacity may be made available through the use of additional facilities (e.g. Area 2 Pit). Nevertheless, this surge capacity is a key input into the design requirements of the Water Management Plan for Phase V/VI and relies heavily on water balance modelling and predictions.

Minto Mine has faced difficulties in the past in terms of accurate water balance predictions and, as a result, the Proponent has had to apply for several emergency water releases due to unexpected surplus water on site. Since these emergency releases, changes have been made to water management on site

[77] YOR 2013-0100-266-1
[78] YOR 2013-0100-266-1

and there is greater confidence in the water balance modelling for the mine. However, uncertainty remains in modelling and predictions. Practices should be conservative to ensure adequate surge capacity at all times.

Erosion

The Main Pit Dam will be constructed out of locally sourced materials that will be erodible. Extreme precipitation events, slope failures, ground movements, etc. could lead to localized and/or extensive erosion that, if not rectified, could lead to further erosion and potential dam failure.

The Main Pit Dam is required to function in perpetuity. As such, it will be susceptible to the forces of erosion over an indefinite period. The additive impacts from long-term exposure to meteorological events (some of which may become more frequent and/or extreme as suggested by climate change models) will present ongoing challenges to the dam's integrity. Long-term monitoring and maintenance will be required to counteract the forces of erosion.

Piping

'Piping' or internal erosion could occur within or below the proposed Main Pit Dam. The Proponent has indicated that "moderate seepage from the dam during the operational phase would be acceptable provided that the structural integrity of the dam is not compromised."[79] Seepage through dams is generally not considered a problem, as long as the amount of seeping water through the structure is controlled and no particle migration is involved. Under certain circumstances, however, seepage can initiate internal erosion or 'piping' which can seriously damage the structure or the foundation, eventually resulting in serious accidents or failure (Jantzer and Knutsson 2009).

The Main Pit Dam Conceptual Design Report conservatively considers a long-term phreatic surface of 804 m (full supply level). This planning assumption indicates that the retained tailings will be saturated in the long term and that the seepage from the dam will remain a risk factor for piping. The Main Pit Dam will include, however, measures to reduce the risks associated with piping (e.g. appropriate filter zones/material, adequate tailings beach to keep ponded water away from the dam and lower phreatic surface, keyed trench, potential grout curtain, etc). Nevertheless, due to the exposure time involved (in perpetuity), there will be ongoing risks for piping associated with an elevated phreatic surface, erodible material and variable foundation conditions.

Seismicity

There is a risk that a large earthquake might cause catastrophic failure of the Main Pit Dam. The probability of such a catastrophic failure is low, but the consequences should it occur are very high. The Main Pit Dam Conceptual Design Report provides a brief summary of the regional tectonic setting of the Project and indicates that the site is relatively inactive. The Tintina Fault is the closest tectonic fault (~ 75 km to the northeast). Based on the Main Pit Dam's hazard rating, it will be designed to withstand ground motion associated with a 1/5000 year event (i.e. Maximum Design Earthquake MDE).

[79] YOR 2013-0100-025-1

Other Risk Factors

In addition to the risk factors associated with the Main Pit Dam listed above, there are other factors that could affect dam integrity. For example, near the end of the operational phase and into the closure phase, the tailings retained behind the dam may remain saturated at a relatively high elevation. The Proponent notes, "the Main Pit will have a phreatic surface no greater than 804 m; however, it may be somewhat lower."[80] The long-term phreatic surface is uncertain. However, the Proponent is anticipating relatively saturated tailings during the closure phase as indicated by their plan for placing waste rock prior to cover installation due to traffic-ability challenges associated with saturated tailings.[81] A high phreatic surface during operations and into closure/post-closure could present an elevated and ongoing risk for several types of failure modes (e.g. piping and tailings liquefaction potential).

The Proponent has also indicated potential challenges associated with proper tailings deposition in relation to the development of ice lenses within the MPTMF. As noted in the Main Pit Dam Conceptual Design Report, ice lenses could account for up to 20% of the capacity of the MPTMF.[82] In addition to the challenges related to reduced capacity, ice lenses could also hinder proper tailings beach development, which is a key proponent mitigation feature to reduce risks associated with seepage/piping and wave action against the dam.

Perhaps one of the most challenging aspects associated with the proposed Main Pit Dam is the fact that the structure will have to be designed to remain in place in perpetuity. As noted above, some risk factors may dissipate with time as the phreatic surface drops. However, the length of time to adequately reduce the saturation of the tailings is unknown. Furthermore, a permanent drop in the phreatic surface is by no means guaranteed. As such, these risk factors may continue to be relevant into the closure phase. Engineering and building structures to remain in place forever is somewhat unreasonable, even under ideal conditions. Knowing that the dam will be constructed upon challenging foundations in an area that has had recent mass ground movements and infrastructure stability issues, if anything, makes the concept of a permanent structure even more difficult.

> In engineering, designing for 1000 years is essentially designing for perpetuity. Tailings dams are, in that regard, very unique in the engineering world. Very few facilities are designed to last for much longer than a few generations save, for example, spent nuclear fuel disposal sites. In general, it needs be recognized that a flood or earthquake design criterion will have to be at least equal or more stringent for the closure phase than for the production phase, even if the consequences of hypothetical dam failure remain about the same (note that long-term land use changes can occur). This simply is a result of much longer exposure period (design interval) applicable to the closure phase (Szymanski and Davies 2004).

[80] *Ibid*
[81] YOR 2013-0100-065-1
[82] YOR 2013-0100-025-1

5.3.1.4 Risk Factors over the Lifecycle of the Main Pit Dam

Existing risk factors on site may contribute to one or more failure modes. The likelihood of individual failure modes may change, however, depending on the operational status of the dam. This section sections discusses the likelihood and/or potential for different failure modes throughout the lifecycle of the dam.

Construction/Operations

During the operational phase of the Main Pit Dam, there is potential for all of the failure modes listed above to occur. However, the likelihood of certain failure modes varies over time. For example, overtopping is unlikely to occur for most of the operational phase due to significant freeboard availability during the earlier stages of tailings deposition. However, as the tailings/free water surface rises over time and approaches the final design level, there is greater potential for overtopping (e.g. due to extreme precipitation events[83]). Similarly, the likelihood of piping or foundation failure also increases over the operational phase due to the raised phreatic surface over time (seepage and piping risk) and increased loading on the dam (foundation shear surface failure).

The risk of seismic events that could trigger failure modes will not likely change substantially over the duration of operations. However, the magnitude of effects related to failure modes potentially triggered by seismic events would increase. For instance, a seismic event that resulted in ‘liquefied’ tailings at a time when the tailings deposition surface was well below the final design level may not result in a dam breach and associated tailings release. However, a seismic event of sufficient magnitude to ‘liquefy’ the tailings when the deposition surface is near the final design level may result in a dam breach and subsequent release of tailings.

Over time, the risk of most failure modes increases as the level of tailings deposition rises within the MPTMF. Similarly, the magnitude of potential effects due to a dam breach associated with these failure modes also increases due to the rising volume of material that could potentially be released.

Closure

The potential failure modes during closure are similar to those that may occur during the later stages of the operational phase. Notably, the impoundment will be at full capacity and, as indicated by the Proponent’s anticipation of saturated tailings during closure (i.e. plans for traffic-ability challenges), a relatively high phreatic surface.

Post-Closure

There are ongoing risk factors that could affect the long-term integrity of the MPTMF and the Main Pit Dam. Notable examples are associated with the performance of the water conveyance structures and the long-term integrity of the cover proposed for the MPTMF. These components are designed to manage water transport across the facility and to limit infiltration from precipitation events, respectively. If these components do not perform as intended (due to design/construction inadequacies, lack of maintenance or extreme events that alter their integrity), then risk factors such as local erosion and saturated tailings could still result in a dam failure.

[83] The likelihood of overtopping will be reduced by the designed spillway and planned tailings beach (100 m width).

> Stability after closure is a major concern in tailings dam engineering. Many of the physical considerations pertaining to the closure of a tailings facility are the same as those during its operation. The differences are, however, related to the longer time span for which structures need to remain stable. Long-term normally means until the next "ice age" or a couple of thousand years. Thus the difference in time scale is likely to be a minimum of an order of magnitude such as 200 years, or as much as 2,000 years of stability for closure as compared to 20 years of stability for an operating mine.
>
> In the long term, a tailings deposit and its control structures are mainly subject to two classes of disruptive forces:
>
> (a) short duration extreme events such as floods, earthquakes, fires and tornadoes, and
>
> (b) perpetual forces such as water and wind erosion, and frost action (Mylona, et al. 2004).

The likelihood of dam failure during post-closure may be lower than during operations due, at least in part, to the eventual lowering of the phreatic surface. However, as noted above, there is no guarantee that the future groundwater elevation will fall below the natural spill elevation of the Main Pit permanently and there may be future flood events that re-raise the phreatic surface. Additionally, tailings characteristics may also have unintended consequences for the groundwater elevations in the MPTMF. For example:

> Chemical reactions in a tailings deposit may result in a long-term rise of the phreatic surface and/or perched water table as a result of 'hardpan' formation … Chemical reactions may also result in dissolution of minerals contained in dam or dam foundations materials. There was, for instance, much discussion on possible weakening of the marl foundation due to acidic seepage in the case of the 1998 Los Frailes tailings dam failure. Besides the chemical reaction aspects, the potential for piping, filter clogging or creep deformations over hundreds of years cannot really be appreciated by the available dam safety evaluation methods (Szymanski and Davies 2004).

Due to the requirement for the Main Pit Dam to remain intact and functional in perpetuity, there is ongoing potential for failure for an indefinite time period. Some of the design implications and challenges for engineering permanent structures were highlighted above. Stringent design standards, quality assurance/quality control (QA/QC) measures and other mitigations can reduce the likelihood and potential magnitude of a dam failure, but they cannot eliminate the risk entirely. Therefore, there will be an ongoing potential for adverse effects in perpetuity. Based on local conditions on site in the future, the likelihood of failure may increase and/or decrease over time.

5.3.1.5 Main Pit Dam Break Analysis

The Proponent submitted a dam break analysis and associated inundation maps to support their dam hazard classification and to assess the consequences of a failure. This analysis modelled dam breaches under both 'Sunny Day' and 'Extreme Event' conditions. The 'Sunny Day' analysis was modelled as clear water breaching the embankment with an initial standing water level of 805 m. The 'Extreme Event' included analyses of probable maximum precipitation (PMP) events for two scenarios: one where the Main Pit Dam is breached and another where the Main Pit Dam remains intact. Figure 12 below provides a simplification of the 'Sunny Day' and 'Extreme Event (Rainy Day)' conditions prior to a dam failure.

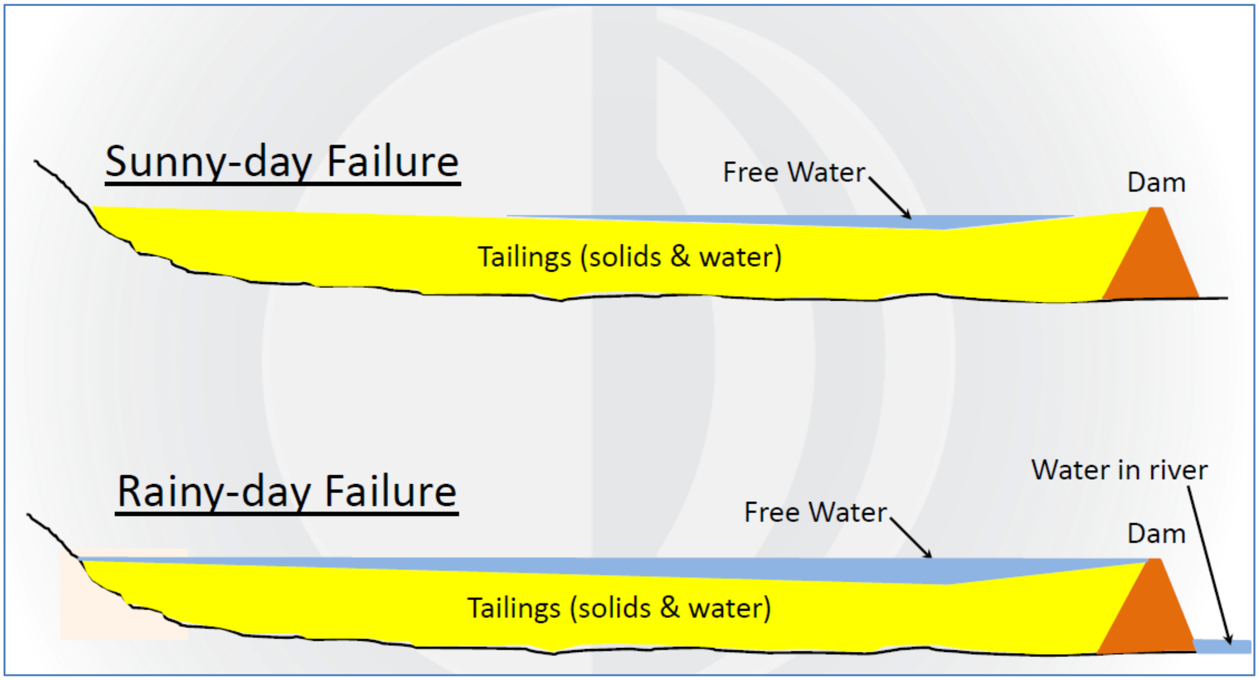

Figure 12: Illustration of supernatant water elevations in tailings dam during 'sunny-day' and 'rainy-day' conditions. Sourced from (Dalpatram 2011).

The following bullets further clarify between these two conditions:

"Sunny-day" Failure

- Supernatant pond at maximum normal operating level;
- Normal flows in watercourse downstream of the dam;
- Caused by earthquake, seepage, foundation failure, etc.

"Rainy-day" Failure

- Flood-induced failure;

- Supernatant pond at design flood level, or higher;
- Flood flows in watercourse downstream of the dam (i.e., flows most likely to occur coincident with the breach event);
- More water than sunny-day failure; more tailings mobilized;

In addition to the characteristics listed above, there are other potential differences between the two conditions that are important. Notably, are the differences in warning signs of initiating conditions that increase risk factors for dam failure that may or may not give the mine operations staff appropriate time to react to an imminent failure. For instance, a seismic event of sufficient magnitude to liquefy the tailings and result in a dam breach in a ‘Sunny Day’ condition may have little in the way of warning signs and, in turn, little time to react to a catastrophic failure. In contrast, an extreme precipitation event may lead to an increase in water levels within the facility that could be tracked and monitored with appropriate management actions taken accordingly (e.g. timely evacuation of personnel within the inundation zone). In both conditions, there could be a catastrophic dam failure; however, between the two conditions, there could potentially be a significant difference in terms of the amount of time between the initiating events (i.e. seismic vs extreme precipitation) and the ultimate dam failure.

The Proponent’s dam break analysis simulated five different breach scenarios to determine the appropriate characteristics for input into the breach analysis for the Main Pit Dam. Breach 2 was selected as the representative hydrograph and its characteristics are listed in Table 12 below.[84] The volume of material released during this breach was modelled to be 332,000 m^3 (approximately 11% of tailings stored above the base of Breach 2 (786 m). Tables 13 and 14 illustrate location-specific breach impacts under both ‘Sunny Day’ and ‘Extreme Event’ scenarios.

Table 12: Breach 2 from Dam Break Analysis. Sourced from 2013-0100-173-1.

Initial Condition (m)		**Rate of Development (m/hr)**		**Final Condition (m)**
Width	Elevation	Horizontal	Vertical	Elevation
5	796	10	10	786.2

[84] See Table 2 from Dam Break Analysis report (YOR Doc #), include rationale for breach choice

Table 13: Location-Specific Breach Impacts Associated with Sunny-day Breach. Sourced from Sourced from 2013-0100-173-1.

Location	Maximum Water Depth (m)	Maximum Velocity (m/s)	Sediment Deposition (m)
Mill Water Pond	1.96	1.87	4.6
Mill Complex	0.64	2.32	0.1
Along Camp	0.92	4.33	Net Scour
Upstream of Reservoir	0.69	2.85	Net Scour
Downstream of Reservoir	0.80	3.84	Net Scour

Table 14: Location-Specific Impacts Associated with PMP Flood Event Breach. Sourced from 2013-0100-173-1.

Location	Without Main Dam Breach		With Main Dam Breach	
	Maximum Water Depth (m)	Maximum Velocity (m/s)	Maximum Water Depth (m)	Maximum Velocity (m/s)
Mill Water Pond	1.81	0.17	1.90	1.75
Mill Complex	0.22	0.70	0.83	2.07
Along Camp	0.44	2.38	0.70	3.02
Upstream of Water Storage Pond	0.41	3.27	0.65	4.73
Downstream of Water Storage Pond	1.18	3.93	1.89	4.61

Hydraulic analysis for Minto Creek from the Water Supply Pond to the Yukon River during a probable maximum flood (PMF) was also modelled under four scenarios:

- PMF with proposed infrastructure in place;
- PMF with Water Storage Dam failure;
- PMF with tailings dam failure; and

- PMF with both Water Storage Dam and tailings dam failures.

Results from these scenarios are shown in Table 15 below

Table 15: Minto Creek Water Storage Dam Break Model Results. Sourced from 2013-0100-173-1.

	No Main Dam Breach				Main Dam Breach				Main Dam Breach Impact[1]			
	PMF		PMF + WSD Breach		PMF		PMF + WSD Breach		PMF		PMF + WSD Breach	
Cross Section	Max. WSEL	Max. Width	Max. WSEL	Max. Width	Max. WSEL	Max. Width	Max. WSEL	Max. Width	Max. Change in WSEL	Max. Change in Width	Max. Change in WSEL	Max. Change in Width
6175	664.2	37	665.4	62	664.7	48	665.6	66	0.5	11	1.4	29
4577	633.1	92	633.9	108	633.4	101	634.1	110	0.3	9	1.0	18
2730	598.8	94	599.3	103	598.9	96	599.5	106	0.1	2	0.7	12
615	482.7	104	483.7	115	483.2	109	483.9	117	0.5	5	1.2	13

Notes:
All units in metres.
WSEL = water surface elevation
WSD = Water Storage Dam
(1) Impacts compared with the PMF case with no breach of either dam.

See figures in Appendix C for a sampling of inundation maps includes in the Dam Break Analysis report (YOR 2013-0100-173-1 and -174-1).

5.3.1.6 Main Pit Dam Hazard Classification

The Proponent's conceptual design for the Main Pit Dam is based upon their preliminary Hazard Classification of 'Very High' (in accordance with CDA technical bulletin "Inundation, Consequences and Classification for Dam Safety"). This classification is based on the severity of potential adverse effects to six consequence categories that could result from a dam breach. The six consequence categories include life safety, economic impacts, environmental consequences, cultural losses, cascade projects and incremental and total consequences.

Table 16 shows the Proponent's summary of the consequences of failure for the proposed Main Pit Dam, based on the highest classification associated with incremental losses (loss of life).

Table 16: Summary of Consequences of Failure of the Main Pit Dam. Sourced from 2013-0100-173-1.

Consequence Category	Incremental losses	Associated Dam Class
Loss of Life	100 or fewer	**Very High**
Environmental and Cultural Values	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Significant
Infrastructure and Economics	Low economic losses; area contains limited infrastructure or services	Low

In general, the principles of dam design are satisfactory for the Main Pit Dam in accordance with the quoted design aids / guidelines. The Proponent acknowledges the challenges associated with differential settlement of the dam foundation due to permafrost thaw and consolidation of overburden soils, and commits to detailed geotechnical investigation, laboratory testing and analyses at the detailed design phase. The Proponent acknowledges that further geotechnical investigations may identify liquefiable foundation soils, even though the region is currently considered to have relatively low seismicity and recognizes that further characterization is required. The Proponent also recognizes that liquefaction analyses must be undertaken if liquefiable soils are identified, and commits to adapting the design to ensure appropriate management of this risk.

The Proponent has provided a table of factors of safety for static and seismic assessment (Tables 17 and 18). The proposed factors of safety for the design of the Main Pit Dam are conforming to the factors of safety recommended by the CDA Safety Guidelines. Where there is a range of minimum factor of safety provided by the Guidelines, e.g. 1.2 to 1.3 for full or partial rapid drawdown, the Proponent has chosen the higher of these minimums, e.g. 1.3. The Proponent has also recognized that the level of safety of this particular dam, given the history of instability, cannot easily be measured using the traditional factor of safety approach. Hence, the Proponent proposes to complement the traditional approach with a risk-based approach. This approach is also recognized in the CDA Safety Guidelines and this combined approach is considered to be appropriate.

Tables 17 and 18 – Proposed Factors of Safety for Slope Stability (static and seismic conditions) for the Main Pit Dam. Sourced from 2013-0100-167-1.

Factors of Safety for Slope Stability – Static Assessment

Loading Condition	Minimum Factor of Safety[1]		Slope
	As defined in CDA (2007)	As proposed for Main Dam	
End of construction before reservoir filling	1.3	1.3	Upstream and downstream
Long term (steady-state seepage, normal reservoir level during, i.e. operational phase)	1.5	1.5	Downstream
Long term (steady-state seepage during closure)	n/a	1.5	Downstream
Full or partial rapid drawdown (operational phase)	1.2 – 1.3[2]	1.3	Upstream

[1] Factor of safety is the factor required to reduce operational shear strength parameters to bring potential sliding mass into a state of limiting equilibrium (using generally accepted methods of analysis).

[2] Higher factors of safety may be required if drawdown occurs relatively frequently during normal operation.

Factors of Safety for Slope Stability – Seismic Assessment

Loading Condition	Minimum Factor of Safety	
	As defined in CDA (2007)	As proposed for Main (Dam)
Pseudo-static	1.0	1.0
Post-earthquake	1.2 – 1.3	1.3

5.3.2 Limitations of the Assessment

The assessment assumes that the dam will be built consistent with the description in the Main Pit Dam Conceptual Design Report[85] and supporting proposal documents. It is recognized that there is uncertainty surrounding many aspects of the dam (e.g. foundation characterization/suitability, suitability of construction materials, etc) and that the submitted design is 'conceptual.' The Proponent has included a list of site characterization work that is required, and that will be completed, prior to construction. This work will inform the detailed engineering plans and designs of the dam including detailed foundation characterization, borrow identification and characterization, tailings confirmation characterization, and geotechnical and hydro-technical engineering analysis. It is possible that the results of this characterization work reveal conditions that may challenge the feasibility of the dam design as currently presented.

Since characterization work in advance of detailed engineering has yet to be completed, the Designated Office does not have the opportunity to review this information. However, the Designated Office assumes further characterization will allow for the Main Pit Dam construction to be completed as proposed. Any material changes in the Main Pit Dam design would fall outside the scope of this assessment and may require re-assessment.

5.3.3 Regulatory Context for Dams in Yukon

YESAB and regulatory bodies (e.g. Yukon Water Board) apply the latest version of CDA's Dam Safety Guidelines for the Consequence of Failure classification, as well as for the design, monitoring and maintenance of dams. However,

> To date, no province or territory explicitly references the CDA Dam Safety Guidelines within its legislation or regulations. The Guidelines are frequently referenced in working documents and regional guidelines and standards of practice and/or parts of the Guidelines explicitly written into the legislation and regulation, but not named as CDA Guidelines.
>
> The Canadian Dam Association Dam Safety Guidelines have been revised in 1999 and 2007 and continue to grow. In 2007, technical Bulletins were added to provide more in-depth discussion on particular items related to the dam industry. Additional Bulletins in progress include mining dams, oil sands dam closure and issues related to the operation of small dams (Campbell 2010).

Dam proposals need to include information on dam design, baseline information to support the design, and information about the potential environmental and socio-economic effects of the dam. The greater the potential effects/risks of a dam, or effects related to its potential failure, the more detailed the information will need to be.

Dams are primarily regulated by water licenses issued under the Yukon *Waters Act*; however, there is no specific legislation governing dams in Yukon. Dam height, storage volume and hazard dictate the type of license required and based on the Main Pit Dam conceptual design, the Proponent will require a type "A"

[85] YOR 2013-0100-025-1

license. A water license will contain conditions which the licensee must adhere to, including, but not necessarily limited to: monthly and annual reports, an annual geotechnical inspection, dam safety reviews every five years, monitoring of piezometers, water levels and outflows. CDA Guidelines are used to help set these conditions.

Once a dam has been licensed, Water Resources of Yukon Environment takes on a monitoring and enforcement role. Information from monthly, annual and annual geotechnical reports are passed on to Water Resources, who also conduct routine inspections of dams and works with dam owners to insure compliance to the license conditions.

5.3.4 Consideration Non-Discretionary Legislation

- Waters Act and Waters Regulation

5.3.5 Consideration of Regulatory Guidance Documents and Polices

Yukon Government and the Yukon Water Board have developed guidance documents for Proponents that provide a framework for managing projects using best practices. Requirements listed within the Plan Requirement Guidance for Quartz Mining Projects (PRGQMP), Reclamation and Closure Planning for Quartz Mining Projects (RCPQMP) and the Yukon Mine Site Reclamation and Closure Policy (YMSRCP) will be considered by the Designated Office in determining the significance of a potential dam failure.

The PRGQMP refers to several policies, guidelines, codes, manuals, etc. that “have been accepted by Energy, Mines and Resources as providing approaches that will be relied upon in reviewing environmental and operational plans” (Yukon Water Board and Yukon Government 2013). Some of these documents that are applicable to the proposed Main Pit Dam and associated plans include:

- Canadian Dam Association. Dam Safety Guidelines.
- Mining Association of Canada, 2011. A Guide to Audit and Assessment of Tailings Facility Management.
- Mining Association of Canada, 2011. A Guide to the Management of Tailings.
- Mining Association of Canada, March 2007. Crisis Management Planning Guide.
- Mining Association of Canada, 2003. Developing an Operations Maintenance and Surveillance Manual for Tailings and Water Management Facilities.

These documents provide invaluable insights and guidance and, in concert with additional specific requirements listed in the PRGQMP, are comprehensive in their recommendations for the development of a robust set of management, operational and monitoring plans.

Section 14 of the PRGQMP speaks to the development of a Tailings Management Plan and includes specific requirements for tailings dams including:

- Operation, maintenance and surveillance;
- Tailings deposition strategy;
- Emergency management; and

- Adaptive management plans.

The RCPQMP is intended to assist proponents with the development of a Reclamation and Closure Plan (RCP) and appropriate liability estimates for quartz mining projects. The RCPQMP includes reclamation and closure principles that apply to the entire mine site; however, some of these principles are particularly relevant to the proposed Main Pit Dam, including:

- Design for closure: Mine components should be designed and constructed to meet closure needs;
- Plan for long-term monitoring and maintenance: Anthropogenic structures (e.g., dams, diversions, waste rock dumps, spillways, covers and passive treatment facilities) require long-term monitoring and maintenance. RCPs should describe proposed long-term monitoring and maintenance activities, and should not focus on complete walk-away plans.

Monitoring, maintenance and reporting are important components of RCPs and plans for these activities should address their requirement for the long term. "Dams that are to remain in place must meet the provisions of the Canadian Dam Association Guidelines and must be certified by a qualified engineer with respect to their long-term physical and chemical stability" (Yukon Water Board and Yukon Government 2013). Additionally,

> If the closed site will include water conveyance or containment facilities, then estimates should include costs for permanent monitoring and maintenance of these facilities (including access costs) unless it can be demonstrated that they pose no environmental, social or economic risk should they fail in the long-term. Assume that some level of periodic maintenance will be necessary for all engineered facilities whose continued function is essential to achieve reclamation objectives. When estimating costs for these facilities, include any costs that would be associated with continued maintenance of permits and licences in the long-term (Yukon Water Board and Yukon Government 2013).

The YMSRCP notes that "the duration of the required monitoring phase will depend on the risks associated with the potential impacts on the environment" and that the "Yukon government will continue to hold an appropriate amount of security to cover future monitoring costs, maintenance requirements and any mitigative contingencies, including holdbacks for stabilization and verification requirement" (Yukon Water Board and Yukon Government 2013). Since the Main Pit Dam and associated water conveyance structures will likely require some level of monitoring and maintenance in perpetuity, there needs to be adequate security held for these requirements in perpetuity as well. Additionally, since there will also be an ongoing risk of dam failure, consideration should be given to the requirement for adequate resources to be held to address activities associated with stabilizing and cleaning up after a dam failure.

5.3.6 Consideration of Proponent Commitments

- The Main Pit Dam will be designed (and ultimately constructed, operated and closed) in accordance with current Canadian (federal and territorial) and international best practice guidelines and principles. Specifically this includes, but is not limited to:

    - Canadian Dam Association's Dam Safety Guidelines;
    - DRAFT Technical Bulletin on Mining Dams (note this has only been distributed to CDA members and Peer reviewers at this time);
    - ICOLD Bulletin 139 "Improving Tailings Dam Safety: Critical Aspects of Management, Design, Operation, and Closure";
    - Mining Association of Canada's "Guide to the Management of Tailings Facilities" (MAC 1998), and "Developing and Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities; and
    - Yukon Environmental and Socio-economic Assessment Boards' (YESAB) "Dam Guide: Design Expectation and Required Information."
- Overall dam geotechnical stability will be in accordance with requirements stipulated in the Canadian Dam Safety Guidelines (2007). This includes minimum factors-of-safety for static and seismic assessments for upstream and downstream dam slopes.
- The traditional standards based approach, as determined by factors of safety, will be complimented with a risk based approach as defined in Section 6 of CDA (2007), (and recently updated, CDA (2013a)).
- Preliminary observations about the foundation conditions will be confirmed through further characterization, and should it be concluded that liquefaction of the foundation soils are in fact possible, the design will be adapted as necessary to ensure appropriate risk management.
- The tailings deposition plan calls for depositing of a tailings beach at least 100 m wide upstream of the dam, which will lengthen the seepage path considerably, with the resultant effect of limiting seepage rates via these pathways.
- Further characterization and associated numerical analysis studies will be carried out to confirm the likelihood and magnitude of seepage via these pathways (i.e. intercepted fault zones and/or the paleochannel).
- A rigorous instrumentation and monitoring program will be implemented.
    - Monitoring instrumentation will consist of direct and indirect methods. Direct monitoring will comprise of deformation and settlement monitoring, which will provide precise information as to the magnitude of movement. Indirect monitoring, consisting of piezometric levels and thermal monitoring, will provide early warning signs associated with the fundamental processes that may trigger foundation instability.
    - Deformation monitoring will include slope inclinometers installed along the downstream slope of the dam. These instruments will not only include shallow instruments within the dam structure, but also deep instruments to specifically monitor foundation creep.
    - Given the overburden gradient downstream of the dam, a series of deep slope inclinometers will also be installed downstream of the dam to provide early warning of potential large scale movements triggered by the dam.

  - Both crest and embankment settlement will be monitored using a series of permanent settlement beacons strategically placed along the dam. These will be monitored using precise survey techniques.
  - Vibrating wire piezometers and deep ground temperature cables will be installed within and immediately up and downstream of the dam

- Notwithstanding the proposed instrumentation and monitoring plan, an observational approach will be adopted to continuously evaluate and, if necessary, implement contingency plans throughout the life of the structure.
- Comprehensive Quality Assurance and Quality Control procedures will be developed and documented in a technical specifications document at the detailed engineering stage of the project.
- Complete documentation of all quality assurance and quality control data will be provided in the relevant as-built reports.
- An operation, maintenance, and surveillance (OMS) manual and emergency preparedness plan (EPP) will be prepared and submitted to regulators prior to commissioning the Main Pit Dam. These will be prepared in general accordance with the Dam Safety Guidelines published by the Canadian Dam Safety Association (2007).
- The performance of Main Pit Dam will be evaluated throughout its life-cycle which includes a construction, operational, closure and post-closure phase.
- If a dam failure were to occur, mitigation of effects would likely consist of measures to reduce the effects to Minto Creek, for example stabilization of the dam breach and remaining upstream tailings mass, restoration of portions of the Minto Creek channel that were subject to severe scour, and excavation of all recoverable tailings deposits and consolidating and stabilizing the recovered tailings in a suitable location. In the event of a breach, the actual mitigation required would depend on the details of the effects.

5.3.7 Significance Determination

As acknowledged above, there is no way to **eliminate** the possibility of a Main Pit Dam failure. Design standards, best practices, Proponent commitments and adherence to legislative requirements all work toward **reducing** the likelihood of a failure. Furthermore, the comprehensive and prescriptive nature of the surveillance, monitoring, and maintenance requirements outlined in the relevant guidance documents above will also aide in **reducing** the likelihood and/or magnitude of a failure. In comparison, contingency measures included in adaptive management practices, in addition to sufficient financial security to address potential outfall of a failure, may only **control** the magnitude of effects.

In addition to considerations discussed in sections above, the Designated Office used the following criteria to assist in determining the significance of a failure of the Main Pit Dam:

Magnitude: As noted above, in the interests in assessing a Main Pit Dam failure conservatively, the ‘worst case’ scenario is considered. As such, a ‘rainy day’ failure with the maximum number of individuals in the inundation zone during operations could result in the death of up to 90 individuals.

The Designated Office acknowledges that the greatest threat to health and safety is during operations due to the greatest number of individuals that may be present in the inundation zone. As the mine transitions to closure and post-closure activities, the number of individuals on site will decrease substantially.

The magnitude of a loss of life due to a dam failure lives is considered an 'extreme/severe' adverse effect.

Location/extent: The potential effects to health and safety are localized to the inundation zone downstream of the Main Pit Dam within the Minto Creek drainage. The primary risk is to workers employed at the site working in the inundation zone.

Scale: Although direct effects of a Main Pit Dam failure would be localized, the indirect effects could have impacts regionally, nationally and internationally depending on the victims involved.

Timing: The magnitude of potential adverse effects is greatest during the operational phase due to presence of the largest population within the inundation zone. The magnitude is likely greatly reduced during the post-closure phase when there may not be any individuals in the inundation zone. Regardless, at any time there are any individuals within the inundation zone, there is potential for loss of life. That being said, the greatest risk to health and safety is during operations.

Duration: The Proponent anticipates an end to the operational life of the mine in 2022, with a subsequent transition to reclamation/closure and post-closure monitoring beginning in 2024. Potential risks to health and safety from a Main Pit Dam failure are ongoing, whenever there are individuals within the inundation zone.

Frequency: A Main Pit Dam failure would likely be a one-time event, with possible associated site conditions and other infrastructure failures, that could also pose health and safety hazards.

Reversibility: Any loss of life would be irreversible.

Socio-economic context: A Main Pit Dam failure would occur within the overall context of a remote mine setting. The Proponent must comply with applicable legislation, and has committed to the development and implementation of emergency plans. Mine employees and contractors within the inundation zone are expected to be well informed of risks, roles and responsibilities in the event of a dam failure.

The Project is occurring on SFN Category A Settlement Land. Through interviews with SFN elders and citizens, SFN members indicated that they use the area for subsistence and other cultural activities and desire that the area remain a site of continued cultural land use.

Likelihood: It is highly unlikely, in a 'worst-case' scenario, that 90 people would be present within the inundation zone. Furthermore, it is expected that surveillance monitoring of the dam and any associated emergency response actions initiated by a failure would provide measures to direct people away from 'danger zones.' The combination of existing legislation, best practice guidelines, Proponent commitments and engineering designs will work toward reducing the likelihood of a Main Pit Dam failure to 'very low/unlikely.'

Due to the extreme/severe magnitude and irreversibility of potential adverse effects and the long duration/presence of the dam (in perpetuity), the Designated Office has determined that the Project may result in significant adverse effects to health and safety such that additional mitigation is required.

Mitigations:

1. The full buttress of the Main Pit Dump shall be built and displacement of the Main Pit south wall arrested prior to any further construction of the Main Pit Dump.

   Rationale: *Adding load without adding resistance (e.g. fully constructed buttress, or filling the main pit with tailings) presents a heightened risk of structural instability.*

2. In situ monitoring devices shall be installed, such as inclinometers, surface monitoring points, and vibrating wire piezometers to aid in determination of the cause of fissures observed at the surface of the in-pit dump and to monitor the changes in geometry or pore pressures in the in-pit dump area.
3. Additional analyses shall be conducted to clarify the assumptions of the Main Pit Dump stability analyses and to indicate what the limiting case is (e.g. waste rock dump fully constructed, but tailings not yet up to Elev. 804 m) to determine the short-term factors of safety.
4. Given the inherent uncertainty in the foundation conditions for the dam and the potential loading the dam must resist in the long term (in perpetuity), the final design of the Main Pit Dam shall conform to the minimum factors of safety as indicated by the Proponent in the information response (shown within Tables 1 and 2 in Information Request (B) Response, YOR 2013-0100-167-1).

   Rationale: *If there is a significant departure from the approach and geometry provided in the Main Pit Dam Conceptual Design Report and Proponent responses to Information Requests, or a departure from the factors of safety provided in the Proponent's response, then the conclusions supporting this recommendation may no longer be valid and the dam design may need to be re-assessed.*

5. The Proponent shall provide regulators a Quantitative Risk Assessment for the Main Pit Dam as indicated in Part 6 of the Canadian Dam Safety Guidelines (CDA 2007).
6. In order to mitigate or reduce risk, further detailed geotechnical investigations are recommended to be undertaken to better refine the subsurface model, and detailed geotechnical laboratory testing is recommended for the foundation and dam fill materials to better define the range of geotechnical properties to be used in design. The results of these investigations shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.
7. Given the site wide instabilities and potential for foundation instabilities (e.g. paleochannel, long-term slope movement, etc.), a sensitivity analysis on all the geotechnical parameters shall be undertaken to understand the implications (size, volumes, slope angles, costs) on the design configuration, on the factors of safety and on the risk assessment. The results of the sensitivity analysis shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.
8. To mitigate the potential for differential settlement of the dam foundation due to thawing permafrost and consolidation of unfrozen overburden soils, detailed geotechnical investigation, laboratory testing and analyses shall be undertaken to better define the

range of geotechnical properties to be used in settlement analyses. The results of these investigations shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.

9. To mitigate long-term risk to the Main Pit Dam, the models used in developing Main Pit Dam designs shall maintain the phreatic surface at Elev. 804 m, as a conservative approach.

Rationale: *The Proponent indicated that the phreatic surface in the impoundment is expected to be at Elev. 804 m and the Proponent indicates that it may lower over time. However, since the phreatic surface is such a sensitive factor in stability calculations, the models should maintain a conservative phreatic surface.*

10. The inflow design flood shall be conservatively set at the Probable Maximum Flood level. The earth dam and the spillway designs should take into consideration the effects of the Probable Maximum Flood.

Rationale: *Although the CDA guidelines recommend an inflow design of 2/3 between the 1/1 000 year and the Probable Maximum Flood, these guidelines must be considered in the context of this specific project. This guideline is not sufficiently conservative in this circumstance for two primary reasons:*

a) Limited climatic data exists for the mine site on which to determine long term climate trends and extreme events; and
b) Climate models predict potential for significant climatic change in Yukon including increases in extreme weather events (ref).

Considering the expected design life (in perpetuity) and significant uncertainty regarding the magnitude of future weather events, the precautionary approach must be applied.

11. The Proponent shall submit plans to the regulator(s) for their tailings depositions strategy (over the life of the impoundment) to provide assurance that a minimum tailings beach width of 100 m will be achieved.

Rationale: *Tailings beaches are important for seepage control, lowering the phreatic surface/hydraulic gradient, keeping ponded water away from the crest and for dam stability.[86] The Proponent indicated that the tailings deposition strategy will create a tailings beach with a minimum width of at least 100 m on the upstream side of the dam. However, the Proponent also noted that ice lenses, which could account for up to 20% of the capacity of the MPTMF could "hinder proper tailings beach development."[87] Current CDA guidelines do not contemplate the concept of a tailings beach (although, the Draft CDA Technical Bulletin for Mining Dams does include information regarding tailings beaches and their implications for tailings dams). Since the proposed tailings beach is so integral to the overall design and function of the MPTMF, it is important that the*

[86] Definition of spigotting stations and the tailings deposition plan for the tailings, over the life of an impoundment, is important for maintenance of tailing beaches, particularly where they are required for seepage control and dam stability (McLeod and Plewes 2003).
[87] YOR 2013-0100-125-1

Proponent provide assurances at the design stage that the tailings deposition strategy is conducive to adequate tailings beach width (particularly in light of challenging site conditions, i.e. ice lens development).

5.4 Residual Effects

The Designated Office considered the residual risk of a failure that will remain after adherence to legislation/regulations, guidelines, best practices and implementation of Proponent commitments (including proposed design standards). The recommended mitigations above are intended to further reduce the likelihood and/or magnitude of a failure. That being said, there is no way to eliminate the possibility of a dam failure. Therefore, even after the application of mitigations, and ongoing or residual risk of a dam failure remains.

5.4.1 Risk of a Main Pit Dam Failure

In consideration of a Main Pit Dam failure, the two most substantial criteria in the significance determination above are magnitude and likelihood. These two criteria have parallels within risk analysis frameworks, which define risk as a product of severity (magnitude) and probability (likelihood). Because it is not possible to reduce the probability of failure in the Main Pit Dam to zero, it is necessary to analyze this component further in terms of residual risk.

ICOLD defines risk as a "Measure of the probability and severity of an adverse effect to life, health, property, or the environment" (ICOLD 2005). If constructed, the Main Pit Dam will pose risk throughout the design life of the facility (i.e. in perpetuity). The level of risk will vary with time, as the consequence of a failure changes (i.e. operational period compared to post closure) and with the various factors affecting the integrity of the Main Pit Dam into the future (as discussed above). As the risk from the Main Pit Dam cannot be eliminated, it is important that the ongoing risk associated with the Main Pit Dam be acceptable or tolerable from the perspective of society.

Societal risks stem from people's concerns. People's concerns can be divided into two general categories:

1. Individual concerns – how individuals see the risk from a particular hazard affecting them and things they value personally …they may be willing to live with a risk that they do not regard as negligible, if it secures them or society certain benefits" provided that such risks are "kept low and clearly controlled.
2. Societal concerns – the risks or threats from hazards which impact on society and which, if realized, could have adverse repercussions for the institutions responsible for putting in place the provisions and arrangements for protecting people …." Societal concerns include multiple fatalities, exposure of especially sensitive groups, and the uneven distribution of risks and benefits. The occurrence of multiple fatalities in a single event are referred to as "societal risk", which is "therefore a subset of societal concerns (HSE 2001).

Acceptability of risk is fundamentally an exercise in judgement. Risk is part of life, and everyone is exposed to risk on a daily basis. We live with and accept certain levels of risk as a society.

> For a modern society to exist we must take risks, but when such risks have the potential for great harm and even loss of life we cannot call these potential outcomes acceptable. However, we are prepared to tolerate or "live with" the potential that these consequences may occur in order to achieve the benefits that come from taking the risks… (Bowles 2007).

An acceptable balance must be struck between the protection of individuals or society (risk avoidance) and the desire to realize the benefits that come with certain development (risk exposure). It is important to recognize the two principles upon which tolerable risk must be evaluated. ICOLD defines the two fundamental principles as:

- Equity – the right of individuals and society to be protected, and the right that the interests of all are treated with fairness; and
- Efficiency – the need for society to distribute and use available resources so as to achieve the greatest benefit (ICOLD 2005).

A base acceptability value for risk can be developed based on what is referred to as "background" risk and is expressed as a probability of death on an annual basis. A base value of risk is determined based on the lowest average annual background risk of death for any gender/age group. From this, societal risk can be divided into categories. These categories and associated risk probabilities are summarized in CDA Guidelines:

- **Broadly acceptable risk** - An annual risk of casualty that is lower than 10^{-6} from any particular source is generally taken as a negligible level of risk.
- **Tolerable risk** - An annual risk of casualty (fatality) between the values of 10^{-6} and 10^{-4}, provided the risk is as low as reasonably practicable at the time.
- **Unacceptable risk** - An annual risk of casualty to members of the public from a hazardous facility in excess of 10^{-4} has been explicitly deemed to be intolerable under normal circumstances. This does not preclude individuals from regular participation in sporting or recreational activities involving much higher levels of risk, often in the range of 10^{-3} to 10^{-2}.

  $P_{LOL}=P_{Event} \times P_{Failure/Event} \times P_{Fatality/Failure}$ (See p. 14 of CDA Technical Bulletin for definitions)[88]

Out of the categorization of risk comes an important distinction between broadly acceptable risk and tolerable risk. As noted above, the probabilities of fatality range across two orders of magnitude for the "tolerable" risk category (CDA 2007). It is important to note the differences between acceptable and tolerable risk and to highlight some important considerations for dams built to risk levels in the tolerable risk range.

- Acceptable risk is "a risk, which for the purposes of life or work, everyone who might be impacted is prepared to accept assuming no changes in risk control mechanisms" (HSE 1995).
- ICOLD (2005) defines tolerable risk as "a risk within a range that society can live with (1) so as to secure certain net benefits. It is (2) a range of risk that we do not regard as negligible or as

[88] (CDA 2007)

something we might ignore, but rather as something we need to (3) keep under review and (4) reduce it still further if and as we can (Bowles 2007).

The risk associated with the Main Pit Dam likely falls within the "tolerable" category, but this must be determined through a thorough risk assessment of the facility. There are four important conditions that must be met when evaluating whether a risk from a dam can be tolerable or not. The following conditions must apply:

1. "to secure certain net benefits": dams are initially constructed to provide benefits to their owners or to society in general; but some are decommissioned when they no longer serve a useful purpose or their impacts are judged to outweigh their benefits.
2. "a range of risk that we do not regard as negligible or as something we might ignore": in most cases dam failure risks are not considered to be negligible, except possibly for the smallest of dams in very remote locations or for such unlikely failure modes as one caused by a large meteor impact.
3. "keep under review": traditional dam safety programs include a regime of surveillance and periodic inspections and design reviews.
4. "reduce it still further if and as we can": risks associated with existing dams are reduced below their design levels through structural and non-structural measures, including improved dam safety management systems (Bowles 2007).

A unique situation exists with the proposed Main Pit Dam due to its location on SFN Category A Settlement Land. As of 2012, SFN beneficiaries made up approximately 11.5% of the workforce at the mine.[89] Based on the framework above, the Main Pit Dam likely falls into the 'tolerable' category for society-at-large. However, SFN is the land 'owner' in this case and, in the long-term, will be the 'society' that would be most affected by a dam failure. As such, it is imperative that their voice and position play a key role in the decision to accept or reject the Main Pit Dam.

During the assessment, SFN's consultants raised concerns regarding the Main Pit Dam and advised SFN that "the foundation conditions are not suitable for the structure proposed, such that the Dam should not be built in that location."[90] The Designated Office recognizes that there is further site characterization work and detailed engineered designs to be completed. The results of this work may alleviate or aggravate SFN's concerns regarding the Main Pit Dam. Regardless, SFN must be a partner in the decision to determine whether the risk associated with the Main Pit Dam is 'tolerable' to them or not. A decision to approve the Main Pit Dam in opposition to SFN's position would equate to imposing unwanted risk to the group that would be most affected by a dam failure.

As noted above, the Designated Office is of the opinion that risk associated with the Main Pit Dam falls within the 'tolerable' category (after implementation of Proponent commitments and adherence to legislation, guidelines and recommended mitigations below). However, the Designated Office also recognizes the special status of Category A Settlement Land as well as the uniquely vested interests that SFN has in its lands. As such, the construction of the Main Pit Dam should only go forward with the

[89] YOR 2013-0100-012-1
[90] YOR 2013-0100-215-1

blessing of SFN. Additionally, if SFN is in agreement with the Main Pit Dam construction, there should be adequate resources in place to ensure that requirements for monitoring, maintenance and emergencies (e.g. clean-up post failure) are in place in perpetuity.

A dam failure that released retained materials (water, tailings) and resulted in any loss of life would be considered significant. As noted above, there is no way to entirely prevent a failure. However, there are reasonable and practical measures available to further reduce the likelihood of a failure. Proposed design standards, Proponent commitments and compliance with existing legislation and guidelines will decrease risk associated with a Main Pit Dam failure. However, the Designated Office has determined that the Project may still result in significant adverse residual effects and that further mitigation is required.

Mitigations:

12. Yukon Government shall engage Selkirk First Nation in determining the acceptability of the final plans for the Main Pit Dam that include and take into account the results of a Quantitative Risk Assessment. The determination should be made on the basis of consensus.

    Rationale: *Given that SFN, as the landowner, must accept a level of risk of dam failure, this condition will ensure social acceptability of that risk. As discussed in this report, a failure of the Main Pit Dam would have significant adverse effects to SFN's citizens and their Category A settlement land. Although the rights to administer mining activities on the Minto Mine Property are retained by Yukon Government, adverse effects from a failure of the Main Pit Dam would extend well beyond the mine site in terms of both loss of life for SFN citizens and environmental degradation. A decision to approve the Main Pit Dam in opposition to SFN's position would equate to imposing unwanted risk to the group that would be most affected by a dam failure.*

13. As part of a detailed maintenance and monitoring plan for the Main Pit Dam, the Proponent shall provide regulators and Selkirk First Nation with a comprehensive evaluation of expected monitoring and maintenance costs, as well as costs associated with a dam failure, through the design life of the dam. In addition to the money currently held, Yukon Government shall ensure that sufficient security is provided by the Proponent to cover the costs of ongoing maintenance and monitoring requirements, as well as costs associated with a failure of the Main Pit Dam.

5.5 Cumulative Effects

The spatial scope considered for the cumulative effects assessment for health and safety includes the Minto Mine site and access road. There are no other known existing or proposed activities from other projects within this area and, as such, there are no other residual effects that could interact with the residual effects from the Main Pit Dam. However, there are existing activities within the mine site and access road from previous/ongoing mine phases that may have residual effects that could interact with residual effects from the dam (i.e. currently licensed activities). Some of these activities include open pit mining, underground mining, hauling/processing of ore and concentrate, transport of fuel, waste and supplies, explosive management and use as we as a variety of other associated activities.

As noted above, both open pit and underground mining involve inherent risks to health and safety. There are myriad ways for mine components to fail, for human errors to occur and/or for mechanical complications. It is possible for certain adverse residual effects of a Main Pit Dam failure to interact with residual effects of existing activities (e.g. a seismic event could trigger a collapse of underground mining areas as well as a dam failure with subsequent flooding of undergoing workings linked to the inundation zone). However, most conceivable accidents, malfunctions and/or other events that lead to adverse health and safety effects are likely to be isolated incidents. A major catastrophic event that leads to the failure of several mine components, the effects of which could interact, while possible, is not likely. Furthermore, as shown in inundation maps that would result from a Main Pit Dam failure, there are no obvious pathways for released materials to enter underground workings.

The existing regulatory environment for both open pit and underground mining is comprehensive. Furthermore, the Proponent's commitments to developing/updating emergency plans will aide in assuring that activities within the mine site are carried out as safely as possible.

Considering the non-discretionary legislative requirements, Proponent commitments, recommendations within this report and the Proponent's existing license requirements, residual effects associated with a Main Pit Dam failure are unlikely to interact with residual effects from existing activities in such a way to result in significant adverse cumulative effects.

6.0 AQUATIC RESOURCES

6.1 Overview

Proposed Phase V/VI activities and the environmental setting of the mine site and surrounding area are detailed in Sections 2.0 and 3.0 respectively. Additional details are provided in the Proponent's project proposal available on the YOR. Key components of the proposed activities and surrounding environment, related to characterizing effects to aquatic resources, are summarized below.

Capstone's Phase V/VI proposal includes significant expansion of surface and underground mining and proposes changes to the management of waste and water. The Phase V/VI expansion includes development of a new open pit mine in the McGinty Creek watershed, located immediately north of the existing mine site (Figure 1). Expansion of mining activities will produce additional waste and tailings that will result in further contaminant loadings at the mine site. In addition, Capstone is proposing significant changes to water management including changes to effluent discharge limits for certain COPCs during the non-freshet period (May to November) and the removal of the receiving environment compliance point.

Phase V/VI activities will affect both the Minto Creek and McGinty Creek watersheds. However, project effects to aquatic resources will be focused in the Minto Creek watershed, as all mine waste will be stored there and mine effluent will be actively released to Minto Creek only. Effects to aquatic resources are characterized and considered separately for Minto and McGinty Creek.

Key project components that may contribute to effect on aquatic resources include:

- Mining of three new open pits and significant expansion of underground workings

- o Additional production of:
  - 10.3 Mm^3 waste rock
  - 4.8 Mm^3 overburden
  - 16.4 Mm^3 tailings and NP:AP<3 waste rock
- Removal of receiving environment compliance point at W2
- Increases to effluent release criteria (at W50 and W17) for:
  - o Ammonia (NH_4)
  - o Cadmium (Cd)
  - o Nitrate ($N\text{-}NO_3$)
  - o Nitrite ($N\text{-}NO_2$)
  - o Selenium (Se)
- Construction of a tailings retention dam (Main Pit Dam)
- All non-point source loadings from mining and related activities

The primary result of these activities is an overall increase in contaminant loadings to the environment. Effects of these contaminants on aquatic resources vary according to concentration and the species exposed. When evaluating effects to aquatic resources we considered the effects of expected contaminant concentrations to the most sensitive species present in the receiving environment (the point where fish and valued aquatic species are present).

As with previous expansions, Phase V/VI includes the operational period when mining, milling and active water conveyance and treatment are occurring on site; and closure, when the mine is reclaimed and closed with some ongoing monitoring and maintenance activities occurring. A transition period will also occur between active mining activities and full closure. The implications of these various phases to aquatic resources are quite different and are considered separately in this section.

As mandated by s.42 (1)c of YESAA, our consideration of effects includes the effects of malfunctions or accidents. This pertains most notably to the effects of a geochemical and/or geotechnical failure of the Main Pit Dam to aquatic resources in Minto Creek and the Yukon River. A characterization of potential dam failure modes is detailed in Section 5.0. A characterization of the effects of expected seepage of contaminated water along with a worst-case failure to aquatic resources is considered in this section.

The following effects to aquatic resources are considered:

- Release of metal contaminants and adverse effects to aquatic life

The Mayo Designated Office has concluded that the project will result in significant adverse effects to aquatic resources. Mitigations to eliminate, reduce or control significant adverse effects to aquatic resources are recommended below.

6.2 Project Effects – Release of contaminants

To characterize the expected and potential effects of Phase V/VI developments to aquatic resources from the release of metal contaminants, an overview and summary of the following project components is necessary:

- ML/ARD potential of mine wastes and implications for metal release
- Waste management
- Water management
- Water and load balance modelling and predicted metal loadings
- Proposed water management and effluent release criteria

These aspects of the Phase V/VI developments are summarized in Section 2.0 and detailed in the project proposal available on the YOR. The proceeding summary highlights conclusions of ML/ARD testing along with waste and water management that will specifically influence the release of metal contaminants from the site.

6.2.1 ML/ARD Potential of Mine Wastes and Implications for Metal Release[91]

6.2.1.1 Background to ML/ARD

As noted in Section 3.1.1 (Geology), the Minto deposits consist of hypogene sulphide mineralization. Drainage waters from sulphidic deposits can contain elevated concentrations of metals and other elements at any pH. Problematic drainage occurs primarily form the exposure of sulphidic deposits to oxygen and water that results in oxidation. Oxidation changes the chemical species from a relatively insoluble form into free ionic species that are easily dissolved. Once dissolved, these metals are readily transported by water.

The oxidation of some sulphide minerals produces acid. In the absence of neutralizing minerals, the lower drainage pH can increase the:

- Rate of sulphide oxidation;
- Solubility of many products of sulphide oxidation; and
- Rate of weathering of other minerals

In addition to leaching of metals, non-metals such as selenium can be readily leached from sulphidic rock at near-neutral or alkaline pH. Depending on the exposure of sulphidic rock to oxidation and weathering processes, contaminant loadings[92] of metals and non-metals from a mine site can readily exceed water quality objectives (MEND 2009).

[91] For a complete discussion of the ML/ARD potential provided in the proposal see *Minto Mine Phase V/VI Expansion: ML/ARD Assessment and Inputs to Water Quality Predictions* (YOR 2013-0100-072-1)
[92] Loading is the concentration multiplied by flow, providing a mass per unit of time flowing from a mine or mine component (MEND 2009).

Understanding the ratio of neutralization potential[93] to acid potential[94] of the minerals present is a critical factor in Acid Base Accounting (ABA). Understanding ABA for the mine site allows for more informed predictions of potential weathering rates and release of metals to the environment.

6.2.1.2 ML/ARD Predictions – Minto

In support of their proposal, Capstone submitted a report detailing the ML/ARD potential of the materials that will be processed during the mining of Phase V/VI deposits.[90] The predictions from this assessment were used to derive the geochemical source terms used in the modelling and predictions of mine drainage. A summary of Phase V/VI surface and underground mining along with the handling and segregation of waste and tailings is provided in Section 2.0.[95]

The current permit for Minto Mine defines material with a NP:AP ratio of less than 3 as PAG. As outlined in the ML/ARD report,[90] this cut-off ratio is considered conservative as the theoretical cut-off ratio would be NP:AP less than 2. This conservatism is designed to account for inherent uncertainties with the on-site sampling, testing, classification and segregation of PAG and non-PAG materials.

The majority of waste rock from Phase V/VI developments is expected to be non-PAG. Limited PAG waste rock is predicted from the Area 2 Stage 3, Ridgetop North and Ridgetop South pits.

Phase V/VI tailings are expected to be non-PAG due to a large excess of neutralizing potential over acid potential. However, neutral pH leaching of selenium, copper and other metals is expected from unsaturated tails, similar to the seepage currently observed from the DSTSF.

6.2.2 Phase V/VI Waste Management

As outlined in Section 2.0, Phase V/VI includes the expansion/addition of a number of waste facilities. The following list identifies each waste facility and notes the type of material to be placed in each facility.

6.2.2.1 Waste Rock and Overburden

- Main Pit Dump Expansion
    - Overburden and waste rock from Minto North Pit
- Main Pit Dump
    - Waste rock and overburden from Area 2 Stage 3 Pit, Ridgetop North Pit, Ridgetop South Pit, and underground development.
- Mill Valley Fill Extension Stage 2

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[93] Acid Neutralization Potential – The total acid a material is capable of neutralizing (MEND 2009).
[94] Acid Potential – The total acid a material is capable of generating, including acid that dissolves, is neutralized and forms acid salts (MEND 2009).
[95] For complete details of waste rock and overburden management and tailings management for Phase V/VI developments see Appendix A and Appendix D-A of the project proposal (YOR 2013-0100-018-1 – 021-1 and 2013-0100-024-1 respectively)

    - Will receive waste rock destined for the Main Pit Dump and potentially the Ridgetop Waste Dump
- Ridgetop Waste Dump
    - Waste rock from the Ridgetop pits
- Area 118 Backfill Dump
    - Overburden from Area 2 Stage 3 pit
- Ridgetop South Backfill Dump
    - Overburden from Ridgetop North pit

6.2.2.2 Tailings

- Main Pit TMF
    - Water, tailings and NP:AP<3 waste rock during operations
    - No free water during closure
- Area 2 Pit TMF
    - Water, tailings and NP:AP<3 waste rock during operations and closure
- Ridgetop North Pit TMF
    - Tailings slurry only

The Proponent's Phase V/VI Expansion Waste Rock and Overburden Management Plan and Tailings Management Plan outline some key aspects of the waste handling aimed at reducing metal loadings. These include:

- Disposal of all PAG[96] waste rock to TMFs
- Disposal of tailings as slurry tails
- Disposal of bulk tailings in permanently-saturated state

Waste rock handling begins with a characterization of the acid-generating potential from on-site ABA testing. Composite samples of blasthole cuttings from each waste blast are processed through an induction furnace to determine total carbon and total sulphur content, used as proxies for NP/AP potential. These results are input into Minto's grade control software used to define waste and ore polygons. This information is then sent to pit operations staff for staking of ore and waste boundaries and dispatching to the appropriate facilities.

6.2.2.3 Closure

At closure, all waste rock dumps will be covered with isolating soil covers. The Main Pit TMF and the Ridgetop North Pit TMF will be covered with isolating soil covers. The Area 2 Pit TMF will be flooded and

[96] PAG as defined under the current permit as NP:AP < 3.

receive water from the Main Pit TMF (and its up-gradient catchment) and from the sub-catchment south of the Area 2 Pit.

Additional closure features include settling ponds to reduce sediment loads to 15 mg/L and contingency treatment using wetlands and bioreactors if required. The placement of contingency treatment facilities is confined by topography; the location of proposed treatment facilities is illustrated in Figure 4.

6.2.3 Phase V/VI Water Management

Phase V/VI water management is detailed in the project proposal and summarized in Section 2.0. The water management plan for the operational and closure periods are necessarily different and are summarized separately. Operational water management is further detailed below.

The Proponent's operational water management strategy is included as Appendix J[97] of the Proposal and summarized below:

- Discharge-compliant (clean) runoff will be collected and diverted to the water storage pond (WSP) and from there to Minto Creek. The release of clean runoff is expected to effectively control the inventory of mine water on site.
- Runoff from developed mine areas (mine water) will be collected and stored in the Main Pit TMF and the Area 2 Pit TMF. Mine water will be used for ore processing and depositions of tailings and waste rock.
- Water diversion and conveyance infrastructure will be upgraded to ensure efficient segregation of runoff from undisturbed and developed catchments.
- Water inventory targets will be defined based in forecasts of water demand and runoff volumes. Regular tracking of mine water inventory will allow operators to determine if the inventory is on target; or, if water must be withheld or released from site.

The WSP is the final control point where water can be discharged to Minto Creek (if compliant with effluent criteria), sent through the water treatment plant and released or directed to one of the TMFs listed above. The water treatment plant uses a Reverse Osmosis system that concentrates 95% of contaminant loads into 5% of the water, producing a brine solution that is discharged to the Main Pit TMF.

6.2.4 Water and Load Balance Modelling and Predicted Metal Loadings

Source terms[98] were developed for both Minto and McGinty Creek from the waste characterization and predicted site conditions such as the exposure of the various wastes to oxygen and water. These source terms were imputed into a stochastic modelling program (GoldSim) that varies annual precipitation rates to predict contaminant loadings during wet and dry climatic conditions. Predictions of contaminant concentrations were developed for water monitoring stations W3 (immediately below the mine site), W1 (in the receiving environment) and the Area 2 pit lake for both operations and post-closure. Table 3-1 of

[97] YOR 2013-0100-043-1
[98] "Source terms" refer to predicted concentrations or loadings in waters that are in contact with various types of geologically-sourced waste materials, under the expected disposal conditions at the site (YOR 2013-0100-072-1).

YOR document 2013-0100-0046-1, details the source terms used and how they were applied in the model.

For source terms from the major sources of load (load from waste rock and tailings) two scenarios were considered that characterize the lower and upper end concentrations. The description of these two scenarios, as applied to the various source terms, is reproduced below from YOR document 2013-0100-072-1:

- Best Estimate source terms, which were intended to cover the range of typical loading rates from the existing mine components and to allow those rates to be applied on a unit basis (surface area or mass/volume) to existing and future sites components;
- Reasonable Worst Case source terms, which were intended to reflect extreme loadings at the upper end of what has been observed from the existing facilities, and to allow those rates to be applied on a unit basis to existing and future site components.

For the Phase V/VI expansion, the general approach to developing source terms was to use data from the site monitoring programs first and supplement this with laboratory test results and scale up calculations where data does not exist.

The Proponent ran their model to produce 'Expected Case' and 'Reasonable Worst Case' predictions for COPC concentrations during the open water season for both Minto Creek and McGinty Creek. These predictions are presented in Appendix K B of the project proposal.[99] The modelling predicted no significant change to background water quality in McGinty Creek. Exceedances of the current SSWQOs are predicted in the 'Expected Case' model run for many COPCs in Minto Creek at the receiving environment (W1). The Proponent notes that many of the COPC concentrations are elevated due to high sediment loads form tributary streams downstream of the mine site and outside the control of the mine. To allow releases of mine water from the site the Proponent proposed changes to their water management, summarized in Section 2.4, including:

- Removal of receiving environment compliance point;
- Changes to SSWQOs for Al (21.38 mg/L), Fe (37.7 mg/L) and Cr (0.0387)
- Changes to end-of-pipe discharge quality criteria for Ammonia (1.5 mg/L),
  Cadmium (0.0003 mg/L), Nitrate (30 mg/L), Nitrite (0.7 mg/L) and Selenium (0.02 mg/L);
- A 3:1 (measured downstream flow at MC1 to maximum discharge rate) effluent discharge rate (quantity) at the proposed effluent quality criteria;
- Unrestricted release of RO treated water; and
- Blending of RO treated release water with WSP release water to maintain a 3:1 release ratio.

6.2.5 Effects Characterization

The following effects assessment considers the Project proposal, along with analysis commissioned by YESAB and comments received during the evaluation. The primary focus of comment submissions was

[99] Appendix K B (YOR 2013-0100-044-1 to 049-1).

on the effects of the proposal to aquatic resources. No external review received during the evaluation fully supported the Proponent's effects assessment or proposed effluent release strategy. Significant disagreement remains between all parties involved in the evaluation regarding the predicted loadings and the potential effects of those loadings to the aquatic resources in Minto Creek. The details of these comments are discussed throughout this section.

The effects characterization is provided separately for Minto and McGinty Creeks and the effects are considered for both the operational and post closure periods. The effects characterization is provided only for those COPCs where the Proponent has proposed changes to the SSWQOs or proposed that higher concentrations than the current SSWQOs would maintain protection of aquatic life, but did not actually propose an updated value. All other SSWQOs are considered to be the concentrations of COPCs that if exceeded will result in adverse effects to aquatic resources (depending on magnitude and duration of the expected exceedance). Hence, the effects assessment is conducted by comparing the predicted water quality at the receiving environment (W2) to either the updated SSWQOs (where appropriate) or the existing SSWQOs. We accept the Proponent's proposal to remove the compliance point at W2, but to maintain monitoring of SSWQOs at W2 to inform adaptive management and have included this as a consideration in our effects assessment.

6.2.5.1 Minto Creek

Aquatic Life

Section 3.2 of this report summarizes the information characterizing aquatic life in Minto Creek. Additional details are provided in the Project proposal. Details pertinent to the characterization of effects include:

- The receiving environment in terms of effects to aquatic life is considered to begin near water monitoring station W2 (below a natural fish break) to the confluence with the Yukon River (~1.5 km distance);
- Aquatic life potentially affected during the open water period only (May to November) as intermittent flows and extensive ice build–up during winter limits potential for overwintering habitat for fish;
- Lower Minto Creek provides rearing habitat for juvenile Chinook salmon during the open water period; and
- Juvenile Chinook salmon comprise 97% of fish using lower Minto Creek. Other species of fish (e.g. slimy sculpin, arctic grayling) and invertebrates are present during the open water period as well.

In their comment submissions, SFN emphasized the importance of protecting the juvenile Chinook salmon (JCS) in lower Minto Creek. SFN notes the prolonged declining trend in the Chinook salmon stocks in the Yukon River system and increased development pressure throughout SFN's Traditional Territory as support for protection of lower Minto Creek. In addition, SFN noted that JCS might begin to use lower Minto Creek earlier in the season, potentially increasing exposure to COPCs. YESAB agrees with the importance of protecting the juvenile salmon in lower Minto Creek and notes that uncertainty must be incorporated into effects characterization. In addition, as use of lower Minto Creek by JCS is predominately temperature dependent, it is likely that the creation of significant reservoirs and wetlands in upper Minto Creek may support earlier and sustained use of lower Minto Creek by JCS in the future.

Pathways to Effects

Metal contaminants from the various sources, as previously described, will enter Minto Creek in contact water leaving the site through the WSP or water treatment plant during operations and through a future wetland during closure. The Proponent has concluded that groundwater flows are not a notable pathway for movement of COPCs from the site to Minto Creek. As noted by Environment Canada (EC)[100], the data presented by the Proponent is not sufficient to support this conclusion. All other technical reviewers agreed with EC's conclusions. Although the contribution of water through subsurface pathways may be limited by volume, depending on the source of the water (e.g. Main Pit TMF), even a small volume of highly contaminated water could lead to significant effects to aquatic resources in Minto Creek. In addition, contaminant plumes from the various waste sites, particularly the TMFs may take considerable time to report to surface waters (i.e. it is likely that site monitoring has not detected these plumes to date). Exclusion of groundwater as a pathway to effects is a considerable oversight with the information presented in the Proposal. YESAB considers both groundwater and surface water to form material pathways for COPC transfer to Minto Creek.

A failure of the Main Pit Dam could release a considerable volume of contaminated water and tailings to Minto Creek. An effects characterization for a Main Pit Dam failure is presented in Section 3.3 of YOR document 2013-0100-173-1. This report details potential physical and chemical consequences of a failure to both Minto Creek and the Yukon River. Effects would occur from the mine site over the extent of Minto Creek into the Yukon River. Effects to Minto Creek would be significant over the short and long term. Effects to the Yukon River are expected to be confined to the immediate pulse of contaminant loads to the River that will be sufficiently diluted as the contaminants mix with background flows. As such, this effects characterization focuses on Minto Creek.

The physical structure of Minto Creek could be significantly altered from the rapid release of water from the site and subsequent scouring of the stream channel. Release of tailings and pore-water would likely result in contaminant loadings to Minto Creek that are acutely toxic to aquatic life including fish. Deposition of tailings in stream sediments and along the stream channel would cause continued contaminant release over a long period (decades following the breach). Contaminant loads are expected to produce exceedances of water quality objectives and sediment quality guidelines in Minto Creek for a long period. The recovery period for Minto Creek without remediation is unknown.

Background Water Quality

In their proposal, the Proponent has concluded that high TSS loads from tributaries to Minto Creek have forced them out of compliance with SSWQOs in the receiving environment at W2. The Proponent concluded that these high TSS conditions (observed since 2011) constitute a new background condition for lower Minto Creek. From these 'new' background conditions, the Proponent developed new SSWQOs for aluminum, chromium and iron using the Background Concentration Procedure (BCP). None of the technical reviewers who submitted comments during the evaluation support either the conclusion that the recent high TSS loads from tributaries to Minto Creek constitute a permanent alteration to background

[100] YOR 2013-0100-206-1.

condition or the methods used by the Proponent[101] to develop new SSWQOs for the aforementioned COPCs.

Our effects assessment is based on the understanding that the recent increases in TSS loads to Minto Creek are likely driven by isolated slumping events in tributary streams and should not be considered a permanent alteration of the background condition of lower Minto Creek. The decrease in TSS loads in the most recent data (2013) may support this conclusion. Blending of the historic background condition with the recent TSS loads is inappropriate for use in developing SSWQOs and effluent release criteria.

Effects of Elevated COPCs

This section characterizes the effects of COPCs to aquatic life along with a discussion of appropriate SSWQO concentrations for the protection of aquatic resources. Effects characterization and proposed SSWQOs are only provided for those COPCs that the Proponent proposed changes to or where alternative effects analysis was proposed (e.g. Bio-ligand Modeling).

Aluminum (Al)

Aluminum is relatively insoluble at pH 6 to 8, although solubility increases under more acidic and more alkaline conditions. Complexing ligands such as dissolved organic matter lead to increased solubility, notably at lower temperatures. Aluminum can bind to dissolved organic matter that reduces the amount of inorganic Al available to interact at biological membranes such as gills; in this way, it increases Al solubility but decreases Al toxicity. Dissolved organic matter tends to bind Al more efficiently with increasing pH.

PH is the dominant controlling factor in Al toxicity to algae. Although Al toxicity tends to vary with changing pH, the trends observed for algae toxicity testing are most consistent when dissolved Al, rather than total Al, is used as the measure of exposure. Dissolved Al is the best predicator of Al toxicity to fish.

Fish are generally more sensitive to Al than benthic organisms. Al is a gill toxicant to adult fish due to iono-regulatory actions, respiratory actions, or both. The iono- regulatory effects predominate at lower pH whereas the respiratory effects are more prevalent as pH increases to moderately acidic levels. Calcium, dissolved organic matter and fluoride have been shown to protect fish against the physiological and toxicological effects of Al. Acclimation of fish to Al has been observed but at a metabolic cost to the organism.

Al does not bioaccumulate in benthic organisms and does not biomagnify in aquatic systems.

The background levels of dissolved and total Al in Minto Creek drainage were identified as regularly exceeding CWQG (Minnow 2009).

The original SSWQO was developed by Minnow (2009) and was partially used to set the SSWQO of 0.62 mg/L defined by the current WUL. The Proponent proposes a revision to this SSWQO (21.38 mg/L) to account for the increased background concentrations observed. In development of this revised SSWQO, Access considered all measured concentrations of Al regardless of TSS in the sample. This approach is not supported and could result in a SSWQO that is biased high.

[101] YOR 2013-0100-031-3

At the request of YESAB, EcoMetrix Incorporated provided an evaluation of the proposed SSWQOs.[102] YESAB asked EcoMetrix to evaluate whether the proposed SSWQOs would be protective of aquatic life and if they were appropriate.

For Al, EcoMetrix concluded that because concentrations are significantly ($p<0.01$) driven by TSS that the current effluent control of 15 mg/L for TSS will sufficiently control the release of Al from the site and will reliably achieve the current SSWQO of 0.62 mg/L at W3 (roughly the point of release). Therefore, EcoMetrix recommends that Al be removed from the effluent release criteria and that monitoring continue at W2.

SFN's technical team disagrees with the removal of Al from the list of COPCs for compliance purposes as it does not account for future increases in load, particularly during closure, and may lead to adverse effects. During closure SFN notes that the Proponent's modelling shows increases in dissolved Al at W2 following spilling from the A2TMF. SFN feels that adoption of the British Columbia WQO for Al is more appropriate because it monitors the dissolved portion and would capture releases from the mine site.

We agree with EcoMetrix's conclusion that Al concentrations can be controlled by the effluent criteria for TSS based on the data available. However, we also recognize SFN's concern that future loadings of Al from the mine site may occur and that it may not be conservative to assume that Al will continue to be driven predominately by TSS. The dissolved fraction of Al may become more of a concern in the future as the Al concentrations from the mine site increase. As such, we have determined that the future uncertainty regarding the magnitude of Al loadings (dissolved) from the mine site are too great to remove Al from the end-of-pipe criteria. An end-of-pipe criteria based on dissolved Al may achieve adequate protection for aquatic life while preserving flexibility for the mine operations.

Iron (Fe)

Iron is the fourth most abundant element by weight in the earth's crust, and is often a major constituent of soils, especially clays.

Iron may be present in both a dissolved state (ferrous iron) and a suspended particulate state (ferric iron). Iron is bioavailable and bioactive when in the soluble ferrous form. The solubility of iron in water varies with temperature, pH and other factors including dissolved oxygen, dissolved and total organic carbon ratio (DOC/TOC), color, humic and other organic acids, exposure to sunlight and chloride. In general, it occurs at low concentrations in well-oxidized waters with near-neutral pH.

High total iron concentrations may naturally be present in aquatic systems; this is often caused by high loads of suspended material in water during high flow conditions where total iron content is associated with the suspended materials. It is possible that this insoluble iron remains suspended in solution, especially in moving waters such as rivers and streams. Egg and early alevin stages of fish are most susceptible to this form of iron. The potential toxic effects from suspended iron generally occur either as:

- Damage to the gills of fish from the corrosive effects of the ferric iron;
- Smothering of eggs or organisms where the iron is deposited; or
- Decreased visibility in the water that can affect feeding success and other behaviour.

[102] YOR 2013-0100-240-1

The background levels of dissolved and total iron in Minto Creek drainage were identified as regularly exceeding CWQG (Minnow 2009).

The Proponent has proposed a new SSWQO for Fe of 37.7 mg/L compared to the existing SSWQO of 1.1 mg/L. In their report,[103] EcoMetrix noted the same concerns with the derivation of the proposed SSWQO for Fe as Al above. EcoMetrix found a significant ($p<0.001$) relationship between Fe concentrations and TSS and notes that controlling TSS with a discharge limit of 15 mg/L will maintain Fe below the existing SSWQO of 1.1 mg/L. As such, EcoMetrix recommends the removal of Fe from the effluent discharge criteria.

SFN's technical team agrees with EcoMetrix conclusion that Fe can be removed from the list of COPC for compliance purposes. However, SFN's rationale is different in that they note the dissolved portion of Fe does not appear to be elevated (i.e. originating from the mine) and can be removed on this basis.

We disagree with the Proponent's proposed change to the SSWQO for Fe. We agree that the evidence supports the removal of Fe from the end-of-pipe criteria as the guidelines for TSS sufficiently mange Fe. Monitoring of Fe concentrations in the receiving environment should continue.

Chromium (Cr)

Chromium can exist in nine different oxidation states from –II to +VI. Hexavalent chromium, Cr(VI) and trivalent chromium, Cr(III), are the most common and the most stable oxidation states. The toxicity of Cr is largely dependent on the oxidation state. Chromium occurs in rock sand soils as Cr(II), which is strongly adsorbed by particulate matter. Chromium (VI) has a high oxidizing potential, is highly soluble, easily permeates biological membranes and is more bio-available and more toxic to aquatic biota than Cr(III). The CCME (1999) provides separate water quality guidelines for Cr(VI) and Cr(III) of 0.001 mg/L and 0.0089 mg/L respectively.

The current SSWQO derived by Minnow (2009) is 0.002 mg/L for total Cr. This guideline does not separate Cr by oxidation state. The Proponent has proposed a revised SSWQO of 0.039 mg/L for total Cr. As outlined by EcoMetrix and other technical reviewers, the methods employed by the Proponent to derive updated SSWQOs are not supported and may bias the values high.

EcoMetrix noted that it is likely that total Cr in Minto Creek is driven by TSS and so it may likely be in the form of Cr(III); therefore, if a complete understanding of the oxidation state of Cr is developed through sampling then there may be room to adjust the SSWQO accordingly. In the absence of this information to support a revision to the SSWQO, EcoMetrix advises maintaining the current SSWQO of 0.002 mg/L. Calculating effluent release criteria based on a SSWQO of 0.039 mg/L for total Cr will likely result in significant adverse effects to aquatic resources.

The information available for review does not support the Proponent's proposed changes to the SSWQO for Cr. We have concluded that the existing SSWQO should remain unaltered to ensure protection of aquatic life in the receiving environment. We agree with EcoMetrix's conclusion that SSWQO for Cr should be re-evaluated based on the speciation of Cr.

Cadmium (Cd)

[103] YOR 2013-0100-240-1

EcoMetrix's report to YESAB[104] summarizes the effects of Cd to aquatic life along with the derivation of WQGs for Cadmium and recent changes to the CCME guidelines. This information is reproduced below:

> The CCME (1999) interim water quality guideline for cadmium, based on chronic exposure, is a hardness-dependent equation:
>
> $$WQG = 10^{0.86\,log(H) - 3.2}$$
>
> where *WQG* is the water quality guideline for cadmium (µg/L) and *H* is the water hardness (mg/L).
>
> It is derived to produce a WQG of 0.017 µg/L at a hardness of 48.5 mg/L. This value is derived from a 21-day LOEC of 0.17 µg/L for effects on the daphnid D. magna (Biesenger and Christiansen, 1972), divided by a 10-fold safety factor. The slope of the hardness relationship comes from acute toxicity studies. As noted by McGeer et al. (2012) the equation produces a guideline that is roughly an order of magnitude below those of other jurisdictions, and is often exceeded in uncontaminated environments.
>
> The current water quality objective of 0.015 µg/L at W2 is based on the CCME (1999) equation, with an assumed water hardness of 40 mg/L. According to the Project proposal average water hardness at W2 is 154 mg/L. From water quality data provided (147-1_IR 37 attachment 4) it appears that hardness is rarely below 50 mg/L at this location, and there is probably no mine discharge at such times. At a hardness of 154 mg/L, the CCME (1999) equation produces a guideline of 0.048 µg/L.
>
> A new CCME guideline has been developed by CCME (2014), following the current CCME (2007) protocol, and the preferred Type A method, in contrast to the older CCME procedure described above. Thus, the new guideline is an equation reflecting the hardness dependence of chronic toxicity. This equation gives the 5th percentile of the SSD for chronic toxicity in soft water (0.09 µg/L) at a water hardness of 50 mg/L.
>
> $$WQG = 10^{0.83\,log(H) - 2.46}$$
>
> At a hardness of 50 mg/L the resulting water criterion is 0.09 µg/L. At a hardness of 154 mg/L, an average value for W2, the resulting water criterion is 0.23 µg/L. At this hardness, the new guideline is 4.7 times higher than the old guideline, and 15 times higher than the current water quality objective of 0.015 µg/L at W2.

Using the updated CCME (2014) guidelines for the calculation of SSWQO for cadmium, EcoMetrix calculated a water criterion, based on average hardness at water monitoring station W2, of 0.23 µg/L. The CCME (2014) guideline represents the most up-to-date evaluation of effects to aquatic resources

[104] YOR 2013-0100-240-1

currently available. Therefore, a revision of the SSWQOs for cadmium may be appropriate for the operational period if concentrations at W2 remain below 0.23 µ/L.

In their comment submission,[105] SFN noted concerns with the application of the new guidelines for Cd to Minto Creek. SFN cited recent debate regarding the use of the updated CCME (2014) guidelines for the calculation of SSWQOs for Cd and highlighted that they feel additional testing of effects to sensitive species found in Minto Creek should be conducted to determine to confirm/reject applicability of the CCME (2014) guidelines to Minto Creek. SFN requested that if CCME (2014) guidelines are applied that they be re-evaluated before closure to ensure the effluent leaving the site remains protective of aquatic life.

Selenium

In their report to YESAB,[106] EcoMetrix provided a discussion of the development of CCME guidelines for selenium along with recent literature relating whole body toxicity to dissolved criteria. EcoMetrix outlines two methods for the Proponent to calculate a SSWQO for Minto Creek. This discussion is reproduced below:

> The selenium concentration of 0.001 mg/L adopted by the CCME was originally introduced by the International Joint Commission (IJC) in 1981 to protect aquatic life in the Great Lakes of Canada and the United States. The CCME guideline is based on field studies at Belews Lake, North Carolina, where waterborne selenium concentrations from 0.005 to 0.01 mg/L were associated with food web contamination causing acute lethality to predatory fish (IJC 1981; as cited in CCREM 1987). The lowest exposure concentration of 0.005 mg/L together with a safety factor of 5 was used by the CCME to estimate a water quality guideline of 0.001 mg/L that is currently considered protective of aquatic life in similar types of lakes.
>
> The US EPA reported that a selenium concentration of 0.005 mg/L provides adequate protection of aquatic life (US EPA, 1987). In 2004, the US EPA developed a draft version of the chronic criterion for selenium that is based on the concentration of selenium in fish tissue. The proposed tissue concentration criterion of 7.91 mg/kg dry weight whole-body is based on increased over-winter mortality of juvenile bluegill sunfish (warm water fish species) exposed to dietary selenium and cold water temperatures (US EPA 2004). If the fish population in lower Minto Creek consists of cold water species, the US EPA criterion could be recalculated excluding the results for warm water species and thereby providing a fish tissue concentration criterion that is more appropriate for the lower Minto Creek receiving environment (i.e., Method 1 below).
>
> The literature suggests that adverse effects from exposure to selenium in aquatic environments is primarily through the food chain and is therefore highly

[105] YOR 2013-0100-261-2
[106] YOR 2013-0100-240-1

site specific. Egg laying vertebrates, such as fish, are regarded as being the most sensitive aquatic organisms. Adverse effects are associated with critical body burden and site specific bioaccumulation factors are required to link potential adverse effects in biota to water concentrations encountered at any location. Various options are available for development of a selenium site-specific water quality guideline protective of aquatic life. Two methods are presented here that could be used to develop a SSWQO for selenium which might result in higher values than the CCME value of 0.001 mg/L currently used.

Method 1 - Recalculation of US EPA Tissue Concentration Guideline

Because the effects of selenium depend on the degree of bioaccumulation through the aquatic food chain, the US EPA (2004) proposed a fish tissue criterion of 7.91 mg/kg dw whole body to protect aquatic life. They found the Bluegill sunfish (warm water fish species) to be most sensitive. Recent literature suggests that fish accumulation rates of selenium in river systems are less than those found in lake systems (Orr et al., 2006, 2012; HabiTech 2012). As selenium accumulates, a threshold in reproductive tissue concentration is reached at which adverse effects are observed. The selenium concentration in reproductive tissue (egg/ovary) provides the most direct way of measuring the potential for adverse effects of selenium. However, it is impractical to set a selenium guideline based on reproductive tissue concentration as it is not always available. For this reason, US EPA developed a basis to convert measured muscle, reproductive and liver tissue concentration to estimated whole body concentration (US EPA 2004)

Assuming that resident fish species in lower Minto Creek are cold water fish, the current tissue guideline could potentially be recalculated to exclude more sensitive warm water fish species. The common method recommended by the US EPA is to use a site-specific bioaccumulation factor for selenium to back calculate a site-specific water quality guideline. Fish tissue and water quality data for the Minto site collected as part of the baseline studies might be used to develop site-specific bioaccumulation factors.

A site-specific water quality guideline for selenium developed using this method should be used as an alert level to trigger more frequent fish tissue monitoring to ensure that fish tissue concentrations do not exceed a site-specific tissue concentration objective.

Method 2 - Site-specific Toxicity Studies on Resident Fish Species

Based on a comprehensive review of available chronic toxicity data the US EPA calculated both, species mean chronic values (SMCV) and genus mean chronic values (GMCV) for a number of fish taxa and one aquatic invertebrate. The GMCV is a geometric mean of all SMCVs for species within a particular genus. The SMCV is a geometric mean of all chronic values from studies

> using a particular species. A chronic value is a concentration associated with a low but detectable level of effect after chronic exposure. The calculated GMCV ranged from 9.5 mg/kg dry weight (dw) whole body for bluegill sunfish to more than 23.28 mg/kg dw whole body for razorback sucker; suggesting that different fish species exhibit different tolerance to selenium (US EPA 2004).
>
> Because different fish species exhibit different sensitivity to dietary exposure to selenium, it would be possible to perform toxicity testing on resident fish species collected from the Project site to develop a SSWQO for selenium in tissue concentrations associated with effects in resident species. However, the selenium toxicity testing with resident fish species would not be expected to result in drastically different tissue concentration guidelines than what are already reported in the literature for cold water fish species.

The Proponent's request for a revised discharge criteria for Se of 0.02 mg/L is not supported by the information provided in the Project proposal as the necessary analysis, outlined above, has not be completed. SFN noted[106] that the work required to develop an understanding of the correlation between water concentrations and effects to aquatic life to develop a bioaccumulation based SSWQO for Se would be extensive and costly. As part of their April 1st, 2014 submission[107] SFN highlighted the work completed for them by MacDonald Environmental Sciences Ltd.,[108] submitted as part of their January 23, 2014 comment submission, as providing rationale for the use of the British Columbia Water Quality Guideline (BCWQG) of 0.002 mg/L Se in Minto Creek. As such, SFN has concluded that the BCWQG will provide sufficient protection to aquatic life in Minto Creek. YESAB disagrees with this conclusion based on the information available for review.

As outlined above, the CCME guideline for Se, suggested by the IJC (1981), was based on an observed population decline in fish in a selenium-contaminated lake (5-10 µg/L) (Cumbie and van Horn, 1978) divided by a safety factor of ten. The BC MWLAP (2012 update) set a water quality guideline for Se of 2 µg/L, using an effect level of 10 µg/L and a safety factor of 5 (based on background considerations for BC) and a weight of evidence approach. BC also set a safe Se whole body tissue/ muscle criterion of 4 mg/kg dry weight for fish (upholding the 2001 criterion which was based on an estimated 60-day EC10 of 6 mg/kg dry weight for Chinook salmon exposed to Se in water and food (Brix et al., 2000).

We agree that tissue-based guidelines are a better tool for assessing effects to sensitive organisms from exposure to Se than water-based guidelines. In spring and summer 2012,[109] Se in slimy sculpin tissue met or exceeded the BC interim tissue value although the total Se water concentration was below the current SSWQO of 0.001 mg/L. Similar data are not available for JCS that use lower Minto Creek for rearing habitat. An increase in the Se SSWQO from 0.001 mg/L to 0.002 mg/L would increase exposure to Se for fish and result in higher Se body burdens than those currently observed in lower Minto Creek. However, there is not enough information available to estimate the potential Se tissue concentrations in slimy sculpin and JCS (i.e. site-/species- specific Se bioaccumulation factors) as a result of increased exposure to Se and to understand the implications of such an increase in exposure to Se on the success

[107] YOR 2013-0100-261-1
[108] YOR 2013-0100-222-1
[109] YOR 2013-0100-053-1

of these populations in lower Minto Creek. A primary objective of the SSWQOs for Minto Creek are to protect JCS; as noted previously, this goal is emphasised by SFN. In the absence of further analysis to support a conclusion that increased exposure to Se will not adversely affect fish in lower Minto Creek, it is prudent to maintain the current SSWQO for Se at 0.001 mg/L to ensure that significant adverse effects do not occur.

In their report to YESAB dated March 17, 2014, EcoMetrix concluded that the proposed effluent criteria for Se of 0.02 mg/L at a 3:1 discharge rate will not be protective of aquatic resources (based the current SSWQO guideline) in Minto Creek. EcoMetrix noted that a discharge quality criteria of 0.0025 mg/L will be required to achieve the current SSWQO for Se at the receiving environment (W2).

Nitrate

The nitrate ion (NO_3^-) is the most oxidized form of nitrogen (N) present in the environment with and oxidation state of +5 (NRC 1978 as cited in CCME 2012). Nitrogen inputs to aquatic systems can lead to both eutrophication and direct toxic effects to aquatic life. The CWQGs for nitrate are set to prevent toxic effects to aquatic life.

Toxicity of nitrate is assessed using NaNO3, NH_4NO_3 or KNO_3 salts. There are two suspected mechanisms for the observed nitrate toxicity in aquatic animals: a) through methaemoglobin formation, resulting in a reduction in the oxygen carrying capacity of blood and b) through the inability of the organisms to maintain proper osmoregulation under high salt contents associated with elevated nitrate levels (Colt and Armstrong 1981 as cited in CCME 2012).

The CCME (2012) water quality guideline for nitrate is 13 mg/L as NO3 (3 mg/L as NO3-N) for chronic exposure, or 550 mg/L as NO3 (124 mg/L as NO3-N) for acute exposure (short durations up to 96 hours). The Project Proposal has suggested that chronic effect levels at W2 are higher than 3 mg/L as NO3-N because early life stage lake trout (the most sensitive species considered by CCME) are not present, and because water hardness at W2 is protective. By recalculating the CCME guideline, without lake trout, the Project Proposal finds that the 5^{th} percentile of the species sensitivity distribution (SSD) changes from 3 to 4 mg/L as NO3-N. The Project Proposal also notes that 10 mg/L as NO3-N is generally considered safe in aquaculture (Pillay and Kutty, 2005).[110]

As discussed in CCME (2012) and EcoMetrix evaluation report,[111] recent work has evaluated modifying effects of hardness to the toxicity of nitrate in aquatic systems. Tests were conducted at various hardness levels for a number of different species. CCME (2012) reviewed the evidence for chronic toxicity modification by hardness (Nautilus, 2011). The study author states that a hardness relationship is clearly present in the data, although the data do not definitively demonstrate the slope of the relationship for all endpoints (response levels were generally less than 25%, so only the IC_{10} endpoint could be calculated at all four hardness levels). Despite the ameliorating effects of hardness to toxicity of nitrate demonstrated in the data, CCME (2012) could not develop a national hardness-adjusted guideline value because the calculated slopes for the hardness-toxicity relationships differ by species and cannot be pooled to develop general hardness-adjusting equations for short-term and long-term exposures.

[110] Summary reproduced from YOR 2013-0100-240-1
[111] 2013-0100-240-1

Following their review of the modifying effects of hardness to nitrate toxicity, EcoMetrix concluded:

> In our opinion, the evidence for a hardness effect on nitrate toxicity is strong, for all the species tested, including sensitive fish and invertebrate species. Even if the slopes of the hardness relationships differ somewhat among species, the result of the hardness effect is that for hardness levels above 50 mg/L we have no evidence for chronic nitrate toxicity in any test where NO_3-N is below approximately 11 mg/L. According to the Project Proposal average water hardness at W2 is 154 mg/L. From water quality data provided (YOR Document 147-1_IR 37 attachment 4) it appears that hardness is rarely below 50 mg/L at this location, and there is probably no mine discharge at such times. Therefore, there should be room to relax the water quality objective for NO_3-N at W2 to some higher value than the CCME guideline of 3 mg/L, as needed for mine operations.

In their follow up report dated March 17, 2014,[112] Ecometrix added:

> The Project Proposal notes that 10 mg/L as NO_3-N is generally considered safe in aquaculture (Pillay and Kutty, 2005). In our opinion a revised nitrate SSWQO of 10 mg/L NO_3–N is an appropriate and supportable value.

In their comment submission of April 1, 2014,[113] SFN expressed strong disagreement with EcoMetrix's conclusion that a SSWQO of 10 mg/L NO_3–N is an appropriate and supportable value. SFN noted that in their view, application of findings in the marine aquaculture industry cannot be deemed applicable to a northern freshwater system and the findings of Pillay and Kutty (2005) do not support an increase to the SSWQO for nitrate (currently 2.9 mg/L NO_3–N). SFN also noted that an increase to the SSWQO for nitrate goes against their requested non-degradation approach for setting WQOs in Minto Creek.

We agree with SFN's conclusions that the applicability of the findings by Pillay and Kutty (2005) to Minto Creek are not well supported in the proposal. A clear technical discussion of the similarities and differences between the two environments related to the toxicity of nitrate would be necessary to support the application of the findings in Minto Creek. Therefore, we do not support a modification of the SSWQO for nitrate to 10 mg/L NO_3–N at this time.

We do agree with the Proponent's re-calculation of the SSWQO based on the species sensitivity distribution (SSD). We feel that increasing the SSWQO for nitrate to 4 mg/L NO_3–N will maintain protection of aquatic life and is appropriate for the operational period. In addition, it appears that there is merit in further evaluating the modifying effects of hardness to the toxicity of nitrate in Minto Creek specifically. However, although the proponent presented this as support for their effects conclusion, they did not actually calculate an alternative SSWQO based on the hardness and sensitivity of species in Minto Creek specifically. Further work would be required of the Proponent to support a modification to the SSWQO based on hardness.

[112] YOR 2013-0100-246-1
[113] YOR 2013-0100-261-1

As noted in Tables 2-9 and 2-10 of EcoMetrix's evaluation report,[114] based on the Proponent's proposed effluent quantity and quality discharge criteria, nitrate is expected to be 8 mg/L NO_3–N at W2 (the receiving environment). This is twice the concentration that we believe is appropriate for nitrate at W2. As such, we conclude that the Project proposal will result in effects to aquatic life from the proposed release of nitrate.

Copper

A critical factor in assessing the hazard of copper is its bioavailability. In the aquatic environment, the concentration of copper and its bioavailability depend on many factors such as water hardness and alkalinity, ionic strength, pH and redox potential, complexing ligands, suspended particulate matter and organic matter, and the interaction between sediments and water. Adsorption of copper to particles and complexation by organic matter can greatly limit the degree to which copper will be accumulated in organisms causing elicit effects. Other cations and ambient pH can also significantly affect bioavailability. Tolerance to copper has been demonstrated in the environment for phytoplankton, aquatic and terrestrial invertebrates, fish and terrestrial plants. Bioaccumulation of copper from the environment occurs if the copper is biologically available.[115]

Copper has been shown to produce adverse reproductive, biochemical, physiological and behavioural effects on a variety of aquatic organisms at very low levels. The complex interactions of copper with other water quality components must therefore be considered when assessing potential impacts at a specific location. Also since there are large variations in sensitivity to and bioavailability of copper between species, knowledge of local aquatic life (sensitive species, sensitive life stages) is an important factor for environmental assessment.

Copper has been shown to adversely affect olfaction (sense of smell) in fish. Fish rely on their sense of smell to find food, avoid predators and migrate. Detection of odours occurs when dissolved odorant molecules bind with olfactory receptor molecules; copper may compete for binding sites affecting activation or signal transmission. Periodic, non-point source contamination of salmon habitats with copper could interfere with olfactory function in natural waterbodies and therefore interfere with behaviours, such as homing, appetite and food intake, and detection of predators. The presence of dissolved organic carbon may diminish these effects of copper on fish (Baldwin, et al. 2003).

Capstone presents an application of the copper Bio-Ligand Model (BLM) in Appendix N of the Project Proposal[116] and summarizes the implications of the BLM results for copper toxicity in lower Minto Creek in Section 8.3.1.3 of the Project Proposal as a tool to evaluate the effects of dissolved copper to aquatic life in Minto Creek. Although the Proponent does not propose a change in copper receiving water or effluent objectives, the BLM is intended for development of site-specific water quality objectives. As the BLM was used in support of the Proponent's effects assessment, we retained EcoMetrix to provide technical review of the applicability and potential application of this effects assessment tool to Minto Creek.

The BLM predicts LC50s for fish and invertebrate species that are used, following the U.S. Environmental Protection Agency (EPA) protocol (Stephan *et al*., 1985), to derive a Criterion Maximum Concentration

[114] YOR 2013-0100-240-1
[115] As cited in YOR 2009-0206-085-1
[116] YOR 2013-0100-151-1

(CMC) and a Criterion Continuous Concentration (CCC), otherwise known as acute and chronic water quality criteria.

In their evaluation of the BLM model,[117] EcoMetrix concluded that the BLM is an appropriate tool to determine the effects levels of copper to aquatic life in Minto Creek. EcoMetrix emphasized the importance of the input data to the model results as the predictions from the BLM are quite sensitive to water chemistry, particularly hardness and dissolved organic carbon (DOC). As such, EcoMetrix used the 25^{th} percentile observation for hardness and DOC from the background data set for lower Minto Creek as a slightly conservative characterization of the most sensitive input parameters to the BLM. EcoMetrix calculated a CCC based on the 25^{th} percentile for hardness and DOC for copper in lower Minto Creek of 0.04 mg/L.

Copper can have significant adverse effects to fish through disruption of their olfactory system. EcoMetrix evaluated whether the CCC they calculated was sufficient to prevent effects to fish olfactory. EcoMetrix determined that because the CCC of 0.04 mg/L was set to protect the most sensitive biotic group in the system (aquatic invertebrates), the CCC value was well below the chronic effects levels for fish for survival, growth and reproduction. This however, does not specifically cover effects to olfactory processes in fish as these effects are not standard aquatic toxicity endpoints and were not considered in the derivation of the BLM CCC. EcoMetrix summarized the conclusions of recent studies that evaluated the protectiveness of the BLM CCCs for olfactory impairment in juvenile salmon. These studies concluded that the US EPA’s BLM-based criteria are also protective of olfactory impairment in juvenile salmon. Therefore, a site-specific water quality criterion based on the BLM CCC for copper is expected to be protective of the olfactory sense in juvenile Chinook salmon in lower Minto Creek.

In their comment submission,[118] SFN disagreed with the Proponent’s application of the BLM to Minto Creek and the conclusions of EcoMetrix regarding its suitability. SFN stated that the BLM is not recognized in Canada as an appropriate method for the derivation of water quality objectives. SFN noted that in 2010 the Yukon Water Board (YWB) was presented with the background concentration procedure (BCP) and the water-effect ratio procedure (WERP) for the derivation of SSWQOs for Minto Creek. The BCP yielded a SSWQO for copper of 0.013 mg/L while the WERP yielded a SSWQO of 0.017 mg/L. The YWB determined that the WERP did not clearly address concerns of olfactory impairment and so the BCP was chosen as the appropriate method for setting the SSWQO for copper. This remains the current SSWQO. In addition, SFN highlighted that toxicity testing conducted previously using Minto Creek water did not support the use of the BLM.

EcoMetrix discussed the disagreement between the toxicity testing and the BLM results from the Minnow (2009) study. EcoMetrix concluded that there was an error in the input data to the BLM for one of the samples that produced toxic results at copper concentrations below those predicted by the BLM. EcoMetrix highlighted the sensitivity of hardness and DOC to the CCC from the BLM.

YESAB has concluded that, although not universally recognized in Canada, the use of the BLM for the development of acute and chronic water quality criteria is well supported, and, WQOs developed using the BLM are protective of olfactory impairment in juvenile salmon. This is a sound tool for use in

[117] YOR 2013-0100-246-2
[118] YOR 2013-0100-261-2

determining adverse effects from the Project. For the operational period, we consider the probable effects level (PEL) for copper in Minto Creek to be 0.04 mg/L. However, a SSWQO of 0.04 mg/L is not appropriate for the closure period, for reasons discussed in Section 7.0.

Evaluation of Proposed Effluent Discharge Criteria (Operational Period)

The Proponent modelled their effluent discharge criteria to develop predicted COPC concentrations at W2. We compared the predicted COPC concentrations to the SSWQO at W2 to determine the extent of potential effects to aquatic resources. Protection of the downstream receiving environment can be achieved by ensuring that mass loadings of COPCs do not exceed downstream concentrations beyond the SSWQOs. As illustrated by the model predictions and highlighted in EcoMetrix's report,[119] the proposed effluent discharge criteria will produce concentrations for many COPCs above the SSWQOs at W2.

The Proponent's model predictions demonstrate continued exceedances of the current SSWQOs in the receiving environment. Model validation against measured data was requested as part of an information request to the Proponent on September 23, 2013.[120] The Proponent's response[121]demonstrated general agreement between the model predictions and the measured data over the period for which data are available, providing further support that predicted exceedances would be realized.

As previously noted, we accept the proposal to change the W2 monitoring station from a compliance point to an objective as originally proposed. This requires continued monitoring of COPCs at W2 and an effective adaptive management plan to modify discharge to ensure mine effluent does not contribute additional mass load to COPCs that exceed SSWQOs in the receiving environment. We originally proposed the W2 compliance point to provide the Proponent the maximum flexibility in managing their effluent and utilizing the full assimilative capacity of Minto Creek during the operational period. The SSWQOs at W2 must remain as the test of adverse effects to aquatic resources.

In their report,[122] EcoMetrix outlined two approaches to calculating discharge limits that ensure mass loadings of COPCs do not cause an increase in downstream concentrations beyond the defined SSWQO. The first approach (the original approach) assumes the downstream tributary will have similar quality as the background drainage within the upper reaches of Minto Creek. The second approach accounts for the difference in water quality within the downstream tributary as compared to the upstream drainage. EcoMetrix used these two approaches to calculate the COPC concentrations at W2 from the proposed effluent release criteria (outlined in Table 2-8 of EcoMetrix report). Predicted water quality at W2 using approach number one and two are presented in Tables 2-9 & 2-10 respectively. Many COPCs will be elevated compared to the SSWQOs in the receiving environment based on the proposed effluent release criteria.

EcoMetrix noted that to achieve protection of aquatic life, the proposed effluent quality, quantity or some combination of the two must be altered from those proposed. In addition, EcoMetrix evaluated the

[119] YOR 2013-0100-240-1
[120] YOR 2013-0100-158-3
[121] YOR 2013-0100-177-1 through 180-1
[122] YOR 2013-0100-240-1

discharge water from the RO treatment plant and concluded that water filtered through the RO system can be released to Minto Creek without restriction.

In their March 17th report,[123] EcoMetrix suggested that the COPCs monitored for compliance at end-of-pipe should be reduced to include only those parameters that characterize the effluent. Parameters that are routinely below analytical detection limits or below ambient levels should not be included as COPCs for compliance purposes. EcoMetrix concluded that the concentrations of ammonia, nitrite, nitrate, copper selenium and zinc characterize the quality of the water stored in the WSP and should form the list of COPCs for compliance purposes. From this reduced list of COPCs (end-of-pipe), EcoMetrix back-calculated (from the SSWQOs[124] at W2) the end-of-pipe discharge quality criteria for a range of discharge quantity criterion from the proposed 3:1 to 6:1. Table 3-3 of EcoMetrix's report[46]details their findings. Of the reduced list of COPCs, significant adverse effects are likely to occur from the proposed selenium (0.02 mg/L) discharge criteria and the current effluent criteria for Zinc (0.15 mg/L)[125] will exceed the SSWQOs at W2.

As discussed, EcoMetrix's conclusions are based on their re-calculated effects levels for several COPCs for lower Minto Creek. In their comment submission, SFN disagrees[126] with EcoMetrix's conclusions for the updated effects levels for nitrate and copper and their reduced list of COPCs. SFN's approach and analysis focused on monitoring the dissolved fractions of the COPCs at end-of-pipe as a way to regulate the portions of metals originating from the mine site. Further to this, SFN noted that allowing for increased concentrations of any COPCs in the receiving environment goes against their stated goal of non-degradation.

Evaluation of Predicted Loadings at Closure

Model predictions for the closure period include considerably more uncertainty than those presented for the operational period. The actual performance of mitigations post closure, loadings from future waste sites and pathways for contaminants to the receiving environment all contribute to additional uncertainty for the closure period. Effects to aquatic resources are evaluated by comparing predicted loadings to SSWQOs (with modifications as discussed previously) for the closure period.

SFN raised considerable concern with the Proponent's closure plan and mitigation strategy in their comment submissions during the evaluation. Noting EcoMetrix's conclusions in their report from February 3, 2014[127] regarding closure, we engaged EcoMetrix to provide additional analysis including a focused review of some of the concerns raised by SFN in their January 24th, 2014 comment submission. EcoMetrix provided a report on their findings on March 5, 2014.[128] In this report, EcoMetrix concluded that without additional mitigation measures (i.e. covers and passive treatment) the current SSWQOs for lower Minto Creek would be exceeded for a number of COPCs. Of the COPCs predicted to exceed the SSWQOs, copper and selenium were determined to pose the most significant risk to aquatic resources. As outlined in Table (1) of EcoMetrix's report, copper is expected to exceed the current SSWQO at W2.

[123] YOR 2013-0100-246-2
[124] EcoMetrix used the updated SSWQOs as they re-calculated them (discussed previously in this report).
[125] At the proposed 3:1 quantity criterion.
[126] YOR 2013-0100-261-2
[127] YOR 2013-0100-240-1
[128] YOR 2013-0100-243-2

However, copper is not predicted to exceed the SSWQO developed by EcoMetrix using the BLM.[129] Therefore, the primary risks to aquatic resources are from selenium. This conclusion assumes that the source terms used in the model accurately represent the actual future loading from the site and that the predicted cover performance is representative. To gain a better understanding of the nature and magnitude of the uncertainty with the model predictions and the availability and performance of additional mitigation measures, we issued an additional information request to the Proponent.[130]

Our first question focused on determining an upper-bound estimate of loadings (i.e. the "worst case" scenario) by asking the Proponent to compare the initial flush and steady state field-scale loading rates calculated from humidity cell test (HCT) data for all COPCs to the loading rates used in the post-closure modelling. In their response, the Proponent provided a report prepared by SRK Consulting Inc.[131] that compares the HCT rates to the source terms used in the modelling and details the conservative assumptions used in the modelling that provide adequate precaution. SRK's analysis demonstrated that scaled up HCT loading rates were higher than empirically derived loading rates for all COPCs, often by an order of magnitude or more. From this comparison, SRK concluded that if the scaled up HCT loading rates were input to their water quality model, the COPC concentrations would be orders of magnitude higher for the majority of COPCs in Minto Creek.

The SRK report outlined conservatism included in their model used to produce the predictions provided in the Proposal. This conservatism focused on the source terms used for subaerial tailings and pit walls along with the exclusion of process known to reduce contaminant loadings from the site. SRK concluded that this conservatism is adequate to conclude that the model predictions are reasonably accurate.

In their comment submission,[132] SFN's technical team stated their agreement that it is unlikely that full scaled up HCT loading rates would be realized in the field; however, they disagree that the conservatism outlined by SRK is sufficient to address the uncertainties that exist in the modelling. SFN's technical team concludes that it is not unreasonable to expect that actual loading rates may be several times higher than predicted.

In addition to the source term comparison, the Proponent provided support for the predicted infiltration rate provided in their proposal along with preliminary findings of their reclamation research program. The Proponent highlighted the wetland research that they are actively engaged in and noted impressive reductions of metal loadings from their laboratory results. The Proponent did not provide similar data for the proposed bioreactors and has not conducted site testing for either the proposed wetlands or bioreactors to date. Because field trials can differ substantially from laboratory testing and the performance of wetlands and bioreactors (in terms of metal reductions) in far northern environments is not well documented, we cannot consider wetlands and bioreactors as feasible mitigations at this time.

Environment Canada (EC) provided comments that included a discussion of the potential effects from contaminant release through groundwater. EC concluded that there is not enough information to support the Proponent's conclusion that groundwater is not a pathway for COPCs to move from the site to Minto Creek. EC noted that a full assessment of groundwater is necessary along with the development of a

[129] YOR 2013-0100-246-2
[130] YOR 2013-0100-244-1
[131] YOR 2013-0100-254-1
[132] YOR 2013-0100-261-2

defensible (numerical) groundwater model to accurately predict effects to the aquatic resources in Minto Creek.

6.2.5.2 McGinty Creek

As discussed previously, the Phase V/VI expansion includes a new open pit located in the McGinty Creek watershed, north of Minto Creek. The Minto North pit is located in the headwaters of McGinty Creek. McGinty Creek flows north-northeast for 9.5 km to the confluence with the Yukon River.

Aquatic Life

Arctic grayling and slimy sculpin were captured in McGinty Creek in 1994. The Proponent notes that the conditions in McGinty Creek were significantly affected by a forest fire following the original sampling in 1994 that changed the morphology of the stream, introducing considerable deadfall. In 2009-2011 only minnow trapping could be used to sample for fish. This sampling yielded very low numbers of slimy sculpin in close proximity to the Yukon River. At the time of the sampling it was felt that the fish captures more appropriately represented fish migrating in from the Yukon River and not fish resident to McGinty Creek. In addition, the Proponent noted several factors including natural fish barriers, steep gradients, discharge volume, depth, configuration and water temperature that create very poor fish habitat.

For our effects assessment, we considered McGinty to provide poor fish habitat overall with marginal habitat near the confluence with the Yukon River. As there is no evidence of use by JCS, we do not consider that JCS will be affected.

Background Water Quality

Water quality data has been collected at five stations in McGinty Creek since 2009. Parameters that show regular exceedances of the CWQG include total aluminum, cadmium, chromium, copper, iron, lead, zinc and fluoride. Parameters that infrequently exceed the CWQG include arsenic, mercury, silver, ammonia, and pH. Many parameters spike during periods of high TSS in the summer months and following rainfall events.

Pathways to Effects

During mining of the Minto North pit, all water will be discharged to Minto Creek. The Proponent has assumed that groundwater flows in the McGinty Creek drainage are topographically controlled in a similar manner to Minto Creek. In addition, the Proponent notes that because the Minto North pit is located in the upper edge of the watershed, little groundwater is expected at the pit.

Due to the considerable unknowns regarding final water elevation in the pit post closure and the hydraulic conductivity and potential pathways for groundwater movement, our assessment considers the potential for both groundwater and surface water to carry contaminants to McGinty Creek.

Model Predictions and Potential Effects

In the development of source terms for McGinty Creek, the Proponent use scaled up HCT data along with some conservative assumptions to characterize the source terms from the Minto North pit.[133]

[133] YOR 2013-0100-072-1

- Pit walls consist entirely of rock (no allowance for reduced loadings from overburden, which is expected to make up nearly 20% of the final wall area);
- Loading rates remain constant over time, as fresh weathering surfaces are exposed bay ravelling of walls; and
- The pit remains empty and none of the wall area is flooded.

From these conservative source term assumptions, the Proponent included the following assumptions in their modelling run:[134]

- The magnitude of loadings was set to be equal to the loads determined for the full extent of the pit walls exposed at the end of mining (i.e. there was no gradual decrease in loadings estimates even if the pit was to fill).
- All geochemical loading generated by weathering of the pit walls is both flushed from the weathering sites and reports to water in the Minto North Pit.
- Accumulated loadings would report un-attenuated to McGinty Creek by surface discharge and/or via groundwater pathways.

The Proponent modelled the above source terms and applied the loadings directly to McGinty Creek. The model results conclude that there will be minimal change to water quality in McGinty Creek from mining of the Minto North Pit. Fluoride is expected to exceed background levels (>95 percentile of background concentrations). Background levels of fluoride in McGinty Creek are already elevated above CWQGs. The Proponent's effects assessment has concluded that modifying effects of the water chemistry in McGinty Creek and the lack of fish presence for most of the year will prevent adverse effects to aquatic resources.

There is general agreement among all technical reviewers that the Proponent has provided an inadequate characterization of groundwater interactions with the Minto North Pit to develop a quantitative evaluation of effects to McGinty Creek. However, for the purposes of this assessment, the significant conservatism proposed in the Proponent's modelling of loadings to McGinty will greatly reduce the risks posed by the uncertainty.

6.2.6 Relevant Non-discretionary Legislation

- Waters Act
- Fisheries Act
- Quartz Mining Act

6.2.7 Relevant Proponent Commitments

- Efficient use of blasting materials to ensure accumulation of residue on waste rock is minimized
- Blasting as soon as possible after blast holes are charged with ANFO to prevent seepage of nitrates into the groundwater

[134] YOR 2013-0100-049-1

- Use of ANFO in dry holes only (pumped dry if necessary and use of a plastic liner), or use of emulsion type explosives in wet holes, as these contain agents that prevent the dissolution of nitrates in water
- Disposal of blasting reagent packaging and related waste done in accordance with the Blast Site Safety Manual Disposal Guidance document (Dyno Nobel North America, Appendix B of the Explosives Management Plan)
- A demonstration-scale wetland will be constructed on site beginning in 2014

6.2.8 Significance Determination

Due to the differences between the operational and post-closure periods for the Phase V/VI expansion in terms of predicted loadings and available mitigations, we provide our significance determination separately for the two periods.

For Minto Creek, the effects of a failure of the Main Pit Dam would be significant due to the magnitude and duration of adverse effects. It is uncertain if Minto Creek would support aquatic life even after a significant period following a failure of the Main Pit Dam. As discussed in Section 5.0, the risk of a Main Pit Dam failure cannot be eliminated. However, the mitigations recommended in Section 5.0 will adequately reduce the likelihood of a failure and potential adverse effects to aquatic resources in Minto Creek. In addition, hazard classification of the Main Pit Dam is set based on the potential loss of life rather than the risk to environmental damage.[135] Therefore, the design standards for the Main Pit Dam will be more conservative than if they were set based on the environmental consequence of a failure alone. This will further reduce the risk to aquatic resources. No additional mitigations are required to address potential effects to aquatic resources from a failure of the Main Pit Dam.

6.2.8.1 Operational Period – Minto Creek

Considerable disagreement exists between the Proponent and technical reviewers as to the potential effects of the Phase V/VI expansion to aquatic resources in Minto Creek. We fundamentally disagree with the Proponent on two key aspects of their proposal and effects assessment:

- That recent TSS loads in lower Minto Creek constitute a change to background water quality in lower Minto Creek; and
- That because high TSS loads from tributaries (outside the mine's control) are driving water quality at the receiving environment in Minto Creek, the mine should be allowed to discharge excess mass loadings of COPCs to Minto Creek regardless of whether the background water quality exceeds SSWQOs at W2.

To the contrary, we are of the opinion that the recent spike in TSS and associated metal loadings in tributaries to Minto Creek do not constitute an alteration to background water quality in lower Minto Creek[136]; and, we equate the increase in TSS and associated metals in lower Minto Creek to a decrease

[135] YOR 2013-0100-173-1
[136] For reasons previously discussed, namely:
- High TSS loads originating in tributaries to Minto Creek; and

in the assimilative capacity of Minto Creek for some COPCs. The reduced assimilative capacity[137] must be factored into mine effluent releases.

The Phase V/VI expansion is expected to produce regular exceedances of SSWQOs in the receiving environment. The SSWQOs are designed as objectives not to be exceeded during regular operations and should be the basis for the derivation of discharge limits for effluent release from the mine site. If sources outside the mine's control cause exceedances of SSWQOs then releases from the mine must not contribute to further mass load of elevated COPCs. Minto Mine should not be allowed to release excess mass loadings to Minto Creek when background water quality exceeds SSWQOs at W2, as this will only further degrade water quality.

As outlined in Table 3-3 of EcoMetrix's March 17, 2014 report,[138] selenium is the primary COPC expected to cause significant adverse effects to aquatic resources as a result of the Proponent's proposed effluent release criteria. In their response to EcoMetrix's findings,[139] the Proponent reiterated their disagreement with EcoMetrix's conclusion that they did not provide enough support for an increased discharge of selenium from the mine site.

We agree that tissue-based guidelines are a better tool for assessing effects to sensitive organisms from exposure to Se than water-based guidelines. In spring and summer 2012,[140] Se in slimy sculpin tissue met or exceeded the BC interim tissue value although the total Se water concentration was below the current SSWQO of 0.001 mg/L. Similar data are not available for JCS that use lower Minto Creek for rearing habitat. An increase in the Se SSWQO from 0.001 mg/L would increase exposure to Se for fish and result in higher Se body burdens than those currently observed in lower Minto Creek. However, there is not enough information available to estimate the potential Se tissue concentrations in slimy sculpin and JCS (i.e. site-/species- specific Se bioaccumulation factors) as a result of increased exposure to Se and to understand the implications of such an increase in exposure to Se on the success of these populations in lower Minto Creek. A primary objective of the SSWQOs for Minto Creek are to protect JCS; as noted previously, this goal is emphasised by SFN. In the absence of further analysis to support a conclusion that increased exposure to Se will not adversely affect fish in lower Minto Creek, it is prudent to maintain the current SSWQO for Se at 0.00 1 mg/L to ensure that significant adverse effects do not occur.

Protection of aquatic resources in Minto Creek can be achieved through regulation of a reduced list of COPCs end-of-pipe and the application of a variable load allocation scheme to mine water releases. This will allow the mine use of the full assimilative capacity of Minto Creek during operations, providing maximum flexibility to mine operators while achieving protection of aquatic resources in lower Minto Creek.

- Slumping in tributaries likely a short duration upset to longer-term background conditions.

137 In this case, "assimilative capacity" refers to the capacity of Minto Creek water to dilute contaminant loadings to concentrations that are below effects levels for aquatic life.
138 YOR 2013-0100-246-2
139 YOR 2013-0100-260-1
140 YOR 2013-0100-053-1

6.2.8.2 Closure Period – Minto Creek

With the addition of soil covers, the Proponent predicts that loadings from the site will result in COPC concentrations that are significantly elevated from baseline conditions, but at or below the SSWQOs (for the operational period) for most COPCs. The lack of active water management and considerable uncertainty in the accuracy of model predictions for the closure period, support the conclusion that additional mitigation measures are required to prevent significant adverse effects to aquatic resources post closure.

For the most part, source terms were developed from water quality monitoring at the site. Although we agree that the use of site data to develop source terms is appropriate, additional conservatism is necessary to address some key uncertainties. For example, we do not know if the peak loadings or long-term steady loading rates are accurately captured in the site data collected to date. Without an understanding of seepage rates from each waste pile, we cannot determine the actual flushing and pore volumes to understand whether the site loadings will increase over time. In addition, as outlined in the Proponent's response to our information request on this subject,[141] HCT data show that after a considerable period of testing (40-50 weeks) the metal loadings remain orders of magnitude higher than those used in the modelling. Although we agree that it is unlikely that loading rates would reach those of the scaled up HCT results, we are of the opinion that loadings may be considerably higher than those predicted.

In addition to the uncertainty in actual site loadings, the Proponent has proposed to utilize the entire assimilative capacity (for some COPCs) of Minto Creek in perpetuity. We do not agree with this approach for the closure period. Removal of the assimilative capacity does not account for higher than expected loadings from the mine site or cumulative loadings from future disturbances in the watershed. If the Proponent's modelling proves accurate, even relatively small additional loadings of some COPCs in the future could result in significant adverse effects to aquatic life. This may include unexpected loadings through groundwater inputs, an issue raised by reviewers throughout the evaluation. A substantial margin of safety should be built into the closure plan to accommodate future cumulative loadings and uncertainty.

6.2.8.3 Operational Period – McGinty Creek

Effects to McGinty Creek during the development of the Minto North pit are not expected to be significant. Contaminated contact water will be deposited to the Minto Creek drainage and will be subject to the discharge standards in that drainage. Due to the location of the pit in the McGinty Creek watershed, we are of the opinion that the risk of significant effects to flows in McGinty Creek is low.

6.2.8.4 Closure Period – McGinty Creek

The effects of the Minto North development are most uncertain following the completion of the pit. The Proponent did not provide an assessment of the post closure water balance for the pit, so it remains unclear what the final flood level will be for the pit (if it floods at all). We recognize that the modelling and effects assessment for the Minto North pit evaluated an unrealistic "worst case" scenario for loadings. However, the effects to McGinty creek following the closure of the Minto North pit may be very different than those predicted in the proposal. We are satisfied that the effects assessment provided for the

[141] YOR 2013-0100-254-1

McGinty Creek watershed is sufficiently conservative for the purposes of our evaluation. However, the regulators should consider the requirements for further details including additional monitoring to allow for the development of a defensible groundwater model to develop a more accurate evaluation of effects post closure.

Mitigations:

The Mayo Designated Office has determined that the Project will have significant adverse environmental project effects on aquatic resources. These effects can be eliminated, reduced or controlled by the application of the following terms and conditions:

14. The Proponent shall adequately monitor potential effects to groundwater flows and quality from the Project. Within the Minto Creek drainage, these should include new multilevel monitoring wells up-gradient and downgradient of Mine activities and increased sampling frequency. These include installation of boreholes and multi-level monitoring wells between current monitoring wells MW12-07 and MW12-06 and downstream of well MW12-05. Longitudinal flow paths shall be evaluated using non-toxic tracer testing to provide a more robust understanding of groundwater movements in support of the development of a numerical groundwater model.
15. The Proponent shall develop a numerical groundwater model for the Minto Creek watershed, informed by additional monitoring, to develop a comprehensive understanding of flow and solute transport with a focus on the closure period. This model shall consider the effects of property geology and potential interaction of the various hydrogeologic and hydrologic domains.
16. The Proponent shall not release additional mass loadings of contaminants of potential concern that are elevated above the site-specific water quality objectives in the receiving environment.
17. The changes to SSWQOs for Al, Fe and Cr proposed by the Proponent will likely result in significant adverse effects to aquatic life. As such, the current SSWQOs should remain for all COPCs. For Fe, the SSWQOs should remain unchanged, but the regulators may wish to consider the merit of removing Fe from the effluent criteria as it is sufficiently controlled by the current restrictions on TSS. Should the Proponent need to relax the SSWQO for Cr, they should provide regulators with an analysis of total Cr in mine releases and Minto Creek background that is Cr(III) and Cr(VI). CCME provides guidelines for appropriate WQOs based on Chromium speciation.
18. The downstream compliance point at W2 can be removed provided the end-of-pipe discharge quality and quantity criteria are based on:
    a. The objective is to ensure protection of the downstream receiving environment. The 2010 WUL defines Lower Minto Creek at W2 as the receiving environment and identifies Chinook salmon as the target species of greatest concern. Protection of the receiving environment must include protection of the most sensitive species in that system to ensure that the system can sustain use by Chinook salmon.

   b. The SSWQO as the basis to derive end-of-pipe discharge limits and for comparison to water quality monitoring data to demonstrate environmental protection.
   c. Ensuring the mass loadings of COPCs do not cause an increase in downstream concentrations beyond the defined SSWQOs.
      i. Mine water releases that have COPC concentrations below the SSWQOs for the receiving environment can be released without control on quantity.
   d. Monitoring water quality in the downstream receiving environment at W2 and applying SSWQOs to the downstream receiving environment at W2.

19. If the Water Use Licence is amended to include the removal of the W2 compliance point, it should include end-of-pipe quality and quantity criteria. We recommend a more restrictive quantity criterion and or more restrictive quality criteria than proposed by the Proponent to achieve the desired SSWQO in the receiving environment*.*
20. If the Proponent is permitted to discharge RO treated water without restriction on discharge rate, the quality of the discharge water must comply with the SSWQOs at the point of release and the release of such water must not result in erosion of the stream banks or alteration to the habitat in Minto Creek.
21. The Proponent shall update their Adaptive Management Plan to, at a minimum:
   a. Establish water concentrations for the Water Storage Pond that trigger changes to release quantity;
   b. Include flow measurements taken at an appropriate location to represent the receiving environment prior to and during periods of release from the WSP;
   c. Include measures to adjust flows from the WSP to the appropriate mixing ratio;
   d. Establish clear procedures for investigating the cause of COPC concentrations that become elevated in the receiving environment. Establish corrective actions to address elevated COPC concentrations that characterize mine effluent. Triggers to begin investigation of elevated COPC concentrations should be set at a value below the SSWQOs to allow for corrective action (where possible) prior to causing effects to aquatic resources.
22. In addition to annual Water Balance and Water Quality model reports, the Proponent shall provide regulators with an annual report outlining the accuracy of the Water Balance and Water Quality model. The report shall at a minimum:
   a. Provide a comparison of waste rock and tailings produced during the course of Phase V/VI production to historical geochemical and water quality monitoring data collected from pre-existing Minto Mine Operations;
   b. Undertake monitoring of pit walls for all open pit operations over the course of mining operations to better define source terms for post-closure modeling;
   c. Identify any discrepancies between model predictions at water quality stations and the exiting monitoring data;

i. Discuss the origin and implication of such discrepancies if they exist;

d. Guide the evolution of existing monitoring programs as appropriate; and
e. Identify follow-up programs to reduce uncertainty associated with the model assumptions.

23. The Proponent shall develop and implement a monitoring program (quantity and quality) of all contact waters including pit-walls, in-situ and down-gradient tailings, and waste rock pore waters during operations. This includes monitoring of the existing DSTF. The results of this program shall be compared to the source terms used in the Water Quality Model and provided to regulators annually as part of the Accuracy of the Water Balance and Water Quality Model Report prescribed by mitigation # 22.
24. As part of the final design for the Main Pit Dam, the Proponent shall include a collection sump to capture, monitor and treat seepage from the Main Pit Tailings Management Facility through the Main Pit Dam. Seepage from the Main Pit Dam must be included in the annual updates to the water quality model and shall be assumed to continue in perpetuity if any uncertainty as to the total duration of seepage exists at the time of model updates.
25. Additional passive and semi-passive treatment systems are required for the closure period to ensure the protection of aquatic resources in lower Minto Creek. Mitigation # 25 from the Decision Document for project 2010-0198 has not resulted in the timely development of a statistically robust evaluation of: 1) in-situ water behaviour (quantity and quality) through different soil covers on selected reclaimed areas and 2) laboratory and scaled experimental passive treatment of wetlands. This mitigation shall be amended to include the following:
    a. No later than 90 days following the issuance of the Decision Document for evaluation 2013-0100, the Proponent shall provide the other members of the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) with a detailed study design to evaluate the site performance of the proposed cover systems in a full scale trial at the site. At a minimum, the study shall be designed to provide a statistically robust review of the following:
        i. Infiltration rates measured at randomly selected locations across the waste facility to adequately capture the variability in cover thickness and slopes;
        ii. Rates of erosion across the site and a percentage of the site affected by cover breakthrough;
        iii. Contaminant loads from the cover system; and
        iv. Any other matters recommended by the advisory committee.
    b. Within 30 days of the issuance of the study design report referred to in ‘a’, the members of the Advisory Committee shall provide the Proponent with suggested changes and feedback on their proposed design.
    c. The study design shall be finalized within 180 days of the issuance of the Decision Document for this assessment (2013-0100).

   d. No later than 60 days following the issuance of the Decision Document for evaluation 2013-0100, the Proponent shall provide the other members of the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) with a detailed study design to evaluate the site performance of the proposed wetland in a demonstration-scale trial at the site. The study design shall include all necessary components to provide a statistically robust and defensible evaluation of the year round performance of the wetland for treating water at the site. The study shall also incorporate measures to monitor metal loads in the wetland to develop a long-term maintenance and monitoring plan.
   e. A demonstration-scale wetland shall be constructed on site beginning in 2014 as outlined by the Proponent in YOR 2013-0100-253-1.

26. The Proponent shall provide to the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) a report detailing all reasonable and practical mitigations for the closure period. When determining what constitutes "reasonable" and "practical", members of the advisory committee shall consider the following:
    a. The expected or actual site performance of a given mitigation;
    b. The cost of the mitigation (both initial cost and long-term maintenance cost) compared to the expected contaminant reductions.
27. The Proponent shall implement all reasonable and practical passive and semi-passive mitigations developed from mitigation # 26.
28. The Proponent shall provide regulator(s) with a fully costed monitoring and maintenance plan for all site components at closure. Moreover, the Regulator(s) shall consider this report when determining the appropriate security to be provided to YG by the Proponent.
29. The Proponent shall maintain a fully functioning water treatment plant on site until such time that they can demonstrate full protection of aquatic life at the receiving environment in Minto Creek through mitigations applied during closure.
30. The Proponent shall immediately begin reclamation of all disturbed areas that are no longer subject to ongoing operations and that will be unaffected by Phase V/VI developments.

6.3 Residual Effects

Residual effects of the project related to aquatic resources include increased metal loadings and altered water chemistry in Minto and McGinty Creeks in perpetuity. Following application of the Proponent's commitments, non-discretionary legislation and the mitigations in this report, no significant residual effects to aquatic resources are expected from the Phase V/VI developments.

The project site includes all past phases of the Minto Mine development. Most of the residual effects of these developments are captured in the Proponent's modelling and are included in the evaluation of aquatic effects for the Phase V/VI expansion. However, the ongoing instability of the DSTF poses significant risk to aquatic resources as this facility cannot be effectively reclaimed and covered until the movement is arrested. As part of their comment submission, SFN provided a report prepared by Norwest

Corporation[142] evaluating the ongoing instability in the DSTF. The author concluded that the Mill Valley Fill extension, proposed as a contingency measure with the Phase V/VI developments, is required to arrest the movement of the DSTF.

6.4 Cumulative Effects

We consider the instability of the DSTF to pose a significant risk to aquatic resources in Minto Creek. Ongoing movement, if not arrested, will hamper reclamation efforts and significantly reduce the effectiveness of a cover. The Mill Valley Fill extension is required to arrest the movement of this facility to allow for proper closure.

The Mayo Designated Office has determined that the Project will have significant adverse cumulative environmental effects on aquatic resources in connection with the effects of other activities. These cumulative effects can be eliminated, reduced or controlled by the application of the following terms and conditions:

31. The Proponent shall update their mine development plans to account for the full construction of the Mill Valley Fill Extension Stage 2.
32. To ensure adequate performance of the Mill Valley Fill buttress, the design and construction program shall include all recommendations detailed on page five of the report prepared by Norwest Corporation (YOR 2013-0100-219-1).

7.0 SELKIRK FIRST NATION SETTLEMENT LAND

7.1 Overview

In their comment submission, SFN highlighted s.14.8.1 of the *Selkirk First Nation Final Agreement* that states:

> Subject to the rights of water users authorized in accordance with this chapter and Laws of General Application, a Yukon First Nation has the right to have water which is on or flowing through or adjacent to its Settlement Land remain substantially unaltered as to quantity, quality and rate of flow, including seasonal rate of flow.

The Minto Mine will permanently affect the water of Minto Creek that runs across SFN's Category A Settlement land Block (R-6A). As Part of the Phase V/VI mine expansion, the Proponent has proposed to use the entire assimilative capacity of Minto Creek (for some COPCs) in perpetuity. Beyond the reduction of the capacity of the system to accommodate unexpected loadings as previously discussed, the use of the full assimilative capacity will limit SFN's options for the future development and use of their settlement land. As such, we have concluded that the use of the full assimilative capacity of Minto Creek will result in significant adverse effects to SFN as a result of lost future opportunity.

[142] YOR 2013-0100-219-1

7.2 Project Effects – Loss of Future Opportunity for SFN

7.2.1 Effects Characterization

SFN may lose future opportunity as a result of degraded water in Minto Creek. If SFN would like to permit future mining or development on any other part of their settlement land block that has the potential to affect the water in the Minto Creek drainage, they will be limited as any additional loadings of COPCs may result in significant adverse effects to aquatic life. SFN may be forced to choose between degrading the water in Minto Creek, affecting aquatic resources, undertake additional actions to treat all loadings to effects levels at point of release or reduce loadings from the existing mine site. Essentially, SFN would bear the entire burden of treatment or additional reclamation to use Minto Creek in the future.

As part of their January 24, 2014 comment submission, SFN provided several documents outlining their desire to see COPC concentrations in Minto Creek restored to background condition. This would essentially constitute a complete restoration of the assimilative capacity of the creek to pre-mining condition. Through their analysis, SFN concluded that non-degradation plus a margin of 10% is achievable during closure using passive and semi-passive treatment to reduce loadings from the mine site. In a follow up submission on April 1, 2014 SFN outlined that they would accept the restoration of 50% of the assimilative capacity of Minto Creek as sufficient contingency.

7.2.2 Relevant Non-discretionary Legislation

- Selkirk First Nation Final Agreement

7.2.3 Significance Determination

The use of the entire assimilative capacity for some COPCs in Minto Creek in perpetuity will result in significant loss to future opportunity for SFN's use of their R6-A Settlement Land block. The mitigations proposed to eliminate effects to aquatic resources should achieve a partial restoration of the assimilate capacity as this is required to accommodate future uncertainty. However, without water quality objectives for closure, it is unclear if these mitigations will sufficiently reduce the significant adverse effects to SFN from the effects characterized above. As such, we recommend additional mitigations.

Mitigations:

The Mayo Designated Office has determined that the Project will have significant adverse socio-economic project effects to SFN. These effects can be eliminated, reduced or controlled by the application of the following terms and conditions:

33. Non-degradation (compared to historical background quality) of Minto Creek water quality shall provide the basis for the development of water quality objectives for the closure period. However, if non-degradation cannot be achieved using reasonable and practical passive treatment mitigations (as outlined in mitigation # 29), then the closure objective shall be guided by what can be practically achieved (as long as the objectives are below the effects levels for aquatic resources with sufficient contingency).
34. In the event that that COPC concentrations remain elevated in Minto Creek compared to historical background levels during closure, the Yukon Water Board shall consider whether the remaining assimilative capacity preserves sufficient opportunity for SFN on

their Settlement Land and fulfills the spirit and intent of s.14.8.1 of SFNs Final Agreement. The Yukon Water Board should consider whether additional corrective action (i.e. further mitigation or compensation to SFN) is warranted in the event that they decide SFN will experience significant loss of future opportunity as a result of the loss of assimilative capacity in Minto Creek.

7.3 Residual Effects

The Minto Mine is the only project currently affecting water quality in Minto Creek. The application of the proponent's commitments, non-discretionary legislation and the mitigations in this report will sufficiently reduce the residual effects of the project to SFN's Settlement Land.

7.4 Cumulative Effects

The Mayo Designated Office has determined that the Project will not have significant adverse cumulative socio-economic effects to SFN's settlement land in connection with the effects of other activities. Therefore, no further mitigation is required.

8.0 ENVIRONMENTAL QUALITY

8.1 Overview

The Project requires the use of heavy equipment and the clearing of an additional 82 ha of land. These activities, in addition to proposed reclamation works, have the potential to introduce invasive species. Effects pathways include contaminated material on equipment, non-native species in seed mixes and disturbed ground conditions, which may favour invasive species.

The Designated Office has determined that the Project will result in significant adverse effects to environmental quality, such that further mitigation is required. The rationale used to determine the significance of project effects is discussed in the following sections.

8.2 Project Effects – Introduction of Invasive Species

8.2.1 Effects Characterization

Project activities with the potential to introduce invasive plant species include removal of the vegetative mat, reclamation activities and the use of tools and equipment that may be contaminated with invasive plant matter. Seeds from invasive plants, plant material and soils harbouring invasive species can be introduced to a work area via tools and equipment from affected areas.

Invasive plants typically colonize disturbed areas and can out-compete native plants most effectively following disturbance. General attributes of invasive plants can include fast growth rates, prolific seed production, vegetative reproduction, irregular germination and an ability to produce toxins to limit grazing. In Yukon, invasive species of concern include creeping thistle, spotted knapweed, oxeye daisy, common tansy, Sweet clover, perennial sow-thistle, leafy spurge, toadflax, and orange hawkweed (YISC 2010).

Invasive plants displace native vegetation (used as forage and shelter by wildlife and for nutritional, cultural and medicinal purposes by humans), ultimately damaging native ecosystems and reducing biodiversity. Disturbed areas, such as those created by the Project, create environments that are highly suitable to many species of invasive plant. Invasive species result in environmental and socio-economic effects when they replace, inhibit or out-compete native species. Invasive plants can also alter fire intensity and frequency, soil chemistry, and attract pests (YISC 2010).

The Proponent commissioned several vegetation surveying and mapping initiatives. A 1994 report provides baseline information regarding the vegetation on site and a 2010 report provides a record of current/recent vegetation communities in the study area (3,626 ha). The Proponent has also developed an 'ecosystem map' that is "designed to be used as a land management and planning tool. As the mine expands its footprint, the map can be referred to for a quick assessment of which type of vegetation communities will be directly disturbed and how much area is involved."[143]

The vegetation surveys and ecosystem map provide valuable information that will allow the Proponent to monitor and assess the Project's impacts to vegetation over time. However, there is little consideration in the proposal regarding potential adverse effects associated with invasive species.

The Proponent provides detailed information about progressive and final reclamation activities for the project area. Some of the proposed strategies include active re-seeding of disturbed areas. It is imperative that if any re-seeding using seed mix is required that the seed stock used contain only native species suitable for the location. The Proponent provided consideration of the importance of appropriate seed mixes in their Preliminary Reclamation and Closure Plan (PRCP), including information regarding the 'revegetation trials' and 'practical' seed mixes:

> While it is known what seed types have been used at the site previously, and what types of plants have been naturally revegetating the site, further reviews and investigations are necessary to confirm the appropriate seed mixes that should be used in conjunction with different soil covers. The ultimate seed mixtures will be developed using:
>
> - Knowledge of the naturally occurring vegetation and soil conditions;
> - An inventory of naturally occurring seed sources on site;
> - Results from revegetation activities to date;
> - Existing literature on regional revegetation science; and
> - Information gained from revegetation test plot trials on site.144

In addition to the strategy above, the Proponent developed 'dry area' (for most disturbed sites) and 'wet area' (for riparian sites) seed mixes and specific measures to promotes successful, self-sustaining vegetation in disturbed areas (see Tables 4-1 and 4-2 in PCRP for details regarding seed mixes).

The vegetation surveys and ecosystem map provide valuable information that will allow the Proponent to monitor and assess the Project's impacts to vegetation over time. Additionally, the PRCP includes

[143] YOR 2013-0100-012-1
[144] YOR 2013-0100-064-1

practical, detailed information for reclaiming disturbed areas. However, there is little specific information within the proposal that details strategies and mitigations for dealing with invasive species that may be introduced by proposed activities.

8.2.2 Relevant Proponent Commitments

- Progressive reclamation will be implemented throughout the life of mine to effectively re-vegetate any disturbed areas and to minimize the production of fugitive dust;
- Only the minimum amount of clearing (removal of vegetation) will be completed, so that Project operations remain effective and safe;
- The extent of grubbing, stripping, and the removal of shrubs and herbaceous species will be minimized where possible;
- When clearing is required, the vegetative mat will be retained wherever possible;
- Topsoil will be stripped off first and stockpiled separately from overburden, wherever possible. The topsoil is needed as it contains the biological agents needed to induce natural nutrient cycling for plants used in re-vegetation efforts;
- Vegetation buffers will be maintained around wetland and riparian zones; and,
- Placement of new infrastructure will occur within existing disturbed/development areas wherever possible, in an effort to reduce the amount of new vegetation clearing and general site disturbance required.

8.2.3 Relevant Non-Discretionary Legislation

- Environment Act
- Quartz Mining Act and Quartz Mining Land Use Regulation (Schedule 1 Operating Conditions)

8.2.4 Significance Determination

The Designated Office considers that this Project may result in the introduction of invasive plants to the Project site. As mentioned previously, the introduction and establishment of invasive plants can cause considerable adverse effects to the surrounding environment. Once established on a site, invasive plants may grow to create a substantial seed bank that could spread to other areas. It is crucial that operators recognise invasive plants and mange outbreaks if they occur. The Designated Office has determined that the Project poses significant risk of introducing invasive species to the region that would result in significant adverse effects to environmental quality.

Mitigations:

The following terms and conditions are recommended by the Mayo Designated Office to mitigate significant adverse effects of the Project on environmental quality.

35. The Proponent shall familiarize themselves and their contractors with Yukon invasive species and how to manage them by referring to the document "Why Should I Care

About Invasive Species?" available from http://www.yukoninvasives.com/pdf_docs/WhyshouldIcare2011_sm.pdf.

36. The Proponent shall remove foreign soil and plant material from equipment prior to moving it to the project site.
37. The Proponent shall report the presence of any invasive plants that are listed on the Yukon Invasive Species Council website (http://www.yukoninvasives.com/pdf_docs/plants_all_invasives.pdf) to Yukon Government by e-mail (invasives@gov.yk.ca) or to the Northern Tutchone Regional Biologist (867-996-2162).

8.3 Residual Effects

Because of the nature of the proposed mining activities (e.g. vegetation clearing, use of heavy equipment, stockpiling of overburden, etc.), there is potential for ongoing adverse effects to environmental quality. However, implementing Proponent commitments/plans and recommended mitigations, in addition to adhering to non-discretionary legislation, will reduce or control residual effects such that they are not significant.

8.4 Cumulative Effects

There are no other projects within the Project area that are likely to have residual effects on environmental quality that will interact with residual effects of the Project. However, there are potential natural disturbance events such as forest fires and significant precipitation events can also result in vegetation disturbance that could be conducive to invasive species' colonization. These natural events are largely beyond control, but they can interact with human-caused disturbances and exacerbate adverse effects. Proper reclamation techniques and diligence in operations can reduce the potential for natural events to contribute to adverse cumulative effects.

Additionally, residual effects from previous mining phases at Minto could also interact with residual effects from Phase V/VI operations. However, the proposed PCRP contemplates closure of the site as a whole and, as such, residual effects of the entire mine are addressed within closures activities. The Designated Office has determined that the residual effects from Phase V/VI will not result in significant adverse cumulative effects to environmental quality.

9.0 WILDLIFE AND WILDLIFE HABITAT

9.1 Overview

Several proposed activities have the potential to adversely affect migratory birds and their habitat. These activities include clearing up to 82 ha of land, road construction, use of heavy equipment, use of explosives and human presence. Direct effects include loss of habitat, mortality and destruction of nests. Indirect effects include disturbances (e.g. noise, human presence) that could lead to avoidance behaviours and/or abandonment of nests. Proposed activities may overlap with migratory bird presence in the area and, as such, the following project effects have been considered:

- Effects to migratory birds and habitat

The Designated Office determined that the Project will result in significant adverse effects to migratory birds and their habitat, such that further mitigation is required. The rationale used to the determine the significance of project effects is discussed in the following sections.

9.2 Project Effects – Effects to migratory birds and habitat

9.2.1 Effects Characterization

In Yukon, the core breeding period for most, though not all, migratory birds extends from approximately May 1 to July 31; however, breeding can occur outside of this period. Migratory birds may nest in a variety of habitat types and features, which makes it difficult to predict or locate the nests. Locations that birds may select to nest include on the ground or in ground cavities; in grasses and shrubs; on cliffs, in trees or tree cavities; and other sites that are often well concealed. The nesting stage is critical in maintaining sustainable populations of migratory birds. As described in Section 3.2, the Project area may host a variety of avian wildlife, including raptors and migratory bird species, some of which are listed as threatened or are protected under the *Migratory Birds Convention Act* and/or the *Species at Risk Act*.

Project activities involving ground disturbance, clearing and increased noise can disturb birds in a number of ways, including nest abandonment, increased mortality of eggs and young and disrupted feeding.

9.2.2 Relevant Proponent Commitments

- The disturbance footprint and related vegetation clearing will be limited to the extent necessary to minimize habitat loss;
- Only the minimum amount of clearing (removal of vegetation) will be completed, so that Project operations remain effective and safe;
- The extent of grubbing, stripping, and the removal of shrubs and herbaceous species will be minimized where possible;
- Vegetation buffers will be maintained around wetland and riparian zones;
- Placement of new infrastructure will occur within existing disturbed/development areas wherever possible, in an effort to reduce the amount of new vegetation clearing and general site disturbance required;
- Consistent with Section 92 of Yukon *Wildlife Act*, a “no wildlife harassment” policy will be enforced for company and contractors' employees while working within the Project area. This policy comprises: safe deposit of garbage, employee wildlife education, and wildlife avoidance;

9.2.3 Relevant Non-discretionary Legislation

- Migratory Birds Convention Act (MCBA)
    - Migratory Birds Regulations
- Species at Risk Act

- Yukon Wildlife Act, Section 17, which prohibits a person from destroying, taking or possessing any egg or nest of a bird that belongs to a species that is wild by nature; and Section 92 which prohibits the harassment of wildlife.

9.2.4 Significance Determination

The destruction or disturbance of migratory bird nests and eggs, incidental or otherwise, is prohibited under the *Migratory Bird Regulations*. These regulations were established under the MBCA, pursuant to the international agreement to protect migratory birds given their continued decline. As such, the Designated Office considers the destruction of nests, birds, and/or eggs in contravention to the Act to be a significant adverse effect.

The Proponent has provided mitigations that will reduce, to some extent, the chances of incidental destruction of migratory birds. However, the extent of additional clearing required as part of the mine expansion (82 ha) is substantial. Since mining operations will overlap with migratory bird presence in the area (for several seasons), it is important that clearing activities occur outside of the bird-nesting window as much as possible. Further mitigation is required to reduce, eliminate and control significant adverse effects to avian wildlife, and in particular, migratory birds.

Mitigations:

The Mayo Designated Office has determined that the Project will have significant adverse environmental effects on avian wildlife. These effects can be eliminated, reduced or controlled by the application of the following terms and conditions:

38. Wherever practicable, vegetation clearing for this Project shall occur after July 31st. In the event that land clearing activities occur during the core-breeding period of May 1st to July 31st, prior to clearing the Proponent must plan to avoid disturbing or destroying nests of birds listed under the *Migratory Birds Convention Act*. Contact the Canadian Wildlife Service (Whitehorse) for information on considerations related to determining the presence of nests.
39. If active nests of birds listed under the *Migratory Birds Convention Act* are discovered, the Proponent shall postpone activities in the nesting area until nesting is completed (i.e. the young have left the vicinity of the nest).

9.3 Residual Effects

Due to clearing activities and disturbance associated with other mine site activities (e.g. heavy equipment use, blasting, human presence), there will be a reduction in available breeding/nesting habitat for migratory birds in the project area (direct and indirect loss of habitat). However, as noted above, there are no identified key habitat areas at or surrounding the mine site and there is no shortage of available land base for migratory bird breeding/nesting habitat in the larger region.

After mining is completed, disturbed areas will be reclaimed actively and naturally. As such, any displacement and/or loss of habitat will be temporary. Existing non-discretionary legislation, Proponent commitments and recommended mitigations will reduce the adverse residual effects to migratory birds and their habitat, such that these effects are not significant.

9.4 Cumulative Effects

While the spatial scope for migratory birds is enormous, the temporal scope during which these birds are most vulnerable to ground activities is during a nesting period that occurs between May 1st and July 31st. The proposed Project is occurring in an area that is disturbed by past and ongoing mining activities.

There are other mining and exploration projects in the general region that also involve vegetation clearing and ground disturbance activities. As such, they may result in similar effects to migratory birds as the proposed Project. However, most of these other projects are located a sufficient distance from the Minto site,[145] such that their respective residual effects are unlikely to interact with residual effects from Phase V/VI.

Residual effects from previous phases of the Minto project may interact with residual effects from Phase V/VI. For instance, areas cleared during Phase IV activities that are not yet reclaimed may take several years before they could support migratory bird habitat requirements. The habitat that will be affected in Phase V/VI will be in addition to habitat that was effectively removed in previous phases. The residual effects of previous phases and proposed activities will overlap in time and space. However, residual effects from previous phases will also be temporary and do not occur in key habitat areas.

Other projects (and previous Minto phases) are also subject to non-discretionary legislation. Additionally, in many cases, other projects have either proposed measures or had mitigations recommended for their operations to reduce effects to migratory birds.

The Designated Office is satisfied that implementation of mitigations listed above and strict adherence to relevant non-discretionary legislation are sufficient to prevent significant adverse cumulative effects to migratory birds.

10.0 CONCLUSION OF THE ASSESSMENT

The Project will result in significant adverse environmental and socio-economic effects. The application of the Proponent’s commitments, non-discretionary legislation and the mitigation measures recommended in this report will sufficiently eliminate, reduce or control the significant adverse environmental and socio-economic effects of the Project. This conclusion comes from the understanding that mitigation measures will be applied as prescribed. In addition, we recognize that our evaluation considered the effects of the activities proposed and that a significant departure from the proposal may result in environmental or socio-economic effects not considered in this evaluation.

The Mayo Designated Office has given full and fair consideration to information received during this assessment, as per s. 39 of YESAA. The Mayo Designated Office has also taken into consideration the matters referred to in s. 42(1) of YESAA.

[145] The closest is an exploration project (Quartz Land Use Permit LQ00261) with claims located approximately 4 km north of the Minto Mine site.

Under s. 56(1)(b) of *the Yukon Environmental and Socio-economic Assessment Act*, the Mayo Designated Office recommends to the Decision Bodies that the Project be allowed to proceed, subject to specified terms and conditions. The Designated Office determined that the Project will have significant adverse environmental and socio-economic effects in or outside Yukon that can be mitigated by those terms and conditions.

The terms and conditions of the recommendations are as follows:

1. The full buttress of the Main Pit Dump shall be built and displacement of the Main Pit south wall arrested prior to any further construction of the Main Pit Dump.

Rationale: *Adding load without adding resistance (e.g. fully constructed buttress, or filling the main pit with tailings) presents a heightened risk of structural instability.*

2. In situ monitoring devices shall be installed, such as inclinometers, surface monitoring points, and vibrating wire piezometers to aid in determination of the cause of fissures observed at the surface of the in-pit dump and to monitor the changes in geometry or pore pressures in the in-pit dump area.
3. Additional analyses shall be conducted to clarify the assumptions of the Main Pit Dump stability analyses and to indicate what the limiting case is (e.g. waste rock dump fully constructed, but tailings not yet up to Elev. 804 m) to determine the short-term factors of safety.
4. Given the inherent uncertainty in the foundation conditions for the dam and the potential loading the dam must resist in the long term (in perpetuity), the final design of the Main Pit Dam shall conform to the minimum factors of safety as indicated by the Proponent in the information response (shown within Tables 1 and 2 in Information Request (B) Response, YOR 2013-0100-167-1).

Rationale: *If there is a significant departure from the approach and geometry provided in the Main Pit Dam Conceptual Design Report and Proponent responses to Information Requests, or a departure from the factors of safety provided in the Proponent's response, then the conclusions supporting this recommendation may no longer be valid and the dam design may need to be re-assessed.*

5. The Proponent shall provide regulators a Quantitative Risk Assessment for the Main Pit Dam as indicated in Part 6 of the Canadian Dam Safety Guidelines (CDA 2007).
6. In order to mitigate or reduce risk, further detailed geotechnical investigations are recommended to be undertaken to better refine the subsurface model, and detailed geotechnical laboratory testing is recommended for the foundation and dam fill materials to better define the range of geotechnical properties to be used in design. The results of

these investigations shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.

7. Given the site wide instabilities and potential for foundation instabilities (e.g. paleochannel, long-term slope movement, etc.), a sensitivity analysis on all the geotechnical parameters shall be undertaken to understand the implications (size, volumes, slope angles, costs) on the design configuration, on the factors of safety and on the risk assessment. The results of the sensitivity analysis shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.
8. To mitigate the potential for differential settlement of the dam foundation due to thawing permafrost and consolidation of unfrozen overburden soils, detailed geotechnical investigation, laboratory testing and analyses shall be undertaken to better define the range of geotechnical properties to be used in settlement analyses. The results of these investigations shall be submitted to regulators and considered in the review and approval of plans associated with the Main Pit Dam.
9. To mitigate long-term risk to the Main Pit Dam, the models used in developing Main Pit Dam designs shall maintain the phreatic surface at Elev. 804 m, as a conservative approach.

Rationale: *The Proponent indicated that the phreatic surface in the impoundment is expected to be at Elev. 804 m and the Proponent indicates that it may lower over time. However, since the phreatic surface is such a sensitive factor in stability calculations, the models should maintain a conservative phreatic surface.*

10. The inflow design flood shall be conservatively set at the Probable Maximum Flood level. The earth dam and the spillway designs should take into consideration the effects of the Probable Maximum Flood.

Considering the expected design life (in perpetuity) and significant uncertainty regarding the magnitude of future weather events, the precautionary approach must be applied.

11. The Proponent shall submit plans to the regulator(s) for their tailings depositions strategy (over the life of the impoundment) to provide assurance that a minimum tailings beach width of 100 m will be achieved.

Rationale: *Tailings beaches are important for seepage control, lowering the phreatic surface/hydraulic gradient, keeping ponded water away from the crest and for dam stability. The Proponent indicated that the tailings deposition strategy will create a tailings beach with a minimum width of at least 100 m on the upstream side of the dam. However, the Proponent also noted that ice lenses, which could account for up to 20% of the capacity of the MPTMF could "hinder proper tailings beach development." Current CDA* *guidelines do not contemplate the concept of a tailings beach (although, the Draft CDA Technical Bulletin for Mining Dams does include information regarding tailings beaches and their implications for tailings dams). Since the proposed tailings beach is so integral to the overall design and function of the MPTMF, it is important that the Proponent provide assurances at the design stage that the tailings deposition strategy is conducive to adequate tailings beach width (particularly in light of challenging site conditions, i.e. ice lens development).*

12. Yukon Government shall engage Selkirk First Nation in determining the acceptability of the final plans for the Main Pit Dam that include and take into account the results of a Quantitative Risk Assessment. The determination should be made on the basis of consensus.

Rationale: *Given that SFN, as the landowner, must accept a level of risk of dam failure, this condition will ensure social acceptability of that risk. As discussed in this report, a failure of the Main Pit Dam would have significant adverse effects to SFN's citizens and their Category A settlement land. Although the rights to administer mining activities on the Minto Mine Property are retained by Yukon Government, adverse effects from a failure of the Main Pit Dam would extend well beyond the mine site in terms of both loss of life for SFN citizens and environmental degradation. A decision to approve the Main Pit Dam in opposition to SFN's position would equate to imposing unwanted risk to the group that would be most affected by a dam failure.*

13. As part of a detailed maintenance and monitoring plan for the Main Pit Dam, the Proponent shall provide regulators and Selkirk First Nation with a comprehensive evaluation of expected monitoring and maintenance costs, as well as costs associated with a dam failure, through the design life of the dam. In addition to the money currently held, Yukon Government shall ensure that sufficient security is provided by the Proponent to cover the costs of ongoing maintenance and monitoring requirements, as well as costs associated with a failure of the Main Pit Dam.

14. The Proponent shall adequately monitor potential effects to groundwater flows and quality from the Project. Within the Minto Creek drainage, these should include new multilevel monitoring wells up-gradient and downgradient of Mine activities and increased sampling frequency. These include installation of boreholes and multi-level monitoring wells between current monitoring wells MW12-07 and MW12-06 and downstream of well MW12-05. Longitudinal flow paths shall be evaluated using non-toxic tracer testing to provide a more robust understanding of groundwater movements in support of the development of a numerical groundwater model.

15. The Proponent shall develop a numerical groundwater model for the Minto Creek watershed, informed by additional monitoring, to develop a comprehensive understanding

of flow and solute transport with a focus on the closure period. This model shall consider the effects of property geology and potential interaction of the various hydrogeologic and hydrologic domains.

16. The Proponent shall not release additional mass loadings of contaminants of potential concern that are elevated above the site-specific water quality objectives in the receiving environment.

17. The changes to SSWQOs for Al, Fe and Cr proposed by the Proponent will likely result in significant adverse effects to aquatic life. As such, the current SSWQOs should remain for all COPCs. For Fe, the SSWQOs should remain unchanged, but the regulators may wish to consider the merit of removing Fe from the effluent criteria as it is sufficiently controlled by the current restrictions on TSS. Should the Proponent need to relax the SSWQO for Cr, they should provide regulators with an analysis of total Cr in mine releases and Minto Creek background that is Cr(III) and Cr(VI). CCME provides guidelines for appropriate WQOs based on Chromium speciation.

18. The downstream compliance point at W2 can be removed provided the end-of-pipe discharge quality and quantity criteria are based on:

a. The objective is to ensure protection of the downstream receiving environment. The 2010 WUL defines Lower Minto Creek at W2 as the receiving environment and identifies Chinook salmon as the target species of greatest concern. Protection of the receiving environment must include protection of the most sensitive species in that system to ensure that the system can sustain use by Chinook salmon.

b. The SSWQO as the basis to derive end-of-pipe discharge limits and for comparison to water quality monitoring data to demonstrate environmental protection.

c. Ensuring the mass loadings of COPCs do not cause an increase in downstream concentrations beyond the defined SSWQOs.

i. Mine water releases that have COPC concentrations below the SSWQOs for the receiving environment can be released without control on quantity.

d. Monitoring water quality in the downstream receiving environment at W2 and applying SSWQOs to the downstream receiving environment at W2.

19. If the Water Use Licence is amended to include the removal of the W2 compliance point, it should include end-of-pipe quality and quantity criteria. We recommend a more restrictive quantity criterion and or more restrictive quality criteria than proposed by the Proponent to achieve the desired SSWQO in the receiving environment.

20. If the Proponent is permitted to discharge RO treated water without restriction on discharge rate, the quality of the discharge water must comply with the SSWQOs at the

point of release and the release of such water must not result in erosion of the stream banks or alteration to the habitat in Minto Creek.

21. The Proponent shall update their Adaptive Management Plan to, at a minimum:

a. Establish water concentrations for the Water Storage Pond that trigger changes to release quantity;

b. Include flow measurements taken at an appropriate location to represent the receiving environment prior to and during periods of release from the WSP;

c. Include measures to adjust flows from the WSP to the appropriate mixing ratio;

d. Establish clear procedures for investigating the cause of COPC concentrations that become elevated in the receiving environment. Establish corrective actions to address elevated COPC concentrations that characterize mine effluent. Triggers to begin investigation of elevated COPC concentrations should be set at a value below the SSWQOs to allow for corrective action (where possible) prior to causing effects to aquatic resources.

22. In addition to annual Water Balance and Water Quality model reports, the Proponent shall provide regulators with an annual report outlining the accuracy of the Water Balance and Water Quality model. The report shall at a minimum:

a. Provide a comparison of waste rock and tailings produced during the course of Phase V/VI production to historical geochemical and water quality monitoring data collected from pre-existing Minto Mine Operations;

b. Undertake monitoring of pit walls for all open pit operations over the course of mining operations to better define source terms for post-closure modeling;

c. Identify any discrepancies between model predictions at water quality stations and the exiting monitoring data;

i. Discuss the origin and implication of such discrepancies if they exist;

d. Guide the evolution of existing monitoring programs as appropriate; and

e. Identify follow-up programs to reduce uncertainty associated with the model assumptions.

23. The Proponent shall develop and implement a monitoring program (quantity and quality) of all contact waters including pit-walls, in-situ and down-gradient tailings, and waste rock pore waters during operations. This includes monitoring of the existing DSTF. The results of this program shall be compared to the source terms used in the Water Quality Model and provided to regulators annually as part of the Accuracy of the Water Balance and Water Quality Model Report prescribed by mitigation # 22.

24. As part of the final design for the Main Pit Dam, the Proponent shall include a collection sump to capture, monitor and treat seepage from the Main Pit Tailings Management Facility through the Main Pit Dam. Seepage from the Main Pit Dam must be included in the annual updates to the water quality model and shall be assumed to continue in perpetuity if any uncertainty as to the total duration of seepage exists at the time of model updates.

25. Additional passive and semi-passive treatment systems are required for the closure period to ensure the protection of aquatic resources in lower Minto Creek. Mitigation # 25 from the Decision Document for project 2010-0198 has not resulted in the timely development of a statistically robust evaluation of: 1) in-situ water behaviour (quantity and quality) through different soil covers on selected reclaimed areas and 2) laboratory and scaled experimental passive treatment of wetlands. This mitigation shall be amended to include the following:

a. No later than 90 days following the issuance of the Decision Document for evaluation 2013-0100, the Proponent shall provide the other members of the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) with a detailed study design to evaluate the site performance of the proposed cover systems in a full scale trial at the site. At a minimum, the study shall be designed to provide a statistically robust review of the following:

i. Infiltration rates measured at randomly selected locations across the waste facility to adequately capture the variability in cover thickness and slopes;

ii. Rates of erosion across the site and a percentage of the site affected by cover breakthrough;

iii. Contaminant loads from the cover system; and

iv. Any other matters recommended by the advisory committee.

b. Within 30 days of the issuance of the study design report referred to in ‘a’, the members of the Advisory Committee shall provide the Proponent with suggested changes and feedback on their proposed design.

c. The study design shall be finalized within 180 days of the issuance of the Decision Document for this assessment (2013-0100).

d. No later than 60 days following the issuance of the Decision Document for evaluation 2013-0100, the Proponent shall provide the other members of the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) with a detailed study design to evaluate the site performance of the proposed wetland in a demonstration-scale trial at the site. The study design shall include all necessary components to provide a statistically robust and defensible evaluation of the year round performance of the wetland for treating water at the site. The study shall also incorporate measures to monitor metal loads in the wetland to develop a long-term maintenance and monitoring plan.

e. A demonstration-scale wetland shall be constructed on site beginning in 2014 as outlined by the Proponent in YOR 2013-0100-253-1.

26. The Proponent shall provide to the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) a report detailing all reasonable and practical mitigations for the closure period. When determining what constitutes “reasonable” and “practical”, members of the advisory committee shall consider the following:

a. The expected or actual site performance of a given mitigation;

b. The cost of the mitigation (both initial cost and long-term maintenance cost) compared to the expected contaminant reductions.

27. The Proponent shall implement all reasonable and practical passive and semi-passive mitigations developed from mitigation # 26.

28. The Proponent shall provide regulator(s) with a fully costed monitoring and maintenance plan for all site components at closure. Moreover, the Regulator(s) shall consider this report when determining the appropriate security to be provided to YG by the Proponent.

29. The Proponent shall maintain a fully functioning water treatment plant on site until such time that they can demonstrate full protection of aquatic life at the receiving environment in Minto Creek through mitigations applied during closure.

30. The Proponent shall immediately begin reclamation of all disturbed areas that are no longer subject to ongoing operations and that will be unaffected by Phase V/VI developments.

31. The Proponent shall update their mine development plans to account for the full construction of the Mill Valley Fill Extension Stage 2.

32. To ensure adequate performance of the Mill Valley Fill buttress, the design and construction program shall include all recommendations detailed on page five of the report prepared by Norwest Corporation (YOR 2013-0100-219-1).

33. Non-degradation (compared to historical background quality) of Minto Creek water quality shall provide the basis for the development of water quality objectives for the closure period. However, if non-degradation cannot be achieved using reasonable and practical passive treatment mitigations (as outlined in mitigation # 29), then the closure objective

shall be guided by what can be practically achieved (as long as the objectives are below the effects levels for aquatic resources with sufficient contingency).

34. In the event that that COPC concentrations remain elevated in Minto Creek compared to historical background levels during closure, the Yukon Water Board shall consider whether the remaining assimilative capacity preserves sufficient opportunity for SFN on their Settlement Land and fulfills the spirit and intent of s.14.8.1 of SFNs Final Agreement. The Yukon Water Board should consider whether additional corrective action (i.e. further mitigation or compensation to SFN) is warranted in the event that they decide SFN will experience significant loss of future opportunity as a result of the loss of assimilative capacity in Minto Creek.
35. The Proponent shall familiarize themselves and their contractors with Yukon invasive species and how to manage them by referring to the document "Why Should I Care About Invasive Species?" available from http://www.yukoninvasives.com/pdf_docs/WhyshouldIcare2011_sm.pdf.
36. The Proponent shall remove foreign soil and plant material from equipment prior to moving it to the project site.
37. The Proponent shall report the presence of any invasive plants that are listed on the Yukon Invasive Species Council website (http://www.yukoninvasives.com/pdf_docs/plants_all_invasives.pdf) to Yukon Government by e-mail (invasives@gov.yk.ca) or to the Northern Tutchone Regional Biologist (867-996-2162).
38. Wherever practicable, vegetation clearing for this Project shall occur after July 31st. In the event that land clearing activities occur during the core-breeding period of May 1st to July 31st, prior to clearing the Proponent must plan to avoid disturbing or destroying nests of birds listed under the *Migratory Birds Convention Act*. Contact the Canadian Wildlife Service (Whitehorse) for information on considerations related to determining the presence of nests.
39. If active nests of birds listed under the *Migratory Birds Convention Act* are discovered, the Proponent shall postpone activities in the nesting area until nesting is completed (i.e. the young have left the vicinity of the nest).

RELEVANT PROPONENT COMMITMENTS

The following is a compilation of relevant commitments proposed by the Proponent that were considered by the Mayo Designated Office because they contribute to the mitigation of significant adverse effects of the project. The inclusion of these commitments was essential to the final determination of whether a specific project effect was determined to be significantly adverse. The recommendation is based on the understanding that they will be reflected as terms and conditions of the Proponent's permit.

Health and Safety

- The Main Pit Dam will be designed (and ultimately constructed, operated and closed) in accordance with current Canadian (federal and territorial) and international best practice guidelines and principles. Specifically this includes, but is not limited to:
- Canadian Dam Association's Dam Safety Guidelines;
- DRAFT Technical Bulletin on Mining Dams (note this has only been distributed to CDA members and Peer reviewers at this time);
- ICOLD Bulletin 139 "Improving Tailings Dam Safety: Critical Aspects of Management, Design, Operation, and Closure";
- Mining Association of Canada's "Guide to the Management of Tailings Facilities" (MAC 1998), and "Developing and Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities; and
- Yukon Environmental and Socio-economic Assessment Boards' (YESAB) "Dam Guide: Design Expectation and Required Information."
- Overall dam geotechnical stability will be in accordance with requirements stipulated in the Canadian Dam Safety Guidelines (2007). This includes minimum factors-of-safety for static and seismic assessments for upstream and downstream dam slopes.
- The traditional standards based approach, as determined by factors of safety, will be complimented with a risk based approach as defined in Section 6 of CDA (2007), (and recently updated, CDA (2013a)).
- Preliminary observations about the foundation conditions will be confirmed through further characterization, and should it be concluded that liquefaction of the foundation soils are in fact possible, the design will be adapted as necessary to ensure appropriate risk management.
- The tailings deposition plan calls for depositing of a tailings beach at least 100 m wide upstream of the dam, which will lengthen the seepage path considerably, with the resultant effect of limiting seepage rates via these pathways.
- Further characterization and associated numerical analysis studies will be carried out to confirm the likelihood and magnitude of seepage via these pathways (i.e. intercepted fault zones and/or the paleochannel).

- A rigorous instrumentation and monitoring program will be implemented.
- Monitoring instrumentation will consist of direct and indirect methods. Direct monitoring will comprise of deformation and settlement monitoring, which will provide precise information as to the magnitude of movement. Indirect monitoring, consisting of piezometric levels and thermal monitoring, will provide early warning signs associated with the fundamental processes that may trigger foundation instability.
- Deformation monitoring will include slope inclinometers installed along the downstream slope of the dam. These instruments will not only include shallow instruments within the dam structure, but also deep instruments to specifically monitor foundation creep.
- Given the overburden gradient downstream of the dam, a series of deep slope inclinometers will also be installed downstream of the dam to provide early warning of potential large scale movements triggered by the dam.
- Both crest and embankment settlement will be monitored using a series of permanent settlement beacons strategically placed along the dam. These will be monitored using precise survey techniques.
- Vibrating wire piezometers and deep ground temperature cables will be installed within and immediately up and downstream of the dam
- Notwithstanding the proposed instrumentation and monitoring plan, an observational approach will be adopted to continuously evaluate and, if necessary, implement contingency plans throughout the life of the structure.
- Comprehensive Quality Assurance and Quality Control procedures will be developed and documented in a technical specifications document at the detailed engineering stage of the project.
- Complete documentation of all quality assurance and quality control data will be provided in the relevant as-built reports.
- An operation, maintenance, and surveillance (OMS) manual and emergency preparedness plan (EPP) will be prepared and submitted to regulators prior to commissioning the Main Pit Dam. These will be prepared in general accordance with the Dam Safety Guidelines published by the Canadian Dam Safety Association (2007).
- The performance of Main Pit Dam will be evaluated throughout its life-cycle which includes a construction, operational, closure and post-closure phase.

Aquatic Resources

- Efficient use of blasting materials to ensure accumulation of residue on waste rock is minimized
- Blasting as soon as possible after blast holes are charged with ANFO to prevent seepage of nitrates into the groundwater

- Use of ANFO in dry holes only (pumped dry if necessary and use of a plastic liner), or use of emulsion type explosives in wet holes, as these contain agents that prevent the dissolution of nitrates in water
- Disposal of blasting reagent packaging and related waste done in accordance with the Blast Site Safety Manual Disposal Guidance document (Dyno Nobel North America, Appendix B of the Explosives Management Plan)
- A demonstration-scale wetland will be constructed on site beginning in 2014

Environmental Quality

- Progressive reclamation will be implemented throughout the life of mine to effectively re-vegetate any disturbed areas and to minimize the production of fugitive dust;
- Only the minimum amount of clearing (removal of vegetation) will be completed, so that Project operations remain effective and safe;
- The extent of grubbing, stripping, and the removal of shrubs and herbaceous species will be minimized where possible;
- When clearing is required, the vegetative mat will be retained wherever possible;
- Topsoil will be stripped off first and stockpiled separately from overburden, wherever possible. The topsoil is needed as it contains the biological agents needed to induce natural nutrient cycling for plants used in re-vegetation efforts;
- Vegetation buffers will be maintained around wetland and riparian zones; and,
- Placement of new infrastructure will occur within existing disturbed/development areas wherever possible, in an effort to reduce the amount of new vegetation clearing and general site disturbance required.

Wildlife and Wildlife Habitat

- The disturbance footprint and related vegetation clearing will be limited to the extent necessary to minimize habitat loss;
- Only the minimum amount of clearing (removal of vegetation) will be completed, so that Project operations remain effective and safe;
- The extent of grubbing, stripping, and the removal of shrubs and herbaceous species will be minimized where possible;
- Vegetation buffers will be maintained around wetland and riparian zones;
- Placement of new infrastructure will occur within existing disturbed/development areas wherever possible, in an effort to reduce the amount of new vegetation clearing and general site disturbance required;

- Consistent with Section 92 of Yukon *Wildlife Act*, a “no wildlife harassment” policy will be enforced for company and contractors' employees while working within the Project area. This policy comprises: safe deposit of garbage, employee wildlife education, and wildlife avoidance;

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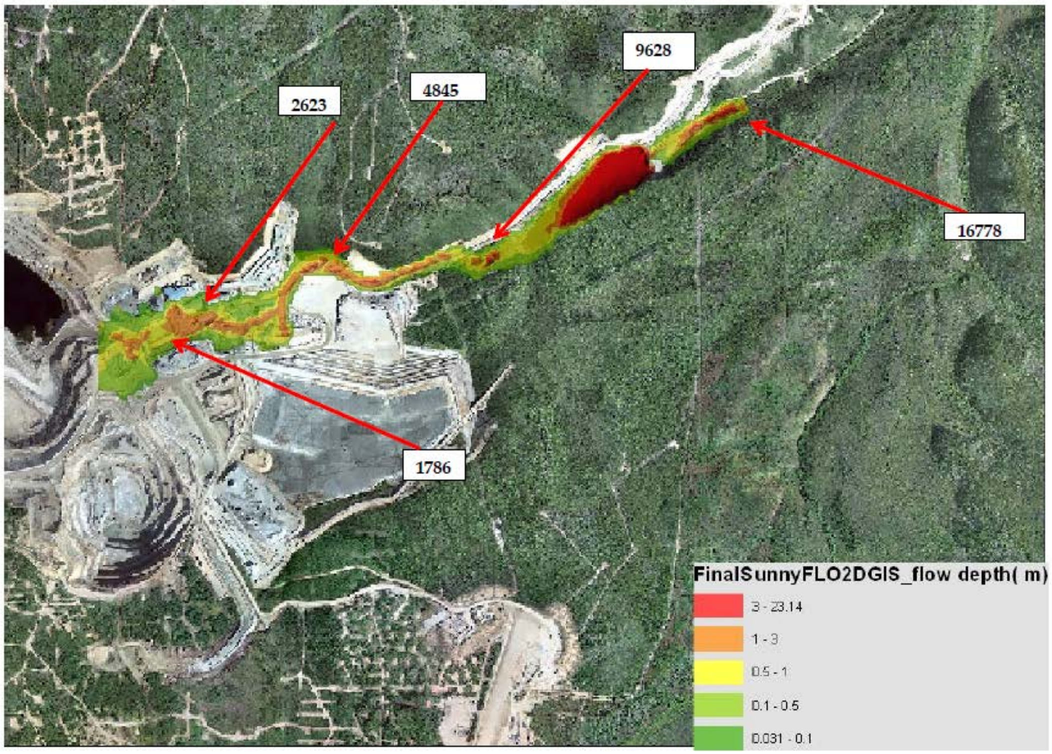
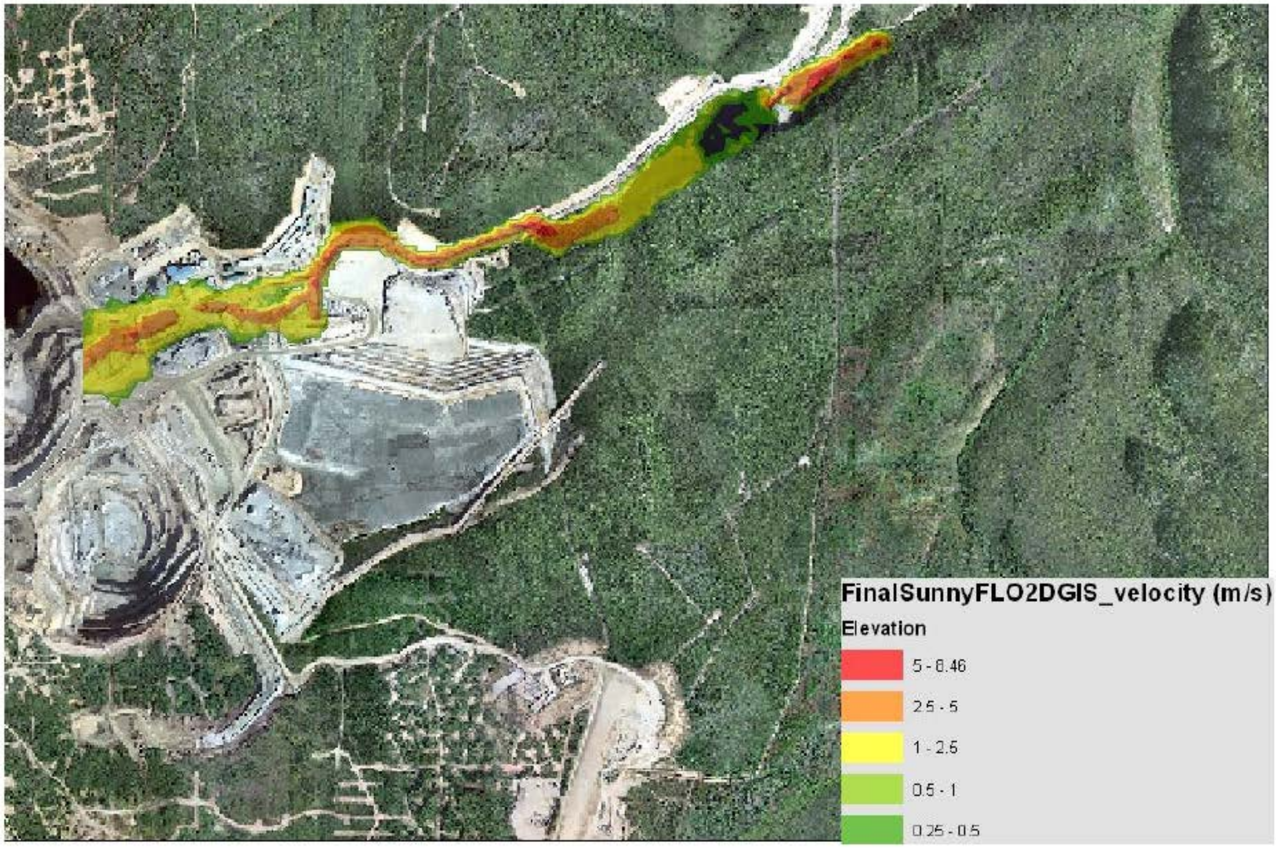
INUNDATION MAPPING FROM DAM BREAK ANALYSIS



srk consulting / Montgomery Associates Resource Solutions LLC	capstone MINTO MINE	Dam Break Analysis for Main Dam at Minto Mine
		Maximum Depth of Flow during Sunny-Day Breach Event
Job No: 1CM002.014 Filename: Fig10_Max Depth of Flow Sunny Day_1CM002-014_dbm_rev00	Minto Mine	Date: Nov. 2013 · Approved: JFD · Figure: **10**



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capstone
MINTO MINE

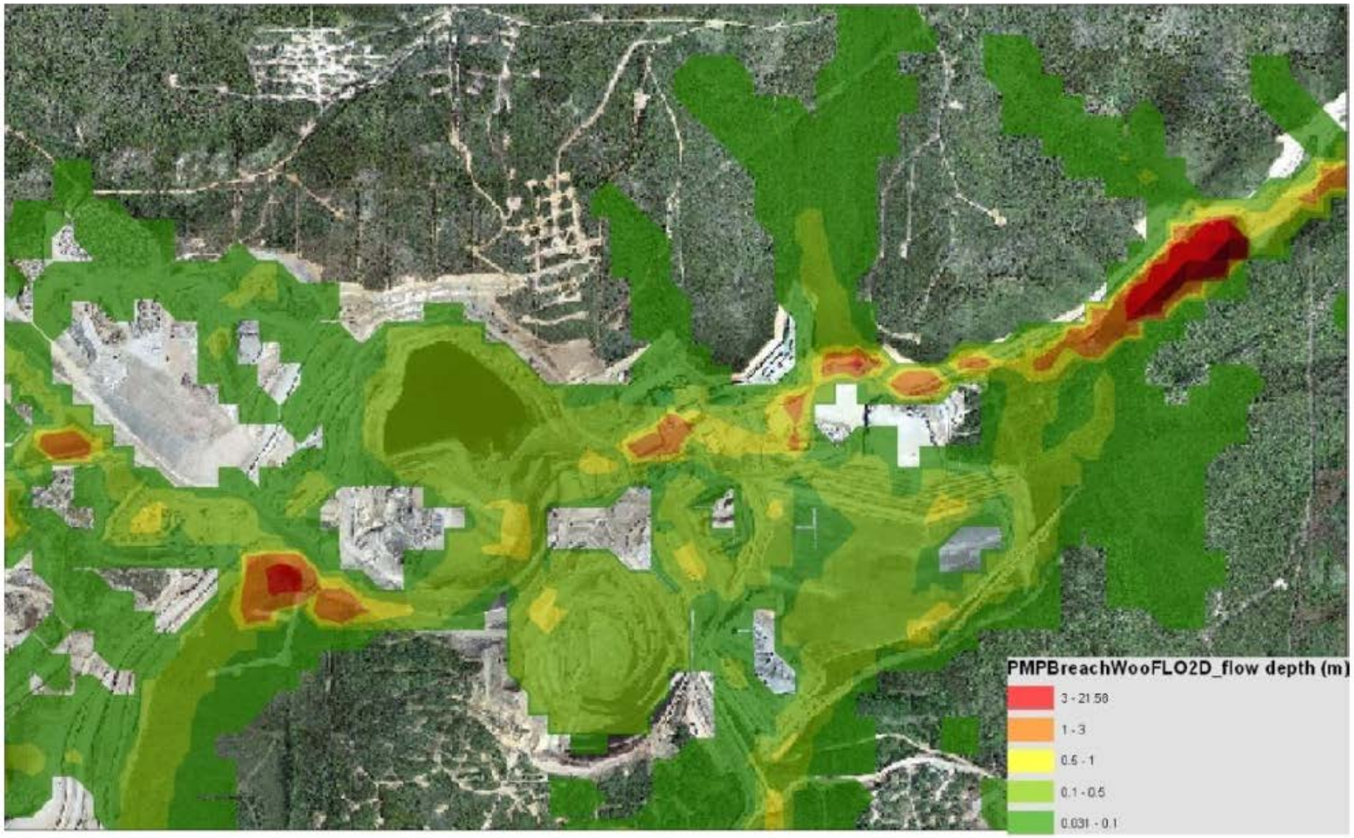
Dam Break Analysis for Main Dam at Minto Mine

Maximum Velocities during Sunny-Day Breach Event

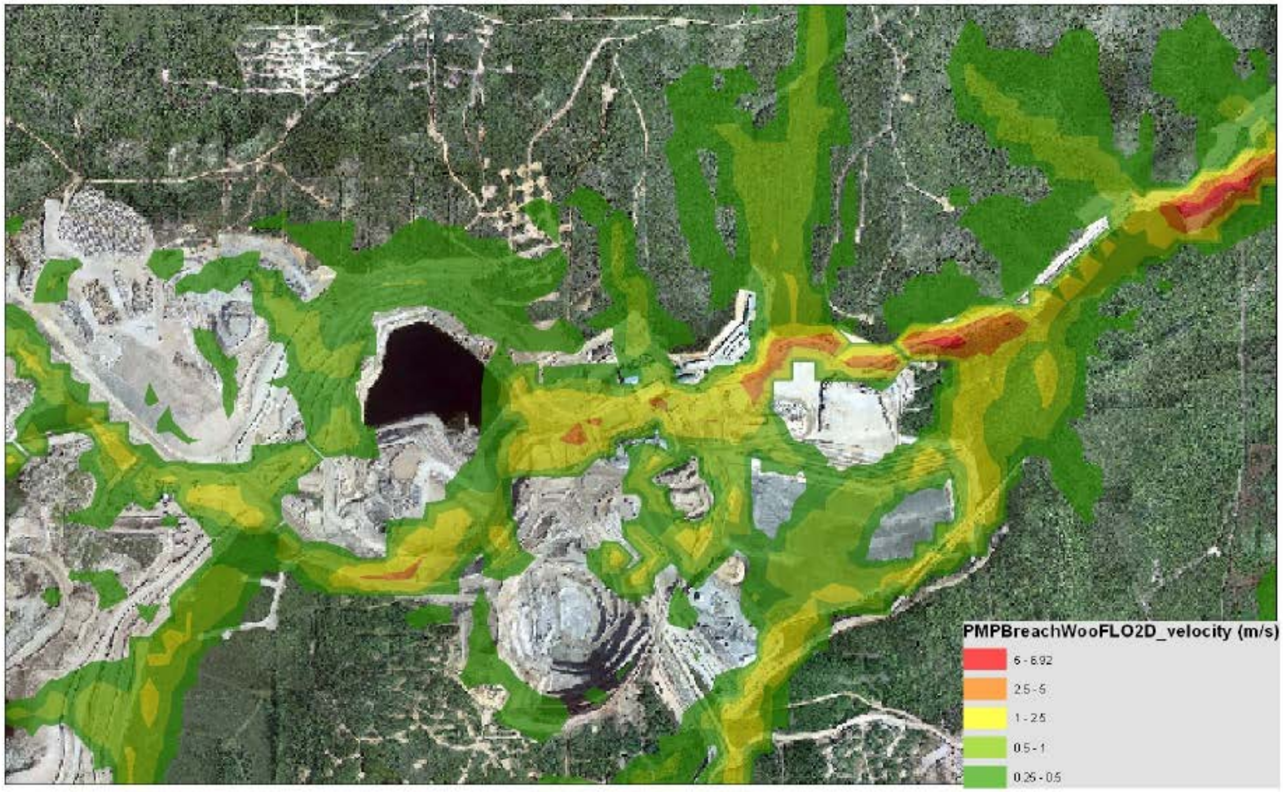
Job No: 1CM002.014
Filename: Fig11_Max Velocities Sunny Day_1CM002-014_dbm_rev00

Minto Mine

Date: Nov. 2013
Approved: JFD
Figure: 11



srk consulting Montgomery Associates Resource Solutions LLC	capstone MINTO MINE	Dam Break Analysis for Main Dam at Minto Mine **Maximum Flow Depths during Extreme Flood Event with Main Dam Breach**
Job No: 1CM002.014 Filename: Fig17_Max Flow Depths during Extreme Flood Breach_1CM002-014_dbm_rev00	Minto Mine	Date: Nov. 2013 · Approved: JFD · Figure: 17



srk consulting Montgomery Associates Resource Solutions	capstone MINTO MINE	Dam Break Analysis for Main Dam at Minto Mine **Maximum Velocities during Extreme Flood Event with Main Dam Breach**
Job No: 1CM002.014 Filename: Fig18_Max Velocities during Extreme Flood Breach_1CM002-014_dbm_rev00	Minto Mine	Date: Nov. 2013 / Approved: JFD / Figure: **18**