capstone
MINTO MINE

Unit 13 Calcite Business Centre
151 Industrial Road
Whitehorse, YT, Y1A 6S1, Canada
Tel: 604-759-0860 Fax: 604-759-0861
Toll Free: 866-684-8894
www.capstonemining.com

August 11, 2014

Bob Holmes, Director
Mineral Resources Branch
Energy Mines and Resources
Yukon Government

400- 211 Main Street
Box 2703
Whitehorse, YT Y1A 2C6

Dear Mr. Holmes

Please find enclosed an updated Reclamation and Closure Plan (RCP version 5.1) for Minto Mine as part of Capstone's application for Phase V/VI. The RCP submitted on July 2 (version 5.0) did not include cost estimates.

Detailed cost estimates are now included in section 9. In addition RCP version 5.1 includes updated figures. The text of the RCP, except for section 9, has not changed.

Sincerely

Martin Haefele
Permitting Manager

MINTO MINE PHASE V/VI RECLAMATION AND CLOSURE PLAN

REVISION 5.1

August 2014

Prepared for:

CAPSTONE MINING

ACCESS CONSULTING GROUP ACKNOWLEDGEMENTS

Access Consulting Group would like to acknowledge the input of the following authors:

Scott Keesey

Jim Theriault

David Morissette

Ken Bolt

Holly Goulding

Nicole Scotney

Marie Ducharme

Anastasiya Matlashevska

Andrea Badger

Amy Johnson

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CONTEXT OF THIS DOCUMENT

This fifth revision of the Minto Mine Reclamation and Closure Plan (RCP) is presented for review and will be revised to incorporate reviewer comments. This version is a new RCP including the Phase V/VI Expansion, but also identifies measures for decommissioning and reclaiming site developments from previous mining phases. Closure planning is a process continuum, and RCP documents accordingly advance in detail as the Project proceeds through its mine life.

This RCP is now considered to be Revision 5.0. Significant advancements in the RCP over the 2011 DRP and the 2013 Phase IV RCP include:

- An improved understanding and analysis of site closure hydrology, validated with a regional analysis. It has has informed revisions to site runoff conveyance alignments, sizing and design;
- Updated water balance and geochemistry source term evaluation, combined for a revised site water quality prediction;
- Supporting rationale for the selection of isolating soil covers as the primary reclamation measure, based on a further characterization of available construction materials;
- Advanced supporting for the eventual application of semi-passive treatment technologies as determined to be reasonable and practical for contaminant load reduction at Minto at closure, including the framework for a research program aimed at providing proof of concept for these technologies in the Minto site context and early results from the first year of this plan; and
- An updated closure cost estimate for financial assurance purposes (currently being developed), including all proposed revisions to the closure methodologies and adjustments to the costing based on emergent closure costing guidance from YG EMR.

PROJECT CONTACTS

MINTO EXPLORATIONS LTD.	
c/o Capstone Mining Corp. Suite 900, 999 W Hastings St Vancouver B.C. Telephone: (604) 684-8894 Fax: (604) 688-2180 Website: www.capstonemining.com	**Ron Light** General Manager Email: rlight@capstonemining.com **Jennie Gjertsen** Environmental Manager Email: jennieg@mintomine.com **Martin Haefele** Permitting Manager Email: mhaefele@capstonemining.com
ACCESS CONSULTING GROUP	
#3 Calcite Business Centre 151 Industrial Road Whitehorse, Yukon Y1A 2V3 Telephone: (867) 668-6463 Fax: (867) 633-4882 Website: www.accessconsulting.ca	**Jim Theriault, P.Eng. (ON, YT)** Email: jtheriault@alexcoresource.com **T. Scott Keesey, B.Sc., EPt** Email: skeesey@accessconsulting.ca

EXECUTIVE SUMMARY

This RCP addresses the long-term physical and chemical stability of the site, including reclamation of surface disturbances. A program is presented for site management and monitoring both during implementation of closure and after decommissioning and reclamation measures are completed.

The RCP has been specifically scoped to fulfill the requirements of closure plan submissions in both of the projects primary regulatory instruments – Quartz Mining Licence QML-0001, and Water Use Licence QZ96-006, and to adhere to guidance documentation on closure plan development from both the Yukon Government and the Yukon Water Board.

A systematic approach to decommissioning and closure reclamation has been developed for the Minto project. Progressive reclamation measures have been implemented where possible during mine construction and operations. This approach has provided valuable reclamation success feedback for use in advanced/final closure, and these progressive efforts will also help reduce slope erosion through physical slope stabilization of revegetation efforts, enhancing ultimate reclamation success.

The closure phase of the Minto mine will commence with the cessation of economic mining of the open pits and the milling of ores and stockpiles from the ore zone. Once all mineable ore reserves have been processed, the mill, concentrator and other facilities will be decommissioned, and waste facilities and disturbed areas will be covered and revegetated. During the active closure phase, which is expected to last approximately 3 years, the number of personnel required will vary depending on site activities; however, it is expected that as major decommissioning and reclamation tasks are completed the number of site personnel required will decline.

Cost estimation for implementation of the proposed closure measures is the basis for establishing the financial security that will be required on the project. The Phase V/VI closure cost estimate has been prepared based on the final extent of disturbance for each of the infrastructure units described in this report. Decommissioning and reclamation cost estimates have been completed for Year 0, End of Mine Life (EOM - Year 9) and Year 2 Scenarios. The estimated closure costs associated with implementing the current RCP for Year 0, EOM and Year 2 closure scenarios are: $52.0M, $26.3M and $26.5M for Year 0, EOM and Year 2 closure scenarios, respectively..

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1 INTRODUCTION

Minto Explorations Ltd. (Minto), a wholly owned subsidiary of Capstone Mining Corporation (Capstone), owns and operates the Minto Project located 240 km (150 miles) northwest of Whitehorse, Yukon. For the purposes of this reclamation and closure plan, the "Minto Project" means the mining of the Minto deposit by both open-pit and underground mining methods and related ancillary facilities.

This reclamation and closure plan (the RCP) addresses the long-term physical and chemical stability of the site, including reclamation of surface disturbances from existing development. A program is presented for site management and monitoring both during implementation of closure and after decommissioning and reclamation measures are completed.

1.1 CLOSURE PHILOSOPHY AND GUIDING PRINCIPLES

In keeping with its high standards for environmental and social responsibility, Minto intends to implement an environmentally sound and technically feasible decommissioning and reclamation plan for the Minto mine. Closure planning and the implementation of this phase at a mine site must be undertaken with appropriate environmental care while respecting local laws, Selkirk First Nation (SFN) agreements, and the public interest and ensuring that Minto's high environmental standards are achieved. Necessary environmental protection measures have been adopted in the development of this Plan to ensure that a healthy environment exists after mine closure. This approach is consistent with Minto's corporate policies.

A principle tenet of the philosophy followed during the development of this Plan was to work towards an eventual passive closure scenario, with minimal management required to achieve long-term chemical and physical stability of reclaimed mine components. This involved an assessment of the key mine components that require mitigation based on the current understanding of materials contained within these components. Mitigation measures have been incorporated into elements of the RCP to address public safety issues and environmental concerns with post-closure monitoring and inspections planned to ensure that this objective is met. Once the effectiveness of each mitigation measure is assured, then management of the site can be safely reduced to a level that is consistent with closure objectives. It is anticipated that final determination of the effectiveness of closure measures will be the subject of review and concurrence with regulatory agencies, SFN and the public.

Minto has entered into a Cooperation Agreement (the Agreement) with the SFN. All activities at the site including closure measures are guided by this Agreement. Therefore, a strong working relationship with the SFN forms a foundation for this document. To that end, meetings with SFN related to closure issues have been ongoing since the first version of the RCP, and their comments on closure and other issues raised during ongoing dialogue were considered in the ongoing development of this Plan. This dialogue continues, and parties continue to work towards refinement of reclamation issues in the ongoing closure planning discussions.

To ensure that the overall closure philosophy and goal can be achieved, Minto has taken an objectives-based approach to the reclamation and closure planning for the site. Section 3 provides information on this approach and the fundamental and site-specific closure objectives.

1.2 SCOPE OF PLAN

The RCP has been specifically scoped to fulfill the requirements of the EMR and YWB guidance document *Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guidance* released August 2013. In addition, Minto has taken into consideration requirements concerning closure plan submissions in both of the project's primary regulatory instruments – Quartz Mining Licence QML-0001, and Water Use Licence QZ96-006.

Specifically, the licenced requirements for closure plan submission under each licence are:

- QML-0001: Section 9.0 Reclamation and Closure Plan

  9.1 The Licensee must undertake reclamation at the site in accordance with the approved closure plan.

  9.2 The Licensee must:

  a) submit to the Chief for approval a reclamation and closure plan within 30 days of the effective date and then on June 1, 2013 [Amended to September 16, 2013] and June 1, 2015; and

  b) implement the reclamation and closure plan and any conditions of the approval as of the date each plan becomes an approved plan.

  9.3 The Licensee acknowledges that on the date an updated reclamation and closure plan, as described in paragraph 9.2(a) and including any amendments to it and any additional terms and conditions required by the Chief, becomes an approved plan, the previous reclamation and closure plan shall cease to be an approved plan.

- WUL QZ96-006: Clause 103 Permanent Closure

  The Licensee shall submit an updated detailed decommissioning and reclamation plan (DRP) to the Board by September 16, 2013 as an application for amendment of this licence. The detailed DRP shall:

  a) include the results of a Failure Modes and Effects Assessment of the proposed closure measures in the DRP that will examine risks associated with the proposed closure measures and will identify specific contingency plans necessary to manage risks identified in the assessment;

  b) be adequate for an independent assessment of the physical and geochemical stability of the mine wastes and mine workings remaining after application of the proposed closure measures and of the costs of the proposed closure measures and post closure monitoring and maintenance; and

  c) the DRP shall include, but not necessarily be limited to, the following components:

     i. preliminary designs for the closure of all major mine facilities , including dams, spillways, diversion ditches, pits, dumps and mill/camp facilities;

     ii. plans to ensure long term stabilization of the DSTSF, including revegetation;

     iii. calculations of the Maximum Credible Earthquake;

iv. calculations of the inflow design flood proposed for closure and the rationale for the severity or return period of the flood event;

v. designs for the closure water management structures and conveyance channels to withstand the inflow design flood event;

vi. an updated Reclamation Research Plan and proposed schedule for implementing the plan;

vii. a detailed Post-Closure Monitoring Program to verify that performance objectives for all facilities are being achieved;

viii. an updated Water Balance and Water Quality Model for the mine site and Minto Creek; and

ix. an updated detailed cost estimate, including clearly defined assumptions and calculations for decommissioning and on-going post closure monitoring and maintenance.

YG's Decision Document issued on June 4, 2014 has specific guidance for RCP development for the Minto Site. Specifically, these are:

> ***Clause #25.*** *The Proponent shall provide an updated Reclamation and Closure Plan to Regulators as a part of License applications. This Plan shall include a reclamation research program, performance evaluation, and implementation schedule, for both passive and semi-passive water treatment systems and cover systems that may be implemented during the closure period. When preparing the Plan, the Proponent shall seek and consider input from the advisory committee (referred to in mitigation #13 of Decision Document 2010-0198) prior to submission of documents to regulatory bodies. Regulatory approvals for the Phase V/VI project shall include specific time lines for completion of the tasks described in this condition. Those time lines should focus on completing the tasks as soon as practical; and*

> ***Clause #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, 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). Determination of "reasonable" and "practical" mitigations must take into account the expected or actual site performance of a given mitigation, and the cost of the mitigation (both initial cost and long-term maintenance cost) compared to the expected contaminant reductions.*

1.3 STATUTORY AND REGULATORY RESPONSIBILITIES

Versions 1 through 4 of Minto Mine's Closure Plans were developed to meet the regulatory requirements as stipulated in Minto's Water Use Licence and Quartz Mining Licences. Closure methods and details associated with the Phase IV Expansion were approved most recently by in the DRP version 3.2 Yukon Government, Energy Mines and Resources (YG EMR) in September 2011. An updated Phase IV RCP (Revision 4.0 and subsequent updated closure costing Revision 4.1) were submitted to YG EMR and YWB on September 16, 2013. This plan and the associated costing was the basis for a security adjustment by YG EMR, finalized on March 14, 2014.

This RCP incorporates site developments undertaken as part of Phase IV and Phase V/VI due to their inter-related nature, and closure concepts advanced since the approval of the last Plan. It is intended to meet the regulatory requirements from the primary project authorizations as presented above in Section 1.2.

Prior to implementing the closure measures described in this Plan, meetings will be held with the SFN and the local community to ensure that First Nations and community interests and concerns are addressed and included in the closure planning of the Minto mine. Section 1 above describes the current state of closure plan discussions with SFN. Also prior to implementation of the RCP, the YG Water Resources and Mining Land Use Divisions will be informed of Minto's intentions. Meetings will also be held with Environment Canada, Environmental Protection, Department of Fisheries and Oceans, Environmental Health, and Government of Yukon Departments of Environment and Occupational Health and Safety to apprise regulators of planned site activities. These meetings will ensure that regulatory agencies' concerns with closure implementation are met.

1.4 REGULATORY APPROVALS

Several government agencies and SFN are involved in reviewing, assessing, authorizing and monitoring the Minto Mine. The relevant legal, regulatory and guideline-based instruments include:

- Selkirk First Nation Cooperation Agreement;
- Metal Mining Effluent Regulations (MMER) of the federal Fisheries Act, including guidance for:
- Effluent Characterization; and
- Environmental Effects Monitoring.
- Type A Water Use Licence QZ96-006 ("WUL QZ96-006"), issued in April 1998 and including subsequent amendments, and valid until June 30, 2016;
- Type B Water Use Licence MS04-227 ("WUL-B") issued in August 1996 and valid until June 30, 2016;
- Quartz Mining Licence QML-0001 ("QML-0001") issued in October 1999 and subsequent amendments and valid until June 30, 2016;
- Mining Land Use Permit;
- Fish Collection Permits;
- Waste Management Facility Permits:
- Multi-Use Land Treatment Facility Permit;
- Special Waste Permit;
- Commercial Dump Permit; and
- Air Emissions Permit.

In accordance with these instruments, Minto has submitted operational and monitoring plans including but not limited to:

- General Site Plan;
- Site Characterization Plan
- Mine Development & Operations Plan;
- Underground Mine Development & Operating Plan;
- Main Waste Rock Dump Design Plan;
- Southwest Waste Dump Design Plan;

- Reclamation Overburden Dump and Ice-Rich Overburden Dump Design Plans;
- Dry Stack Tailings Storage Facility Design and Management Plans;
- Engineering Plans and a Construction Quality Assurance Manual for the Water Storage Pond dam;
- Mill Water Pond Design;
- Waste Management Plans;
- Waste Rock & Overburden Management Plans;
- Tailings Management Plan;
- Spill Contingency Plan;
- Heritage Resource Protection Plan;
- Sediment & Erosion Protection Plan;
- Explosives Management Plan;
- Wildlife Protection Plan;
- Emergency Response Plan; and
- Decommissioning and Reclamation Plan.

1.5 Project Schedule

The Minto Mine is currently an open pit mining operation with conventional crushing, grinding, and flotation to produce copper concentrates with significant gold and silver credits. Underground mining is licenced and expected to commence in Q3 of 2013; development work began in Q3 2012. Concentrates are exported internationally via the Port of Skagway, Alaska for smelting and sale. Closure and reclamation of all Phase V/VI Project components follows completion of Phase V/VI mining and milling.

The table below outlines the Project development schedule from current status to the completion of mining/milling activities.

Table 1-1 Project Schedule

Year	Summary of Main Project Activity
2014	It is anticipated that the necessary authorizations will be granted by late 2014 to allow Phase V/VI mining to commence. Mining of Minto North begins.
2015	Stripping in Area 2 Stage 3 begins as the final benches of Minto North are mined out. Underground production (which will have been underway at Phase IV stopes) ramps up to 2,000 tonnes of ore per day.Mining continues in Stage 3 of Area 2 until the pit is completed in the fourth quarter of the year. Stripping of Ridgetop South begins as the last benches of Area 2 Stage 3 are mined; production of near-surface ore follows approximately one month later. The mining rate is slowed to 7,200 BCM/day.
2016	Ridgetop North starts production. Underground mine operations continue in parallel from the Minto South Underground and the East Keel Underground at a steady rate of 2,000 ore tpd.
2017	Ridgetop North production ends mid-2017, concluding open pit mining. Underground operations continue at 2,000 ore tpd. Open pit stockpile drawdown begins.
2018	Minto South Underground and East Keel Underground production finishes, while development on the Wildfire Underground begins.
2019	Mining of the Wildfire Underground finishes; all mining operations complete.
2020 - 2022	Stockpiles are processed through the mill until they are depleted.

1.6 ACKNOWLEDGEMENTS

This Plan benefited from input by the following companies, many of which have contributed to previous versions of the Minto Mine closure plans:

Access Consulting Group (ACG) – Developed, authored or supported Revisions 1 through 4 of the site Decommissioning and Reclamation Plan (DRP), now Reclamation and Closure Plan (RCP);

Contango Strategies Ltd. – Provided specialist expertise related to the evaluation, design, and implementation of constructed wetland treatment systems in cold climates;

EBA Engineering Consultants Ltd. (EBA) – Assisted with development of Revision 2 of this Plan, developed Phase IV conceptual closure plan, and co-authored Revision 3, including the preliminary engineering design;

Selkirk First Nation (SFN) – Longstanding participation in many components of the closure planning process based on current and potential future use of the project area, including the development of closure objectives, reclamation measures and closure cost estimations; and

SRK Consulting Ltd. – Provided geochemical characterization and predictive water chemistry modeling, as well as lead support on waste cover evaluation and recommendations.

2 RECLAMATION AND CLOSURE PLANNING

This RCP is an advancement of the measures and methods previously approved or presented in previous closure plan iterations for the Minto Mine. Section 3.1 outlines the objectives-based approach used to refine this version of Minto's RCP.

Minto has worked with stakeholders (SFN, YG) over the years to refine the closure objectives and proposed closure methods for the Minto site, and this dialogue is ongoing in the context of further refinement of objectives and reclamation research programs. Section 2.1 below presents a brief outline of the current status of reclamation and research planning for the Minto site, and section 2.2 outlines the ongoing and planned reclamation research for Minto's closure planning.

2.1 STATUS OF RECLAMATION AND CLOSURE PLANNING

The figure below illustrates how closure planning for mining projects is a continuum, and details surrounding the closure measures implementation strategy, including level of design, should increase as a mine moves through the mine life cycle.

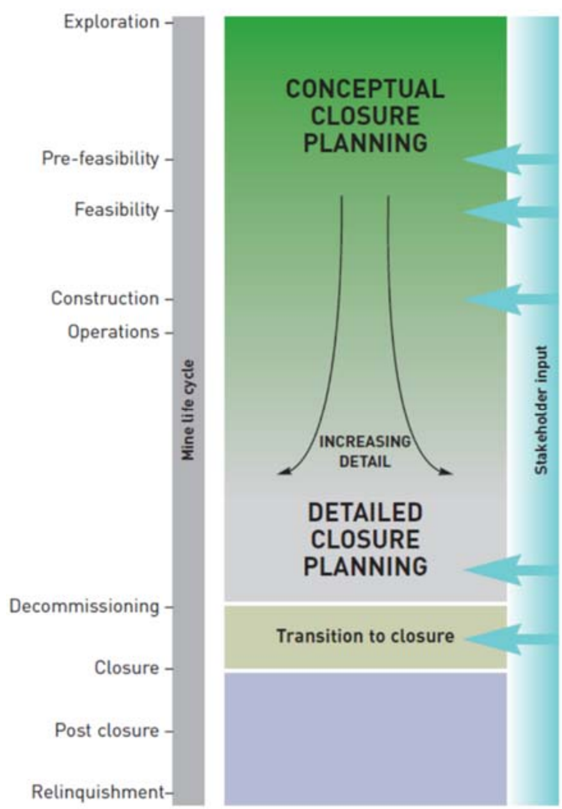

Figure 2-1 Continuum of closure planning relative to mine life cycle

Minto is still in the operational phase of its mine life, with this phase being proposed for extension through Phase V/VI Expansion. Some site facilities (DSTSF, SWD) are either completed or nearing completion, and it is reasonable to expect a higher degree of detail to be developed with respect to these facilities. Where Minto is unable to provide this higher degree of detailed closure planning, it has identified what is required to finalize the designs in the short term, and has made allowances for this work in the closure cost estimations. Specific examples of this include:

- Further design for construction of high quality bituminous geomembrane (BGM) waste cover on the High Grade Waste (HGW) portion of the SWD, currently planned for placement in summer of 2015. Refinement of placement methodology and logistics are required, which will include discussions with supplier and Minto's engineering department;
- Closure water conveyance on South West Dump - a refinement of designs and alignments for secondary ditches (leading to primary conveyance ditches 200 and 300) is required.
- Additional information is being collected through the Reclamation Research Program, and will inform closure measures and implementation strategies for final closure of the site after the completion of Phase V/VI operations. This additional level of detail is reasonably expected later in the mine life once final closure is approaching. This will specifically include passive treatment measures, including:
    - Wetlands
- Demonstration scale will refine performance expectations and contaminant removal rates;
- Foundation investigations will inform locations, constructability and final design; and
- Design for construction:
    - Bioreactors
- YRC and site trials will refine performance expectations and contaminant removal rates, also optimal substrate and amendment requirements for design;
- Trials will inform 'treatment train' optimization with Constructed Wetland Treatment Systems (CWTS);
- Foundation investigations will inform locations, constructability and final design; and
- Design for construction.

Reclamation and closure planning has been a primary consideration in the Phase V/VI mine planning and operational decision making. The planning of new dumps has been guided by long term closure design criteria (i.e. final slopes, water conveyance requirements), and the completion of Phase IV dump facilities provides an opportunity for the economical direct placement of overburden from Phase V/VI pit stripping activities as dump closure covers. The design for the Mill Valley Fill Expansion Stage 2 has incorporated an allowance for the Ditch 400 alignment and spillway for closure water conveyance, as well as planning for an access road realignment.

Rock materials specifications and quantities for closure water conveyance structures (rip rap, bedding materials, crush rock) have been identified (Section 7) and will be produced and stockpiled during active mining activities. This will reduce requirements to produce or source the materials at closure.

2.2 RECLAMATION RESEARCH

An important component of the reclamation planning process is ongoing reclamation research with the objective of developing the methods required to implement a successful reclamation program. Reclamation research will focus primarily on the key closure methods proposed for the site:

- Soil Covers;
- Revegetation; and
- Passive Water Treatment.

The relative success of these techniques at the Minto site compared with expectations built on evidence from applications and use in other similar sites will be dependent on a number of site-specific conditions. A comprehensive reclamation research program has been designed and initiated to provide proof of concept for these techniques in the Minto Mine setting. The elements of this program are presented in this section. Other aspects of mine site reclamation including recontouring and erosion stabilization techniques are well established and are less reliant upon site-specific research for success.

Documentation of natural revegetation successes is ongoing during current reclamation research activities as documented in the annual reclamation reports. Information developed on site will be supplemented with information obtained from other mine reclamation programs in the Yukon and other jurisdictions. Considerable research has been carried out into the reclamation and revegetation of disturbed lands in the Yukon, including operating and abandoned mines, and mineral exploration sites. Much of this information is in the public domain and is well presented in the guidance document Mine Reclamation in Northwest Territories and Yukon (INAC 1992).

The true benefits of reclamation research will be realized if the information obtained and knowledge gained is incorporated into larger scale reclamation projects as quickly as possible.

This section provides a summary of reclamation research initiatives at the Minto Site. These programs are intended to increase the support closure measures decisions and implementation strategies for the site, as well as increasing the level of confidence in the proposed measures. This section includes:

- Results from reclamation research programs to date, and
- Plans for additional reclamation research.

2.2.1 Soil Cover

Mine waste at Minto Mine includes both waste rock and tailings (dry stack and in-pit tailings) (SRK, 2013a). At the end of Phase V/VI, there will be a total of six distinct waste rock and overburden piles on site. Isolating soil cover systems constructed from locally available stockpiled or mined materials are proposed in order to reduce metal loadings to the receiving environment (Section 7). Geochemical characterization of the mine waste has confirmed that acid generation potential is low at the site, and performance estimates for these covers are based on considerable relevant experience on similar projects.

Refinement of site-specific performance expectations related to infiltration reduction is not considered to be valuable given the reduced reliance on infiltration reduction and the nature of the available cover construction materials at site. Further research related to cover performance will be conducted in the context of revegetation and erosion control, as discussed in the following sections.

2.2.2 Growth Media and Revegetation

Plants require, as a minimum, a medium that will allow roots to penetrate, that will retain adequate moisture, and that contains suitable levels of nutrients for successful growth. The natural vegetation found on undisturbed sites around the mine generally provides information the underlying soil properties, including texture, drainage, and pH, and the level of available nutrients that presently occur at the site. A soil-sampling program was initially conducted in the project area during 1994 as described in the original environmental assessment report. The results of this program provide the basic information required for reclamation planning.

Research is being proposed for 2014-2016 to characterize moisture and nutrient regimes more adequately, and will be dovetailed with the soil cover research where possible. This will include three sub-projects in partnership with Yukon College, which are identified at a preliminary level below.

The revegetation trials are designed to determine the best methods of restoring the Minto mine site footprint to a functioning and self-sustaining ecosystem. Four important components of a revegetation process that are being examined presently or proposed are briefly described below and other related considerations are further discussed.

1. 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.

2. Soil covers: different plant varieties and species, waste characteristics, cover designs and other environmental conditions are all factors influencing uptake of metals by plant tissues. Sampling of plant tissues from both background plots and expanded revegetation test plots (i.e., Main Waste Dump) will be conducted to assist in designing the revegetation program, and existing literature and research regarding plant metal uptake and animal foraging patterns will be incorporated into the seed mix design.

3. Transplanting and collection of seeds of local plants that have been noted, during monitoring, to have colonizing potential (especially trees, shrubs and nitrogen-fixing legumes). The creation of vegetation islands can also enhance natural succession.

4. Utility of soil amendments: such as biochar, peat, wood fibre, or mulches need to be investigated for usefulness in areas where soils are deficient or unstable.

The establishment of an initial ground cover of graminoids (all grasses and grass-like plants, including sedges and rushes) has historically been viewed as a desirable objective on most disturbed areas to stabilize slopes and control soil erosion. Initial test plots were typically small and optimum conditions may have applied. The information obtained from test plots was then applied to larger reclamation efforts in 2011/12 on the face of the Main Waste Dump. Moving forward, vegetation growth will be assessed using standardized methods each summer. The successes from the trial plot program will be transferred to more progressive reclamation efforts (e.g. face of Main Waste Dump) that will provide a large-scale opportunity for refinement of reclamation and revegetation techniques and measures.

The revegetation component of the reclamation research program will be expanded in the following ways:

1. Revegetation trial plots will be established in concert with soil cover trials (i.e. waste dump progressive reclamation initiative covers);

2. Revegetation research will be expanded beyond grasses to larger, later successional shrub/tree species. Establishment of these species in the revegetation program will enhance the natural succession. This will involve a combination of the following:

    - Local stock collection and transplanting trials;
    - Local seed collection and broadcasting and propagation trials;
    - Live planting for erosion control; and
    - Preferred aspect and slope conditions for different plants.

3. Nearby areas for native vegetation seed and stock collection will be identified. Areas slated for clearing need to be inspected so suitable plants can be salvaged. A general inventory of indigenous plant communities in the area was conducted in 2010 as a component to the Minto Mine Ecosystem Mapping program, and the network will be resurveyed in 2015. This information can be used to locate naturally occurring shrub or tree species that could be used in transplanting /seeding trials;

4. Vegetative erosion control methods will be field tested on site—they can provide a cost-effective alternative to synthetic or other manufactured products. Grass seeding of slopes is an immediate step towards stabilizing soils on steep slopes; however, live shrub/tree plantings are more effective at reducing soil/cover erosion on steeper slopes and gullies;

5. Nitrogen-fixing flora will be included as a critical component of revegetation prescriptions, so soils are not depleted of plant-available nitrogen. Native species that are nitrogen-fixing candidates for seed collection are:

    - Arctic lupine (Lupinus arcticus)
    - Yellow locoweed (Oxytropis campestris)
    - Hedysarum alpinum;
    - Alder (Alnus sp.); and
    - Agronomic species include alfalfa and clover.

Reclamation Knowledge to Date

Based on the specific reclamation research results to date and on a review of other reclamation and trial projects, the following points will guide reclamation activities during progressive and final closure:

- Chemical analysis of soils indicate that the overburden soils are deficient in macronutrients (nitrogen, carbon, phosphate and potassium), but have adequate micronutrients (copper, iron, manganese, molybdenum, zinc). It is recommended that soils be amended with fertilizer and/or mulched to promote grass/plant growth after seeding;
- The nutrient uptake by northern native seed varieties on nutrient deficient soil is usually more effective than nutrient uptake by southern agronomic species. Seeding with agronomic species over most disturbed areas at the Minto mine site may be required because of the high cost and limited availability of northern native revegetation species;
- Where additional areas at the mine may be targeted for progressive reclamation, seed and fertilizer treatments should be formulated based on the monitoring results of the revegetation trials to date. Two seed mixes are recommended below:
    - a dry area seed mix (Table 2-1), which would be applied to most disturbed sites in the area; and
    - a wet area seed mix (Table 2-2) for riparian sites.

Table 2-1 Dry Area Seed Mix.

Species	Botanical Name	Application Rate (kg/ha)	Percentage
Violet Wheatgrass	*Agropyron violaceum*	12	40.0
Sheep Fescue	*Festuca ovina*	7	23.3
Rocky Mountain Fescue	*Festuca saximontana*	7	23.3
Glaucous Bluegrass	*Poa glauca*	4	13.4
Total		**30**	**100**

Table 2-2 Wet Area Seed Mix.

Species	Botanical Name	Application Rate (kg/ha)	Percentage
Violet Wheatgrass	*Agropyron violaceum*	16	53.3
Fowl Bluegrass	*Poa palustris*	8	26.7
Tufted Hairgrass	*Deschampsia caespitosa*	6	20.0
Total		30	100

In addition to each grass mix, a nitrogen-fixing plant species will be added. If native species Yellow locoweed (Oxytropis campestris) and Arctic lupine (Lupinus arcticus) are available, they can be applied at 2 kg/ha. Agronomical species Medicago sp. (Rambler or Drylander) and Alsike clover at can also be applied at 2 kg/ha. Rhizobium inoculant is needed for these legume seeds.

- Topsoil and logs (coarse woody debris) should be salvaged during stripping and clearing and stockpiled to the side. The topsoil, as well as being a seed bank, contains micro-fauna and fungus necessary for nutrient cycling. The logs are carbon/moisture reservoirs and provide habitat and preferred regrowth microsites. This material is needed to jump start soil-building processes and to accelerate revegetation growth.

- Vegetation islands of shrubs, trees and coarse woody debris act as a seed banks, attract wildlife which transport seeds and nutrients into the grassed area and speed up vegetation succession. Vegetation islands should be incorporated into both the revegetation research program and the larger scale progressive reclamation efforts. Retention of islands of vegetation where possible within the Minto Mine future expansion plans will enhance landscape diversity and accelerate vegetation succession after mine closure.
- Local shrub/tree species can be salvaged and planted on corresponding aspects. Use ecosystem polygons already mapped to assist in finding local plant stock, and in determining species adapted to particular aspects and conditions.

2.2.2.1 Main Waste Dump Trials

Previous years' research has provided Minto Mine with information to pursue a large-scale project: the cover trial on the Main Waste Dump (MWD) re-contoured rock surface. Two variables were considered in the trial; the suitability of the major types of overburden found on-site as cover material and amendments such as fertilizer and organic material. These will be compared to simply seeding the overburden, allowing Minto Mine to gauge if these amendments improve seeding success. Re-vegetation success will be monitored and will provide Minto with information to customize site-specific reclamation methods. The cover trial will also stabilize inactive slopes, reduce the amount of reclamation taking place at end of mine life, and improve aesthetics on-site.

Ongoing data collection from the next few growing seasons will provide Minto Mine with additional information, including:

- Assessing success of seed mix on large scale plots;
- Determining if different types of overburden on-site can support vegetation; and
- Gauging benefit of using amendments to overburden (organic matter and/or fertilizers).

Figure 2-2 shows the reclamation work that Minto Mine completed on the Main Waste Dump in 2011. At the beginning of the 2012 summer Minto completed the re-contouring of the slopes (Figure 2-3) and placed 1m of overburden over the re-contoured slopes (Figure 2-4). As sections of the overburden were placed, they were hand seeded and fertilized (depending on plot amendment) (Figure 2-5).

Figure 2-2 Main Waste Dump near the end of construction season 2011 (September)

Figure 2-3 Main Waste Dump as it appeared in July 2012 with final placement of overburden into distinct plots

Figure 2-4 Final plot placement in August 2012. Note seedling emergence in upper right plots

To support SRK's further investigation into available cover construction materials at site, materials were recovered from the site's Reclamation Overburden Dump, characterized, and placed in distinct plots (Figure 2-5). The naming convention of the overburden plots reflects the position the overburden was placed on the Main Waste Dump. There are two benched areas, identified as "Upper and Lower". West facing slopes and east facing slopes are also pointed out in the convention. Table 4-4 below indicates the naming convention for the plots, along with their areas.

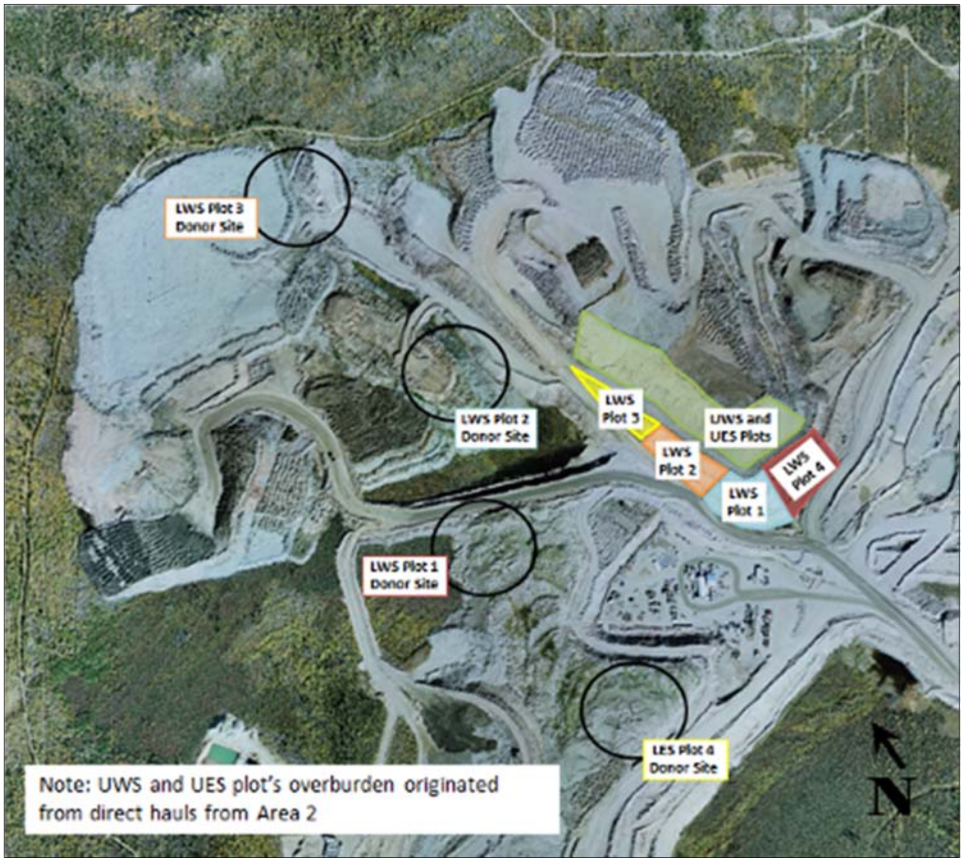

Figure 2-5 Origin of overburden material from ROD placed in distinct plots on the MWD re-contoured rock surface

Table 2-3 Naming convention, areas, volumes and depths of each overburden plot

			Area (m^2)	Area (ha)	Depth of OVB cover (mm)	Total volume of material placed (m^3)
Plot Name	Upper West Slope (UWS) and Upper East Slope (UES)	UWS and UES Plots	17229	1.72	1000	17229
	Lower West Slope (LWS)	LWS Plot 1	10309	1.03	1000	10309
		LWS Plot 2	6237	0.62	500	3118
		LWS Plot 3	6219	0.62	1000	6219
	Lower East Slope (LES)	LES Plot 4	3970	0.40	1000	3970

Plot size was chosen to balance the minimum area required to gather scientifically sound information, initiating enough diverse treatments to analyze different scenarios, and field fitting the plots for the most efficient use of space. Each overburden plot was chosen to represent materials available from the overburden stripping that occurred in Main and 2 pits. As shown in Figure 2-5, the upper slope plots were capped with material directly excavated and hauled from Area 2 pit development indiscreetly, without much segregation. A selection method occurred for the lower slope's plots within the ROD area. Sites were chosen to represent a wide range of materials on site (gravelly and sandy overburden, to loam-textured, to overburden containing high clay content pockets). Stockpiles and pads of materials were surveyed for material types using field cues (hand texturing, colour comparison, visual estimation of coarse to fine material composition).

Minto is currently re-evaluating the reclamation research objectives and structure of these plots, and the ongoing observations and findings from these larger scale efforts will inform revegetation and erosion control measures elsewhere on the site.

2.2.3 Passive Water Treatment

2.2.3.1 Constructed Wetland Treatment Systems

Contango Strategies Limited (CSL) has been contracted to carry out reclamation research associated with the passive treatment systems (PTS) and CWTSs for the Minto project. The phases of reclamation research for the PTS have been refined as:

1. Information Gathering;
2. Site wetlands assessment;
3. Pilot-scale testing and optimization;
4. Refinement of design by on-site demonstration; and
5. Full-scale design and implementation.

Highlights of work completed to date include completion of a site assessment, construction, monitoring, and optimization of pilot-scale CWTSs (both reported in Appendix XX), and design of on-site demonstration-scale CWTS.

The site assessment was initiated with gathering of relevant historical and predicted models for the site in closure, and progressed through two site visits in 2013 (timeline in Table X1). The first site visit (August) familiarized scientists with the Minto site and identified specific locations of interest for sample gathering. The second site visit (September) involved a directed research program, specific to the natural wetland between the W10 and W15 areas receiving seepage from the South West Dump. The wetland assessment produced data indicating that substantial natural treatment is ongoing in the natural W15 wetland on site.

The second visit also provided information regarding priority plant species and borrow sites for piloting and building the CWTSs. During the second site visit, plants (Carex and Sphagnum) were harvested from site and brought to CSL's year-round pilot research facilities. Information gained from the site visit, past experience of designing CWTSs for copper treatment (and other elements), literature searches, and predicted water quality and conditions at closure, were taken into account for designing the pilot CWTSs specifically for the Minto site.

In October 2013, three variations of site-specific pilot CWTSs were constructed using plants from the Minto site, each in duplicate, to evaluate the treatment performances of three different designs. The three systems incorporate a) *Carex aquatilis*, b) *Carex aquatilis* and *Sphagnum*, c) *Carex aquatilis*, *Sphagnum*, and biochar added to soils. These three types of systems are designed not only to improve confidence in the accuracy of removal rate calculations and sizing of the full-scale CWTS, but will also provide valuable information in terms of maintenance schedules as the Sphagnum moss accretes in the system. All systems included peat from site incorporated into the soils, and pine wood chips. The peat borrow site was tested for metals content and other relevant parameters such as nutrients (N, P,K) before using. Synthetic water was developed to mimic the predicted water quality in closure.

The synthetic water underwent five iterations of design, testing, and optimization to ensure the composition and method of formulating the water resulted in analytical chemistry that matched the predicted water quality in closure. Design of the synthetic water chemistry focused on constituents requiring treatment and elements/compounds that are expected to affect treatment rates or capacity based on our previous experience and scientific literature.

Two phases of water chemistries were tested; the first reflecting and early closure scenario where ammonia and nitrate are present from blasting residue in the waste rock. The second water chemistry had lower ammonia and nitrate present, as would occur further into closure once blasting residues have depleted. On average, each pilot CWTS started operating with a hydraulic retention time (HRT) of 39 hours, later increasing to 54 hours once plants were established. Together, all six systems used approximately 1,000 litres of synthetic water per 5 days.

2.2.3.1.1 Summary of Findings to Date

The following subsections provide a summary of findings to date including Natural Wetlands Assessment and pilot scale CWTSs.

Natural Wetlands Assessment

The W15 sampling point currently receives water through creek(s) that are fed by seepage from the SWD, underground seepage from the SWD, and by a culvert reporting water from the Pelly Lay Down area and road runoff. For this reason, the W15 water quality being reported has higher concentrations of elements of concern (e.g., copper, selenium), than what is present in the creek receiving seepage from the SWD.

The natural wetlands upstream of the W15 area have abundant natural treatment capacity, decreasing copper concentrations of ~100ug/L from seeps to less than 20ug/L at the inlet of the creek to the W15 sampling area. However, this treatment capacity is currently being masked in sampling at the W15 point because high concentrations of elements in the water originating from the culvert are mixing with the creek water at the W15 pond area.

Based on the treatment performance of the natural wetland receiving seepage from the SWD upstream of the W15 monitoring point, it is recommended that in closure this natural wetland should be retained. As a contingency, options for natural treatment augmentation may be explored in this area, such as structures to decrease channeling of water (and increased retention time), or removal of undesirable plant species that are associated with channeling features (e.g., willow, spruce; Figure 2-6) as has been observed at the cleared area near the W32 seepage monitoring location (Figure 2-7).

Figure 2-6 Example of undesirable channeling through willow

Figure 2-7. Clearing at W32 location.

Pilot-scale CWTSs

The pilot CWTS have provided data needed for development of site-specific removal rate coefficients and optimization of designs. It was found that the growth of Sphagnum moss significantly improved treatment, while the addition of biochar did not have a significant effect on any of the primary constituents targeted for treatment (i.e., ammonia, copper, selenium). Presence of ammonia and nitrate during early closure were of particular interest as ammonia is readily converted to nitrate in oxidizing environments, however nitrate then competes with other compounds and elements for electrons and is well known as an inhibitor of selenium reduction (and therefore can inhibit selenium treatment).

For this reason, both early closure (high ammonia, nitrate) and late closure (low ammonia, nitrate) scenarios were tested in the pilot CWTSs. An abundance of selenium reducing microbes were found in all systems, and there was no significant difference in selenium treatment with or without nitrate present. The removal rate coefficients calculated for selenium in all pilot CWTS designs tested indicate that the thermodynamic minimum for selenium had not yet been reached, and therefore an increase in HRT (i.e., wetland size) should relate to a further improvement in selenium treatment, as long as it is not so large of an increase in HRT that treatment effects become counteracted by evaporation.

Treatment of copper in the pilot CWTSs has exceeded performance expectations. The copper removal rates to date in the pilot-scale CWTS (k = 0.055 – 0.11) are much more effective than those that we had originally used to estimate removal rates for the full-scale CWTS on site (k = 0.028, Huddleston and Rodgers, 2008).

2.2.3.1.2 Plans for Additional Research

Pilot-scale CWTSs

The pilot-scale CWTSs are currently being tested as hybrid bioreactor/CWTSs (hybrid CWTS), with the first wetland cell being augmented with organic matter to further improve performance while retaining the same footprint. The hybrid CWTS trials are scheduled to be completed July 2014. The expanded scope also includes a trial to conduct analysis on the characteristics of metals release from the Sphagnum and Carex vegetation of the pilot wetlands through a freeze thaw cycle.

Table 2-4 List of Work Undertaken to Date

Item	Description	Date (Aug 2013- July 2014)
Site Visit 1	Identify putative sampling locations	August 12-14
Site Visit 2	Sampling	September 21-22
Pilot CWTS built	6 series in total, 3 different designs (in duplicate), with 2 cells in each series	October 29-31
Acclimation	Municipal water (dechlorinated)	Nov 1 – December 10
Design and testing of synthetic water for pilot CWTS	2010-2012 synthetic water tested	December 1-5
	Synthetic predicted closure water tested	December 5-10
	Revised recipe for synthetic predicted closure water tested	December 20
Synthetic water flowing through pilot CWTS	Synthetic predicted closure water	December 10-16
	Synthetic predicted closure water (revised recipe)	December 22 – April 12
	Long-term closure synthetic water (low ammonia and nitrate)	April 13 – July 28
Performance Monitoring of pilot CWTS	Basic CWTS mode: See Table 2-5 for details	December 10 – May 28
	Hybrid CWTS/bioreactor trial	May 29 – July 17

Table 2-5 Pilot CWTS Monitoring Schedule for Dec – May (all cells, unless noted)

Water	
Temperature	weekly
pH	
Dissolved oxygen	
Alkalinity	monthly
Hardness	
Conductivity	
Chemical oxygen demand (COD)	
Regulated metals water package	
Total organic carbon	
Phosphorus	
Ammonia	
Total Kjeldahl Nitrogen (TKN)	
Nitrate	
Sulphate	
Biological oxygen demand (BOD)	monthly (outflow only)
Total suspended solids	
Soil	
Eh (redox)	weekly
Available NPK	seasonally
Regulated metals package	
Total organic carbon	start and end
Particle size analysis	
Conductivity	
Cation exchange capacity (CEC)	
Sodium adsorption ratio	
Plant	
Regulated metals	start and end
Microbial	
Most probable number (growth-based)	seasonally
Genetic microbial community profiles	

Demonstration-scale CWTSs

A phased approach is being implemented for PTS reclamation research, with aspects of each stage outlined in Table 2-6. The overriding objectives of the demonstration-scale CWTS are to:

- Refine the design that was obtained through the pilot-scale CWTS
- Identify the best PTS or combination of PTSs for water treatment
- Validate function of PTS in cold climate
- Demonstrate function of system on site

Construction of the demonstration-scale CWTS is scheduled for late summer 2014, with acclimation and maturation ongoing until mid 2015. Constant flow rates will be maintained until 2016, when flow variations will be introduced according to seasonal variations. In late 2016 or 2017, a hybrid bioreactor/CWTS phase will be tested, with exact timing based on the results from initial operations of the demo scale and results of hybrid CWTS/bioreactor pilot testing. Routine monitoring will occur throughout all stages of the on-site technology demonstration.

Table 2-6 Phased Approach for PTS Reclamation Research

Aspects and Parameters Related to Different Constructed Wetland Scales	Constructed Wetland Scale		
	Pilot (CSL facilities)	Demo (on site)	Full
Test various water chemistries and formulations	+		
Test different sediment makeups	+		
Test different plant efficacies/properties	+		
Environmental parameter control	+		
Develop flow rates and water depths (HRT)	+		
Develop rate coefficients and kinetics	+		
Acquire proof-of-concept	+		
Intensive monitoring	+	+	
Determine parameters for proper sizing	+	+	
Measure removal extent	+	+	+
Evaluate cold weather performance	+*	+	+
Compare demo/full scale data to pilot data (e.g., rate coefficients)		+	+
Confirm removal rates/extents		+	+

* only if performed outdoors

Table 2-7 Draft Schedule for On-Site Demonstration Scale CWTS

Item		Timing
Identify potential location for demonstration scale CWTS		June 1-14 2014
Engineering and geotechnical		June - July 2014
CWTS Construction		July 2014
Planting and bringing system online		August 2014
Operation and Monitoring	2014	Acclimation and maturation at constant flow rate
	2015	Spring - continued maturation/acclimation. Operation at constant flow rate
		Summer - Increase water depth
	2016	Operation with weekly flow variations based on seasonal variations
		Summer - switch to hybrid bioreactor phase if appropriate
	2017	Hybrid Bioreactor/CWTS phase, late in operation 2016 or 2017, exact timing to be determined based on results from initial operations of the demo scale and results of hybrid CWTS/bioreactor pilot testing. This will involve adding solid organic matter (such as alfalfa hay, straw) to the CWTS cell(s).
Reporting	2014 - 2016	Reporting will be performed twice annually, in the form of an interim update and comprehensive (all data to date) report.

Table 2-8 Draft Monitoring Schedule for On-Site Demonstration Scale CWTS

Frequency	Parameter	Location	Sample Type
Weekly	Temperature (by data logger)	All Cells + Inflow	Water
	pH		
	Dissolved Oxygen		
	Conductivity		
	Inflow rates/outflow rates (by meter)		
	Regulated Metals (ICP) (Total and dissolved)		
	Eh (redox)	All Cells	Soil
Monthly	Alkalinity	All cells + Inflow	Water
	Hardness		
	Sulfate		
	Chemical Oxygen Demand		
	Total Organic Carbon		
	Ammonia		
	Nitrate/Nitrite		
	Total Kjeldahl Nitrogen		
	Biological Oxygen Demand	Outflow + Inflow	
	Total Suspended Solids		
	Stem counts (and height)	All cells	Plant
Seasonally	Available NPKS	All cells	Soil
	Regulated Metals (ICP)		
	Total Organic Carbon		
	Cation Exchange Capacity (CEC)		
	Sodium Adsorption Ratio		
	Conductivity		
	Sequential Leaching		
	MPN for SeIV, NO_3, and sulphate reducing microbes, and total heterotrophs		
	Genetic microbial community profiles		
Twice per year	Detritus depth/accretion measurement	All Cells	Soil
	Regulated Metals (ICP)		Plant
	Available NPK and Sulphur		

2.2.3.2 Bioreactors

The bioreactor treatment process is a semi-passive treatment technology, with the primary activity required the replacement or replenishment of the media. The bioreactor process itself is relatively straightforward to evaluate, with the primary evaluation requirements related to site-specific conditions in which the system is designed to operate.

A primary challenge with the design of bioreactors (and PRB systems), which can lead to poor performance, is the inadequate characterization of the in situ flow conditions within the permeable reactive media which results in the bioreactor failing to achieve suitable hydraulic performance and residence time. The nature of potential failures includes improper sizing of the reactor for the flow conditions at the site, and problems with the substrate composition. Examples of flow-related failures are cases where the range flow is too great, causing—at certain times of the year—situations where not all of the flow can be routed through the bioreactor (because of physical limitations of the media), or where the concentration of seepage varies through the year, and the mass loading exceeds the potential mass removal. Examples of these substrate-related failures includes insufficient inclusion of porous media (typically gravel), layered substrates where one layer becomes a flow barrier, and changes in hydraulic properties of organic substrates as they degrade. Other design considerations that affect the potential for bioreactors to work are the physical configuration of the reactor, with some configurations more susceptible to dead zones where substrate is partially or entirely unused for treatment because flow does not pass through these zones.

To avoid these potential pitfalls, the scope of work for evaluating the potential application of bioreactor technology at the Minto Site has been divided into several stages—beginning with detailed characterization of the seepage inputs and foundation conditions in the areas where bioreactors are being considered and advancing to laboratory characterization and bench scale testing of substrate mixtures before ultimately advancing to field scale pilot trials.

It is recognized that complementary field studies and monitoring programs are already underway at the Minto site: e.g., seepage monitoring and ongoing water quality monitoring. This will lead to defined flow and mass loading curves for the seepage areas. It is anticipated that it will be possible to incorporate this information directly into the bioreactor evaluation program as it becomes available and refined. It is also anticipated that it may be possible to enhance further the usefulness of the existing/ongoing sampling and monitoring programs in a cost-effective manner by incorporating some additional analysis and/or adjusting the timing and frequency of the sampling/monitoring programs. Additionally, synergies exist between the evaluation of the bioreactor treatment systems, and the constructed wetlands characterization program.

The following sections outline the first three phases of the research program and planned field trials for bioreactor treatment.

Information Gathering

Additional site and contaminant source characterization work is required in order to facilitate effective design of both bioreactors and constructed wetlands, which is as follows:

- Assimilate all available site information and identify information gaps;
- Field characterization program;
- Visual inspection along the toe of SW Dump, Main Dump, DSTSF and area down gradient of W37;
- Document primary seeps and collect basic parameters;
- Identify probable locations for constructed wetlands;
- Determine options for intercepting/routing seepage the bioreactor cell and ultimately into constructed wetlands;
- Evaluate native plants and tree stands for use as a compost/ solid phase organic carbon source for the bioreactor;

- Basic foundation investigation (test pitting / shallow bore holes);
- Install pH and temperature probes along potential seepage interception;
- Construct field trial of an interception trench adjacent to significant seep, install Eh and temperature probes (with datalogger) and bury a portion of the instrumented trench under 3 m of granular fill to confirm that it is feasible to insulate the seepage interception trench and bioreactor cell to facilitate year round operation;
- Collect shallow soil samples along potential alignment of interception trench(s) and bioreactor sump area for laboratory characterization;
- Install a sampling port into interception trench;
- Collect local organics for use in laboratory/bench scale trials; and
- Collect local granular fill materials for detailed characterization.

Laboratory Characterization / Bench Scale Trials

A successful bioreactor requires media that is permeable, to allow through-flow of water, and to maintain that permeability over time even as the organic phase of the media degrades. The media must also supply a carbon source and nutrients to maintain microbial reactions that improve water quality over the time of operation. This phase evaluates potential media with these requirements in mind. The tests and evaluations proposed in this phase include:

- Evaluate potential permeable media and carbon sources (both soluble and slower or faster release-insoluble carbon sources) in flow-through bioreactor test columns, to identify variable sulphate reduction rates based on media composition;
- Detailed characterization of physical properties of on-site granular fill which could be incorporated in the bioreactor;
- Evaluation of potential sources of wood chips and/or mulch that is locally available for their nutrient and carbon source characteristics; and
- Evaluate long-term stability of the precipitated contaminants by leaching tests.

Large Scale Field Pilot Trials

As the results of the first two phases become available, a site-specific bioreactor design will become the focus of the research program. The results of this phase will be to place a realistic-scale bioreactor in a site setting that is similar to what would be encountered in closure. This will include flow rates and contaminant loading that is similar to what would be treated in closure. This may best be obtained by placing the reactor near a seep that has flow and loading characteristics that were defined in other investigations, or could instead receive flow from a pumpback/collection system. The work scope for this phase includes the following:

- Scope potential site for bioreactor field trial informed by site-specific investigations, site constraints, and bench scale trials. It is anticipated that the site must have the following characteristics:
- Secure location for over 2 years, near mill area, water pumped back from W37 or other seepage collection site with consistently available flow, suitable footprint with respect to foundation conditions; and
- Design field trial based on results of laboratory characterization program: flow rates and contaminant loading matched to substrate volumes expected to yield consistent contaminant removal.
- Construct pilot trial of bioreactor and implement monitoring program – the feasibility and timing of this task will depend entirely on the progress and results achieved in all the preceding tasks.

The composition of the media used in the larger scale bioreactor will be determined from the column studies performed during laboratory characterization. A preference will be given to locally available media if the performance is adequate to meet the treatment requirements, and only will be supplemented by media if a cost-benefit analysis of the importing more distant media shows that to be superior to a bioreactor that uses on-site materials only or primarily.

2.2.3.3 Summary of Findings to Date

Minto and its consultants and partners have undertaken portions of the information gathering and bench-scale investigations presented in the previous section. The CWTS site assessment report in Appendix XX outlines findings on area substrates, seepages and foundations conditions that will be directly relevant to eventual bioreactor design. Minto Mine Environment Department Staff also conduct annual seepage monitoring under a licenced monitoring program. These findings (reported in Minto's Annual Reports) will also contribute to the knowledge base required to determine bioreactor locations and configurations.

Minto has collaborated with the Yukon Research Council to advance early bench scale bioreactor trials that have been focused on evaluating candidate bioreactor substrates for effectiveness evaluations. Findings of the 2013/2014 YRC program have led to proposed continuation with the bench scale trials using actual Minto site water in 2014. Findings of the 2013/14 program are included in Appendix P.

2.3 COMMUNITY ENGAGEMENT

Summary of community engagement activities (e.g. governments, local communities, regulatory agencies and non-government agencies) undertaken to support the development of the RCP.

2.3.1 Introduction

Minto and the Selkirk First Nation (SFN) share the desire to minimize adverse environmental and socio-economic impacts resulting from the Mine operation and during closure. Minto believes this can be accomplished through consultation and open communication with stakeholders that include SFN, project regulators, and others. Accordingly, Minto has increased its focus on stakeholder engagement.

2.3.2 Engagement with Selkirk First Nation

The Minto Mine is located on the west side of the Yukon River within SFN Category A settlement land. As the landowner, SFN is Minto's primary stakeholder. Minto has therefore engaged SFN in a process of meaningful and significant involvement in the planning and development of the Phase V/VI expansion.

While Minto and SFN have had a collaborative relationship prior to commercial production commencing in 2007, a number of initiatives have recently been established to enhance effective engagement through many channels.

These initiatives include regular meetings between Capstone leadership and SFN Chief and council, as well as with SFN leadership representatives.

For the past several years, Minto and SFN have committed a bi-lateral technical working group (BTWG) to discuss technical issues related to the Minto Mine regularly. The BTWG comprises four teams of Minto and SFN representatives tasked with engagement in the following areas: geotechnical, water quality, consultation, and closure and reclamation, particularly as it relates to the Phase V/VI expansion.

Minto and SFN are parties to a confidential Cooperation Agreement.

2.3.3 Tri-partite Socio-economic Working Group

Another important area of engagement in Phase V/VI planning was the creation of a tri-partite socio-economic working group that comprises SFN, YG and is led by Minto. It is responsible for a socio-economic effects monitoring program, as described in the decision document related to Phase IV (YESAB project # 2010-0198). The working group has met several times in order to determine the scope of the monitoring program, discuss availability of data, responsibilities and reporting. Meetings occurred in March and April of 2013 where the working group reviewed the draft Minto Mine project effects monitoring program and the Minto Mine socio-economic monitoring framework. Next steps include having a governance meeting this Spring and launching the monitoring program this summer/fall; with the initial report being issued in summer/fall of 2014.

2.3.4 Identification of Other Stakeholders

Minto recognizes the role that federal/territorial boards and government departments play in protecting the interests of Yukoners as well as providing advice and expertise related to the Project. Therefore, Minto has taken care to engage these stakeholders throughout the Phase V/VI expansion planning process.

This engagement has included communication through technical working groups, site tours, updates, phone calls, regulator meetings, and reports. Stakeholders and regulators who are frequently engaged by Minto are:

- YESAB,
- YWB,
- YG EMR,
- YG Water Resources, and
- Environment Canada.

2.3.5 Forms of Engagement

For details regarding specific First Nation, stakeholder, and regulator engagement, please see the SFN, Stakeholder and Regulator Engagement Table (Appendix A). This table provides details of engagement that has occurred since 2011 and includes communication related to earlier phases of the Minto Mine. Forms of engagement include:

- Bilateral Technical Working Group Meetings,
- Community sessions,
- Meetings between SFN leadership and company senior management,
- Bilateral meetings with regulators, and
- Technical meetings involving multiple stakeholders.

2.4 CLOSURE ALTERNATIVES (I.E. FMEA)

Minto has received substantial feedback on closure plan submissions – from regulatory bodies, from Selkirk First Nation and their respective technical reviewers. This feedback – combined with results from reclamation research and specific evaluations of site conditions – has enabled Minto to refine their reclamation strategy for the Minto Mine site. A key exercise guiding this evaluation and refinement of the Minto reclamation strategy was undertaken in January 2013 in the form of a preliminary Failure Modes and Effects Assessment (FMEA) session. A two day workshop (followed by partial day sessions to complete the exercise with a smaller group was held to identify the risks involved with components of a few different closure option scenarios being considered for the Minto mine. The workshop, facilitated by Dirk van Zyl of the University of British Columbia, was held in Whitehorse from January 15th – 19th, 2013. Technical representatives from the following stakeholders and government agencies participated:

- Capstone Mining Corp.;
- Selkirk First Nation;
- Access Consulting Group;
- SRK Consulting;
- Yukon Government, Energy, Mines, and Resources (Steve Jan Consultants); and
- Yukon Water Board (Gomm Environmental Engineering Company).

Lead up meetings on closure planning strategies with technical representatives from SFN and YG EMR in December 2012 had 'shortlisted' 6 candidate closure scenarios for the Minto Site, each of which had a different key closure measure focus. The FMEA group concurred after reviewing some preliminary water quality estimations for each scenario that there were 3 most likely scenarios that were appropriate to carry forward through the FMEA process. These are presented below with the key assumptions of each:

Scenario: Source Control Focus

- Highest quality covers on waste rock and tailings; and
- No treatment.

Scenario 2: Hybrid of Source Control and Treatment Focus

- High quality covers on waste rock and tailings; and
- Use of active and passive treatments on site.

Scenario 3: Treatment Focus

- Routine quality covers on waste rock and tailings; and
- Use of active and passive treatments on site, managing water using reservoirs to optimize treatment plant function and collection systems.

The outcomes of the preliminary FMEA process were captured in the tables presented in Appendix C of the Phase IV RCP v4 (September, 2013). The group initially identified classes of failure, which were used to identify potential failure mechanisms with associated likelihood and consequence factors. The pre-developed spreadsheet tools then assigned each failure mechanism with a risk ranking, and the team collaborated on considerations and potential risk mitigation measures for failure modes. The session completed with an understanding that once the final closure strategy for the site were determined, that the FMEA exercise should be revisited specific to the proposed closure measures.

As a result of the review of the preliminary FMEA findings (specifically the potential failure mechanisms assigned the highest risk), and further informed by more recent site evaluations (updated water quality prediction and cover material evaluation), Minto has adopted limited source control of potential contaminants as the principle tenets of the reclamation strategy for the Minto site. In addition, Minto has committed to implement reasonable and practical passive and/or semi-passive treatment options. Minto's ongoing research program will determine which methods are practical and reasonable.

The revisiting of the FMEA in the context of this preferred strategy has not been completed to date, largely due to outstanding uncertainty regarding the required stabilization measures for DSTSF instability (for which internal and 3rd party evaluations have only recently been completed). Minto recognizes the sensitivity of the participating parties to the application of these preliminary results, however Minto and SFN continue to work together on both leadership and technical levels to resolve key differences of opinion related to closure of the Minto site. It is Minto's goal to continue these discussions in the ongoing collaborative closure planning efforts and to ultimately achieve a set of closure objectives and mitigation measures that has the full support of SFN. In the interim, the preliminary FMEA results have been exceedingly useful in guiding the closure planning team towards the preferred closure strategy. Minto suggests that these findings adequately cover potential failure modes for the strategy presented in this RCP, and is confident that the reclamation and closure strategy put forward is a responsible and achievable plan that will effectively achieve the stated closure objectives for the Minto site.

The application of the revised closure and reclamation strategy will be presented in Section 7 and detailed in key reclamation measures outlining the isolation of mining wastes from the environment. The use of passive water treatment technologies at the site has been contemplated as a key in previous site closure plans. Revision 4.0 of the closure plan concluded that the additional load reduction offered by passive treatment will not be required to meet suitable discharge water quality. Passive treatment systems were only included as contingency closure measures in revision 4.0.

The Decision Document for the Phase V/VI expansion proposal prescribes the use of reasonable and practical passive treatment options to achieve post closure water quality objectives. Consequently, and based on consultation with Selkirk First Nation Minto will determine what reasonable and practical passive treatment options exists through its ongoing research program. Passive treatment options found to be reasonable and practical, as well as effective in removing contaminants will be implemented.

Active treatment is discussed but is considered mitigation for the active decommissioning and transitional closure period, and beyond that, a worst-case final fallback mitigation to potential water quality impacts from the site if the mitigative measures described in Section 4.2 are not effective in reducing metal loadings to the receiving environment.

There is inherent uncertainty in developing reclamation and closure plans, as mitigations and closure method performance are contingent upon the predictions of future conditions. Minto believes it is critical to acknowledge these areas of uncertainty and to provide for mechanisms in the planning stage that will address unexpected results or conditions in the closure period. Adaptive Management Planning is widely accepted as an appropriate tool for achieving this objective, and Minto has included a draft AMP with this RCP (Appendix B) and intends to advance its level of detail in future versions of this plan in collaboration with SFN and their technical advisors.

3 CLOSURE OBJECTIVES AND DESIGN CRITERIA

3.1 OBJECTIVES-BASED PLANNING

Principles and approaches for reclamation planning from the recently published Reclamation and Closure Planning for Quartz Mining Projects guidance document (Yukon Government 2013) have been considered in the closure planning approach for Minto's Phase V/VI RCP. This guidance document provides direction on the level of detail, information required and processes necessary for developing reclamation and closure plans (RCPs) in Yukon. To achieve its purpose, the guide has the following objectives:

- Describing the context for mine closure planning in the Yukon, and the rationale for requirements to submit RCPs and liability estimates;
- Describe the principles, philosophy and broad objectives for closure planning for Yukon mining projects;
- Describe the information expectations for RCPs and liability estimates; and
- Identify key sources of additional guidance for preparing RCPs and liability estimates.

Principles and approaches presented by Yukon Government (2013) include fundamental reclamation and closure objectives, community and regulatory engagement, reclamation and closure principles and principles for estimating liability. The intent of this section is to present the closure goals, objectives, and criteria for reclamation and closure of the Minto Mine, in the context of closure planning that is objectives-based.

Table 3-1 below includes reclamation and closure objectives to be achieved during all stages of reclamation and closure projects in the Yukon and their accompanying value. Information from this table has been incorporated into tables 3-2 and 3-3 below.

Table 3-1 Fundamental Mine Reclamation and Closure Objectives (YG 2013)

Value	Reclamation and Closure Objectives
Physical Stability	All mine-related structures and facilities are physically stable and performing in accordance with designs. All mine-related structures, facilities and processes can withstand severe climatic and seismic events.
Chemical Stability	Release of contaminants from mine related waste materials occurs at rates that do not cause unacceptable exposure in the receiving environment.
Health and Safety	Reclamation eliminates or minimizes existing hazards to the health and safety of the public, workers and area wildlife by achieving conditions similar to local area features. Reclamation and closure implementation avoids or minimizes adverse health and safety effects on the public, workers and wildlife.
Ecological Conditions and Sustainability	Reclamation and closure activities protect the aquatic, terrestrial and atmospheric environments from mine-related degradation and restore environments that have been degraded by mine-related activities. The mine site supports a self-sustaining biological community that achieves land use objectives.
Land Use	Lands affected by mine-related activities (e.g., building sites, chemical and fuel storage sites, roads, sediment ponds, tailings storage facilities, waste rock storage areas, underground workings, etc.) are restored to conditions that enable and optimize productive long-term use of land. Conditions are typical of surrounding areas or provide for other land uses that meet community expectations.
Aesthetics	Restoration outcomes are visually acceptable.
Socio-economic Expectations	Reclamation and closure implementation avoids or minimizes adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits. Reclamation and closure activities achieve outcomes that meet community and regulatory expectations.
Long-term Certainty	Minimize the need for long-term operations, maintenance and monitoring after reclamation activities are complete.
Financial Considerations	Minimize outstanding liability and risks after reclamation activities are complete.

An objectives-based approach has been adopted for the development of Minto's Phase V/VI RCP. In an objectives-based approach, the closure goal is supported by closure principles which guide the selection of clear and measurable closure objectives for all project components. For each closure objective, proponents propose a set of closure options that could achieve the objective, and a selected closure activity is chosen from these options. Closure criteria measure whether the selected closure activity achieves the specific closure objective.

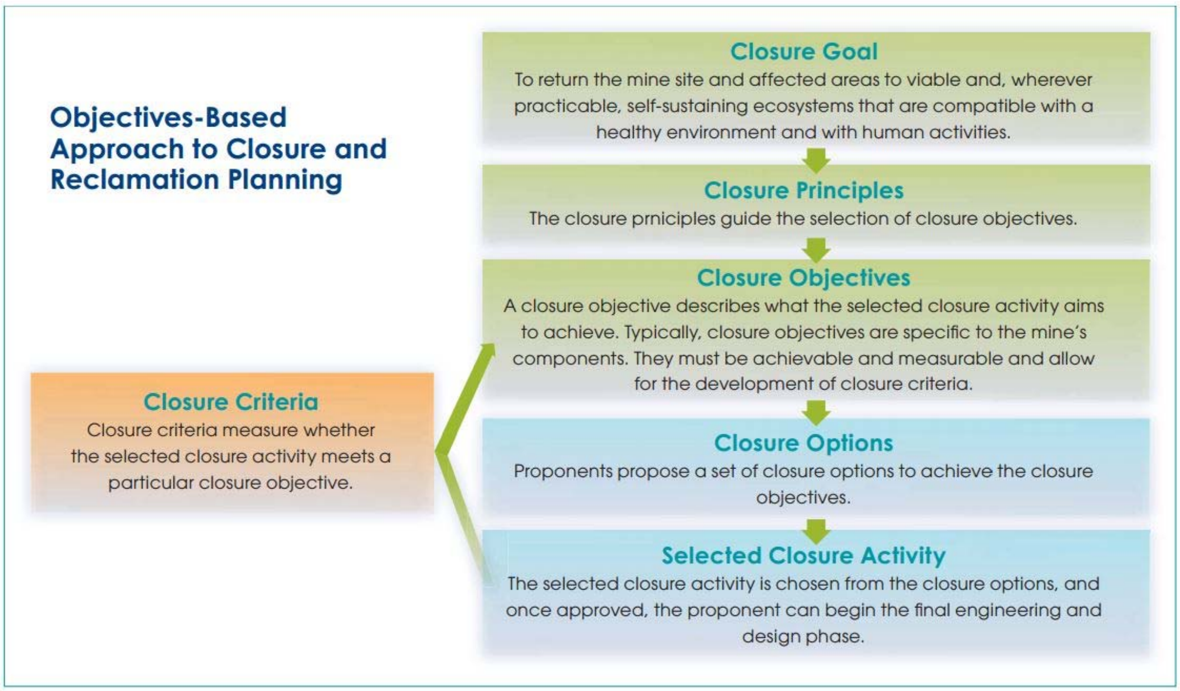

Figure 3-1 Objectives Based Approach to Closure and Reclamation Planning (from MVLWB/AANDC, 2013)

Details defining an objectives-based approach, adapted from the MVLWB/AANDC (2013) are presented below, in some instances where information has been gathered from additional authors, sources are cited.

3.1.1 Closure Goal

The closure goal is the guiding statement and starting point for closure and reclamation planning. Establishment of goals are meant to ensure the long-term success of the program by developing a clear and executional plan. The closure goal is met when the proponent has satisfied all closure objectives.

For the Minto Project, the closure goal at all mining operations is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities.

3.1.2 Closure Principles

Closure principles guide the selection of closure objectives. Four core closure principles applicable to the Minto project include:

- physical stability
- chemical stability
- no long-term active care requirements; and
- future use (including aesthetics and values).

3.1.3 Closure Objectives

Closure objectives are statements that clearly describe what the selected closure activities aim to achieve. They must be measurable, achievable, and allow for the development of closure criteria. Objectives are short-term concrete stepping stones toward achieving a goal and should be specific, appropriate and realistic (Huggard and Nadeau 2013). Selected closure objectives found in the Yukon Mine Site and Reclamation Closure Policy – Financial and Technical Guidelines (2008) directly relate to the closure goal and closure principles required for a RCP.

Component-specific closure objectives, categorized under the four closure principles presented above, are intended to be objectives-based and non-prescriptive. The purpose of implementing performance-based objectives is to encourage research and innovation resulting in cost-effective applications while ensuring public health and safety and environmental protection are met (YG 2008).

3.1.4 Closure Options and Selected Closure Activity

Closure options are potential activities that proponents could take to ensure that progressive and post-closure reclamation meets the stated closure objectives. These should utilize and adhere to the best available practices and technologies suitable to the site for each of the mine components.

Closure activities are chosen based on the closure options for each project component and outlines specific actions and measures to be undertaken. Established literature, bench scale, or pilot testing should support the activity so that stakeholders can be reasonably assured that the option will be successful. Reclamation research (detailed below) also provides certainty to planning appropriate activities. The selected closure activity may change prior to the final RCP based on factors such as environmental considerations, stakeholder input, the availability of new technologies/practices, the results of environmental monitoring programs, or the results of specific reclamation research.

3.1.5 Closure Criteria

Closure criteria are standards that measure the success of selected closure activities in meeting closure objectives. Also referred to as targets (Doran 1981), closure criteria should be clearly established to evaluate reclamation and restoration projects (Ruis-Jaen and Aide 2005) by meeting the closure objectives for each project component. Closure criteria should measurable, realistic, and achieved within a specified time frame (Huggard and Nadeau 2013) to ensure successful reclamation of project components. Closure criteria can be site-specific or adopted from provincial/territorial/federal standards and can be narrative statements or numerical values.

3.1.6 Reclamation Research

Studies and investigations which are aimed at providing site specific performance information, proof of concept and ultimately design refinement for closure measures are best referred to as reclamation research. Reclamation research includes engineering studies and/or focused research undertaken with the intention of reducing uncertainties to an acceptable level. It is the results of targeted reclamation research programs which provide the technical basis for mitigation and reclamation technologies that will be incorporated into both primary closure and contingency planning.

3.1.7 Closure Monitoring

Monitoring of closure components will continue until such a time that closure objectives have been met. Monitoring programs typically consist of three phases:

- Assessment – Baseline conditions of ecosystems that will potentially be impacted by the project (complete for Minto);
- Operational – confirms or refutes accuracy of predictions on impact of the project that were made during the environmental assessment (ongoing for Minto); and
- Transition/Post-Closure – monitoring that will begin with the start of the approved decommissioned and reclamation activities, and carry on into the post-closure period (outlined in this RCP).

Defining monitoring needs during the baseline and operational phases of a project will ensure that measurable targets are relevant to achieving the overarching goals of the closure plan.

3.2 MINTO RECLAMATION AND CLOSURE OBJECTIVES

The goal of the Minto Project RCP is to return the mine site and affected areas to viable and, wherever practicable, self-sustaining ecosystems that are compatible with a healthy environment and with human activities. This goal guides the selected closure scenario for the Minto site through the above mentioned objectives-based closure planning method. Fundamental closure planning objectives developed by Yukon Government (2013) in the Reclamation and Closure Planning for Quartz Mining Projects have been used to guide the development of detailed objectives that are site-specific, defined by factors that include environmental conditions, site conditions and community expectations.

These clearly defined closure objectives and tangible criteria against which to measure performance are presented in the following tables, which present Mine Components (Table 3-2 Summary of Reclamation and Closure Planning for Mine Components) and Valued Components (Table 3-3) separately.

With respect to closure water quality objectives, Minto has received recent guidance regarding their development from the Decision Document for the Phase V/VI Expansion Activities:

> ***Clause #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, 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). Determination of "reasonable" and "practical" mitigations must take into account the expected or*

actual site performance of a given mitigation, and the cost of the mitigation (both initial cost and long-term maintenance cost) compared to the expected contaminant reductions.

Minto is in the process of evaluating the expected performance of passive treatment mitigations through its ongoing Reclamation Research Program. Until such time as these performance expectations can be refined in the context of site conditions (meteorological, constructability, available area, cost effective substrates, etc.), a determination of whether or not non-degradation of Minto Creek water quality can be achieved – or furthermore, what could be reasonably and practically achieved – cannot be made. As such, numerical closure water quality objectives that meet this guidance cannot be presented in this RCP. In lieu of these, Minto proposes the following approach to the application of water quality objectives for closure:

1. **Apply operational water quality objectives on an interim basis for closure planning purposes -** the Decision Document also presents guidance regarding the development of operational period water quality objectives at the Minto site, specifically:

   Clause #17. *For the purposes of defining end-of-pipe effluent discharge quality and quantity standards that are protective of the most sensitive species in the downstream environment, the Proponent shall include, in their water use license application, Water Quality Objectives for Lower Minto Creek at W2 for the operational period for all contaminants of potential concern;*

   and

   Clause #18. *The amended water use license shall remove the compliance point at W2 and specify end-of- pipe effluent discharge quality and quantity criteria that are protective of the downstream receiving environment. The end-of-pipe discharge criteria must be based on:*

- (a) protection of the downstream receiving environment at W2; 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 use of WQOs at W2 as the basis to derive end-of-pipe discharge; and
- (c) ensuring that mass loadings of contaminants of potential concern, released from the mine site, do not cause an increase in downstream concentrations beyond the defined WQOs.
- This RCP will show how the currently proposed source control measures for the closure of Minto Mine will, at meet these objectives in the closure period. The RCP also presents a closure AMP that utilizes water quality predictions and the operational objectives as specific thresholds for investigative and/or mitigative action in the closure period. Together, this will provide assurance that a plan is in place for the protection of aquatic resources downstream of the mine in the event of an early closure before numerical closure water quality objectives are established.

2. **Develop numerical closure water quality objectives prior to implementation of closure plan** – Minto commits to the implementation of additional passive treatment measures, as determined to be reasonable and practical through both the Reclamation Research Program, and ongoing discussion with stakeholders. At this point, actual configurations and associated performance expectations of candidate passive treatment technologies cannot be developed to a level that supports establishment of related water quality targets. Minto is committed to pursuing these in collaboration with SFN.

Table 3-2 Summary of Reclamation and Closure Planning for Mine Components

Mine Components	Water Retention and Water Conveyance Structures	Open Pits	Waste Rock Storage Facilities	Tailings Storage Facilities	Mine Infrastructure	Roads and Other Access	Temporary Closure Site Conditions
Relevant Fundamental Objectives[1]	Physical Stability	Health and Safety Physical Stability Chemical Stability	Physical Stability Chemical Stability	Physical Stability Chemical Stability	Health and Safety	Land Use Health and Safety	Health and Safety
Specific Closure Objectives	Ensure decommissioning of, or upgrades to, water retention and sediment control structures, and appurtenances, in such a way that drainage at, and adjacent to the site, is stable in the long term Convey flows into and throughout the mine footprint, and off of the site in a controlled, stable fashion under a reasonable range of anticipated conditions	Ensure physical and chemical stability of decommissioned pit Able to withstand severe climatic events Protect humans and wildlife from topographic hazards associated with pit and pit lake	Ensure long-term physical stability to minimize erosion, subsidence or slope failure Able to withstand severe climactic and seismic events Ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria	Ensure facilities are designed for closure conditions, so as to ensure physical and chemical stability when decommissioned Minimize potential of mobilization (Aeolian or aqueous) of tailings or tailings contaminants	Remove potential threats to public health and safety Decommission facilities in a safe manner Ensure physical stability of any remaining structures	Minimize, eliminate or manage invasive species colonization at linear features in closure Provide for public safety	Ensure public health and safety and protection of the environment in the event of a temporary closure and to manage risks associated with potential abandonment of site
Closure Measures	Maintain suitable gradients to permit flow and reduce infiltration and erosion Design facilities to minimize contact of surface flow with mine influenced soils Modifications of flow patterns at site to achieve enhanced stability or accommodate water quality or other objectives	Safety berm highwalls and control access to pit Engineering design of controlled outflow from pit lake	New waste rock storage areas designed with maximum of 3:1 slope angles to minimize long term erosion concerns Placement of waste covers to reduce infiltration, encourage vegetation growth and minimize erosion Provide source control measures – operational waste handling and waste covers in combination with passive treatment systems as reasonable and practical to yield water quality acceptable for discharge	DSTSF movement mitigated through Stage 2 expansion of MVFE All facilities covered with either aqueous, soil or wasterock/soil cover	Mine site structures not required will be decommissioned and removed (partially or completely) Foundations demolished and buried Pad areas re-graded as necessary, scarified and re-vegetated	Identify key or essential roads in coordination with SFN Develop a plan to minimize the advance of invasive species Decommission, scarify and vegetate non-essential roads to provide a means of protection to public safety and encourage development of wildlife habitat	Care and maintenance of facilities Ongoing monitoring of physical and chemical stability monitoring programs Site water management /treatment as required Control site access and security

1. Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guide (2013), Government of Yukon.

Table 3-3 Summary of Decommissioning and Reclamation Planning for Valued Components

Valued Components	Terrain Stability	Watercourses	Water Quality and Aquatic Resources	Vegetation/Wildlife Habitat	Socio-Economic Benefits and Effects	Long-term Certainty
Relevant Fundamental Objectives[1]	Health and Safety Physical Stability	Physical Stability	Physical Stability Ecological Conditions and Sustainability	Ecological Conditions and Sustainability	Socio-Economic Expectations	Long-term Certainty
Specific Closure Objectives	Remaining terrain should present no more significant hazard to people and wildlife by achieving conditions similar to local features Ensure physical stability such that slopes, excavations and other disturbed lands are in a conditions that will limit the incidence of soil erosion, slumping and other instabilities that are likely to impede re-vegetation of a reclaimed site, pose a threat to public safety, lead to wildlife mortality, or cause excessive sediment loads to enter nearby water bodies Can withstand severe climatic and seismic events	Ensure long-term stability for natural and created watercourses so that erosion and sediment processes are within a natural and acceptable condition	Minimize exposure to and mobilization of substances that pose a risk to aquatic resources through physical and chemical stability Avoid long term reliance on active water treatment Provide for functioning aquatic habitats similar to baseline conditions	Ensure long-term physical stability that allows for successful re-vegetation Encourage natural development of native species and communities Return temporarily developed land to sustainable wildlife habitats	Reclamation and closure implementation avoids or minimizes adverse socio-economic effects on local and Yukon communities, while maximizing socio-economic benefits Reclamation and closure activities achieve outcomes that meet community and regulatory expectations; maximizing benefits for SFN businesses and citizens	Minimize the need for long-term operations, maintenance and monitoring after reclamation activities are complete Minimize the level of ongoing activity at site
Closure Measures	Re-grading of pads and facilities as necessary Utilize safety berms where appropriate Develop soil covers that reduce erosion potential, while accounting for precipitation patterns, infiltration capacity, cover depth, cover materials' erodibility, optimal rooting depths of grasses and woody species prescribed for re-vegetation Consider natural (bioengineered) and synthetic controls where erosion potential may still exist	Establish stable channel geometries and design for appropriate flood return periods (hydraulic capacity) Where appropriate, rehabilitate disturbed watercourses to achieve characteristics similar to pre-disturbance conditions	Apply source control measures in the form of soil waste covers, and operational waste management strategies such as subaqueous disposal to minimize contaminant mobilization Utilize active water treatment technologies during transition to permanent closure Continue research into application of reasonable and practical passive treatment technologies, and implement technologies as appropriate for closure Use results from progressive reclamation opportunities to refine soil cover specifications to minimize metal leaching	Establish self-propagating early seral native plant communities Encourage opportunities for progressive reclamation over the project life Preparation and use of soil salvage location to store overburden for use in closure soil covers Develop growth media stockpile locations for storage of materials during pit stripping Develop re-vegetation plans according to prescriptions which include native species Develop and implement invasive plant species SOPs Ensure that synthetic liners or other materials that may entrap wildlife are not exposed	Continue Reclamation and Closure Planning with SFN representatives Include SFN and Yukon representatives and contractors in reclamation and research work where possible	Closure measures are planned to meet long term water quality objectives without reliance on active water treatment Closure measures are planned to stabilize and reduce erosion potential

1. Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guide (2013), Government of Yukon

3.3 DESIGN AND CLOSURE CRITERIA

Reclamation and closure planning have been guided by many design criteria, ranging from regulatory and guidance based-criteria, constraints imposed by the project location and history, and criteria established through consultation with stakeholders.

Design criteria are presented in this section by closure component, including the applicable geotechnical, hydrologic, and water quality criteria for each component. Each section also includes references to the guidance documents, reports and analysis that supports the design criteria.

3.3.1 Water Management Structures and Systems

A water management layout has been developed for closure to meet the reclamation objectives. Drainage, ditches, energy dissipation basins, water retention structures, and spillways will be constructed or upgraded to ensure the safe conveyance of water downstream from the mine site. The long term stability and effectiveness of the water management system will be ensured through the use of the selected design criteria. They are presented below.

3.3.1.1 Drainage ditches and associated structures

A system of drainage ditches will be built to convey water over and away from the mine site.

<u>Primary ditches:</u> Major conveyance channels that will route accumulated overland flow over a significant portion of the mine watershed and/or that connect significant water bodies within the mine site. These ditches have catchment areas ranging from approximately 2 to 10 km^2.

<u>Secondary ditches</u>: Conveyance channels that will route runoff from elevated catchments (i.e. from the top of the waste rock dumps, and the DSTSF) into primary ditches. The design of secondary ditches will incorporate structures, where necessary, to drop water along the steep faces of waste rock dumps, and energy dissipation ponds at the base of steep slopes to protect against erosion. The relatively flat secondary ditches have catchment areas less than 1km^2, while the secondary ditches that convey water down steep slopes will be limited to 5 ha. The conveyance channels will incorporate both rip-rap and bedding/filter layers to mitigate against erosion of underlying materials.

<u>Tertiary ditches</u>: Minor ditches and swales that will direct overland flow on the elevated catchment areas towards secondary ditches. Tertiary ditches will convey small flows and incorporate vegetative cover to mitigate against erosion.

Design criteria that were selected are presented in Table 3-4. The hydrological study and preliminary design for each ditch is summarized in Section 7-5 and presented in detail in Appendix C.

Table 3-4 Drainage Ditch Design Criteria

Ditch	Design Flood	Minimum allowable slope (%)	Maximum allowable velocity (m/s)	Froude number	Freeboard (m)	Side slopes (H:V)	Geometry
Primary Ditches	1/200 year	0.5	3.5	<2	0.5	2:1	- Trapezoidal cross-section - Minimum base width of 2m - Maximum ratio of base width over water depth of 2
Secondary Ditches	1/200 year	0.5	2	<2	0.3	2:1	- Trapezoidal cross-section - Minimum base width of 1 m on gentle slopes and 2m on steep slopes
Tertiary Ditches	0.5 m^3/s	0.5	2	-	0.3	2:1	- Trapezoidal cross-section - Minimum base width of 1 m

Drainage ditches will be sized to adequately convey the design flood. Appropriate ditch dimensions to prevent overtopping and adequate means of erosion protection will provide a safe and reliable design under varying ground conditions. Erosion protection can be provided by adequate channel protection (riprap or synthetic liners), and drop structures and energy dissipation basins in steep reaches where hydraulic jumps are likely to form.

3.3.1.2 Energy Dissipation Basins

Energy dissipation basins are boulder fields, rock check dams or stilling basins used to dissipate energy resulting from supercritical (fast and shallow) flow conditions. These will be placed at the bottom of steep slopes to allow the formation of a hydraulic jump resulting from supercritical flow (with a Froude number larger than 2) in a controlled location. Energy dissipation basins will also be required at the junction of ditches, to provide an adequate transition to the downstream ditch.

Design criteria that were selected are presented in Table 3-5. A more detailed discussion of these water conveyance structures is presented in Section 7-5. A preliminary design of energy dissipation basins is presented in Appendix C.

Table 3-5 Energy Dissipation Basin Design Criteria

Mine Feature	Design Flood Events	Basin Geometry
Energy dissipation basins	1/200 year	• Basins will have a square base, with width and length at a minimum 2 times the width of the connecting ditch; • Minimum water depth of 1 m; • Side slopes 2H:1V;

Basins will be lined and protected with riprap (D_{50}=600 mm) to prevent erosion due to high flow velocities and turbulence levels.

3.3.1.3 Inlets, Outlet and Spillways

Flow conveyed into and out of open pits, and down spillways - associated both with dams and steep reaches - require more robust designs due to erosion control and constructability challenges.

Inlet structures convey flow from primary and secondary ditches to energy dissipation basins through a progressive expansion, while outlet structures convey flow from a large body of water to a ditch through a progressive constriction Two spillways will convey flows into the Area 2 Pit: the Main Dam spillway, conveying flows from the Main Pit in addition to flows from the upper catchment ditches, and the Tailings Diversion Ditch spillway.

Design criteria that were selected are presented in Tables 3-6 and 3-7. A more detailed discussion of these water conveyance structures is presented in Section 7-5. The design of Area 2 Pit outlet structure is presented in Drawing 08, while the detailed design of the Main Dam and Tailings Diversion Ditch spillways (SRK) are presented under separate cover.

Table 3-6 Inlets and Outlets Design Criteria

Mine Feature	Design Flood Events	Maximum allowable velocity (m/s)	Channel Geometry
Inlet Structures	1/200 year	1.5	Progressive expansion: - Final width: 3 times the base width of the ditch - Longitudinal length (expansion): 5 times the base width of ditch - Side slope 2H:1V Overflow section: - Rip rap size with a D_{50} of 500 mm will be required.
Outlet Structures	1/200 year	2.5	Progressive constriction: - Initial width: 3 times the base width of the ditch - Longitudinal length (constriction): 5 times the base width of ditch - Side slope 2H:1V Invert sill: - Elevation set at normal water elevation of water body - Maximum flow depth 1 m over sill - Long broad crested weir: 2 m longitudinal length - Upstream longitudinal slope: 2H:1V - Downstream longitudinal slope: 0.5%

Table 3-7 Spillways Design Criteria

Mine Feature	Design Flood Events	Erosion Control/ Sediment Removal	Freeboard	Flow Routing Velocity
Main Dam Spillway	2/3 between 1/1,000 year flood and PMF	Bedrock or armoring placed along the base and 1 m vertical height of the spillway channel	Minimum 0.5 m	<2.5 m/s
Tailings Diversion Ditch Spillway	PMF minus the 1:100 year flow	N/A	N/A	<2.5 m/s

3.3.1.4 Water retention structures

The Minto mine site at closure will have two dams in place:

1) The Main Dam, that will contain tailings from the Main Pit and will remain through the final closure of the site; and

2) The Water Storage Pond Dam, that is used to retain water in a pond at the downstream end of the site, will be decommissioned during closure when water quality at the site has stabilized relative to water quality objectives.

Design criteria selected for the construction of these dams are presented in Table 3-8 and are based on the Canadian Dam Association (CDA) Dam Safety Guidelines 2007. The preliminary design for the Main Dam is presented in SRK Consulting's Main Dam Preliminary Design Report (2014). The detailed design for the Water Storage Pond Dam was prepared by EBA Engineering and was constructed in 2006/07. The decommissioning plan for the WSP Dam is presented in Section 7.2.5.1.

Table 3-8 Dam Design Criteria

Dam	Hazard Classification	Earthquake Design Ground Motion	Factors of safety	Slope Angles	Material Strengths	Seepage Control	Design Flood Events
Main Dam	Very High (SRK, 2013)	1/5,000 year event	Static and seismic for upstream and downstream dam slopes. 2m of freeboard	upstream 2H:1V, downstream 3H:1V, spillway 10H:1V	Excavation and backfill using low permeability core material that is not frozen	Estimated to be 10^{-9} cm/s under thawed conditions	2/3 between the 1/1,000 year flood and PMF
Water Storage Pond Dam	Significant	0.150 g (EBA, 1997), 1/475 year event in mid-1990s, well above 0.078 g for a 1/1000 year event as currently defined (CDA, 2007)	1.5 m of freeboard targeted	Upstream 2.5H:1V, spillway channel on downstream face of dam 4H:1V	Zoned earth fill structure with a core, graded downstream filters, upstream/ downstream rock fill shells and downstream rock fill toe berm	Seepage flows to a pond - a weir is present on the downstream side of the ponded seepage water to measure/monitor flow from the dam. Estimated flow rate during last inspection: 1 L/s (SRK, 2013)	1/100 to 1/1,000 year flood

3.3.2 Overburden and Waste Rock Dumps

Per Yukon requirements, design criteria for overburden and waste rock dumps are based on the recommended Factors of Safety (FOS) listed in the "Mined Rock and Overburden Piles Investigation and Design Manual" (BC Mine Waste Rock Pile Research Committee 1991) and are provided in Table 3-9. Table 3-9 presents ranges of minimum design values reflecting different levels of confidence in understanding site conditions, material parameters and consequences of instability.

Table 3-9 BC Mined Rock and Overburden Pile Minimum Factor of Safety Guidelines

Stability Condition	Suggested Minimum Design Values for FOS	
	Case A	Case B
Stability of Dump Surface		
Short-term (during construction)	1.0	1.0
Long-term (reclamation – abandonment)	1.2	1.1
Overall Stability (Deep Seated Stability)		
Short-term (static)	1.3 – 1.5	1.1 – 1.3
Long-term (static)	1.5	1.3
Pseudo-static (earthquake)	1.1 – 1.3	1.0
Case A • Low level of confidence in critical analysis parameters • Possibly unconservative interpretation of conditions or assumptions • Severe consequence of failure • Simplified stability analysis method (charts, simplified method of slices, etc…) • Stability analysis method poorly simulates physical conditions • Poor understanding of potential failure mechanism(s)		
Case B • High level of confidence in critical analysis parameters • Conservative interpretation of conditions, assumptions • Minimal consequence of failure • Rigorous stability analysis method • Stability analysis method simulates physical conditions well • High level of confidence in critical failure mechanism(s)		

3.3.2.1 Main Waste Dump and Expansion

The Main Waste Dump is located west of the Main Pit and has served as a combined waste and overburden dump since 2007. Previous operation of the Main Waste Dump included disposal of waste from the Main Pit, disposed of in lifts. The Main Waste Dump is constructed on solid rock and no physical stability issues have been observed to date (SRK 2013).

The Main Waste Dump Expansion, which includes the placement of additional mine waste on the northwestern portion of the existing Main Waste Dump and further expansion to the footprint to the northwest, was designed by SRK. A brief summary of the design criteria is provided here and the full design report "Phase V/VI Main Waste Dump – Physical Stability Assessment, 2013".

Case B (as listed in Table 3.9) is considered appropriate for the Main Waste Dump Expansion and was used to guide the analyses. Sensitivity analyses we completed to gain further understanding of the critical stability parameters and to confirm the suitability of the Case B design criteria.

For pseudo-static (earthquake) analyses, BC Mine Waste Rock Pile Research Committee (1991) specifies peak ground accelerations with a 10% probability of exceedance in 50 years. The peak ground acceleration of 0.057 g was used in this analysis.

Southwest Waste DumpThe Southwest Waste Dump was designed by EBA. A brief summary of the design criteria is provided here.

The above listed report states the predicted minimum factor of safety for the dump under static stability as 1.36. Under pseudostatic (earthquake) cases, the minimum predicted factor of safety was 1.14.

3.3.2.2 Main Pit Dump

The Main Pit Dump was designed by SRK. A brief summary of the design criteria is provided here and the full design report "Phase V/VI Main Pit Dump Physical Stability Assessment" (SRK 2013)".

Case B (as listed in Table 3.9) is considered appropriate for the Main Pit Dump and its design criteria were used to guide the analyses. This determination was based on the following two conditions: notable geotechnical characterization studies have been completed around the Main Pit south wall area and the dump will be constructed wholly within the mined out Main Pit. Sensitivity analyses were completed to gain a further understanding of the critical stability parameters, and confirmed the suitability of the Case B design criteria.

For pseudo-static (earthquake) analyses, BC Mine Waste Rock Pile Research Committee (1991) specifies peak ground accelerations with a 10% probability of exceedance in 50 years. The peak ground acceleration of 0.057 g was used in this analysis.

3.3.2.3 Ridgetop South and Area 118 Backfill Dumps

The Ridgetop South and Area 118 Backfill Dumps were designed by SRK. A brief summary of the design criteria is provided here and the full design report "Phase V/VI Ridgetop South and Area 118 Backfill Dumps: Physical Stability Assessment" (SRK 2013).

Case B (as listed in Table 3.9) is considered appropriate for the Ridgetop South and Area 18 Backfill Dumps, because these overburden backfill dumps will be constructed primarily within mined out pits. Sensitivity analyses were completed to gain a further understanding of the critical stability parameters, and confirmed the suitability of the Case B design criteria.

For pseudo-static (earthquake) analyses, BC Mine Waste Rock Pile Research Committee (1991) specifies peak ground accelerations with a 10% probability of exceedance in 50 years. The peak ground acceleration of 0.057 g was used in this analysis.

3.3.2.4 Ridgetop Waste Dump

The Ridgetop Waste Dump was designed by SRK. A brief summary of the design criteria is provided here and the full design report "Phase V/VI Ridgetop Waste Dump Physical Stability Assessment, 2013".

Case B (as listed in Table 3-9) is considered to be appropriate for the Ridgetop Waste Dump. Sensitivity analyses were completed to gain a further understanding of the critical stability parameters, and confirmed the suitability of the Case B design criteria.

For pseudo-static (earthquake) analyses, BC Mine Waste Rock Pile Research Committee (1991) specifies peak ground accelerations with a 10% probability of exceedance in 50 years. The peak ground acceleration of 0.057 g was used in this analysis.

3.3.2.5 Dry Stack Tailings Storage Facility

The Mill Valley Fill was placed to partially buttress the deep seated slope movements beneath the DSTSF. There are stakeholder concerns that ongoing sliding movements could impact the integrity of the DSTSF for reclamation and mine closure. These slope movements have been occurring in frozen ground below the DSTSF.

3.3.2.6 Mill Valley Fill Extension

The Mill Valley Fill Extension Stage 2 was designed by SRK Consulting. A brief summary of the design criteria is provided here and the full design report "Mill Valley Fill Extension Stage 2 Preliminary Design Report – Final" (SRK 2014) can be found under separate cover.

The primary purpose of the Mill Valley Fill Extension Stage 2 is to provide addition buttressing to the Drystack Tailings Storage Facility and resist the currently observed movement. In response to the current status of the Mill Valley Fill Extension Stage 1, an increase in the FOS values of 50% over the existing buttress was selected as an appropriate target for the current design.

Case A (as listed in Table 3-9) is considered to be appropriate for the Mill Valley Expansion Stage 2 because although numerous geotechnical characterization studies have been completed around the Mill Valley Fill Extension Stage 2 area, mass movement has been observed in this area.

For pseudo-static (earthquake) analyses, BC Mine Waste Rock Pile Research Committee (1991) specifies peak ground accelerations with a 10% probability of exceedance in 50 years. The peak ground acceleration of 0.057 g was used in this analysis.

3.3.3 Water Treatment Systems

Mine Feature	Capacity	Contaminants of Concern	Water Treatment	Discharge	Receiving Body
Water Treatment Plant - basic	4,000 **m^3**/day	copper	Lamella clarifier unit, removes TSS, total metals and dissolved copper	n/a	Upper Minto Creek
Water Treatment Plant - RO	2,500m3/day x 2	Nitrate, selenium	Reverse Osmosis	RO permeate (75% of the feedwater), brine stream (25% of the feedwater)	RO permeate: Main Pit, WSP, Minto Creek, A2PTMF Brine stream: MPTMF, A2PTMF

3.3.4 Closure Criteria for Overburden and Waste Rock Dumps

Objectives

(TECHNICAL GUIDELINES • MINE SITE RECLAMATION AND CLOSURE POLICY, YG)

Reclaimed rock piles and dumps must be physically and chemically stable in the long term to prevent erosion, subsidence or collapse, and such that dump runoff and surface drainage meet legal requirements.

Specific Closure Goals:

- Ensure long-term physical stability to minimize erosion, subsidence or slope failure;
- Able to withstand severe climactic and seismic events; and
- Ensure long-term chemical stability such that runoff and seepage quality meets water quality criteria.

Closure Measures:

- New waste rock storage areas designed with maximum of 3:1 slope angles to minimize long term erosion concerns;
- Placement of waste covers to reduce infiltration, encourage vegetation growth and minimize erosion; and
- Provide source control measures – operational waste handling and waste covers in combination with passive treatment systems as reasonable and practical to yield water quality acceptable for discharge.

4 ENVIRONMENT DESCRIPTION

4.1 SITE OVERVIEW

The Minto Mine is located on the west side of the Yukon River, approximately 240 km northwest of Whitehorse, Yukon (Figure 4-1) and is centered at 62°370020032'N latitude and 137°15'W longitude (NAD 83, UTM Zone 8 coordinates 6945000N, 384000E). 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.

A summary the environmental conditions are summarized in the table below.

Table 4-1 Summary of Environmental Conditions in the

Project Area Attribute Description	Project Area Attribute Description
Region:	Yukon
Topographic map sheet:	NTS 115 I/10, 115 I/11
Geographic location name code:	Minto Project
Latitude:	62° 36' N
Longitude:	137° 15' W
Drainage region:	Yukon River
Watersheds:	Yukon River, Big Creek, Wolverine Creek, Dark Creek, McGinty Creek, and Minto Creek.
Ecoregion:	Yukon Plateau (Central) - Pelly River ecoregion.
Study area elevation:	Rolling hills above mine site at 1131 to 600 m at the Yukon River Valley bottom.
Site climate:	Temperature ranges from –43.2°C (November 2006) to 30.3°C (July 2009). Mean annual temperature of –1.8°C. Mean annual rainfall is 174mm.
Vegetation communities:	Riparian, black spruce, white spruce, paper birch, lodgepole pine, buck brush/willow and ericaceous shrubs, feather moss, sedge, sagewort, grassland, mixed forest (aspen, balsam, and sub-alpine). Discontinuous permafrost is present on site. Site has been subject to recent forest fires.
Wildlife species:	Moose, caribou, Dall sheep, mule deer, grizzly and black bear, varying hare, beaver, lynx, marten, ermine, deer mouse, fox, mink, wolverine, least weasel, wolf, squirrel, porcupine coyote, muskrat, otter and wood frog. Bird species include: spruce, blue, ruffed, and sharp-tail grouse, waterfowl, raptors, and a variety of smaller birds.
Fish species:	In the Yukon River, 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 Big Creek, Chinook and chum salmon, Arctic grayling and whitefish species; In Wolverine Creek, Chinook salmon, Arctic grayling, and slimy sculpin; In Minto Creek (lower reaches only), Chinook salmon, slimy sculpin, round whitefish, Arctic grayling, longnose sucker, burbot; In McGinty Creek (lower reaches only), slimy sculpin, Arctic grayling

The Minto 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 (2,000 ft.). The highest elevation on the property is 975 m (3,200 ft.) above sea level, compared to lower elevations in the region with elevations of 460 m (1,500 ft.) along the Yukon River.

The Minto Mine is near the height of land with relatively gentle slopes and smooth ridges that often have spines of bedrock outcrops (tors) at their crests left from long periods of weathering. Broad ridges are typically mantled with felsenmeer (fields of angular, frost-heaved, in situ rock fragments). Below the ridge crests, bedrock exposures are limited or negligible. The Project area lies in a zone of extensive discontinuous (50–90%) permafrost and is included in the western portion of the Yukon plateau central ecozone. North-facing slopes in the area are commonly underlain by permafrost. Valley-bottom deposits and upland soils usually contain ice-rich horizons. Well-drained uplands may have permafrost-free soils.

As the ecoregion is largely unglaciated, the dominant parent materials are stony residual materials along ridge tops and summits, coarse colluvium on upper slopes, and silty colluvium and loess, rich in organic matter, on lower slopes and floors of main valleys. Muck is usually capped with peat and underlain by permafrost. In the Minto Mine area, much of the colluvium on ridge slopes is coarse sand derived from decomposition of the largely granitic bedrock in the area. Overburden of relic soils that predate the last glaciation includes lacustrine deposits overlain by colluvium and organic silt in some upper valleys, some of which was exposed during excavation on the south side of the pit.

The mine development area is in the transition from the forested to non-forested (alpine) zone. Below the treeline (elev. ~1,000 m) the vegetation patterns reflect the discontinuous distribution of permafrost with stunted black spruce woodlands on cold, north-facing sites and mixed (aspen, white spruce, minor birch) forests on warm, south-facing slopes. The area has been burned over by several wild fires, the latest of which was in 2010 (Minto Landing to lower Minto Creek area). Many of the burnt trees have blown down and natural regeneration of pine and alder is occurring over much of the property and the Project area.

The climate of the region is continental with short, warm summers and very cold winters. Annual precipitation ranges from 300 to 500 mm. Mean annual temperatures are near –5°C with mean mid-winter temperatures of –23°C to –32°C, in July from +10°C to +15°C and extremes in the lower valleys ranging from –60°C to +35°C.

The area is drained by tributaries of the Yukon River. The rate of runoff is controlled by almost total vegetation ground cover and moderate slope gradients. Infiltration rate is expected to be high in areas of thicker colluvium. However, permafrost and seasonally frozen soils inhibit vertical percolation.

Topography in the Dawson Range is moderate and the active geomorphological processes in the study area are typically limited to include slow mass movement (solifluction) and some minor gully erosion. Although there are no reports of large-scale active natural landslides in the Minto Project area, smaller scale instabilities have recently been documented in the Minto Creek catchment area, downstream of the mine site. Substantial sediment loading in lower Minto Creek in the absence of effluent discharge from the site was observed throughout the open water months of 2011 (Appendix D, Minto Creek Water Quality Characterization). This prompted a targeted water quality survey and an aerial investigation of the creek and tributaries in spring of 2012 in an attempt to identify the source(s) of the sediment. Two areas were identified in tributaries on the southern side of the Minto Creek catchment, below the area of control of the mine, where soil materials had slumped and transported a significant amount of material into the creek channel. Although ground investigations were not conducted, it is suspected that these instances may be related to thawing of frozen ground conditions, or may simply be small-scale instability of fine textured (lacustrine) soils.

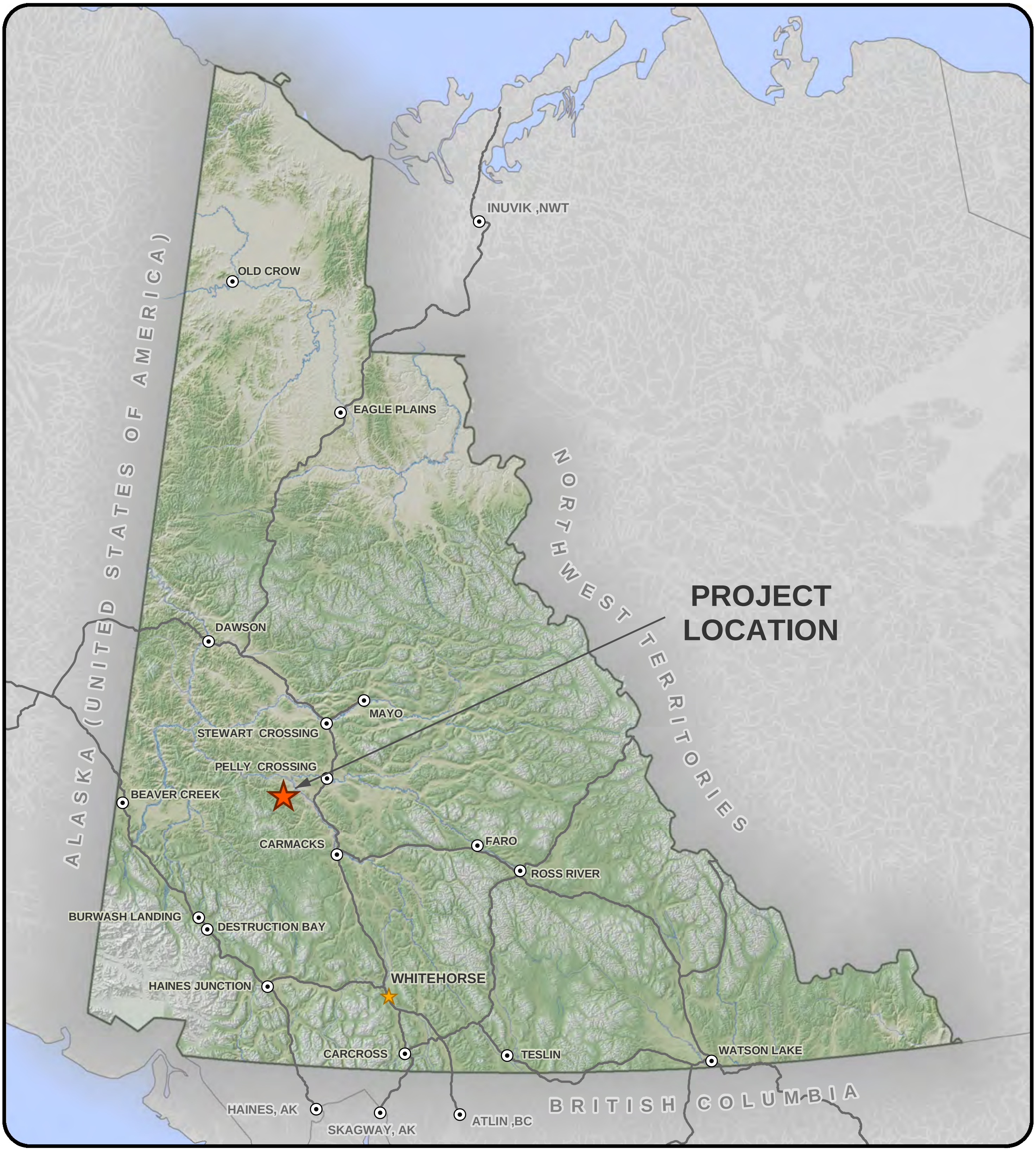

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FIGURE 4 -1

PROJECT LOCATION

4.2 METEOROLOGY

The existing meteorology of the Project area and the climate trends and projections of the Minto region of Yukon were described in detail in EBA's report Minto Mine – 2010 Climate Baseline Report and subsequently in ACG's Minto Climate Baseline Report (2012) (Appendix E). The meteorological data contained in the report was recorded by two on-site meteorological stations over a period of about seven years. Snow depth data was provided from ten annual on-site snow surveys since 1994. The data used in climate trend analyses was sourced from regional monthly and annual records provided by the Meteorological Service of Canada and applied to the Project area. Environment Canada's Coupled Global Climate Model (CGCM2) provided future temperature and precipitation scenarios for the purpose of climate forecasting for the region. Details of the data collection program and the procedures used for analysis are provided in the Climate Baseline Report in Appendix E.

4.2.1 General Regional Climate

The climate in the Minto region is subarctic continental characterized by long, cold winters and short, cool summers. The area experiences moderate precipitation in the form of rain and snow and a large range of temperatures on a yearly basis with a mean annual temperature below 0°C.

4.2.2 Summary of Meteorological Conditions (2005-2012)

Two meteorological stations installed at the property have recorded wind speed and direction, air temperature, relative humidity, barometric pressure, solar radiation and rainfall in one-hour intervals since September 7, 2005 for the HOBO and October 15, 2010 for the Campbell Scientific station.

4.2.3 Wind

Severe rime ice build-up on the HOBO anemometer cups has resulted in extended periods of recorded zero or diminished wind speeds during the winter (EBA 2010a). The Campbell Scientific anemometer has shown to be much less prone to icing. Based on the wind record from the two meteorological stations, and excluding periods where the anemometer was iced up, the two predominant wind directions at site are S to SE and N to NW. Average wind speed is 2.64 m/s at 3 m height and 2.9 m/s at 10 m.

4.2.4 Air Temperature

Summer is characterized by temperatures in the range of 10°C to 20°C. Winter is characterized by a much larger day-to-day variation in temperatures, typically between –10°C and –30°C. Diurnal variation in air temperatures tends to be less during the winter period than during the summer period. The transitions between winter and summer are characterized by a quick rise or fall in air temperatures. July has been the warmest month on average (14.6°C) while the coldest has been January (–19.1°C). The mean annual air temperature at the site is –1.8°C. The maximum air temperature ever recorded was 30.3°C. The minimum air temperature ever recorded was –43.2°C.

4.2.5 Relative Humidity

Relative humidity is highest during the winter months (typically in the range of 75% to 95%) and lowest during the spring and early summer, typically in the range of 40% to 60%. Relative humidity has a much larger day-to-day variability during the summer. The lowest recorded %RH was 10.25%. The highest was 100%. Annually, mean relative humidity is 71%.

4.2.6 Barometric Pressure

Barometric pressure recorded on-site at 885 m elevation has been converted into a meteorological standard sea level equivalent. Barometric pressure is slightly higher on average between May and September (above 1009 hPa), and lowest between October and April (below 1006 hPa), with the exception of February. Mean annual sea level equivalent barometric pressure is 1007.5 hPa.

4.2.7 Solar Incident Radiation

As would be expected at a latitude of 62.6°N, a strong seasonal pattern is evident in solar radiation, with a maximum being received near the summer solstice in late June (daily maximums on the order of 750 W/m^2), and daily maximums slightly above zero around the winter solstice. The average amount of solar radiation received at the site annually is 111 W/m^2. The highest daily average is received in June (230 W/m^2). The lowest is in December (5 W/m^2).

4.2.8 Precipitation

4.2.8.1 Rainfall

The tipping bucket rain gauge mechanism used to record precipitation at site is designed to record rainfall. However, wet snow falling into the catch tube and melting in the bucket at temperatures near 0°C would result in an instance of recorded precipitation. In order to provide an accurate estimate of total rainfall only, any recorded precipitation occurring when air temperatures were below zero was omitted from the record (EBA 2010). Based on a cumulative of average monthly rainfall, 174.2 mm of rain is expected on average at site in a single year (EBA 2010). August is the rainiest month with an average rainfall of 51.0 mm. The largest monthly rainfall total was 101.8 mm (July 2011). The largest one-day rainfall was 28.2 mm (August 25, 2008). Rainfall has been recorded in every month of the year.

4.2.8.2 Total Precipitation

On October 14, 2011, a snowfall conversion adaptor was installed on the tipping bucket of the Campbell Scientific station; however, the total precipitations record is not long enough yet to provide meaningful statistics. Environment Canada's Canadian Climate Normals (1971-2000) for Pelly Ranch indicate that on average, annual precipitation occurs 64% as rainfall and 36% as snow. With the assumption that regional precipitation is homogeneous and ignoring any significance of elevation, orographic effects or valley orientation, the Minto property can be estimated to receive an additional 100 mm of water-equivalent precipitation in the form of snow annually for a total annual precipitation of approximately 274 mm (EBA 2010).

4.2.8.3 Snowpack

Based on the ten years of snow surveys, the average water-equivalent snow depth remaining on the first day of March and April is 95.0 mm and 96.8 mm respectively. In four of the seven May surveys, the snowpack had melted entirely by May 1. In the three years where snow remained on the ground on May 1 (1995, 2006, and 2008), the mean snowpack had reduced to 10%, 27%, and 20%, respectively, of the peak measured snowpack in that year. The data indicates that the majority of runoff due to snowmelt occurs in April.

4.2.8.4 Evaporation

No evaporation data have been recorded at the Minto site. Applying Environment Canada's average daily evaporation estimates from Pelly Ranch over the period 1971–1999, corrected for elevation, suggests an annual evaporation rate at site on the order of 400 mm/year (EBA 2010). An instruction for evapotranspiration (ET) calculation was incorporated into the Campbell Scientific program and will provide ET estimates starting in July 2012.

4.2.9 Regional Climate Trends

4.2.9.1 Temperature

Past Trends

The annual mean temperature has been increasing at Pelly Ranch by 0.06°C per year on average over a 50-year period, corresponding to a total average increase of 3.0°C between 1957 and 2006. January (winter) mean temperatures have experienced the highest rate of increase (0.13°C per year on average), corresponding to a total average increase of 6.5°Cover the 50-year period. The mean annual temperature at Carmacks has been increasing by 0.06°C per year on average, corresponding to a total average increase of 3.0°C between 1964 and 2011. With respect to seasonality, January mean temperatures have been increasing by 0.19°C per year on average, corresponding to a total average increase of 9.3°C from 1964 to 2011. A close correlation between monthly average temperatures recorded at Minto and at Pelly ranch and Carmacks, as well as the proximity of the stations to the property, suggests that the 50-year trend would also be applicable to the Minto property. Winter temperatures at Minto however are approximately 3°C to 5°C higher due to a predominant Yukon winter temperature inversion of +8°C/ km up to an elevation of 1200 m (EBA 2010).

Future Trends

Using the average of five Global Climate Models that were found to perform best over Alaska and the Arctic, averages have been calculated using a 50 km buffer around the Minto Mine site, and suggest an increase in mean annual temperature of 2.0 to 2.2°C by 2030 and 2.6 to 3.8°C by 2050 from the 1961–1990 baseline.

4.2.9.2 Precipitation

Past Trends

Environment Canada monthly precipitation records at Pelly Ranch and Carmacks show a general increase in total annual precipitation over the last 60 years of 1.1 mm/year and 1.4 mm/year on average respectively, corresponding to an increase in annual precipitation between 1955 and 2006 of between 60 and 80 mm over the region (EBA 2010).

Future Trends

Many GCMs predict increasing mean annual precipitation at high latitudes of North America (Nohara et al. 2006). The Scenarios Network for Alaska and Arctic Planning projections suggest an increase in annual precipitation ranging from 8 to 13% by 2030 and 12 to 20% by 2050 from the 1961–1990 baseline.

4.3 SURFACE WATER HYDROLOGY

The baseline surface hydrology of the Minto Creek watershed prior to mining activity was detailed in Clearwater Consultants Ltd.'s Memorandum CCL-MC6 Minto Copper Project—Surface Water Hydrology Conditions (baseline memorandum attached as part of Appendix F). CCL-MC6 also covered conditions during mine operations until 2009. This CCL-MC6 report has been supplemented with onsite data collection from 2009 until the end of the 2012 open water season. Additionally since 2009, data has been gathered from the McGinty Creek catchment which is located directly north of the Minto Creek catchment. The McGinty Creek catchment is similar in size to Minto Creek, and it also drains into the Yukon River. An updated Surface Hydrology Baseline Conditions Report prepared by ACG (2013) is presented in Appendix F. Figure 4-2 shows the Minto and McGinty Creek hydrometric monitoring network and catchment areas.

Hydrological data have been gathered by either ACG or Minto representatives. Data coverage from year to year varies, depending on when in situ dataloggers were installed and removed, and when instantaneous discharge measurements were taken. Instantaneous discharge is measured using the velocity-area method and a current meter. Solinst Water Leveloggers are used to collect continuous stage readings which are then corrected based on physical staff gauge measurements. The records are processed into continuous discharge based on the stage-discharge relationship. This relationship (stage and discharge) is established each season through rating measurements obtained during regular field visits to the sites.

The locations for which the greatest amount of data have been collected are stations W1, Minto Creek near the mouth (catchment area of 42 km^2); and W3, Minto Creek downstream of water storage pond dam (catchment area of 10.4 km^2 area). In 2010, another continuously monitored hydrometric site called MC1 was added, approximately 2 km upstream of W1. In 2011, data collection did not allow for processing of stage records into continuous discharge; however, improved monitoring allowed for successful processing in 2012.

In addition to Minto Creek, the catchment to the north has been monitored since 2009 to support development of the Minto North deposit, and is referred to as McGinty Creek. There are five stations on McGinty Creek at which discharge is measured. In 2009, four stations were established including MN-4.5, MN-2.5, MN-1.5 and MN-0.5; in 2011 a fifth site, MN-0.2, was added (Figure 4-2). Continuous hydrometric data has been collected at MN-4.5 since 2009, and additional continuous logging instruments were added to stations MN-2.5 and MN-0.5 in late 2012.

All mining to date has taken place within the Minto Creek catchment area. Phase V/VI will include the development of the Minto North Pit, which is in the McGinty Creek catchment area. McGinty Creek was named by SFN elders after the family whose traditional trapping area is in the vicinity of the Minto Mine.

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FIGURE 4 - 2

MINTO AND MCGINTY CREEK HYDROMETRIC MONITORING NETWORK AND CATCHMENT AREAS

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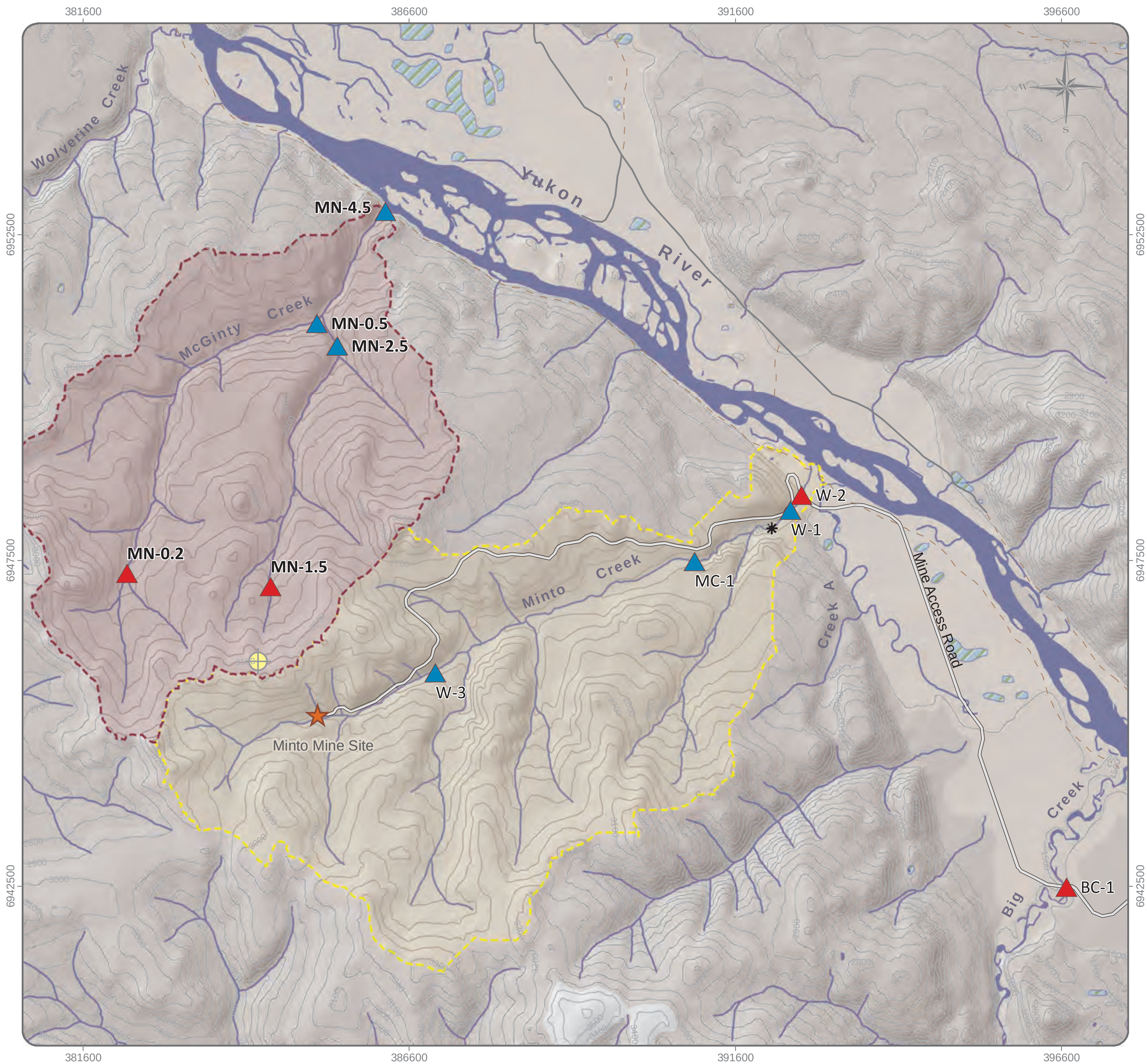

- Water Quality Station
- Hydrometric Station
- Obeserved Fish Barrier - Minto Creek
- Minto North Deposit
- Minto Access Road
- Limited-use road
- Trail
- Contours (ft)
- Watercourse
- Minto Creek Catchment
- McGinty Creek Catchment
- Waterbody
- Wetland

1:80,000 *when printed on 8.5 x 11 inch paper*

0 1 2 3 km

ACCESS

NAD 83 UTM Zone 8N

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4.3.1 Minto Creek

Monitoring of hydrological parameters on Minto Creek began in 1993 and has continued intermittently at sites W1 and W3 (Figure 4-2). Monitoring has been more intensive since mine commissioning in 2007. W3 is an in-stream trapezoidal flume with a manufacturer-specified stage-discharge relationship. Both discharge and stage are read on an integrated gauge in the throat of the flume. A Solinst Levelogger record is calibrated with these field observations to process a continuous discharge record at this site. Sites MC1 and W1 are natural stream channels where manual velocity measurements are taken across the channel and discharge is calculated using the velocity area method. Continuous water levels from Solinst Leveloggers are processed into continuous discharge using these rating measurements. Updated mean monthly flows for W1 and W3 are presented in Table 4-2 and Table 4-3, respectively.

Table 4-2 Mean Monthly[1] Discharge (m^3/s) on Minto Creek at Station W1

	April	May	June	July	August	Septembe r	October
1993						0.069	
1994		0.312	0.058	0.095	0.007	0.073	
1995		0.027	0.001	0.091		0.133	
1996		0.031	0.024	0.324		0.146	
1997		1.447			0.265		
1998		0.161			0.003		
1999					0.033		
2000		1.004					
2001		0.467					
2002							
2003					0.129		
2004				0.118			
2005		0.097	0.012	0.127	0.209	0.219	0.134
2006	0.203	0.354	0.15	0.02	0.0068		0.031
2007	0.645	0.175	0.053	0.061	0.025	0.034	0.035
2008		0.117	0.015	0.026	0.184	0.184	0.026
2009		0.868	0.351	0.249	0.139	0.026	
2010	0.560	0.081	0.038	0.106	0.118	0.125	0.092
2011			0.229	0.200	0.200	0.082	
2012		0.174	0.071	0.048	0.048	0.077	0.066
Mean							
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

[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.

Table 4-3 Mean Monthly Discharge (m^3/s) on Minto Creek at Station W3

	April	May	June	July	August	September	October
1993						0.028	
1994		0.101	0.028	0.039	0.011	0.028	
1995			0.0035	0.017		0.027	0.008
1996		0.013		0.087		0.021	
1997		0.554					
1998					0.006		
1999					0.006		
2000							
2001		0.16					
2002							
2003					0.037		
2004				0.026			
2005		0.046	0.008	0.014	0.017	0.022	0.02
2006	0.018	0.128	0.042	0.006	0.0149	0.0093	0.01
2007	0.0012	0.0118	0.0088	0.0062			
2008					0.064	0.122	0.003
2009			0.026	0.106	0.092	0.124	0.11
2010	0.002	0.004	0.005	0.034	0.071	0.086	0.070
2011			0.005	0.005	0.006	0.005	
2012	0.004	0.020	0.003	0.004	0.004	0.004	0.004
Mean							
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.*

Table 4-4 shows the discharge data gathered to date at station MC1. Appendix F contains the associated baseline report and the available hydrographs from 2007-2012 for stations W1, W3, and MC1.

Table 4-4 Instantaneous (2011) and Mean Monthly Discharge (2012) (m^3/s) Measured on Minto Creek at Station MC1

	Month					
	May	June	July	August	September	October
2011[1]					0.118	0.093
2012	0.153	0.059	0.048	0.038	0.096	

[1] *2011 data based on two spot flows in September and four in October.*

4.3.2 McGinty Creek

Instantaneous discharge readings gathered on McGinty Creek since 2009 are included in McGinty Creek Water Quality Characterization (Appendix G). These values have been averaged to show the mean discrete discharge measured during a given month. Caution should be exercised in using these to represent the actual mean monthly discharge. Comparison of the mean discrete flows for MN-4.5 to the mean monthly flows calculated from the continuous discharge show that the mean discrete measurements are generally higher. Dataloggers were installed at MN-2.5 and MN-0.5 late in the season in 2012; no continuous data are available at this time. Review of future continuous discharge records at these sites will provide better accounting of surface flows for McGinty Creek.

Table 4-5 Mean Discrete Discharge (m^3/s) measured on McGinty Creek, at station MN4.5

	Month						
	April	May	June	July	August	September	October
MN-4.5	0.447	0.347	0.152	0.192	0.162	0.067	0.016
MN-2.5		0.161	0.043	0.070	0.050	0.018	0.010
MN-1.5	0.024	0.027	0.015	0.016	0.012	0.005	0.008
MN-0.5		0.216	0.097	0.116	0.111	0.054	0.016

Table 4-6 Mean Monthly Discharge (m^3/s) Calculated from Continuous Discharge Records on McGinty Creek, at Station MN 4.5

	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

Hydrographs from 2009–2012 at MN-4.5 are shown in the corresponding baseline study (Appendix F). Based on a combination of spot flow measurements and the hydrographs, it appears that maximum monthly discharge on McGinty Creek occurs in May. These data points suggest a later peak runoff on McGinty Creek than on Minto Creek; this could arise from McGinty Creek having a more northerly exposure and a resultant delayed snowmelt. However, April discharge needs to be more thoroughly documented to determine the timing of McGinty Creek's maximum monthly discharge.

4.4 SURFACE WATER QUALITY

Surface water quality is a key consideration in the evaluation of potential effects of mining and mineral development projects. Effects from mining activities can be observed for significant distances downstream and changes to water quality parameters have the potential to impact aquatic resources and to affect human use of water resources. Both Minto and McGinty Creeks have been monitored for water quality conditions, with more intensity and duration of sampling in Minto Creek as part of the initial baseline and more recently the intensive operational monitoring under the mine water quality monitoring programs (licenced and otherwise). Characterization reports for water quality in these two watersheds have been developed with the intention of presenting either baseline or existing water quality conditions as the foundation of assessing potential effects from proposed mine expansion activities. These characterization reports are included as Appendix D and Appendix G Key findings from the characterization reports are included below.

4.4.1 Minto Creek

The characterization of Minto Creek water quality includes January 2005 to December 2012 monitoring data (this was the temporal scope of data presented for the Phase V/VI YESAB Project Proposal). Minto Creek water quality data has been reviewed and characterized for key water quality monitoring stations for the pre-mine operation phase and for the operational phase (during both periods of mine effluent discharge to Minto Creek and without mine effluent discharge). A background water quality data set was also redeveloped with the addition of new appropriate data (using data collected up to December 2013) to a previous data set prepared by Minnow Environmental (Minnow 2009).

4.4.1.1 Background Water Quality

In 2009, to support the redevelopment of the mine WMP, Minnow Environmental compiled Minto Creek water quality monitoring data into a pooled data set that reflected background (unimpacted by development activities) conditions. This data set was screened against the CWQG to determine a rate of exceedance. An exceedance rate of >10% triggered the development of a site-specific water quality objective (SSWQO). SSQWOs were calculated for the following parameters: aluminum, chromium, copper, and iron. These SSWQOs were intended to be used as comparative metrics for ongoing water quality monitoring, for parameters that are naturally elevated above the generic CWQGs. Together, these water quality objectives (WQOs) provide a useful tool for evaluating changes in water quality, and to provide an indication of potential effect thresholds.

The mine water-quality monitoring program has continued to monitor stations within the operational area, downstream stations which are exposed to the influence of mine effluent discharge, and downstream stations which are not exposed to effluent. Data from these non-exposed stations are considered to be relevant the background water quality condition in Minto Creek, and were therefore added to the pre-existing 2009 background data set. New background data sets were developed for periods up to the end of 2010 and to the end of 2012. A comparison of the summary statistics of these two data sets shows the substantial change in background water quality in Minto Creek in 2011 and 2012 without the influence of any site effluent discharge (see discussion below).

4.4.1.2 Downstream Water Quality (Station W2)

Generally speaking, during the pre-mine operation phase, aluminum, cadmium, chromium, copper, and iron concentrations showed exceedances of the CWQGs. These natural elevations were primarily associated with natural mineralization and/or elevated TSS concentrations. A much more robust data set exists for the operations with no discharge phase which also showed exceedances of the CWQGs for the same parameters as during pre-operations: aluminum, cadmium, chromium, copper, and iron.

In 2011 TSS levels in lower Minto Creek were observed to increase at stations MC1 and W2, the source of which has since been identified as a substantial natural release of soil materials into a tributary of the Minto Creek watershed (downstream of the mine.) This had a leveraging effect upon metal concentrations, increases of which have also been observed in the lower stations of Minto Creek.

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; and,
- The total phosphorus limit is exceeded for most of the samples.

These comparative results illustrate the propensity for water quality in lower Minto Creek to exceed the W2 water use licence standards frequently, in mine non-discharge periods.

4.4.2 McGinty Creek

Water quality data for McGinty Creek has accumulated at five stations over the course of more than three years of monthly monitoring since May 2009, as conditions allowed. Activities to date within the upper watershed consisted of exploration drilling in the vicinity of the Minto North deposit in 2008 and early 2009 (all predating the water quality monitoring activities).

Parameters that show regular exceedances of the CWQG include total aluminum, cadmium, chromium, copper, iron, lead, zinc, and fluoride. Parameters that have been shown to infrequently exceed 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 with spikes in TSS and can be attributed to corresponding heavy precipitation events. When TSS concentrations are elevated due to heavy rains or freshet runoff, it is not uncommon for TSS-associated metals to be elevated as well.

Concentrations are typically highest at station MN-1.5. Parameter concentrations appear lowest in the winter, rising again in the spring with peak levels recorded in July and August during precipitation/runoff events. A set of WQOs was developed for McGinty Creek (using the entire McGinty Creek monitoring data set to identify SSWQOs, and the CWQGs where they were not routinely exceeded.) The WQOs are utilized as a screening tool in section 8 where they are compared with predictive water quality modeling for the McGinty Creek catchment. The summary statistics for the water quality data set also provided for the appropriate development of an 'unimpacted' source term for the water quality modeling work.

4.5 GROUNDWATER

In August 2010, SRK produced a Groundwater Baseline Conditions report for the Minto Mine area. The 2010 report included an assessment of data collected from groundwater wells in the area and resulted in a conceptual model of the groundwater flow system and its interaction with receiving surface water bodies. A monitoring program was devised and subsequently upgraded to monitor any effects on groundwater quality and quantity as the Phase IV mine plan was carried out. In 2013, an updated Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report was provided by SRK (Appendix H).

SRK used drilling information and piezometer installation information to inform the conceptual model and help determine appropriate locations for the multi-layer wells that were installed in 2009 and 2012. These wells were installed downgradient of the waste rock and overburden dumps, Main pit, Minto North and the DSTSF.

Generally, the groundwater chemistry was observed to be similar to the surface water mean annual concentrations (significantly less than 1 order of magnitude) (Groundwater Baseline Conditions report, SRK 2010, Appendix I).

Groundwater flow is dominated by topography and most will be confined below the permafrost layer where it occurs. Minor seasonal shallow subsurface flow will occur above the permafrost in those areas. It is believed that flows both above and below site permafrost ultimately reports to Minto Creek. The site is broken down into sub areas and flow regimes are described in detail within the 2013 Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report (in Appendix H). At Minto, groundwater flow direction is likewise dominated by topography, with groundwater flowing from the upland areas towards Minto Creek.

The flow regime at Minto Mine is a relatively simple groundwater system, but the system has some components that are difficult to characterize. With the exception of Minto North Pit, the entire mine footprint exists in a single catchment with Minto Creek as its main channel of surface discharge. However, permafrost distribution is not comprehensively known as it is discontinuous and is undoubtedly affected by mining, which results in changes in the location of permafrost boundaries over time. As permafrost creates an aquiclude (groundwater barrier), precise groundwater flow paths are challenging to determine or incorporate into a numerical model. Because the system has a main drainage location (Minto Creek), groundwater can be monitored at multiple points along the gradient, thus providing the opportunity to track possible effects on groundwater (SRK, 2014).

Another factor that could significantly affect the groundwater flow regime is the fractured bedrock. Fractures in the bedrock have the potential to act as conduits for groundwater flow if they are well connected and are not blocked by low permeability materials such as clay. This factor is also difficult to characterize in a numerical groundwater model, even if extensive data is available. However, observations of drill core indicate that the bedrock generally has tight fractures or fractures filled with weathered material including clay and hematite (SRK, 2014).

The proposed Minto North Pit is part of the McGinty Creek watershed (Figure 4-2). The catchment containing the pit has an area of approximately 100 ha, and is located in the upper portion of the east tributary of McGinty Creek. Minto North Pit is the only component of the proposed mine expansion within this catchment. Throughout pit operations, the pit sump water will be pumped into the Minto Creek watershed and managed with all other mine water; this pumping will result in a short term depression of the local water table. After pit operations are complete, it is expected that groundwater and local surface runoff will accumulate in the pit resulting in the groundwater table rebounding to near the pre-mining elevation (907 to 896 m above sea level) (SRK, 2014).

Hydraulic conductivity data have been collected during two studies at Minto Mine. The first tests were a series of packer injection tests conducted by Golder Associates as part of the initial mine feasibility studies (Golder 1974). In the second study, rising head tests were completed as part of the multi-port (MP) monitoring well installation program in the fall of 2012 (SRK 2013b).

The bulk hydraulic conductivity for different bedrock and overburden characteristics is presented in Table 4-7. These represent the best estimate of hydraulic conductivity for each of the rock categories on site. These values were obtained by averaging all available tests for a given rock condition and they seem reasonable, based on observations of pit wall rock, drill core, typical literature values, and experience elsewhere.

Of note is the observation that the "fresh jointed" rock does not exhibit increased hydraulic conductivity when compared to all other rock categories. This implies that the jointing is not well connected through the rock mass (i.e., the fractures do not interlink to provide a flow path). Therefore, it appears that rock on site is consistently low K with a low probability of extensive higher K zones that could transmit significant water flux.

Table 4-7 Assumed Bulk Hydraulic Conductivity Value

Rock Condition	Hydraulic Conductivity (m/s)
Overburden & Highly Weathered Bedrock	2×10^{-07}
Moderately Weathered Bedrock	6×10^{-08}
Non-Weathered Bedrock	8×10^{-08}
Fault Zone	5×10^{-09}

The site is broken down into sub areas and flow regimes are described in detail within the 2013 Minto Mine Phase V/VI Expansion: Hydrogeological Characterization Report (Appendix H). Groundwater will flow from the ridges on both sides and surface along the Minto Creek valley (Section A, Appendix H). On the south slope, groundwater will have minor seasonal suprapermafrost flow, and deeper water will be confined until it reaches the valley where it will then report to the creek. From the ridge near the airstrip, groundwater travels sub-permafrost beneath the DSTSF and to the Minto Creek valley (Section B). This slope contains permafrost, with seasonal flow through the active layer towards the valley. From the west, shallow groundwater will flow through and beneath the SWD, with the permafrost confining deeper water (Section C). Shallow groundwater will only flow through the active layer of the overburden before reporting to surface channels. Groundwater will flow down gradient from the east ridge to the valley, also directed to either shallow soils in the active layer or confined below the permafrost. The Minto North Pit will fill with surface and groundwater inflows to a static water level that is expected to approximate pre-mining groundwater levels (Section F). Groundwater will flow from the ridge top down gradient into the McGinty Creek watershed.

Generally, the groundwater chemistry was observed to be similar to the surface water mean annual concentrations (significantly less than 1 order of magnitude) (Groundwater Baseline Conditions report, SRK 2010, Appendix I).

4.6 Wildlife

Wildlife assessments were completed within, or near, the Project area between 1994 and 2012. These assessments are summarized in ACG's Summary of Wildlife Baseline Surveys Conducted 1994–2012 (Appendix J).

The completed assessments mainly focused on moose (Alces alces), Dall's sheep (Ovis dalli), caribou (Rangifer tarandus dalli), and raptors. Other wildlife observations and sign (tracks, scat, browse, etc.) were also recorded during these surveys. The existing conditions for wildlife at the Minto Mine are summarized in Table 4-8. (EBA 2010), which lists the wildlife surveys and studies conducted since 1994 in the Minto Mine area.

Table 4-8 Wildlife Surveys and Studies Undertaken in the Minto Mine Project Area

Dates	Type of Survey	Conducted By
January–March 2012	Late Winter Ungulate Studies	EDI, Environment Yukon
Fall 2012	Klaza Caribou Herd Study	Environment Yukon
March 2011	Late Winter Ungulate Study	EDI, Environment Yukon on behalf of Casino Mining Corporation
July 2010	Baseline Ecosystems and Vegetation Report*	Access Consulting Group
March 2010	Minto Mine Environmental Baseline Ecosystems and Vegetation Report	EBA Engineering Consultants Ltd.
February 2010	Late Winter Moose (Aerial)	Access Consulting Group
December 2010	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.

*The 2010 Baseline Ecosystems and Vegetation Study (ACG 2010a) was not focused primarily on wildlife; however, general wildlife observations were made during the vegetation survey and were recorded on plot data sheets. This ground-based survey provided information regarding the presence of smaller animals as well as larger mammals that can be more easily seen by aerial surveys.

Since the last wildlife baseline studies inventory (EBA 2010a), there have been three YG-led wildlife studies conducted that included the Minto site and vicinity. Two of these were late-winter ungulate surveys performed in 2011 and 2012. The survey area encompassed the Carmacks West moose management unit and the Klaza caribou herd range, for a total area of 6,430 km^2. In January 2013, ACG contacted the Mayo Regional Biologist, Mark O'Donoghue, for further information on these studies. Mr. O'Donoghue provided the following bulleted summary (via email) regarding recent ungulate surveys in the Project area:

- A late-winter distribution survey of moose and caribou in March 2011 covering a very large area west and south of the Yukon River (south to about the Nansen Road, west to about the Klotassin River, so covering the Minto Mine area). This was repeated by EDI in March 2012;
- A survey of sheep along the Yukon River from Minto to Fort Selkirk in June 2011 and June 2012—these have been done since 2000;

- A census of Klaza caribou in October 2012 (which followed a composition survey in September). This was done in alpine areas to the west and southwest of the mine;
- A survey to map lambing range of sheep and alpine raptor nests in the Dawson Range in May 2012, to the west and southwest of the Minto Mine. This was only partially completed because of poor weather and we are aiming to complete it in 2013 so there's no survey report yet. This survey was well to the west and southwest of the mine site, though"; and
- The sheep survey referenced is attached in Appendix J which includes a figure of the surveyed area. Other surveys were not officially available as of March 2013.

4.6.1 Moose

The following sections summarize the existing information on moose in the Project area.

4.6.1.1 2007 Early-Winter Moose Survey

The early-winter 2007 moose survey for the Carmacks West Moose Management Unit was conducted by YDOE. The following information has been summarized from O'Donoghue et al. (2008).

This survey was conducted in a much larger study area than the surveys conducted by ACG during the winter of 2009/2010, which were specifically focused on the area surrounding the Minto Mine site. However, the densities should be comparable as they are similar habitat types and YG's survey included the study area of the ACG 2010 surveys. The total survey area within this management unit is 4,206 km^2, of which 4,081 km^2 was considered to be suitable moose habitat. A stratified sampling approach was used for this survey, in which the survey area is covered by a grid and each square within the grid is classified as to contain high quality moose habitat or low quality moose habitat (methods as per Kellie and DeLong 2006).

During this survey, a total of 208 moose were observed, with a total population estimate of 520 moose for the study area. The calculated moose density of 124 moose per 1,000 km^2 is considered low. Average moose densities for Yukon are 150 to 249 per 1,000 km^2 (EDI 2011). From the survey data, biologists estimated a ratio of 21 calves and 10 yearlings per 100 cows; this suggests that the survival rate for the previous two years was relatively low. The sex ratio of 75 bulls per 100 cows is considered to be a healthy sex ratio. The average sex ratio for other areas surveyed within Yukon is 68 bulls per 100 cows.

4.6.1.2 Aerial Moose Survey - Winter 2009/2010

Aerial moose surveys were completed on December 15, 2009 (post-rut) and February 23, 2010 (late-winter) by ACG (2010). For both of these surveys, the study area included the Minto and McGinty creek drainages (3 in ACG's Summary of Wildlife Baseline Surveys Conducted (2012) (Appendix J)). Results of the 2009 and 2010 moose surveys are presented in Table 4-9. More detailed information for these surveys can be found in the ACG 2010 report.

Assuming a 600 m visibility on both sides of the helicopter, the total area surveyed was 112 km^2. Using this survey area, the moose density for the post-rut survey was estimated to be approximately 125 moose per 1,000 km^2, which is nearly the same density found in the 2007 early-spring aerial survey conducted by YG. The calf-to-cow ratio estimated from this data was 25 calves and no sub-adults for every 100 adult cows, and the estimated adult sex ratio was 50 mature bulls for 100 cows, which is low and could be a factor in the low recruitment ratio.

For the late-winter survey, estimated densities were approximately 45 moose per 1,000 km^2. The yearling to cow ratio was 1:1 sub-adults to cows, and no calves were observed during this survey. The estimated adult sex ratio was 300 mature bulls for 100 cows. The difference in this ratio from the YG survey result could be attributed to a small survey area, low number of observations and lack of visual confirmation of gender. It should be noted that on seven occasions during this survey fresh tracks were observed without an associated moose observation.

Table 4-9 Summary of Moose Observations During the 2009 and 2010 Winter Surveys

Survey	Total	Adult Male	Adult Female	Sub-adult	Calf	Unknown
Post-rut survey December 15, 2009	14	4	8	0	2	0
Late-winter survey February 23, 2010	5	3	1	1	0	0

4.6.2 Caribou

Two woodland caribou herds have the potential to occur within the Minto Mine area: the Klaza and Tatchun. Although neither range for these herds overlap with the Project area, caribou may still occasionally pass through, as documented by HKP during baseline surveys in 1994. No caribou were observed in the Project area during the 2009 and 2010 aerial surveys conducted by ACG.

4.6.2.1 Klaza Herd

In 2005, the Klaza herd population was estimated at 650 and predicted to increase (Yukon Environment 2005). There are concerns for this caribou herd, as the impacts of increased exploration projects and road development may combine to reduce their population. The herd's range is west of the Minto site. Because the area around the Minto Mine site has experienced numerous fires recently, the habitat is of minimal value for caribou, according to Troy Hegel of Environment Yukon, a caribou, sheep, & goat biologist (pers. comm.). A wildlife key area (WKA) for woodland caribou winter range was identified approximately 9 km west-northwest of the Project area (Yukon Environment 2010). Members of Klaza herd could travel through the site area occasionally and sightings should be recorded and reported. A recent fall (rut) count of the Klaza herd was conducted by Environment Yukon, Environmental Dynamics Inc. (EDI 2010a), and Little Salmon Carmacks First Nation members in 2012. The results of this study have yet to be released.

4.6.2.2 Tatchun Herd

The Tatchun Caribou herd's range is to the east of the Yukon River and does not overlap with the Minto Mine Project area. This caribou herd is small, heavily harvested, and should be managed carefully. In 2005, the population estimate for the Tatchun herd was 500 animals. A rutting season composition survey that focused on this range was conducted in 2007, and indicated that the count was much lower than in previous years. The reduced count could result from caribou congregating in areas such as tree cover, where they could not be detected (Yukon Environment 2007). Another count was conducted in the fall of 2012; results are still under analysis and the report is pending.

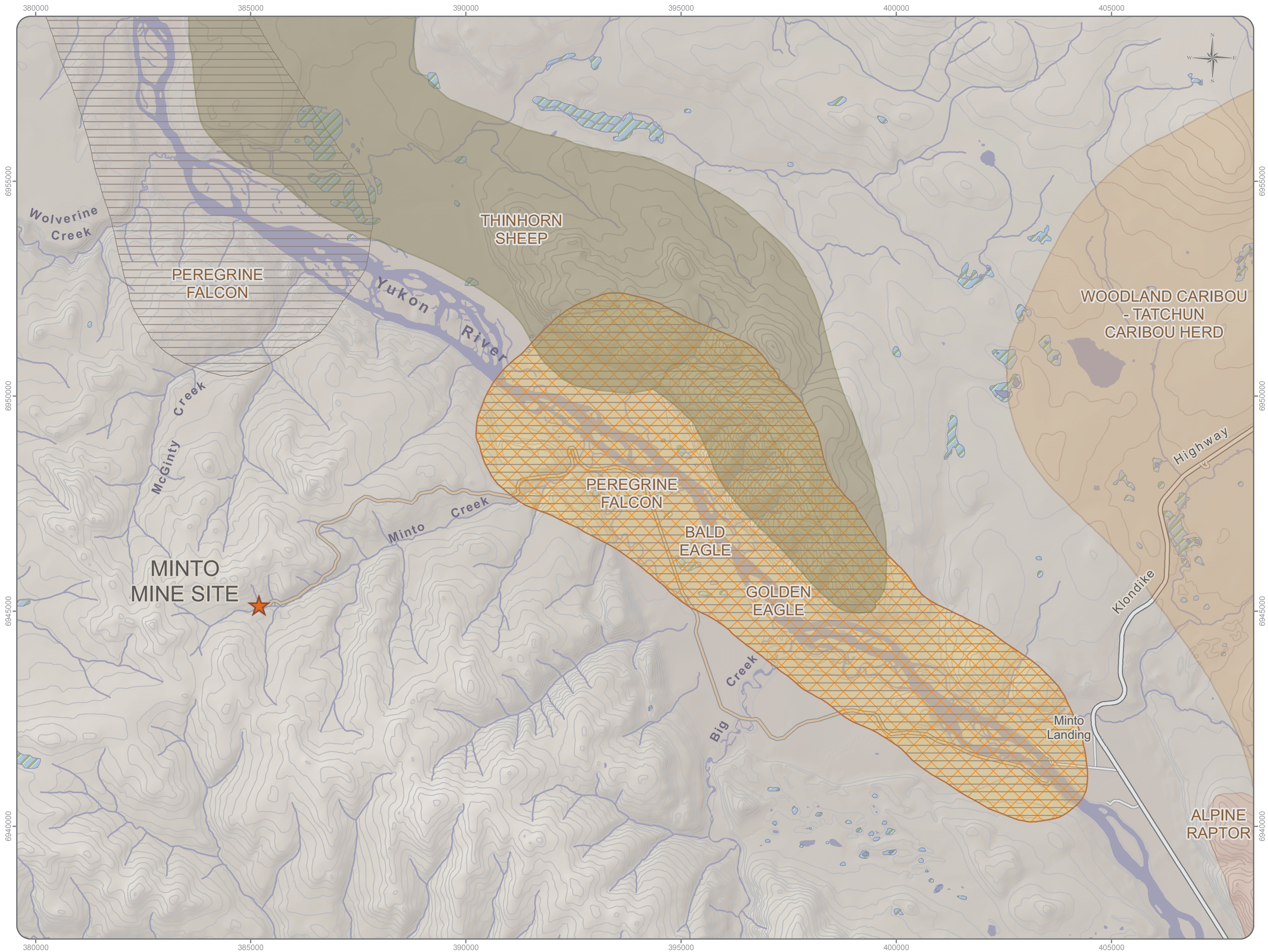
MINTO MINE
PHASE V/VI EXPANSION

RECLAMATION AND CLOSURE PLAN
REVISION 5.1

FIGURE 4 - 3

KEY WILDLIFE AREAS

AUGUST 2014



capstone
MINTO MINE

Minto Mine Site
Highway
Local Road
Mine Access Road
Contours
Waterbody
Wetland

Wildlife Key Areas

Bald Eagle
Peregrine Falcon
Alpine Raptor
Golden Eagle
Thinhorn Sheep
Woodland Caribou

1:85,000 when printed on 11 x 17 inch paper

0 0.5 1 2 3 Kilometers

ACCESS

Wildlife Key Area data compiled by the Yukon Department of Environment.
Publication Date: May 2009
Obtained from Geomatics Yukon.

Projection: NAD 83 UTM Zone 8N

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4.6.3 Sheep

Dall's sheep are known to inhabit the Project area, particularly the Minto Bluffs along the east side of Yukon River (O'Donoghue 2009). Although the access road to the Minto Mine passes near sheep habitat, sheep habitat within the project area itself is limited, and sheep are not expected to occur in the project area for any extended length of time.

Between 2000 and 2009, Yukon Department of Environment conducted annual sheep surveys within close proximity of the Minto Mine site. The survey area extends from the Minto Landing airstrip downstream (north) along the Yukon River to Fort Selkirk (O'Donoghue 2009). Surveys have also been conducted opportunistically by air (in 1989, 1991, 1994, and 2000) and by boat (2000–2009). Between 2000 and 2008, sheep surveys of the Minto–Pelly Bluffs resulted in the observations of between 31 and 91 sheep annually; with the majority of observations being ewes, yearlings, and lambs. During the 2009 survey, 97 sheep were observed, 34 of which were observed on the Minto Bluffs (which is located about 8 kilometres downstream of Minto, across the river from the Minto Mine site). This is the highest recorded population for this area. Most sheep observed during these surveys have been located on the Minto Bluffs, Split Mountain, and Mount Hansen (O'Donoghue 2009).

Aerial sheep surveys were conducted in 1994 as part of the wildlife baseline studies conducted prior to the start-up of Minto Mine. This survey focused on the cliffs on the northeast side of the Yukon River from Minto Landing. Unfortunately, data from this survey were not included in the final report. This report did indicate that sheep were observed, but location(s) were not mentioned.

4.6.4 Other Wildlife

Fur and big game harvest statistics indicate that the following species occur in the Minto project area: grizzly bear, black bear, coyote, gray wolf, red fox, wolverine, marten, least weasel, river otter, beaver, and lynx. Cougars may also have the potential to occur in the area as they are known to follow mule deer (Smith et al. 2004); however, the probability of an occurrence is considered to be low.

Of the species listed above, the following species or sign of the species have been observed, on site: grizzly bear, black bear, gray wolf, lynx, river otter (HKP 1994, Capstone 2007, Capstone 2008, ACG and Horizon Ecological Consultants 2010).

Small mammals common to the area include red squirrel, varying hare, fox, mink, weasel, vole, and shrew. The Minto Mine site is situated at the apex of five drainages that are part of the Yukon River watershed, so wildlife uses the area to access the valleys offering conduits from lowlands to highlands for seasonal foraging and hunting (ACG 2010).

A total of 13 raptor species (Summary of Wildlife Baseline Surveys Conducted (2012) (Appendix J)) have the potential to occur within the study area. Raptors may breed throughout the study area, with select areas attracting higher breeding densities (e.g., riparian zones) than other areas (e.g., pine stands). Species that have been observed and documented in the Project area include the red-tailed hawk (HKP 1994), peregrine falcon (Mossop, pers. comm. as cited in HKP 1994), and golden eagle. Only one aerial-based raptor survey was conducted as part of the Minto Mine baseline studies (HKP 1994).

High quality riparian cliff habitat for raptors exists along the Yukon River downstream of the Minto Mine access road. A WKA (wildlife key area) for golden eagle summer nesting habitat has been identified approximately 3 km to the east of the project area (Yukon Environment 2010b) (Figure 4-3). This WKA is primarily associated with the steep bluffs along the Yukon River and includes a buffer area. No cliff-nesting raptor habitat has been identified within the Project area itself. The access road to the Minto Mine, however, runs adjacent to potential nesting areas for cliff-nesting raptors, such as the golden eagle and peregrine falcon.

Game birds that have been observed or that have the potential to occur in the study area include grouse (spruce, ruffed, sharp-tailed) and ptarmigan (willow, white-tailed, and rock). Of the species of grouse that live in Yukon, the sharp-tailed grouse is currently the only species of management concern. Sharp-tailed grouse have a limited distribution in Yukon due to the lack of suitable habitat. Gravel outwashes with fairly stable aspen parkland habitat and wet sedge-hummock meadows after fire are considered suitable habitat for this species. Sharp-tailed grouse have been observed in the Project area.

4.6.5 Species at Risk

There are currently eleven wildlife species in Yukon rated as "threatened," "of conservation concern," or "of special concern" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2011). Ten of these species have ranges that could include the area around Minto Mine site. Species that have the potential to occur in the study area are listed in Table 4-10.

Table 4-10 List of Species at Risk in Yukon Considered Possible to Occur in the Study Area

Species	Status	Source
Birds		
Peregrine Falcon* (Falco peregrinus anatum - tundrius)	Special concern	COSEWIC (2007), Yukon Wildlife Act (2002)
Short Eared Owl* (Asio flammeus)	Special concern	COSEWIC (2008)
Common Nighthawk* (Chordeiles minor)	Threatened	COSEWIC (2007)
Olive-sided Fly Catcher* (Contopus cooperi)	Threatened	COSEWIC (2007)
Rusty Blackbird* (Euphagus carolinus)	Special concern	COSEWIC (2006)
Gyrfalcon (Falco rusticolus)	Specially protected	Yukon Wildlife Act (2002)
Trumpeter Swan (Cygnus buccinator)	Specially protected	Yukon Wildlife Act (2002)
Barn Swallow* (Hirundo rustica)	Threatened	COSEWIC (2011)
Bank Swallow* (*Riparia riparia*)	Conservation concern	Yukon Environment (2011)
Canada Warbler (Wilsonia canadensis)	Threatened	COSEWIC (2008)
Northern Shrike (Lanius excubitor)	Conservation concern	Yukon Environment (2011)
Mammals		
Wolverine* (Gulo gulo)	Special concern	COSEWIC (2004)
Grizzly Bear* (Ursus arctos)	Special concern	COSEWIC (2009)
Woodland Caribou* (Rangifer tarandus caribou)	Special concern	COSEWIC (2002), SARA (2002)
Mule Deer (Odocoileus hemionus)	Specially protected	Yukon Wildlife Act (2002)
Mountain Goat (Oreamnos americanus)	Conservation concern	Yukon Environment (2011)
Cougar (Puma concolor)	Specially protected	Yukon Wildlife Act (2002)
Collared Pika* (Ochotona collaris)	Special concern	COSEWIC (2011)
Little Brown Bat (*Myotis lucifugus)*	Endangered	COSEWIC (2012)

* *confirmed presence in the mine site vicinity*

4.7 AQUATIC RESOURCES

A complete report on Aquatic Resources is presented in the Aquatic Resources Baseline Report (ACG 2012) (Appendix K), which constitutes an update to EBA's 2010 report. A summary of the key findings of ACG's report is presented in the sections below.

4.7.1 Aquatic Systems Overview

The Minto Mine region includes the Yukon River and its smaller tributaries, including 7 km upstream to Big Creek and 13 km downstream to Wolverine Creek. The local study area related to the Minto Mine centres on three small drainages in the mine area that drain directly to the Yukon River: Minto Creek, Creek A, and McGinty Creek.

4.7.1.1 Minto Creek

Minto Creek, with its headwaters in the mine area, is the primary drainage affected by Phase V/VI. Minto Creek flows northeast from the existing mine site ~17 km to the Yukon River, and covers an approximate area of 41 km^2. The creek has five primary tributaries along its length, and flows through large tracts of land that have been recently influenced by forest fire. Water from the mine area flows into the upper reaches of Minto Creek through the water storage pond and other conveyances. Investigations into Minto Creek have found it to be generally shallow, ephemeral in nature, and to have frequent build-ups of layered ice during the winter (sometimes to the substrate).

4.7.1.2 Creek A

Creek A is a small watercourse that drains an area adjacent to the Minto Mine access road and the Yukon River. The headwaters of Creek A originate approximately 4 km southeast of Minto Creek and flow for 7 km along a riparian floodplain into the Yukon River. The drainage area of Creek A is traversed by the Minto Mine access road, including one direct watercourse crossing.

4.7.1.3 McGinty Creek

McGinty Creek (formerly referred to as Unnamed Creek B) is located to the north of Minto Creek and flows north-northeast for 9.5 km to the Yukon River confluence. Minto North Pit, which is to be mined as part of Phase V/VI, is located near McGinty Creek headwaters and within the McGinty Creek catchment area.

4.7.2 Fish and Fish Habitat

4.7.2.1 Regional Overview (Yukon River)

A variety of resident and migratory fish species inhabit the Yukon River near Minto Mine. These include Chinook, Coho and chum salmon, lake trout, least cisco, Bering cisco, round whitefish, lake whitefish, inconnu, Arctic grayling, northern pike, burbot, longnose sucker, and slimy sculpin.

Previous studies on the Yukon River within the vicinity of 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 Mine, near Big Creek. These offer an extensive network of side channels and sloughs which provide good spawning gravel.

This portion of the Yukon River also provides rearing habitat for Chinook salmon, as evidenced by past studies in the Project area. Juvenile Chinook salmon (JCS) generally spend up to 1.5 years feeding and growing in fresh water tributaries prior to out-migrating to the ocean, and feed or stage in various tributaries to the Yukon River during this slow out-migration. Usage of the Project area tributaries by JCS is outlined further below.

As outlined in Appendix K, Yukon River salmon runs have observed moderate variability over the last 50 years; however, there has been a general decrease in salmon returns over the last ten to fifteen years. Chinook returns began to drop markedly beginning in 1998, and poor runs are still observed to this time. Chum salmon returns demonstrated a marked reduction in 1997 through 2002, but have been demonstrating trends that are more positive for summer and fall since 2001 and 2003, respectively.

4.7.2.2 Local Fish Habitat Investigations

Minto Creek

Fish and fish habitat studies of Minto Creek have been ongoing for many years, with contemporary studies including those from 1994 through to 2012. A summary of effort and catches is presented in Table 4-11 while complete results can be found in Appendix K. Generally, Minto Creek has been noted to provide only limited habitat to fish. Flows within the stream are quite variable on a yearly basis, with intermittent flows and extensive ice build-up during winter that limits the potential for overwintering habitat for fish. Also, the distribution of fish within Minto Creek has been observed to be limited to the lower 1.5 km of the watercourse, as there is a barrier and steep canyon upstream of that location. As noted above, Chinook salmon, slimy sculpin, Arctic grayling, longnose sucker, burbot, and round whitefish have been captured in Minto Creek; however, the latter have not been observed since the original baseline studies in 1994. Slimy sculpin have been observed consistently, but at a low density.

During baseline studies, it was noted that trends in annual Chinook salmon occurrence in Minto Creek can be related to water temperature on a seasonal basis. During the early summer (e.g., May/June), the occurrence of JCS has been low, with individuals captured more frequently near the Yukon River confluence. Catches in July, August, and September have generally been higher; presumably, because out-migrating Chinook seek out non-natal tributaries as foraging habitat and cover. 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. In response to the observed high density of JCS in Minto Creek during these releases, a fish transfer program was initiated during the fall of 2009 and 2010 to prevent these fish being stranded by the onset of winter.

Creek A

Creek A was investigated during the 1994 baseline study program at the Project site, at which time no fish were observed or captured (including a site at the road-crossing location). Creek A is not considered to offer high quality habitat for fish.

McGinty Creek

Arctic grayling and slimy sculpin were captured in McGinty Creek in 1994, through electrofishing and minnow trapping. Because substantial deadfall caused by a forest fire changed creek conditions, only minnow trapping was used in 2009–2011, yielding very low numbers of slimy sculpin. Since these captures were consistently made in close proximity to the Yukon River, these fish were presumed to be associated with the Yukon River, as opposed to McGinty Creek. These results are similar to those found in the 1994 survey, in that fish were only captured in close proximity to the Yukon River confluence. The physical nature of the McGinty Creek drainage is not conducive to a consistent year-round use by fish. Many factors, including gradient, discharge volume, depth, configuration, and paucity of an upstream reservoir, limit wintering habitat potential for fish. Also, several potential natural fish barriers were observed and documented in the lower reach of McGinty Creek.

Table 4-11 Minto Fish Habitat Studies: 1994 – 2012

Study Timing		Study Type	Minto Creek		Creek A		McGinty Creek	
Year	Month		Effort	Catches	Effort	Catches	Effort	Catches
1994	June	Baseline Environmental Studies	EF, MT	Rw, Ss	EF	-	EF, MT	Ss, Ag
	August	Baseline Environmental Studies	EF, MT, A	Ss, Ag	EF	-	EF, MT	Ss, Ag
	September	Baseline Environmental Studies	EF, MT	Ag	EF	-	EF	-
2006	September	Baseline / Permitting	MT	-	-	-	-	-
2007	May	Baseline / Permitting	EF, MT	Cs	-	-	-	-
	June	Baseline / Permitting	EF, MT	Cs, Ss	-	-	-	-
	August	Baseline / Permitting	MT	Cs, Ag, Ss	-	-	-	-
	September	Baseline / Permitting	MT	Cs	-	-	-	-
2008	June	EEM, Cycle 1	EF, MT	-	-	-	-	-
	September	EEM, Cycle 1	EF, MT	Cs	-	-	-	-
2009	May	Baseline, Minto North	-	-	-	-	MT	Ss
	June	Baseline, Minto North	MT	-	-	-	MT	Ss
	July	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
	September/ October	Fish Relocation, Minto North	-	-	-	-	MT	-
2010	June	Mark-Recapture Study	MT	Cs, Ss	-	-	-	-
	July	Mark-Recapture Study, Minto North	MT	Cs, Ss	-	-	MT	Ss
	August	Mark-Recapture Study	MT	Cs, Bb, Ag	-	-	-	-
	September	Mark-Recapture Study	MT	Cs, Bb, Ss, Ag	-	-	-	-
	October	Mark-Recapture Study	MT	Cs, Bb	-	-	-	-
	November	Fish Relocation	MT	Cs	-	-	-	-
2011	July	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
	August	Ongoing Monitoring	MT	Cs, Ls	-	-	-	-
	September	Ongoing Monitoring, Minto North	MT	Cs, Ss, Ls	-	-	MT	-
	October	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-
2012	June	Ongoing Monitoring	MT, EF	Ss, Ag	-	-	-	-
	July	Ongoing Monitoring	MT	Ss	-	-	-	-
	August	Ongoing Monitoring	MT	-	-	-	-	-
	September	Ongoing Monitoring	MT	Cs, Ss	-	-	-	-

Effort: EF=backpack electrofishing, MT=minnow trapping, A=angling
Catches: Cs=Chinook salmon, Ag=Arctic grayling, Ss=slimy sculpin, Rw=round whitefish, Bb=burbot, Ls=longnose sucker

4.7.3 Aquatic Environment and Habitat

4.7.3.1 Stream Sediments

Stream sediments were studied for particle size and metal concentrations in 1994, and annually since 2006. Sediment particle size distribution was notably different when comparing earlier sampling years to more recent years. The change in distribution from 1994–2009 compared to 2010–2012 reflects methodological changes that were implemented in 2010. Sediment metal concentrations were also complicated by the change in methodology. With this qualification in mind, 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). Copper was the only metal that consistently exceeded guideline levels every year, including during baseline sampling in 1994. This could indicate that there are naturally high levels of copper at the exposure area. Arsenic was above the ISQG in most sampling years except during baseline sampling in 2007 and 2009.

Additional detailed results for sediment physical and chemical parameters are available in Appendix K.

4.7.3.2 Benthic Invertebrate Community

Benthic macroinvertebrates (benthos) are non-backboned animals inhabiting the bottom substrates of aquatic habitats. The abundance, diversity, and taxonomic composition of benthos can be used as indicators of changing environmental conditions as their distribution and abundance can be influenced by a wide variety of physical parameters. Baseline and numerous other benthic invertebrate studies were undertaken in the Minto Mine area from 2006–2012.

Basic results of the 2008 and 2011 environmental effects monitoring (EEM) benthic analyses indicated that Minto Creek (treatment) had a significantly higher benthic invertebrate density and slightly lower number of taxa (not significant) compared to McGinty Creek (Appendix F of Appendix K). The 2011 EEM benthic results show that Minto Creek had significantly higher number of taxa and higher density compared to both reference sites. Increased taxa, higher density, and lower evenness are indicative of a site that is experiencing nutrient enrichment.

Under the terms of Minto's Water Use License #QZ06-006, benthic macroinvertebrate communities are required to be annually monitored in Minto Creek. In 2011, the mean number of taxa in lower Minto Creek was less than in the reference area in lower Wolverine Creek and less than the 1994 baseline (this result is contrary to the 2011 EEM results, but could be explained by the use of a different reference site, or by temporal variability). However, the 2011 count was an increase over that measured in 2006, another year that the mine did not discharge. Changes in density and evenness over time likely reflected high temporal variability of benthic invertebrate communities in the region, also evident at reference areas.

A detailed report on Minto Creek sediment, periphyton and benthic invertebrate community was prepared by Minnow (2012) and is presented in Appendix F of Appendix K.

4.7.3.3 Periphyton

Periphytic algae are simple aquatic plants which inhabit the substrate of water bodies. They can provide a valuable biological monitoring tool to assess potential impacts of nutrient enrichment and metal toxicity. Chlorophyll a is the primary photosynthetic pigment common to all algae. Determining chlorophyll a concentrations provides a measure of algae biomass and thus, the primary productivity of a given location. Periphyton was sampled in 1994, 2011, and 2012, in Minto Creek (exposure) and Wolverine Creek (reference). Overall, the periphyton community of lower Minto Creek relative to lower Wolverine Creek had lower density and taxon richness. Periphyton communities of lower Minto Creek and lower Wolverine Creek in 2011 both differed from the community documented at lower Minto Creek in 1994.

Detailed results and analysis are presented within Appendix K (specifically appendices F and I).

4.8 VEGETATION

The Minto Mine lies within the Boreal Cordillera ecozone and is situated in the far western part of the Yukon Plateau ecoregion, adjacent to the Klondike Plateau ecoregion in the west. This area was part of the eastern extent of Beringia, which remained ice-free approximately 15–20 thousand years ago. Endemic and rare plant species are associated with the Beringia area as it was a unique and isolated ecosystem. These remnant species are usually associated with grasslands and wetlands.

The Minto property lies within the eastern part of the Dawson Range, with elevations from 700 to 950 m; the landscape has rounded mountains intersected by broad valleys and drainages that are part of the Yukon River watershed. Discontinuous permafrost occurs on northern slopes and low-lying areas where sunlight is reduced.

Forest fires are frequent in this part of Yukon as it lies in the rain shadow of the St. Elias–Coast Mountains and receives less than 300mm of precipitation per year (Smith et al. 2004). As a result, the study area around Minto Mine has experienced numerous fires over the last forty years, rendering it a complex mosaic of plant communities at various stages of succession.

The following subsections summarize vegetation surveys conducted in the Project area. For further detail, please see the Vegetation Baseline Survey (2010) in Appendix L.

4.8.1 Vegetation Survey (2010)

Vegetation surveying and mapping was undertaken by ACG and Horizon Ecosystem Consulting in 2010 and resulted in the Vegetation Baseline Survey (2010) (Appendix L). A previous survey was conducted in 1994 by Hallam Knight Piesold (HKP), before any mine development had begun in the area. The 2010 report provides a record of current vegetation communities that exist within a 3,626 ha study area and estimates the type and area of vegetation to be removed in the Project area. In the intervening years between the 1994 and 2010 studies, the local landscape has been altered by the footprint of the current mine, further exploration and three major fires (See Fire History Map, of the Vegetation Baseline Report, ACG 2010).

In the 2010 Vegetation Baseline Survey, different vegetation communities that exist within the study area were identified through aerial photo interpretation and delineated into polygons. Since most of the study area is regenerating from past fire disturbances, a mosaic of vegetation communities at different successional stages was delineated and classified. It was found that willow and trembling aspen have the greatest crown cover within the study area as they are indicative of early forest succession. Lodgepole pine is a later successional species that will gradually dominate mid and upper slopes of well-drained southern aspects.

Shade-tolerant white spruce was often found in the understory as seedlings. It is a climax species that will eventually overgrow the pine and trembling aspen communities, particularly on cooler aspects. Black spruce is also a climax species that is adapted to wetter, cooler sites, often the persistent species in white/black spruce mixed areas along the toe of slopes and valley bottoms. Small areas of grasslands are scattered along dry crests and steep south facing slopes; these locations do not retain enough moisture to sustain tree growth and are more likely to contain rare or uncommon plants.

Approximately 82.04 ha of vegetated land will be disturbed by the proposed mine expansion. Most of the planned expansion is along ridge tops and mid slopes; the main vegetation to be removed are upland willow species, trembling aspen, Lodgepole pine, and associated understory growth. These areas have already been impacted by drilling, road development, and other exploration activities.

The ecosystem map (Appendix L) was 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. Sensitive areas that should be avoided, if possible, include: riparian corridors, bog/wetlands, mature forests, and grasslands.

4.8.2 Site Conditions: Vegetation Types

During the survey, plants species with 0.5% or greater coverage were identified and recorded on data sheets at each plot. Rare or uncommon species were searched for within plots and between plots, as well as uncommon ecosystems, i.e., wetlands and grasslands. No rare plants were found during the field 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. The main plant communities identified in and around the Minto property are briefly described in the subsections below.

4.8.2.1 Trembling Aspen/Lodgepole Pine

This association is found in early successional forests originating after fire disturbance, on mesic to subxeric sites. Lodgepole pine (Pinus contorta latifolia) is more dominant than trembling aspen (Populus tremuloides) on well-drained south facing slopes and terraces. Coarse soils are often exposed, and lichens are well represented in the ground cover. Typically, these sites have low growing shrubs such as lingonberry (Vaccinum vitis idaea), kinnikinnick (Arctostaphylos uva-ursi), and prickly rose (Rosa acicularis).

4.8.2.2 Black Spruce/Labrador Tea/Sphagnum

Found in low lying areas and north facing slopes (cool sites), usually sparse to open forests (<50% crown cover), common shrubs in this ecosystem include Labrador tea, scrub birch, willow, and bog blueberry. Herbs present were sweet coltsfoot (Petasites frigidus), cloudberry (Rubus chamaemorus), and horsetail (Equisetum sp.) Sites are poorly drained (hydric to mesic) with peat horizons over mineral soils, often associated with permafrost.

4.8.2.3 White/Black Spruce

This association is typically located on south facing lower slopes with upland willow species and Labrador tea. A thick carpet of feather mosses and sphagnum covers the mineral soil. Ground cover shrubs include lingonberry, bog blueberry, and crowberry.

4.8.2.4 Willow/Trembling Aspen

This was the most common vegetation association in study area, indicative of regenerative growth (>10yrs) after a fire event. Most trees and shrubs are less than 5 m tall; cover can be open to closed as the canopy layer is of uniform height. Other species that may be present include: Alder (Alnus crispa) and Alaskan birch (Betula neoalaskan) on north facing slopes. Lodgepole pine and white spruce are also present in the understory and will eventually overtop other competing species to form the dominant canopy as the forest matures. The moisture regime ranges from subhygric to subxeric.

4.8.2.5 Willow/Scrub Birch

Willow (Salix sp.) and scrub birch (Betula glandulosa) occur in fluvial ecosystems adjacent to streams and fens. Other shrubs present are bog blueberry (Vaccinum uliginosum), Labrador tea (Ledum groenlandicum), and shrubby cinquefoil (Potentilla fruticosa). Associated graminoids include water sedge (Carex aquatilis), bluejoint grass (Calamagrostis canadensis), and rushes (Juncus sp.). Sphagnum, feather, and glow mosses are common.

4.8.2.6 Trembling Aspen/Grassland

This association features sparse to open cover of trembling aspen (Populus tremuloides), often with lodgepole pine (Pinus contorta latifolia) present as a minor component. Found on steep south and southwest facing slopes, its understory shrubs include prickly rose (Rosa acicularis), soapberry (Shepherdia canadensis), kinnikinnick (Arctostaphylos uva-ursi), purple reedgrass (Calamagrostis purpurascens), Glaucous bluegrass (Poa glauca), Threadleaf sedge (Carex filifolia), Death camas (Zygadenus elegans), common yarrow (Acillea millefolium), pussytoes (Antennaria sp.), and prickly saxifrage (Saxifraga tricuspidata).

4.9 GEOLOGY

The Minto Project is found in the north-northwest trending Carmacks Copper Belt along the eastern margin of the Yukon-Tanana Composite Terrain, which is comprised of several metamorphic assemblages and batholiths (Figure 4-4). The Belt is host to several intrusion-related Cu-Au mineralized hydrothermal systems. The Yukon-Tanana Composite Terrain is the easternmost and largest of the pericratonic terrains accreted to the Paleozoic northwestern margin of North America (e.g., Colpron et al., 2005). It is regarded to be the product of a continental arc and back-arc system, preserving meta-igneous and metasedimentary rocks of Permian age on top of a pre-Late Devonian metasedimentary basement (e.g., Piercey et al. 2002).

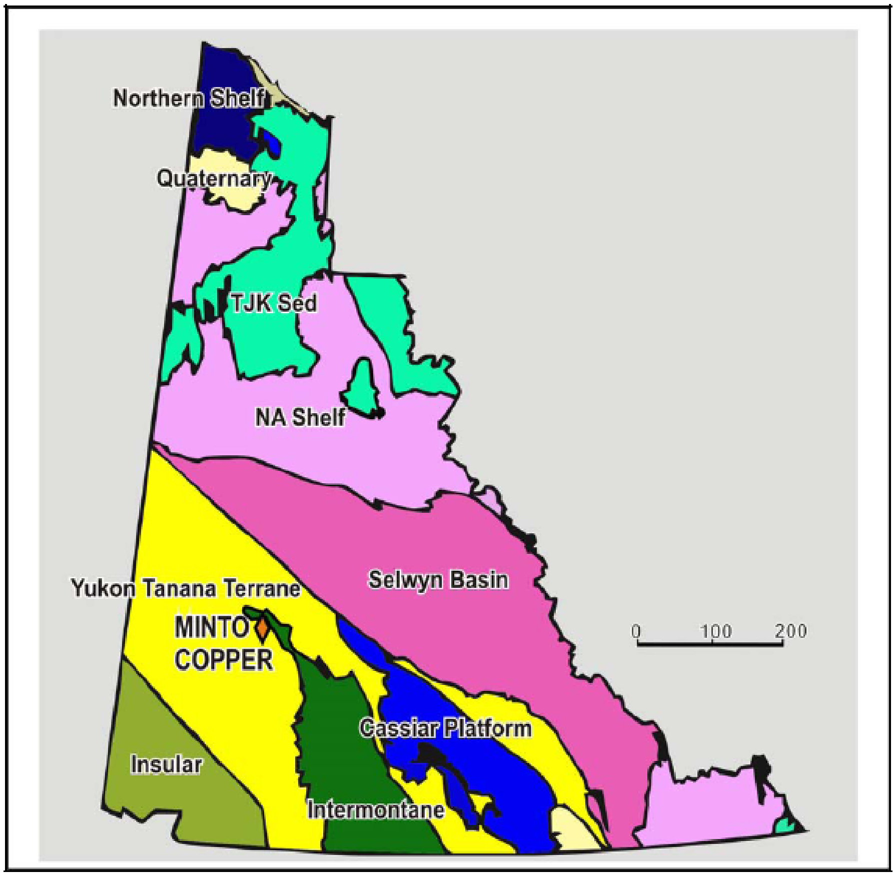

Figure 4-4 Yukon Geology (from Yukon Geologic Survey "Maps Yukon" website, www.geology.gov.yk.ca)

The Minto Property and surrounding area are underlain by plutonic rocks of the Granite Mountain Batholith (Early Mesozoic Age) (Figure 4-5) that have intruded into the Yukon-Tanana Composite Terrain. They vary in composition from quartz diorite and granodiorite to quartz monzonite. The batholith is unconformably overlain by clastic sedimentary rocks thought to be the Tantalus Formation and andesitic to basaltic volcanic rocks of the Carmacks Group, both of which are assigned a Late Cretaceous age. Immediately flanking the Granite Mountain Batholith, to the east, is a package of undated mafic volcanic rocks, outcropping on the shores of the Yukon River. The structural relationship between the batholith and the undated mafic volcanics is poorly understood because the contact zone is not exposed.

Geobarometry and geothermometry data (Tafti and Mortensen, 2004) suggests that the Granite Mountain Batholith was emplaced at a depth of at least 9 km, while the presence of euhedral to subhedral epidote, interpreted by Tafti and Mortensen as magmatic in origin, suggests a deeper emplacement depth in the order of 18 to 20 km.

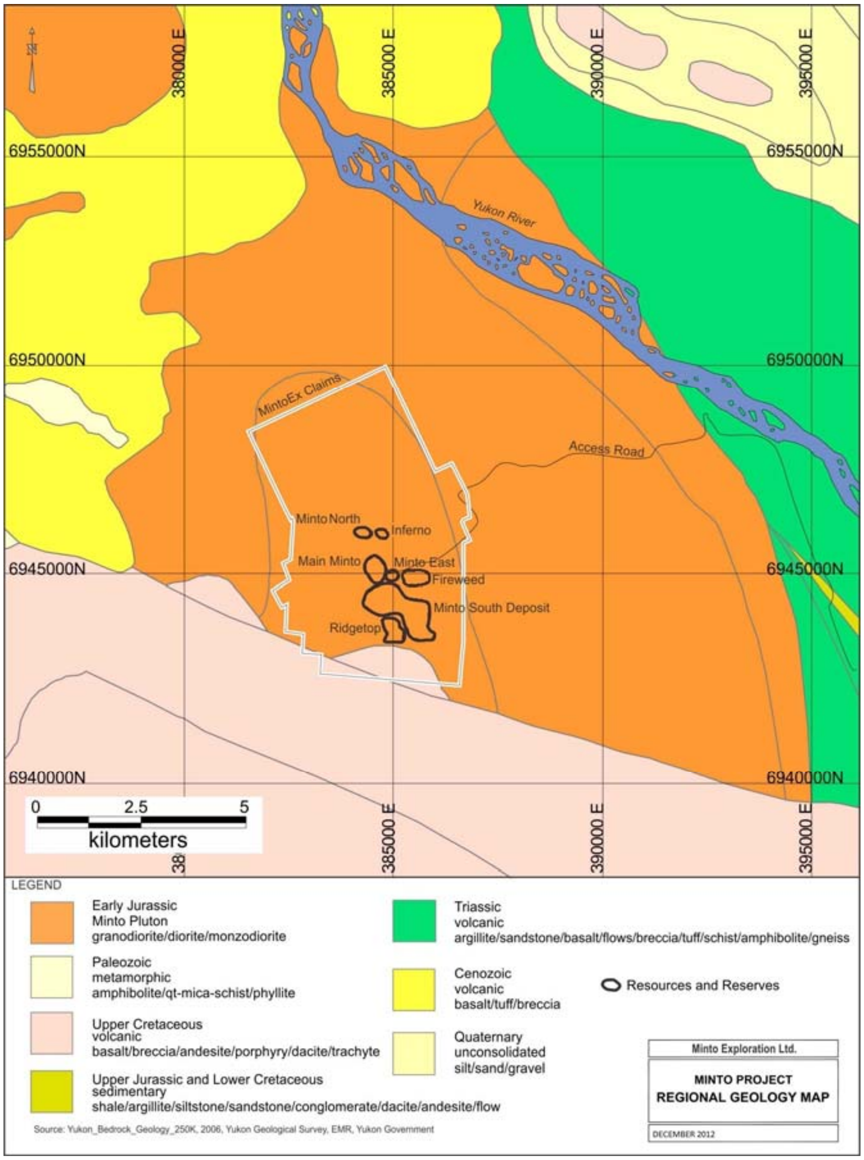

Figure 4-5 Regional Geology

4.9.1 Property Geology and Lithological Description

Much of the geological understanding of the rock around the Minto deposits is based on observations from diamond drill core and extrapolation from regional observations. The reason for this is poor outcrop exposure (less than 5% coverage), as well as the deep weathering and oxidation of any existing exposed outcrop. The terrain was not glaciated during the last ice age event.

Five additional deposits of mineralization are reported in this document outside of the Minto Main Deposit; Minto South Deposit, Ridgetop, Minto North, Inferno, Fireweed, and Minto East. For the purpose of this report Area 2, Area 118, Copper Keel, and Wildfire resource sub-domains are now considered continuous and reported as one deposit, namely Minto South Deposit (MSD) located immediately south of Main Minto. Names of these resource sub-domains are retained for ease of discussion when discussing regions within MSD. The Ridgetop deposit is located just over 300 m south of the Area 2/118 resource sub-domain, the Minto North and Inferno deposits are located about 700 m north of the Main Deposit, the Fireweed deposit is located just over 500m east of the south end of the Minto Main deposit, the Minto East deposit is located about 200 m east of the south end of the Minto Main deposit, while the Copper Keel and Wildfire sub-domains form a southeast extension from Area 2/118. Each of these deposits closely shares a similar style of mineralization of shallow dipping copper sulphide mineralized zones. The Main Minto deposit was exposed in the dormant open pit mine; similarly, this flat geometry is currently exposed in the Minto South Deposit (Area 2 resource sub-domain) starter pit. In addition to these mineral deposits which have NI 43-101 compliant mineral resources there are several significant mineral prospects. These deposits and prospects define a general north-northwest trend.

The hypogene copper sulphide mineralization at Minto is hosted wholly within the Minto pluton, which intrudes near the boundary between the Stikinia and Yukon-Tanana terrains, however since the contact is not exposed it is unclear if the pluton stitches the two terrains. The Minto pluton is predominantly of granodiorite composition. Hood et al. (2008) distinguish three varieties of the intrusive rocks in the pluton. The first variety is a megacrystic K-feldspar granodiorite. It gradually ranges in mineralogy to quartz diorite and rarely to quartz monzonite or granite, typically maintaining a massive igneous texture. An exception occurs locally where weakly to strongly foliated granodiorite is seen in distinct sub-parallel zones several meters to tens of meters thick.

A second variety of igneous rock is quartzofeldspathic gneiss with centimeter-thick compositional layering and folded by centimetre to decimetre-scale disharmonic, gentle to isoclinal folds (Hood et al., 2008). The third variety of intrusive is a biotite-rich gneiss. MintoEx geologists consider all units to be similar in origin and are variably deformed equivalents of the same intrusion.

Copper sulphide mineralization is found in the rocks that have a structurally imposed fabric, ranging from a weak foliation to strongly developed gneissic banding. For this reason all core logging by the past and present operators separates the foliated to gneissic textured granodiorite as a distinctly discernible unit. It is generally believed by MintoEx geologists that the foliated granodiorite is just variably strained equivalents of the two primary granodiorite textures and not a separate lithology.

While this interpretation, based upon detailed observations from logging of tens of kilometers of drill core is highly likely but it still needs to be conclusively proven. Tafti & Mortensen (2004) noted that the relatively massive plutonic rocks have similar mineral and chemical composition as the foliated rocks. Research in collaboration with the Mineral Deposits Research Unit ("MDRU") of the University of British Columbia is on-going.

The contact relationship between the foliated deformation zones and the massive phases of granodiorite is generally very sharp. These contacts do not exhibit chilled margins and are considered by MintoEx geologists to be structural in nature, separating the variably strained equivalents of the same rock type. Tafti and Mortensen (2004) had interpreted the sharp contacts to be zones of deformed rock within the unfoliated rock (i.e. rafts or roof pendants). Supergene mineralization occurs proximal to near-surface extension of the primary mineralization and beneath the Cretaceous conglomerate.

Conglomerate and volcanic flows have been logged in drill core by past operators. New drilling has confirmed the presence of conglomerate, but not the volcanic flows. The latter cannot be confirmed by the authors as the drill core from historic campaigns was largely destroyed in forest fires and no new drilling has intersected such rocks. However, undated volcanic rocks are mapped by Hood, near the southwest margin of the property, south of a fault that is inferred from geophysics to separate them from the Jurassic Age intrusive rocks. The conglomerate has been dated (unpublished date pers. com. Dr. Maurice Colpron - Yukon Geological Survey) as Cretaceous Age. It is now recognized as an outcrop within a borrow pit exposure located west of the airstrip as well as in numerous recent drill holes. Observations of foliated and even copper mineralized cobbles in drilling indicate that “Minto-type” mineralization was exposed, eroded and reincorporated in sedimentary deposits by the Cretaceous Age.

Other rock types, albeit volumetrically insignificant, include dykes of simple quartz-feldspar pegmatite, aplite; and an aphanitic textured intermediate composition rock. Bodies of all of these units are relatively thin and rarely exceed the one meter core intersections. These dykes are relatively late, and observed contact relationships suggest they generally postdate the peak ductile deformation event; however some pegmatite and aplite bodies observed in a rock cut located north of the mill complex are openly folded.

It is unclear if this folding is contemporaneous with foliation development in the deformed rocks or post-dates the foliation development. Observations from drill core and open cut benches in the mine show examples where the foliation and the pegmatitic/aplitic intrusions are both folded, as well as examples where the intrusions are not folded, suggesting two populations of minor dykes.

4.10 SOIL AND BEDROCK

4.10.1 Overburden

Overburden thickness across the site is correlated with geomorphological features. Near topographic highs (or ridges) there is little to no overburden, while overburden thickness increases down valley slopes and is generally thickest in valley bottoms. Unconsolidated material deposited along the valley bottom varies in thickness. Typically, the ridge tops are dominated by sandy, residual soils grading to weathered bedrock. It is generally observed that fine weathering products have been washed down slope. Overburden in the valley bottoms consists of finer materials dominated by sandy silts and clays (SRK 2008a). A representative selection of drill hole logs from various geotechnical drilling programs is presented in Appendix H. The drill holes shown provide spatial coverage within the core site footprint and high quality data regarding depth to bedrock. In isolated cases, drill holes that did not reach bedrock are also included; these provide minimum bedrock depths.

Several geotechnical studies have been conducted across the site (e.g. Golder 1974; SRK 2007, 2013; EBA 2009, 2011 and 2012). Figure 3 in Appendix H presents the overburden depth determined from these studies. It should be noted that overburden thicknesses for the Dry Stack Tailings Storage Facility generally represent data collected post-construction, and therefore reflect combined tailings and overburden thickness. The drill holes located at the toe of the Southwest Waste Dump were drilled prior to the full extent of the current waste rock and provide a good indication of the overburden depth.

Along the ridge near the proposed Ridgetop North and Ridgetop South pits, bedrock is close to the surface (less than 15 m). In most cases, the bedrock is within 5 m of the surface. The proposed Minto North Pit also has minimal overburden near the ridge top. To the north/northeast of the Dry Stack Tailings Storage Facility, overburden is controlled by the steep valley slopes and Minto Creek cutting through the bottom of the valley. The overburden thickness near the creek bed is less than 15 m, but increases in some areas, especially along the southern valley slopes. In some areas, this overburden can exceed 50 m, but typically ranges between 30 and 50 m.

The ridge tops to the north and south of the mine footprint have little overburden, and that which exists consists of sandy residual soils that grade into weathered bedrock. In the valley east of the Southwest Waste Dump, the subsurface soils consist of sand and silt layers that overlie the residual sandy soil and weathered bedrock. Some locations have a mix of sand, silt, and gravel layers with no clear stratigraphic continuity evident through the valley. (SRK, 2014).

4.10.2 Bedrock

The Minto Mine site is underlain predominantly by igneous rocks of granodiorite composition. The granodiorite is generally categorized based on textures which are associated with foliation and crystal size. Rock texture ranges from massive granodiorite to foliated granodiorite, with foliated granodiorite typically characterized by increased biotite content. The biotite-rich foliated granodiorite hosts mineralized zones of copper sulphide. Crystal textures range from equigranular to porphyritic.

Other minor lithologies consisting of small dykes of simple quartz-feldspar pegmatite, aplite, and an aphanitic textured intermediate composition rock are also observed. Bodies of all of these units are relatively thin and rarely exceed one metre core intersections. These dykes are relatively late, generally postdating the peak ductile deformation event; however, some pegmatite and aplite bodies observed in a rock cut located north of the mill complex are openly folded. There has been evidence of conglomerate and volcanic flows in drill core by past operators, and drilling has demonstrated that a conglomerate unit bearing local granodiorite pebbles occurs across much of the southern part of the project area. This is of particular note in the vicinity of the proposed Ridgetop North and Ridgetop South pits. (SRK, 2014).

There are both ductile and brittle phases of deformation around the Minto deposits. Copper-sulphide mineralization is strongly associated with foliated granodiorite. This foliation is defined by the alignment of biotite in areas of weak to moderate strain, and by the segregation of quartz and feldspar into bands in areas of higher strain, giving the rock a gneissic texture in very strongly deformed areas. The deformation zones form sub-horizontal horizons within the more massive plutonic rocks of the region and can be traced laterally for more than 1,000 m in the drill core. They are often stacked in parallel to sub-parallel sequences (SRK 2013c).

The Minto Creek Fault (MC Fault) bisects the Minto Main deposit, dividing it into north and south areas and is modeled as dipping steeply north-northeast with an apparent left lateral reverse displacement. The northern block moved up and to the west relative to the southern block. Both the vertical and horizontal displacements are evident by offsets in the main zone mineralization and appear to be minimal. A lack of marker horizons in the plutonic rocks, however, makes it difficult to determine the absolute magnitude of the movement (SRK 2008b).

The DEF Fault defines the northern end of the Minto Main deposit. It strikes more or less eastwest and dips north-northwest and cuts off the Main Zone mineralization. The vertical orientation of most of the drilling is less than optimal to intersect steep to vertical faults; the DEF fault may have a similar sense of movement to the MC fault, however, a significant amount of displacement is inferred. (SRK 2013c).

The mineralization in the proposed Ridgetop North and Ridgetop South pits is also controlled by structure. The boundary between the Area 2 and Area 118 pits is defined by a northeast dipping fault. At least two parallel structures have also been identified in Area 118 (SRK 2008b).

4.11 SEISMICITY

The tectonics and seismicity of southwestern Yukon are influenced primarily by the Pacific and North American lithospheric plate margins. In Yukon's St. Elias region, northwest British Columbia and southeast Alaska, the boundary of the two lithospheric plates changes from right lateral transform to subductive. Instead of sliding past each other, the Pacific Plate is forced beneath the stable North American plate resulting in the St. Elias region being uplifted. This transfer of force along the fault into uplift or mountain building dissipates tectonic energy, reducing seismic effects on the region northeast of and across the fault (SRK 2013c).

An assessment of peak ground acceleration was performed for the Minto project area using the 2010 National Building Code Seismic Hazard Calculation. The BC Mine Waste Rock Pile Research Committee 1991 outlined that a 10% probability of exceedance in 50 years or the 1:475 event is appropriate for dump design. This peak ground acceleration in the Minto project area is approximately 0.057 g.

The potential effects of seismic activity on the Project are dependent on the magnitude of any event. Damage to Project infrastructure may range from no major damage/minor interruption in operations to, in the case of a large earthquake (i.e., maximum credible), loss of equipment or major structural damage to Project facilities.

After the January 30, 2008 earthquake, Minto had EBA conduct a review of the engineering design of all major infrastructure units (EBA 2010). EBA evaluated the design standards for the water storage pond dam, main waste dump, dry stack tailings storage facility, ice-rich overburden dump and reclamation overburden dump. Table 4-12 shows the design peak ground accelerations used in site facility designs to that point.

Table 4-12 Design Peak Ground Acceleration of Minto Structures

Structure	Design Peak Ground Acceleration
Water storage pond dam	0.150 g
Main waste dump	0.150 g
Ice-rich overburden dump	0.055 g
Dry stack tailings storage facility	0.055 g
Reclamation overburden dump	0.055 g

Please note, the difference in the design criteria for the water storage pond dam and main waste dump, as these infrastructure units were designed in the mid-1990s. Subsequent to the design of these two units, the Geological Survey of Canada reduced the peak ground acceleration for the design event (1:475 year earthquake) from 0.150 g to 0.055 g.

5 PROJECT DESCRIPTION

5.1 PROJECT LOCATION AND BACKGROUND

The Minto Project is a copper-gold-silver project located on the west side of the Yukon River approximately 75 km (47 miles) north-northwest of Carmacks, Yukon Territory. The mine site and access road lie within the traditional territory of the SFN and comprises part of land claim settlement parcels R 6A, R-44A (Type A settlement lands) and R-40B. Minto concluded a comprehensive Cooperation Agreement with the SFN on September 16, 1997. This agreement is still in effect, however an amended agreement is being negotiated.

The Minto Property is centered at approximately 62°37'N latitude and 137°15'W longitude (NAD 83, UTM Zone 8 coordinates 6945000N, 384000E). The Minto Project consists of 284 claims. There are 120 pending quartz claims, 99 quartz claims and 65 quartz claims under lease. Minto is the 100% registered owner of the claims and leases. The property is accessible by crossing the Yukon River at Minto Landing. Barge landings have been constructed for ice-free crossing and an ice bridge is used upon freeze-up of the Yukon River.

Copper deposits were first discovered in 1970 and claims were staked in 1971. Extensive exploration yielded the first significant drill intersection in July of 1973. The claims and leases cover an area of approximately 10 square miles. Figure 4-1 and Figure 5-1 present visual depictions of the general project location within the Yukon and the project area overview.

Preliminary site development was initiated at the property in 1996 and continued during the following decade with Minto commencing operations in October 2007. From 2007 through April 2011, mining at Minto took place in what is known as the Main Pit. Exploration during those years identified several other high-grade areas of the ore deposit that are amenable to both surface and underground mining. These areas were upgraded from resources to reserves by a series of prefeasibility studies completed in 2010, 2011, and 2012.

The first of these reserves were submitted to YESAB for assessment in November of 2010 as application 2010-0198 (the Phase IV Project Proposal). That application presented two new pits and an underground mine, extending mining operations to early 2014 and milling operations to 2016. The Minto Mine has been conducting operations under the Phase IV Mine Plan since February 2011.

Pre-stripping of the Area 2 Pit commenced in April 2011, with ore processing following in May 2012. Processing of stockpiled ore from the Main Pit continued during the pre-stripping period; some low-grade and partially oxidized ore from the Main Pit still remains to be processed.

Development of the underground mining assessed in Phase IV commenced in August 2012 with stripping of overburden around the portal access; ore production is expected in Q3 2013.

The ore deposits are mined using conventional open pit truck and loader operations and processed in a mill plant on site. A 200 person camp is presently near capacity with the mine construction management, contractors and support staff. All existing facilities and development described in Section 2.4 have been assessed by YESAB (Minto Mine Phase IV Expansion, Project Assessment 2012-0198) and licensed under amendments to the QML-0001 and WUL QZ96-006.

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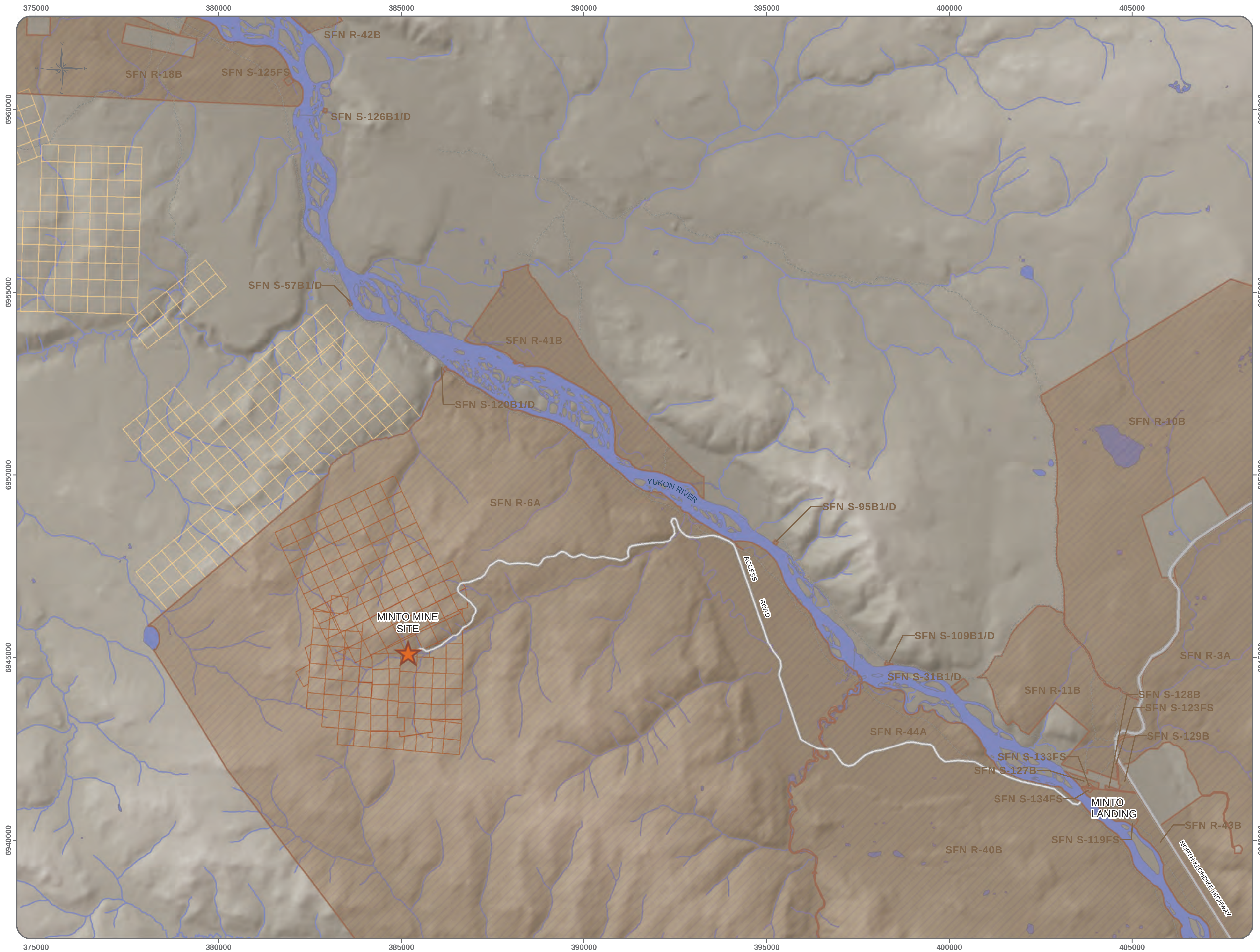
FIGURE 5 - 1

AREA OVERVIEW

AUGUST 2014



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Minto Mine Site

Mine Access Road

Road

Trail

Selkirk First Nation Settlement Lands

Quartz Claims

Minto Explorations Ltd. Claims

Other Claims

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0 0.5 1 2 3 4 5 km

ACCESS

First Nation Settlement land obtained from Natural Resource Canada. Quartz claim boundaires and ownership are current as of Feb 18 th 2013. Data obtained from Mineral Resources Branch, Energy Mines and Resources Department, Government of Yukon.Site hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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Table 5-1 provides an overview of the project area and environmental setting information for the study area. This table provides physical project location information, geographic reference, access route, watershed drainage, special designations, and key environmental features within the study area. The information has been extracted from a number of documents, including previous Canadian Environmental Assessment Act (CEAA) and Yukon Environmental and Socio-Economic Assessment Act (YESAA) screenings.

Table 5-1 Project Area Overview and Environmental Setting

Project Area Attribute	Description
Region:	Yukon
Topographic Map Sheet:	NTS 115 I/10, 115 I/11
Geographic Location Name Code:	Minto Project
Latitude:	62° 36' N
Longitude:	137° 15' W
Drainage Region:	Yukon River
Watersheds:	Yukon River, Big Creek, Wolverine Creek, Dark Creek, and Minto Creek.
Nearest Community:	Pelly Crossing, Yukon, approx. 33 km north on Klondike Highway.
Access:	Klondike Highway, Barge crossing on Yukon River at Minto Landing, Minto mine access road. Airstrip on site.
Traditional Territory:	Northern Tutchone, Selkirk First Nation peoples. Traditional use for hunting, trapping and fishing.
Surrounding Land Status:	Selkirk First Nation Settlement Lands and Federal Crown Land.
Special Designations:	Lhutsaw Wetland Habitat Protection Area located approx. 17 km NE of Minto Landing (outside the project area).
Ecoregion:	Yukon Plateau (Central) - Pelly River Ecoregion.
Study Area Elevation:	Rolling hills above mine site at 1131 metres to 600 metres at the Yukon River Valley bottom.
Site Climate:	Temperature ranges from –43.2°C (November 2006) to 30.3°C (July 2009). Mean annual temperature of –1.8°C. Mean annual rainfall is 174 mm.
Vegetation Communities:	Riparian, black spruce, white spruce, paper birch, lodgepole pine, buck brush/willow and ericaceous shrubs, feathermoss, sedge, sagewort grassland, mixed, aspen, balsam, and sub-alpine. Discontinuous permafrost is present on site. Site has been subject to recent forest fires.
Wildlife Species:	Moose, caribou, Dall sheep, mule deer, grizzly and black bear, varying hare, beaver, lynx, marten, ermine, deer mouse, fox, mink, wolverine, least weasel, wolf, squirrel, porcupine coyote, muskrat, otter and wood frog. Bird species include: spruce, blue, ruffed, and sharptail grouse, waterfowl, raptors, and a variety of smaller birds.
Fish Species:	In the Yukon River, 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 Big Creek, Chinook and chum salmon, arctic grayling and whitefish species; In Wolverine Creek, chinook salmon, arctic grayling, and slimy sculpins; In Minto Creek and project area watershed (lower reaches only), slimy sculpin, round whitefish, arctic grayling and Chinook salmon.
Known Heritage Resources:	East side of Yukon River in the vicinity of Minto Landing four historic sites designated KdVc-2 (Minto landing), KdVc-3 (Minto Resort), KdVc-4 (Old Tom's Cabin), and KdVD-1 (Minto Creek).

5.1.1 Phase IV Activities

The following activities are in progress as part of Phase IV:

- Development, mining and milling of materials from the Area 2 open pit which contains 3,192 Kt of ore plus 25,980 Kt of waste;
- Development, mining and milling of materials from the Area 118 open pit which contains 88 Kt of ore plus 639 Kt of waste;
- Development, mining and milling of materials from the Area 2 and Area 118 underground areas which contain approximately 1,541 Kt of ore and 341 kt of waste;
- Expansion of the Southwest Waste Dump and Reclamation Overburden Dump;
- In-Pit deposition of tailings from Phase IV deposits;

- Construction of the South Wall buttress in Main Pit;
- Construction of the Mill Valley Fill Expansion buttress;
- Extension of the camp pad;
- Operational water management; and
- Progressive reclamation of infrastructure components, as and whenever possible to reduce site liability.

The open pit mining is being conducted using standard blast and haul open pit mining practices. Milling is conducted using a conventional crushing, grinding and flotation process plant utilizing standard unit processes and equipment). The plant currently processes a maximum of 4,200 tpd (metric tonnes per day).

Figure 5-2 shows the Phase IV development at End of Mine life (2014). Additional details and information on the project are contained in the Minto Mine Expansion - Phase IV Project Application submitted to YESAA in August 2010.

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FIGURE 5 - 2

END OF PHASE IV SITE LAYOUT

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Phase IV Tailings
Phase IV Dumps
Phase IV Pits
Phase IV Footprints

1:15,000 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500 Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11 th 2013.

Datum: NAD 83 Projection: UTM Zone 8N

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5.1.2 Phase V/VI Expansion

The Phase V/VI expansion of the Minto Mine has been assessed under YESAA, and a Decision Document recommending it proceed to the regulatory licencing stage has been issued. The principal activities associated with Phase V/VI are:

- Mining of Phase V/VI pits (Area 2 Stage 3, Minto North, Ridgetop North, and Ridgetop South) using conventional surface mining methods, including an expanded network of haul roads (2.3 km of new roads) to accommodate the mining activities;
- Open pit mining at a rate of 12,800 BCM/day, followed by a decrease to 7,200 BCM/day after the completion of Area 2 Stage 3;
- Expanded mining of the Minto South Underground using conventional underground mining methods;
- Mining of a new Wildfire Underground, which will be accessed through its own separate decline and possess its own surface infrastructure separate from that developed for the Minto South Underground;
- An increase in open pit mine life to Q2-2017, underground mine life to Q4-2019, and milling of stockpiled ore to Q2-2022;
- New management practices for waste rock and overburden mined from the Phase V/VI pits; specifically, cessation of waste rock segregation on the basis of copper grade and adoption of material dispatching based on on-site assessments of acid-generating potential;
- Creation of a new waste rock dump (Main Pit Dump) within the footprint of the mined-out Main Pit;
- Continued placement of waste rock on the existing Main Waste Dump, including an expansion beyond its currently permitted design footprint and capacity;
- Backfilling of the completed Area 118 and Ridgetop South pits with overburden, and the further stacking of overburden on the footprints of these pits;
- Creation of a new waste rock dump (Ridgetop Dump) to the west of the Ridgetop North and South pits;
- The expansion of the current Mill Valley Fill to further stabilize dry stack tailings storage facility;
- The expanded use of the Main Pit and Area 2 Pit – and the new use of the Ridgetop Pit – as storage locations for slurry tailings from milling; and
- Construction of a dam (Main Dam) to retain tailings within the footprint of the Main Pit.

Additional details and information on the project are presented in the following sections, and Figure 5-3 shows the proposed site layout at the completion of Phase V/VI mining activities. Figure 5-4 shows the proposed site layout 2 years into Phase V/VI activities, at approximately June 2016. This site configuration is the basis of the Year 2 closure cost liability calculation in Section 9.

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RECLAMATION AND CLOSURE PLAN
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FIGURE 5-3

END OF PHASE V/VI SITE LAYOUT

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- Phase V/VI Tailings
- Phase V/VI Pits
- Phase V/VI Dumps
- Phase IV Features
- Dam
- Spillway
- Connector Road
- Tailings Diversion Ditch

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0 50 100 200 300 400 500 Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11th 2013.

Datum: NAD 83 Projection: UTM Zone 8N

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FIGURE 5-4

KEY PHASE V/VI SITE COMPONENTS COMPLETED JUNE 2016

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- Overburden Cover
- Completed Phase IV & V/VI Features
- Spillway
- Dam
- Connector Road
- Tailings Diversion Ditch

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0 50 100 200 300 400 500
Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11 th 2013.

Datum: NAD 83 Projection: UTM Zone 8N

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5.2 MINE FEATURES, FACILITIES AND EQUIPMENT

5.2.1 Underground Workings

The Underground Areas will be mined during Phase IV and Phase V/VI. Year 2 of Phase V/VI will reveal underground mining ongoing in Area 118 and Area 2 Pit underground areas.

The underground mining assessed as part of Phase IV consists of several stopes in the Area 2 and Area 118 zones, accessed via the Minto South Portal.

The underground mining assessed as part of Phase V/VI adds several new ore zones to the mine plan:

- To the existing Minto South Underground complex, accessed from the Minto South Portal, Phase IV will add the Minto East and Copper Keel zones, as well as some deeper stopes in the Wildfire zone; and
- A separate underground complex, known as the Wildfire Underground, will access the upper stopes of the Wildfire zone.

The following table summarizes the nomenclature associated with Minto's ore zones and lists the phase of permitting under which each has been assessed.

Table 5-2 Nomenclature for Underground Complexes, Portals and Zones at Minto

Underground Complex	Access	Zones	Permitting
Minto South Underground	Minto South Portal	Area 118	Phase IV
		Area 2	Phase IV
		Minto East	Phase V/VI
		Copper Keel	Phase V/VI
		Wildfire	Phase V/VI
M-zone	M-zone Portal	M-zone	Phase IV
Wildfire Underground	Wildfire Portal	Wildfire	Phase V/VI

Figure 5-5 shows all of the aforementioned ore zones and the development required to access them.

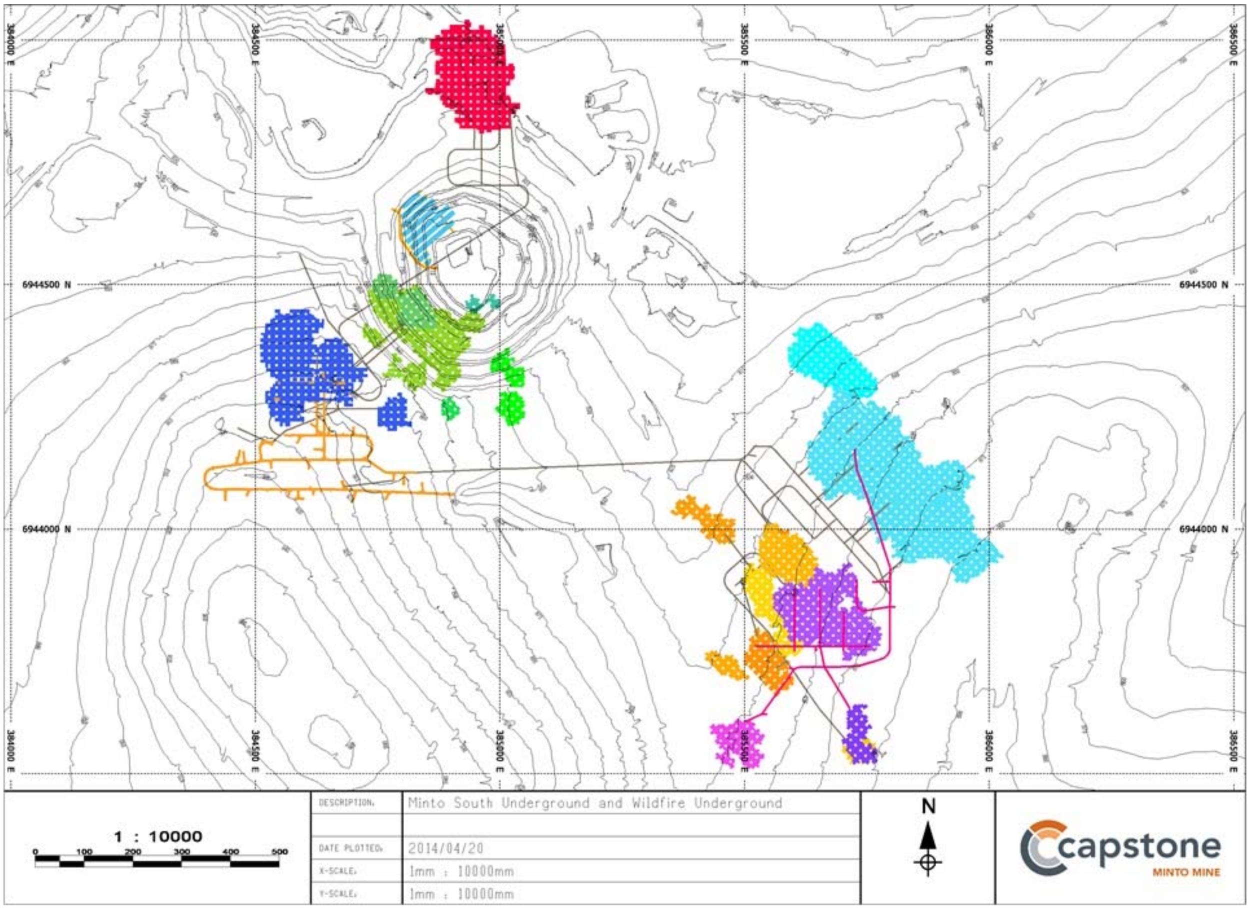

Figure 5-5 Minto Underground Ore Zones and proposed access locations.

The MSU (Minto South Underground) describes development underneath and around the Area 2 and Area 118 pits, accessed from the Minto South Portal, which is southwest of the Area 2 Pit. This underground development was presented in the Phase IV application to YESAB and approved in subsequent major license amendments.

The Wildfire Underground accesses relatively shallow ore zones from a separate portal that will have its own dedicated infrastructure. It will be mined after the completion of the MSU; underground mining activity will transition to the Wildfire Underground as the other zones near completion.

The waste rock from the underground will follow the approved Waste Rock and Overburden Management Plan for Phase V/VI. To date, geochemical characterization for the underground waste rock recovered from core samples show that underground waste rocks are similar in geochemical properties to waste rock from Area 2 and Area 118 open pits.

It is estimated that approximately 1,541 kt of ore and 341 kt of waste will be excavated from underground mining at Minto Mine.

- Mining Rates: 2000 tonnes of ore per day from combined underground sources
- Ore estimates: 1,519,000 tonnes from combined underground sources
- Volume of waste rock: 102,000 BCM with a swell factor of 1.3
- Volume of Waste Rock Removed: 133,000 m^3 from combined underground sources
- (20% PAG – 26,600 m^3)

5.2.2 Open Pits

5.2.2.1 Main Pit

The Main Pit was mined to completion in previous phases of mining. The Main Pit has been accepting tailings slurry and will continue to do so during Phase V/VI. Year 2 of Phase V/VI will reveal the Main Pit with a completed buttress, ongoing waste rock placement in the Main Pit Dump and ongoing tailings slurry deposition.

The Main Pit encompasses the original drainage channel for Minto Creek and hosted the Minto deposit which was the first deposit mined at the Minto Mine. Mining activity occurred in the Main Pit between 2006 and April 2011. The north wall of the pit is benched in competent bedrock while the south wall is composed of bedrock and ice-rich overburden. Acid-base accounting indicates that the open pit wall rocks are net neutral to slightly acid consuming (non acid generating). Results to date indicate that the open pit wall geochemistry is consistent with the initial geochemical predictions put forward in the original geochemical characterization report (Mills, 1997).

A buttress was constructed in the pit to reinforce the south wall which is comprised of bedrock and ice-rich overburden. The Main Pit served as the second stage tailings depository; initially accepting tailings slurry between November 2012 and February 2014 of Phase V/VI.

After this first stage of tailings slurry deposition, the Main Dam will be constructed on the east side of the pit to increase the tailings storage capacity of the Main Pit. The Main Dam will be constructed to increase the storage capacity of the Main Pit to accommodate the required volume of tailings. The Main Dam will be constructed with waste rock and overburden with a low permeability core comprised of a geosynthetic liner and compacted fine-grained material. A tailings beach will be established on the east side of the Main Pit Tailings Management Facility minimizing the potential for seepage to the east, towards the Main Dam.

Tailings slurry deposition will occur in two more phases; from June 2015 to January 2018 and December 2019 to June 2021.

- Surface Area: 12.66 ha (current), Main Pit tailings (final) 14.82 ha
- Topography:

Final pit rim elevation (spill elevation)	– 791 m increase to 804 m after Main Dam
Elevation at end of Phase IV	– tailings to 786 m
Main Dam crest	– 807 m
Elevation at year 2 of Phase V/VI	– 804 m

- Composition of Waste Unit: Pit walls are neutral to acid-consuming

  Tailings and PAG rock

- Volume of Waste Stored:

  Tailings – 6.9 Mm^3 with 1.1 Mm^3 of that being pore water in the waste rock piles
  Waste rock – see south wall buttress

5.2.2.2 Area 2 Pit

Area 2 Pit is located south of the mill area and southeast of the Main Pit. The Area 2 pit was mined in two stages during Phase IV of mine development, the first of which began in April 2011 and the second of which was completed in Q1 2014. An additional stage is proposed for Phase V/VI. Open pit mining at Area 2 Pit Stage 3 will begin in July 2015 and end in June 2016.

Mining in Area 2 Pit began during Phase IV. Two stages of mining were completed and a third stage is proposed for Area 2 Pit during Phase V/VI, an underground access through Area 2 Stage 2 will also be completed during Phase IV. Year 2 of Phase V/VI will reveal Open pit mining completed in Area 2 Stage 3 and tailings slurry deposition complete in Area 2 stage 2. After Year 2 of Phase V/VI the entire Area 2 pit will be filled with tailings slurry.

Underground mining of the Area 2 M-Zone ore lenses via a portal in the base of the pit started following the completion of Area 2 Stage 2 open pit mining. In the final stages of the Phase IV mine plan, when underground mining via the M-Zone portal is complete Area 2 Stage 2 pit will receive slurry tailings.

Area 2 Stage 2 Pit will act as a tailings slurry depository from March 2014 to April 2015 of Phase V/VI and Area 2 Stage 3 Pit will act as a tailings slurry depository from July 2021 to the end of milling in July 2022. Area 2 Stage 2 and 3 pits are separated by a saddle. Area 2 Stage 2 pit will be filled with tailings until the saddle elevation is reached at which point Area 2 Stage 3 pit will be filled until below the natural spill elevation of the Area 2 Stage 3 pit rim.

- Surface Area: 21.98ha
- Ore estimates (Area 2 Stage 2): 3,192,000 tonnes
- Mineral Reserves (Area 2 Stages 2 & 3): 3,888 K tonnes
- Mining Rates Area 2 Stage 3 (during Phase V/VI): 12,800 BCM/day
- Topography:

  Original elevation – 775 m Stage 2 and 835 m Stage 3
  Final pit rim elevation – 799 m
  Minimum elevation during operations – 685 m Stage 2 and 733 m Stage 3
  Elevation at year 2 of Phase V/VI – 760 m saddle elevation
  Elevation at closure – 886.966 m
  Approximate lake depth 35 m
  The pit will be flooded above the tailings ~ 799 m intake structure elevation

- Composition of Waste Unit (removed during Phase mining):

  Waste Rock Mass (Area 2 Stage 2): 25,980,000 tonnes
  Waste Rock Volume: 1,465,000 BCM with a swell factor of 1.3
  Total waste rock volume (Area 2 Stage 3): 1,905,000 m^3
  Estimated PAG waste rock volume: 20% - 381,000 M^3
  Overburden Volume: 2,230,000 BCM with a swell factor of 1.3
  Overburden volume to be removed: 2,899,000 m^3
  Pit walls are neutral or slightly acid consuming

- Volume of Waste Stored:

  2.2 Mm^3 below saddle and 7.7 Mm^3 after Stage 3 is complete
  Tailings and NP:AP <3 waste rock

5.2.2.3 Area 118 Pit

Mining in Area 118 Pit was completed during Phase IV. Area 118 Pit will be backfilled to create the Area 118 Backfill Dump during Phase V/VI. Year 2 of Phase V/VI will reveal a completely filled Area 118 Pit. There will be no change in the Area 118 Pit or Backfill Dump from Year 2 of Phase V/VI to the end of the project.

Area 118 Pit is located upslope and to the south-west of Area 2 Pit and was the final open pit mined during Phase IV of Minto Mine. The Area 118 pit is located upslope and to the west of the Area 2 pit and will be mined during 2014. The Area 118 open pit will be constructed using standard drill and blast mining techniques with the proposed excavation occurring mostly in competent bedrock. The upper benches will be excavated into overburden and there is the potential for shallow surficial instability to occur in the overburden unit.

- Surface Area: 5.08ha
- Area 118 backfill dump 3.6 ha outside the footprint of Area 118 Pit
- Mineral Reserves: 483 K tonnes
- Ore estimates: 88,000 tonnes
- Topography:

Final pit rim elevation	– 862 m
Elevation at year 2 of Phase V/VI	– 886 m
Elevation at closure	– 886 m
Final slopes (dump)	– 3H:2V

- Composition of Waste Unit (during Phase V/VI mining):

  Total waste rock volume: 639,000 m^3
  Pit walls are neutral or slightly acid consuming

5.2.2.4 Minto North Pit

Mining in Minto North Pit will be completed during Phase V/VI. Minto North will be the first pit mined in Phase V/VI. Year 2 of Phase V/VI will have mining at Minto North complete and the Pit will fill with water as the rest of Phase V/VI passes.

The Minto North Pit is located north east of the Main Waste Dump in the McGinty Creek drainage. Minto North will be the first deposit mined during Phase V/VI of mine development, from August 2014 to August 2015.

- Surface Area: 10.4ha
- Ore estimates: 1,605 tonnes
- Mining Rates: 12,800 BCM/day
- Topography:

  Elevation at closure – 976.44 m

- Composition of Waste Unit (during Phase V/VI mining):

  Waste Rock Released: 3,269,000 BCM with a swell factor of 1.3
  Total waste rock volume: 4,250,000 m^3 (0% PAG)
  Overburden Released: 697,000 BCM with a swell factor of 1.3
  Overburden volume to be removed: 906,000 m^3
  Pit walls are neutral or slightly acid consuming

5.2.2.5 Ridgetop North Pit

Mining in Ridgetop North Pit will be completed during Phase V/VI. Ridgetop North will be the last pit mined in Phase V/VI. Year 2 of Phase V/VI will reveal mining in Ridgetop North that began one month prior. By the end of mining Ridgetop North Pit will be filled with tailings slurry.

The western portion of the proposed Ridgetop pits are anticipated to contain 1 to 5m of soil overburden deepening to the east to generally about 5 to 15m at the eastern edge, with a maximum depth of 21m at the far northeast portion of Ridgetop North and at the far east portion of Ridgetop South. The bedrock at Ridgetop is generally weathered to a depth of approximately 45 to 70m below ground surface.

The Ridgetop pits share Area 2's recommended 30° slope in the overburden zone and a 53° interramp angle in waste rock, based on the recommendations of SRK's report.

The Ridgetop North Pit is located south-east of Area 118 Pit. Ridgetop North will be the final open pit of Minto Mine operations with mining occurring from July 2016 to April 2018 and will be the last open pit to be mined during Phase V/VI.

- Surface Area: 11.64ha
- Mineral reserves: 2,093 K tonnes shared with Ridgetop South
- Mining Rates: 7,200 BCM/day

- Topography:

  Final pit rim spill elevation – 862 m
  Elevation at closure – 931.856 m

- Composition of Waste Unit (removed during Phase V/VI mining):

  Waste rock volume: 2,628,000 BCM with a swell factor of 1.3
  Total waste rock volume: 3,416,000 m^3 (20% PAG – 683,200 m^3)
  Overburden Volume: 702,000 BCM with a swell factor of 1.3
  Overburden volume to be removed: 913,000 m^3

5.2.2.6 Ridgetop South Pit

Mining in Ridgetop South Pit will be completed during Phase V/VI. Year 2 of Phase V/VI will reveal mining in Ridgetop South that is ongoing. By the end of mining Ridgetop South Pit will be filled with overburden.

The Ridgetop South Pit is located south of Ridgetop North Pit. Ridgetop South will operate concurrently with Ridgetop North with mining occurring from June to November 2016.

- Surface Area: 4.05
- Mineral reserves: 2,093 K tonnes shared with Ridgetop North
- Mining Rates: 7,200 BCM/day
- Topography:

  Elevation at closure – 931.856 m
  Final slopes (dump) – 3H:1V

- Composition of Waste Unit (removed during Phase V/VI mining):

  Waste rock volume: 482,000 BCM with a swell factor of 1.3
  Total waste rock volume: 627,000 m^3 (20% PAG – 125,400 m^3)
  Overburden volume: 135,000 BCM with a swell factor of 1.3
  Overburden volume to be removed: 176,000 m^3

5.2.3 Overburden and Waste Rock Dumps

5.2.3.1 Main Waste Dump

The Main Waste Dump has been used in previous phases of mining. The Main Waste Dump will be expanded during the first year of Phase V/VI. The condition of the dump will not change between Year 2 of Phase V/VI and the end of the project.

The Main Waste Dump is located west of the Main Pit and has served as a combined waste and overburden dump since 2007. Previous operation of the Main Waste Dump included disposal of waste from the Main Pit, disposed of in lifts. The Main Waste Dump is constructed on solid rock and no physical stability issues have been observed to date.

The Main Waste Dump will be expanded as part of Phase V/VI. Construction of the Main Waste Dump Expansion will involve the combined placing of waste rock and overburden between August 2014 and February 2015 with only waste rock placement continuing until August 2015. The overburden will be placed in the northwest corner of the dump with waste rock placed all around to buttress it. This will limit potential long term weaknesses caused by degrading overburden, including ice-rich material.

The waste accepted by the Main Waste Dump during Phase V/VI will originate in the Minto North Pit. In order to limit the potential impacts on McGinty Creek, waste from Minto North will be stored in the Minto Creek catchment in the Main Waste Dump Expansion.

- Surface Area: 11.13 ha
- Topography:
  - Elevation before phase V/VI – 930 m
  - Elevation at year 2 of Phase V/VI – 961m
  - Elevation after Phase V/VI – 961 m
  - Elevation after Phase V/VI closure – 961 m
  - Final slope – 2.5H:1V (26 to 28 degrees) including a large bench at 930 m the overall slope is 3H:1V
- Composition of Waste Unit: 0 – 0.64% copper originating from Main Pit and Minto North Pit
  - No evidence of ARD or potential ARD
  - NP/AP ratio 48.5 and average paste pH 8.61
- Volume of Waste Stored:
  - Phase V/VI volumes – 4,250,000 m^3 of waste rock from Minto North
  - – 906,000 m^3 of overburden
  - – 5,160,000 m^3 Total Dump volume
  - Ice-rich and thaw stable co-disposed
- Cover thickness: 0.5 m with ~20% of the benches having 2.0 m thick cover
- Overburden Cover Volume: 400,000 m^3

5.2.3.2 Reclamation Overburden Dump

The Reclamation Overburden Dump has been used in previous phases of mining. The Reclamation Overburden Dump will not be accepting material during Phase V/VI, and there will be no change between the dump condition at the beginning of Phase V/VI and Year 2 of Phase V/VI. The Reclamation Overburden dump will be used as a source for reclamation materials.

The Reclamation Overburden Dump is located west of the Main Waste Dump. The Reclamation Overburden Dump was in use from 2008 to current and will not be used to store overburden during Phase V/VI, unless required. Overburden stripped from the Main Pit and Area 2 was stockpiled in the Reclamation Overburden Dump. There is capacity in the Reclamation Overburden Dump to store additional overburden released during Phase V/VI if necessary.

Overburden will be removed from the Reclamation Overburden Dump and used for covers and growth media during Phase V/VI.

- Surface Area: 30.41
- Topography:

Elevation at closure	– 924.284 m
Final slopes	– max 2.5:1

- Composition of Waste Unit: Overburden stripped from various areas prior to Phase V/VI
- Volume of Overburden Stored: estimated 4.43 Mm^3, available for soil cover construction at the end of Phase IV

5.2.3.3 Ice-Rich Overburden Dump

The Ice-Rich Overburden Dump has been used in previous phases of mining. The Ice-Rich Overburden Dump will not be accepting material during Phase V/VI, and there will be no change between the dump condition at the beginning of Phase V/VI and Year 2 of Phase V/VI. The Ice-Rich Overburden dump will be used as a source for reclamation materials.

The Ice-Rich Overburden Dump is the furthest west reclamation unit at Minto Mine. A toe berm of waste rock was constructed to provide stability as the ice in the overburden melts. Monitoring of the Ice-Rich Overburden Dump has been ongoing throughout operation and no stability issues have been identified to date. Materials from the Ice-Rich Overburden Dump will be used as a source of growth media during reclamation.

- Surface Area: 2.4 ha
- Topography:

Maximum elevation during operations	– 894 m
Elevation at year 2 pf Phase V/VI	– 894 m
Elevation at closure	– 894 m
Final slopes	– max 2.5H:1V

- Cover thickness: 0.5 m over toe berm only

5.2.3.4 Southwest Waste Dump

The Southwest Waste Dump was used in previous phases of mining. The Southwest Waste Dump will be accepting material during the second year of Phase V/VI. There will be no change between the dump condition at Year 2 of Phase V/VI and the end of mining.

The Southwest Waste Dump is located south of the Main Waste Dump. Construction of the SWD began in March 2009; it received waste rock and non-ice rich overburden continuously until XXX, initially from the final stages of mining of the Main Pit, and later from mining of Stages 1 and 2 of Area 2 Pit. Segregation of waste rock into classes on the basis of copper content was conducted. Waste rock of high and medium grades were placed separately in the southern-most extent of the Southwest Waste Dump. Foundation movements have been observed in the foundation of the Southwest Waste Dump.

Expansions of the dump's height and footprint were permitted as part of Phase IV. The Southwest Waste Dump will receive an overburden cover from July 2015 to September 2015 of Phase V/VI.

- Surface Area: 75.5 ha
- Topography:
  Elevation at closure – 919 m
- Composition of Waste Unit: 6.44 Mm^3 waste with copper content < 0.1% as part of Phase IV
  No evidence of PAG
- Overburden Cover Volume:
  365,000 m^3 for low-grade waste area cover and 306,000 m^3 for mid-grade and high-grade waste area cover for a total of 671,000 m^3
- Cover thickness: 0.5 m with ~20% of the benches having 2.0 m thick cover
  Perimeter slopes will be covered with a minimum 1 m thick cover

5.2.3.5 Dry Stack Tailings Storage Facility

The Dry Stack Tailings Storage Facility (DSTSF) was used in previous phases of mining. The DSTSF will not be accepting waste during Phase V/VI, but will be accepting cover material during the second year of Phase V/VI. There will be no change between the DSTSF condition at Year 2 of Phase V/VI and the end of mining.

The DSTSF was the first tailings depository in Minto Mine development. Tailings were placed in the DSTSF until October 31, 2012. The DSTSF accepted tailings from milling of Main Pit ore and tailings from seven months of milling of Area 2 Pit ore. All tailings placed in the DSTSF were dewatered using ceramic filters before being conveyed by truck for spreading and compaction in the Dry Stack Tailings Storage Facility (DSTSF). Construction of the facility was done in accordance with EBA's Geotechnical Design Report, Dry Stack Tailings Storage Facility, Minto Mine, Yukon (EBA, 2007). Further details on the tailings handling procedures are available in Minto's Tailings Management Plan (TMP) and the related Operations, Maintenance and Surveillance Plan (OMS) for the DSTSF.

The DSTSF is located on a bench to the south of the mill and upslope from the Minto Creek channel. The facility has been constructed as per the specifications provided in the TMP and overseen by the Engineer of Record (EBA). Field compaction of placed dewatered tailings was regularly verified using a nuclear densometer, as per the quality control program. The last tailings placement in the DSTSF occurred in November of 2012, at which point issuance of the water licence amendment for Phase IV operations allowed for the switch to the placement of slurry tailings in the Main Pit. Monitoring of the stability of the tailings stack has been conducted through daily visual inspections and through monitoring the installed instrumentation (piezometers, ground temperature cables and settlement monuments). Regular field visits and an annual geotechnical inspection are conducted by the Engineer of Record as required under the Quartz Mining Licence QML-0001 (Section 9.3.2). These investigations revealed facility movement beyond expectations, and evaluation of options for mitigating the movement.

Minto submitted a risk assessment report on the DSTSF to the Department of Energy Mines and Resources (EMR) in March 2009 (SRK, 2009b). The report evaluated all conceivable failure modes for the facility using the Failure Modes and Effects Analysis (FMEA) method. The report recognizes the lowered physical risks associated with the DSTSF versus a conventional slurried tailings impoundment and noted that the regulatory requirements necessary to mitigate risks are currently in place.

The Mill Valley Fill which is described in the next section was designed to buttress the DSTSF and eliminate its movement. The Mill Valley Fill Stage 1 was built to design completion and movement was slowed, however ongoing facility movement identified through the monitoring program facilitated further investigation. The rate of movement varied across the dry stack; along the centerline of the facility, where tailings fill is thickest, it is approximately 3.0 mm/d (DSSH12), while the rate at the eastern edge measures 1.5 mm/d (DSSH17). The movement rates of these survey hubs peaked at 8.6 mm/d and 2.5 mm/d, respectively, suggesting that the MVFE has had a significant effect.

The DSTSF is monitored for stability daily through visual inspections and monitoring of the installed instrumentation. Movement has been observed in the DSTSF and the Mill Valley Fill Extension was constructed to mitigate this. The Mill Valley Fill and Mill Valley Fill Extension are directly downslope from the DSTSF and provide support to the DSTSF. The Mill Valley Fill Extension is discussed in detail in Section XX.

The DSTSF will be accepting cover material stripped from Area 2 Pit and Area 118 Pit during September and October 2015 of Phase V/VI.

- Surface Area: 20.54 ha
- Maximum elevation during operations– 801.952m (from 3D surface)
- Topography:

  Elevation at year 2 of Phase V/VI – 801.952m (from 3D surface)
  Elevation at closure – 801.952m (from 3D surface)

- Composition of Waste Unit:

  Tailings from Main Pit Milling
  Tailings from Area 2 Pit milling: 5.1 million dry metric tonnes
  No acid generating potential

- Cover thickness 0.5 m is being placed as overburden is released from Area 2 stripping

  Cover material volume 490,000 m^3 overburden

- Volume of Soil cover required for cover: Part of 490,000 m^3 (total shared with Mill Valley Fill Extension)

5.2.3.6 Mill Valley Fill

The Mill Valley Fill and the first stage of expansion were constructed in previous phases of mining. The Mill Valley Fill Extension Stage 2 will be accepting waste rock during and an overburden cover during the second year of Phase V/VI. There will be no change between the Mill Valley Fill Extension condition at Year 2 of Phase V/VI and the end of mining.

The Mill Valley Fill is located in the Minto Creek valley at the toe of the Dry Stack Tailings Storage Facility. It was constructed early in the life of Minto Mine to provide space for milling and related activities and to provide additional stability to the Dry Stack Tailings Storage Facility.

The Mill Valley Fill Extension is an extension of the Mill Valley Fill located immediately east of the original dump. It was constructed during Phase IV to provide additional support to and halt the movement of the Dry Stack Tailings Storage Facility after observations of movement. Monitoring of the DSTSF has shown rates of movement slowing down since the Phase IV Mill Valley Fill Extension but the movement has no ceased completely. Phase V/VI will see Mill Valley Fill Extension Stage 2 add more rockfill to the existing buttress both vertically and to the east will improve the long-term stability of the DSTSF. The Mill Valley Fill Extension Stage 2 will also provide a foundation for a water conveyance channel for the re-establishment of Minto Creek along the lowest point in the newly established topography.

Mill Valley Fill Extension Stage 2 will be accepting waste rock from July 2015 to April 2016. A soil cover will be placed over the entire Mill Valley Fill and Dry Stack Tailings Storage Facility areas from November 2015 to April 2016 of Phase V/VI of Minto Mine operation.

- Surface Area: 21.82 ha

  4.11 ha from Mill Valley Fill Extension Stage 2

- Topography:

  Maximum elevation during operations – 784 m
  Elevation at closure – 784 m
  Final slopes – 2.5H:1V
  With benches and mid height catchment overall slopes are 3H:1V

- Composition of Waste Unit:

  Low copper content run-of-mine rock

- Volume of Waste Stored:

  Mill Valley Fill Extension: – 1,637,000 m^3 volume for Phase V/VI

- Cover thickness: 0.2 m of growth media – no source control required
- Volume of Soil cover required for cover: Part of 490,000 m^3 (total shared with Dry Stack Tailings Storage Facility)

5.2.3.7 South Wall Buttress and Main Pit Dump

The South Wall Buttress began during previous phases of mining. The Main Pit Dump is an upward expansion of the South Wall Buttress that will be constructed during Phase V/VI. Year 2 of Phase V/VI will reveal the Main Pit Dump with ongoing waste rock and overburden cover placement.

Construction on the South Wall Buttress began in May 2011 after a failure of the south wall of the Main Pit was observed. The South Wall Buttress is a rock fill structure designed to buttress the south wall of the Main Pit and preserve the remainder of the pit volume for tailings deposition. The South Wall Buttress was receiving waste rock from Area 2 Pit and was completed during Phase IV of mine operations.

The Main Pit Dump is an upwards expansion of the South Wall Buttress. The Main Pit Dump is wholly within the Main Pit footprint. Waste rock placement will occur from May to November 2016 with cover placement beginning in June and ending in November 2016.

The Main Pit Dump will receive waste rock from Area 2 Stage 3 Pit, Ridgetop South Pit and the Underground areas. The dump will also receive overburden from Ridgetop North and South Pits.

- Surface Area: 13.01 ha, 16.13ha
- Topography:

  Elevation before phase V/VI – 810 m
  Elevation after Phase V/VI – 838 m (max elevation)
  Final slope – 2.5H:1V
  Bench and road bring the final slope to nearly 3H:1V 32%
- Volume of Waste Stored:

  Waste rock – 1.03 Mm^3 from Area 2 Stage 3 pit, Ridgetop South and Underground
  Overburden – 349,000 m^3
  Waste Rock and Overburden Combined – 1,377,000 m^3
  Total - 3,014,000 m^3

5.2.3.8 Ridgetop Waste Dump

The Ridgetop Waste Dump will be completed during Phase V/VI. Year 2 of Phase V/VI will reveal waste placement that began one month prior. By the end of mining the Ridgetop Waste Dump will be completely constructed.

The Ridgetop Waste Dump is a waste rock dump that is to be built on a thaw stable-foundation west of the Ridgetop North and South Pits and south of the Area 118 Backfill Dump. The Ridgetop Waste Dump will accept waste from Ridgetop South Pit starting in July 2016 and continuing until April 2018, being the last operational waste dump of Phase V/VI.

The dump will be built on the west side of the catchment divide such that drainage off the Ridgetop Waste Dump will primarily report to the W15 catchment that already contains the Southwest Waste Dump and the Main Waste Dump. This will limit drainage off the waste dump eastward into the W35 catchment.

- Surface Area: 29.15

  25.4 ha west of catchment divide and 1.5 ha & 1.9 ha sections east of catchment divide
- Topography:

  Elevation at closure – 970 m
  Pit Rim Elevation at closure – 909m
  Final slopes – 3H:1V

- Composition of Waste Unit (placed during Phase V/VI):
- Dump Waste Rock Capacity: 3,416,000 m^3

5.2.4 Ore Stockpiles

There are four stockpile pads southeast of the mill complex. Three of these pads are generally used for sulfide ore and the fourth is used for partially oxidized ore. Two additional stockpile pads have been constructed west of the Main Pit and are used to store partially oxidized ore and low-grade ore. Milling of all stockpiled area will be completed before final closure. Both the high grade sulphide stockpile and pad located south of the mill and the low grade sulphide stockpile and oxide ore pad located between the Main Pit and the Main Waste Dump will be depleted prior to final closure. No stability issues have been identified to date with either of the ore stockpiling areas.

- Surface Area: 8.6 ha
- Elevation at closure: 804m
- Cover thickness at closure: 0.5 m

5.2.5 Mine Infrastructure

The following sections describe major mine infrastructure that requires consideration at closure. Other infrastructure items that will require general closure measures include: access road, barge landing, Pelly laydown, Pelly camp, airstrip and explosives plant site.

5.2.5.1 Mill Complex

The mill is located on the north side of the Minto Creek valley east of the Main Pit and west of the camp. The mill processes both stockpiled and run-of-mine ore at a nominal rate of 4200 tonnes per day, increased from the initial 1,563 tonnes per day. This rate will continue through Phase V/VI. The ore is processed using conventional crushing, grinding, flotation and dewatering to produce copper concentrates with significant gold and silver credits. The mill facilities include:

- 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; and
- Tailings thickening and pumping to an in-pit deposition location.

Slurry tailings produced at the mill are currently discharged to the Main Pit and will be discharged to Area 2 Stages 2 and 3 and Ridgetop North, as described in previous sections.

- Surface Area: 23.11 (Mill, Camp, Laydown, Fuel Storage and Crusher)
- Elevation at closure: 792 (for the Camp area and Mill area)

5.2.5.2 Solid Waste Facility

Minto Mine operates a solid waste facility under Commercial Dump Permit # 81-005 issued by YG, Department of Environment, Environmental Programs Branch. The facility includes a burning pit for untreated wood and paper waste, a construction waste disposal area, metal and rubber tire disposal areas and an incinerator for food waste and other wastes. No material is placed in the landfill that could potentially be an animal attractant. The burn pit and incinerator are surrounded by an exclusion (bear) fence. Figure 5-6 below shows the current locations of all the waste management facilities on site.

MINTO MINE
PHASE V/VI EXPANSION

RECLAMATION AND CLOSURE PLAN
REVISION 5.0

FIGURE 5-6

WASTE MANAGEMENT INFRASTRUCTURE

JUNE 2014

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when printed on 11 x 17 inch paper

0 50 100 150
Meters

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11 th 2013.

Datum: NAD 83 Projection: UTM Zone 8N

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(*Last edited by: amatlashevska;30/06/2014/11:53 AM*)

5.2.5.3 Water Storage Pond and Water Treatment Plant

Water used for grinding and flotation is currently sourced from the Main Pit. After cycling through the mill complex, water is disposed of in the Area 2 Pit as tailings slurry or is discharged to the Mill Pond to be recycled.

The Water Treatment Plant accepts water from the Main Pit or the Water Storage Pond and discharges treated water to the Main Pit, Water Storage Pond or Minto Creek. The Water Treatment Plant discharges sludge and reverse osmosis concentrate to the Main Pit. The Water Treatment Plant consists of:

- Ballasted lamella clarifier unit (Actiflo©) for removal of TSS, total metals and dissolved copper;
- Clarification;
- Filtration; and
- Two reverse osmosis trains to treat nitrate and selenium.

The RO process successfully removes 95-99% of all constituents in the feed water. This process produces two streams, 75% of the water is discharged to the receiving environment with 95-99 % removal and 25% is co-disposed of with the tailings.

5.3 MINING OPERATIONS

5.3.1 Surface Mining

The expansion of surface mining as part of Phase V/VI activities consists of three new open pits – Minto North, Ridgetop South, and Ridgetop North – and the expansion of the Area 2 Pit previously presented in Phase IV with a third pushback (referred to as Area 2 Stage 3).

Area 2 was first added to the mine's mineral reserves by a prefeasibility study (PFS) completed in November 2007, though the pit design created at that time did not include the Stage 3 pushback proposed in the most recent YESAB application. The subsequent Phase IV PFS confirmed the design, still without the Stage 3 pushback; this design formed the basis for the Phase IV mine plan. The Phase V PFS expanded Area 2 to include the Stage 3 pushback.

The Minto North deposit was brought into the mine's reserves in late 2009 with the release of the Phase IV prefeasibility study; the Phase V and Phase VI studies updated the reserve to reflect changes in the cut-off grade and optimization of the pit design. The Ridgetop North and Ridgetop South pits were added to the reserve as part of a technical report prepared in June 2008 and updated in subsequent prefeasibility studies. These pits were not included in the Phase IV project proposal because insufficient information was available at the time.

These pits will extend surface mining at Minto to 2017.

5.3.1.1 Mineral Reserves

Table 5-3 shows Minto's open pit ore reserves as of January 1, 2013.

Table 5-3 Open Pit Reserve Estimate as of January 1, 2013

	Mineral Reserve Class	Tonnes	Diluted Grade			Contained Metal		
		(K tonnes)	Cu (%)	Au (g/t)	Ag (g/t)	Cu (MLb)	Au (k troy oz)	Ag (k troy oz)
North	Proven	1,596	2.26	1.21	8.12	80	62	417
	Probable	9	1.68	0.58	6.92	0	0	2
	Subtotal	1,605	2.26	1.21	8.11	80	62	419
Ridgetop	Proven	1,073	1.02	0.25	2.12	24	9	73
	Probable	1,020	1.00	0.28	2.97	22	9	97
	Subtotal	2,093	1.01	0.26	2.53	47	18	171
118	Proven					0	0	0
	Probable	483	1.28	0.10	1.81	14	2	28
	Subtotal	483	1.28	0.10	1.81	14	2	28
Area 2	Proven	2,310	1.43	0.53	4.80	73	39	357
	Probable	1,578	1.02	0.29	3.40	36	15	173
	Subtotal	3,888	1.27	0.43	4.23	108	54	529
Open Pit Subtotal	Proven	4,979	1.61	0.69	5.29	177	110	846
	Probable	3,090	1.06	0.26	3.02	72	25	300
	Subtotal	8,069	1.40	0.52	4.42	249	136	1,147

It should be noted that in Table 5-1 the reserves are quoted for the entire Area 2 Pit, including the portion mined in Phase IV. The Ridgetop North and South pits are reported as a combined total.

In addition to the ore reserves described above, these pits will release the following volumes of waste rock and overburden as shown in Table 5-2 and Table 5-3.

Table 5-4 Volume of Waste Rock Released from Phase V/VI Mine Components

Source Location	Quantity (BCM)	Swell Factor	Waste Rock Volume (m^3)
Minto North	3,269,000	1.3	4,250,000
Area 2 Stage 3	1,465,000	1.3	1,905,000
Ridgetop South	482,000	1.3	627,000
Ridgetop North	2,628,000	1.3	3,416,000
Underground	102,000	1.3	133,000
	Total Waste Rock (Phase V/VI)		**10,331,000**

Table 5-5 Volume of Overburden Released from Phase V/VI Mine Components

Source Location	Quantity (BCM)	Swell Factor	Overburden Volume (m^3)
Minto North	697,000	1.3	906,000
Area 2 Stage 3	2,230,000	1.3	2,899,000
Ridgetop South	135,000	1.3	176,000
Ridgetop North	702,000	1.3	913,000
Underground	0	1.3	0
	Total Overburden (Phase V/VI)		**4,894,000**

The following figures provide an overview of the locations and designs for all open pit development in Phase V/VI.

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PHASE V/VI EXPANSION

RECLAMATION AND CLOSURE PLAN
REVISION 5.1

FIGURE 5 - 7

OVERVIEW OF PHASE V/VI OPEN PITS

AUGUST 2014

capstone MINTO MINE

Phase V/VI Pits

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0 50 100 200 300 400 500 Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics.
Imagery acquired August 11[th] 2013.

Datum: NAD 83 Projection: UTM Zone 8N

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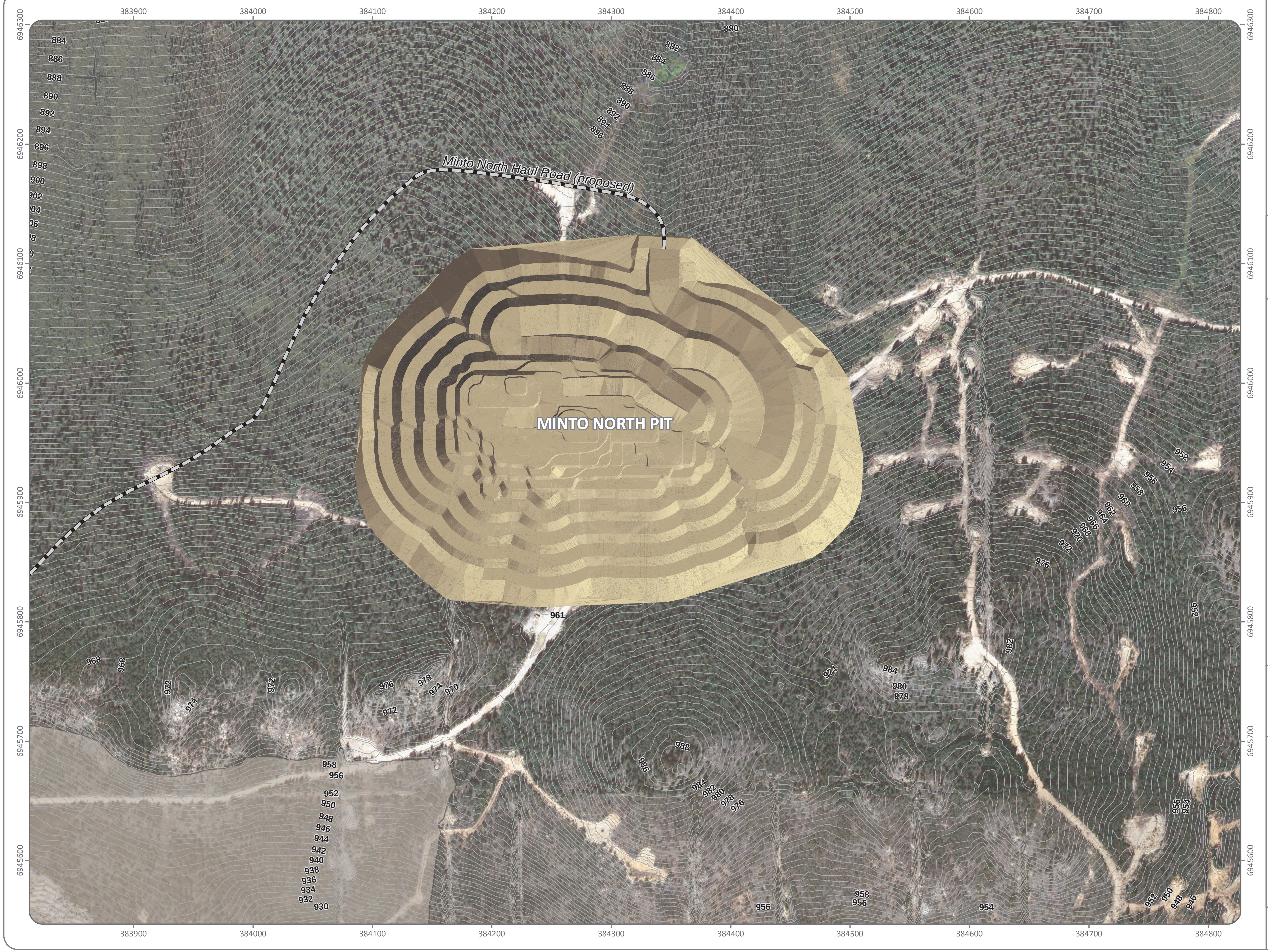

MINTO MINE
PHASE V/VI EXPANSION

RECLAMATION AND CLOSURE PLAN
REVISION 5.1

FIGURE 5 - 8

PHASE V/VI OVERVIEW OF MINTO NORTH PIT

AUGUST 2014

capstone
MINTO MINE

Phase V/VI Pit

1:3,000 *when printed on 11 x 17 inch paper*

0 25 50 75 100 Meters

ACCESS

Coutour lines provided by Capstone Ltd. Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11 th 2013. Site contours derived from 2013 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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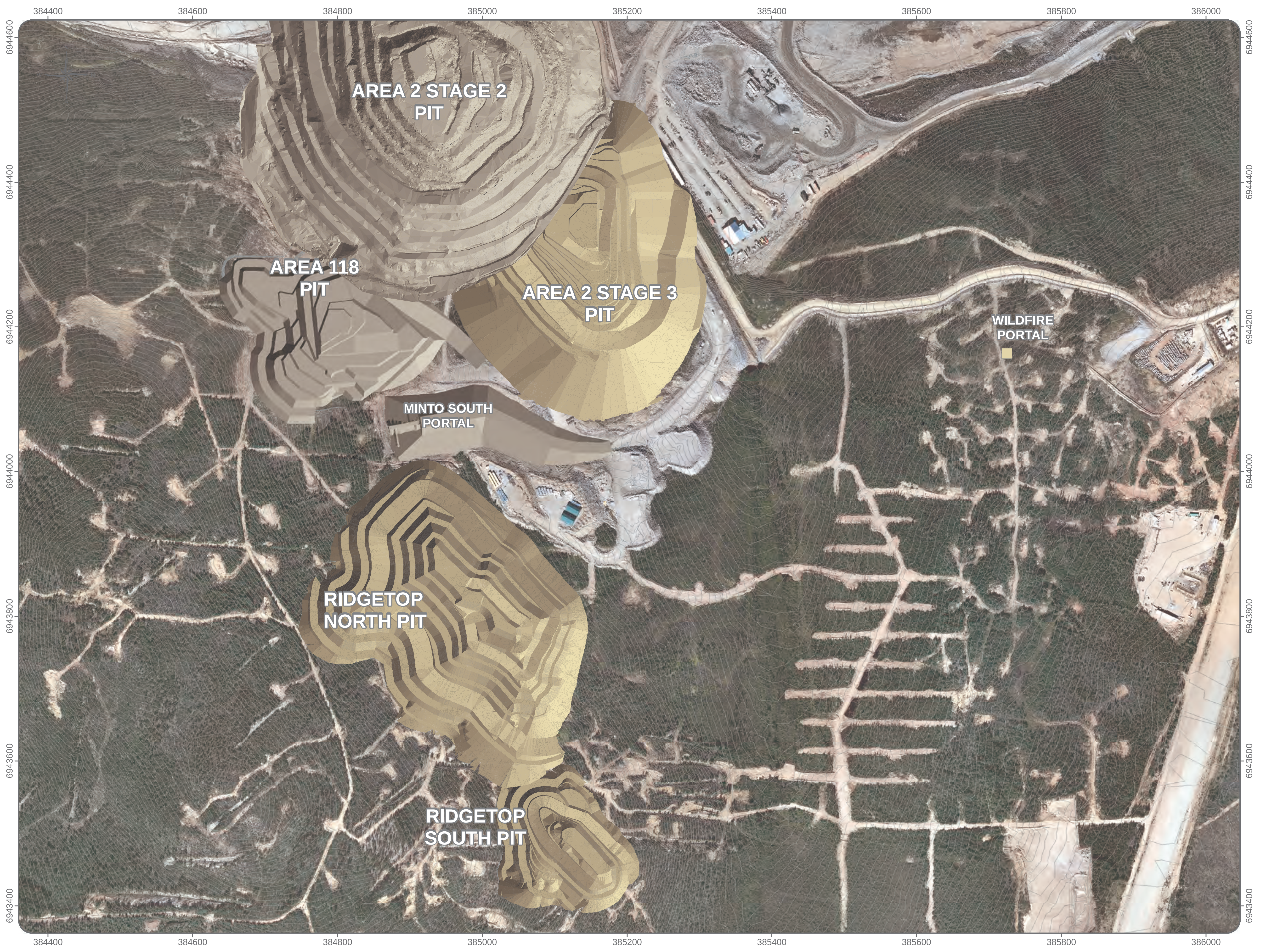
MINTO MINE
PHASE V/VI EXPANSION

RECLAMATION AND CLOSURE PLAN
REVISION 5.1

FIGURE 5 - 9

PHASE V/VI OVERVIEW OF AREA 2, RIDGETOP SOUTH, AND RIDGETOP NORTH PIT

AUGUST 2014



capstone MINTO MINE

Phase V/VI Pits

Phase IV Features

1:5,000 *when printed on 11 x 17 inch paper*

0 25 50 100 150 200 Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11[th] 2013. Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Datum: NAD 83 Projection: UTM Zone 8N

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(*Last edited by: amatlashevska;07/08/2014/14:28 PM*)

5.3.1.2 Open Pit Mining Sequence

Of the Phase V/VI pits, Minto North is planned to be mined first, as it represents the highest-grade reserve. The mining sequence then moves to Area 2 Stage 3, the completion of which will allow for tailings deposition into the full volume of the Area 2 Pit. Mining will then move to Ridgetop South and conclude with the Ridgetop North pit.

Figure 5-10 below presents the proposed open pit mining schedule for the Phase V/VI mining plan.

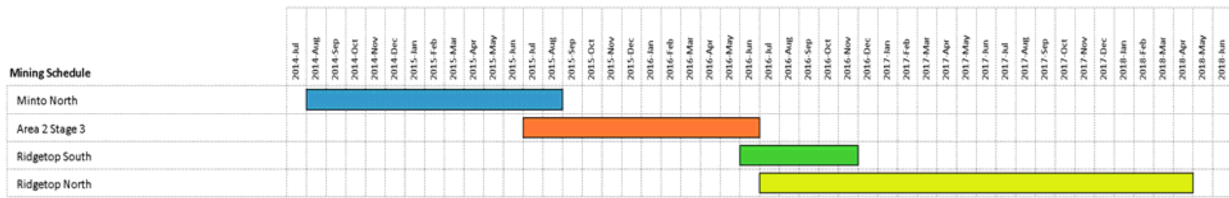


Figure 5-10 Phase V/VI Open Pit Mining Schedule

Mining of Minto North and Area 2 Stage 3 are currently scheduled to proceed at a rate of 12,800 BCM/day, this rate being set around a number of operational constraints, chiefly the need to complete pits in a timely manner so that Area 2 Stage 3 can be used for tailings storage. Ridgetop will be mined at a reduced rate of 7,200 BCM/day, as its tailings storage volume is not time-critical, and its ore release will supplement ongoing feed from stockpiles and the underground operation.

At these rates, open pit mining will require 47 months to complete. Individual pits have the following lifetimes as shown in Table 0 5; note that mining of consecutive pits will overlap slightly.

Table 5-6 Lifetimes of Phase V/VI Pits

	Mining Duration (months)
Minto North	13
Area 2 Stage 3	11
Ridgetop South	5
Ridgetop North	22

Mining in the first of the Phase V/VI pits, Minto North, is currently scheduled to begin in late 2014, or as shortly thereafter as procurement of appropriate authorizations allows.

5.3.1.3 Mine Equipment

The open pit portion of the mine will continue to operate as a conventional truck/excavator operation using diesel-powered excavators, trucks, drills, and auxiliary equipment. Rock will be broken by blasting using ANFO where ground- and surface-water conditions permit and by emulsion where the presence of water makes the use of ANFO impractical. Overburden will be ripped and pushed using dozers or blasted.

The scale of the operation will initially remain similar to that in Phase IV; therefore, the basic composition of the mining fleet will remain relatively similar. When mining of Ridgetop South commences in 2016, Minto will see a reduction in trucks, excavators, drills, and dozers in proportion to the drop in mining rate.

Table 5-5 lists the major heavy equipment expected to be in use at Minto.

Table 5-7 Open Pit Equipment Fleet for Phase V/VI Mining

Equipment Type	No. of units
Hydraulic Excavators, Hitachi EX1200 or similar	3
100-ton Haul Trucks, Cat 777 or similar	9
60-ton Haul Trucks, Cat 773 or similar	4
Front-end loaders, Cat 990 or similar	2
Small Hydraulic Excavators, Cat 330 or similar	2
D11-class dozer	2
D10-class dozers	2
Graders, 16' blade	2
Blast hole drills, 9 7/8" hole diameter	2
Blast hole drills, 6 ¾" hole diameter	2
Blast hole drills, 4" hole diameter	1

The mining fleet will continue to be contractor-owned and operated. The mine will continue to operate with two 11-hour shifts per day, seven days per week, year-round.

5.3.1.4 Grade Control and Material Segregation Practices

Accurate in-pit separation of ore from waste, as well as segregation of various types of waste, will continue to be essential to the successful operation of the mine. Overburden from pit stripping will be stockpiled separately for use at closure as a cover/reclamation medium, and Minto will place overburden on completed dumps as part of progressive reclamation activities during mining. Further detail on waste handling and placement can be found in the Waste Rock and Overburden Management Plan (separate cover).

Grade control practices for waste rock and ore can be summarized as follows:

- Drill cuttings from every blast hole are sampled, tagged, and sent for assay at the on-site lab prior to blasting;
- Representative samples of the cuttings are assayed using atomic absorption (AA) to determine the metal content;
- The on-site assay lab, under supervision of the chief assayer, tests each sample for copper, soluble copper, and silver content;
- The environmental assay lab tests the sample for total sulfur and total inorganic carbon content, allowing for a determination of NP/AP ratio;
- The assay results are sent to the geology department for interpretation;

- The geology department plots the results spatially, then draws polygons enclosing holes with similar assay results to identify regions of similar average grade (for ore) or similar waste class (for waste);
- After blasting, the aforementioned polygons are laid out in the field by the mine surveyor working with the production geologist, using stakes and flags of various predefined colours; and
- Mine operations personnel, under the supervision of the pit foreman, excavate and haul material to the destination designated for the material type. Destinations are communicated to foremen and operators by the production geologist.

5.3.1.5 Explosives Use and Management

Surface mining of Phase V/VI will continue the explosives use and management practices used in both the Main Pit and Phase IV.

The mine is currently authorized, through Natural Resources Canada license F72384, to store 180,200 kg of emulsion explosive and 1,500,000 kg of ammonium nitrate (unmixed with fuel oil).

Minto also has two explosives magazines on site, allowing for the storage of 10,000 detonators and 60,000 kg of explosives under YWCHSB permit numbers YT534 and YT533, respectively.

Due to cost considerations and the relatively small quantity of emulsion permitted on site, ANFO is the mine's preferred explosive. In areas where the ground is dry, ANFO is loaded directly into blast holes. If there is a small quantity of water within a blast hole, an attempt will be made to pump it dry: if successful, a waterproof plastic liner will be inserted into the hole, which will then be loaded with ANFO.

Where a hole cannot be pumped dry—for example, if the water table is high—a water-resistant emulsion blend will be used.

5.3.1.6 Underground Mining

Through Minto's prefeasibility studies, the most recent of which was completed in August of 2012, several distinct areas have been demonstrated to have grade, volume, and continuity sufficient to justify underground mining. These areas are to be accessed from three separate portals, each of which will have its own surface infrastructure:

- Minto South Underground (MSU);
- East Keel Underground (EKU); and
- Wildfire Underground (WFU).

The MSU (Minto South Underground) describes development underneath and around the Area 2 and Area 118 pits, accessed from the Minto South Portal, which is southwest of the Area 2 Pit. This underground development was presented in the Phase IV application to YESAB and approved in subsequent major licence amendments.

The East Keel Underground describes an underground mining complex accessed from the proposed Highwall Portal to be located east of the Main Pit. It will access two distinct areas known as Copper Keel and Minto East.

The Wildfire Underground is a third underground mining complex designed to target the Wildfire ore zone. This area will be accessed through a proposed Wildfire Portal and will have its own dedicated infrastructure. It will be mined after the completion of the MSU and the EKU; underground mining activity will transition to the Wildfire Underground (WFU) as the other underground zones near completion.

5.3.1.7 Underground Reserves

Table 5-8 summarizes the underground reserves.

Table 5-8 Underground Reserves (including Phase IV Minto South Underground Reserves)

Underground								
Minto East	Proven	0	0	0	0	0	0	0
	Probable	709	2.28	1.04	6.15	36	24	140
	Sub-total	709	2.28	1.04	6.15	36	24	140
Area 2/118	Proven	0	0	0	0	0	0	0
	Probable	1731	1.76	0.74	7.19	67	41	400
	Sub-total	1731	1.76	0.74	7.19	67	41	400
Copper Keel	Proven	106	1.74	0.61	6.30	4	2	21
	Probable	1455	1.81	0.65	6.70	58	30	313
	Sub-total	1561	1.81	0.65	6.67	62	32	335
Wildfire	Proven	301	1.80	0.65	6.06	12	7	59
	Probable	59	1.59	0.77	7.85	2	2	15
	Sub-total	360	1.77	1.00	6.35	14	9	74
Underground Subtotal	Proven	407	1.78	0.81	6.12	16	10	80
	Probable	3954	1.87	0.73	6.83	163	97	869
	Sub-total	4361	1.86	0.76	6.77	179	107	949

5.3.1.8 Underground Mining Methods

Each of the areas summarized in the reserves consist of many separated lenses of ore, ranging in size from hundreds of tonnes to hundreds of thousands of tonnes. The physical characteristics of each ore zone determine which mining methods can be applied. The general characteristics of the underground ore zones are summarized in Table 5-9.

Table 5-9 Summary of Deposit Characteristics and Context

Parameters	Unit	Value	Comment
Depth below surface	m	100-320	
Dip	deg.	10-30	
Thickness	m	3-25	10 m average
Size (aerial)	m	100x150	Average size
Production capacity	t/vm	10,000	Approximate tonnes per vertical metre
Mineral value	$/t NSR	98	Average value
Mineralization	Mineralized zones are visually and geochemically obvious due to density of visible sulphides and the degree of foliation.		
Continuity	The zones appear to be continuous over tens of metres.		
Regularity	The deposits appear to be well-defined zones that are thick in the middle and thin toward the edges with sharp hangingwall and footwall contacts.		
Geotechnical	Generally very favourable rock conditions with strong granitic rock in deposit and in FW and HW. Some faulting but generally not seen to be a significant issue. No anticipated concerns with seismic activity created by mine excavations		
Hydrogeology	Not well defined, but tightness of the rock infers that there will likely not be hydrogeological issues.		
Constraints	There are no known constraints such as heat, radiation, groundwater, or rock stress.		

The irregular geometry of the mineralization, with thicknesses averaging 10 m but highly variable, and a 20° average dip angle, constrain the choice of mining method. Sub-level caving and sub-level open stoping would not be suitable for the deposit because of these geometric constraints, while the value of the ore, in most parts of the deposit, cannot support the economics of a drift and fill method with cemented backfill.

Two methods were found to be suitable for underground mining at Minto: room-and-pillar (RAP) where the deposit thickness is approximately ten m or less, and post-pillar cut-and-fill (PPCF) where the thickness is greater.

5.3.1.9 Description of Room-and-Pillar Mining

The most suitable mining method for deposits less than 10m thick was found to be RAP. The method is simple and has numerous examples of success in low-dipping, moderately thick, shallow deposits with favourable rock conditions. The method allows excellent production capacity potential and relatively low cost while still providing mining flexibility and low dilution.

RAP mining utilizes un-mined rock as pillars to support a series of "rooms" around the pillars. The method is often designed with pillars in a checkerboard pattern, but pillar location may be modified within the geotechnical constraints to maximize recovery of higher-grade ore. The pillars can sometimes be extracted on retreat to help improve the overall recovery.

At Minto, many of the mineralized zones are thicker than can be mined in a single pass: the RAP mining method is applicable to deposits of up to 10m thickness, while the standard drift round height is approximately half that. In these areas, two cuts will be made: a first hangingwall cut via drifting, and, after the back is supported, a bottom cut via benching. This sequence requires that the back only be supported (rockbolted) once, improving productivity, and reducing costs.

Productivity from RAP mines is normally very high due to multiple available mining faces, and the method has a simple, repetitive mining sequence. Mobile equipment required for RAP is the same as that used in development mining; therefore, specialty equipment is not required.

The strong, massive nature of the Minto rock and shallow depth of the deposits mean that fairly high extraction ratios (plus 75%) would reasonably be expected.

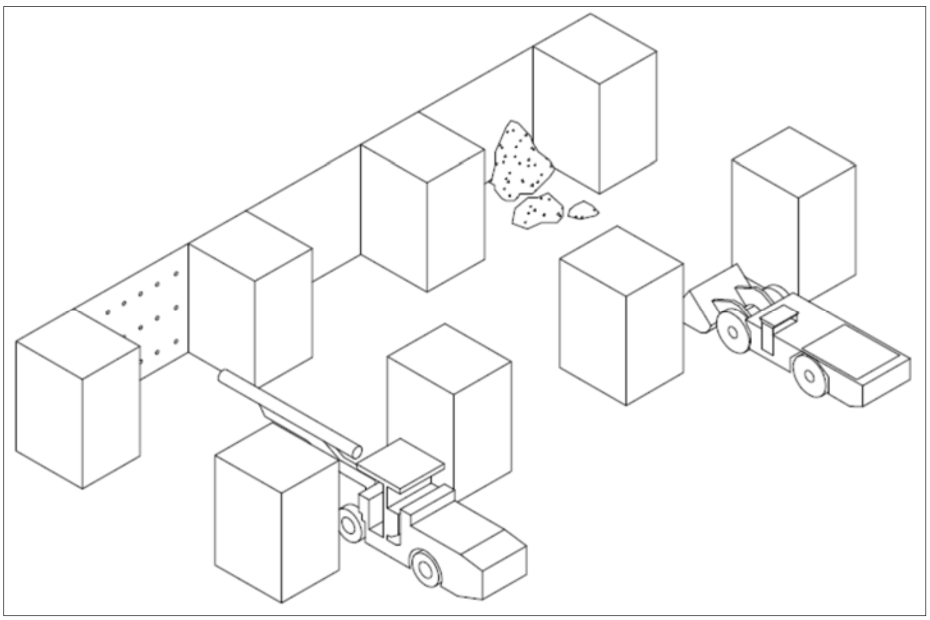


Figure 5-11 Simplified RAP Mining Method Illustration

5.3.1.10 Description of Post-Pillar Cut-and-fill Method

Stopes higher than 10 m will generally be mined via PPCF. Because the pillar dimensions required to ensure stability increase substantially as deposit height increases, RAP ceases to be economically viable at large stope heights. PPCF overcomes this problem by supporting the pillars at their bases using uncemented rockfill (Figure 5-11).

The method is similar to RAP in that a checkerboard pattern of tunnels is driven into the deposit and pillars are left behind to support the back. The first cut is at the bottom of the deposit rather than at the top, and when extraction of a level is completed, uncemented rock fill is placed to provide confining support to the bases of the pillars. In this way, pillar sizes can be kept small.

The primary drawback of the method is that, because mining starts at the bottom of the deposit and proceeds toward the top, the back must be supported after each cut. This lowers productivity and increases mining costs, disadvantages that are weighed against the increased extraction ratio enabled by the method.

Once established with a sufficient number of headings, PPCF can be a productive mining method. Maintaining satisfactory production rates is based upon developing and following an efficient mining cycle of ground support, drilling, blasting, mucking, hauling, and filling. In order to maintain strength and continuity, the pillars of each lift must be surveyed and positioned exactly over the pillars from the previous cut.

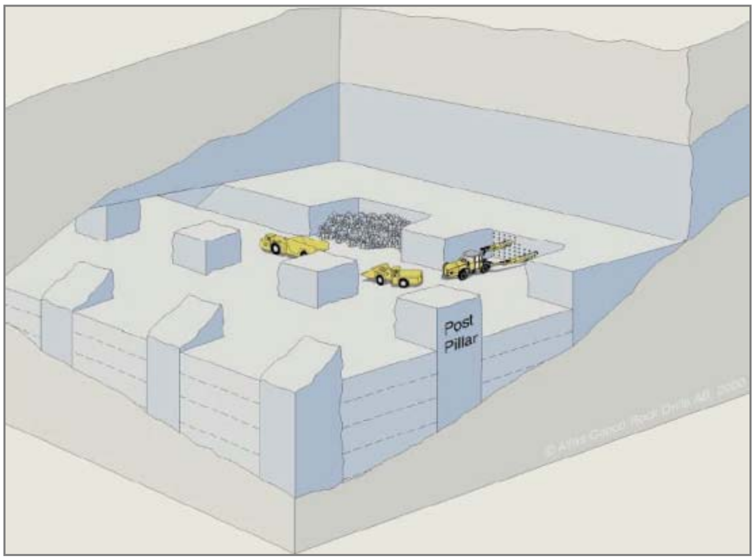


Figure 5-12 Simplified PPCF Mining Method Illustration (from Atlas Copco)

5.3.1.11 Other Mining Methods

In-fill/definition drilling completed from within the underground workings may identify regions of sufficient thickness and lateral extents to justify open stoping methods. Such mining would involve the addition of long hole drills to the equipment fleet, as well as remote-control for LHDs.

5.3.1.12 Mining Plan – East Keel Underground

Access from surface will be via a single 5x5 m decline; Figure 5-13 and Figure 5-14 show the locations of the Copper Keel and Minto East zones targeted by the EKU.

Total production from all underground operations will be 2,000 tonnes of ore per day; this is unchanged from Phase IV. Development and ore production will take place concurrently in MSU and EKU.

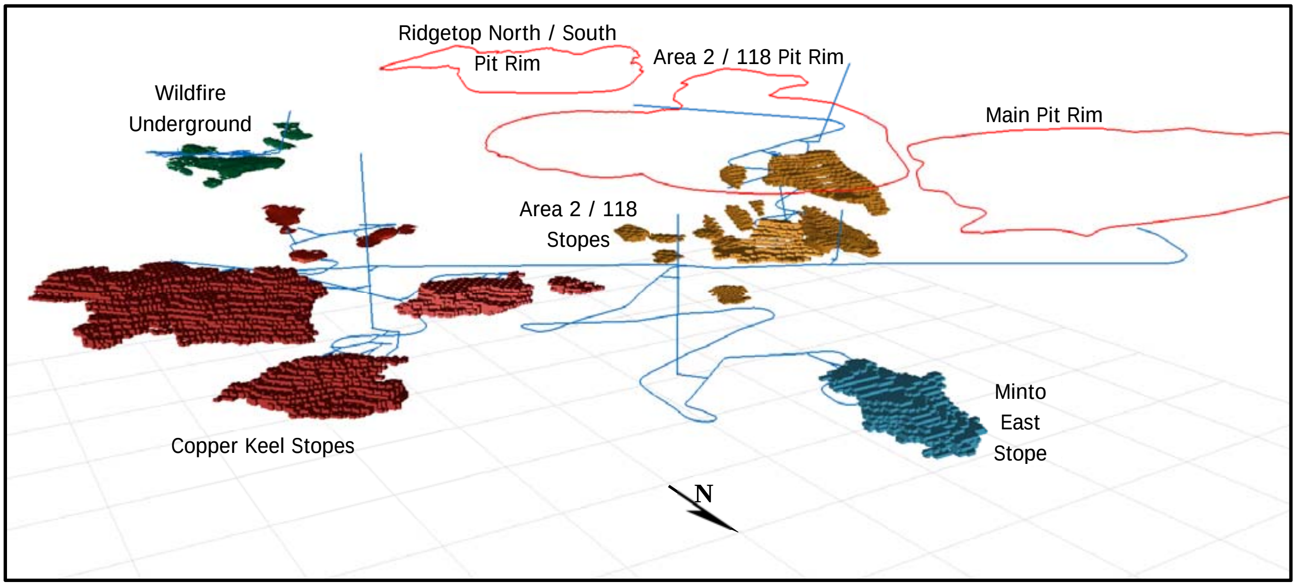


Figure 5-13 Perspective View, Looking Southwest, of Underground Stopes and Development.

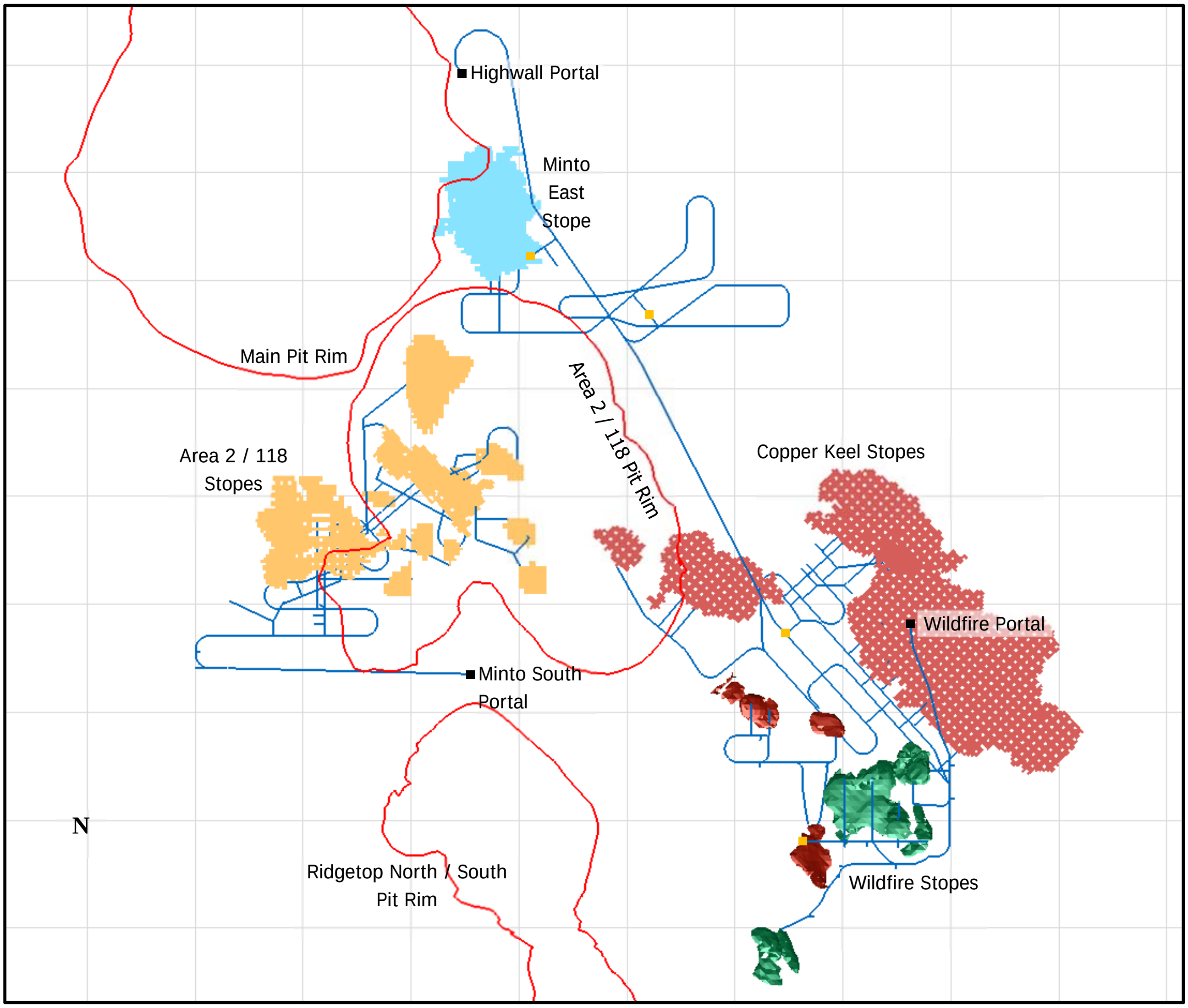


Figure 5-14 Plan View of the Minto South Underground Deposit and Wildfire Underground.

The East Keel Underground requires the construction of new fresh air and exhaust raises, which will be mined via an Alimak system. The Alimak system is a method for developing raises starting from the bottom and advancing vertically. It comprises an operator cage and drill platform, running up a rail system that advances up the raise as development progresses. From the cage/platform, miners drill the rock above them and load it with explosives. The cage/platform is then retracted, the explosives are fired, and blasted material falls to the bottom of the raise where it is loaded and then hauled away. Three raises are planned: a fresh air raise near the top of the ramp system and two exhaust raises, one for the Copper Keel area and one for Minto East.

At the planned mining rate of 2,000 tonnes of diluted ore per day, the combination of the MSU and the EKU (which will be mined in parallel) will produce ore for 5.5 years. In actuality, ore release will be preceded by several months of development, and there will be a gradual increase to full production. Development of the East Keel Underground and the Highwall Portal will commence upon receipt of the necessary licenses.

5.3.1.13 Mining Plan – Wildfire Underground

The Wildfire Underground will be accessed via a single decline developed at a –15% gradient, which will serve as the sole means of ore and waste haulage and personnel access (Figure 5-15). It will also be used as an exhaust airway. The decline will be sized at 5.0 m x 5.0 m to accommodate the same equipment fleet used in the MSU and EKU.

The decline will measure 660 m in length. An additional 165 m of supplemental development will take place in the form of remuck bays, a ventilation raise access, and sumps.

The ventilation raise to surface will be approximately 100m in length, driven as a 3.0 m x 3.0 m Alimak raise. A manway will be installed so that the raise can serve as an emergency egress from the mine.

The mine will use the same RAP and PPCF mining methods as the MSU and EKU. At the planned mining rate of 2,000 diluted tpd, the 360,000 tonne reserve of the Wildfire Underground will provide for six months of production once development is complete.

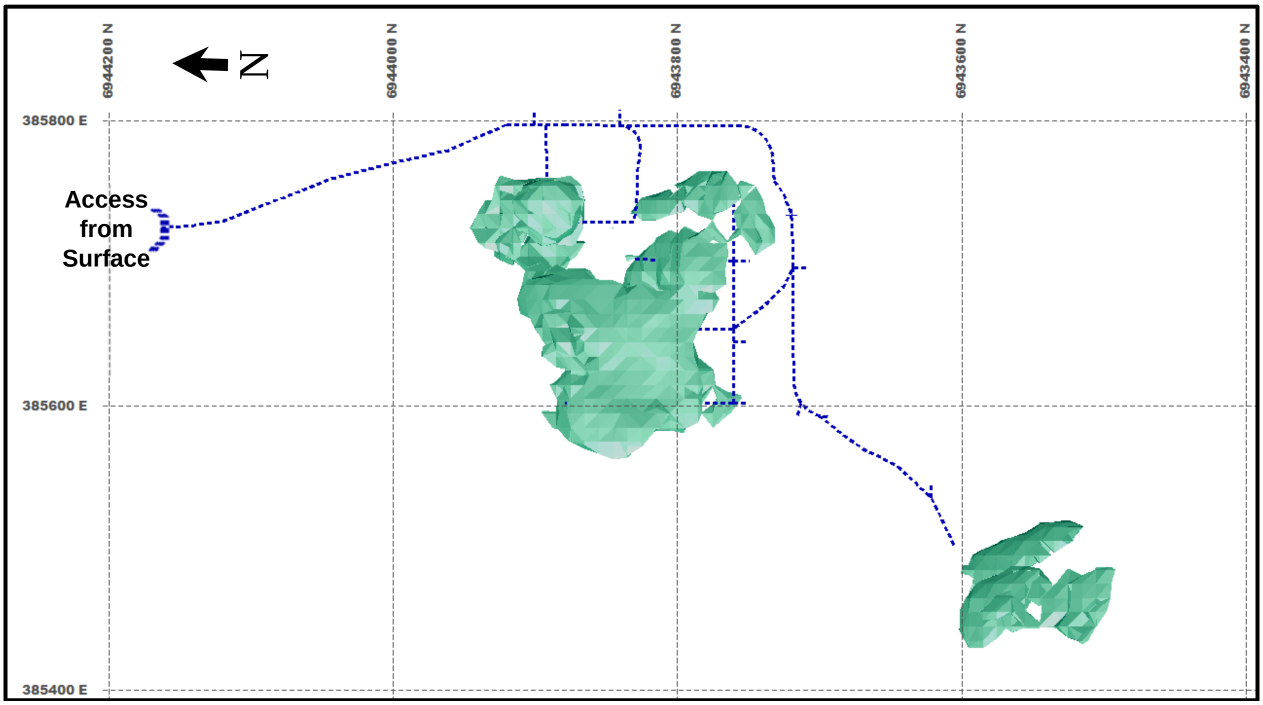


Figure 5-15 Plan View of Wildfire Underground.

5.3.1.14 Ground Support

Ground support will generally take the form of fully grouted resin rebar bolts on the back and the walls of the ramp, with welded wire mesh and shotcrete as needed. Ground support standards will be established under the supervision of Minto's engineering staff with assistance from geotechnical engineering consultants where needed.

Ground support will be installed using mechanized rockbolters, and in some cases manually from the blasted rock muck pile, or from a scissor lift platform using jacklegs and stopers.

5.3.1.15 Equipment Fleet

The mine will use equipment typical of a RAP/PPCF operation accessed through a trackless decline. Production mucking will use rubber-tired load-haul-dump (LHD) units with 10-yd3 buckets, loading 40 tonne underground haul trucks. Drilling of both development and ore production headings will be done by two-boom electric-hydraulic jumbo drills with diesel engines for propulsion. Ground support will be installed using a combination of integrated scissor deck/drilling units and mobile self-propelled scissor decks/manually operated air drills.

The underground fleet will also include a number of smaller utility/service machines, such as underground-rated light utility vehicles, smaller LHD units for cleanup tasks, explosives carriers, telehandlers, etc.

The mine fleet will increase in size as needed to produce at the target rate of 2,000 tpd. Initially, Minto will supplement the fleet with equipment from a mining contractor.

5.3.1.16 Ventilation

The design basis of the ventilation system at Minto underground operation is to dilute exhaust gases produced by underground diesel equipment adequately. Air volume was calculated based on a factor of 0.064 m^3/s per installed kW of diesel engine power (100 cfm per installed hp). The kW rating of each piece of underground equipment was determined and then utilization factors, representing the diesel equipment in use at any time, applied to estimate the amount of air required.

The East Keel Underground will require three ventilation raises, while Wildfire will require one.

Underground workings will be heated to a temperature sufficient to prevent freezing of drill water and icing of ramps and accesses. Mine air for the underground portions of both Phase IV and Phase V/VI will be heated using propane burners.

5.3.1.17 Services

The major electrical power consumption in the mine will be from the following:

- Main and auxiliary ventilation fans;
- Drilling equipment;
- Mine dewatering pumps;
- Air compressors; and
- Maintenance shop.

High voltage cable will enter the mine via the decline and be distributed to electrical sub-stations located near production stopes. The power cables will be suspended from the back of development headings. All equipment and cables will be fully protected to prevent electrical hazards to personnel.

High voltage power will be delivered at 4.16 kV and reduced to 600 V at electrical sub-stations. All power will be three-phase. Lighting and convenience receptacles will be single-phase 120 V power.

Table 5-10 lists equipment power usage for the East Keel Underground, while Table 5-11 lists the requirements for the Wildfire Underground.

Table 5-10 Electrical Power Requirements for East Keel Underground

Description	Quantity	Unit (kW)	Load Factor (%)	Utilization (%)	Power Consumption (kWh/yr)
Surface					
Shop equipment	1	50	80	20	70,080
Air compressor	1	100	80	10	70,080
Lighting	1	10	80	60	42,048
Office	1	10	80	80	56,064
Parking lot	1	10	80	30	21,024
Main ventilation fan	1	350	80	100	2,452,800
Pumps	1	10	85	67	49,888
Heat trace	1	25	80	60	105,120
Underground					
Jumbo, two-boom	3	135	95	60	2,022,246
Rockbolter	2	70	95	60	699,048
Exploration drill	1	75	95	50	312,075
Portable compressor	2	100	80	30	420,480
Portable welder	2	34	80	10	47,654
Exhaust fan (Minto East or Copper Keel)	1	475	80	100	3,328,800
Auxiliary fan, 75 kW	2	75	80	90	946,080
Auxiliary fan, 50 kW	2	50	80	90	630,720
Auxiliary fan, 40 kW	2	40	80	90	504,576
Refuge chamber	2	5	80	100	70,080
Main dewatering pump	1	100	85	67	498,882
Portable pump	4	15	85	50	223,380
				Sub-total:	12,571,126
Miscellaneous power allowance	10%				833,129
				Total power:	13,828,238

Table 5-11 Electrical power Requirements for Wildfire Underground

Equipment	Quantity	Unit (kW)	Load Factor	Utilization Factor	Power Consumption kWh/year
Surface					
Wildfire Ventilation Fan	1	150	80%	100%	1,051,200
Pumps	1	10	85%	67%	49,888
Heat Trace	1	25	80%	60%	105,120
Underground					
Jumbo, two-boom	2	135	95%	60%	1,348,164
Rockbolter	1	70	95%	60%	349,524
Portable Compressor	1	100	80%	30%	210,240
Portable Welder	1	34	80%	10%	23,827
Auxiliary Vent Fan, 40 kW	2	40	80%	90%	504,576
Refuge chamber	1	5	80%	100%	35,040
Portable Pump	3	15	85%	50%	167,535
				Sub-total:	3,845,114
Miscellaneous Power Allowance	0.1				384,511
				Total Power:	5,229,626

5.3.1.18 Explosives

Blasting practices will continue unchanged from the mining assessed in Phase IV: ANFO will be used as the major explosive for mine development and production. Packaged emulsion or nitroglycerin-based dynamite will be used as a primer for ANFO-loaded holes and as a bulk explosive in loading lifter holes (holes at the toe of a round, very likely to be wet) in development and production headings.

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.

Powder factors in underground development are significantly higher than in surface mining. Ramp development, PPCF ore production, and ore production from the first level of a RAP stope will typically employ a powder factor of 0.6 kg/tonne. Subsequent cuts in a RAP stope will have lower powder factors due to the availability of two free faces into which blasted rock can expand.

At a production rate of 2,000 t/day, the underground operation will use approximately 900 kg of explosives per day. For comparison, the surface mining operation used 7,300 kg/day in 2011.

5.3.1.19 Fuel Storage and Distribution

An average fuel consumption rate of approximately 5,482 L/d is estimated at full production; details are presented in Table 5-12.

Haulage trucks, LHDs, and all auxiliary vehicles will be fuelled at fuel stations on surface. The fuel/lube cassette will be used for the fuelling/lubing of drills, rockbolters, and other less mobile equipment.

Table 5-12 Daily Fuel Requirements for the Underground Equipment Fleet

Description	Quantity	Consumption (L/hr)	Load Factor (%)	Utilization (%)	Total Fuel (L/day)
LHD, 5.4 m^3	3	57.5	75	80	1,768
Truck, 40t	4	68.9	70	80	2,637
Jumbo, two-boom	3	22	50	10	56
Rockbolter	2	18	50	20	62
Grader	1	36	75	30	138
Explosives truck	1	27	50	20	46
ANFO loader	2	22	50	30	113
Cassette carrier	2	27	70	50	323
Mechanics truck	1	22	50	25	47
Scissor lift	2	27	50	25	115
Supervisor vehicle	3	22	50	20	113
Electrician vehicle	1	22	50	30	56
Forklift	1	16	60	20	33
Total					**5,482**

5.3.1.20 Equipment Maintenance

Mobile underground equipment will be maintained in a mechanical shop located on the surface. Some small maintenance and emergency repairs will be performed in a service bay underground.

5.3.1.21 Personnel

There is no significant change to the expected number of personnel employed by the underground mine relative to the operation assessed in Phase IV, as Phase V/VI represents an increase to the length of the mine life rather than a production rate increase. Table 5-12, taken from the Phase IV Project Proposal, details the number of personnel expected to be required for a 2,000 t/day operation. Personnel requirements are lower in the first year of the operation, as ore production will not reach the full rate until several stopes are simultaneously activated. By the end of the second year, the mine will employ 83 people within a combination of production, supervisory, and technical roles.

Table 5-13 Personnel Requirements for Underground Mining

Job	Year 1	Year 2 +
Technical Services		
Senior Engineer	1	1
Mine Engineer	1	1
Mine Technician	1	2
Surveyors	2	2
Geologist	1	1
Geological Technician	1	1
Subtotal	**7**	**8**
Maintenance		
Superintendent	1	1
Mechanical/Electrical G.F	1	1
Maintenance Planner/ Clerk	1	1
Dry/Lampman/ Bitman	1	1
Mechanics, Lead Hand	4	4
Mechanics, stationary	2	2
Mechanics, mobile	4	4
Mechanics, mobile app	2	2
Electricians, instrumentation	2	2
Subtotal	**18**	**18**
Mining		
Superintendent	1	1
Mine Captain	1	1
Shift boss	4	4
Safety/Training	1	1
Subtotal	**7**	**7**
Jumbo/LH operator *	6	8
LHD operator *	6	8
Truck driver *	10	12
Ground support/ services *	4	8
Helpers	10	12
Backfill/construction/utility		2
Subtotal	**36**	**50**
Total Manpower	**68**	**83**

As the end of mine life approaches in 2019, there will be a gradual reduction in workforce as the number of working faces decreases and the resulting ore production declines.

5.3.2 Ore Processing

Minto is currently authorized to mill ore at a rate of up to 4,200 tpd. The following sections describe the major components of the ore processing and storage facilities at Minto.

5.3.2.1 Crushing Circuit

Run-of-mine ore is first passed through a two-stage crushing circuit located outdoors on a pad west of the main process plant. Ore is first loaded into a hopper using a Caterpillar 980 front-end loader. A screen over the hopper rejects boulders larger than the crusher opening; these are moved aside and broken using an excavator-mounted hydraulic rock-breaking tool.

The primary crusher was originally intended to operate six hours per day, 365 days per year at 75% availability but, due to increased throughput, now operates 24 hours per day, 365 days per year at an availability of 75%.

5.3.2.2 Processing Plant

The processing plant consists of the following main unit operations:

- Two-stage grinding circuit comprised of a single SAG (semi-autogenous grinding) 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 mill circuit operates 24 hours per day, 365 days per year at an availability of approximately 93%. Availability is defined as the operating hours in a 24-hour day.

5.3.2.3 Concentrate Building

The concentrate storage shed on site is capable of holding 18,000 tonnes of concentrate. Shipping from site stops in the fourth quarter, while the Yukon River freezes up and the ice bridge is built, and in the second quarter, for spring thaw.

5.3.2.4 Tailings Filtration Building

The tailings filtration building currently holds all of the equipment formerly used to produce filtered cake, including a 13.5 m tailings thickener and five Lasta pressure filters. Dry stack tailings operations ceased in November 2012. The tailings thickener is still operational and thickened tailings are directed to the Main Pit using a combination of sub-aerial and sub-aqueous deposition over the life of deposition into the Main Pit, and then will transition to the Area 2 and Ridgetop North pits.

5.4 WATER MANAGEMENT

Management of water at the Minto Mine plays an important part in the mine planning; strategies and systems for managing water are in place for the current mining operations, and proposed for Phase V/VI. The Phase V/VI site water management plan has been refined through extensive planning and authorization amendment processes since the inception of the original water management plan prepared and presented with the original project water licence application in 1996. Most recently, these optimizations have been presented in applications for Water Use Licence QZ96-006 amendments 7 and 8. Amendment 7 was specific to the water management plan, and involved amendments to the effluent quality limits, whereas Amendment 8 involved relatively minor changes specific to the Phase IV mine expansion. The Phase V/VI water management plan presents changes to manage water in the next phase of mining operations at Minto Mine.

The purpose of water management at the mine is to ensure that the mine operations do not result in unacceptable impacts on surface and groundwater systems, including downstream water quality.

This section describes the following aspects of water management at the Minto Mine:

- The overall site water management strategy;
- The site water balance;
- The Water Management Plan (WMP);
- Load balance model and water quality predictions; and
- Proposed changes to water management, including infrastructure and currently licenced effluent quality limits.

5.4.1 Water Management Strategy

The Minto Mine Site has a positive water balance. Therefore, it is necessary to release water to from site from time to time to prevent the accumulation of excess water. The primary objective of the water management strategy is to control the release of water from site in a way that eliminates or minimizes potential effects to the water quality in Minto Creek.

Runoff from developed mine areas (mine water) can mobilize metals and mine-sourced contaminants, such as nitrate, that could have potential adverse effects to the water quality in the receiving environment. The water management strategy in place is intended to limit and manage the inventory of mine water stored on site by segregating clean runoff from mine water that has been impacted by mining activities.

The strategy for managing the mine water inventory can be summarized as follows:

- The site water balance will be used to define mine water inventory targets and targets for volumes to be released to Minto Creek. Regular tracking of the mine water inventory will allow operators to determine if the inventory is on target and if and when water must be released from site.
- Runoff from developed mine areas (mine water) will be collected and stored in the Main Pit Tailings Management Facility and the Area 2 Pit Tailings Management Facility. Mine water will be used for ore processing and deposition of tailings and waste rock.
- The primary method for controlling and limiting the inventory of mine water on site is to collect and divert discharge-compliant (clean) runoff to the water storage pond (WSP) and from there to Minto Creek.
- If collection, diversion and release of clean water is not sufficient for meeting mine water inventory targets then Minto has the option of treating and releasing mine water.

The following sections will describe elements of the water balance for the Minto Mine site and highlight the importance of the site water balance in the development of the water management strategy.

5.4.2 Water Balance

Understanding the site water balance is integral for the development of the water management strategy. The water balance is influenced by a number of factors including the geography of the site, precipitation, evaporation and evapotranspiration, surface runoff, site water inventory, and water use.

5.4.2.1 Water Balance Model

The water balance model for Phase V/VI was built on previous water balance modelling work prepared for the Phase IV Yukon Environmental and Socioeconomic Assessment Board (YESAB) application (SRK 2010) and for the Water License Amendment 8 application (SRK 2012). The water balance includes the development of a stochastic water balance model that incorporates historical water balance data and produced predictions of the range of future precipitation and surface runoff events for the proposed development through to post-closure. These predictions contribute to the refinement of options for managing both discharge to the environment and water inventory at the mine site.

The water balance model divides the site and surrounding areas into catchments and sub-catchments within the Upper Minto Creek (Minto Mine site) catchment as well as the sub-catchment for the Minto North Pit, which is located within the adjacent McGinty Creek catchment. The area of the sub- catchments are calculated and classified as undisturbed, developed, or partially developed. Undisturbed catchments typically produce clean runoff that is of similar quality as background water quality in lower Minto Creek; developed catchments produce mine water runoff. The mine water runoff is generally of poorer quality than the clean runoff but the quality varies over a wide range depending on degree and type of development and season. Runoff from the undisturbed catchments WSP and W35a are the main targets for collection and diversion of clean water for Phase V/VI. Sub-catchments are listed in Table 5-14.

Table 5-14: Minto Mine Site Sub-Catchments.

Catchment	Area (ha)	Catchment Type	Description
Area 2 Pit	82	Developed	Includes the Area 2 Pit, Ridgetop North and Ridgetop South.
Main Pit	90	Developed	Includes Main Pit and northern upstream catchment
Minto North	14	Developed	Includes Minto North Pit and upstream catchment. The Minto North catchment is located within the McGinty Creek catchment.
W15	374	Partially developed /undisturbed	Includes the South-West Dump, Main Dump and the majority of the western undisturbed catchments.
W35a	172	Undisturbed	Includes the southern undisturbed catchment, laydown area and airstrip.
W37	79	Developed	Includes dry stack tailings facility, the plant site and the Mill Valley.
WSP	235	Undisturbed	Includes the undisturbed catchments south and north-west of the WSP.
Total	1046		

5.4.2.2 Precipitation and Runoff

Assessments of the annual water balance for the site have concluded that the portion of precipitation that ultimately is collected as runoff is approximately 30% of the total annual precipitation. Thus, an estimated 70% of the annual precipitation is lost through evapotranspiration, sublimation, and groundwater recharge. Table 5-15 shows the estimated range of annual precipitation and site-wide runoff.

Table 5-15 Minto Mine Site Precipitation and Runoff Estimates

		1:100 Dry Year	Average Annual Precipitation	1:200 Wet Year
Precipitation	Mm	205	329	498
Estimated Site-Wide Runoff	m^3/year	450,000	850,000	1,400,000

5.4.2.3 Groundwater

Groundwater represents a relatively minor component of the site's water balance. The mine is located at the headwaters of Minto Creek and therefore has limited inputs of regional groundwater. The tight bedrock and discontinuous permafrost limit the sub-surface movement of groundwater. Some groundwater is encountered during active mining of the pits; however, discharge volumes are relatively low. An evaluation of groundwater for the Minto Site is available in the Hydrogeological Characterization Report (Appendix H).

5.4.2.4 Annual Operational Water Balance

Table 5-16 shows a summary of the annual operational water balance for Minto Phase V/VI. The operational water demand for Phase V/VI includes subaqueous deposition of tailings and NP:AP<3 waste rock . The annual water balance shows that runoff yields approximately 240,000m3 of water in excess of the operational demands in a year with average precipitation. This volume corresponds to approximately 28% of all surface runoff collected from the Minto Mine site catchment. This water can either be stored on site or be released to Minto Creek. In a 1 in 100 dry year, the runoff volume would not be sufficient to cover the operational water demand, while runoff in excess of the operational demand would amount to approximately 790,000m3 in a 1 in 200 wet year. The strategy proposed for managing the excess surface runoff and mine water inventory for Phase V/VI is to divert and release clean runoff to Minto Creek to the greatest extent possible.

Table 5-16: Annual Operational Water Balance Summary for Minto Phase V/VI.

Water Balance Component	Unit	1:100 Dry Year	Average Annual Precipitation	1:200 Wet Year
Water Input				
Annual site-wide runoff	m^3/year	450,000	850,000	1,400,000
Operational Water Demand				
Water to tailings pores	m^3/year	550,000	550,000	550,000
Water to waste rock pores[A]	m^3/year	60,000	60,000	60,000
Water in Excess of Operational Demands				
Water to store on site or to Minto Creek	m^3/year	-160,000	240,000	790,000
Water to store on site or to Minto Creek	% of total runoff	-36%	28%	56%

Notes: [A]NP:AP<3 waste rock

5.4.2.5 Diversion of Clean Runoff

Table 5-17 shows a summary of sub-catchments for Minto Phase V/VI. Sub-catchments that can be considered to be undisturbed (i.e. consistently produce clean/discharge-compliant runoff) include the WSP and W35a catchments.

The WSP catchment accounts for approximately 22% of the total catchment area of the Minto Mine site. Runoff from the northeastern WSP catchment is collected in a ditch along the mine access road and flows through a culvert to the WSP. The eastern portion of the southern WSP catchment reports to the south diversion ditch that follows the southern boundary of the dry-stack tailings facility. From there, it is piped to the WSP. Runoff from westernmost portion of the southern catchment reports directly to the WSP.

The W35a catchments represent approximately 16% of the total catchment area of the Minto Mine site. For Phase V/VI of the Minto Mine development water collected at W35a will be conveyed to the south diversion ditch and from there flow to the WSP.

Combined, the WSP and W35a catchments account for about 38% of the total upper Minto Catchment area. The volume of runoff that can be diverted to the WSP depends on the collection and diversion efficiencies of the water management ditches, sumps, and pipes. Assuming that actual diversion efficiencies range between 60% and 80%, the average annual runoff volume that would be diverted to the WSP would range between 210,000 m^3 and 280,000 m^3, or between 25% and 33% of the total runoff from upper Minto Creek. Therefore, diverting runoff from these two catchments may be sufficient for maintaining a net zero water balance for the Phase V/VI operation, assuming that the precipitation on site over the remaining mine life (8 years) is close to the average annual precipitation of 329 mm.

However, in order to reduce the current mine water inventory, or in the event that runoff volumes are greater than estimated, it may be advantageous or necessary to release additional water. If so, additional runoff may be diverted from W15 to the WSP. W15 receives runoff from both undisturbed catchments and developed mine areas. However, runoff that historically has reported to W15 has generally met water quality limits listed in Water Use License QZ96-006 for the months of May, June, July, and August. The W15 catchment represents 36% of the total upper Minto Creek catchment and could yield another 150,000 m^3 to 200,000 m^3 of relatively clean runoff. Therefore, with diversion in place for the WSP, W35a and W15 sub-catchments, a total volume of 360,000 m^3 to 480,000 m^3 may be collected and released annually from the Minto Site.

Table 5-17: Minto Phase V/VI: Sub-Catchments and Potential Runoff Volumes Diverted, Average Year.

Sub-Catchment	Area	% of Minto Mine Site-Wide Catchment	Diverted Clean Runoff, 60% Diversion Efficiency		Diverted Clean Runoff, 80% Diversion Efficiency	
	ha	%	m^3/year	% of Site-Wide Runoff	m^3/year	% of Site-Wide Runoff
W35a	172	16%	120,000	14%	160,000	19%
WSP	235	22%	90,000	11%	120,000	14%
W15	374	36%	150,000	18%	200,000	24%
Diversion Options						
W35a + WSP	407	39%	210,000	25%	280,000	33%
W35a + WSP + W15	781	75%	360,000	42%	480,000	56%

If clean surface runoff does not meet the Phase V/VI water quality limits then water treatment may be required.

5.4.3 Phase V/VI Operational Water Management Plan

Minto's comprehensive Water Management Plan (WMP) consists of segregation, diversion, conveyance, treatment and discharge of water to effectively manage water at the Minto Mine and meet licensed effluent discharge standards. The main components and features of the operational water management plan are described below, and more detail can be found in the Phase V/VI Water Management Plan (WMP) in under separate cover.

As outlined in previous sections, the overall management strategy is to divert and release clean runoff to Minto Creek which can be achieved through the use of a series of collection points, diversion structures, and decision making on water management. Figure 5-16 contains an overview of the Phase V/VI water management.

A water and load balance model developed for the Minto Site was used to develop and refine the water balance and management strategy as well as to evaluate potential risks. Water and load balance model results are described in Section 5.4.4.

MINTO MINE
PHASE V/VI EXPANSION

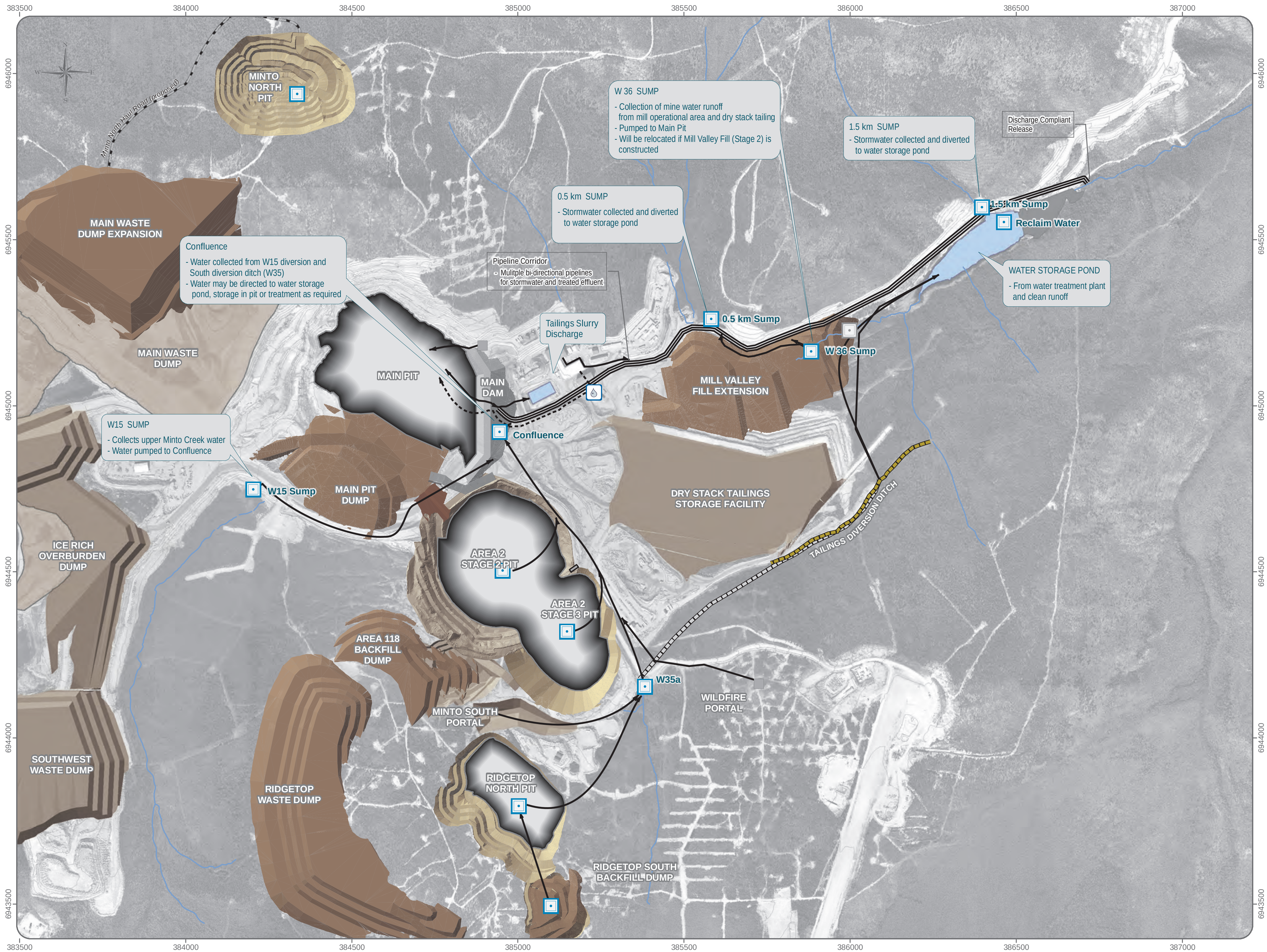
RECLAMATION AND CLOSURE PLAN
REVISION 5.1

FIGURE 5-16

OPERATIONAL WATER MANAGEMENT

AUGUST 2014

capstone MINTO MINE



- Collection Point/Sump
- W-36 Potential location for relocation
- Water Treatment Plant
- Pipe Alignment
- Piping Corridor
- Tailings Slury Discharge
- Diversion Ditch
- Phase V/VI Dumps
- Phase V/VI Pits
- Phase IV Features
- Phase V/VI Tailings
- Spillway
- Dam

1:11,000 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500 Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11th 2013.
Site contours derived from 2013 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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(Last edited by: amatlashevska;07/08/2014/11:19 AM)

5.4.3.1 WMP Operating Principle

The primary objective of the Phase V/VI water management plan is to manage release of water from site and by extension the inventory of mine water stored in the MPTMF and the A2PTMF. The mine operation must have sufficient water to operate but an excess of mine water that cannot be released to Minto Creek without treatment is a potential operational and environmental liability.

During Phase V/VI, water collected at the Minto Mine will be segregated on the basis of clean runoff and mine water. Clean runoff will be diverted around the active mining areas to the water storage pond, and mine water will be contained in the MPTMF and A2PTMF. Runoff is classified as 'clean' if the water meets the water quality limits defined in the applicable water use license. Runoff that does not meet water quality limits is categorized as 'mine water'. For Phase V/VI clean runoff is intended to be released to Minto Creek from the WSP while mine water will be used for processing of ore and for sub-aqueous deposition of tailings and waste rock.

To ensure that the mine operation has sufficient volumes of water for operation and be able to identify excess water volume to be diverted or treated, the WMP describes in detail how the operation must monitor mine water inventories and update inventory targets on a routine basis.

Figure 5-17 shows a diagram of the work flow for the proposed water management plan. The work flow includes the following steps:

Step 1. Define a mine water inventory target. The target will be set based on the available storage capacity, operational water demand, and runoff estimates. The water balance model will be used as a tool to evaluate the potential range of precipitation and runoff events that will have to be planned for.

Step 2. Track the site's mine water inventory. The inventory of mine water stored in the MPTMF and A2PTMF will be tracked on a weekly or monthly basis or as required, by surveying the water levels in the two reservoirs and by tracking the volume of waste rock and tailings solids deposited sub-aqueously in the two tailings management facilities. If the mine water inventory is increasing at a rate that would result in an exceedance of the inventory target, then steps would be taken to release additional water from site. Discharge management is described in Section 3.3.

Step 3. Update the water inventory target every 6 months, or as required and repeat Step 2. Operational, physical or water quality changes may change the water demand, storage requirement, availability of reservoirs or other elements that was used as a basis for defining the water inventory target. Therefore, the inventory target will be updated regularly.

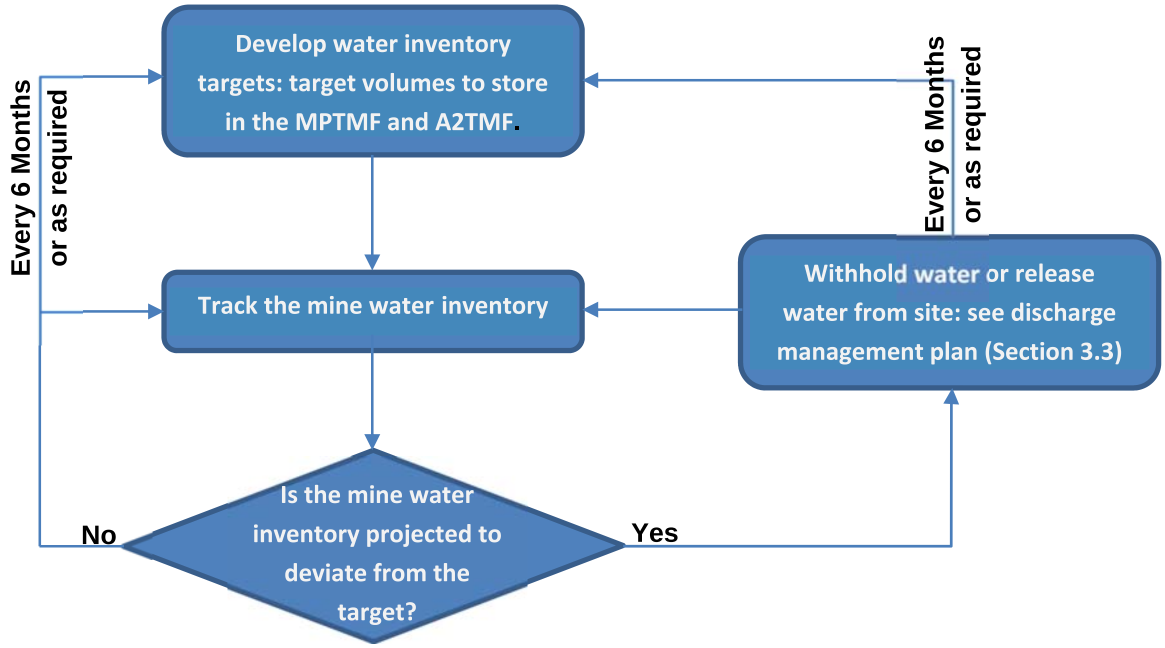

Figure 5-17 Water Management Plan Workflow.

5.4.3.2 Defining Mine Water Inventory Target

The mine water inventory target will be defined based on the following considerations:

- As a guiding principle, a minimum of 600,000 m^3 of free water, or one year of operational water demand, should be stored on site at all times. This water inventory will ensure that the operation has adequate supply of water and that the mine water reservoir has sufficient residence time to allow for proper settling and management of suspended solids;
- Storage capacity to hold a minimum of 1,000,000 m^3 of mine water runoff must be available on March 30 each year. This storage capacity is estimated to represent water that would report to the MPTMF or the A2PTMF in a 1 in 200 wet year (approximately 1,400,000 m^3 of site-wide runoff minus approximately 400,000 m^3 diverted); and
- Climatic variability. The water and load balance model developed for the Minto site will be used to evaluate the mine water inventory targets against a range of precipitation and runoff events (dry and wet years).

The inventory targets will be used by water operators as a basis for deciding whether to release additional water from site or to scale back water release. Inventory targets will be updated every 6 months or as required.

5.4.3.3 Mine Water Inventory Tracking

Water operators at the Minto Mine will track the mine water inventory on a weekly or monthly basis or as required. The following data will be collected and used for inventory tracking:

- Surveys of water levels in;
- The Main Pit Tailings Management Facility (MPTMF);
- The Area 2 Pit Tailings Management Facility (A2PTMF);
- The Water Storage Pond (WSP);
- Volumes of tailings solids and waste rock deposited sub-aqueously in the MPTMF and A2PTMF;
- Pumped flows on site;
- Precipitation and snow accumulation; and
- Runoff at hydrometric stations.

Surveyed water levels will be converted to volumes using level-volume curves for the MPTMF and A2PTMF. The frequency of updates to the water inventory will depend on the season and operational factors. During winter months when flows are low, inventory updates may only be required every 4 to 8 weeks. However, before freshet and during periods with heavy precipitation in the summer and fall months, it may be necessary to update the inventory every 1 to 3 weeks.

5.4.3.4 Reservoirs

The water management plan was developed in conjunction with the waste rock management plan and the tailings management plan (ACG 2014 2013b, 2013c). The tailings management plan was developed to make use of three tailings management facilities planned for Phase V/VI, namely the MPTMF, A2PTMF and the Ridgetop North Pit TMF (RNPTMF). The water management plan will primarily rely on the water storage capacity available in the MPTMF and the A2PTMF.

Main Pit Tailings Management Facility

The total storage capacity of Main Pit to its natural spill elevation is approximately 4.9 Mm^3. As part of Phase V/VI, Minto intends to construct a dam across the low point of the east wall of Main Pit to increase the storage capacity of MPTMF. Additional details concerning the proposed MPTMF are available in the TMP.

Deposition of tailings and management of water in the MPTMF is expected to proceed as follows: tailings deposition to the MPTMF would continue through the transition of Phase IV to Phase V/VI until the completion of the Area 2, Stage 2 Pit in the fourth quarter of 2014. The Main Pit would serve as a reservoir for mine and reclaim water throughout this period.

In the fourth quarter of 2014, tailings deposition would be directed to the Area 2, Stage 2 pit for a period of 12–16 months. During this time, the Main Pit would continue to serve as a reservoir for mine and reclaim water, which is expected to result in a net reduction of the water volume stored in the MPTMF. Tailings deposition to the Main Pit would resume sometime in 2015 and would continue until 2018. However, from the end of 2017 until closure in 2022, reclaim water will be sourced from the Area 2 Pit.

Area 2 Pit Tailings Management Facility

The final A2PTMF will consist of two intersecting pits separated by a saddle (Figure 5-18 and Figure 5-19). The larger and more northerly of the intersecting pits is a Phase IV development called Area 2 Stage 2 Pit, while the smaller and more southerly pit will be a Phase V/VI development referred to as Area 2 Stage 3 Pit. The total storage capacity of the final A2PTMF below the natural spill elevation of 802 m will be approximately 7.9 Mm^3.

During development and mining of the Area 2 Stage 2 Pit, the mine water collected will be pumped to the MPTMF as part of the Phase IV operations. When mining of the Stage 2 area has been completed in the fourth quarter of 2014, tailings and NP:AP<3 waste rock will be deposited in the Stage 2 area. At this time, some mine water may be allowed to accumulate the in Stage 2 area. However, excess water will continue to be pumped to the MPTMF.

Prior to completion of Area 2 Stage 3 Pit, storage of tailings and water in Stage 2 Pit is limited to that volume below the saddle elevation of 760 m (roughly 2.1 Mm^3, see Figure 5-19). After the Stage 3 Pit is complete, the entire volume of the combined Area 2 Stage 2 and Stage 3 pits will be available for storage (Figure 5-19).

Prior to the completion of mining in Area 3, mine water collected in the pit would be pumped to the MPTMF. After completion of mining, the entire Area 2 Pit (now the A2PTMF) would be used as a mine water reservoir and for deposition of tailings and NP:AP<3 waste rock. Local mine water runoff would be allowed to accumulate and any excess mine water from the Main Pit would be conveyed to the A2PTMF. In 2017 (approximately), the reclaim barge would be relocated to the A2PTMF pit to allow for complete infilling of the MPTMF with tailings.

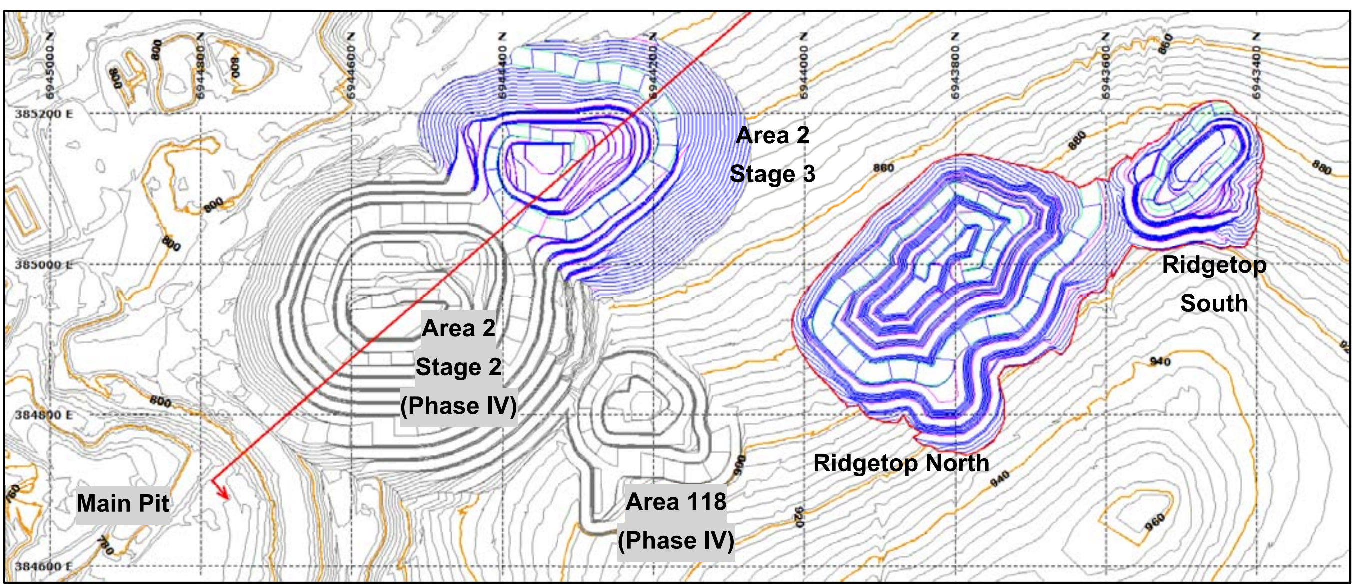

Figure 5-18 Overview of Phase V Pits (Excluding Minto North).

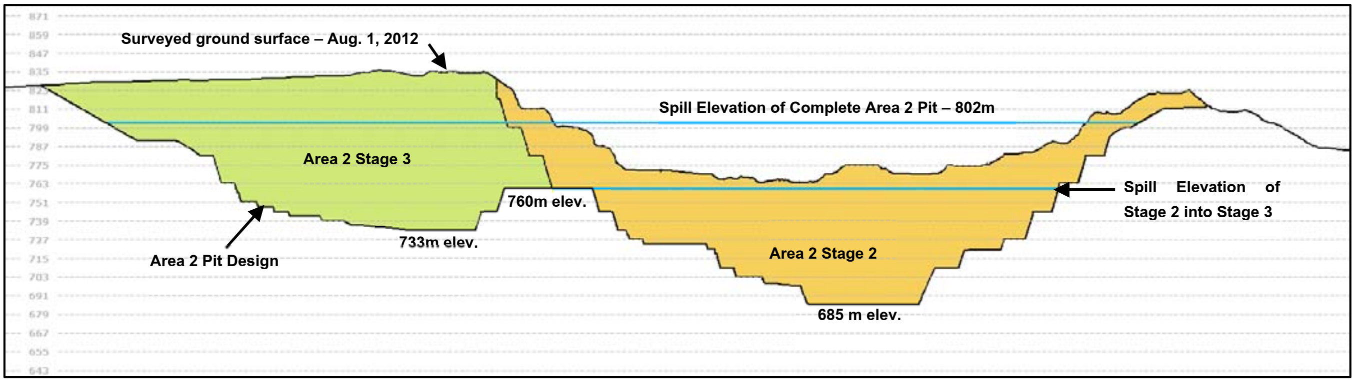

Figure 5-19 Section through Area 2 Pit Showing Staging and Spill Elevations.

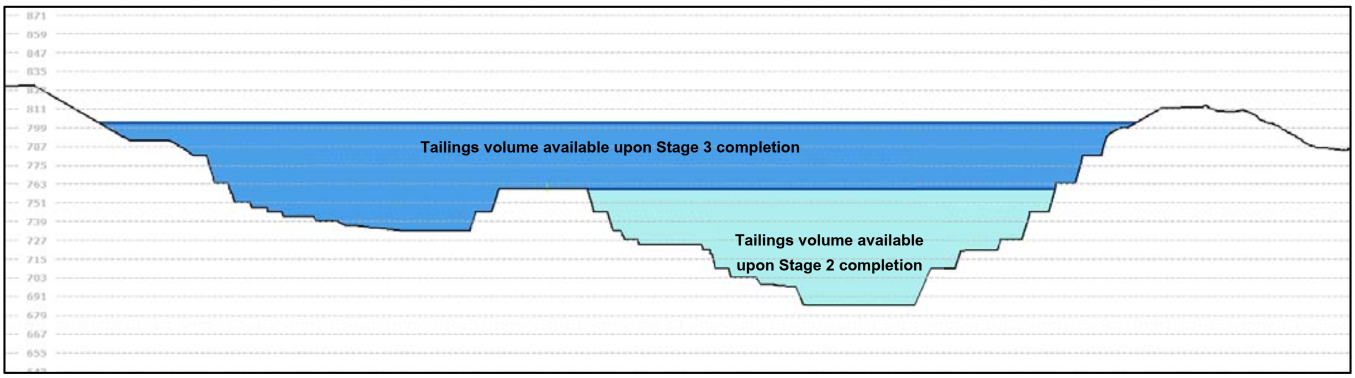

Figure 5-20 Section Through Area 2 Pit Showing Tailings Volume Made Available with Staged Mining of Area 2.

Ridgetop North Pit TMF

Ridgetop North Pit is expected to be the final open pit mined as part of Phase V/VI, with mining scheduled to be completed during Q3 2017. Ridgetop North Pit TMF is projected to have a total storage volume of 1.9 Mm^3 below the natural spill elevation of 862 m.

The Ridgetop North Pit TMF will only receive tailings slurry; no NP:AP<3 rock will be stored in this facility. During Phase V/VI operations, Minto anticipates pumping excess water from the Ridgetop North Pit TMF to the adjacent A2PTMF for purposes of water management. There will be no surface discharge from the TMF and no spillway.

Minto North

During active development and mining of the Minto North pit (2014 through 2017), mine water will be pumped to the MPTMF. There will be no surface discharge from the Minto North Pit and no spillway.

5.4.3.5 Discharge management

Operational water management decisions for Phase V/VI can be summarized as follows:

1. The primary water management decision for Phase V/VI is whether or not water (clean runoff or mine water) must be released from site.

2. Secondary decisions include:

    a. The quantity of water;

    b. The preferred water source; and

    c. Timing of the release.

If the mine water inventory is running a surplus, the following actions will be taken in the order listed to release water from site:

1. Divert water from W35a to WSP: water will be diverted from the southwest catchment (collected at station W35a) to the WSP. Historically, the water at W35a has been of a similar quality to clean runoff measured in lower Minto Creek.

2. Divert water from W15 to WSP: if diversion of water from W35a is insufficient to meet water inventory and release targets, then water collected at W15 can be diverted to the WSP. Water collection point W15 collects runoff from undisturbed areas and from waste rock. The water quality parameter concentrations have historically been elevated compared to undisturbed catchments but have generally met water quality limits in the months of May, June, July, and August.

3. Release mine water stored in the MPTMF or A2PTMF to WSP. The mine water stored on site may typically (but not always) require water treatment. Water treatment considerations are discussed in Section 7.4.4.

Water will only be released from the WSP to Minto Creek when the water quality complies with limits prescribed in the water use license. On-going water quality monitoring will ensure that water in the WSP remains in compliance with the water use license water quality limits. In addition, the water quality, flow, and channel conditions of lower Minto Creek must be considered before a decision is made to release water from the WSP to Minto Creek.

5.4.3.6 Water Treatment

Water treatment may be required if:

- Water stored in the WSP does not meet water quality limits prescribed in the water use license; and/or
- Mine water stored in the MPTMF or the A2PTMF is to be released to Minto Creek but the water does not meet water quality limits prescribed in the water use license.

The WSP is intended as a clean water reservoir where discharge-compliant water is stored and monitored prior to release to Minto Creek. However, storm events, seepage losses from the Mill Valley or other events may cause certain water quality parameter concentrations to exceed water use license water quality limits. When treating WSP water, it may be necessary to release the treated water directly to Minto Creek from the water treatment plant rather than returning the water to the WSP. It is likely that mine water stored in the MPTMF or the A2PTMF must be treated before it can be released to the WSP.

The first stage of the water treatment plant at Minto was constructed in 2010. The water treatment process included a ballasted lamella clarifier unit (Actiflo®) system for removal of TSS, total metals and dissolved copper. The plant was designed for a maximum capacity of 3,600 m^3/day but had proved to operate reliably at flows of approximately 4,000 m^3/day.

In 2012, two reverse osmosis (RO) trains capable of handling 2,500 m^3/day per train were added to the treatment process downstream of the existing clarification and filtration units, for the purpose of treating nitrate and selenium, based on water quality limits received in the Water Use Licence Amendment 7. Treated effluent from the RO units may also be amended, when necessary, with sodium bicarbonate to adjust the pH and add salinity and alkalinity.

The RO process removes 95–99% of all constituents in the feed water. The feed water for the RO unit is the effluent from clarification and filtration unit, which is operated as a pretreatment step. The RO unit produces a clean effluent stream that consists of approximately 75% of the feed water (the RO permeate). The by-product of the process is a brine stream, which consists of about 25% of the feed water and 95–99% of constituent loadings. The brine stream will be pumped to the MPTMF or A2PTMF. Because of this brine by-product, RO cannot be considered a true water treatment process but is rather a process that concentrates mine water into a smaller volume with higher constituent concentrations.

During Phase IV, feed water for the plant could be pumped from the Main Pit reservoir or from the WSP. Treated effluent could be directed to the Main Pit, the WSP or directly to Minto Creek. Sludge or RO brine is pumped to the Main Pit for disposal. The Phase IV configuration will be maintained through the transition to Phase V/VI; until 2017, when the option of conveying water from and to the A2PTFM will be added to the conveyance network.

Although RO is considered to be a conventional technology, the treatment process described above for removal of selenium to ultra-low concentrations (0.003 mg/L) is outside the realm of conventional technology. The use of RO alone for removal of selenium or any other constituent is, in effect, a mine water concentration process, rather than a true water treatment process. If RO alone is used for "treatment" of mine water at Minto, the brine would be pumped back to the MPTMF or the A2PTMF where the loadings removed would mix with the untreated mine water. This would result in a gradual increase in all parameter concentrations over time. If RO is used for an extended period of time, the parameter concentrations in the mine water reservoir may increase to a point where RO is no longer effective. In other words, long-term use of RO alone simply causes a gradual worsening of the mine water quality and is therefore not a sustainable water treatment method.

5.4.3.7 Conveyance Network

The Minto Mine water conveyance network consists of diversion ditches, culverts, sumps, pumps, and pipelines installed throughout the mine site. The system is designed to segregate clean runoff and mine water. Clean water is conveyed to the WSP while mine water is conveyed to the mine water storage reservoirs, which includes the Main Pit for Phase IV and the MPTFM and A2PTFM for Phase V/VI.

Figure 4-2 shows the proposed Phase V/VI water conveyance network. Infrastructure for diverting clean runoff includes the W35a sump, South diversion ditch, tailings diversion ditch and the 0.5 km and 1.5 km sumps and ditches. Mine water conveyance infrastructure includes the W15 and W37/W36 sumps.

Changes to the conveyance network for the Phase V/VI expansion include:

- Further development of the Main Pit into a tailings management facility (MPTMF) and as a reservoir for storage of mine water;
- Development of the Area 2 Pit into a tailings management facility (A2PTMF) and as a reservoir for storage of mine water;
- Addition of mine water sumps and mine water pipelines to dewater the Ridgetop North Pit, and Ridgetop South Pit 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 include piping of runoff from the eastern end of the ditch to the WSP; and
- Decommissioning of the south diversion ditch and modification to the W35a collection point to allow for conveyance of several features.

The infrastructure upgrades were planned to maximize the ability to divert clean runoff away from developed mine areas and towards the WSP. The conveyance network is intended to provide a high degree of operational flexibility such that appropriate water management actions can be taken based on informed management decisions.

5.4.3.8 Source Control

Since total suspended solids (TSS) can be a significant factor affecting water quality, an important part of the Water Management Plan is source control consisting of erosion prevention and dust suppression. Dust control efforts currently consist of watering roads, the addition of water and a dust-suppression reagent at the crusher, and use of a curtain at the top of the stacker conveyor. Minto continues to monitor dust levels and address any issues.

The primary erosion control initiative at the site is the establishment of the water diversion and conveyance network which significantly decreases water movement over disturbed areas at Minto Mine. On areas where diversion and collection as part of this network is not afforded, or areas upgradient of diversion and collection, protection against the mobilization of significant amounts of sediment is based on runoff, erosion and sediment control best management practices. Successful runoff control will reduce the need for more expensive and difficult erosion and sediment control measures. Ongoing BMPs at the Minto Mine include:

- Swales and tail ditches to limit sediment mobilization on exploration roads;
- Recovering and re-seeding of disturbed areas in order to establish a vegetative mat to address erosion; and
- Recontouring of disturbed surfaces to minimize the distance and control the direction of water flow across them.

5.4.3.9 Monitoring Program and Mine Water Discharge

A key component of the current and proposed water management plans is the water quality surveillance program. The water quality (and quantity) monitoring program results provide valuable information that is used on a variety of timescales from instantly to annually to make water management decisions at the site. The water quality surveillance program is reported monthly, quarterly and annually as required by the water use licence.

5.4.4 Closure Water Quality Predictions

Minto retained SRK to develop a predictive water chemistry model in order to understand more thoroughly what the potential water quality discharging from the site would be at closure. The predictive water chemistry model is based on site monitoring data and the ongoing geochemical characterization program which includes humidity cells conducted on appropriate material types, and is an update of previous similar work conducted by SRK for both closure and operational periods.

Previous water quality prediction work in support of the closure planning for Minto incorporated the following key elements:

- Hydrology source terms from the site water balance model;
- Areas and locations of waste placement;
- Geochemical source terms based on information available at the time; and
- Mitigation measures required to achieve closure water quality objectives for Phase IV. These included:
    - Soil covers; and
    - Passive/semi-passive treatment of surface waters at key locations.

Most of these key elements have been revisited for the update of the predictive modeling for Phase V/VI. This predictive modeling work for the post-closure period at Minto for the Phase V/VI mining activities was initially conducted as a screening exercise using isolating soil covers on waste facilities as the sole closure mitigation, and did not incorporate expected load reductions from planned passive treatment systems. This was conducted to inform the closure planning team of the initial mitigative value of isolating soil covers in mitigating expected water quality from site runoff and seepage at closure. A series of scenarios was evaluated in the modeling (typical/upper limit concentrations, expected case/reasonable worst-case) and summary tables for key parameters during the 'open months' (April through October) are provided below in Table 5-18 through Table 5-24.

Table 5-18: Expected Case Predictions for Effluent Quality (WSP) for key parameters during open water season, Total Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.00011	0.77	0.038	0.0014	0.000100	0.00077	0.0019	0.029	1.3	0.57	0.000054	0.29	0.0080	13	0.0029	0.52	0.0065	0.00057	0.0023	0.0034	45	0.84	0.000079	0.013
May	0.00011	0.77	0.037	0.0014	0.000099	0.00075	0.0019	0.029	1.2	0.55	0.000051	0.27	0.0077	12	0.0029	0.51	0.0065	0.00057	0.0022	0.0033	45	0.81	0.000078	0.013
Jun	0.00011	0.77	0.037	0.0013	0.000097	0.00074	0.0019	0.028	1.2	0.53	0.000049	0.26	0.0074	12	0.0029	0.50	0.0063	0.00056	0.0021	0.0031	45	0.78	0.000079	0.013
Jul	0.00011	0.78	0.036	0.0013	0.000097	0.00075	0.0019	0.028	1.3	0.52	0.000051	0.26	0.0073	12	0.0029	0.49	0.0062	0.00056	0.0021	0.0030	44	0.77	0.000078	0.013
Aug	0.00011	0.79	0.036	0.0013	0.000097	0.00075	0.0019	0.028	1.3	0.52	0.000053	0.26	0.0072	12	0.0029	0.49	0.0061	0.00057	0.0021	0.0030	43	0.77	0.000077	0.013
Sep	0.00011	0.78	0.035	0.0014	0.000096	0.00075	0.0019	0.028	1.3	0.53	0.000052	0.26	0.0072	12	0.0029	0.48	0.0060	0.00057	0.0021	0.0030	42	0.77	0.000078	0.013
Oct	0.00011	0.77	0.034	0.0014	0.000096	0.00075	0.0019	0.028	1.3	0.53	0.000052	0.27	0.0072	12	0.0029	0.47	0.0059	0.00057	0.0021	0.0030	42	0.77	0.000079	0.013
Upper Limit Concentrations																								
Apr	0.00011	0.78	0.12	0.0015	0.00010	0.00081	0.0020	0.031	1.3	0.71	0.000055	0.30	0.014	19	0.0030	1.7	0.021	0.00060	0.0035	0.0040	58	1.2	0.000084	0.014
May	0.00011	0.78	0.12	0.0015	0.00010	0.00080	0.0020	0.031	1.3	0.70	0.000054	0.29	0.014	19	0.0030	1.6	0.021	0.00059	0.0034	0.0040	59	1.2	0.000084	0.014
Jun	0.00011	0.78	0.12	0.0014	0.00010	0.00079	0.0020	0.030	1.3	0.67	0.000051	0.27	0.013	18	0.0030	1.6	0.020	0.00058	0.0033	0.0036	59	1.2	0.000084	0.013
Jul	0.00011	0.79	0.12	0.0014	0.00010	0.00080	0.0020	0.029	1.3	0.65	0.000054	0.27	0.013	18	0.0030	1.6	0.020	0.00059	0.0033	0.0036	58	1.1	0.000083	0.013
Aug	0.00011	0.79	0.11	0.0014	0.00010	0.00080	0.0020	0.029	1.3	0.65	0.000054	0.27	0.013	18	0.0030	1.6	0.020	0.00059	0.0032	0.0035	56	1.1	0.000081	0.013
Sep	0.00011	0.79	0.11	0.0014	0.000100	0.00080	0.0020	0.029	1.3	0.65	0.000054	0.27	0.013	18	0.0030	1.5	0.019	0.00059	0.0032	0.0035	55	1.1	0.000082	0.013
Oct	0.00011	0.78	0.11	0.0014	0.000099	0.00079	0.0019	0.029	1.3	0.66	0.000053	0.28	0.013	18	0.0030	1.5	0.019	0.00059	0.0032	0.0035	55	1.1	0.000083	0.013

Table 5-19: Expected Case Predictions for Effluent Quality (WSP) for key parameters during open water season, Dissolved Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.000031	0.16	0.038	0.0011	0.000053	0.00041	0.0012	0.020	0.36	0.57	0.000045	0.23	0.0075	12	0.0016	0.52	0.0065	0.00031	0.0023	0.0034	45	0.79	0.000074	0.0065
May	0.000029	0.15	0.037	0.0011	0.000052	0.00039	0.0012	0.020	0.34	0.55	0.000043	0.21	0.0072	11	0.0016	0.51	0.0065	0.00030	0.0022	0.0033	45	0.76	0.000073	0.0063
Jun	0.000028	0.15	0.037	0.0010	0.000050	0.00038	0.0011	0.019	0.32	0.53	0.000041	0.20	0.0069	11	0.0015	0.50	0.0063	0.00030	0.0021	0.0031	45	0.73	0.000074	0.0061
Jul	0.000028	0.14	0.036	0.0010	0.000050	0.00037	0.0011	0.019	0.32	0.52	0.000043	0.20	0.0067	11	0.0015	0.49	0.0062	0.00029	0.0021	0.0030	44	0.72	0.000072	0.0062
Aug	0.000028	0.14	0.036	0.0010	0.000050	0.00037	0.0011	0.019	0.33	0.52	0.000045	0.20	0.0067	11	0.0015	0.49	0.0061	0.00028	0.0021	0.0030	43	0.72	0.000072	0.0061
Sep	0.000028	0.14	0.035	0.0010	0.000049	0.00037	0.0011	0.019	0.33	0.53	0.000044	0.20	0.0066	11	0.0015	0.48	0.0060	0.00029	0.0021	0.0030	42	0.72	0.000073	0.0061
Oct	0.000028	0.14	0.034	0.0010	0.000049	0.00037	0.0011	0.019	0.34	0.53	0.000044	0.20	0.0067	11	0.0015	0.47	0.0059	0.00029	0.0021	0.0030	42	0.72	0.000073	0.0061
Upper Limit Concentrations																								
Apr	0.000033	0.17	0.12	0.0012	0.000058	0.00046	0.0013	0.022	0.36	0.71	0.000047	0.24	0.013	18	0.0017	1.7	0.021	0.00033	0.0035	0.0040	58	1.2	0.000079	0.0070
May	0.000033	0.17	0.12	0.0012	0.000058	0.00046	0.0013	0.022	0.35	0.70	0.000046	0.23	0.013	18	0.0017	1.6	0.021	0.00032	0.0034	0.0039	59	1.2	0.000078	0.0070
Jun	0.000031	0.16	0.12	0.0011	0.000054	0.00043	0.0012	0.021	0.33	0.67	0.000043	0.21	0.013	17	0.0017	1.6	0.020	0.00032	0.0033	0.0036	59	1.1	0.000078	0.0067
Jul	0.000030	0.16	0.12	0.0011	0.000054	0.00043	0.0012	0.021	0.33	0.65	0.000046	0.21	0.012	17	0.0017	1.6	0.020	0.00031	0.0033	0.0036	58	1.1	0.000077	0.0067
Aug	0.000030	0.15	0.11	0.0011	0.000054	0.00042	0.0012	0.021	0.33	0.65	0.000046	0.21	0.012	17	0.0017	1.6	0.020	0.00031	0.0032	0.0035	56	1.1	0.000076	0.0067
Sep	0.000031	0.15	0.11	0.0011	0.000053	0.00042	0.0012	0.021	0.34	0.65	0.000046	0.21	0.012	17	0.0017	1.5	0.019	0.00031	0.0032	0.0035	55	1.1	0.000077	0.0066
Oct	0.000031	0.15	0.11	0.0011	0.000053	0.00042	0.0012	0.021	0.34	0.66	0.000045	0.22	0.012	17	0.0017	1.5	0.019	0.00031	0.0032	0.0035	55	1.1	0.000077	0.0066

Table 5-20: Reasonable Worst Case Predictions for Effluent Quality (WSP) for key parameters during open water season, Total Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.00016	0.89	0.14	0.0024	0.00018	0.0011	0.0030	0.050	1.5	0.71	0.00014	0.55	0.015	16	0.0039	3.0	0.084	0.0012	0.0042	0.0031	68	1.2	0.000089	0.020
May	0.00016	0.89	0.14	0.0023	0.00018	0.0010	0.0029	0.048	1.5	0.69	0.00014	0.53	0.015	15	0.0038	3.0	0.083	0.0011	0.0041	0.0030	68	1.2	0.000088	0.020
Jun	0.00015	0.88	0.13	0.0022	0.00017	0.0010	0.0028	0.047	1.4	0.67	0.00013	0.51	0.014	15	0.0038	2.9	0.082	0.0011	0.0040	0.0029	68	1.1	0.000089	0.019
Jul	0.00015	0.89	0.13	0.0022	0.00017	0.0010	0.0028	0.047	1.5	0.67	0.00013	0.51	0.014	15	0.0038	2.9	0.080	0.0011	0.0040	0.0028	66	1.1	0.000087	0.019
Aug	0.00015	0.90	0.13	0.0022	0.00017	0.0010	0.0028	0.047	1.5	0.67	0.00013	0.51	0.014	15	0.0038	2.8	0.079	0.0011	0.0040	0.0028	65	1.1	0.000086	0.019
Sep	0.00015	0.89	0.13	0.0022	0.00017	0.0010	0.0028	0.047	1.5	0.68	0.00013	0.51	0.014	15	0.0038	2.8	0.078	0.0011	0.0040	0.0028	65	1.1	0.000087	0.019
Oct	0.00015	0.89	0.12	0.0022	0.00017	0.0010	0.0028	0.047	1.5	0.68	0.00013	0.51	0.014	15	0.0038	2.7	0.076	0.0011	0.0040	0.0028	65	1.1	0.000088	0.019
Upper Limit Concentrations																								
Apr	0.00018	0.96	0.20	0.0028	0.00021	0.0012	0.0034	0.056	1.6	0.96	0.00016	0.62	0.023	23	0.0044	4.3	0.12	0.0014	0.0067	0.0040	90	1.8	0.000095	0.021
May	0.00018	0.95	0.19	0.0028	0.00021	0.0012	0.0034	0.055	1.5	0.95	0.00016	0.62	0.023	23	0.0043	4.3	0.12	0.0014	0.0066	0.0040	90	1.8	0.000094	0.021
Jun	0.00017	0.94	0.19	0.0026	0.00020	0.0011	0.0032	0.053	1.5	0.90	0.00015	0.57	0.022	22	0.0043	4.2	0.12	0.0013	0.0063	0.0036	88	1.7	0.000094	0.020
Jul	0.00017	0.96	0.19	0.0026	0.00019	0.0011	0.0032	0.052	1.5	0.89	0.00015	0.57	0.022	22	0.0043	4.1	0.12	0.0013	0.0062	0.0036	87	1.7	0.000093	0.020
Aug	0.00017	0.96	0.19	0.0026	0.00019	0.0011	0.0032	0.052	1.5	0.88	0.00015	0.57	0.021	22	0.0042	4.0	0.11	0.0013	0.0061	0.0035	85	1.6	0.000091	0.020
Sep	0.00017	0.95	0.18	0.0026	0.00019	0.0011	0.0032	0.052	1.5	0.88	0.00015	0.57	0.021	21	0.0042	4.0	0.11	0.0013	0.0061	0.0035	84	1.6	0.000092	0.020
Oct	0.00017	0.95	0.18	0.0026	0.00019	0.0011	0.0032	0.052	1.5	0.89	0.00015	0.57	0.021	21	0.0042	3.9	0.11	0.0013	0.0061	0.0035	84	1.6	0.000093	0.020

Table 5-21: Reasonable Worst Case Predictions for Effluent Quality (WSP) for key parameters during open water season, Dissolved Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.000082	0.29	0.14	0.0021	0.00014	0.00072	0.0023	0.041	0.58	0.71	0.00013	0.49	0.014	14	0.0026	3.0	0.084	0.00091	0.0042	0.0031	68	1.1	0.000084	0.013
May	0.000079	0.28	0.14	0.0020	0.00013	0.00069	0.0022	0.040	0.55	0.69	0.00013	0.47	0.014	14	0.0025	3.0	0.083	0.00089	0.0041	0.0030	68	1.1	0.000083	0.013
Jun	0.000075	0.27	0.13	0.0019	0.00013	0.00066	0.0021	0.038	0.53	0.67	0.00012	0.45	0.014	14	0.0025	2.9	0.082	0.00085	0.0040	0.0029	68	1.1	0.000083	0.012
Jul	0.000074	0.26	0.13	0.0019	0.00013	0.00065	0.0021	0.038	0.53	0.67	0.00012	0.44	0.014	14	0.0025	2.9	0.080	0.00084	0.0040	0.0028	66	1.1	0.000082	0.012
Aug	0.000074	0.26	0.13	0.0019	0.00013	0.00065	0.0021	0.038	0.53	0.67	0.00012	0.44	0.014	14	0.0025	2.8	0.079	0.00084	0.0040	0.0028	65	1.1	0.000081	0.012
Sep	0.000075	0.26	0.13	0.0019	0.00013	0.00065	0.0021	0.038	0.54	0.68	0.00012	0.45	0.014	14	0.0025	2.8	0.078	0.00084	0.0040	0.0028	65	1.1	0.000082	0.012
Oct	0.000075	0.26	0.12	0.0019	0.00013	0.00066	0.0021	0.038	0.54	0.68	0.00012	0.45	0.014	14	0.0025	2.7	0.076	0.00085	0.0040	0.0028	65	1.1	0.000083	0.012
Upper Limit Concentrations																								
Apr	0.000098	0.35	0.20	0.0025	0.00016	0.00085	0.0027	0.047	0.66	0.96	0.00016	0.56	0.023	22	0.0031	4.3	0.12	0.0011	0.0067	0.0040	90	1.7	0.000090	0.014
May	0.000096	0.35	0.19	0.0025	0.00016	0.00084	0.0027	0.047	0.65	0.95	0.00015	0.56	0.023	22	0.0030	4.3	0.12	0.0011	0.0066	0.0039	90	1.7	0.000088	0.014
Jun	0.000089	0.33	0.19	0.0023	0.00015	0.00078	0.0025	0.044	0.59	0.90	0.00014	0.51	0.022	21	0.0029	4.2	0.12	0.0010	0.0063	0.0036	88	1.7	0.000088	0.013
Jul	0.000087	0.32	0.19	0.0022	0.00015	0.00077	0.0025	0.044	0.59	0.89	0.00014	0.50	0.021	21	0.0029	4.1	0.12	0.0010	0.0062	0.0036	87	1.6	0.000087	0.013
Aug	0.000087	0.32	0.19	0.0022	0.00015	0.00076	0.0024	0.043	0.59	0.88	0.00014	0.50	0.021	21	0.0029	4.0	0.11	0.00099	0.0061	0.0035	85	1.6	0.000086	0.013
Sep	0.000087	0.32	0.18	0.0023	0.00015	0.00077	0.0024	0.043	0.60	0.88	0.00014	0.51	0.021	20	0.0029	4.0	0.11	0.0010	0.0061	0.0035	84	1.6	0.000087	0.013
Oct	0.000088	0.32	0.18	0.0023	0.00015	0.00077	0.0025	0.044	0.61	0.89	0.00014	0.51	0.021	20	0.0029	3.9	0.11	0.0010	0.0061	0.0035	84	1.6	0.000088	0.013

Table 5-22: Expected Case Predictions for Lower Minto Creek (W1) for key parameters during open water season, Total Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.000040	0.35	0.023	0.00066	0.000049	0.00037	0.00099	0.015	0.61	0.27	0.000024	0.097	0.0028	5.9	0.0019	0.15	0.0065	0.00032	0.00090	0.0017	39	0.34	0.000073	0.0065
May	0.000038	0.34	0.023	0.00064	0.000048	0.00036	0.00097	0.015	0.61	0.25	0.000023	0.091	0.0026	5.6	0.0019	0.15	0.0065	0.00032	0.00087	0.0016	39	0.32	0.000074	0.0064
Jun	0.000032	0.26	0.021	0.00071	0.000042	0.00034	0.00086	0.0097	0.62	0.33	0.000041	0.084	0.0024	7.7	0.0018	0.12	0.0063	0.00025	0.00087	0.00089	24	0.33	0.000056	0.0068
Jul	0.000036	0.60	0.020	0.00080	0.000051	0.00061	0.0014	0.011	0.98	0.33	0.000029	0.11	0.0027	7.9	0.0021	0.13	0.0062	0.00045	0.00086	0.0010	19	0.38	0.000053	0.0070
Aug	0.000043	0.33	0.024	0.00074	0.000034	0.00037	0.00095	0.010	0.75	0.36	0.000023	0.10	0.0025	7.3	0.0019	0.13	0.0061	0.00032	0.00087	0.0011	19	0.38	0.000084	0.0059
Sep	0.000043	0.30	0.019	0.00073	0.000033	0.00033	0.00091	0.011	0.77	0.32	0.000025	0.11	0.0024	7.1	0.0019	0.13	0.0060	0.00031	0.00088	0.0012	19	0.36	0.000082	0.0055
Oct	0.000037	0.29	0.020	0.00073	0.000047	0.00036	0.00085	0.011	0.69	0.31	0.000024	0.13	0.0027	7.1	0.0018	0.14	0.0059	0.00024	0.00093	0.0010	19	0.36	0.000059	0.0048
Upper Limit Concentrations																								
Apr	0.000045	0.35	0.051	0.00076	0.000050	0.00041	0.0010	0.016	0.62	0.45	0.000024	0.11	0.0044	11	0.0020	0.48	0.021	0.00033	0.0013	0.0029	43	0.61	0.000075	0.0067
May	0.000040	0.35	0.050	0.00067	0.000050	0.00038	0.0010	0.016	0.62	0.29	0.000024	0.098	0.0043	7.5	0.0020	0.46	0.021	0.00033	0.0012	0.0018	43	0.44	0.000075	0.0066
Jun	0.000039	0.35	0.049	0.00073	0.000049	0.00037	0.00099	0.016	0.62	0.36	0.000043	0.091	0.0042	9.3	0.0020	0.46	0.020	0.00033	0.0012	0.0017	43	0.43	0.000075	0.0070
Jul	0.000037	0.62	0.043	0.00082	0.000053	0.00064	0.0015	0.011	1.00	0.37	0.000043	0.12	0.0041	9.4	0.0022	0.40	0.020	0.00046	0.0012	0.0012	26	0.48	0.000056	0.0071
Aug	0.000044	0.62	0.051	0.00082	0.000053	0.00063	0.0015	0.011	1.00	0.39	0.000029	0.12	0.0039	9.1	0.0021	0.40	0.020	0.00046	0.0012	0.0012	22	0.47	0.000087	0.0071
Sep	0.000044	0.31	0.050	0.00075	0.000034	0.00037	0.00095	0.011	0.77	0.39	0.000025	0.11	0.0039	8.8	0.0019	0.42	0.019	0.00032	0.0012	0.0013	23	0.47	0.000087	0.0059
Oct	0.000044	0.30	0.044	0.00075	0.000050	0.00038	0.00093	0.012	0.77	0.36	0.000025	0.13	0.0043	8.8	0.0019	0.44	0.019	0.00032	0.0013	0.0013	23	0.47	0.000083	0.0056

Table 5-23: Expected Case Predictions for Lower Minto Creek (W1) for key parameters during open water season, Dissolved Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.000016	0.084	0.023	0.00052	0.000033	0.00025	0.00071	0.011	0.22	0.27	0.000023	0.074	0.0025	5.7	0.0014	0.15	0.0065	0.00023	0.00090	0.0017	39	0.33	0.000071	0.0046
May	0.000015	0.084	0.023	0.00049	0.000032	0.00024	0.00070	0.011	0.22	0.25	0.000022	0.068	0.0024	5.3	0.0014	0.15	0.0065	0.00023	0.00087	0.0016	39	0.31	0.000072	0.0046
Jun	0.000012	0.056	0.021	0.00057	0.000031	0.00019	0.00057	0.0072	0.21	0.33	0.000039	0.061	0.0023	7.5	0.0012	0.12	0.0063	0.00012	0.00088	0.00091	24	0.32	0.000054	0.0073
Jul	0.000014	0.055	0.020	0.00062	0.000028	0.00018	0.00053	0.0068	0.26	0.33	0.000027	0.068	0.0025	7.7	0.0013	0.13	0.0062	0.00014	0.00085	0.0010	19	0.36	0.000052	0.0044
Aug	0.000016	0.052	0.024	0.00057	0.000020	0.00021	0.00066	0.0073	0.31	0.36	0.000021	0.074	0.0023	7.1	0.0014	0.13	0.0061	0.00025	0.00088	0.0011	19	0.42	0.000084	0.0037
Sep	0.000017	0.056	0.019	0.00057	0.000021	0.00022	0.00070	0.0076	0.34	0.32	0.000021	0.085	0.0023	6.9	0.0014	0.13	0.0060	0.00023	0.00090	0.0012	19	0.35	0.000081	0.0035
Oct	0.000015	0.063	0.020	0.00061	0.000030	0.00020	0.00053	0.0078	0.32	0.31	0.000018	0.100	0.0025	7.0	0.0012	0.14	0.0059	0.00012	0.00093	0.0011	19	0.35	0.000057	0.0028
Upper Limit Concentrations																								
Apr	0.000016	0.089	0.051	0.00065	0.000034	0.00031	0.00074	0.012	0.23	0.45	0.000023	0.091	0.0043	11	0.0014	0.48	0.021	0.00023	0.0013	0.0029	43	0.59	0.000074	0.0048
May	0.000016	0.089	0.050	0.00053	0.000034	0.00026	0.00074	0.012	0.23	0.29	0.000023	0.076	0.0041	7.2	0.0014	0.46	0.021	0.00023	0.0012	0.0018	43	0.42	0.000074	0.0048
Jun	0.000016	0.086	0.049	0.00060	0.000033	0.00025	0.00071	0.011	0.22	0.36	0.000041	0.068	0.0039	9.1	0.0014	0.46	0.020	0.00023	0.0012	0.0017	43	0.42	0.000074	0.0076
Jul	0.000015	0.058	0.043	0.00064	0.000031	0.00020	0.00059	0.0074	0.27	0.37	0.000041	0.071	0.0039	9.3	0.0013	0.40	0.020	0.00015	0.0012	0.0012	26	0.46	0.000054	0.0076
Aug	0.000016	0.057	0.051	0.00064	0.000029	0.00022	0.00069	0.0077	0.31	0.39	0.000027	0.077	0.0037	8.9	0.0014	0.40	0.020	0.00026	0.0012	0.0012	22	0.51	0.000087	0.0043
Sep	0.000017	0.059	0.050	0.00059	0.000022	0.00023	0.00073	0.0080	0.35	0.39	0.000022	0.089	0.0037	8.6	0.0014	0.42	0.019	0.00026	0.0012	0.0013	23	0.51	0.000087	0.0038
Oct	0.000017	0.067	0.044	0.00064	0.000032	0.00023	0.00073	0.0082	0.35	0.36	0.000022	0.10	0.0041	8.7	0.0014	0.44	0.019	0.00024	0.0013	0.0013	23	0.45	0.000081	0.0036

Table 5-24: Reasonable Worst Case Predictions for Lower Minto Creek (W1) for key parameters during open water season, Total Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.000057	0.40	0.031	0.0010	0.000077	0.00048	0.0014	0.022	0.70	0.33	0.000054	0.19	0.0052	7.0	0.0023	0.39	0.030	0.00053	0.0015	0.0017	47	0.46	0.000076	0.0085
May	0.000055	0.39	0.031	0.00097	0.000075	0.00046	0.0013	0.021	0.68	0.31	0.000051	0.17	0.0049	6.5	0.0023	0.37	0.022	0.00052	0.0015	0.0016	47	0.44	0.000077	0.0082
Jun	0.000045	0.30	0.028	0.00098	0.000063	0.00042	0.0012	0.015	0.68	0.38	0.000064	0.15	0.0043	8.5	0.0020	0.31	0.028	0.00041	0.0014	0.00089	30	0.43	0.000058	0.0083
Jul	0.000050	0.64	0.027	0.0011	0.000074	0.00069	0.0017	0.016	1.0	0.39	0.000052	0.18	0.0046	8.7	0.0024	0.32	0.030	0.00061	0.0014	0.0010	26	0.48	0.000056	0.0085
Aug	0.000057	0.37	0.032	0.0010	0.000057	0.00045	0.0013	0.015	0.81	0.41	0.000047	0.17	0.0044	8.2	0.0022	0.32	0.024	0.00049	0.0014	0.0011	26	0.47	0.000087	0.0074
Sep	0.000058	0.34	0.026	0.0010	0.000057	0.00042	0.0012	0.016	0.84	0.38	0.000050	0.18	0.0045	8.0	0.0022	0.34	0.023	0.00049	0.0014	0.0012	26	0.46	0.000084	0.0072
Oct	0.000053	0.33	0.027	0.0011	0.000073	0.00046	0.0012	0.017	0.77	0.37	0.000051	0.21	0.0049	8.1	0.0022	0.35	0.029	0.00043	0.0015	0.0010	27	0.47	0.000061	0.0065
Upper Limit Concentrations																								
Apr	0.000063	0.40	0.073	0.0011	0.000080	0.00052	0.0014	0.023	0.71	0.52	0.000055	0.20	0.0072	12	0.0024	1.2	0.12	0.00056	0.0022	0.0029	52	0.76	0.000079	0.0087
May	0.000058	0.40	0.071	0.0010	0.000080	0.00049	0.0014	0.023	0.70	0.37	0.000055	0.19	0.0070	8.6	0.0024	1.2	0.047	0.00055	0.0021	0.0018	52	0.60	0.000078	0.0087
Jun	0.000055	0.39	0.070	0.0010	0.000075	0.00047	0.0014	0.022	0.68	0.42	0.000065	0.17	0.0067	10	0.0023	1.2	0.062	0.00052	0.0020	0.0017	51	0.57	0.000078	0.0085
Jul	0.000052	0.66	0.061	0.0011	0.000076	0.00072	0.0018	0.017	1.1	0.43	0.000065	0.19	0.0063	10	0.0025	1.0	0.070	0.00064	0.0019	0.0012	33	0.61	0.000058	0.0087
Aug	0.000058	0.66	0.069	0.0011	0.000076	0.00072	0.0018	0.017	1.1	0.45	0.000053	0.19	0.0062	10.0	0.0024	1.0	0.064	0.00063	0.0019	0.0012	30	0.60	0.000089	0.0087
Sep	0.000059	0.36	0.068	0.0011	0.000059	0.00046	0.0013	0.017	0.84	0.45	0.000051	0.19	0.0062	9.7	0.0023	1.1	0.049	0.00050	0.0020	0.0013	31	0.60	0.000089	0.0076
Oct	0.000059	0.34	0.064	0.0011	0.000077	0.00048	0.0013	0.019	0.84	0.42	0.000053	0.22	0.0068	9.9	0.0023	1.1	0.072	0.00050	0.0021	0.0013	31	0.62	0.000085	0.0074

Table 5-25: Reasonable Worst Case Predictions for Lower Minto Creek (W1) for key parameters during open water season, Dissolved Concentrations

	Ag	Al	Ammonia	As	Cd	Co	Cr	Cu	Fe	Fluoride	Hg	Mn	Mo	Na	Ni	Nitrate-N	Nitrite-N	Pb	Se	Sn	Sulphate	Sr	Tl	Zn
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Typical Concentrations																								
Apr	0.000034	0.13	0.031	0.00088	0.000061	0.00035	0.0011	0.018	0.31	0.33	0.000053	0.16	0.0050	6.7	0.0018	0.39	0.030	0.00044	0.0015	0.0017	47	0.45	0.000074	0.0066
May	0.000032	0.13	0.031	0.00083	0.000059	0.00034	0.0011	0.017	0.30	0.31	0.000050	0.15	0.0047	6.3	0.0017	0.37	0.022	0.00042	0.0015	0.0016	47	0.42	0.000075	0.0064
Jun	0.000026	0.093	0.028	0.00085	0.000052	0.00027	0.00087	0.012	0.27	0.38	0.000062	0.13	0.0041	8.3	0.0015	0.31	0.028	0.00029	0.0014	0.00091	30	0.42	0.000057	0.0088
Jul	0.000028	0.094	0.027	0.00091	0.000051	0.00026	0.00083	0.012	0.33	0.39	0.000050	0.14	0.0044	8.6	0.0016	0.32	0.030	0.00031	0.0014	0.0010	26	0.46	0.000054	0.0059
Aug	0.000030	0.091	0.032	0.00085	0.000043	0.00029	0.00097	0.013	0.38	0.41	0.000044	0.14	0.0043	7.9	0.0017	0.32	0.024	0.00041	0.0014	0.0011	26	0.51	0.000086	0.0053
Sep	0.000031	0.098	0.026	0.00087	0.000045	0.00031	0.0010	0.013	0.41	0.38	0.000047	0.16	0.0043	7.8	0.0017	0.34	0.023	0.00041	0.0014	0.0012	26	0.46	0.000083	0.0052
Oct	0.000031	0.11	0.027	0.00094	0.000056	0.00030	0.00088	0.014	0.39	0.37	0.000045	0.18	0.0047	7.9	0.0016	0.35	0.029	0.00031	0.0015	0.0011	27	0.46	0.000060	0.0046
Upper Limit Concentrations																								
Apr	0.000035	0.14	0.073	0.0010	0.000064	0.00041	0.0011	0.019	0.31	0.52	0.000054	0.18	0.0070	12	0.0018	1.2	0.12	0.00046	0.0022	0.0029	52	0.74	0.000077	0.0069
May	0.000035	0.14	0.071	0.00090	0.000064	0.00037	0.0011	0.019	0.31	0.37	0.000054	0.17	0.0068	8.3	0.0018	1.2	0.047	0.00045	0.0021	0.0018	52	0.58	0.000077	0.0069
Jun	0.000032	0.13	0.070	0.00088	0.000059	0.00035	0.0011	0.018	0.29	0.42	0.000064	0.15	0.0065	10.0	0.0018	1.2	0.062	0.00043	0.0020	0.0017	51	0.55	0.000077	0.0091
Jul	0.000030	0.099	0.061	0.00094	0.000054	0.00028	0.00089	0.013	0.33	0.43	0.000063	0.15	0.0061	10	0.0016	1.0	0.070	0.00033	0.0019	0.0012	33	0.59	0.000057	0.0091
Aug	0.000031	0.098	0.069	0.00093	0.000052	0.00031	0.0010	0.014	0.38	0.45	0.000051	0.15	0.0060	9.8	0.0018	1.0	0.064	0.00043	0.0019	0.0012	30	0.64	0.000089	0.0059
Sep	0.000033	0.10	0.068	0.00090	0.000048	0.00033	0.0011	0.014	0.42	0.45	0.000048	0.17	0.0061	9.5	0.0018	1.1	0.049	0.00043	0.0020	0.0013	31	0.64	0.000089	0.0054
Oct	0.000033	0.11	0.064	0.00098	0.000059	0.00033	0.0011	0.015	0.42	0.42	0.000048	0.19	0.0066	9.8	0.0017	1.1	0.072	0.00043	0.0021	0.0013	31	0.60	0.000084	0.0054

For the post-closure period, the expected case (typical concentrations) and reasonable worst-case (upper limit concentrations) scenarios were evaluated against the proposed operational water quality objectives (Table 5-26 below). The outcomes suggest that in the expected case predictions, mitigation of potential metal loading from waste facilities using operational source control and closure isolating soil covers constructed from available site materials alone are not expected to exceed these objective, in any month, and are therefore not predicted to result in adverse effects to aquatic resources downstream of Minto mine at closure.

Only in the most conservative of prediction conditions (reasonable worst case, upper limit concentrations) is there any predicted exceedance of any of the proposed operational objectives (dissolved aluminum, dissolved chromium). The proposed AMP presents a framework for utilizing the expected case predictions as specific thresholds for the monitoring of all of these parameters. Monitoring results that exceeded these thresholds would trigger further analysis/investigation and ultimately action to ensure that objectives are not exceeded. Furthermore, these predictions do not account for any contaminant load reduction from passive water treatment technologies. Minto expects that, based on reclamation research results to date (section 2.2), water quality released from site at closure – and consequently water quality in lower Minto Creek - should be improved over these predictions.

Table 5-26: Predicted Closure Condition W2 Water Quality vs. Proposed Water Quality Objective (Operational) – Maximum Monthly Concentrations during Open Water Period

Parameter	Proposed Water Quality Objective for Lower Minto Creek (W2) (mg/L)	Predicted W2 Water Quality (Closure Condition Expected Case, Max. Typical Concentration, mg/L)	Predicted W2 Water Quality (Closure Condition, Reasonable Worst Case, Max Upper Limit Concentration, mg/L)
Dissolved Aluminium	0.1	0.084	0.14
Dissolved Cadmium	0.0001	0.000033	0.000064
Dissolved Chromium	0.001	0.00071	0.0011
Dissolved Copper	0.020	0.011	0.019
Dissolved Selenium	0.005	0.0009	0.0022
Ammonia-N	0.25	0.024	0.073
Nitrate-N	10	0.15	1.2
Nitrite-N*	0.06	0.0065	0.12*

*Predictions do not account for nitrification, which is expected to reduce nitrite concentrations by approximately 75%.

6 TEMPORARY CLOSURE

6.1 DEFINITIONS AND TEMPORARY CLOSURE OBJECTIVES

Temporary closure is defined in the Yukon Mine Site Reclamation and Closure Policy (Financial and Technical Guidelines) as closure that exceeds six months and is not expected to last longer than five years and can include both planned and unplanned closure (Yukon Government 2006). YG's guidance on the development of Reclamation and Closure Plans (2013) elaborates further:

Temporary closure is a closure in which mining related activities cease with the intent of resuming activities in the near future. Temporary closures may be planned or unplanned and could arise from a variety of circumstances including financial challenges, design failures, extreme climatic conditions, etc. Temporary closures may last for weeks, or could extend for years. Maximum durations of temporary closure periods are frequently defined in QMLs and WLs. At the conclusion of a defined temporary closure period, proponents will be required to implement permanent closure measures. In the event of a temporary closure, a full review of the RCP as well as liability estimate and security may be undertaken.

This section describes the measures and activities that will be undertaken at the Project in the event of a temporary closure, and how protecting public health and safety, and the environment will be accomplished. It presents fundamental and site-specific reclamation and closure objectives for temporary closure, and demonstrates how they will be met. The main activities would focus on site stabilization and safety, followed by care and maintenance of all site facilities and routine monitoring until production recommences or full closure is implemented. Depending on the reasons for a temporary cessation of surface mining operations, the process facilities can be expected to continue to recirculate solutions and recover copper until all economically viable ore is processed.

For purposes of this temporary closure plan, temporary closure refers to a suspension of mining and/or milling activities for more than 90 days but less than three years.

There are certain general objectives which are paramount during temporary closure:

In general, temporary closure plans must focus on ensuring public health and safety, protecting the environment and managing risks associated with potential abandonment of a site. (Yukon Government, 2013)

The sections following identify the fundamental and site specific closure and reclamation objectives which are relevant to mine components and values during a potential temporary closure of the Project, with associated temporary closure measures planned to ensure these objectives are met.

6.2 SITE ACCESS, SECURITY AND MAINTENANCE

Access control, security and site care and maintenance are key to meeting the critical temporary closure objectives of protecting human health and safety and the environment. The Care and Maintenance Program is the program where a reduced workforce will inspect and maintain property assets, restrict access to mine site locations, manage site chemical and explosive storage, continue to implement the site WMP, and continue with the operational environmental monitoring for applicable elements. The Care and Maintenance Program will be implemented once the transition period from the operating mine to the suspended activities is achieved. Transition activities before the Care and Maintenance Program is initiated will include:

- Complete all necessary outstanding repairs; and
- Winterize seepage collection systems and mobile equipment, buildings and other site infrastructure.

The temporary decommissioning and closure activities will only be conducted to a level such that all infrastructure, process and mining facilities are stable for a period of up to three years and such that full operations can be resumed in a timely manner should the decision be made to resume production. To meet these objectives of temporary closure, the essential equipment and assets will remain onsite to maintain infrastructure and facilities. All hazardous materials will either be removed from site and/or stored in a safe and secure manner with primary and secondary containments as required to ensure compliance with applicable regulations.

Full-time care and maintenance staff will be housed onsite in the main camp to provide security, control site access and monitor site activities. Access to the site will be restricted and enforced on a 24 hour per day basis. Restricted access consists of a vehicle gate at the entrance to the property.

Two caretakers will work different rotations to provide site security and monitoring. These two individuals are in addition to the reduced operations staff. Site equipment and vehicles will be kept onsite for the use of both the operations staff and caretakers. Contingency equipment (dozer/loader) will also remain onsite should earthworks be required during the temporary closure phase.

During temporary closure, the security gates on the access road will be locked with warning signs clearly posted at the gates and at key locations around the property indicating risk of entry. All site buildings will be kept locked and secured. The main access road will be maintained for access by the caretakers and operations staff with equipment retained onsite (grader/loader).

The caretakers and operations staff will be responsible for a variety of security measures including the following examples:

- Assign a Care and Maintenance Coordinator for continued direction and management of all activities;
- Safety, Security and First responders to support site inspections, security controls first aid and emergency response and Communications;
- Process Operators to support Water Management and any MWTP operations, sample collection and support site monitoring;
- Environmental Technicians to support site monitoring and sample collection and ensure compliance to ongoing regulatory requirements;
- Adequate maintenance staff to ensure critical process equipment such as pumps and generators, and some mobile equipment are maintained in operating condition;
- Some C&M personnel will also be trained in operating equipment required for snow removal and road access; and
- Additional support from Capstone's corporate office for IT and administration.

It is currently planned that staff will work in 8 to 12 hour shifts with coverage day and night for safety, security and water. Management and maintenance (caretakers) and environmental personnel will work 8 to 12 hour day shifts only.

6.3 Temporary Closure Measures

6.3.1 Interim Water Management Plan

The appropriate management of site water is critical to meeting the objective of environmental protection in the event of a temporary closure. All water management facilities, including the use of the mine water treatment plant, will be managed as if operations were continuing. A description of the management of water during the operational period can be found in the Section 5.4.

Operational water management structures will be maintained and operated according to the operational water management plan.

6.3.2 Open Pits

Pit operations will be ceased in a temporary closure situation. The key temporary closure objective for the Open Pits relates to the protection of human health and safety, and therefore access control is the key temporary closure measure. Areas of particular concern for the public, if any, will be bermed or fenced and posted with warning signs.

A geotechnical engineer will be retained to conduct water management and physical stability monitoring at the Open Pits. Monitoring will include visual inspections in accordance with requirements of regulatory authorities.

6.3.3 Diversion Channels

The key temporary closure objective for the diversion channels is the maintenance of physical stability to ensure that the structures retains their functionality. The diversion channels may require repair and maintenance to preserve this physical stability during temporary closure. Monitoring, repairs and maintenance will be carried out by the site caretaker as required by regulatory authorities.

6.3.4 Waste Rock Dumps

Temporary closure objectives for the Waste Rock Dumps include:

- Ensure short-term physical stability to minimize erosion, subsidence or slope failure; and
- Ensure short-term chemical stability such that runoff and seepage quality meets water quality criteria.

The following actions will be undertaken during operations to reduce the risk of Waste Rock Dump physical instability at any point following their construction, including a temporary closure:

- Maintain sloped grading of bench surfaces to minimize surface water infiltration and erosion of downstream slopes; and
- Maintain surface water collection ditches to control surface drainage during operations and progressive reclamation.

During a temporary closure, waste rock dump inspections will be carried out by a geotechnical engineer on the predetermined schedule. Any repairs or maintenance of the facility, or improvements to runoff, erosion and sediment control will be undertaken on recommendation from the inspections.

Chemical stability of the runoff and seepage from the dumps will be maintained through the continued implementation of the water management plan. A senior operator will monitor seepage and runoff water quality as per licensed monitoring programs, and water treatment by the MWTP will be implemented as required.

6.3.5 Mine and Processing Facilities

Temporary closure objectives for these facilities will be to remove potential threats to public health and safety and to maintain the physical stability and operational capacity of any remaining structures and assets. In order to meet these objectives of temporary closure, the process plant and related facilities will be secured. Processed ore and non-essential chemicals will be removed from the site. All essential chemicals will remain onsite will be securely stored within double containment. The site caretaker will conduct weekly visual inspections of the buildings and containment. The caretaker will also secure the buildings and maintain the equipment required for solution recirculation and treatment. The solution treatment plant and required chemicals will be maintained. The caretaker will monitor the water quality and systems as required in the licenses. To preserve physical stability of the process plant the caretaker will conduct quarterly structural inspections of the facilities.

6.3.6 Other Infrastructure

This section refers to infrastructure not considered in mine facilities and ancillary facilities within the mine footprint, but also infrastructure outside the mine footprint (e.g., transmission line and access road upgrades).

The access road system will require periodic visual inspections. Private contractors will be retained to complete maintenance of surface drainage infrastructure, culvert repair or road grading as required. Other miscellaneous infrastructure buildings will be secured and structural inspections and maintenance will be provided by the caretaker as necessary. Restricted access to site will contribute to the security of site buildings.

Site infrastructure, including buildings and process machinery, will be emptied/drained of hazardous reagents and process fluids where appropriate and stabilized for temporary closure based on recommendations from mechanical and chemical suppliers, contractors and engineers. This includes the removal of all hazardous wastes, including waste hydrocarbons, coolants, lubricants, mill reagents, and process chemicals.

6.3.7 Fuel and Explosives Facilities

The physical stability of the fuel and explosives facility will be maintained by a senior operator throughout the temporary closure. Controlling site access and ensuring the security of the fuel and explosives facilities will be of paramount importance.

The bulk explosives inventory will be removed from site and explosives storage containers and facilities will be inspected regularly. Hazardous wastes that will be removed from site include waste hydrocarbons, coolants and lubricants. All hazardous fluids will be drained from non-essential machinery and mining equipment based on recommendations from mechanical and chemical suppliers, contractors and engineers.

6.3.8 Monitoring

Monitoring activities for the site will follow both licenced and non-licenced surveillance programs. These may include, but are not limited to the following:

- Regular inspections of the site to observe and document the condition of any changes to site security, public safety measures, and mine infrastructure;
- Documentation of potential environmental or public health and safety issues;
- Routine physical stability monitoring;
- Routine chemical stability monitoring;
- Regular water quality and flow monitoring;
- Monitoring of existing climatic conditions will continue with operation of the onsite weather station;
- No regular air monitoring is planned; however, visual monitoring of the crushing facility, waste rock storage areas and open pits conducted daily and weekly;
- Submittals of inspection and monitoring reports on a regular basis as required; and
- Response to any security/safety breaches as required.

Site inspections and monitoring will likely be conducted by vehicle when seasonally possible. Some areas of the site may be inaccessible in winter as snow removal will not be reasonable in some locations. Inspection results will be documented and submitted on a regular basis, or as required. Reports of changes to the physical status of any part of the site may warrant a follow-up investigation by the appropriate personnel. Some elements of the monitoring program such as geotechnical and structure inspections and non-routine water quality and biological monitoring, will be conducted by appropriate professionals. The results of these inspections will be included in annual reports and other required submittals.

6.3.9 Notification and Reporting

If a temporary closure is triggered, a notice will be provided within ten days (or as the authorizations dictate) to the appropriate authorities stating the following:

- The nature and reason for the temporary closure;
- The anticipated duration of the temporary closure;
- Actions planned to maintain compliance with project permits and plan approvals; and
- Any event which would reasonably be anticipated to result in the resumption of mining or the permanent closure of the mine.

Capstone will submit a detailed temporary closure plan to YG within ten days of a temporary closure notification being submitted. The temporary closure plan will present expanded descriptions of the methods planned for meeting the temporary closure objectives for the site and the individual components. Once the temporary closure plan is implemented, monitoring and inspection data and reports will be compiled and submitted according to the applicable annual reporting requirements of the authorizations.

Table 6-1 presents a summary of the care, maintenance and monitoring activities of the various project components which would occur in the case of a temporary closure.

Table 6-1 Summary of Care and Maintenance Activities and Monitoring During Temporary Closure

Project Component		Area of Interest	Care/Maintenance Activities	Monitoring Activities	Monitoring Responsibility	Monitoring Timing/Frequency
Open Pits		-Water Management/Treatment -Physical Stability	-Maintain creek diversions around pits -Treat excess pit water and transfer to WSP if required -Restrict access to hazardous areas with physical barriers	WUL Physical Monitoring Program	Caretaker	As per WUL
				Water Quality Monitoring for Treatment	Water Treatment Technician	As required
				Geotechnical Inspection of Creek diversion	Engineer	Annual
Ore Stockpiles	**High Grade**	Physical Stability	Reduce High Grade Stockpile Inventory	n/a	n/a	n/a
		Geochemical Stability	Monitor for seepage	WUL Water Quality Surveillance Program	Caretaker	As per WUL
	Low Grade	Physical Stability	Monitor for stability	WUL Physical Monitoring Program and Annual Geotechnical Inspection	Caretaker	As per WUL
		Geochemical Stability	Monitor for seepage	WUL Water Quality Surveillance Program	Caretaker	As per WUL
Waste Rock and Overburden Dumps		Physical stability	Runoff/Erosion/Sediment control, as required.	WUL Physical Monitoring Program	Caretaker	As per WUL
				Geotechnical Inspection	Engineer	Annual
		Geochemical Stability	Monitor for seepage	WUL Water Quality Surveillance Program	Caretaker	As per WUL
Dry Stack Tailings Storage Facility		Physical stability	-Surface water diversion structure repair/maintenance, as required -Runoff/Erosion/Sediment control, as required. -Stability Monitoring as required	Visual inspection elements of Monitoring Program from Tailings Management Plan (TMP) WUL Physical Monitoring Program	Caretaker	As per TMP
				Geotechnical Inspection from WUL and TMP	Engineer	Annual
		Geochemical Stability	Monitor for seepage and water quality	WUL Water Quality Surveillance Program and TMP Monitoring Elements	Caretaker	As per WUL
Mill and Camp Site		-Buildings, Equipment, and Infrastructure -Physical Stability	Concentrate removed from site Secure buildings and maintain necessary equipment onsite for resumption of milling Inspect for site stability	Visual inspection periodically for signs of instability	Caretaker	Monthly
				Structural Inspection	Engineer	Twice Annually
		-Mill Pond -Physical Stability	-Maintain pond liner, repair as required. -Maintain culverts.	WUL Physical Monitoring Program	Caretaker	As per WUL
Water Storage Pond Dam and Main Dam		-Water Management -Physical stability	-Maintain spillway and structure as required based on geotechnical inspections. -Monitor pond levels and water quality, where applicable. -Maintain spring/early summer pumping drawdown equipment.	WUL Physical Monitoring Program	Caretaker	As per WUL
				Geotechnical Inspection	Engineer	Annual
		Geochemical Stability	Monitor for seepage water quality	WUL Water Quality Surveillance Program	Caretaker	As per WUL
Explosives Facility		Physical stability	-Remove bulk explosives from site. -As required, repair and replace infrastructure	Visual inspection periodically for signs of instability.	Caretaker	Monthly
Barge Landing		Access to Yukon River	As required, granular upgrade to landing site.	Visual inspection periodically for signs of instability.	Caretaker	Weekly
Access Road and Surface Drainage		Entire Route	As required, surface grading and granular amendments, ditch and culvert maintenance.	Visual inspection periodically for signs of instability/erosion	Caretaker	Weekly and after heavy precipitation events
Entire Site		Physical stability	-Runoff/Erosion/Sediment control, as required. -Road/culvert maintenance as required.	WUL Physical Monitoring Program	Caretaker	As per WUL
				Geotechnical Inspection	Engineer	Annual
		Water Quality/Management	-Retain Water Treatment Plant and Operators -Maintain storm water diversion systems -Continue seasonal water treatment as required for excess pit and site water	-Undertake expanded temporary closure monitoring and submit to the YWB pursuant to Water Use Licence QZ96-006 (see Tables 7-4 and 7-5 for expanded monitoring program sites and schedule.) -Continue required monitoring under Metal Mining Effluent Regulations (MMER)	Caretaker	As per WUL and MMER
		Security	Full time site caretaker will check, repair and replace as required: • precautionary signage • security gate – installed on Access Road at Main Dam	Site Inspection and Security Monitoring of all infrastructure and site elements	Caretaker	Daily: Inspection Sheets included in Annual Reporting
		Miscellaneous Infrastructure	Shut down and winterize camp, except for caretaker facilities Inspect power line	Site Inspection and Security Monitoring of all infrastructure and site elements – report any changes to stability/condition of miscellaneous infrastructure.	Caretaker	Daily: Inspection Sheets included in Annual Reporting
		Reporting	-Prepare and submit annual report to the Yukon Water Board pursuant to Water Use Licence QZ96-006, including details of temporary closure activities and monitoring. -Prepare and submit annual report to YG Mineral Resources Branch pursuant to the Quartz Mining License QML-0001, including details of temporary closure activities and monitoring. -Prepare and submit quarterly monitoring reports to Environment Canada under MMER.		Minto Explorations Ltd.	Annually, by July 30 Quarterly, Online RISS Registry

7 Final Reclamation and Closure Measures

This section outlines the proposed reclamation methodologies that will be applied to the different reclamation units present at the site. A general discussion regarding key closure measures is presented in section 7.1, and each subsequent sub-section contains a description of the area in addition to discussion of the closure issues that help govern the closure methodologies chosen for that unit. References to previous reports or supporting documentation are also contained in each sub-section.

Figure 5-3 presents the overall site plan at the end of the Phase V/VI expansion project, in addition to a general summary of the various closure measures proposed for the reclamation units that will be present at the end of mining under the Phase V/VI application. Figure 7-2 shows the final site water management layout for the site based on the currently proposed closure plan, including proposed major diversion alignments, and pit flooding projections.

The disturbed area has been divided into reclamation units as follows:

- Waste Rock and Overburden Dumps;
- Ore stockpiles;
- Open Pits;
- Underground Workings;
- Dry Stack Tailings Storage Facility and Diversion Structures;
- Mill Valley Fill Extension;
- Haul Roads;
- Water Storage Pond Dam;
- Mill and Ancillary Facilities;
- Mill Pond;
- Access Road; and
- Miscellaneous Components.

It is estimated that a total of approximately 375 hectares will be disturbed by the end of Phase V/VI mine development. Figures 9-1 through 9-3 in illustrate and quantify the areas of disturbance for the critical security estimation milestones of Current (Year 0), June 2016 (Year 2) and End of Mine Life (Year 9). These figures show the total area expected to be disturbed by each unit during the construction and operations phases and the final surface area of the reclamation unit that will require reclamation. The areas to be reclaimed are presented as both two and three dimensional areas. The three dimensional estimates more closely reflect the actual areas as opposed to the two dimensional disturbed footprint areas which do not account for slope.

7.1 Organization, Site Access & Security

A number of personnel will be required on site to implement the various decommissioning and closure tasks. Generally these tasks entail closure of mine workings, regrading of waste rock and overburden piles, decommissioning of the TMF, removal of the Water Storage Pond Dam, salvage and removal of infrastructure, equipment and reagents, decommissioning of access roads and reclamation and revegetation of disturbed lands. These activities would be undertaken on a seasonal basis and directed by an onsite manager responsible for decommissioning and reclamation of the Minto mine.

During site decommissioning, it is anticipated that at least a portion of the existing camp accommodations would remain on site to support site personnel. It is anticipated that during the initial post-closure phase, site security requirements will continue with a caretaker remaining on site following seasonal closure of the site. A site inspection schedule will continue for the period of closure implementation (3 years) and then move into a post-closure monitoring period (10 years) for a total of 13 years. Security personnel will no longer be required once decommissioning and reclamation activities are completed on the property. Once the majority of physical reclamation works are performed on the site, the number of employees or contractors required will be reduced. Minto is committed to having SFN members employed during implementation of the RCP and will continue to work with SFN to optimize long term closure monitoring requirements.

The main access road, barge landings and property security gate will be maintained during implementation of the post-closure phase. Site access along the main road, barge support and Big Creek Bridge will be required for personnel and truck haulage requirements to and from the site. The security gate and fencing will be maintained while the main access road is in use. Decommissioning and reclamation of various haul and site access roads will be completed once closure measures have been completed at each facility and site access is no longer required.

Once decommissioning activities are completed onsite, and following a period of post-closure monitoring, a determination will be made about whether to permanently close the main site access road. This decision will be made in conjunction with SFN as the access road lays within SFN Category "A" settlement lands. Closure of the main access road is expected to be consistent with the RCP's closure philosophy; however, it is recognized that the performance of physical reclamation of the site must be assured before a final determination of the main access road closure is made. Government regulators and the local trapper will also be consulted regarding decommissioning plans for the road.

7.2 Supervision and Documentation of Work

All decommissioning and reclamation works shall be supervised to ensure that works are constructed according to their design and that the work is properly carried out and documented. The project manager or the construction supervisor will be responsible for supervising all closure works. Daily inspection procedures would be completed to document work progress, deficiencies and completion. Existing plans for spill response or other site internal procedures for fuel handling, waste disposal, fire control and suppression, health and safety and environmental management systems would be used, developed and followed as necessary.

Environmental inspections and tests conducted prior to the implementation of closure measures would be used to confirm areas requiring clean up.

For the WRD and TMF, plans for all earth works and inspections would be prepared and submitted to the YWB and EMR for review prior to construction. These plans would be submitted in a timely manner to facilitate agency review and Board approval prior to implementation. A competent engineer following standard quality control and assurance procedures would inspect and document this construction work. As-built plans and drawings would be completed and the results of the closure work completed on the removed water dam and tailings management facility documented in a final RCP report. This report would then be submitted to the YWB and regulatory agencies upon completion of closure activities.

A competent environmental practitioner following standard quality control and assurance procedures would design, direct and document the following restoration work. For the Big Creek Bridge removal (if required) and Minto Creek culverts, plans for all restorative works would be prepared and submitted to the YWB prior to decommissioning. A summary report of the works would then be prepared and submitted to the YWB and regulatory agencies upon completion of closure activities.

Upon completion of the decommissioning and reclamation works, a final site plan report (summary text and drawings) would be prepared to outline the facilities or works remaining on the site following closure. This plan would identify the location of buried concrete structures or scrap and landfill disposal areas. It is expected that this plan would accompany an Application for a Certificate of Closure under the Yukon Quartz Mining Act.

7.3 Mine Records

As noted in the previous section, all decommissioning and reclamation works would be documented. Active Mining period records showing the extent of open pit workings would be retained by Minto. Other site records, files and plans would also be archived at the site. Where plans or drawings are required for mine safety reasons, these plans would also be submitted to government mine safety offices. As-built reports for structures completed for closure and the final site closure report would be retained for record by Minto and submitted to government agencies and boards.

7.4 Key Reclamation and Closure Methods

Through previous closure planning initiatives and ongoing reclamation research, Minto has identified several key reclamation and closure methods that are consistent with meeting the reclamation objectives identified in the previous section. To this end, the company has considered closure and reclamations measures that are low maintenance, cost effective, and has adopted standard or widely accepted methods where appropriate. Where opportunities exist to reduce active management in closure through the application of more innovative techniques (i.e., application of passive/semi-passive technologies), the company has explored their viability using a combination of the current state of industrial knowledge, plans for furthering proof of concept through site-specific research, and adaptive management planning to mitigate remaining uncertainty.

Most of the methods proposed for employment at Minto are standard practice (e.g. recontouring, seed and fertilizer application, scarification of compacted surfaces) and do not require detailed explanation of their application. The remainder of this section describes the techniques and methods that are specific to addressing potential project effects on water quality. These include:

a) Source Control methods;

b) Passive and Treatment Systems; and

c) Contingency Water Treatment.

7.4.1 Source Control

Source control is intended to be the primary control for the reduction of metal loadings to the receiving environment through limiting the access of water to materials known to have metal leaching potential. Source control includes such measures as operational characterization and materials handling programs, sub-aqueous disposal, engineered cover systems and encapsulation. Source control measures that are proposed for Minto Phase V/VI will primarily be a combination of operational characterization and materials handling programs and sub-aqueous disposal (operational strategies detailed in the Phase V/VI Project Proposal and appendices) and waste covers that reduce infiltration of precipitation and isolate waste materials from atmospheric influences.

7.4.1.1 Operational Materials Characterization and Materials Handling Plans

Materials characterization allows mining companies to understand the different ore and waste material types present at a site and develop special handling plans based on any identified environmental concerns associated with each material type. Minto tests all of its development rock in advance of the materials being removed from the active mining face. The waste rock in Phase V/VI will be characterized based on the acid rock drainage potential indicators. Information on these proposed characterization and handling programs is provided in the Minto Mine Phase V/VI Waste Rock and Overburden Management Plan (WROMP).

Overburden segregation is required for mine sites where there is a need to ensure that waste materials generated by stripping and other development activities are preserved for future reclamation activities. The implementation of reclamation at the Minto Mine will likely require a large volume of a variety of overburden types. SRK's characterization of available and expected overburden materials in the context of their potential for use in construction of waste covers is presented in their report entitled Scoping Level Cover Assessment for Minto Closure Covers (finalization pending).

7.4.1.2 Sub-aqueous Disposal

Sub-aqueous disposal involves the placement of materials underwater in order to their limit exposure to oxygen. This method of source control can be very effective given that the dissolved oxygen content of water is approximately 10,000 times less than for materials that are located above water.

Minto currently employs this method with NP:AP<3 waste material from the Phase IV mining, and intends to use this method of source control for any NP:AP<3 materials encountered in Phase V/VI. Minto currently disposes of the slurry tailings from Phase IV milling in this fashion (in the Main Pit currently) and likewise proposes this method of disposal for most of the tailings generated from milling Phase V/VI ore.

Flooding of waste rock in a pit lake will result in some initial flushing of metals as the materials become wetted but this can be actively treated prior to water being discharged from the pit. Once the waste rock and tailings within the pit has become flooded the movement of water through the flooded materials becomes controlled by diffusion which acts to limit metal leaching.

Over time, the development of a fine sediment layer on the surface of flooded materials helps to seal off the materials and further limits their ability to contribute to metal loadings. The period immediately following the placement of soil covers onto waste dumps will potentially contribute to the development of sediment layers until such a time as vegetation becomes well established.

7.4.1.3 Waste Cover Systems

A number of candidate waste cover systems have been identified for Minto's waste facilities. SRK Consulting has undertaken a scoping level evaluation of available materials at the Minto site (and commercially available products) to identify types of covers that could be considered for placement on site waste materials at closure. Different cover options have very different performance, installation and maintenance considerations. SRK's report is pending finalization and is entitled: Scoping Level Cover Assessment for Minto Closure Covers.

As identified in section 5.4.4 previously, the water quality prediction for the closure period returned an acceptable outcome – even under most reasonable worst case, upper limit concentration conditions – from the application of a simple isolating soil cover on waste materials. Accordingly, the reclamation strategy for Phase V/VI adopts the application of this cover type to all site waste facilities. This cover type can be constructed from available materials (stockpiled overburden) at the Minto site – either existing or anticipated from Phase V/VI development. Much of this is anticipated to be direct-placed from mining activities, eliminating additional handling requirements involved in stockpiling.

The isolating soil cover is the simplest and least expensive of evaluated cover options. It is expected to provide modest reductions to infiltration (from approximately 30% of mean annual precipitation on native ground to 20% MAP), but not without expected periods of significant breakthrough. The construction materials are expected to be erodible, and revegetation and runoff control will be key to establishing and maintaining their integrity. The following sections detail additional mitigation measures that are intended to provide additional load reduction capacity from site sources, and to provide for contingency mitigation should the isolating soil covers not provide the anticipated mitigation.

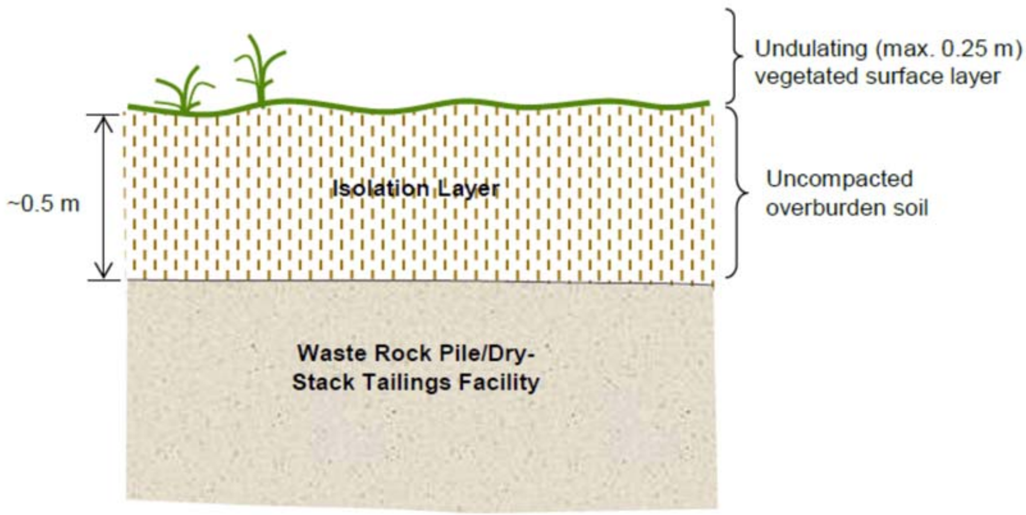

Figure 7-1 Conceptual Isolation Cover for all Waste Rock Dumps and DSTSF (SRK, Appendix)

7.4.2 Passive Water Treatment Systems

Passive treatment systems were identified as both a key measure to achieving required closure water quality and as a contingency water treatment measures in previous Minto closure planning efforts. Refinement of expected site geochemistry and drainage at closure by SRK suggests that treatment of any form of site water after cessation of Phase V/VI mining and the application of standard reclamation measures and covering of wastes with isolating soil covers may not be necessary to achieve the interim water quality objectives (operational objectives) on a regular basis. That being said, the importance of additional load mitigation measures to account for expected periods of soil cover breakthrough and other unexpected site conditions is acknowledged by the closure planning team, as is the importance of applying reasonable and practical mitigation effort to minimize effects to the receiving environment. Passive and semi-passive treatment systems are therefore proposed as key mitigation measures for the achievement of acceptable water quality from the Minto site in the closure condition.

Passive treatment as a remediation method for mine-impacted water can be a sustainable method used during post-closure of a mine, as they generally involve significantly less direct capital costs, as well as lower operations and maintenance costs, when compared to traditional active treatment options (Kilbourn Inc., 1999).

There are numerous definitions of passive treatment that have been used. Gusek (2002) defined passive treatment in terms of the use of each type of treatment that occurs within a system, such that:

Passive treatment is a process of sequentially removing metals and/or acidity in a natural-looking, man-made bio-system that capitalizes on ecological and geochemical reactions. The process requires no power and no chemicals after construction and lasts for decades with minimal human help.

While Pulles et al. (2004) defined passive treatment processes in terms of energy:

A water treatment system that utilizes naturally available energy sources such as topographical gradient, microbial metabolic energy, photosynthesis and chemical energy and requires regular, but infrequent maintenance to operate successfully over its design life.

The Global Acid Rock Drainage (GARD) Guide's (INAP, 2010) definition builds from the previous two to describe passive treatment as:

Processes that do not require regular human intervention, operations, or maintenance and should typically employ natural construction materials, (e.g., soils, clays, and broken rock), natural materials (e.g., plant residues such as straw, wood chips, manure, and compost) and promote the growth of natural vegetation. Passive treatment systems use gravity flow for water movement.

The terms "passive" and "semi-passive" are often used almost interchangeably, with no clearly defined transition between the two terms. In general, the term passive suggests a system that is largely self-sustaining with minimal requirement for ongoing maintenance while semi-passive refers to systems engineered systems that require a higher degree of monitoring and active management to perform optimally.

All of the definitions involve a minimal amount of operations and maintenance, and the use of mimicking natural mechanisms in a controlled environment; however, it is Gusek's definition which includes the concept of sequential that becomes significant for the purposes of remediating mine-closure sites. No single cell or specific type passive treatment system can completely remediate a complicated mine drainage site on its own. The use of numerous systems or groups of systems are designed to target different aspects of the whole to work together to achieve adequate removal. Thus, passive treatment must be seen as a sequence of processes that achieve an end result together, since there is no single system that can be effective in every situation (Gusek, 2009).

With that in mind, it was recognized at the outset that reclamation research into passive treatment at the Minto site would need to focus not only the individual technologies but also innovative ways in which the various complementary passive treatment technologies can be combined in an optimal manner to create robust, self-sustaining, integrated passive treatment systems which can handle a wide range of operational conditions, variable flow rates and large fluctuations in water quality.

The incorporation of passive treatment systems to treat mining impacted waters at the Minto mine site has been discussed previously at a fairly conceptual level. The current reclamation plans and reclamation research are now working towards developing specific, detailed, quantifiable designs. In order to confirm the feasibility of passive treatment systems to treat a significant portion of the provide significant reduction of contaminant load generate by the mine it was necessary to confirm that 1) a significant portion of the contaminant load could be passively routed through areas which are amenable to constructing passive treatment systems, and 2) that passive treatment technologies would work at Minto given the anticipated contaminant loads and cold climate.

The various potential passive treatment technologies were evaluated and ranked in order to determine which passive treatment technologies held the greatest promise for incorporation in Minto water management and closure planning. A guidance document to help short list and then select an appropriate method for managing mine waste sites was created by The Interstate Technology and Regulatory Council (ITRC), a body of socio-economic and environmental regulators, industry, federal government, and stakeholders that work towards innovative environmental decision making (ITRC, 2010).

ITRC's "Mining Waste Treatment Technology Selection" guidance document (and associated literature reviews) is an interactive and iterative web-based decision tree which provides a systematic framework that can be used to identify a short list of appropriate technologies (ITRC, 2012). The ITRC decision tree framework was used for identifying the range of potential passive treatment technologies which may be applicable at the Minto Mine because it provides a straightforward and transparent method for selecting treatment technologies. It also provides legitimacy in the selection process by using an internationally recognized method that was created specifically for mining waste sites.

Following the identification of potential passive treatment technologies, a screening level evaluation and ranking of the potential passive treatment technologies was conducted. Some of the key considerations evaluating the reasonability and practicality of various treatment technologies included:

- Work acceptably in cold weather;
- Sustainable in the long-term;
- Minimal/low intensity active maintenance scenario;
- Suitable for addressing Minto's specific CoCs (e.g., Cu, Cd, Se, Al);
- Robust technology with adequate precedent of successful application;
- Amenable to collaboration with SFN and consistent with their aspirations for long-term employment and future land use;
- Cost effective; and
- Amenable to incorporation in an Adaptive Management Plan and modifying/expanding if initial design underperforms.

The full list of criteria considered in the ranking matrix included: 1) ability to operate in near freezing temperatures; 2) application near the source of the contaminant load; 3) requirement for consistent power source; 4) ability to engage local communities; 5) suitable for treatment of primary contaminants of concern including Cu, Cd and Se; 6) demonstrated longevity of effective performance; 7) ease of access of monitoring/mitigation; 8) frequency of operator intervention; 9) aesthetics and 10) requirement for chemical reagents. The comparison of anticipated treatment effectiveness was benchmarked against actual water quality data from W15 and various seeps on the Southwest Dump – recognizing that actual removal rates are extremely site specific and inconsistently reported in the literature.

The technology evaluation and ranking (based on key considerations listed above) concluded that biological reactors (bioreactors) and constructed wetland treatment systems (CWTSs) are the two most promising technologies for further, site-specific consideration at Minto. Permeable reactive barriers (PRBs) also ranked high; however, it was recognized that foundation conditions (in particular discontinuous permafrost) combined with the site layout may limit potential applicability at the Minto site. Research is also ongoing into the potential for in-pit treatment to play a role in addressing site wide water quality issues; however, in-pit treatment will not be relied upon as a primary treatment component but rather will be evaluated in the context of an adaptive management plan (i.e., batch treatment as a contingency).

7.4.2.1 Constructed Wetland Treatment Systems (CWTS)

Wetlands are areas of transition between uplands and open water, possessing unique biogeochemical cycles that function to transfer and transform materials within the ecosystem (Mitsch and Gosselink 1993). These biogeochemical cycles are influenced by a number of interrelated biological, chemical, and physical processes involving unique hydrologic, vegetation, hydrosoil, and microbial conditions (Mitsch and Gosselink 1993). Because of their inherent ability to transfer and transform materials that flow through them, wetlands have received considerable attention for water treatment (Hammer 1989, Dunbabin and Bowmer 1992, Moshiri 1993, Davies and Cottingham 1994, Kent 1994). Mitsch and Gosselink (1993) listed the following wetland attributes that can affect surface water character:

- A decrease in water velocity, causing sediments and chemical sorbed to sediments to drop out of the water column;
- A variety of anaerobic and aerobic processes in close proximity, promoting de-nitrification, chemical precipitation, and other chemical reactions that remove certain materials from the water column;
- High rates of productivity that can enhance mineral uptake by vegetation and subsequent burial in the sediments when plants senesce;
- A diversity of decomposers and decomposition processes in wetland sediments;
- Significant sediment-water exchange; and
- Accumulation of organic peat, resulting in burial of sediment-bound chemicals.

However, natural wetlands are often not available or appropriate for water treatment purposes. Therefore, wetlands can be constructed with specific design features (vegetation, hydroperiod and hydrosoil) that enhance transfers and transformations of targeted materials (Sinicrope et al. 1992, Hawkins et al. 1997, Gillespie et al. 1999, Gillespie et al. 2000, Huddleston et al. 2000).

Constructed wetlands differ from natural wetlands in that they are typically designed for a specific purpose or purposes, such as wastewater treatment, fish and wildlife habitat, migratory waterfowl usage, flood control, and aesthetic values (Bastian and Hammer, 1993). Wetlands have been designed and constructed for treatment of wastewaters from a variety of sources, including storm water and agricultural runoff (Livingston 1989, Ferlow 1993, Higgins et al. 1993, Rodgers and Dunn 1992, Moore 2000) municipalities (Bastian et al. 1989) petroleum refineries (Litchfield and Schatz 1989, Hawkins et al. 1997, Gillespie et al. 2000, Huddleston et al. 2000), pulp and paper mills (Sherwood 1992, Boyd et al. 1993, Thut 1993, Moore et al. 1994), and acid mine drainage (Brodie 1993, Eger et al. 1993, Hedin et al. 1994). Wastewater constituents that have been successfully treated (decreased or removed) by constructed wetlands include biochemical oxygen demand, suspended solids, nitrogen and phosphorus compounds, organic chemicals, and metals (Hammer 1989, Moshiri 1993, Kent 1994).

There exists considerable literature (even entire books) that report successes and failures of passive treatment systems in cold climates (e.g. Mander and Jenssen 2002). This literature needs to be winnowed to focus on studies that are applicable to this particular situation and site. Of critical importance will be studies regarding the influence of cold temperatures on:

- removal pathways for constituents requiring a decrease in concentrations;
- the success of decreasing concentrations of specific constituents;

- the effects on reaction rates and removal efficiency;
- designs employing detention basins for equalizing flows and increasing residence times that might equalize concentrations; and
- Other important factors, such as nitrogen-limited CWTSs for sustained treatment.

One of the assessments that must be made when considering the potential for impacts of cold climate on the performance of a CWTS is the determination of whether water will be requiring treatment year-round, or only during warm, free flowing months. Much of the scientific literature on cold climate function of CWTS has focused on treatment of municipal wastewater, which is produced year round and requires treatment year round. In the situation of municipal wastewater, rarely is it possible to use a retention pond to store the volumes of water requiring treatment until the summer months. In contrast, at a northern mine site during post-closure, impacted water is only occurring during the months where water is free flowing and the amounts of water that might flow (typically seepage of ground water) during frozen months would be minimal and can be stored in retention ponds until spring thaw. This difference in periodicity of treatment needs alters the design considerations and applicability of both cold-climate concerns and technologies. In light of these aspects of CWTS design basis, it must be realized that the available literature can form an initial basis for a feasibility study, but information gleaned from the literature alone will need to be supported by and confirmed through more site-specific investigation.

Constructed wetlands are considered to be one of the most established passive treatment methods for remediating mine-impacted water and have been used by the mining industry since the mid-1980s (Eger and Wagner 2003, Gusek, 2000, ITRC 2003). Wetlands have numerous unique characteristics. Anaerobic CWTS can be designed to facilitate microbial metabolism involved in sulphate reduction, achieving treatment of the water through reduction of the valency of elements such as aluminum, antimony, arsenic, cadmium, chromium, copper, lead, mercury, manganese, molybdenum, nickel, silver, selenium, sulphur, thallium, uranium, and zinc. Some elements will be precipitated in their reduced form, for example, selenium will be reduced from Se IV or VI valency to Se 0 which becomes a precipitate. Treatment in an anaerobic CWTS is also achieved through precipitation of metal sulphides, including primary metal sulphides as well as precipitation of iron sulphides such as amorphous FeS and co-precipitation of metals within the FeS matrix. For example, manganese and aluminum are traditionally thought of as elements that are treated aerobically; however, they may be precipitated in mineral form through complexation with FeS matrixes.

There have been many wetland systems that have had long-term success but there have also been failures among improperly designed systems, and these failures have had a negative impact on the perception of wetland effectiveness. Many of the systems that failed or were not effective at remediating the contaminants of concern were either improperly sized or designed, all of which can be corrected through a systematically designed piloting program (INAP 2010).

It must be recognized that it is not the origin (e.g., mining, oil and gas, industrial) of the water requiring treatment that is important in the design and effectiveness of a CWTS, but rather, the characteristics of the water chemistry itself and the elements requiring treatment. There are two main types of constructed wetlands; those that are designed to maintain surface flow conditions, and those that have been designed to encourage sub-surface flow. Surface flow wetlands can be designed to encourage either aerobic or anaerobic conditions, depending on design, while sub-surface flow wetlands typically encourage permeable, anaerobic conditions. (Gammons and Frandsen 2001, Eger and Wagner 2003, ITRC 2003, Kilbourn Inc., 1999).

For long-term removal to continue within constructed wetlands, not only must the mechanisms at work keep pace with the contaminant loadings but must also account for seasonal loadings. To achieve effective water treatment, the CWTS must be designed with the proper characteristics and size. A series of sequential treatment cells, incorporating aerobic and anaerobic treatment can be used in combination with other aspects such as oxygenating waterfalls and sediment collecting riffles. Regular monitoring and maintenance will ensure that clogging or invasive plants have not inhibited the removal processes, also monitoring the flow rate and paths will ensure full use of the wetland (ITRC 2003, Kilbourn Inc. 1999).

One of the main constraints of using a constructed wetland for remediation of mine-impacted water is that it can requires a significant amount of land. The amount of land is proportional to the volume of flow being treated and the removal coefficient for the contaminants of concern. This does not mean that size alone means an effective remediation wetland, and a solid understanding and application of the mechanisms described previously should be considered. Treatment wetlands require a footprint that is dependent on the volume of flow to be treated and loading of constituents of concern. A widely used approach in municipal wastewater treatment is based on volumetric loading, with a treatment volume of 3.28 to 6.57 m^3/day per square meter of wetland (INAP 2010). However, depending upon the targeted constituents, other approaches to determine the footprint including rate coefficients and removal pathways may be more reliable to determine appropriate sizing of a CWTS, especially when metals treatment is of importance.

Areas that have been identified as potential locations for construction of passive treatment wetlands on the Minto Site include the:

- Area up gradient of the W15 Collection Point at the toe of the Southwest Dump;
- Surface of the Main Pit tailings; and
- Existing Water Storage Pond and Dam location (W37).

7.4.2.2 Biological Reactors

In the broadest sense, a bioreactor can be defined as permeable treatment zone that uses biochemical processes. Biological reactors use the degradation of organic materials for the purposes of treatment and often involve installation of the treatment materials into lined trenches or pond systems. These systems have been used in mining applications to treat groundwater discharges from underground workings and also for shallow groundwater systems. Treatment media for biological reactors in the documented studies are often derived from local municipal and industrial waste sources; however, it would be necessary to determine whether these sources exist in the local area or can be sourced and transported to site in a cost effective manner. Wood chips or peat are local products that could be utilized. These systems could also be operated in a semi-passive mode where an alcohol tank can be set up to drip into the influent end of the biological reactor, and only require infrequent refilling.

Because of the northern climate for this location, a bioreactor at the Minto mine site is anticipated to be an in-place (buried) treatment cell. By its location and placement, it is designed to intercept and remediate contaminated (mining impacted) water.

In general, the bioreactor treatment zones being considered for Minto will be created indirectly using materials designed to stimulate secondary processes e.g., adding carbon substrate such as wood chips or soluble carbon sources such as sugars and alcohols to enhance microbial activity which will in turn generate biochemical reducing conditions that will enhance metals removal. The COCs in consideration at the Minto site can be reductively precipitated either as an elemental precipitate (such as Se0) or as a sulphide form (such as CuS). In the same reactor, other mine-related parameters, such as nitrate, will also be removed by the microbial processes. Bioreactors with excess reduced species (elevated sulphide, dissolve organic carbon, or reduced metals such as iron or manganese) will need to be paired with a subsequent oxidation cell, which could be an open water body such as a pit lake, a rock-filled cell, a buried or surface water cascade, or an aerobic wetland) to remove these constituents prior to entry into potentially fish-bearing streams.

In this document the term bioreactor refers to shallow permeable treatment zones which are gravity fed and installed immediately down gradient of the source of contamination (e.g., intercepting shallow seeps along the toe of the waste rock dumps). The term "permeable reactive barrier" (PRB) is a specialized form of bioreactor in which the reactive media is trenched and placed deeper into the subsurface, forming a permeable reactive barrier through which a contaminant plume flows. When a PRB is working according to design, water passes through the PRB but the contaminant is retained and removed in the PRB by precipitation processes. Biochemical PRBs, where the permeable substrate contains a carbon source, operates on the same basic principles described for the bioreactor above. It is anticipated that there is limited potential for the application of PRBs at the Minto Site, with the possible exception of the area down gradient of W37 where the ground is presumed to be thawed by the presence of the reclaim pond.

For a PRB to work, it is essential that the in situ hydrogeology of the flow path is known, and that there is certainty that contaminant plume flow will go through the PRB, and that the flow is reasonably uniform across the plume thickness. Where PRBs fail is typically because of flow around the PRB, or concentrated flow through one section of the PRB exhausting the treatment capacity faster than other sections. PRBs are not currently being considered as a primary passive treatment technology for the Minto site—but may play a role as part of an Adaptive Management Plan.

As discussed previously, the bioreactors proposed for Minto are not intended to be a stand-alone remedy, but rather an important piece of the passive "treatment train" which will include engineered wetlands and monitored natural attenuation. Research is also ongoing for additional in-pit treatment as mining-impacted waters are routed through the open pits at the end of mine life.

It is generally recognized that the success or failure of a bioreactor depends on the ability of bioreactor to accomplish the following (adapted from ITRC-PRB Technology Update June 2011) (ITRC 2011):

- Promote hydraulic performance whereby target contaminants are routed through the reactive material with an appropriate residence time;
- Adequately collected and routed through the bioreactor (i.e., seepage is not allowed to flow around the bioreactor without being treated); and
- Promote contaminant treatment within the bioreactor zone whereby target contaminants are reduced to intended concentrations in the outflow through the targeted treatment processes.

The bioreactor treatment process itself is relatively straightforward to evaluate. A primary challenge with the design of bioreactors and PRB systems, which can lead to poor performance, is the inadequate characterization of the in situ flow conditions within the permeable reactive media which results in the bioreactor failing to achieve suitable hydraulic performance and residence time. The nature of potential failures includes improper sizing of the reactor for the flow conditions at the site, and problems with the substrate composition. Examples of flow-related failures are cases where the range flow is too great, causing—at certain times of the year—situations where not all of the flow can be routed through the bioreactor (because of limitations of the media), or where the concentration of seepage varies through the year, and the mass loading exceeds the potential mass removal. Examples of these substrate-related failures includes insufficient inclusion of porous media (typically gravel), layered substrates where one layer becomes a flow barrier, and changes in hydraulic properties of organic substrates as they degrade. Other design considerations that affect the potential for bioreactors to work are the physical configuration of the reactor, with some configurations more susceptible to dead zones where substrate is partially or entirely unused for treatment because flow does not pass through these zones.

7.4.3 Contingency Water Treatment Methods

7.4.3.1 Pit Lake Pre-Treatment

The Area 2 open pit will be flooded at closure and will create a large sedimentation pond in the post-closure period. Using the pit for the removal of suspended solids will act to reduce potential total metal loadings to the receiving environment. Flooding of the pit will also allow for some natural attenuation and removal of metals from the water column based on the results of investigations on in-pit lakes at other mine-sites. The potential in-pit treatment of site water has not been included in the current predictive modelling conducted for the closure of the site, but may be used as a pre-treatment technique, if conditions in closure are amenable, to improve water quality leaving the Area 2 Pit.

Completely passive mechanisms for water quality improvements in pit settings may include:

- Particle settling to remove suspended solids in runoff waters.
- Oxygenation of constituents in seepage by exposure of collected water to the atmosphere. Oxygenation of iron or manganese contained in waste rock or tailings seepage can lead to precipitation of iron or manganese oxides, which will provide a sorption-based removal mechanism for some trace metals including copper.
- Algal or other photosynthetic microbial sorptive removal of dissolved metals by sorption on organic biomass. Naturally, pit lakes will develop some photosynthetic biomass, which in a low-productivity catchment such as that absorbed at Minto Mine will be low in nutrients; consequently this mechanism will be limited unless enhanced by nutrients. The use of pits as pre-treatment sites for semi-passive treatment vessels could be done especially during the transition from active water treatment to passive closure. Two approaches that make sense and could be combined include:
- Addition of organic reagents and/or alkaline reagents to the pits to create an anaerobic zone in the lake where metal removal in reductive forms, including metal sulphides or reduced metal oxides, is encouraged. Typically a combination of carbon sources is utilized to achieve both rapid formation of reductive conditions (carbon sources such as sugars and alcohols), and sustained maintenance of reductive conditions (carbon sources such as wood chips and other biomass forms).

- Addition of nutrients including nitrogen and/or phosphate will enhance the development of a photosynthetic algal or microbial population in the lake, which will provide both a direct removal by sorption on biomass, as well as sustaining anaerobic conditions in the deeper part of the lake as the photosynthetic biomass decays, acting as a sustainable mechanism for anaerobic conditions in the lake bottom.
- Examples of the pre-treatment of pit lakes for metals removal include:
- The Anchor Hill pit at the Gilt Edge Mine in South Dakota, which had ice-covered conditions for more than five months of the year, where alkaline reagents and multiple organic sources including wood chips, alcohols, and sugar syrups were added (Harrington et al., 2004). Greater than 90% removal of metals including copper were achieved and sustained for several years.
- The pit lake at the Barite Hill Mine in South Carolina, alkaline reagents and multiple organic sources including wood chips, alcohols, and sugar syrups were added (Harrington et al. 2009). Greater than 99% removal of most metals including copper was achieved.

7.4.3.2 Active Water Treatment

As per the stated reclamation objectives, Minto is committed to trying to close out the Minto Mine in a manner that does not require the long-term use of active water treatment to achieve discharge criteria. The application of the source control mitigation measures described in the preceding sections should be successful in reducing metal loadings from the waste dumps on site; however, it is realized that there will be the need to actively treat water during the immediate post-closure period while revegetation of the cover systems and reclaimed areas becomes established, and while other source load reduction and tertiary water treatment systems stabilize. Minto currently operates a water treatment plant and supporting collection/conveyance system for impacted waters under a management plan which has been approved under Water Use Licence QZ96-006. This system has been shown to be successful in reducing metal loads to a level where it is possible to discharge the treated water directly into the receiving environment. Information on this WTP and supporting water collection/conveyance system is presented in the Minto Mine Phase V/VI Water Management Plan.

Minto will retain and keep operational the required elements of this active collection/conveyance and treatment system for as long as is required to ensure that appropriate site water quality performance objectives are met. Its use will be guided by the Adaptive Management Plan (Appendix B).

7.5 Water Management Structure and Systems

A closure water management plan has been developed for closure of the Minto Mine to safely route flow downstream of the mine site towards Minto Creek. It includes a preliminary design, including sizing and protection against erosion, for the water conveyance structures required at closure.

The design objectives and criteria, methodologies and results of the hydrological analysis and hydraulic design completed for Minto Mine closure are presented in the Minto Mine Phase V/VI Closure Hydrology Report, presented in Appendix C. A summary of the report is presented in the next sub-sections along with additional narrative to support costing assumptions.

7.5.1 Site layout

The proposed site layout of water conveyance channels has been updated based on the layout proposed in the Minto Mine Phase IV Closure Hydrology Report prepared as an appendix to the Minto Mine Phase IV Reclamation and Closure Plan (Revision 4.0), the previous decommissioning and reclamation plan (DRP Revision 3.2), and the mine site topographical constraints at closure after Phase V/VI. The main objective is to safely convey water downstream of the site, avoiding erosion of waste rock dump covers, tailings and other remaining works at closure.

The proposed water conveyance ditch alignments are presented in Figure 7-2. These alignments will be refined at closure to adapt to site conditions and provide safe routing of surface water over and around waste dumps and the DSTSF.

A combination of primary, secondary and tertiary ditches are proposed. Primary water conveyance channels are the main channels that will route the accumulated overland flow through the mine site. They will convey highly variable and intermittent flows that are expected to peak during spring freshet and following intense rain storms. Adequate erosion protection will be incorporated to ensure the stability of the channels. Energy dissipation works will be required to ensure that flow across steep slopes is managed safely and energy is dissipated in controlled locations. The following section provides a narrative description of the principle design aspects of the water conveyance features.

Four primary ditches (Ditch 100, 200, 300 and 400) have been incorporated into the water conveyance design, and are described below:

- The South Diversion Ditch (referred to as Ditch 100 in closure) has been constructed as part of mine operations to intercept surface flow and divert it from the Area 2 Pit. The ditch currently has the capacity to carry up to 13.3 m^3/s (SRK, 2013a). In Phase V/VI of Minto Mine, this ditch will be altered to accommodate the Area 2 Stage 3 Pit, redirecting base flows, via gravity drainage in buried pipes, to the upgraded TDD (discussed below) and ultimately to the Water Storage Pond. Excess surface flow (exceeding capacity of the pipelines to the TDD) will be directed towards Area 2 Pit via an overflow spillway. The preliminary design of the SDD overflow spillway and pipeline connection to the TDD are presented in an SRK memorandum titled "Preliminary Design of the Tailings Diversion Ditch Upgrade" (SRK, 2013c) At closure all flow from Ditch 100 to the TDD will be blocked off and Ditch 100 will be modified such that all flow is safely conveyed to the Area 2 Pit. The closure concept for Ditch 100 (based on the preliminary design operational SDD configuration presented in SRK, 013c) is presented on Drawing 02. The closure concept consists of three distinct elements: 1) Construction of Impervious (residuum) plug to block flow to the TDD; 2) partial backfilling of the SDD in the vicinity of the overflow spillway to ensure smooth hydraulic function as all surface flow will now be routed over the spillway to the Area 2 Pit; and 3) Regrading of the steep overburden slope downgradient of the overflow spillway and capping with BGM liner all the way to the first bench. The BGM liner will be placed directly on prepared overburden foundation and anchored into small perimeter containment berms that would contain the flow to a maximum depth of about 0.5m.
- Ditch 200 will control flow predominantly originating from the Southwest Dump, out of the constructed wetland area (W15). Ditch 200 will flow across the Main Pit Dump and intersect with Ditch 300. The closure concept for Ditch 200, including plan, profile and typical sections is presented on Drawing 03. The routing of surface flow from the W15 area to the Main Pit will require the construction of an outlet control structure (i.e., concrete wing-wall overflow weir) and a significant excavation across the existing Mine Haul Road. Additionally, a stilling basin will be required at the intersection of Ditch 200 and Ditch 300.

- Ditch 300 will run along the access ramp of the Main Pit Dump, to the base of the Main Pit from where it will flow over the Main Pit spillway and into Area 2 Pit. The proposed layout of Ditch 300 along with typical cross-sections are presented on Drawing 04. The Main Pit Spillway will be constructed during operations to direct flows from the Main Pit toward the Area 2 Pit. The spillway is detailed in SRK's Main Dam Conceptual Design Report (2013c).
- The Area 2 Pit will provide detention for upper catchment flows in the form of a pit lake at closure. The outlet of the Area 2 Pit will direct flow into Ditch 400. Thus, Ditch 400 will convey the majority of on-site flows (peak flow of 6.9 m^3/s). The Ditch 400 alignment will stay as far north as possible when crossing the MVFE, hugging the existing hillside, and will be routed down the MVFE NE slope, continuing to the valley bottom (to the north of the W37 collection point) and ultimately terminating up gradient of the current water storage pond location. The proposed Ditch 400 alignment is presented on Drawings 1, 6 and 7 along with the ditch profile and typical cross-sections. Design details of the outlet from Area 2 Pit (to Ditch 400) is presented on Drawing 08. Ditch 400 will be lined with an impervious liner (bituminous geomembrane). The final transitional reach of Ditch 400 down the eastern abutment of the MVFE (40% or 2.5:1 slope) will be designed at closure. Preliminary dimensions have however been considered for costing purposed as presented in section 7.5.4.4.

Secondary water conveyance channels are ditches that will route runoff water from elevated catchments (i.e. from the top of waste rock dumps and the DSTSF) into primary ditches. The design of secondary ditches will incorporate structures, where necessary, to drop water along the steep faces of waste rock dumps, in addition to energy dissipation ponds at the base of steep slopes. Catchment areas contributing to flows that will be routed down steep slopes will be limited to 5 ha when possible in order to minimize flows, velocities and erosion. Secondary ditches will be laid out to follow the natural topography and low points when possible. The typical cross-section of secondary ditches that will convey surface runoff down steep (3H:1V) slopes will include: 2 m wide channel base with 2:1 side slopes, 0.25 m of filter material (filter compatible with overburden) covered with 0.5 m thickness of D_{50} 300 mm rip-rap. In instances where the sub-catchment area feeding into the secondary ditch is greater than 5 ha, or the slopes are steeper than 3:1 the base channel width will need to be increased proportionally and or the size of the rip-rap will need to be increased to ensure stability of the rip-rap.

Tertiary water conveyance channels are relatively minor ditches and swales that will direct overland flow on the elevated catchment areas towards secondary ditches, protecting the steep slopes from concentrated surface flow. They will be designed to intercept flow before it can concentrate and potentially erode cover materials. These ditches will route small flows with low flow velocities due to the very small areas of surface runoff being managed.

The Tailings Diversion Ditch (TDD) is designed to intercept surface run-on flows, directing the flow away from the DSTSF and towards the Water Storage Pond. The TDD will be upgraded in summer 2014 as part of operations and will be constructed to its closure configuration. During operations, the TDD will accept base flow from the SDD (Ditch 100) via gravity fed buried pipes. Excess flow from the SDD is diverted over an emergency overflow spillway towards the Area 2 Pit. A preliminary design for the TDD is presented in SRK (2013c). At closure, the connection to Ditch 100 will be eliminated (as described above for closure of Ditch 100) and the TDD will be otherwise left as constructed for operations.

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RECLAMATION AND CLOSURE PLAN
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FIGURE 7 - 2

CLOSURE WATER MANAGEMENT LAYOUT

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- Outlet Structure
- Primary Ditch
- Spillway
- Transition Reach
- Energy Dissipation Basin
- Water over Tailings
- Dumps
- Pits
- Pit Tailings
- Dam
- Spillway
- Connector Road
- Tailings Diversion Ditch

1:12,000 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500 Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11th 2013.
Site contours derived from 2013 aerial imagery and edited by Capstone to show the Phase V/VI feature and their coutours.

Hydrology data provided by Minto Explorations Ltd, May 2009 and edited by ACG.

Datum: NAD 83 Projection: UTM Zone 8N

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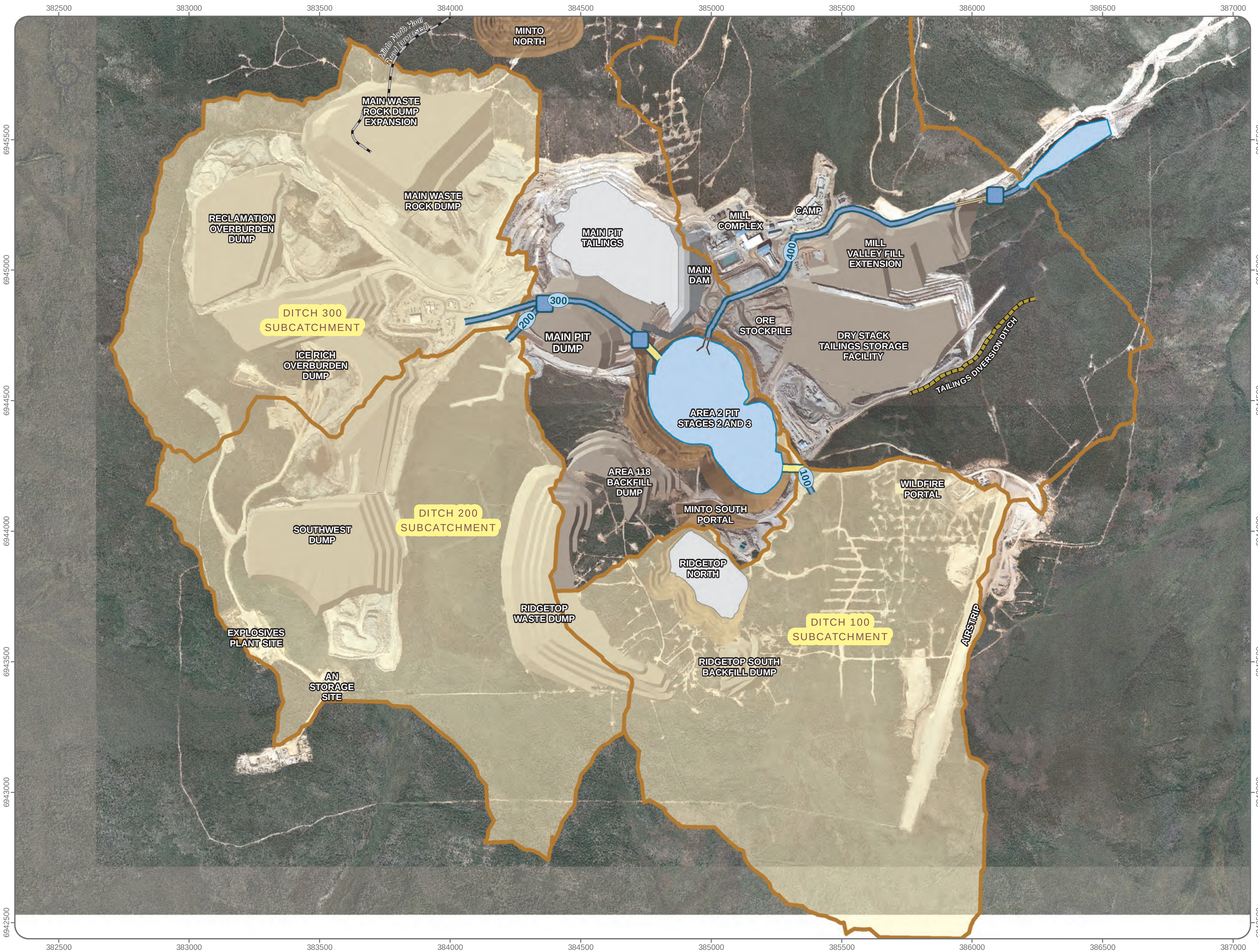
7.5.2 Hydrological Study

A hydrological study (Appendix C) was undertaken to determine floods of various return periods for each sub-catchment within the Minto Mine site. Catchments were delineated for each proposed primary ditch to determine their surface area.

Three primary ditches (100, 200 and 300) will be located upstream from the Area 2 Pit, and will convey flow into the pit. The surface area of the catchments for the three ditches vary between 1.7 and 3.7 km^2. The peak flood flows for those catchments have been determined using the Rational Method applied for the calculated time of concentration (varying between 80 and 90 minutes depending on the catchment). The time of concentration is a theoretical parameter that can be defined as the time required for all areas in the catchment to contribute to the flow at the outlet. Precipitation data (Intensity Duration Frequency curves) have been obtained from Environment Canada for the Pelly Ranch weather station, located in proximity to the mine site. Figure 7-3 shows the catchments of these three ditches.

One primary ditch, Ditch 400, will act as the outflow from the Area 2 Pit and thus will experience significant routing of floods through the pit lake. Ditch 400 has a catchment area of 9.8 km^2, encompassing most of the mine site. Peak flood flows were determined from a volume based analysis since flows will be significantly routed through Area 2 Pit. The freshet period was selected for calculation of the design flows, since it is expected that the largest volume of runoff will yield the largest flows for this ditch. A constant base flow resulting from snowmelt was estimated and superimposed on a 24-hour rainfall event with a 200-year recurrence. Using this method, it is assumed that the inflows to the pit will be constant over a period of time and lead to a balance between inflows and outflows. This methodology maximizes the flows into Area 2 Pit and considers a realistic scenario. Figure 7-4 shows the catchment of Ditch 400.



MINTO MINE
PHASE V/VI EXPANSION

RECLAMATION AND CLOSURE PLAN
REVISION 5.1

FIGURE 7 - 3

UPPER PRIMARY DITCH CATCHMENTS

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- Outlet Structure
- Primary Ditch
- Spillway
- Transition Reach
- Energy Dissipation Basin
- Water over Tailings
- Pit Tailings
- SubCatchments
- Dam
- Tailings Diversion Ditch

1:14,000 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500
Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11th 2013.
Site contours derived from 2013 aerial imagery and edited by Capstone to show the Phase V/VI feature and their coutours.

Hydrology data provided by Minto Explorations Ltd, May 2009 and edited by ACG.

Datum: NAD 83 Projection: UTM Zone 8N

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RECLAMATION AND CLOSURE PLAN
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FIGURE 7 - 4

LOWER PRIMARY DITCH CATCHMENTS

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- Outlet Structure
- Primary Ditch
- Spillway
- Transition Reach
- Energy Dissipation Basin
- Water over Tailings
- Pit Tailings
- Ditch 400 Intermediate Subcatchment
- Area 2 Pit Subcatchment
- Tailings Diversion Ditch

1:16,000 *when printed on 11 x 17 inch paper*

0 50 100 200 300 400 500 Meters

ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11 th 2013.
Site contours derived from 2013 aerial imagery and edited by Capstone to show the Phase V/VI feature and their coutours.

Hydrology data provided by Minto Explorations Ltd, May 2009 and edited by ACG.

Datum: NAD 83 Projection: UTM Zone 8N

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The 200-year flood was used as the inflow design flood and the main design criteria for ditch sizing. This design flow provides a reasonably conservative design flood for mine closure that is based on reliable site specific data. A larger flood recurrence would be highly hypothetical for small watersheds like for the Minto Mine Site due to the lack of flow and meteorological data on site, and thus unreliable. The selected design criteria for the ditch sizing will provide a significant allowance for additional hydraulic capacity. Table 7-2 presents the selected design flows that will be used for each ditch, and for the Area 2 Pit outlet.

Table 7-1 Design Flows for Primary Ditches

Component	Drainage area (km²)	Design flow (m³/s)
Ditch 100	2.1	2.1
Ditch 200	2.0	2.2
Ditch 300 (upper reach)	1.7	2.4
Ditch 300 (lower reach)	3.7	4.7
Ditch 400	9.8	6.9
Area 2 Pit outlet structure	5.8	5.0

The rational method was also applied to secondary ditches to determine a 200-year flood flow for a standardized secondary ditch design for both ditches with mild slopes of less than 10% and ditches with steep slopes ranging from 10 to 40%. A simplified approach was used to determine catchment characteristics. Catchments for the low gradient ditches are less than 1 km^2 (i.e. the waste rock dump and DSTSF surfaces), while for the high gradient ditches catchment areas will be limited to 5 ha when possible in order to minimize flows, velocities and erosion. Given the small size of the sub-catchments contributing to tertiary ditches, conservative design flows were selected in comparison to the calculated secondary ditch flows. Table 7-3 presents the design flows for the secondary and tertiary ditches.

Table 7-2 Design Flows for Secondary and Tertiary Ditches

Component	Design flow (m³/s)
Secondary ditches (<10% slope)	1.5
Secondary ditches (>10% slope)	0.3
Tertiary ditches	0.5

7.5.3 Channel sizing

The sizing of drainage ditches was based on additional design criteria and assumptions. They are outlined in Section 3.3.1 and Appendix C (Hydrology Report).

7.5.3.1 Primary ditches

Preliminary sizing of primary ditches has been done using the Manning's equation, using a trapezoidal cross-section. The natural ground longitudinal profile for each primary ditch alignment has been extracted from the most recent topography. The proposed alignments generally travel through slopes that vary between 0 and 10%, with a few exceptions where slopes as steep as 40% are observed. A Manning's roughness coefficient of

0.035 was selected for primary ditches with mild slopes, as it applies to engineered channels with rockfill elements. For steeper sections with larger rip rap protection, a Manning's roughness coefficient of 0.06 was chosen, since flows will tend to flow through rather than over the larger rip rap, thus increasing the resistance experienced by the flow.

The design work involved a two-step process that is as follows:

1. The minimum channel slope leads to the largest water depth in the channel. The depth of each ditch is sized based on the minimum slope.

2. The maximum channel slope leads to the fastest velocities. The maximum channel slope was defined based on the maximum allowable velocity of 3.5 m/s that was selected as the design criteria. The Isbash equation was used to relate the flow velocity to the required rip rap size.

Table 7-3 presents the selected base widths, slopes and the required rip rap mean diameters (D_{50}) for each primary ditch. The minimum channel depth should be equal to the maximum flow depth with an additional 0.5 m of freeboard.

Table 7-3 Design Parameters for Primary Ditches

Ditch	Design flow (m^3/s)	Base width (m)	Minimum slope (%)	Maximum slope (%)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum rip rap size – D_{50} (mm)	Steep slopes/stilling basin
100	2.1	2	0.5	2	0.6	1.8	150	No
200	2.2	2	0.5	2	0.6	1.8	150	No
300 (upper)	2.4	2	0.5	10	0.8	2.6	300	Yes – energy dissipation basin
300 (lower)	4.7	3	0.5	10	0.9	3.0	300	Yes – energy dissipation basin
400	6.9	3	1	5	1.1	2.6	300	Yes - transition reach

7.5.3.2 Ditch 100

Ditch 100 already exists on the Minto site and is known as the South Diversion Ditch. It currently intercepts water from the hills to the south east of the mine site and conveys it towards and around the Area 2 Pit. At closure this ditch will be raised to the level of the overflow spillway invert, but will remain the same dimensions. The current ditch has an estimated total capacity of 13.3 m^3/s (SRK, 2013a) which is nearly 6 times the calculated 200-year design flow of 2.2 m^3/s. If the ditch was to be reconstructed, only a 2 m channel base width is selected as the minimum constructible base width. The ditch can be constructed on a slope between 0.5 and 2%, which easily follows the current topography with only grading required and no significant excavation or fill. The minimum required depth of the ditch is 1.1 m (0.6 m maximum flow depth and 0.5 m freeboard allowance). A minimum D_{50} of 150 mm is required for the rip rap. The current ditch has rip rap with a D_{50} of 200 mm, which is sufficient to resist the calculated flow velocities resulting from the design flood.

Ditch 100 empties into the Area 2 Pit through an overflow spillway, which is discussed in section 7.1.4. This spillway is already constructed, but requires enhanced erosion protection for long term stability at closure.

7.5.3.3 Ditch 200

Ditch 200 will convey water from the western half of the mine site, where the waste rock dumps are located. In particular, it captures flow from the Southwest Dump in the southwest corner of the mine site and out of the W15 wetland area, and also intercepts flow coming from the Ridgetop area to the south. A minimum base width of 2 m is required to convey the 2.2 m^3/s design flow, along with a minimum depth of 1.1 m (0.6 m maximum flow depth and 0.5 m freeboard allowance). This given cross-section can be constructed on a slope varying between 1 and 2%. A minimum D_{50} of 150 mm is required for the rip rap.

The routing of surface flow from the W15 area into Ditch 200 will require the construction of an outlet control structure to be designed at closure (i.e., concrete wing-wall overflow weir). Additionally, a trafficable excavation across the existing Mine Haul Road of approximately 25,000 m^3 will be required to route Ditch 200 to its junction with Ditch 300.

Ditch 200 will connect with Ditch 300, which flows into the Area 2 Pit. Ditch 200 will empty into an energy dissipation basin at its junction with Ditch 300. The energy dissipation basin is described in Section 7.1.4.

7.5.3.4 Ditch 300

Ditch 300 will intercept water from the northwest corner of the mine site, i.e. from the Reclamation Overburden Dump and the Main Waste Dump. Approximately halfway along its length, Ditch 300 is joined by Ditch 200, and thus a separate design has been developed for the upper and lower sections of Ditch 300. A minimum base width of 2 m is required to convey the 2.4 m^3/s design flow in the upper portion of Ditch 300. The depth of the ditch should be at least 1.3 m (0.8 m maximum flow depth and 0.5 m freeboard allowance). This cross-section can be constructed on a slope varying between 0.5 and 10% to safely convey the flow. Expected slopes along the ditch are in the upper end of the design range (8 to 10%). After the junction with Ditch 200, the design flow is 4.7 m^3/s in the lower portion of Ditch 300. A minimum base width of 3 m is required and the depth of the ditch should be at least 1.4 m (0.9 m maximum flow depth and 0.5 m freeboard allowance). This cross-section can be constructed on a slope varying between 0.5 and 10% to safely convey the flow. Again slopes between 8 and 10% are expected along this reach. A minimum D_{50} of 300 mm is required for the rip rap for both the upper and lower portions of the ditch.

Ditch 300 will connect to the Main Dam spillway, which will be constructed in operations to direct flows toward the Area 2 Pit (SRK Consulting, 2013c). Two energy dissipation basins will be required to dissipate energy in Ditch 300 - at the junction where Ditches 200 and 300 meet, and at the end of Ditch 300, upgradient of the Main Dam spillway. Energy dissipation basin design is described in Section 7.1.4.

7.5.3.5 Ditch 400

Ditch 400 will convey most of the surface water out of the mine site. It will convey the routed outflows from the Area 2 Pit, which will receive inflows from Ditch 300 and Ditch 100, and capture flows from its intermediate watershed downstream of the Main Pit. Ditch 400 will run either adjacent to, or within the limits of the main access road downstream from Area 2 Pit, to the north of the Mill Valley Fill Extension (MVFE). It will then be conveyed down the MVF east face, referred to as the Ditch 400 transition reach, to the bottom of the main valley that leads to the Water Storage Pond at the downstream end of the mine site.

Ditch 400 has a design flow of 6.9 m^3/s. Flows from the upper catchments will experience significant routing through the Area 2 Pit, such that the flood peaks are attenuated. A minimum base width of 3 m and a minimum depth of 1.6 m (1.1 m flow depth and 0.5 m freeboard allowance) is required for Ditch 400. The longitudinal slope of the constructed ditch can vary between 1 and 5%. A minimum D_{50} of 300 mm is required for the rip rap. The design allows for the incorporation of an impervious element (proposed bituminous geomembrane).

Ditch 400 will require the construction of an outlet structure at the outlet of the Area 2 Pit. A steep transition reach, channel/spillway, with a slope of up to 40%, will also need to be constructed along the MVFE east slope to convey surface flow from the top of the MVFE to the valley below. An energy dissipation basin will be constructed at its toe to dissipate energy coming from the transition reach. These structures are discussed further in section 7.5.4.

7.5.3.6 Secondary ditches

Secondary ditches will flow on top of covers and convey water from high flat ground down the steep faces towards the primary ditches. Their design includes two parts:

- A typical channel cross-section on mild slopes (less than 10%); and
- A steep section down the waste rock dump faces, with a slope up to 40%.

Secondary ditches will be laid out as a single main channel on the top of covers, but will be required in certain locations to be divided into numerous smaller parallel channels, each with a contributing basin of less than 5 ha, to drop from the steep faces to lower ground. Smaller channels will allow a reduction in discharge and flow velocities in each channel, and thus reduce the importance of the erosion protection measures required. Energy dissipation basins at the toe of the steep faces will be required to dissipate the energy of the flow coming from higher ground, before it enters the primary ditches.

A single cross-section was developed for all secondary ditches with mild slopes to meet the design criteria and safely convey the 200-year flood at a minimum. This cross-section is applicable to the section of secondary ditches flowing on top of covers, or on mild slopes. A single cross-section for the steeper secondary ditches was also developed, designed to have adequate erosion protection for the small flows (less than 0.5 m^3/s) on steep slopes (USDI, 1982). Table 7-5 presents the calculated values.

Table 7-4 Design Parameters for Secondary Ditches

Ditch	Design flow (m^3/s)	Base width (m)	Minimum slope (%)	Maximum slope (%)	Maximum flow depth (m)	Maximum flow velocity (m/s)	Maximum rip rap size – D_{50} (mm)
Secondary ditches	1.5	2	0.5	7	0.5	2.5 m/s	150
	0.3	2	10	40	0.1	n/a	300

A cross-section with a minimum base width of 2 m and a minimum depth of 0.8 m (0.5 m maximum flow depth and 0.3 m freeboard allowance) will work properly for all reaches of secondary ditches with a slope less than

7%. For secondary ditches with a slope between 10 and 40%, a 2 m base width and a minimum depth of 0.5 (0.1 m maximum flow depth and 0.4 m freeboard allowance) has been chosen. These designs will be finalized at closure.

7.5.3.7 Proposed ditch cross-sections and profiles

Conceptual drawings have been prepared for each primary ditch.

The natural ground profile and a potential proposed longitudinal profile for each ditch that optimizes the cut and fill volumes is presented. The proposed longitudinal ditch profile is based on the range of slopes that were defined above. The optimal profile should be determined at closure, based on the final topography along the proposed alignments.

The cross-sections for each primary ditch were determined based on the results presented in Table 7-4. Each cross-section was made 0.5 m wider than the calculated minimum based with to provide an additional safety margin against potential obstruction with debris or ice. The depth of all primary ditches was set at 1.6 m, which matches the largest minimum depth required for all primary ditches. Ditch 400 has a calculated maximum water depth of 1.1 m, which leads to a 1.6 m channel depth with the 0.5 m freeboard design criteria. The selected cross-sections are shown in the conceptual design drawings.

The following conceptual design drawings were produced as part of the RCP and are appended to the report (prior to the Appendices):

- Drawing No. 01: Primary Drainage Ditch Overview;
- Drawing No. 02: Closure Concept for Ditch 100;
- Drawing No. 03: Primary Ditch 200 - Plan / Profile / Typical Section;
- Drawing No. 04: Primary Ditch 300 - Plan / Profile;
- Drawing No. 05: Primary Ditch 400 Overview;
- Drawing No. 06: Ditch 400 – Plan / Profile / Typical Section – 1;
- Drawing No. 07: Ditch 400 – Plan / Profile / Typical Section – 2;
- Drawing No. 08: Area 2 Pit Outlet - Plan / Profile / Typical Section;
- Drawing No. 9: Typical Waste Rock Regrading (Southwest Dump); and
- Drawing No. 10: Removal of Water Storage Pond Dam at Closure.

Various areas of optimization and conservatism could be studied for the proposed ditch alignment and profiles if required later in the closure phase. The main ones include:

1. Ditch alignment: ditch alignments could be modified to better accommodate the topography at closure. If longitudinal slopes are too steep in certain locations to properly manage the design flows, alignments could be routed over a longer path to provide for milder slope.

2. Ditch cross-section: cross-sections could be widened or deepened if it is anticipated that they could be partially blocked either due to debris, ice jams, sediment deposition, settlement of foundations or

glaciation. The current freeboard does provide primary ditches with up to double the hydraulic capacity of a given cross-section at the calculated water level.

3. Secondary and Tertiary Ditches that route surface runoff over the top of the covered/revegetated waste rock dumps and down the steep side slopes will maintain a minimum of 0.5m of fine grained overburden at the base of the ditch (to mitigate against infiltration) and appropriate erosion protection to protect against soil migration.

4. Geosynthetic liner: in steeper reaches with high flow velocities, synthetic liners could be used to reduce the risk of erosion. Larger riprap is another option although it may prove to be less economically attractive.

5. Longitudinal slope: longitudinal slopes should be kept to a minimum to limit flow velocities and the risk of erosion. The calculated maximum allowable slope for each ditch could be reduced by increasing cut and fill volumes, or adding drop structures (and stilling basin at their toe to dissipate energy).

6. Drop structures/spillways: in steep reaches, drop structures and/or spillways could be added to the design to limit high flow velocity in short reaches and ensure energy dissipation in controlled locations (energy dissipation basins).

7. Impervious or low permeability materials can be incorporated into the design to minimize seepage/infiltration. It is currently anticipated that Ditch 400 is the only primary ditch that will require focused measures to reduce seepage as this will enable the isolation of surface runoff from seepage that originates from DSTSF.

7.5.4 Additional Conveyance Structures

Additional structures will be required to convey water over steeper slopes and at convergences. The current section outlines the additional structures that are envisioned at the current state of design of closure. However, it is possible that additional structures may be required at closure depending on the updated site conditions. The design of the additional water conveyance structures is based on the flow criteria presented above, and additional design criteria and assumptions, which are outlined in Section 3.3.1 and Appendix C.

7.5.4.1 Energy dissipation basins

Energy dissipation basins will be required at the following locations:

- at the bottom of channels conveying flow down steep slopes (greater than 10%), in order to control the location of hydraulic jumps resulting from supercritical flow; and
- at channel junctions to allow for optimal hydraulic conditions entering the downstream ditch.

Three energy dissipation basins have been incorporated into the design of primary ditches. Two basins are included in the design of Ditch 300: at the bottom of the upper and lower reach, respectively. One basin is included at the toe of the transition reach in Ditch 400.

Both basins on Ditch 300 will be sized according to the design criteria to have minimum base dimensions of 6 m by 6 m by 1 m deep with 2H:1V side slopes. They will be lined with bituminous geomembrane, and covered with rip rap with a D_{50} of 600 mm.

The energy dissipation basin at the base of the Ditch 400 transition reach, with a slope of 40%, has been placed so it will ensure the formation of a hydraulic jump (weak or oscillating) before discharging flow to the downgradient flow path toward the Water Storage Pond. The minimum dimensions are 10 m by 10 m by 1 m deep, with 2H:1V side slopes. The basin will be lined with bituminous geomembrane, and rip rap with a D_{50} of 600 mm is selected to further dissipate energy and protect against erosion.

Energy dissipation basins are also required at the bottom of most secondary ditches dropping down a steep slope and at the junction where secondary ditches convey flow into primary ditches. Secondary ditches and their respective basins, are not shown on the water management map, or included in the design drawings. These will be sized independently for each channel and protected with rip rap or a synthetic liner to prevent erosion and significant washing of the ground, due to both high velocity and turbulence levels.

7.5.4.2 Inlet Structures

Inlet structures convey flow from primary and secondary ditches to energy dissipation basins (outflow structure) The inlet structures for the two basins at the bottom of Ditch 300 and the Ditch 400 transition reach will be 15 m in length, expanding from 3 m to 6 m in width, with 2H:1V sides slopes. Rip rap with a D_{50} of 600 mm will be used. The inlet structures upgradient of the energy dissipation basin at the junction of Ditches 200 and 300 will each be 10 m in length, expanding from 2 m to 6 m, with 2H:1V sides slopes. 600 mm rip rap will also be required. The design of these inlet structures will be completed at closure.

Inlet structures for secondary ditches will be designed at closure. These will follow the design criteria outlined above for progressive expansion.

7.5.4.3 Outlet Structures

An outlet structure is required to convey water from the Area 2 Pit into Ditch 400 at closure. This intake to Ditch 400 will be designed with an invert elevation of 799 m, which is the minimum water level expected in the pit when it is full. The outlet structure will provide a smooth transition from the deep and slow moving pit lake flow to the shallow and fast flowing ditch. It will start with a width of 9 m and contract to 3 m over 15 m in length with a 0.5 % grade. A long broad crested weir, 2 m in longitudinal length will span the start of the outlet structure, with a 2H:1V upstream longitudinal slope upgradient of the weir. Geotechnical consolidation of the pit edges at the outlet structure will be done, using bituminous geomembrane, to ensure adequate long term stability of the structure. The design of the Area 2 Pit outlet structure is included in Drawing No. 08.

An outlet structure is also required to convey water from the W15 area into Ditch 200 at closure. This structure (i.e., concrete wing-wall overflow weir), will be designed at closure.

Outlet structures for energy dissipation basins will follow the same design, at a smaller scale. The outlet of the 3 energy dissipation basins along primary ditches will constrict from 6 m to 3 m over 15 m in length.

7.5.4.4 Spillways

Spillways will be required in locations where a ditch has to be constructed over a slope steeper than its defined maximum allowable slope (see Table 7-4), and down the steep faces of the waste rock dumps. Spillways allow high velocities and energy levels to be concentrated into confined reaches. All spillways will empty into larger water bodies to safely dissipate the energy of the flow (energy dissipation basins or pit lakes).

The two spillways conveying flow into the Area 2 Pit, the Main Dam spillway and the Tailings Diversion Ditch spillway, have been designed and upgraded by SRK Consulting. No changes will be made to the Main dam spillway for closure. The Tailings Diversion Ditch spillway will be upgraded in Phase V/VI (SRK Consulting, 2014b). At closure, this spillway will be modified for long term stability. For costing purposes these modification will include:

1. The installation of a thick residuum plug to block off the drainage pipes;
2. Partially backfilling the portion of Ditch 100 adjacent to the overflow spillway to the level of the spillway invert and incorporating the existing configuration of the overflow spillway to direct all channel flow towards the Area 2 Pit; and
3. Continuing the spillway outlet downgradient of the existing rip rapped area all the way to the upper bench of the Area 2 Pit, over the upper steep overburden slope. This will protect the steep overburden slope against erosion from surface flows from Ditch 100 and minimize infiltration into the overburden (thereby enhancing geotechnical stability of the overburden slope). The infiltration barrier will be extended to well below flooded elevation of the Area 2 Pit. The overburden is to be regraded to a uniform slope that is suitable for placement of a bituminous geomembrane liner directly over the prepared foundation. One metre high berms will be added along the sides of the bituminous geomembrane lined channel to constrain flow and facilitate the anchoring of the liner in anchor trenches. Bituminous geomembrane is recommended due to the combination of its long life when left exposed to the elements and its puncture resistance which minimizes/eliminates the requirement for the addition of protective bedding layers beneath the liner.

A final spillway is required for closure along the Ditch 400 transition reach. This spillway must be able to convey a peak flow of 6.9 m^3/s from the top of the MVFE to the valley bottom. The current configuration of the eastern extent of the MVFE around of the transition reach includes a uniform 40% slope from the top of the MVFE to the valley bottom. This reach/spillway will be designed at closure, following finalization of the space required for closure measures to be implemented within the valley bottom (e.g. passive treatment areas). For costing purposes a conceptual conventional rip-rapped spillway design has been assumed with the following characteristics: 10m wide channel base with 2H:1V side slopes, prepared foundation with 0.3m of bedding material, lined with Coletanche E3 BGM to 2m above channel bottom and anchor trenched in place and covered with carefully placed D_{50} 750 mm rip-rap.

For secondary ditches, a spillway type design will be required to channel concentrated flow (collected in tertiary ditches) for all ditches that drop flow from the top of the waste rock dumps to lower elevations. Slopes of up to 40% are possible with such a scheme, thus secondary ditches will be divided into additional channels, with a maximum contributing area of 5 ha, in such locations to limit the flow transiting through steep slopes. The size of rip rap required to control erosion on steep slopes increases substantially with both increased slope and increased flows. The design peak flow is directly related to the size of the catchment area feeding into the water conveyance channel – hence the desire to limit sub-catchment areas feeding into secondary ditches to less than 5 ha. Limiting sub-catchment areas to under 5 ha will enable conventional rip rap and granular filter design to be used as both erosion protection and energy dissipation. It is anticipated that D_{50} of 300mm (and D_{max} of 1.25 D_{50}) will provide robust water conveyance for typical 3H:1V closure slopes of waste rock dumps for channels with 2 m base width. These steep secondary channels will require the construction of energy dissipation structures (e.g., rock piles or stilling basins) at their toe to dissipate the high energy supercritical flow and allow the formation of a hydraulic jump within a controlled area to mitigate erosion.

The Water Storage Pond Dam spillway, designed by EBA Engineering, will be decommissioned during closure. The closure plan calls for the complete removal of the structure once the Minto Mine site is able to consistently meet discharge water quality requirements.

7.5.5 Water Retention Structures

7.5.5.1 Water Storage Pond and Dam

The location of the Water Storage Pond Dam relative to other site developments is shown in Figure 5-3. The dam on Minto Creek provides water retention for mill processes and various site uses during operations and is considered to be the furthest downstream point for discharge control at the site. The original project proposal initially predicted that excess water would meet the Water Use Licence (WUL) effluent criteria and be discharged passively to Lower Minto Creek over the dam spillway. Operational experience based on heavy precipitation and snowpack years has shown that a water treatment plant, as per the current site Water Management Plan, is required. The treatment plant was installed and operational during the second quarter of 2010 and will remain in operation until WUL criteria (to be established) can be achieved consistently without its utilization.

The dam will remain in place until such time that the water quality at the site has stabilized relative to water quality objectives. In the interim it will act as a settling pond where turbid runoff waters will undergo retention, monitoring and treatment if required. Physical stability of the Water Storage Pond Dam will be ensured during post closure by regular geotechnical inspections.

Once water quality on the mine site reaches acceptable effluent criteria, water will be allowed to move into the creek over the dam spillway for the remainder of the open flow season. The dam would then be decommissioned with any sediment in the facility being excavated and hauled to a suitable waste rock dump for disposal.

As a final treatment measure, this area could potentially be converted into a constructed passive treatment system that will accommodate a design flow consistent with the available area in the vicinity. During certain peak flow events, an overflow system may be required that routes excess runoff below the CWTS to avoid overwhelming and/or destruction of the system. This would most likely follow the current alignment of the access road along the Water Storage Pond. The design and construction of this CWTS will be advised by the pilot and demonstration scale CWTSs outlined in the Reclamation Research (see Section 2.2). By the time this final CWTS is constructed, there will be many years of site-specific operational performance data with which to optimize the design of this and other site CWTSs.

Drawing No. 10 shows the proposed dam removal layout.

7.5.5.2 Main Dam

During Phase V/VI additional storage capacity will be needed for tailings and NP:AP < 3 waste rock (rock with neutralization potential: acid potential ratio values less than 3). Since the total volume of tailings and NP:AP < 3 waste rock is expected to exceed the natural capacity of the Main Pit, a waste rock and tailings storage alternatives assessment, including an evaluation of candidate tailings disposal sites, was carried out. The assessment process concluded that the construction of a containment dam to increase the storage capacity of Main Pit was the best solution.

The Main Dam will retain both tailings solids and free water during its operational phase. At closure the dam will not retain free water; however, surface runoff flow-through facilities will remain in place. Moderate seepage from the dam during the operational phase would be acceptable provided that the structural integrity of the dam is not compromised. Such seepage must, however, be monitored and captured if necessary to prevent negative downstream operational and environmental impacts.

A preliminary Dam Hazard Classification for the Main Dam has been carried out and concludes that, since the dam will be located upstream of the mill and processing facilities, there is likelihood for loss of life should a dam failure occur. The appropriate hazard category for the dam is therefore VERY HIGH.

To increase the design storage capacity of the Main Pit, a roughly 300 m long containment dam with a maximum crest height of 23 m must be constructed across the low point along its east wall. The average height of the dam is about 10 m. This dam will allow for continuation of the existing deposition strategy of conventional low solids content (50 to 60% solids by weight) slurry tailings. The Main Dam will have a Full Supply Level of 809 m and a total freeboard of 2 m, which puts the final crest elevation at 812 m.

A permanent spillway will be constructed south of the dam, directing water towards the Area 2 Pit in accordance with the site wide water management plan. The spillway has to be continuously crossed with mine haul trucks during operations and, therefore, it has been designed as a large swale with a 25 m base width and 10H:1V side slopes.

Construction material for the dam and spillway consists of core, transition and run-of-mine material. All the material will be sourced locally from mine development areas.

The preliminary design of the Main Dam has only just been completed. As the design process continues, consideration of the closure implications of the dam will be addressed further. In particular, a long term plan to control and convey potential seepage at closure will be developed during operations.

7.6 Mill and Ancillary Facilities

This section addresses the decommissioning measures for the mill and the ancillary facilities in the immediate vicinity that support the milling activities. The facilities addressed in this section include:

- Mill building;
- Generator building;
- Concentrate shed;

- Tailings filter building;
- Mill water pond;
- Mill reagents and chemicals; and
- Contractor's shop and work area.

Figure 7-5 shows details on the closure measures for these facilities.

Physical stability concerns for these structures at closure will be mitigated by their disassembly and removal from the site with the exception of the mill water pond which will require earthworks to mitigate physical stability issues. Environmental concerns for these areas will arise primarily from contamination of surrounding soils by fuel, chemicals or other wastes. Such instances will be documented through an environmental audit, conducted upon the completion of milling activities. Any contaminated soils identified will be remediated on site at the site's approved land treatment facility, and any recyclables and/or special wastes will be removed from the solid waste facility. Closure plans will be submitted to YG Environment prior to the final decommissioning of the land treatment facility and the solid waste facility.

A salvage program will be conducted towards the end of mine life to minimize the volume of scrap generated by the decommissioning of these facilities that will require in-situ disposal. It is expected that removal of these facilities, namely the camp and explosives plant site, will be done by auction or contractor for salvage value.

The reclaim line and all above ground power cables and overhead power line gear will be salvaged. Any buried services such as piping and wiring will remain buried. Concrete footings will be broken down to slightly below grade as required and covered with fill. Recontouring of areas will also be conducted as required in order to establish final drainage runoff patterns. Culverts will be removed and pertinent areas will be covered in approximately 0.5 metres (unless otherwise noted) of growth media prior to application of seed and fertilizer.

MINTO MINE
PHASE V/VI EXPANSION

RECLAMATION AND CLOSURE PLAN
REVISION 5.1

FIGURE 7-5

MILL AND ANCILLARY FACILITIES RECLAMATION MEASURES

AUGUST 2014

1:2,000 *when printed on 11 x 17 inch paper*

0 10 20 40 60 Meters

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11th 2013.

Datum: NAD 83 Projection: UTM Zone 8N

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(<ita>Last edited by: amatlashevska;07/08/2014/16:13 PM</ita>)

7.6.1 Mill Building

Closure measures for this reclamation unit will include the removal of salvageable mill components, such as the ball and SAG mills and other milling-related equipment within the structure. It is anticipated that the building and steel framework will also be salvageable and that there will be minimal materials requiring disposal onsite. Any recyclable materials will be shipped to an appropriate recycling facility and all wastes will be disposed of either in the site solid waste management facility or an approved offsite disposal facility.

The concrete foundations and building footprint will be reclaimed in the manner described at the start of this section. The toe slopes of the fill at both the mill and the campsite pads will be recontoured to assume a more rounded slope, limiting erosion as much as possible. The angle and subsequent stabilization/revegetation measures will be contingent upon reclamation research findings from variable slope trial plots.

7.6.2 Generator Buildings

The generator buildings will be removed from the site after the power hook-ups are disassembled. Site reclamation of the area occupied by the generator buildings will be conducted in the same manner described for the camp area.

7.6.3 Concentrate Shed

The concentrate shed will be dismantled and removed for sale or salvage at the end of mine life. The remaining concrete footings will be broken down to slightly below grade and covered in fill material. Recontouring will also be conducted as required in order to establish final drainage runoff patterns and areas being reclaimed will be covered in 0.25 metres of growth media and revegetated using the approved reclamation seed mixture.

The southwest corner of the foundation may require complete removal to facilitate the excavation of the reclaimed drainage channel for Minto Creek in the vicinity of the mill water pond. This section of the foundation would be broken down and pushed into the interior of the remaining footings area, and all footings will be collapsed inward and buried with fill prior to surface reclamation.

7.6.4 Tailings Filter Building

The tailings filter building and associated tailings handling infrastructure (conveyors, etc.) will be dismantled and removed for sale or salvage at the end of mine life. Any recyclable materials will be shipped to an appropriate recycling facility and all wastes will be disposed of in an appropriate disposal area, either the site solid waste management facility or an approved off-site disposal facility.

Concrete footings will be broken down to slightly below grade and covered in fill material. Recontouring will also be conducted as required in order to establish final drainage runoff patterns and areas being reclaimed will be covered in 0.25 metres of growth media prior to application of seed and fertilizer.

7.6.5 Mill Water Pond

The mill water pond is a geosynthetic lined pond, constructed according to EBA's Final Preliminary Design – Mill Water Pond, Minto Property, Yukon Territory (EBA, 1997). Together, the mill water pond and the Water

Storage Pond Dam contain enough water to make process water for milling activities, supplementing water from the pit dewatering wells and mill groundwater well.

The mill pond will be left in place as an interim holding area for water entering the water treatment plant during the initial closure period, but then will be decommissioned when not required. The liner will be removed and repurposed if possible for closure ditch lining. The area will be regarded, covered and revegetated.

7.6.6 Mill Reagents and Chemicals

Following the end of milling operations any unused mill reagent supplies will be returned to the supplier for credit. It is anticipated that all reagent product at the site will be properly contained/stored so that no product will be considered as special waste. A closure inventory/investigation of reagents and hazardous materials on site will be conducted upon the cessation of milling activities. Should some product's containment be deemed suspect upon the closure inspection, that volume of materials will be added to an inventory of special wastes. As such, the material will be stored under Minto's Special Waste Permit # 43-040, and removed from the site for disposal in a permitted facility by a licenced contractor with other special wastes on site.

It is expected that the mine's inventory of hydrocarbon products will be consumed during the closure activities. Fuels and lubricants will be required during the implementation period of the closure plan following the end of milling activities. The inventory remaining on site once all activity has ceased will be removed from the site by one of three methods:

- returned to the original supplier for credit wherever possible;
- sold to a third party user; or
- trucked to an authorized disposal agency to be recycled or destroyed.

It should be noted that the operation of diesel powered vehicles and any electrical generators used on site will provide Minto with a method of reducing remaining inventory of diesel fuel as the mining operations cease. Gasoline will be similarly removed, and any remaining inventories of diesel and gasoline will be returned to suppliers or sold based on wide spread local use.

The propane supplier will remove the propane tanks. Associated propane delivery lines at the camp will be removed and disposed of in a manner similar to that of the gasoline and diesel fuels.

Other hydrocarbon products that are present at the mine site are primarily hydraulic fluids, lubricating oils, greases, antifreeze, and solvents packaged in either 1000 litre bulk containers, 205 litre drums or smaller packaging. In most cases the remaining inventory of these materials will be returned to the original suppliers for reuse or sold to other third party users in the local area. In certain circumstances, specialized products may have to be disposed of through a licenced waste disposal firm. It is anticipated that the volume of materials requiring disposal as special waste will be limited.

Any fuel storage areas and refueling stations, once decommissioned, will be assessed for hydrocarbon contamination of the underlying soils. A formal site assessment to identify hydrocarbon contaminated soils in other portions of the site will be conducted as part of the closure program and any soils identified by this assessment will be excavated and transported to Minto's permitted Land Treatment Facility (LTF).

It is anticipated that landfarming of soils in the LTF will be required for a period of several years following the completion of closure activities at the site.

7.6.7 Contractor's Shop and Work Area

The mining contractor's area, constructed on site adjacent to the toe of the MWD, serves as the base of operations for the mining contractor during active mining activities. At closure, the buildings in this area will be dismantled and removed, and any scrap will be recycled or hauled to the onsite permitted Solid Waste Facility.

Physical stability will not be a concern at closure for this area. This is a low elevation pad and will only require proper erosion control at closure. Environmental concerns for the contractor's shop and work area will arise primarily from contamination of surrounding soils by fuel, chemicals or other wastes. Such incidents will be documented through an environmental audit, conducted upon the completion of milling activities. Any contaminated soils identified will be remediated on site at the site's approved land treatment facility, and any recyclables and/or special wastes will be removed from the solid waste facility. Closure plans will be submitted to YG Environment prior to the final decommissioning of the land treatment facility and the solid waste facility.

7.6.8 Laydown Area

The Laydown area, located south of the stockpile pads and west of the DSTSF, will require reclamation at closure consisting of recontouring to establish drainage. Additionally a 0.5 m thick overburden cap will be placed and revegetated using the approved reclamation seed mixture.

7.7 Underground Workings and Openings to Surface

Underground mining schematics and plans are presented in Minto's Underground Mine Development and Operations Plan. Upon completion of underground mining, the underground workings will be allowed to flood. Recently updated hydrogeologic investigations indicate that in the post-closure period the groundwater table will not rise sufficiently to result in water discharging at the surface. In Accordance with the Yukon Quartz Mining Act, at the completion of mining the portals to the underground workings will be sealed, preventing access by people and wildlife. The ventilation raise will also be sealed to prevent access.

The portal areas will be backfilled and recontoured to a stable and natural slope. This will be followed by the application of appropriate seed and fertilizer to restore vegetation to the area.

7.8 Open Pits

7.8.1 Main Pit

The open pit was exhausted of ore during April 2011. An area of instability in the south wall of the pit failed shortly after completion of mining activities, and a stabilization buttress (South Wall Buttress) for the area is nearing completion.

To accommodate the generation of tailings from the Phase V/VI Expansion milling activities, Minto is proposing the construction of a containment dam on the eastern margin of the Main Pit (Main Dam). The Tailings Management Plan for the Main Pit also includes an overflow spillway from the Main Pit into the Area 2 Pit. Information regarding the proposed design of the Main Dam and spillway is presented in SRK's Main Dam Preliminary Design Report (2014, separate cover.) Excess water accumulated in the Main Pit prior to the construction of the spillway channel will be either:

- Subject to treatment in the water treatment plant and discharged to the receiving environment; or
- Pumped into the Area 2 pit to accelerate flooding of that unit.

The completion of tailings and waste rock deposition into the Main Pit is scheduled to occur towards the end of the Phase V/VI operational period (late 2021). At closure any accessible benches in the pit excavated in overburden will be scarified to encourage natural revegetation, but no additional reclamation work will be done on the open pit high walls. Boulders, up to 1 m in size, will be placed on all potential access routes to prevent uncontrolled human access to the pit.

The tailings surface will be reclaimed with the cover system represented in figure 7-6 below.

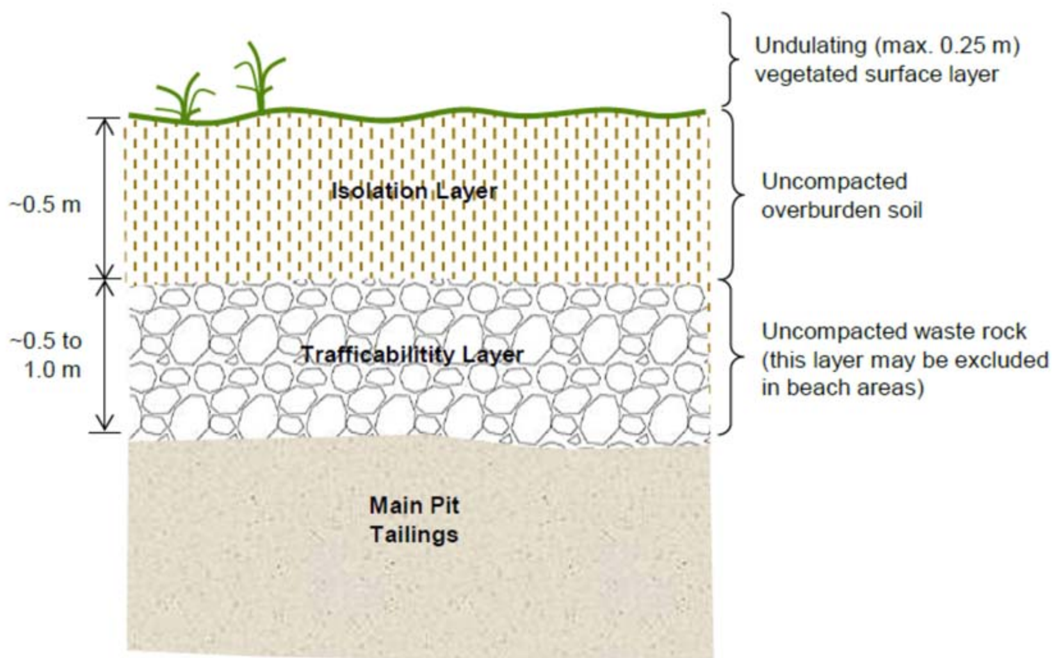


Figure 7-6 Conceptual Isolation Cover for Main Pit Tailings (SRK, 2013)

Surface runoff from upgradient of the Main Pit will be passive routed through the Main Pit via primary water conveyance channels Ditch 200 and Ditch 300. Ditch 200 will passively convey surface runoff from the W15 area to the south of the Main Pit and will require lowering of the Mine Access Road to allow open channel flow in Ditch 200 over the Main Pit Dump and connect with Ditch 300. Ditch 300 will be constructed along the inside portion of the Main Pit access ramp, also along the Main Pit Dump. The surface runoff will be directed to the base of the pit where it will be slowed by a stilling basin prior to flowing over the operational spillway and into the Area 2 Pit.

7.8.2 Area 2 Pit

The Area 2 Pit is located to the west of the Dry Stack Tailings Storage Facility. The Area 2 open pit has been constructed using standard drill and blast mining techniques with the proposed excavation occurring primarily in competent bedrock. The Area 2 pit will be used to store tailings once the Main Pit has been filled to its design capacity.

Some of the upper benches will be excavated into overburden and there is the potential for shallow surficial instability to occur in the overburden unit. Any areas of instability noted during operations will be addressed during subsequent updates of this document. Acid-base accounting indicates that the open pit wall rocks are net neutral to slightly acid consuming (non-acid generating).

Following the cessation of operations, the Area 2 pit will be flooded until it overflows into the engineered drainage channel. To facilitate this, the existing Southwest Diversion Ditch (referred to as Ditch 100 in this RCP) will be diverted into the Area 2 Pit at closure. Minto will evaluate whether pumping water into the Area 2 pit is required in order to accelerate flooding at closure. Pumping into the Area 2 pit is currently considered a favourable measure to submerge non-acid generating sulphide materials that are exposed as a result of the mining operations in this area. Accelerated flooding of the pit will act to reduce the oxidation of any exposed materials in the pit walls resulting in lower overall metal loadings due to less soluble secondary weathering products being produced from sulphide oxidation. The Area 2 pit lake will have an approximate depth of 35 m following flooding.

Due to the limited topography in Area 2 pit it is estimated that approximately 20% of the open pit walls will be exposed following flooding of this unit. The proposed Area 2 pit lake will spill to the north at an elevation of approximately 799 m into a designed intake structure and drainage channel that will convey the flow out of the pit. The conceptual intake structure invert elevation is estimated to be at approximately the same elevation as the low point on the pit rim, but the final invert elevation will be determined following development of that portion of the pit. The discharge channel (Ditch 400) from the Area 2 pit is discussed in Section 7.5.4 and shown on Drawing No. 08.

Prior to flooding, any accessible benches in the pit excavated in overburden will be scarified to encourage natural revegetation, but no additional reclamation work will be done on the open pit high walls. Boulders, up to 1 m in size, will be placed on all potential access routes to prevent uncontrolled human access to the pit.

7.8.3 Area 118 Pit / Backfill Dump

Any areas of instability noted during operations will be addressed during subsequent updates of this document. Acid-base accounting indicates that the open pit wall rocks are net neutral to slightly acid consuming (non-acid generating). Area 118 Pit will be backfilled, creating the Area 118 Backfill Dump with overburden from stripping of Area 2 Stage 3. Thaw stable and ice rich overburden will be dumped below the pit rim, and thaw stable only overburden will be dumped above the pit rim. Backfilling of Area 118 Pit will occur from November 2015 to March 2016 of Phase V/VI.

The Area 118 Backfill Dump will be used as a source for overburden for cover materials during Phase V/VI reclamation of the Ridgetop area facilities. The Area 118 Backfill dump will store 1,338,000 m^3 of overburden some ice rich overburden below pit rim elevation. To a final elevation of 886 mASL.

At closure the perimeter slopes will be regraded to 3(H):1(V), capped with overburden and revegetated.

7.8.4 Ridgetop North

Once exhausted of ore, the Ridgetop North Pit will receive slurry tailings, to roughly the elevation of the pit invert. Tailings will placed and contoured above the pit phreatic surface and spill elevation with an appropriate cover applied to isolate the tailings materials from precipitation and runoff. The placement of tailings and cover application will be conducted in such a manner as to avoid ponding of surface water, and will promote shedding of runoff towards the northeast. The cover will be revegetated using appropriate revegetation techniques refined through the ongoing reclamation research program.

7.8.5 Ridgetop South Pit

Once exhausted of ore, the Ridgetop South Pit will be backfilled with overburden and mounded at surface to promote positive drainage accounting for some settling of materials. The surface will be revegetated using appropriate revegetation techniques refined through the ongoing reclamation research program.

7.8.6 Minto North Pit

The Minto North Pit will be located in the extreme upper elevation of the McGinty Creek catchment area, directly north of the Minto Site. This deposit will be the first pursued through excavation in the Phase V/VI mine life. Accumulation of water in the pit during active mining will be managed through the pumping of water back to the Main Pit. At closure, the pit will be allowed to flood; however, drill hole groundwater elevation results and preliminary water balance modeling under most scenarios indicate that the Minto North Pit is not likely to fill to the point where it would spill directly. Pit water levels and water quality will be monitored in closure along with down gradient groundwater quality in the post-closure monitoring program.

7.9 Tailings Facility Areas

7.9.1 Dry Stack Tailings Storage Facility

The preliminary FMEA exercise for the Minto Closure Planning conducted in January 2013 acknowledged the ongoing uncertainty regarding the mechanism of instability and the potential need for further mitigation measures. Minto engaged SRK to conduct a targeted investigation into the extent of continued movement at the site with a view towards the development of ultimate mitigation measures for the DSTSF instability. In April 2013, nine new inclinometer holes were installed in and around the DSTSF to better characterize the rate of movement and the depths at which it is occurring. This geotechnical drilling program provided additional data for an assessment of what, if any, further measures would be required to stop movement of the facility.

Minto and SFN have also engaged a 3rd party expert on geotechnical stability under mutually agreed upon terms of reference to assist in the evaluation of the facility movement and the development of appropriate mitigation. This evaluation is now complete, and the final mitigation recommendation is for a further expansion of the MVFE (Stage 2) to the east of the existing footprint. The proposed layout of the expanded MFVE is presented in Figure 5-3, and all details regarding the design of the facility is presented in SRK's preliminary design document for the Stage 2 Expansion.

7.9.1.1 DSTSF Diversion Structures

The South Diversion Ditch closure measures and upgrades are presented previously in section 7.2.

Field observations have shown that the Tailings Diversion Ditch to the south of the facility required reconstruction to ensure that water is successfully captured and routed around the facility. This work is being conducted currently according to EBA's design document from October 2011 Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility (EBA, 2011). This will include an upgrade of the TDD and will include an analysis that shows that the TDD is adequate to convey anticipated closure design flows, and an upgraded design including a ditch conveying these flows to the WSP is in development, for both operational and closure application. Secondary and tertiary ditches will direct any excessive direct precipitation from the DSTSF surface to the Ditch 400 for discharge off site.

Geochemical characterization of the tailings has indicated there is no acid-rock drainage potential in this reclamation unit, however neutral metal leaching of copper and other elements has been identified. Closure measures for the DSTSF will focus on reduction of source loadings from the facility in addition to ensuring the physical stability of the facility. Managing water movement in and around the DSTF is seen as the key factor in the design of closures measures. The compacted tailings have a low permeability due to the mechanical compaction of the tailings following placement and spreading in the facility. Infiltration of precipitation and run-on water is not expected to have a significant influence on the DSTSF and surface grading will be utilized during the closure phase to assist in the shedding of water from the surface. Upgradient run-on water will be minimized through the operational construction (upgrading) of the Tailings Diversion Ditch (see below).

Progressive reclamation of the DSTSF is currently underway and a thick layer of overburden, ranging in thickness is in the process of being placed over the tailings surface, as released from Area 2 stripping activities. This thick overburden layer will obviate the risk of surficial erosion exposing the underlying tailings. The tailings surface will be recontoured to divert surface runoff efficiently off the tailings stack. The closure costing allows for an additional 0.5m of select overburden to ensure that the cover is suitable for revegetation. The current reclamation seed mixture and fertilizer application rates will be followed unless ongoing reclamation research programs show that changes to these are warranted.

7.9.2 In-Pit Tailings Storage

Closure measures for the in-pit tailings storage facilities are presented previously in section 7.5.

7.10 MILL VALLEY FILL EXTENSION

Closure of the MVFE will be conducted at the end of milling and will involve the removal of any temporary buildings and materials stored in the laydown areas. The location of the MVFE in the main valley of Minto Creek means that it will be necessary to route the main site discharge channel alongside the MVFE and a spillway down the face of the MVFE. The main site discharge channel (called Ditch 400 in the closure water management layout) will be designed to accommodate the 200-year event for the entire upstream catchment area including the routing provided by the two pits. The cost of the spillway design has been included in the closure costing for Ditch 400.

The total calculated volume of waste required to construct the Stage 2 MVFE is 1.67 M-m^3. Construction is scheduled to take place during the first 2 years of operation following the commencement of the Phase V/VI mine plan; therefore, no closure costs have been including for construction of the MVFE in the Year 2 and Year 9 closure costing scenarios. Recontouring of areas of the MVFE that are not required for channel construction will be conducted in order to establish final drainage runoff patterns and re-route the main site access road along the MVFE surface (as the Ditch 400 will be constructed on the current road alignment from the camp area to the eastern extent of the MVFE. The surface of the MVFE will be covered with a 0.5 metre deep soil isolation cover prior to application of seed and fertilizer.

7.10.1 Seepage at Toe of MVFE

Currently, seepage from the toe of the MVFE, which includes seepage from the DSTSF via the finger drain channels beneath the facility, is collected at the Minto Creek Detention Structure and pumped back to the Main Pit prior to treatment for discharge. This collection facility will be re-established at the new toe of the MVFE Stage 2, and pumping back will be redirected to the A2 Pit as tailings placement and capping in the Main Pit is completed. This will be continued through the active decommissioning stage as required until upstream and local reclamation works are completed to a stage that allows release of this water without compromising the suitability of site discharge as measured by the existing site effluent discharge standards and MMER Schedule 4 criteria. Accordingly, water quality in this area will be monitored and any adverse trends in water quality will be addressed as per the AMP.

7.11 WASTE ROCK AND OVERBURDEN DUMPS

This section addresses the reclamation of the waste rock and overburden dumps at the site which include the following reclamation units:

- Main Waste Dump;
- Southwest Waste Dump;
- Ice-Rich Overburden Dump; and
- Reclamation Overburden Dump.

7.11.1 Main Waste Dump

The Main Waste Dump (MWD) is located immediately northwest of the open pit, and has been constructed in sequential lifts as materials are extracted from the Main Pit. The MWD has been constructed according to EBA's Geotechnical Evaluation – Proposed Main Waste Dump, Minto Project, Yukon (EBA, 1998) which addresses physical stability design considerations, such as maximum credible earthquake criteria so the likelihood of major failure of the facility is deemed to be low. Annual inspections of the MWD have taken place as per Section 9.3.2 of the Quartz Mining Licence QML-0001 and no physical stability issues have been identified to date. The MWD will receive waste rock from mining of the Minto North Pit in Phase V/VI, with the waste rock being placed on top of the existing waste rock, in keeping with the original dump design that was not completed when waste rock was diverted to the Southwest Dump mid-way through the mining of the Main Pit.

Waste materials placed in the facility currently contain copper concentrations ranging from 0–0.64% since the majority of the MWD was constructed prior to the development of specific material handling plans based on the copper content which were employed in placement of some waste in the Southwest Dump. Geochemical characterization of the materials as part of permit requirements has shown that the materials currently in the facility do not present an acid rock drainage concern. The average NP/AP ratio of materials placed into the MWD is 48.5 with an average paste pH of 8.61 (Minto 2009). Neutral metal leaching has been identified as being a potential chemical concern associated with closure of this reclamation unit based on the ongoing geochemical characterization program (SRK 2010a) for the mine.

Section 2.2.2 discusses reclamation that has been conducted on the south face of the Main Waste Dump as part of the ongoing Reclamation Research Program. Results from this program will assist in optimizing dump face reclamation strategies for site waste dumps. A trial reclamation plot was established on a slope of the MWD. Direct application of seed onto a trial plot on the first lift of the MWD already graded to final slope was attempted in fall 2008. The amount of fine material and acceptable nutrient levels allowed the establishment of a vegetative cover (80%) suggesting that direct seeding onto parts of the final dump will meet the final revegetation objectives for the facility. Further seeding of additionally reclaimed slopes in 2012 showed variable results, with significant growth and coverage observed on the sections that were applied with the highest fertilizer rates.

At closure, the slope of each lift will be reclaimed with standard techniques. Slope crests will be rolled over using a tracked dozer with recontouring conducted in areas where the dump faces are greater than the long-term angle of repose. The materials in the MWD will be covered using an isolating soil cover constructed from reclamation soil materials available on-site. The MWD Expansion is scheduled for construction early in Phase V/VI to accept waste materials from the Minto North Pit. The design of the dump will be optimized prior to construction to incorporate landform design concepts. These optimizations will introduce undulations in the slope faces and the dump surface to encourage direct precipitation to drain down the face of the dump in armoured swales (secondary/tertiary ditches).

7.11.2 Southwest Waste Dump

The Southwest Waste Dump (SWD) is located to the south of the MWD and was designed by EBA in 2008 in order to optimize operations and provide additional storage areas for waste rock and non-ice-rich overburden material. Construction began shortly after the design approval in October 2008 and is currently being developed as per the EBA report entitled Geotechnical Design, Proposed Southwest Waste Dump (EBA, 2008a). The Phase IV expansion of the SWD has been constructed in accordance with the Waste Management Plan (EBA, 2010a) which outlines the design criteria for this unit. The dump has been constructed in progressive lifts with ongoing monitoring of the stability of the SWD being conducted as recommended in the design report through a combination of visual inspections, deformation surveys and monitoring instrumentation (piezometers, ground temperature cables and survey hubs).

The majority of waste rock scheduled for surface disposal as a result of Phase IV has been placed into the SWD. Segregation of waste on the basis of copper content was conducted, and the highest grade waste (HGW) which was originally destined for a Grade Bin Disposal Area (GBDA) south of the Main Pit was instead stockpiled in a segregated area in the southern-most extent of the SWD area. This was due to the instability and south wall failure of the Main Pit in the GBDA area. Medium grade waste (MGW) was also placed in an area separate from the rest of the waste in the dump. Some of the original portions of the SWD constructed as part of past mine workings have been covered as a result of the expansion of this unit. The covering of the older portions of the SWD, which are suspected to contain higher copper content waste rock materials, will help to reduce potential metal loadings from these materials.

The SWD is estimated to receive a total of approximately 6.44 M-m^3 of waste materials with copper content less than 0.1% from the Phase IV development. Initial geochemical characterization of the waste materials scheduled for placement in the SWD has shown that the materials do not present an acid rock drainage concern. Neutral pH metal leaching has been identified as being a potential geochemical concern associated with closure of the dump based on the ongoing geochemical characterization program (SRK, 2010).

It is anticipated that the entire surface of the SWD, with the possible exception of the isolated area of high grade waste, will be covered with a rudimentary, revegetated isolation soil cover similar to that proposed for the MWD. Research into optimal cover thickness is ongoing; however, based on our current understanding of cover material properties, the following assumptions have been made regarding the anticipated cover configuration. Bench areas will be covered with a minimum 0.5m thickness of soil cover with 20% of the bench areas to be covered with an average 2.0m cover thickness to facilitate the incorporation of deeper rooting vegetative cover. For costing purposes, all bench areas will be covered with an average 0.8m thickness of soil cover. All perimeter slopes are to be covered with a minimum 1.0m of soil cover. A 'rough and loose' surface will be encouraged for erosion control, moisture retention and promotion of seed and propagule capturing. Drawing 09 shows regrading of a typical SWD slope to 3H:1V at closure.

While updated water quality predictions indicate that rudimentary soil cover is appropriate for the entire SWD surface, Minto has conservatively allowed for the placement of an engineered very low permeability cover over the area containing high grade waste. The closure costing has allowed for the installation of a bituminous geomembrane over the area of HGW. Details regarding the design and installation of this cover will be refined leading up to its placement (2015).

Reclamation overburden will be loaded with an excavator and hauled by trucks from stripping activities for the Area 2 Stage 3 pit. This direct placement reduces double handling effort and expense. Overburden will be placed with the trucks and further spread with a low ground pressure dozer. Compaction of the overburden during spreading will be minimized by the use of low ground pressure equipment, however, areas observed to have compaction will be ripped to reduce compaction effects prior to seed and fertilizer application, to create a 'rough and loose' surface.

The current reclamation seed mixture and fertilizer application rates presented in Section 2.2 will be followed unless ongoing reclamation research programs show that changes to these are warranted.

7.11.3 Ice-Rich Overburden Dump

The ice-rich overburden dump (IROD) is the furthest west reclamation unit on the site and has been constructed immediately up gradient of the SWD. A toe berm has been constructed from waste rock to retain the ice-rich overburden and prevent migration of the material downslope as ice in the stockpiled materials melt. The IROD has been constructed according to EBA's Geotechnical Design, Ice-Rich Overburden Dump, Minto Mine, Minto YT (EBA 2006) and has been inspected since as per the Quartz Mining Licence (QML-0001, Section 9.3.2) with no stability issues identified to date. Physical stability of the IROD is the primary closure concern given the ice-rich nature of the materials placed into this unit.

Materials from the IROD will be used as a source for growth media during reclamation of the SWD. Reclamation of the IROD will involve the placement of a 0.25 m layer of overburden on the toe berm as this unit is not deemed to require source control. This material will cover the uppermost 75% of the slope, leaving the furthest downslope area of the toe berm (where it contacts the original ground surface) uncovered to allow moisture seepage as per the construction design. This will avoid raising the phreatic surface inside the IROD.

Any overburden remaining in the dump after closure and reclamation has been completed will be resloped to less than 2.5H:1V and revegetated.

7.11.4 Reclamation Overburden Dump

The reclamation overburden dump (ROD) is located to the west of the MWD and north of the SWD. The ROD will not be expanded during the Phase V/VI Expansion activities. The existing portions of the ROD have been constructed in accordance with EBA's Geotechnical Design, Proposed Reclamation Overburden Dump, Minto Mine, Yukon (EBA 2008a), and subsequent revisions.

The overburden materials stockpiled in the ROD will be used as a source for growth media during reclamation of other units at the site. Any overburden remaining in the ROD after closure and reclamation has been completed will be resloped to less than 2.5H:1V and revegetated.

7.11.5 Main Pit Dump

Development of this facility will be, effectively, a continuation of placement of waste rock on top of the South Wall Buttress in the Main Pit. The continued placement of waste in this location will serve to stabilize the south wall area further. The Main Pit Dump has been designed for closure, with all slopes designed at no more than 3H:1V. At closure, the dump will therefore not require substantial regrading. The dump has also been designed to incorporate the closure conveyance ditches 200 and 300 (See Figure 7-2 and Drawings 03 and 04). The haul road ramp on the dump will accommodate haul trucks during operations (primarily for progressive reclamation activities.) At closure, the ramp will form the foundation for the 300 ditch, which will be excavated on the inside of the ramp alignment (nearer the slope) to allow a narrower road alignment for smaller trucks on the outside. Construction of these water conveyance features is outlined in Section 7.2.

The materials in the Main Pit Dump will be covered using an isolating soil cover constructed from reclamation soil materials from the Reclamation Overburden Dump, and revegetated as per the standard site prescription.

7.11.6 Ridgetop Waste Dump

The Phase V/VI Waste Rock and Overburden Management Plan proposes the development of a new waste rock facility named the Ridgetop Waste Dump, located to the west of the Ridgetop Pits. This facility will be constructed from waste rock generated by mining of the Ridgetop North and Ridgetop South pits. At closure, the slope of each lift will be reclaimed with standard techniques. Slope crests will be rolled over using a tracked dozer with recontouring conducted in areas where the dump faces are greater than the long-term angle of repose. The materials in the Ridgetop Waste Dump will be covered using an isolating soil cover constructed from reclamation soil materials available on-site, with a 'rough and loose' placement technique to discourage erosion and encourage revegetation germination success.

7.12 Ore Stockpiles and Pads

The Phase V/VI mine plan includes the milling of all stockpiled ore prior to final closure. The following stockpiles at the site will be treated in this fashion and therefore are not deemed to be an issue at closure:

- High and medium grade sulphide ore stockpiles and pads (located south of the mill); and
- Low grade sulphide ore stockpile and oxide ore pad (located between the pit and the MWD).

Both the high and low-grade sulphide stockpile pads were constructed from waste rock according to design criteria set out in EBA's Waste Rock Stability Evaluation, Minto Project, Yukon (EBA 1996). The ore stockpiles have been inspected annually as per the Quartz Mining Licence (QML-0001) and there are no issues identified to date that suggest long-term stability concerns for these units.

Reclamation of the stockpile pads will be conducted following the completion of milling of stockpiled ore materials. The top layer of the high and medium grade pads will be scraped and relocated to a waste facility to reduce potential metal loading as the geochemical characterization program indicates that there is potential for neutral metal leaching from these materials. The pads will be covered using an isolating soil cover constructed from reclamation soil materials available on-site.

7.13 Mine Infrastructure

This section addresses the decommissioning measures for miscellaneous facilities and sites around the property. These facilities include:

- Mine camp and related infrastructure;
- Airstrip;
- Exploration sites and trails;
- Land treatment facility;
- Solid waste facility;
- Explosives plant site; and
- Site roads.

Figure 7-5 shows details on the closure measures for the camp area. Closure measures will focus on long term physical stability of these areas following closure and ensuring that any areas of contamination are identified and remediated in an appropriate manner. The physical stability of these structures/areas at closure will be mitigated for the most part by either:

- Disassembly and removal from the site; and/or
- Recontouring and revegetation of the area.

Environmental concerns for these areas will arise primarily from contamination of surrounding soils by fuel, chemicals or other wastes. Such incidents will be documented through an environmental audit, conducted upon the completion of milling activities. Any contaminated soils identified will be remediated on site at the site's approved land treatment facility, and any recyclables and/or special wastes will be removed from the solid waste facility. Closure plans will be submitted to YG Environment prior to the final decommissioning of the land treatment facility and the solid waste facility.

A salvage program will be conducted towards the end of mine life to minimize the volume of scrap that will require in-situ disposal. It is expected that removal of these facilities, namely the camp and explosives plant site, will be done by auction or contractor for salvage value.

Buried services such as piping and wiring will remain buried. Concrete footings will be broken down to slightly below grade, where required, and covered with fill. Recontouring of areas will also be conducted as required in order to establish final drainage runoff patterns. Culverts will be removed and pertinent areas will be covered in 0.25 metres of growth media prior to application of seed and fertilizer.

7.13.1 Mine Camp and Related Infrastructure

In 1999 Minto completed construction of a camp for mine staff that included living quarters for 42 persons – a seven-unit accommodation/kitchen/diner/change room complex. In 2006, the camp was expanded by the addition of trailers and other construction to provide capacity for 140 persons, including an office complex. The facility provides a potable water supply (drilled groundwater well, 1998), gas-fired heat, a local power supply, and sewage disposal to two adjacent septic fields. The septic system has now been converted to a packaged treatment plant, and the camp is being reconstructed again to allow for greater occupancy. Several structures behind the facility house the fuel supply to the furnaces, relay power from a diesel electrical generator, and pump fresh water.

Closure measures for the campsite include disassembly of the camp trailers and related infrastructure. All salvageable material will then be removed from the site. The remaining campsite landing will be scarified and recontoured, as required, to establish drainage patterns and then covered with 0.25 m of growth media and revegetated. Seed mixtures and fertilization specifications will be based on both revegetation trials and natural revegetation observations and success.

7.13.2 Exploration Sites and Trails

Current exploration activities being conducted on the site operate under a Class III Mining Land Use Authorization are subject to specific closure measures as identified in the Class III Authorization. These measures will be implemented as required by the exploration crew, and are not subject to closure planning in this plan.

7.13.3 Land Treatment Facility

The Minto land treatment facility (LTF) is located near the airstrip in an area originally excavated on bedrock for an equipment laydown area. This facility is permitted by YG, Department of Environment, Environmental Programs Branch under Permit #24-204 to treat a maximum volume of 700 m^3 of hydrocarbon contaminated soil. Contaminated soils from fuel/oil spills during operations will be treated in this facility to appropriate levels of remediation before being used as industrial fill as per permit requirements.

The closure of this facility is subject to the submission of a formal Closure Plan to YG, along with sampling results which demonstrate the final concentrations of contaminants in the soil being treated. It is expected that upon final closure of the entire site, dismantling and decommissioning activities may reveal or result in soil contamination requiring the relocation of contaminated soil to the LTF and an undetermined number of months of treatment to achieve desired remediation levels. As such, the LTF Closure Plan and final sampling results will be prepared and submitted sometime after final closure of the mine site has begun.

Generally, once the desired contaminant levels have been reached in the final volumes of treated soil, and the Closure Plan has been approved by YG, the soils will be spread at approved locations at the site, recontoured in place and revegetated. If required, additional overburden may be hauled and used as cover material and growth media for revegetation.

7.13.4 Solid Waste Facility

Under Commercial Dump Permit # 81-005, issued to Minto Explorations Ltd. by YG, Department of Environment, Environmental Programs Branch, Minto has established a Solid Waste Facility adjacent to the Land Treatment Facility near the airport that includes:

- A burning pit for wood and paper waste;
- Construction waste disposal area;

- Metal and rubber tire disposal areas; and
- Incinerator ash disposal in old exploration trenches.

The solid waste facility will receive construction and operational waste throughout the operation of the mine, as permitted. At closure the area will be covered by fill and compacted in 'lifts' as per common landfill practice.

Scrap equipment will be stored in various lay down areas located on site and along the access road, including primarily scrapped equipment stored to be utilized on the mine site as a source of spare parts or good recyclable scrap material. Salvageable material from these sites will be sold as scrap and removed from the site at closure. Material that has no scrap value will be disposed of in the solid waste facility. Prior to disposal in the landfill, all of this material will be examined to ensure that all hazardous materials are removed.

Any hazardous materials identified in these areas will be removed and shipped off site to a licenced waste disposal site, along with other stored hazardous or special wastes, as permitted under Minto's Special Waste Permit # 43-040.

The submission of a formal Closure Plan to YG for the solid waste facility will be required at final closure. The formal closure plan will document the conditions and materials at final closure. Preceding the final reclamation of this facility, tires and salvageable scrap metal will be hauled off site for salvage/recycling. Once the closure plan is approved by YG, the facility will be covered by two compacted lifts of 200 mm thick compactable soil material obtained from local borrow sources. The cover material will be graded to prevent pooling of precipitation runoff and to encourage the shedding of water. The site will then be revegetated using a suitable seed mixture.

7.13.5 Explosives Plant Site

The ANFO explosives (ammonium nitrate – fuel oil) production area is comprised of the production plant and AN bag storage and powder magazine storage areas, located near the drainage boundary southwest of the mine site.

At closure, unused explosives that remain on site will be returned for credit and the explosives magazines and other equipment will be returned to the explosives supplier. The septic system at the site will be pumped of contents, broken down and backfilled. Fuel-contaminated soils will be excavated and hauled to the land treatment facility for remediation. Disturbed areas will be recontoured as required and covered with 0.25 m of overburden or growth media prior to application of seed and fertilizer. Seed mixtures and fertilization specifications will be based on both revegetation trials and natural revegetation observations and success.

7.14 Roads and Other Access

7.14.1 Main Access Road

The main access road to the property was constructed in 1996 and 1997. This road was constructed to facilitate 26-ton ore concentrate truck traffic. The road was constructed by cut and fill methods with a road width of 8 meters and associated ditch drainage and culvert installations. Figure 5-1 shows the alignment of the main access road. Minto expects that the determination of the extent to which the main access road is deactivated will be made in consultation primarily with SFN and secondarily with local trappers, the community, and government regulators. This closure plan recognizes three potential outcomes for road reclamation:

1. No road deactivation;

2. Road deactivation from Minto Creek to the mine site; or

3. Deactivation of the entire road.

In making a final decision about closing the main access road, consideration will also be given to the potential requirement for equipment access. Despite the identified closure timing and schedule, final access road removal (if selected) would only be undertaken once it is concluded that the site is stable and there is no need for heavy equipment access to the site.

The primary consideration for the physical stability of the main access road at closure will be slope stability where culverts have been removed and drainage channels have been established through the road alignments. Siltation of streams could occur during culvert removal and slope stability work. The road will be inspected during an environmental audit to take place at the end of mine life to identify any spills or contamination that was not addressed during operations. The results of the audit would be shared with and/or conducted by SFN Lands and Resources Department so that a scope of work for closure could be jointly developed.

Should one of the two options involving deactivation of the road be chosen, then standard road decommissioning and reclamation measures at closure, including culvert excavation, drainage recontouring, slope stabilization and surface scarification will be applied.

Culvert removal work will be conducted in the late summer/early fall when flows are low or non existent. Culvert removals and bank recontouring works at locations where there is still flow will include pump around or flow diversions to ensure that work is done in the dry and silt loads are not added to stream systems. Regrading/contouring the roads will ensure that runoff sheds off the road surface. The road surfaces are not expected to require seeding, only surface scarification to encourage natural revegetation.

The removal of culverts at stream crossings which are fish bearing is of primary concern. At these stream crossings, the roadbed would be cut down to the culvert and original streambed elevation with side slopes brought back to 2H:1V. Material removed during culvert removal will be spread loosely on adjacent road surface to promote revegetation. The stream channel would be stabilized as required and slopes revegetated. The Big Creek Bridge and all culverts will be removed once all heavy equipment has been removed from the mine and closure activities have been completed in the upper Minto Creek basin.

The disturbed footprint of the access road occupies only a portion of the cleared right-of way. Site experience shows that vegetation should re-establish itself in the 30 m wide right-of-way during the life of mine and only remedial revegetation work will likely be required. The preferred methodology is to encourage natural revegetation to occur, after first preparing the road surface by recontouring and scarifying. Temporary sediment management measures such as silt fencing will be installed as required in order to minimize sediment transport during establishment of a vegetative cover.

7.14.2 Haul Roads

The haul roads on the site radiate out from the open pit to the mill, the ore stockpiles, the waste rock dumps and the ice-rich overburden dump. Haul roads, site roads and the main access road will be subject to standard road decommissioning and reclamation measures at closure, including culvert excavation, drainage recontouring, slope stabilization and surface scarification. Regrading/contouring of the roads will ensure that runoff sheds off the road surface and does not become ponded. Site reclamation experience indicates that road surfaces are not expected to require seeding, only surface scarification in order to encourage natural revegetation. Sediment management measures will be installed where drainage channels have been re-established in order to prevent sediment from entering streams while revegetation occurs. Short term sediment management measures may include installation of silt fencing and enviro-matting at select sites until vegetation becomes established.

7.14.3 Airstrip

The airstrip area was noted to be subject to colonization by natural vegetation during a period of project inactivity from 1997 to 2005. Based on these observations, reclamation of the airstrip will focus on scarification of compacted surfaces. Natural revegetation will be allowed to occur in order to minimize the introduction of non-native species. Seeding of this reclamation unit is not deemed to be required as there is minimal erosion potential of the airstrip.

7.15 Borrow Materials Planning

7.15.1 Overburden

Overburden for the isolation covers will be obtained from the Reclamation Overburden Dump (Figure 5-3) and from overburden stripped during the development of Phase V/VI open-pit mining operations (Figure 5-7). Overburden from the ROD has been extensively characterized (e.g., SRK 2013a) and demonstrated to be suitable for use in revegetated isolating soil cover. The site has significantly more overburden available for reclamation than required, with the ROD alone estimated to contain on the order of 4.43 Mm^3, available for soil cover construction at the end of Phase IV (refer to Section 5.2.3.2).

7.15.2 Waste Rock

7.15.2.1 General Fill (MVFE)

A significant quantity of geochemically benign waste rock, on the order of 1.67 Mm^3 of fill, is required for the completion of the Mill Valley Fill Extension (refer to Section 5.2.3.6). The necessary waste rock for the MVFE will be obtained during the development of Phase V/VI open-pit mining and it is anticipated that this waste rock will be direct placed from active open-pit mining during operation, within the first two years of Phase V/VI.

7.15.2.2 Rip-Rap

The reclamation planning calls for on the order of 20,000 m^3 of durable, geochemically benign rip-rap for lining water conveyance ditches and protecting slopes from erosion due to surface runoff. Rip-rap material will be required at closure ranging in size from D_{50} of 150mm to D_{50} of about 800 mm. The largest quantity of rip-rap (on the order of 14,000 m^3) will be in the D_{50} 300 mm range as this gradation is specified as erosion protection for Ditch 300, Ditch 400 and secondary ditches on steep slopes. On the order of 2,000 m^3 of large rip-rap (500mm to 800mm) will be required, primarily for energy dissipation structures.

This geochemically benign rock for use as rip-rap will be obtained primarily from Phase V/VI development of the Minto North open-pit. It is anticipated that suitable source rock will be stockpiled in the vicinity of the Main Waste Dump Expansion (location TBD) and operations will be set up for crushing, screening and washing. Large boulders for use in energy dissipation structures will also be opportunistically sourced from the existing piles on the SWD and MWD and stockpiled for later use.

7.15.2.3 Filter/Bedding Layers

The reclamation planning requires on the order of 8,000 m^3 of granular fill for filter and bedding layers associated with rip-rapped and/or lined water conveyance ditches. Pit-run sand and gravel is not readily available onsite; therefore, it is anticipated that this material will be obtained primarily as a by-product of screening and/or crushing of rip-rap stockpiles. In the event that insufficient quantities are produced as a by-product of crushing, additional dedicated crushing and screening operations will be required. The filter/bedding layer will be well-graded with a D_{50} of about 25mm and less than 5% fines. It is anticipated that some washing of the crushed, screening filter/bedding layer may be required to control the amount of fines.

7.15.3 Residuum (Low Permeability)

Residuum is abundant on site and has historically been opportunistically obtained by small borrow pits along the main access road or in connection with overburden stripping. The material has been thoroughly characterized in connection with historic usage as a low permeability component in ditch design and water retaining structures (e.g., EBA 1998). Residuum is typically silty sand with some fine gravel. The current reclamation plan calls for minimal use of residuum – primarily for the construction of a low-permeability plug in Ditch 100 at closure (Drawing 02).

7.15.4 Organics

There are limited readily available sources of organics on-site. Potential sources for incorporation in passive treatment systems are currently being evaluated in connection with ongoing reclamation research. One option currently under consideration includes mulching of locally available trees for incorporation in bioreactors and CWTS.

7.16 Monitoring & Maintenance

7.16.1 Compliance Monitoring and Reporting

Environmental compliance monitoring, internal monitoring of earthworks and independent geotechnical inspections are presently ongoing at the property. The environmental monitoring at the Minto mine employs several types of scheduled periodic inspections to ensure that the facility is meeting environmental performance objectives and complying with appropriate regulatory standards. These inspections entail:

- Scheduled inspections of the waste rock and overburden storage areas, tailings management facility, water retaining structures and mine components to monitor environmental performance;
- Scheduled water quality sampling and flow measurements of effluent streams and local receiving water streams;
- Scheduled receiving water programs for benthic invertebrates, stream sediments and fish to monitor downstream environmental quality;
- Scheduled piezometric monitoring of water levels in wells and the spillway structure at the Main Water Pond Dam (if still in place);
- Monitoring of other instrumentation installed in the DSTSF as per the Tailings Management Plan (thermistors, survey hubs, etc.);
- Annual inspections of the TMF by a qualified geotechnical engineer, diversion channel, waste rock and overburden storage areas, and Main Water Pond Dam for structural stability; and
- Scheduled environmental tours and audits of the property by Minto staff to look for environmental hazards and site stability. Minto will endeavour to invite various Government agencies' representatives as part of the environmental inspections.

At present, site personnel undertake the scheduled environmental monitoring and inspection programs with the exception of annual geotechnical inspections and the benthic invertebrates, stream sediment and fish monitoring programs, which are conducted by qualified professionals. All results are reported to the YWB, and YG EMR as monthly or annual reports.

During the active closure phase environmental and physical compliance monitoring and inspections will continue as required by the present Water Use Licence or Quartz Mining Licence monitoring programs utilizing site-based personnel. It is expected that the amount of environmental and physical monitoring and inspection (frequency and quantity) will decline once all closure measures are implemented. The approach to closure monitoring will be to continue with the present licence monitoring and inspection programs until decommissioning and reclamation measures have been completed and then reduce the frequency of site monitoring and the number of monitoring stations over time as satisfactory closure performance is confirmed. Revisions to the current Water Use Licence requirements will be required upon closure to authorize the proposed monitoring programs.

The schedule for monitoring programs planned for the 13-year period immediately following cessation of active mining and milling operations are presented in Table 7-1. For the first 3 years following the cessation of mining/milling, and during active closure and decommissioning, routine operational environmental monitoring will be completed. The Year 4 to 8 period (Post-Closure I) is expected to demonstrate the effectiveness of closure measures and includes monitoring of their performance, but monitoring frequencies would be reduced to periodic inspections, with a further reduction of frequency for years 9 to 13 (Post-Closure II). The purpose of these periodic inspections would be to ensure that waste discharges remain compliant, closure and water quality objectives are being consistently met, and physical structures are performing as designed. Should these inspections or monitoring initiatives identify issues of concern, then plans would be developed to address the concerns, as per the AMP.

Based on the results of site monitoring for the 13-year post-closure monitoring period and discussion with the SFN and the appropriate regulators the need for and the frequency of additional site monitoring will be determined. If the results from monitoring indicate that the site is stable with acceptable geotechnical and environmental performance, then Minto would propose to decrease the frequency of monitoring further. If the results from monitoring indicate there are concerns with either geotechnical conditions or environmental issues, then the site would continue to require more frequent monitoring than otherwise proposed and possibly additional remedial work would be proposed.

As previously mentioned, Minto is interested in having the SFN participate actively in both the closure activities and in post-closure monitoring. Minto will work directly with SFN in this regard.

Environmental monitoring and inspections conducted during the post-closure periods (years 4-13 after cessation of mining) will be undertaken by periodic visits to the site. Access to the property for post-closure monitoring would be via ATV, snowmobile, and/or helicopter if the road is decommissioned.

Table 7-5 Post Closure Monitoring Program

		UTM LOCATION (m) ZONE 8		YEAR 1-3 FREQUENCY (Active Closure)				YEAR 4-8 FREQUENCY (Post-Closure I)			YEAR 9-13 FREQUENCY (Post-Closure II)		
SITE	DESCRIPTION	Easting	Northing	Surface Water	Sediment	Benthos	Flows	Surface Water	Sediment	Benthos	Surface Water	Sediment	Benthos
W-2	Mainstem Minto Creek directly u/s Access Road Crossing	392616	6948477	W	A	A	DCR, W	M	BA	BA	SSF	BA	BA
W-3	Mainstem Minto Creek 50 m d/s toe of Dam (Final Point of Discharge)	386747	6945682	W	A	A	DCR, W	M	BA	BA	SSF	BA	BA
W-6	Tributary to Minto Creek	387544	6946420	Q			Q	Q					
W-7	Tributary to Minto Creek	387504	6946069	Q			W	Q					
W-10	Mainstem Minto Creek (south fork at headwaters)	383348	6943654	M			M	Q					
W-12	Discharge from Open Pit	384819	6944991	M				SA			A		
W-15	Minto Creek, downstream of the SWD	384286	6944754	M				SA			A		
W-16	Main Water Storage Pond Discharge (or Main Water Storage Pond if not discharging)	386538	6945573	W*									
W-17	Main Water Storage Pond Dam Seepage	386615	6945645	M*									
W-37	Seepage from toe of MVFE			M				SA			A		
W-8	Alternate Tailings Area Seepage/Runoff	385620	6945067	M				SA			A		
W-8A	Tailings Seepage/Runoff	385707	6945071	M				SA			A		

BA – biannually = every 2 years
SSF – Spring, Summer, Fall….. May, July, September

W	Weekly
W2	Every 2 Weeks
M	Monthly
Q	Quarterly
SA	Semi-annually
A	Annually
BA	Bi-annually
NLA	No longer active
DCR	Daily Continuous Record during open season

During the post-closure period, reporting on all environmental and inspection programs carried out on the property will continue. These reports will be filed with the YWB, and EMR in accordance with conditions contained in the Water Use Licence, Quartz Mining Licence and other operating permits and approvals as they are.

Company personnel responsible for the management of the Minto mine would continue to meet with regulatory agencies, SFN, and the community (Pelly Crossing) on an as-needed basis to keep interested parties appraised of decommissioning activities and the results of post-closure monitoring.

It is expected that a review of the environmental performance of the mine following closure would be made with EMR and other interested parties. Once this review is completed, Minto would consider applying to the Minister of EMR for a Certificate of Closure for the Minto mine under the Yukon Quartz Mining Act Mine Production Regulations. The Certificate of Closure will confirm that Minto has fulfilled its closure obligations for the site.

7.16.2 Maintenance

Provisions for maintenance of reclamation tasks such as erosion control and maintenance seeding have been included as part of the long-term closure requirements. Based on physical inspections and monitoring, maintenance works will be planned for and conducted as required to meet closure performance standards and objectives.

It is a reasonable expectation that site features will require ongoing or periodic maintenance in the closure period. Examples include:

- Water conveyance structures:
    - Ditches will require cleaning of debris, fines accumulation, sediments and periodic fixing of ditch sides/liners;
    - Settling basins will require periodic cleaning of sediments; and
    - Ditches and settling basins may require rip rap or boulder replacement or fixing.
- Soil Covers
    - Covers will require periodic attention for erosion; and
    - Covered areas may require additional cover material and/or armouring in areas where continued erosion is occurring.

7.17 PERFORMANCE UNCERTAINTY AND RISK MANAGEMENT

7.17.1 Adaptive Management Plan

An adaptive management plan (AMPs) has been developed as part of the Phase V/VI closure planning. The entire AMP is attached in Appendix B and a summary is provided here.

AMPs are tools used to address the inherent uncertainty in closure planning. AMPs outline a range of possible, unexpected outcomes and the responses that will be undertaken to curb possible negative impacts associated with these unexpected situations.

An AMP is a flexible, iterative process that emphasises learning while doing. This implies that an AMP is never complete in nature, but in a continuous state of refinement in response to feedback from monitoring, analysis of data and changing conditions. The ideas presented within this document build on information gathered through operations and environmental monitoring at Minto. Phase V/VI is part of a sequence of stages in the evolution of the Minto mine site. Until final closure, the project is anticipated to continue to evolve and change. For example, as mining and development of Phase V/VI commences, Phase IV mining components will be proceeding into the reclamation and closure process. The various components and activities related to the phases do not occur in isolation, and plans such as this AMP must be dynamic in order to effectively deal with change. As a result, any future developments that occur at the Minto mine site will necessitate updates to the AMP. Thus the AMP is considered a "living document". Subsequent iterations of the closure AMP will take these changes into account.

7.17.1.1 Adaptive Management Planning

Adaptive management is an approach to environmental management that, according to the Canadian Environmental Assessment Agency, is appropriate when a mitigation measure may not function as intended or when broad-scale environmental change is possible. Mine closure planning includes both of these potentialities due to the long term planning horizon and associated uncertainty. Adaptive management plans are precautionary in nature, and provide a level of security in long term environmental planning. Adaptive management plans also allow for the inclusion of improved science into mitigation measures as they are continually revised.

Adaptive management has been evolving since its emergence in the 1970s. Adaptive approaches include an ability to incorporate knowledge into the management plan as the knowledge is gleaned and circumstances change. Eberhard et al. described the categories of knowledge that may trigger changes to water quality management plans; system understanding, measuring progress and anticipating changes. These categories allow for the inclusion of knowledge and adaptation of management to changed conditions. Embedding adaptation into environmental plans involves thinking about how the results of monitoring will change management actions. Adaptive management plans are a way to accept uncertainties and build a structured framework to respond to changing conditions.

Adaptive management conducts a flexible path with actions to take when specific triggers occur. AMPs are a formalization of a plan for performance monitoring and project re-evaluation in the future. The general structure of adaptive management can be described by the following steps:

1. Identify risk triggers associated with vulnerabilities or uncertainties;
2. Quantify impacts and uncertainties;
3. Evaluate strategies and define implementation path that allows for multiple options at specific triggers;
4. Monitor the performance and critical variables in the system; and
5. Implement or re-evaluate strategies when triggers are reached.

Although there are no widely used AMP terms, the steps listed above are representative of typical AMP processes. Within AMPs, triggers provide decision points in a stepwise decision-making framework that identifies how and when management action should be taken. A key characteristic of adaptive management is monitoring, which is used to advance scientific understanding and to adjust management policies in an iterative process. Adaptive management is a rigorous method for addressing uncertainties in ecosystem management.

Minto has used the general steps listed above to establish a set of adaptive management terms and apply them to the ongoing Minto closure planning process.

7.17.1.2 AMP Objectives

An AMP is a management tool wherein a framework is provided to make quick and effective decisions to guide responses to unforeseen events. This document identifies areas of uncertainty within the Phase V/VI RCP and its predictive elements and provides an AMP framework for each. For each component the AMP describes monitoring commitments, thresholds, triggers and responses to underperforming elements or emerging risks within the component. The steps laid out in the AMP framework are precautionary, and therefore they provide the confidence that action will be taken before adverse environmental impacts are observed.

Response planning, and results for anticipated events are contained within site management plans while AMPs guide responses to unforeseen or contingency events. This AMP provides a framework to guide responses to unanticipated monitoring results and to potential but low probability events where uncertainty exists.

It is difficult to predict the specific environmental condition that may arise which requires a response from management and, therefore, the AMP does not provide specific detailed descriptions of responses to a situation. The AMP provides a range of possible responses to use as a guide to respond to specific environmental conditions encountered. Management should use the information provided in the AMP and undertake the appropriate response.

7.17.1.3 AMP Approach

In addition to the conclusions drawn from research, the approach presented in this AMP generally follows the Environmental Code of Practice for Metal Mines, Section 4.1.17 on Adaptive Management:

"Mine owners/operators should use adaptive management methods to revise and refine the environmental management strategy. Adaptive management should consider a wide range of factors, including:

- the results of environmental audits or other evaluation activities;
- the results of environmental monitoring;
- the results of monitoring of the performance or condition of environmental infrastructure, such as containment structures, water management systems or treatment facilities;
- technological developments; and
- changing environmental conditions." (Environment Canada 2009)

7.17.1.4 AMP Components

The activities associated with the Phase V/VI mining life cycle may contribute to future environmental conditions requiring the implementation of an adaptive management plan. Two primary AMP components have been identified for AMP development:

- Surface water quality and quantity; and
- Water collection and conveyance structures.

The specific AMP framework for each of these components are described in the attached AMP (Appendix B)

7.17.1.5 AMP Framework

The AMPs for each component are laid out using a common element approach to create consistency in implementation of the AMP protocol for all components. The common elements are:

1. Description of the component
    - Description including the engineering design associated with the component. Thorough description and understanding of the component leads to narrative risk triggers and specific performance thresholds.
    - Risk Narrative describe the possible environmental impacts and environmental conditions that implementation of the AMP will prevent. The risk narrative is used to establish early warning indicators.
2. Monitoring the component
    - Specific Indicators are the environmental or physical parameters to be monitored and assessed. Specific indicators are measurable or observable, and are indicative of changes from the designed or expected condition.

- Monitoring Requirements describes the monitoring regime for the component including frequency, type of data required and interpretation of results.
- Specific Performance Thresholds define the conditions, in terms of specific indicators, when action is triggered. Performance thresholds are staged to accommodate levels of concern and a diversity of actions. To the extent possible, specific performance thresholds will include early warning thresholds.

3. Responding to unexpected conditions of the component

- Specific Responses are staged according to specific performance thresholds and they describe the actions to be implemented if specific performance thresholds are crossed. Specific responses were developed through various means including, consultation with SFN and their agents, site operations such as monitoring and management, and input from ACG as well as other consultants.

4. Annual Reporting and Review

- Annual Report reflects annual changes made to the AMP as the site conditions change. The AMP should be modified whenever unexpected circumstances are encountered and the protocol is implemented or when additional proven science or technology becomes available.

7.17.1.6 AMP Risk Narrative, Specific Indicators and Specific Performance Thresholds

In concept, it is Minto's position that risk narrative, specific indicators, and specific performance thresholds have been selected in order to maintain closure objectives in the event of emergence of unanticipated conditions at and surrounding the project site during operations and post-closure. Specific to water quality, Minto has identified operational water quality objectives upon which the AMP indicators and performance thresholds are based. These start well below the calculated no effects level and would initiate a progressive series of steps to both investigate potential reasons for the observed changes to metal concentrations in the water and, if warranted, implement plans to mitigate against undesirable changes to discharge water quality. Minto expects that these operational objectives will be refined into closure water quality objectives to address the requirement to achieve site runoff quality that reflects all 'reasonable and practical' treatment using passive measures. This work will be conducted as results from the passive treatment research programs refine the performance expectations at the site.

7.17.1.7 General Approach to AMP Specific Responses

The following general steps may be taken if any AMP performance thresholds(s) have been exceeded:

1. Internal notification to management, followed by timely notification to SFN and the Water Inspector that a performance threshold has been exceeded;
2. Investigation of the root cause of the exceedance;
3. If a root cause of the exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector will be notified of the remedy and the implementation according to permit requirements;

4. If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause(s);

5. An action plan will be devised for the mediation of the problem;

6. Increased monitoring/sampling frequencies to monitor the situation and see if prescribed mitigation is appropriate and effective;

7. Inspect and monitor any modification to infrastructure; and

8. Review, report and make changes to the AMP.

7.17.1.8 Annual Review and Annual Reporting

An annual review of the AMP will be performed and any necessary amendments or updates to the AMP elements will be made. The annual review will include a review of the relevant monitored data and AMP elements.

Updates, amendments, performance thresholds crossed, and trigger(s) activated will be provided to the appropriate governmental (including SFN) organizations as required and will be part of the annual report.

8 Reclamation and Closure Schedule and Execution Strategy

The schedule for reclamation and closure activities has used as its foundation the operational development schedules. Progressive reclamation of completed facilities has been integrated into the schedule where possible. Actual scheduling for reclamation activities will depend on the timing and completion of the mining and waste placement activities. Figure 8-1 presents the conceptual closure and reclamation schedule.

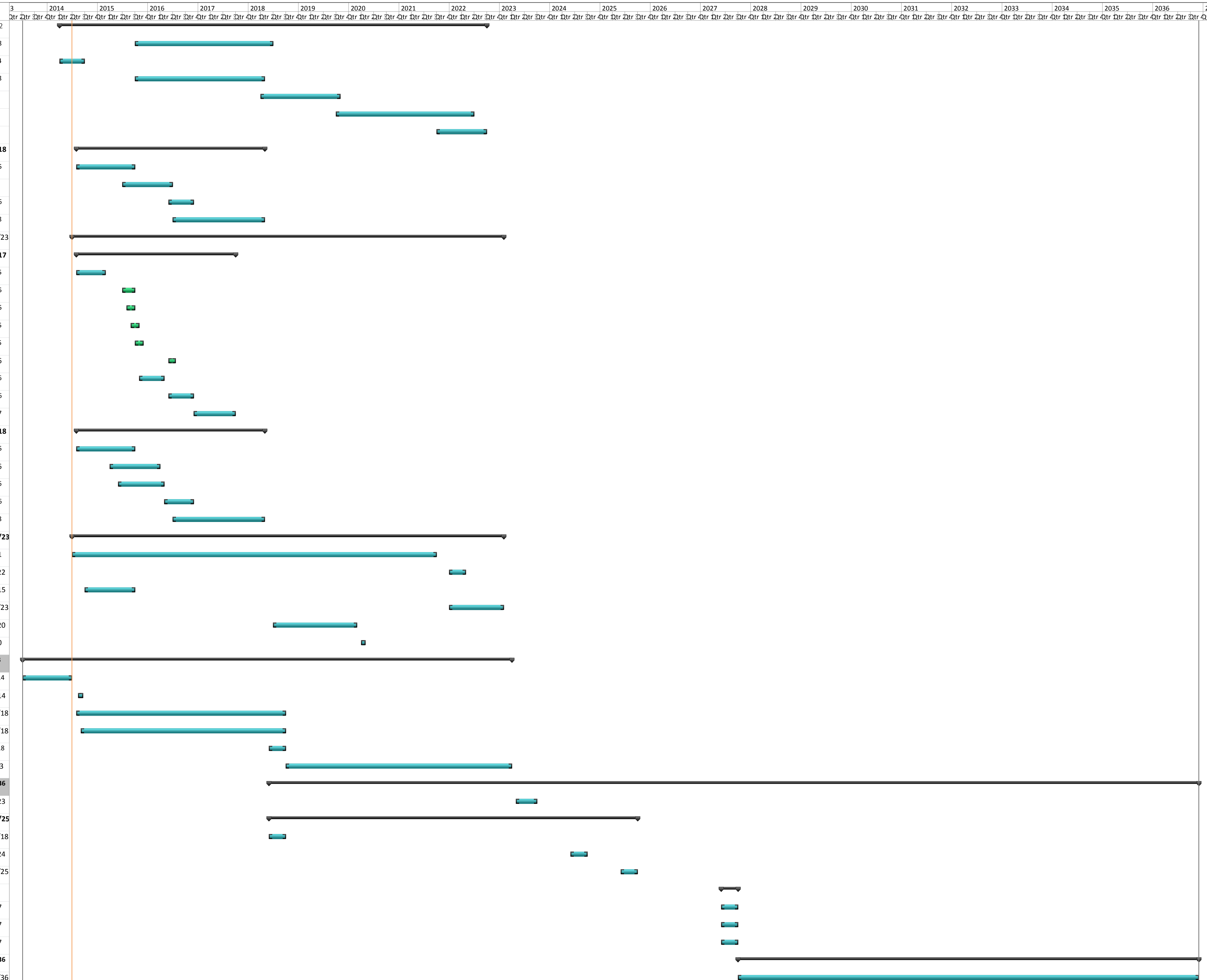
The closure phase of the Minto mine will commence with the cessation of economic mining of the open pit and the milling of ores and stockpiles. Once all mineable ore reserves have been processed, the mill and concentrator will be flushed and the tailings management facility (TMF) will be decommissioned. During the active decommissioning phase which is expected to last approximately 3 years, the number of personnel required will vary depending on site activities; however it is expected that as major decommissioning and reclamation tasks are completed the number of site personnel required will decline.

It is expected that a Water Use Licence or amendment will be required for the decommissioning phase of the operation as water use will continue on a limited basis and wastewater will be released from the WSPD in a controlled fashion, either treated actively or passively depending on the monitoring results. Decommissioning of the Big Creek Bridge along the main access road will be subject to community consultation and this activity may also require a Water Use Licence. The continued need for a Water Use Licence following the decommissioning phase will be dependent on site conditions, performance of closure measures in achieving stated objectives and legislated requirements. Post-closure management and monitoring of the site will be guided to some extent by the Water Use Licence, quartz mining licence or other permit requirements, the performance of physical structures remaining on site and the ability of achieving and demonstrating long term compliance with existing waste discharge standards.

Once overall closure performance has been demonstrated for all aspects of decommissioning, the necessity of maintaining licences or permits will be re-examined. At that point a Certificate of Closure, under the Quartz Mining Act would be requested.

Figure 8-1. Conceptual Reclamation and Closure Schedule.

ID	Task Mode	Task Name	Duration	Start	Finish
1		Underground Mining	2219 days	Tue 01/04/14	Sat 01/10/22
2		Area 118 (Phase IV) UG Mining	718 days	Thu 01/10/15	Sun 01/07/18
3		Area 2 (Phase IV) UG Mining	131 days	Tue 01/04/14	Tue 30/09/14
4		Area 2 (Phase IV) UG Mining continued	674 days	Thu 01/10/15	Tue 01/05/18
5		Minto East UG Mining	416 days	Sun 01/04/18	Fri 01/11/19
6		Copper Keel UG Mining	719 days	Tue 01/10/19	Fri 01/07/22
7		Wildfire UG Mining	262 days	Fri 01/10/21	Sat 01/10/22
8		**Surface Mining**	**978 days**	**Fri 01/08/14**	**Tue 01/05/18**
9		Minto North	305 days	Fri 01/08/14	Thu 01/10/15
10		Area 2 Stage 3	263 days	Wed 01/07/15	Fri 01/07/16
11		Ridgetop South	132 days	Wed 01/06/16	Thu 01/12/16
12		Ridgetop North	478 days	Fri 01/07/16	Tue 01/05/18
13		Waste Placement	2243 days	Mon 30/06/14	Wed 01/02/23
14		**Overburden Placement**	**826 days**	**Fri 01/08/14**	**Sun 01/10/17**
15		Main Waste Dump Expansion - Overburden	152 days	Fri 01/08/14	Sun 01/03/15
16		Southwest Dump - Low-grade Waste Area Cover	67 days	Wed 01/07/15	Thu 01/10/15
17		Southwest Dump - Mid-grade Waste Area Cover - Overburden	45 days	Sat 01/08/15	Thu 01/10/15
18		Main Waste Dump Expansion Cover - Overburden	45 days	Tue 01/09/15	Sun 01/11/15
19		DSTSF Cover	44 days	Thu 01/10/15	Tue 01/12/15
20		MVFE Stage 2 Cover	38 days	Wed 01/06/16	Fri 22/07/16
21		Area 118 Backfill Dump - Overburden	132 days	Sun 01/11/15	Sun 01/05/16
22		Main Pit Dump - Overburden	132 days	Wed 01/06/16	Thu 01/12/16
23		Ridgetop South Backfill Dump - Overburden	218 days	Thu 01/12/16	Sun 01/10/17
24		**Waste Rock Placement**	**978 days**	**Fri 01/08/14**	**Tue 01/05/18**
25		Main Waste Dump Expansion - Waste Rock	305 days	Fri 01/08/14	Thu 01/10/15
26		Main Dam Construction	263 days	Wed 01/04/15	Fri 01/04/16
27		Mill Valley Fill Extension Stage 2 - Waste Rock	241 days	Mon 01/06/15	Sun 01/05/16
28		Main Pit Dump - Waste Rock	155 days	Sun 01/05/16	Thu 01/12/16
29		Ridgetop Waste Dump - Waste Rock	478 days	Fri 01/07/16	Tue 01/05/18
30		**Tailings Placement**	**2243 days**	**Mon 30/06/14**	**Wed 01/02/23**
31		Main Pit Tailings	1895 days	Mon 30/06/14	Fri 01/10/21
32		Main Pit cover placement	87 days	Sat 01/01/22	Sun 01/05/22
33		Area 2 S2 Tailings	262 days	Wed 01/10/14	Thu 01/10/15
34		Area 2 S3 Tailings	284 days	Sat 01/01/22	Wed 01/02/23
35		Ridgetop North Tailings	437 days	Sun 01/07/18	Sun 01/03/20
36		Ridgetop North cover placement	23 days	Wed 01/04/20	Fri 01/05/20
37		Passive Treatment Research	**2540 days**	**Sat 06/07/13**	**Sat 01/04/23**
38		CWTS pilot scale trials	257 days	Sat 06/07/13	Mon 30/06/14
39		CWTS demonstration scale construction	25 days	Fri 15/08/14	Thu 18/09/14
40		Bioreactor site/lab trials	1087 days	Fri 01/08/14	Mon 01/10/18
41		Operation/Monitoring of demo scale CWTS	1064 days	Wed 03/09/14	Mon 01/10/18
42		Final Design of all Passive Treament Systems	87 days	Fri 01/06/18	Mon 01/10/18
43		Continued monitoring of site trials/demonstrations to optimize design	1176 days	Mon 01/10/18	Sat 01/04/23
44		Active Closure and Decommissioning	**4827 days**	**Fri 01/06/18**	**Mon 01/12/36**
45		Mill and Tailings Facility Decommissioning	111 days	Mon 01/05/23	Sun 01/10/23
46		**Water Management**	**1914 days**	**Fri 01/06/18**	**Wed 01/10/25**
47		Ditch 200/300 Construction	87 days	Fri 01/06/18	Mon 01/10/18
48		Ditch 400 Construction	88 days	Sat 01/06/24	Tue 01/10/24
49		Construction of Passive Treatment Systems	89 days	Sun 01/06/25	Wed 01/10/25
50		Post Closure 1 - Transitional Period	**89 days**	**Tue 01/06/27**	**Fri 01/10/27**
51		Decommissioning of Water Treatment Plant	89 days	Tue 01/06/27	Fri 01/10/27
52		Removal of Water Storage Pond Dam	89 days	Tue 01/06/27	Fri 01/10/27
53		Monitoring	89 days	Tue 01/06/27	Fri 01/10/27
54		Post Closure 2	**2392 days**	**Fri 01/10/27**	**Mon 01/12/36**
55		Monitoring	2392 days	Fri 01/10/27	Mon 01/12/36



9 Reclamation Cost Estimate and Construction Methods

9.1 Background

Cost estimation for implementation of the proposed closure measures is the basis for establishing the financial security that will be required on the project. The Phase V/VI closure cost estimate has been prepared in accordance with recent costing guidance from YG EMR in the document Reclamation and Closure Planning for Quartz Mining Projects: Plan Requirements and Closure Costing Guidance (YG, August 2013).

Cost escalation (2% annual) has been applied to the period of active implementation of the RCP whereas the longer term costs associated with post-closure monitoring and maintenance (Post-Closure I and Post-Closure II) have been calculated as net present value (NPV) based on an assumed real rate of return of 2.5%.

The current costing calculation has applied 18% Indirect cost plus an additional 7% of base reclamation costs under the heading of "Project Management and Engineering" within individual costing tables for a combined total of approximately 25% Indirect Costs. This is consistent with the contingency allowance that was previously adopted for the v4.1 closure costing iteration.

A contingency allowance of 12% has been included in the closure cost calculations. This is a slight reduction from the previously adopted 15% contingency allowance used in the Phase IV closure costing calculations. The contingency allowance is intended to account for uncertainty associated with implementation of the approved closure plan due to imperfectly defined field conditions, variation to assumptions and other difficult to predict factors. The justification for this downward adjustment of contingency allowance is based on the significant progress that has been made in addressing many of the areas of technical uncertainly that were previously cited as justification for 15% contingency. Areas where significant progress has been made to reduce technical uncertainty relative to the previous closure costing iteration include:

- Third party geotechnical review of critical site features;
- Commitment to constructing MVFE Stage 2 to stabilize the DSTSF;
- Robust water management within the Main Pit and Area 2 Pit;
- Establishment of numerical water quality objectives; and
- Development of a detailed WQ AMP.

The costing has been prepared to provide an estimate of closure plan implementation for three scenarios: Year 0, Year 2 (June 2016) and Year 9 (End of Mine Life for Phase V/VI). This estimation is based on the final extent of disturbance for each of the infrastructure units described in this report. Reclamation Units and associated areas of disturbance for Year 0, EOM and Year 2 closure scenarios are discussed below and shown in plan on annotated satellite imagery.

The costs have been developed using a combination of current unit rates for available Yukon contractors' equipment, and custom unit rates specific to the project. Custom haul rates were updated in September of 2013 with input from the mine construction heavy equipment contractor and based on their experience on site during the construction activities.

All unit rates, underwent a thorough review and rationalization in April of 2014, incorporating input from technical reviewers, in connection with established closure costs for Phase IV RCP closure costing. These unit rates are considered well vetted and still appropriate. Costs have been applied to levels of effort in sufficient detail to allow thorough scrutiny by the reader. As such, equipment rates have been used where the level of effort is well understood, and in other cases, unit area or volume rates have been employed.

9.2 Closure Costing calculations – Year 0 closure scenario

The starting point for the Year 0 closure costing was developed for the Phase IV RCP. The Reclamation Units for a Year 0 closure scenario along with a table of areas of disturbance are presented on Figure 9-1. The Year 0 costing has been revisited to reflect several recent developments that have significant cost implications. The most significant updates to the Year 0 costing include:

- Requirement for additional fill in the Mill Valley Fill to further stabilize the DSTSF. Third Party reviewers recently expressed the opinion that the MVFE is warranted and it has been incorporated into the Phase V/VI closure planning. The MVFE will require approximately 1.67 M-m^3 of fill. If this was required to be constructed at Year 0, the waste rock would need to come from either the SWD and/or MWD, resulting in a relatively long haul distance ($4.25/$m^3$ hauled and placed).
- Modification of Ditch 400 and Ditch 450 cross-section to incorporate an impervious liner (bituminous geomembrane) and associated bedding layers. This design modification was made in response to feedback from reviewers and provides the flexibility to isolate surface flow exiting the open pits from seepage from the DSTSF. It should be noted that the alignment of the Ditch 400 and 450 ditches varies from that proposed under a Year 2 and EOM closure scenario because in a Year 0 closure scenario there would be no spillway routing Main Pit flows through Area 2 Pit and hence the need for outflow channels from both the Main Pit and Area 2 Pit. Refer to Figure 9-2 for Year 0 diversion ditch alignments.
- Additionally, passive treatment is now being treated as a base case water treatment technology. Passive treatment was previously considered to be part of the AMP with funding allocated for a comprehensive reclamation research program which included pilot testing and proof of concept trials. The specifics of optimal passive treatment are still being evaluated in connection with the RRP and will continue to evolve over the next several years. The funding for reclamation research remains unchanged, but an additional $1M capital cost and annual operating and maintenance costs of $50,000 in years 5 through 15 has been allocated for construction of full scale passive treatment (CWTS). It is assumed that passive treatment systems will be constructed in the final year of Active Closure.

The tables of estimated costs to implement the decommissioning and reclamation measures for the Year 0 Closure Scenario described in this report are presented in Tables 9.1-1 through 9.1-16 (Appended below):

- Table 9.1-1 provides a summary of cost estimates prepared for End of Mine;
- Table 9.1-2 contains a summary of the unit rates used in the calculations;
- Table 9.1-3 to Table 9.1-12 provide closure cost estimates for the specific site development reclamation components;
- Table 9.1-13 and 9.1-14 provide closure cost estimates for revegetation activities, and supporting studies & reclamation research respectively;

- Table 9.1-15 outlines costs associated with the site management during closure implementation and presents post-closure costs for compliance monitoring and maintenance for the entire projected 15 year active closure and post-closure monitoring life; and
- Table 9.1-16 presents the calculation of Net Present Value (NPV) for water treatment, compliance monitoring and maintenance, and reclamation research.

The Year 0 closure implementation costs are estimated at $32,133,936. The post closure care, maintenance and monitoring costs are estimated with a NPV of $12,435,136, which includes 10 years of active water treatment, and 11 years of passive treatment (6 years of overlap) which is funded by a $1M capital cost allowance and $50,000 annually for operation and maintenance costs. **The total Year 0 financial security is estimated to be $49,917,361**.

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FIGURE 9-1

CURRENT MINE LAYOUT COST ESTIMATE RECLAMATION UNITS

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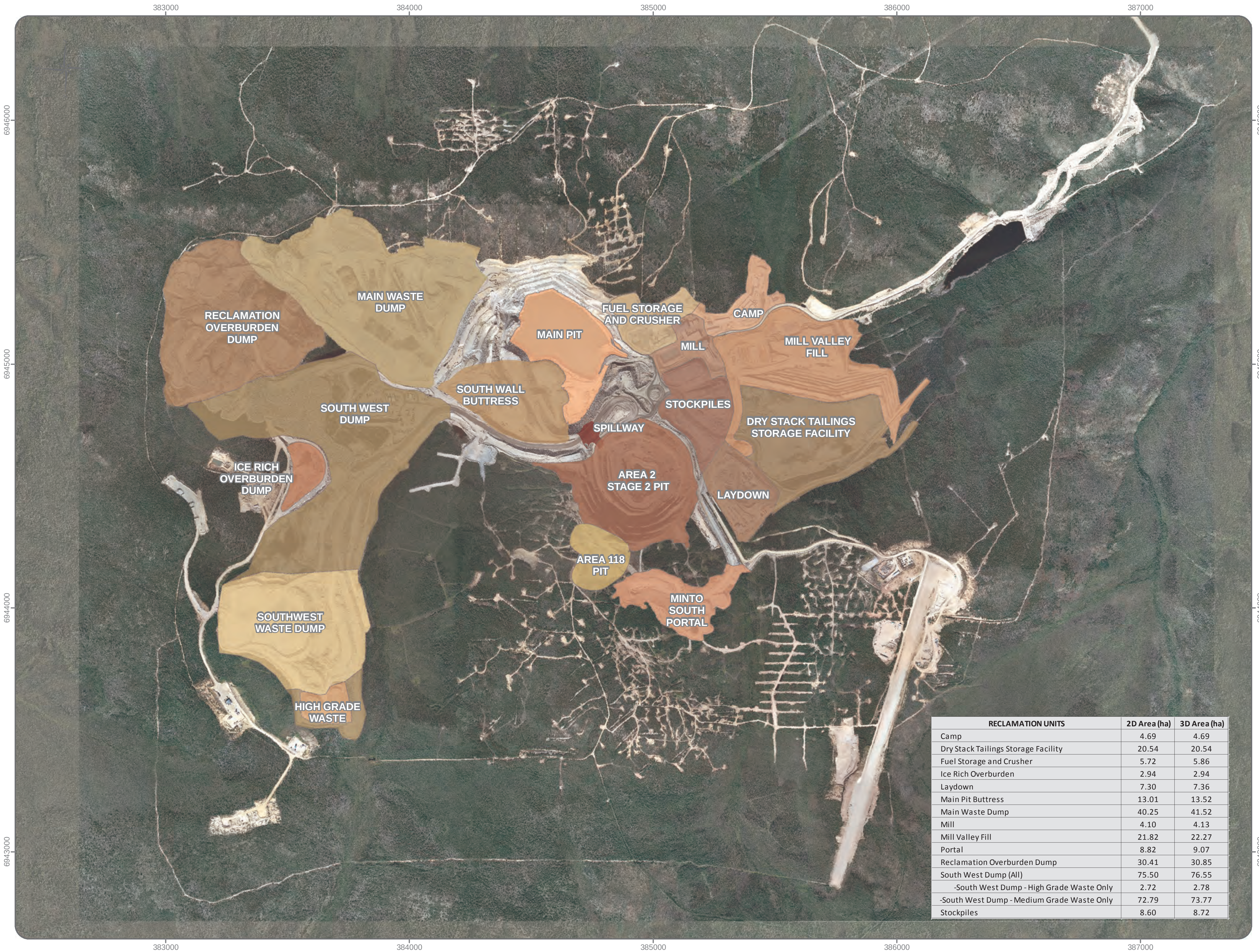

RECLAMATION UNITS	2D Area (ha)	3D Area (ha)
Camp	4.69	4.69
Dry Stack Tailings Storage Facility	20.54	20.54
Fuel Storage and Crusher	5.72	5.86
Ice Rich Overburden	2.94	2.94
Laydown	7.30	7.36
Main Pit Buttress	13.01	13.52
Main Waste Dump	40.25	41.52
Mill	4.10	4.13
Mill Valley Fill	21.82	22.27
Portal	8.82	9.07
Reclamation Overburden Dump	30.41	30.85
South West Dump (All)	75.50	76.55
-South West Dump - High Grade Waste Only	2.72	2.78
-South West Dump - Medium Grade Waste Only	72.79	73.77
Stockpiles	8.60	8.72

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ACCESS

Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11th 2013

Datum: NAD 83 Projection: UTM Zone 8N

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FIGURE 9 - 2

YEAR 0 CLOSURE WATER MANAGEMENT LAYOUT

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- Pit Lake
- South Diversion Ditch/100
- Existing Diversion Ditch
- Proposed Diversion Structure (Primary)
- Tailings Diversion Ditch

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Aerial imagery obtained from Challenger Geomatics. Imagery acquired August 11 th 2013.
Site contours derived from 2013 aerial imagery and edited by Capstone to show the Phase V/VI feature and their coutours.

Hydrology data provided by Minto Explorations Ltd, May 2009 and edited by ACG.

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9.3 CLOSURE COSTING CALCULATIONS – END OF MINE LIFE (YEAR 9)

Due to the similarities in closure costing requirements between Year 2 and EOM, both costing scenarios have been presented on the same series of tables. The Reclamation Units for an EOM (Year 9) closure scenario along with a table of areas of disturbance are presented on Figure 9-3. The tables of estimated costs to implement the decommissioning and reclamation measures for both the Year 2 and EOM Closure Scenarios described in this report are presented Tables 9.2-1 through 9.2-17 (appended below).

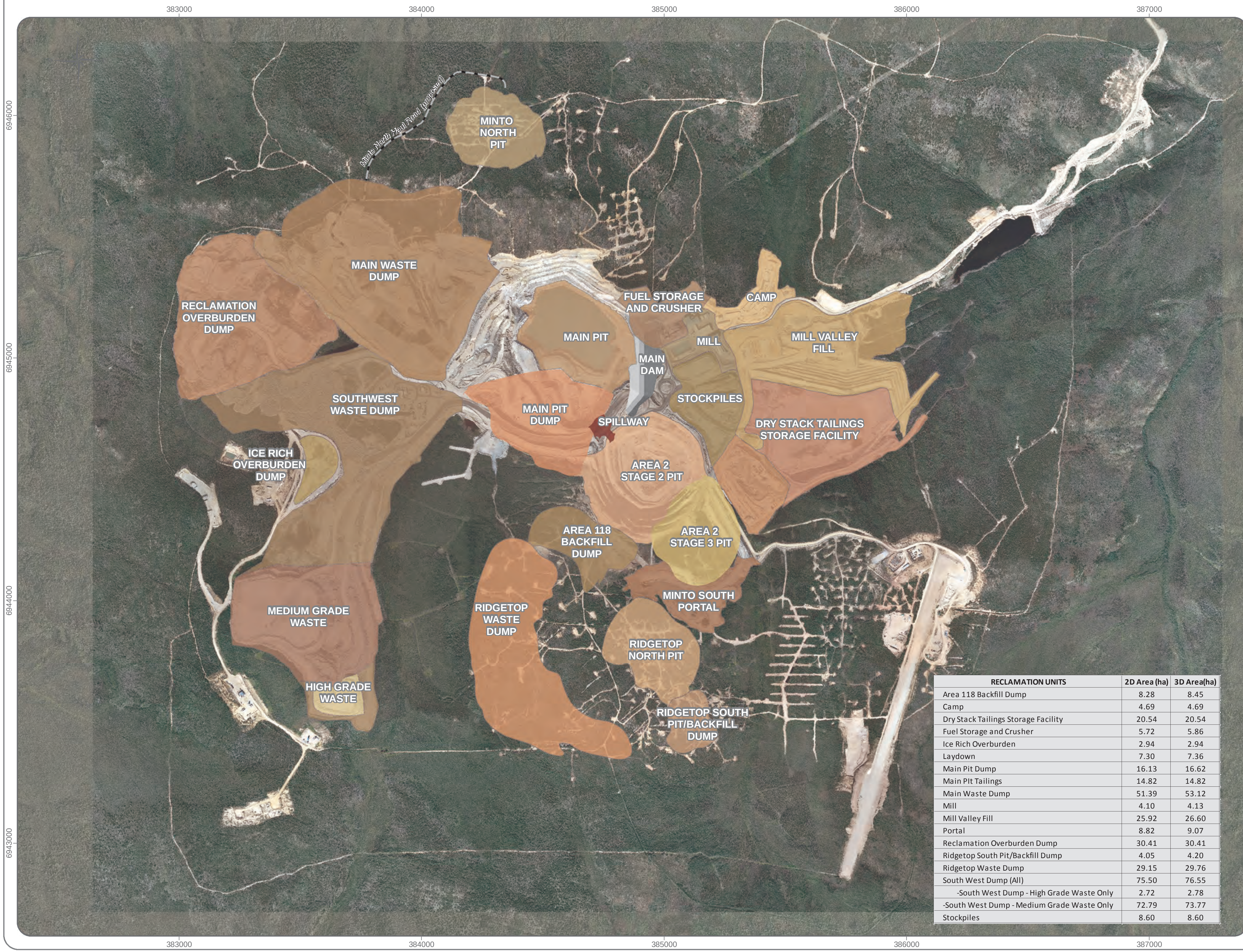
- Table 9.2-1 provides a summary of cost estimates prepared for End of Mine, as well as Year 0 and Year 2 closure scenarios;
- Table 9.2-2 contains a summary of the unit rates used in the calculations;
- Table 9.2-3 to Table 9.2-12 provide closure cost estimates for the specific site development reclamation components;
- Table 9.2-13 and 9.2-14 provide closure cost estimates for revegetation activities, and supporting studies & reclamation research respectively;
- Table 9.2-15 outlines costs associated with the site management during closure implementation and presents post-closure costs for compliance monitoring and maintenance for the entire projected 15 year active closure and post-closure monitoring life; and
- Table 9.2-16 and 9.2-17 present the calculation of Net Present Value (NPV) for water treatment, compliance monitoring and maintenance, and reclamation research.

The closure measures presented in this plan have been prepared at a preliminary level of engineering design. It is recognized that a certain level of detailed engineering will be required for major closure activities including, dam removal, and conveyance or diversion ditches. The approach is to ensure that closure measures are sound and have undergone review before detailed engineering is undertaken. Detailed engineering is planned for major works prior to implementation, and where required the estimate costs for the development of these designs is included in the financial assurance costing estimation.

Construction of the Ditch 200 channel will require an excavation of the haul road of approximately 25,000 m^3 with the excavated material expected to be placed at the toe of the Southwest Dump. Equipment requirements for this excavation are based on operational capabilities of the listed equipment and assumes the use of a single excavator loading to two haul trucks. Bucket volume, load rates, haul distances and speeds, and utilization were all considered in the estimation. Requirements for the excavation of the Area 2 Pit outlet were similarly estimated.

The closure plan costing allows for 8-years of Active Treatment during the Active Closure and the Post-Closure I period. Passive water treatment systems are assumed to be constructed in the final year of the Active Closure period and operated through to the end of Post-Closure II, after which time it is anticipated that all site conditions will have stabilized such that mine water will be suitable for discharge without the need for additional treatment. The closure costing also funds the ongoing reclamation research into passive/semi-passive supplemental treatment technologies (i.e., CWTS, bioreactors and batch treatment of open-pits).

The EOM closure implementation costs are estimated at $14,917,364. The post closure care, maintenance and monitoring costs are estimated with a NPV or $8,161,867, which includes 8 years of active water treatment, and 11 years of passive treatment (6 years of overlap) which is funded by a $1M capital cost and $50,000 annually for operation and maintenance costs. **The total EOM financial security is estimated to be $25,848,738**.



RECLAMATION UNITS	2D Area (ha)	3D Area(ha)
Area 118 Backfill Dump	8.28	8.45
Camp	4.69	4.69
Dry Stack Tailings Storage Facility	20.54	20.54
Fuel Storage and Crusher	5.72	5.86
Ice Rich Overburden	2.94	2.94
Laydown	7.30	7.36
Main Pit Dump	16.13	16.62
Main PIt Tailings	14.82	14.82
Main Waste Dump	51.39	53.12
Mill	4.10	4.13
Mill Valley Fill	25.92	26.60
Portal	8.82	9.07
Reclamation Overburden Dump	30.41	30.41
Ridgetop South Pit/Backfill Dump	4.05	4.20
Ridgetop Waste Dump	29.15	29.76
South West Dump (All)	75.50	76.55
-South West Dump - High Grade Waste Only	2.72	2.78
-South West Dump - Medium Grade Waste Only	72.79	73.77
Stockpiles	8.60	8.60

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FIGURE 9-3

END OF MINE LIFE LAYOUT COST ESTIMATES RECLAMATION UNITS

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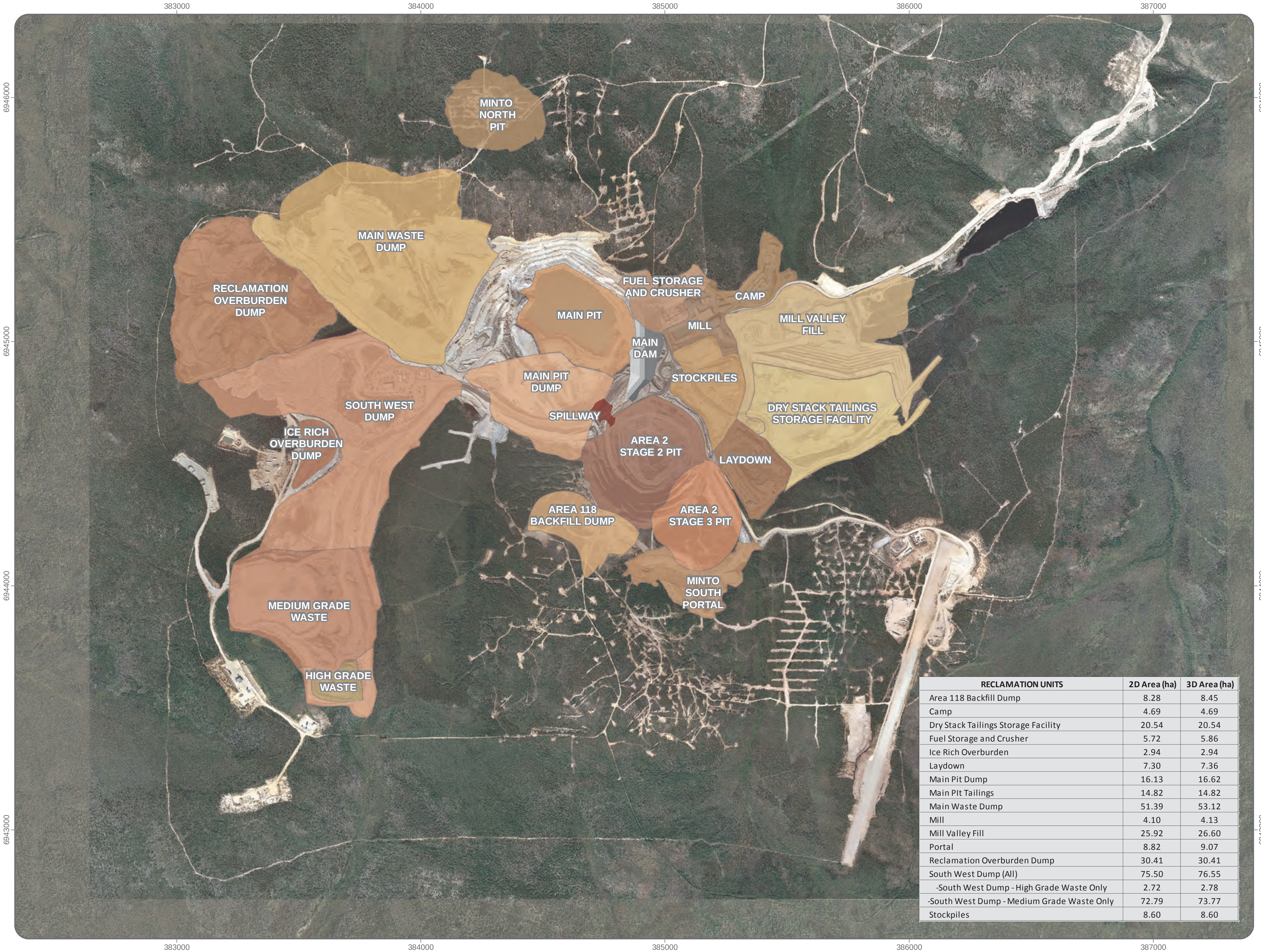
9.4 CLOSURE COSTING CALCULATIONS -YEAR 2 CLOSURE SCENARIO

The Year 2 costing scenario has been developed using the End of Mine Life closure costing at the starting point and then identifying aspects of the mine development and/or stage of closure that differ and adjusting those specific costs accordingly. For this costing exercise Year 2 is taken as June 2016. A snapshot of the mine development at this time is presented on Figure 9-4. Using June 2016 as the costing basis provides a relatively clean basis for cost comparison as several significant closure components will have been completed while other significant mine development aspects will not have been started. Some of the significant closure aspects require modified closure planning include:

- Ridgetop North and South Pits will not be developed by Year 2;
- Closure of the Main Pit Dump will be required for the Year 2 costing scenario, however it will be completed by EOM;
- The quantity of secondary ditching required is greater in the Year 2 costing scenario, however by EOM all waste dumps will be reclaimed with the exception of those associated with the Ridgetop mining activities; and
- The Minto North Pit will require reclamation in the Year 2 costing scenario but will be reclaimed by EOM.

The other significant difference between the End of Mine (Year 9) cost scenario and the Year 2 scenario is in the calculation of NPV. The two scenarios present the same amount of years of care, maintenance, and monitoring, however the Year 2 scenario takes place closer to present day and therefore less of a discount is realized at the time of closure.

The Year 2 closure implementation costs are estimated at $13,018,022. The post closure care, maintenance and monitoring costs are estimated with a NPV or $10,414,933, which includes 8 years of active water treatment, and 11 years of passive treatment (6 years of overlap) which is funded by a $1M capital cost and $50,000 annually for operation and maintenance costs. **The total financial security estimate for the Year 2 closure scenario is $26,244,910.**



RECLAMATION UNITS	2D Area (ha)	3D Area (ha)
Area 118 Backfill Dump	8.28	8.45
Camp	4.69	4.69
Dry Stack Tailings Storage Facility	20.54	20.54
Fuel Storage and Crusher	5.72	5.86
Ice Rich Overburden	2.94	2.94
Laydown	7.30	7.36
Main Pit Dump	16.13	16.62
Main PIt Tailings	14.82	14.82
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Mill Valley Fill	25.92	26.60
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South West Dump (All)	75.50	76.55
-South West Dump - High Grade Waste Only	2.72	2.78
-South West Dump - Medium Grade Waste Only	72.79	73.77
Stockpiles	8.60	8.60

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FIGURE 9-4

YEAR 2 LAYOUT COST ESTIMATE RECLAMATION UNITS

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9.5 Financial Security Updates

YG has developed a policy respecting mine site reclamation and closure with one of the stated principles being "adequate security must be provided by the project proponent at each stage of mine development reclamation and closure consistent with the requirements of relevant legislation and Yukon financial security guidelines" (YG, 2006). Typically requirements for mine security bonding are conditions of the Type A Water Use Licence or Yukon Quartz Mining Production Licence. The latest YG closure costing guidance is provided in "Reclamation and Closure Planning for Quartz Mining Projects: Plan requirements and closure costing guidance (YG, August 2013). This guidance document was developed jointly by EMR and the Yukon Water Board and describes the requirements for RCPs to meet the needs for both QML and WL processes.

Minto intends to adhere to the principles for mine reclamation and closure and security requirements in accordance with YG's policy which identifies that the security estimate be updated every second year.

Minto and YG will jointly determine a schedule for security payment scheduling.

Minto will discuss road decommissioning requirements with SFN, which will ultimately refine the final closure costs associated with the access road decommissioning.

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Personal Communication

Hegel, Troy. Environment Yukon, Caribou, Sheep, & Goat Biologist