Minto Mine

Phase V/VI Adaptive Management Plan

November 2014

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Minto Mine
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1 Introduction

1.1 Overview

Minto Explorations Ltd. (Minto), a wholly owned subsidiary of Capstone Mining Corp. (Capstone), owns and operates the Minto copper mine. Minto Mine is located within Selkirk First Nation (SFN) Category-A Settlement Land (Parcel R-6A), and is approximately 240 km northwest of Whitehorse, Yukon Territory. The Minto mine commenced commercial operations in October 2007.

The Yukon Government's Decision Document (Yukon Government, 2014) following the YESAA review of Minto's Phase V/VI project proposal (file # 2013-0100, (Minto Explorations Ltd., 2013)) requires an Adaptive Management Plan (AMP) for the mine operations. AMPs are tools used to address uncertainty or conditions beyond those anticipated in mining operations. AMPs outline a range of possible but unexpected outcomes and the responses that will be undertaken to curb possible negative impacts associated with these unexpected situations.

Mining activities are highly managed operations, with very prescriptive and detailed management plans required for both operational control and regulatory approval. More mature mines such as Minto have management plans which benefit from the operational experience at the site, and uncertainty in the range of conditions expected is reduced through this operational experience.

Minto has developed a number of operational management plans which describe the management and response actions for expected conditions at the site. These plans currently include:

- Solid Waste Management Plan;
- Environmental Monitoring, Surveillance, Reporting Plan;
- Wildlife Protection Plan;
- Spill Contingency Plan;
- Sediment and Erosion Control Plan;
- Mine Development and Operations Plan;
- Underground Mine Development and Operations Plan;
- Mill Operations Plan;
- Water Management Plan;
- Tailings Management Plan;
- Waste Rock and Overburden Management Plan;
- Emergency Response Plan;
- Heritage Resources Protection Plan; and
- Reclamation and Closure Plan

This AMP is intended to provide a framework for responses to conditions beyond those expected and identified in these decision-based management plans. Consequently, this AMP addresses a limited range of components.

1.2 Adaptive Management Planning

Adaptive management is an approach to environmental management that is appropriate when a mitigation measure may not function as intended or when broad-scale environmental change is possible. 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. (Eberhard, et al., 2009) 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.

1.3 Adaptive Management Plan 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 operational phase of Minto's Phase V/VI expansion 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.

1.4 Adaptive Management Plan Approach

In addition to the conclusions drawn from research, the approach presented in this AMP 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)

In addition to the guidance provided by the Environmental Code of Practice for Metal Mines, the AMP serves to meet the Yukon Government's Decision Document following the YESAA review of Minto's Phase V/VI project proposal which identifies some areas that an AMP for operations should be prepared to address including "*water quality, physical stability, covers, water treatment, and water management;".* Though some covers are anticipated to be placed as part of progressive reclamation, they are not an operational feature and therefore have not been included in this AMP.

1.4.1 AMP Components

The following AMP components have been identified as having the potential for unexpected conditions during the operational period for which the Operational Management Plans may not provide adequate mitigation against potential effects to the environment or human health and safety:

- Water quantity;
- Water quality;
- Physical Stability; and

The specific AMP framework for these components is described in subsequent sections.

1.4.2 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 as illustrated in Figure 1-1. The common elements are:

1. Description of the component

   - *Description* - description and understanding of the component leads to risk narrative and specific performance thresholds.
   - *Risk Narrative* describe the possible environmental impacts and environmental conditions that implementation of the AMP will prevent.

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 describes the actions to be implemented if specific performance thresholds are crossed. They are provided in the following categories:

   a) Notification
   b) Review
   c) Evaluation
   d) Action

4. Annual Reporting and Review

   Annual Reporting 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. 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.

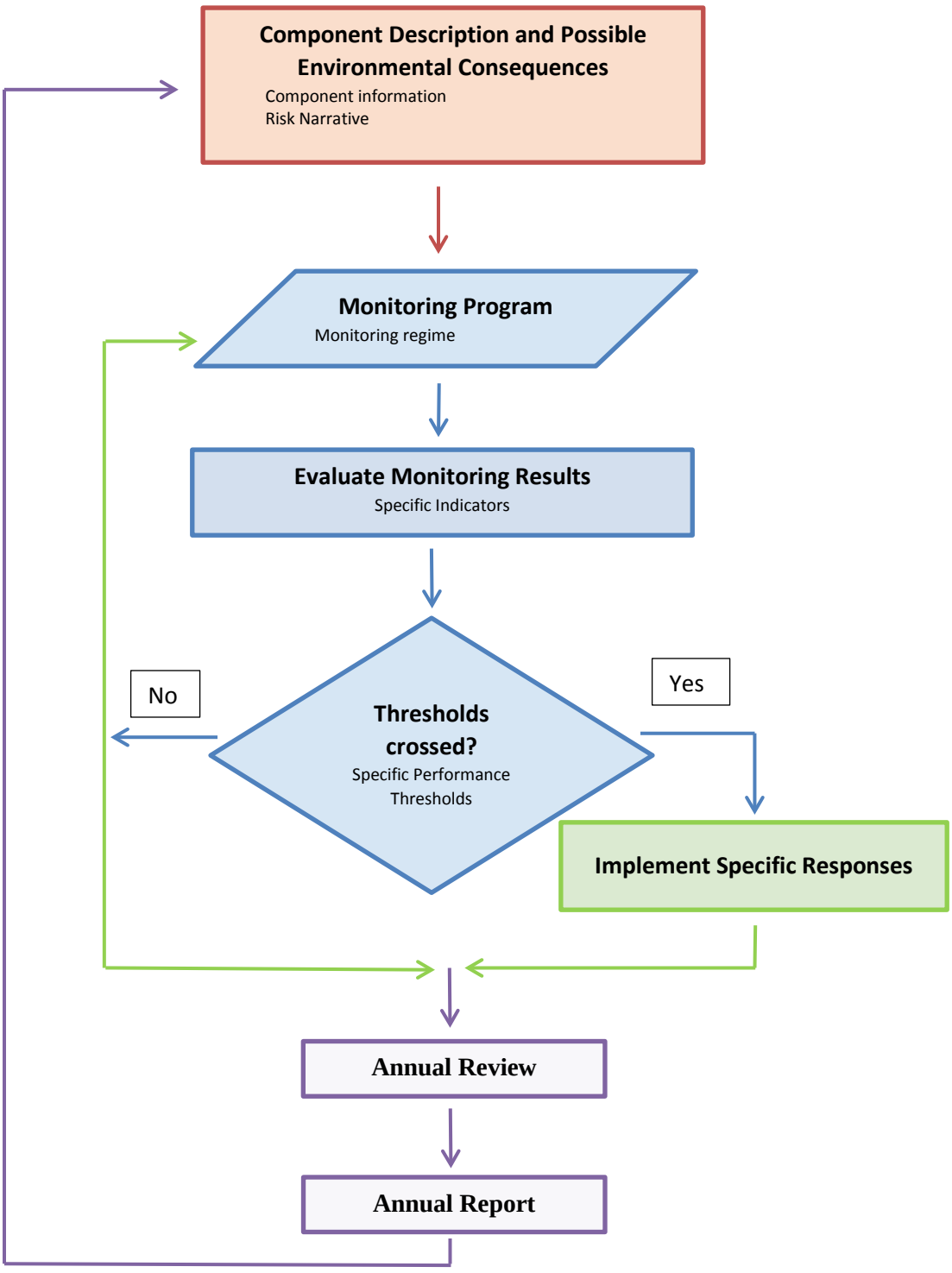

Figure 1-1: Sequential Components of the AMP (Adapted from AECOM 2010)

2 Adaptive Management Plans for Mine Components

2.1 Surface Water Quality

2.1.1 Description

Station W50 (close to station W3 – MMER compliance point) is considered the main control point on Minto Creek. It is also the last surface monitoring point on the mine site property and is considered a discharge compliance point under the current water licence. Additional key surface water monitoring locations up gradient of W50 and within the mine footprint are located at W16, W17, W15, W35, and W37.

As described in the Water Management Plan (Minto Explorations Ltd., 2014), Minto maintains substantial flexibility over the control and management of site runoff. The conveyance, storage and treatment systems are oriented to adequately manage site water to meet the current and proposed discharge standards at W50 (W3).

The W2 monitoring point near the Yukon River is beyond the final mine water discharge point controlled by Minto, and is subject to a broad range of influences from tributaries and catchment areas that are beyond Minto's control. However, Minto is committed to monitoring the water quality at W2 and responding to changing water quality in lower Minto Creek as appropriate. The AMP framework below compliments the operational water management plan at the mine site with a decision-based structure for ensuring that negative impacts to lower Minto Creek from mining activities are avoided.

2.1.2 Risk Narrative

Increase in contaminant concentrations from the mine causes adverse effects to aquatic resources in the receiving environment (lower Minto Creek) despite adherence to discharge standards.

2.1.3 Specific Indicators, Performance Thresholds and Responses

Indicators, performance thresholds and responses specific to water quality and the monitoring program are provided below in Table 2-1. Specific thresholds are identified in Tables 2-2 and 2-3. Thresholds which use Water Quality Objectives (WQOs) are based on proposed WQOs in Minto's Phase V/VI Water Use Licence Application. In some cases the AMP specific threshold has been refined to be based on observed conditions at the time of sampling, as opposed to a statistic from previous sampling data (i.e. dissolved cadmium WQO/threshold calculated using observed hardness.)

Table 2-1: Specific Indicators, Performance Thresholds and Responses for Surface Water Quality

<table>
<tr><th>Specific Indicators</th><th>Specific Performance Thresholds</th><th>Specific Responses</th></tr>
<tr><td rowspan="3">Aqueous Concentrations at Station W2 for the following parameters with water quality objectives

• Dissolved Aluminum
• Dissolved Chromium
• Dissolved Cadmium
• Dissolved Copper
• Dissolved Selenium
• NO_3-N
• NO_2-N
• NH_4-N

(See Table 2-2 below for specific threshold values)

Aqueous Concentrations at Station W2 for the following parameters without water quality objectives:

• Dissolved Iron
• Total Arsenic
• Total Molybdenum
• Total Nickel
• Total Lead
• Total Zinc

(See Table 2-3 below for specific threshold values)</td><td>Specific Threshold 1 (for parameters with WQO – see Table 2-2)

• Exceedance of predicted expected case maximum for dissolved concentrations at W2.</td><td>Notification
• Minto Management
• Include in scheduled Water Use Licence reporting
Review
• Follow QA/QC investigative protocol:
o Review laboratory QA/QC report
o Validate original result, or re-run sample if a laboratory error is indicated
Evaluation
• Compare with W3 results
Action
• If comparison with W3 result indicates mine loadings are responsible for exceedance then:
o Re-sample both W2 and W3 within 24 hours of original sample result review
o Actions will continue until performance thresholds are no longer exceeded.</td></tr>
<tr><td>Specific Threshold 1 (for parameters without WQO – see Table 2-3)

• Exceedance of predicted reasonable worst case maximum concentrations at W2</td><td>Notification
• Notify management and include in monthly reporting
Review
• Review lab QA/QC, validate original result
Evaluation
• Compare with W3 result
Action
• If comparison indicates mine loading responsible and verification confirms result, then resample both W2 and W3, and initiate options assessment for WQO development</td></tr>
<tr><td>Specific Threshold 2 (for parameters with WQO – see Table 2-2)

• Exceedance of predicted expected case maximum for dissolved concentrations in 2 consecutive samples (scheduled or re-sample) where evaluation confirmed mine loading responsible for first exceedance</td><td>Notification
• Minto Management
• Include in scheduled Water Use Licence reporting
Review
• Follow QA/QC investigative protocol:
o Review laboratory QA/QC report
Validate original result, or re-run sample if a laboratory error is indicated Evaluation
• Compare with W3 results. If comparison with W3 result indicates that mine loadings are responsible for exceedance; and validation confirms original result, then:
o Evaluate causes for load contributions and develop investigation plan.
Action
• Implement investigation plan, including at a minimum:
o Re-sampling both W2 and W3 within 24 hours of original sample result review; and
o Site investigation of candidate load contributions.
• Review results of investigation and prepare recommendations if appropriate.
• Implement recommendations.
• Actions will continue until performance thresholds are no longer exceeded.</td></tr>
</table>

Specific Indicators	Specific Performance Thresholds	Specific Responses
	Specific Threshold 2 (for parameters without WQO – see Table 2-3) • Exceedance of CWQG concentration (or 95th percentile of background dissolved for Fe)	**Notification** • Notify management, SFN and YG, and include in monthly reporting **Review** • Review lab QA/QC, verify original result **Evaluation** • Compare with W3 results and resample W2 and W3 **Action** • If comparison with W3 result indicates mine loadings responsible for exceedance – and verification and resampling confirms original result – then: o Evaluate candidate causes for load contributions and develop investigation plan. o Increase monitoring frequency and implement investigation plan (including investigation of candidate loading sources and evaluation of potential effects to aquatic resources.) o Develop WQO for parameter in question and add to AMP. Manage as per other parameters with WQOs.
	Specific Threshold 3 • Exceedance of predicted **worst case** maximum for dissolved concentrations **OR** • WQO exceeded at W2 in a single sample	**Notification** • Minto Management, SFN, YG Inspector • Include in scheduled Water Use Licence reporting **Review** • Follow QA/QC investigative protocol o Review laboratory QA/QC report o Verify original result, or re-run sample if laboratory error indicated **Evaluation** • Compare with W3 results. If comparison with W3 result indicates mine loadings responsible for exceedance – and verification confirms original result – then: o Evaluate candidate causes for load contributions and develop investigation plan (or review/revise as appropriate) **Action** • Maintain weekly monitoring at W2 and W3 • Implement investigation plan, including any reviews/revisions, and at a minimum: o Re-sampling both W2 and W3 within **24 hours** of original sample result receipt; and o Site investigation of candidate load contributions; and o Evaluation of potential effects to aquatic resources (i.e. Compare to PNEC and apply BLM for D-Cu, invertebrate tissue for Se, compare with calculated acute guideline for D-Cd.) • Review results of investigation and prepare recommendations if appropriate • Implement recommendations • Actions will continue until performance thresholds are no longer exceeded.
	Specific Threshold 4 • Exceedance of predicted worst case maximum for dissolved concentrations in **2 consecutive samples (scheduled or re-sample)** where evaluation confirmed mine loading responsible for first exceedance	**Notification** • Minto Management, SFN, YG Inspector • Include in scheduled Water Use Licence reporting **Review** • Compare with W3 results

Specific Indicators	Specific Performance Thresholds	Specific Responses
		• Follow QA/QC investigative protocol **Evaluation** • Compare with W3 results. If comparison with W3 result indicates mine loadings responsible for exceedance; and verification confirms original result, then: o Evaluate candidate causes for load contributions and develop investigation plan (or review/revise as appropriate) o Provide investigation plan to SFN/YG Inspector • Evaluate potential for mine loadings to cause adverse effects to aquatic resources (i.e. redo BLM modeling) **Action** • Maintain weekly monitoring and collect samples at greater frequency as required • Develop investigation plan, including at a minimum: o Re-sampling both W2 and W3 within **24 hours** of original sample result review; and o Site investigation of load contributions o Evaluation of potential effects to aquatic resources • Review results of investigation and prepare recommendations • Implement recommendations arising from investigations. **If threshold consistently exceeded for 2 months**, then: • Develop revised forecast for near-term (12 months) water quality in Minto Creek. • Develop and implement any additional mitigation measures to reduce loading from mine site, if necessary, with appropriate regulatory approvals. • Actions will continue until performance thresholds are no longer exceeded.
	Specific Threshold 5 • WQO or PNEC exceeded in **2 consecutive samples (scheduled or re-sample)** where evaluation confirmed mine loading responsible for first exceedance	**Notification** • Minto Management, SFN, YG Inspector • Include in Water Use Licence reporting **Review** • Compare with W3 results • Follow QA/QC investigative protocol **Evaluation** • All evaluation measures for ST4 and: o Consider ongoing WQ monitoring results in development of investigation plan • Evaluate potential for mine loadings to cause adverse effects to aquatic resources (i.e. redo BLM modeling) **Action** • Maintain weekly monitoring and collect samples at greater frequency as required. • Develop investigation plan, including at a minimum: o Re-sampling both W2 and W3 within **24 hours** of original sample result review; and o Site investigation of load contributions o Evaluation of potential effects to aquatic resources • Review results of investigation and prepare recommendations • Implement recommendations arising from investigations. • Implement necessary reasonable and practical measures to reduce contaminant loading from mine to Minto Creek. • Suspend discharge from the mine until water quality is appropriate for discharge. • Actions will continue until performance thresholds are no longer exceeded.

Table 2-2: Specific Performance Thresholds for Surface Water Quality in Lower Minto Creek (W2) for Parameters with Water Quality Objectives

Water Quality Parameter	Expected Case Water Quality Predictions at W2 – Operational Period (mg/L)	Worst Case Water Quality Predictions at W2 – Operational Period (mg/L)	W2 Water Quality Objective (mg/L)
Dissolved Aluminum	0.057	0.077	0.1
Dissolved Chromium	0.00062	0.00082	0.001
Dissolved Cadmium	0.000027	0.000040	$e^{(0.762(_{ln}(_{hardness}))-6.07)}$
Dissolved Copper	0.0092	0.014	0.020
Dissolved Selenium	0.00055	0.00087	0.005
NO_3-N	1.1	5.1	10
NO_2-N	0.015*	0.057*	0.06
NH_4-N	0.057	0.25	0.25

*Prediction reduced by 75% to account for expected nitrification in Minto Creek.

Table 2-3: Specific Performance Thresholds for Surface Water Quality in Lower Minto Creek (W2) for Parameters without Water Quality Objectives

Water Quality Parameter	Worst Case Water Quality Predictions at W2 – Operational Period (mg/L)	Canadian Water Quality Guideline Concentration (mg/L)
Dissolved Iron	0.37	0.58*
Total Arsenic	0.00070	0.005
Total Molybdenum	0.0015	0.073
Total Nickel	0.0021	25 µg/L if if hardness (as CaCO3) ≤ 60 mg/L or unknown $e^{\{0.76[\ln(\text{hardness})]+1.06\}}$ if hardness > 60 mg/L and ≤ 180 mg/L 150 µg/L if hardness > 180 mg/L
Total Lead	0.00044	1 µg/L if hardness (as $CaCO_3$) ≤ 60 mg/L or unknown $e^{\{1.273[\ln(\text{hardness})]-4.705\}}$ if hardness > 60 mg/L and ≤ 180 mg/L 7 µg/L if hardness > 180 mg/L
Total Zinc	0.0065	0.03
Total Silver	0.000042	0.0001

*95th percentile of 2009 Background Water Quality (Minnow, 2009)

2.2 Water Management

2.2.1 Description

The Minto Mine site has a positive water balance. Therefore, it is necessary to release water from site from time to time to prevent accumulation of excess water. The primary objective of Minto's water management strategy is to ensure that water can be released from site in a way that protects the water quality in Minto Creek. Details concerning water management for Phase V/VI are provided in the Minto Mine Phase V/VI Water Management Plan as amended from time to time (Minto Explorations Ltd., 2014).

The strategy can be summarized as follows:

- Runoff from developed mine areas (mine water) will be collected and stored in the Main Pit Tailings Management Facility (MPTMF) and the Area 2 Pit Tailings Management Facility (A2PTMF). Mine water will be used for ore processing.
- The site water balance will be used to define mine water inventory targets and targets for volumes to be released to Minto Creek. Inventory targets will be defined on an annual basis and reported in the annual water balance update.
- To the extent possible, water will be released from site by collecting and diverting discharge-compliant (clean) runoff to the water storage pond (WSP) and from there to Minto Creek.
- If collection, diversion and release of clean water does not move enough water off site then Minto has the option of treating and releasing mine water.

The water management strategy is able to deal with most foreseeable conditions that may be encountered though the Phase V/VI development. However, certain unforeseen conditions may require an adaptive response as described below.

2.2.2 Risk Narrative

The existing water treatment plant is not able to treat and discharge enough mine water, and as a result the mine water inventory exceeds the target.

2.2.3 Specific Indicators, Performance Thresholds and Responses

Indicators, performance thresholds and responses specific to water management are provided below in Table 2-4.

Table 2-4: Specific Indicators, Performance Thresholds and Responses for Water Management

Specific Indicators	Specific Performance Thresholds	Specific Responses
Water inventory in the Main Pit Tailings Management Facility or the Area 2 Pit Management Facility exceeds target inventory	**Specific Threshold 1** • Water inventory target is exceeded for a period of three months. The water storage capacity still exceeds 1,000,000 m^3.	**Notification** • Minto Management • Include in monthly report **Review** • Review site water balance • Review recent water management and water treatment practices **Evaluation** • Evaluate the water inventory targets. For example, how much water can be stored in the pits for how long? Can the inventory target safely be changed to accommodate the excess volume of water? **Action** • Develop plan to address the water excess inventory such that the target can be met within 6 months. The plan may include: o An adjustment of the target inventory, o Diverting more clean water to the WSP, o Modifying or expanding water treatment.
	Specific Threshold 2 • The water storage capacity is less than 1,000,000 m^3.	**Notification** • Minto Management, SFN and YG Inspector. • Include in scheduled Water Use Licence reporting. **Review** • Review site water balance. • Review recent water management and water treatment practices. **Evaluation** • Evaluate the water inventory targets. For example, how much water can be stored in the pits for how long? Can the inventory target safely be changed to accommodate the excess volume of water? • Evaluate treatment requirements and determine if the exiting water treatment plant has sufficient capacity to meet the requirements. **Action** • Immediately develop and implement a plan to address the lack of storage capacity such that the capacity can be restored prior to subsequent freshet. o The plan may include, modifying or expanding the water treatment plant. o Plans to bring mobile treatment equipment to site may be considered.
	Specific Threshold 3 • The water storage capacity is less than 500,000 m^3.	**Notification** • Minto Management, SFN, YG Inspector and Regulators. • Include in Water Use Licence reporting. **Review** • Review site water balance. • Review recent water management and water treatment practices. **Evaluation** • Evaluate treatment requirements and determine if the existing water treatment plant has sufficient capacity to meet the requirements. **Action** • Immediately make plans to bring mobile treatment equipment to site, if existing plant does not have sufficient capacity.

2.3 Physical Stability

2.3.1 Description

The physical stability of the waste rock, tailings and water storage facilities are monitored according to the Physical Monitoring Plan (Minto Explorations Ltd., 2014). The document describes the inspection and instrumentation data collection frequencies, instrument locations, installation details, as well as the data collection procedures.

The purpose of the monitoring program is to identify physical changes to the conditions of the facilities which may lead to future instability and to allow the mine mitigate these conditions prior to any occurrence of instability. The facilities have been separated into two sets of geotechnical thresholds and response criteria (Table 2-5). The Water Storage Dam has been excluded from the operational AMP as the facility is to be managed according to its Operation, Maintenance and Surveillance (OMS) Manual (Tetra Tech EBA, 2014).

Table 2-*5*: Physical Stability Categories

Category	Facility
1	• Dry Stack Tailings Storage Facility and Mill Valley Fill Extension (Stage 1 and 2) • Southwest Waste Dump • South Wall Buttress / Main Pit Dump
2	• Main Waste Dump and Main Waste Dump Extension • Reclamation Overburden Dump • Ice-Rich Overburden Dump • Ridgetop Waste Dump • Ridgetop South Backfill Dump • Area 118 Backfill Dump • Main Dump

Category 1 facilities are founded in areas of ice-rich periglacial foundations that have previously experienced deep seated foundation movement. The Mill Valley Fill Extension (MVFE) and South Wall Buttress (SWB) are designed to mitigate movements in the Dry Stack Tailings Storage Facility (DSTSF) and Main Pit South Wall areas, respectively, and the Main Pit Dump provides further stabilization to the Main Pit South Wall area. Additional monitoring inspection and response requirements for the DSTSF are detailed in the Operations, Maintenance, and Surveillance Manual (OMS) for the facility (Tetra Tech EBA, 2011).

Category 2 facilities consist of all the remaining waste rock dumps and the Main Dam. These waste dumps are located in areas with good foundation conditions that avoid areas underlain by ice-rich overburden. The Main Dam design is currently in progress. The southern portion of the dam is also founded on ice-rich overburden similar to the Category 1 facilities and some deformation is expected during the operational period due to thaw settlement. Additional monitoring inspection and monitoring requirements may be required for the dam, this will be addressed in the OMS manual to be completed as part of the Main Dam final design.

2.3.2 Risk Narrative

A mass failure of one of the waste facilities has the potential to endanger the health and safety of site employees or visitors, or lead to an increase in contaminant loadings from the mine and subsequent adverse effects to aquatic resources in the receiving environment (lower Minto Creek).

2.3.3 Specific Indicators, Performance Thresholds and Responses

Indicators, performance thresholds and responses specific to Category 1 and Category 2 Facilities are provided in Table 2-6 and Table 2-7, respectively.

Table 2-6: Specific Indicators, Performance Thresholds and Responses for Category 1 Facilities

Specific Indicators	Specific Performance Thresholds	Specific Responses

• Mass movement indicated by monitoring of geotechnical instrumentation
• Visual observations of physical damage
• Visual observations of evidence that could suggest mass movement
• Occurrence of seismic events
	Specific Threshold 1
	
	• Observation of unusual occurrence including:
	  • tension cracks, settlement, or sloughing;
	  • a seismic event that exceeds the 1:475 return period event[1];
	  • abnormal seepage from any area of the slopes;
	  • increased turbidity from seepage;
	  • physical damage.
		Notification
		• Mine Manager
		• Geotechnical Engineer
		• Include in annual report
		
		Review
		• Review previous inspection reports, existing instrumentation including piezometer, temperature, inclinometer, and survey data.
		
		Evaluation
		• Geotechnical Engineer to compare recent monitoring results against older results for additional evidence of instability.
		
		Action
		• Inspect the area for any other signs of instability.
		• Follow any recommendations of the Geotechnical Engineer. At a minimum, the Engineer will consider the need for:
		  o An increase in the frequency of routine inspections and monitoring.
		  o Additional inspection, instrumentation, monitoring, or analyses

	Specific Threshold 2 • One survey hub or inclinometer reading indicating acceleration of movement greater than the long-term trend and outside range of instrumentation error	**Notification** • Site Geotechnical Engineer **Review** • Review existing instrumentation data. **Evaluation** • Site Geotechnical Engineer to compare recent monitoring results against older results. **Action** • Retake reading. • If the reading was accurate, increase the survey hub or inclinometer frequency.

[1] This size of a seismic event would be felt by most people on site. It would shake buildings, and rattle or break dishes, hanging objects, etc. Earthquake information may also be found online at: http://www.earthquakescanada.nrcan.gc.ca/index-eng.php

Specific Indicators	Specific Performance Thresholds	Specific Responses
	Specific Threshold 3 • Increase in pore water pressures such that Ru^2 exceeds 0.2. Or • Temperature greater than zero at a depth of 2 m below original ground *(all SWD ground temperature cables, and DSTSF ground temperature cables DST-10, DST-11, and DST-14 only)*	**Notification** • Mine Manager • Geotechnical Engineer • Include in annual report **Review** • Review previous inspection reports, existing instrumentation including piezometer, temperature, inclinometer, and survey data. **Evaluation** • Geotechnical Engineer to compare recent monitoring results against older results for additional evidence of instability. **Action** • Inspect the area for any other signs of instability. • If pore water pressure threshold exceeded: immediately increase frequency to **semi-weekly** or as directed by the Engineer until determined unnecessary. • Follow any additional recommendations of the Geotechnical Engineer.

	Specific Threshold 4
	
	• Increase in pore water pressures such that Ru exceeds 0.4.
		Notification
		• Mine Manager
		• Geotechnical Engineer
		• Include in annual report
		
		Review
		• Review previous inspection reports, existing instrumentation including piezometer, temperature, inclinometer, and survey data.
		
		Evaluation
		• Geotechnical Engineer to compare recent monitoring results against older results for additional evidence of instability.
		
		Action
		• Inspect the area for any other signs of instability.
		• Immediately increase pore water pressure monitoring and data review frequency to **daily** or as directed by the Engineer until determined unnecessary.
		• Follow any additional recommendations of the Geotechnical Engineer. At a minimum, , the Engineer will consider the need for:
		  o An increase in the frequency of routine inspections and monitoring.
		  o Additional inspection, instrumentation, monitoring, or analyses.
		  o Modifications to the waste placement/construction practices.

[2] Ru is the pore water pressure coefficient which is the ratio of pore water pressure to the overburden pressure. A pore water pressure ratio of 0.5 would be similar to the effect of a groundwater table at surface.

Specific Indicators	Specific Performance Thresholds	Specific Responses
	Specific Threshold 5 • Three consecutive survey hub or inclinometer readings indicating acceleration of movement greater than the long-term trend.	**Notification** • Mine Manager • Geotechnical Engineer • Include in annual report **Review** • Review previous inspection reports, existing instrumentation including piezometer, temperature, inclinometer, and survey data. **Evaluation** • Geotechnical Engineer to compare recent monitoring results against older results for additional evidence of instability. **Action** • Inspect the area for any other signs of instability. • Complete a ground survey of the area of interest to monitor any future displacement. • Immediately increase monitoring and data review frequency to **weekly** or as directed by the Engineer until determined unnecessary. • Follow any additional recommendations of the Geotechnical Engineer. At a minimum, the Engineer will consider the need for: o An increase in the frequency of routine inspections and monitoring. o Additional inspection, instrumentation, monitoring, or analyses o Modifications to the waste placement/construction practices.

Table 2-7: Specific Indicators, Performance Thresholds and Responses for Category 2 Facilities

Specific Indicators	Specific Performance Thresholds	Specific Responses

• Mass movement indicated by monitoring of geotechnical instrumentation
• Visual observations of physical damage
• Visual observations of evidence that could suggest mass movement
• Occurrence of seismic events
	Specific Threshold 1
	
	• Observation of unusual occurrence including:
	  • tension cracks, settlement, or sloughing;
	  • a seismic event that exceeds the 1:475 return period event;
	  • abnormal seepage from any area of the slopes;
	  • increased turbidity from seepage;
	  • physical damage.
		Notification
		• Mine Manager
		• Geotechnical Engineer
		• Include in annual report
		
		Review
		• Review previous inspection reports, existing instrumentation including piezometer, temperature, inclinometer, and survey data.
		
		Evaluation
		• Geotechnical Engineer to compare recent monitoring results against older results for additional evidence of instability.
		
		Action
		• Inspect the area for any other signs of instability.
		• Follow any recommendations of the Geotechnical Engineer. At a minimum, the Engineer will consider the need for:
		  o An increase in the frequency of routine inspections and monitoring.
		  o Additional inspection, instrumentation, monitoring, or analyses.

	Specific Threshold 2
	
	• Survey hub cumulative displacements between 150 mm and 500 mm;
	
	Or
	
	• Increase in pore water pressures such that Ru exceeds 0.2.
		Notification
		• Mine Manager
		• Geotechnical Engineer
		• Include in annual report
		
		Review
		• Review previous inspection reports, existing instrumentation including piezometer, temperature, inclinometer, and survey data.
		
		Evaluation
		• Geotechnical Engineer to compare recent monitoring results against older results for additional evidence of instability.
		
		Action
		• Inspect the area for any signs of instability.
		• Immediately Increase monitoring and data review frequency until determined unnecessary:
		  o If survey hub threshold exceeded: increase frequency to **bi-weekly** or as directed by the Engineer.
		  o If pore water pressure threshold exceeded: increase frequency to **semi-weekly** or as directed by the Engineer.
		• Follow any additional recommendations of the Geotechnical Engineer.

	Specific Threshold 3	**Notification** • Mine Manager

Specific Indicators	Specific Performance Thresholds	Specific Responses
	• Survey hub cumulative displacements greater than 500 mm. Or • Increase in pore water pressures such that Ru exceeds 0.4.	• Geotechnical Engineer • Include in annual report **Review** • Review previous inspection reports, existing instrumentation including piezometer, temperature, inclinometer, and survey data. **Evaluation** • Geotechnical Engineer to compare recent monitoring results against older results for additional evidence of instability. **Action** • Inspect the area for any other signs of instability. • Complete a ground survey of the area of interest to allow for a stability assessment to be completed (if required by the Engineer), and to monitor any future displacement. • Immediately increase monitoring and data review frequency until determined unnecessary: o If survey hub threshold exceeded: increase frequency to **semi-weekly** or as directed by the Engineer. o If pore water pressure threshold exceeded: increase frequency to **daily** or as directed by the Engineer. • Follow any additional recommendations of the Geotechnical Engineer. At a minimum, , the Engineer will consider the need for: o An increase in the frequency of routine inspections and monitoring. o Additional inspection, instrumentation, monitoring, or analyses o Modifications to the waste placement/construction practices.

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