Phase VII Expansion
Waste Rock and Overburden Management Plan
2018-01

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1 Introduction

The Phase VII Waste Rock and Overburden Management Plan (WROMP) specifies the categorization and quantities of waste rock and overburden produced during Phase VII mining, and summarizes how Minto proposes to manage these materials.

Phase VII mining activities consist of two underground mining zones from which waste rock will be produced and brought to surface. In addition to describing these new zones, this document builds on the Phase V/VI site configuration, updating it to show the progress made.

2 Background

Minto Mine has been operating since 2007. Mining is currently taking place as part of the Phase IV and Phase V/VI plans, approved under QML-0001. The current status of each phase of the mine plan is as follows:

- Phase IV
    - Area 2 Stage 1 and 2 open pit – completed in 2015
    - Area 118 pit – completed in 2014
    - Area 118 zone (underground) – completed in 2016
    - Area 2 zone (underground) – in progress

- Phase V/VI
    - Area 2 Stage 3 open pit – in progress
    - Minto North open pit – completed in 2016
    - Ridgetop North and South open pits – not yet started
    - Minto East zone (underground) – in progress
    - Copper Keel zone (underground) – not yet started

- Phase VII
    - Minto East 2 zone (underground)
    - Minto North zone (underground)

2.1 Overview of Phase VII Mine Plan

The Phase VII mine plan adds additional underground mining in two ore zones. The Minto East 2 zone is located underneath the Mill Valley Fill Extension and approximately 450m east of the Minto East zone. It will share infrastructure with the existing Minto South Underground, including the portal, main ramp, fresh air raise, and ore stockpiles; it will be accessed via a continuation of the ramp that currently leads to Minto East.

The Minto North zone is located approximately 50m east of the Minto North pit, approximately 135m below the surrounding topography. It will be accessed via a portal and decline from the Minto North pit wall; it will therefore require no new ground disturbance. During production, a small quantity of ore will be temporarily stockpiled in a staging area within the footprint of the completed pit and access road, to be hauled daily to the existing coarse ore stockpiles adjacent to the mill. Waste rock will either be added to the Main Waste Dump Expansion, remaining within the capacity and footprint previously approved in the Phase V/VI mine plan, or be disposed of below the post-closure water elevations of the existing tailings management facilities.

Both Minto East 2 and Minto North zones will be mined using the same method employed in all other underground mining at Minto. Waste rock will be released only from ramp and level access development; the majority of sill development will be completed in ore. The addition of these deposits therefore represents a small change to the WROMP previously presented as part of Phase V/VI.

Figure 1: Updated Phase V/VI site components.

Figure 2: Key Phase VII site components.

3 Summary of Materials Release

3.1 Waste Rock and Overburden

The volumetric breakdown of planned waste rock and overburden releases is shown in Tables 1 and 2, respectively. For clarity, a bank cubic meter (BCM) is a measure of material volume (rock or overburden) in the ground, prior to mining. The process of blasting, transporting, and dumping the material increases the void space present in it; in this document, the volume of the material, when dumped, is quoted in m^3. A factor of 1.30 is applied to convert BCM into loose cubic meters (m^3).

Table 1: Volume of Planned Waste Rock Release as of December 1, 2017.

Source Location	Quantity (BCM)	Swell Factor	Waste Rock Volume (m^3)
Phase IV/V/VI			
Area 2 Stage 3 Pit	770,000	1.3	1,001,000
Ridgetop North Pit	2,628,000	1.3	3,416,000
Ridgetop South Pit	482,000	1.3	627,000
Area 2 Underground	-	1.3	-
Minto East Underground	13,000	1.3	17,000
Copper Keel Underground	47,000	1.3	61,000
Phase VII			
Minto East 2 Underground	49,000	1.3	64,000
Minto North Underground	13,000	1.3	17,000
	Total Waste Rock Remaining		5,203,000

Table 2: Volume of Planned Overburden Release as of December 1, 2017.

Source Location	Quantity (BCM)	Swell Factor	Overburden Rock Volume (m^3)
Phase IV/V/VI			
Area 2 Stage 3	56,000	1.3	73,000
Ridgetop North	702,000	1.3	913,000
Ridgetop South	135,000	1.3	176,000
Area 2 Underground	-	1.3	-
Minto East Underground	-	1.3	-
Copper Keel Underground	-	1.3	-
Phase VII			
Minto East 2 Underground	-	1.3	-
Minto North Underground	-	1.3	-
	Total Overburden Remaining		1,162,000

3.2 Allowance for Waste Rock with NP:AP<3

During mining of the Main Pit, operational monitoring of waste rock for acid base accounting (ABA) parameters was carried out in accordance with water licence conditions. The results of that operational monitoring confirmed that the ABA characteristics of Main Pit waste rock were consistent with expectations based on pre-production testing (i.e., it could be classified as non-acid generating (NAG)). The water licence defined NAG material as material having a ratio of neutralization potential (NP) to acid potential (AP) greater than 3 (NP:AP>3).

During the metal leaching and acid rock drainage investigations that formed the basis of the Phase IV waste management strategy, a small proportion of drill core samples from the future Area 2 Stage 2 Pit were identified as having NP:AP<3. Due to the large proportion of samples with NP:AP>3, it was concluded that bulk disposal of waste rock was appropriate and that no allowance for separate disposal of NP:AP<3 material was required.

After Phase IV mining was under way, operational monitoring of Area 2 waste rock in 2012 using an off-site commercial laboratory indicated that the proportion of waste rock with NP:AP<3 was higher than anticipated from the pre-production testing. To minimize the long-term risk of development of acidic leaching conditions and associated high metal loadings, the mine adapted the waste rock management strategy to include on-site classification, and separate storage of waste rock with NP:AP>3 and NP:AP<3. To ensure that waste rock with NP:AP<3 would be stored in a location that would be saturated over the long term, the mine initiated dispatching of waste rock with NP:AP<3 to the mined-out Main Pit.

In order to ensure that sufficient saturated storage was available in Phase V/VI, there was a need to estimate the volume of NP:AP<3 rock that would be produced. The Phase V/VI pre-production testing on drill core samples presented a similar range of results for the Area 2 Stage 3 Pit (A2S3), the Ridgetop North Pit, and the Ridgetop South Pit as were found for the Phase IV deposits (i.e. there would not be significant waste rock volumes having NP:AP<3); however, Minto elected to plan for a certain volume of waste rock with NP:AP<3 release from Phase V/VI to ensure that sufficient storage volume below final water table elevations was reserved.

Two independent methods were used to estimate saturated storage volumes that should be reserved for waste rock storage. These methods are described elsewhere in detail (SRK 2013) and are summarized here for completeness.

- The first method was to review the production data from Phase IV mining in the Area 2 Pit and calculate the proportion of total waste rock volume that was determined to have NP:AP<3. This approach was based on samples collected and analysed (on-site) from every blast hole beginning in August 2012, with results interpreted by mine geologists and transmitted to pit operations for excavation and dispatching to either in-pit (for NP:AP<3 waste rock) or ex-pit (for NP:AP>3 waste rock) dump locations.
    - This approach indicated that roughly 17% of the waste rock assessed had NP:AP<3.
- The second method was to create a sulphur block model for the Phase V/VI Minto South pits (A2S3, Ridgetop North, and Ridgetop South) based on sulphur assays from exploration drill core. This approach consisted of estimating sulphur grades for all rock within the pit shells and calculating the volume of rock that was both below ore grade for copper and higher that 0.3% total sulphur (rock with lower than 0.3% sulphur was found to correlate well with rock with NP:AP>3).
    - This approach indicated that roughly 13% of the A2S3, Ridgetop North and Ridgetop South waste rock could be expected to have NP:AP<3.

For planning purposes, Minto has chosen to allow for 20% of the waste rock from the surface mining remaining in Phase V/VI to be stored in locations that will be saturated post-closure. This is considered a conservative estimate; Area 2 Stages 1 and 2 historically produced 17% NP:AP<3 waste rock, based on blasthole samples. This approach is considered to be appropriately conservative in that more volume will be reserved for NP:AP<3 waste rock than will likely be produced. Actual dispatching of waste rock from the pits is done on the basis of blast hole analyses, not pre-production estimates. Table 3 summarizes the volumetric allowances that have been made for NP:AP<3 waste rock.

Table 3: Allowance for NP:AP<3 Waste Rock Volumes as of December 1, 2017.

Source Location	Waste Rock Volume (BCM)	Estimated NP:AP<3 Waste Rock Volume (BCM)
Area 2 Stage 3	770,000	154,000
Ridgetop North	2,628,000	526,000
Ridgetop South	482,000	96,000
Underground	122,000	122,000
Total Waste Rock	**4,002,000**	**898,000**

In total, 898,000 BCM of NP:AP<3 waste rock is planned for; saturated storage locations for NP:AP<3 material are presented in the Tailings Management Plan.

Actual dispatching will be based on blast hole results. To accommodate potential variations in the quantity of NP:AP<3 material released, this plan provides ex-pit dump capacity for the total volume of waste rock released by Phase V/VI and Phase VII mining.

4 Waste Rock Management

4.1 Introduction

The quantities of waste rock expected from Phase VII will be contained within the storage locations presented in the previous (Phase V/VI) Waste Rock and Overburden Management Plan.

As noted in Section 3.2, the Phase VII waste rock has been classified into two categories based on ABA characteristics. These two categories are “Bulk Waste Rock” and “NP:AP<3 Waste Rock”; the two categories have different storage considerations. Management of each category of waste rock is discussed separately in the following sections.

4.2 Bulk Waste Rock

Bulk waste rock, including the amount released by Phase VII, will be stored in four facilities described in previous waste management plans: the Main Waste Dump Expansion, the Main Pit Dump, the Ridgetop Waste Dump, and the Ridgetop South Backfill Dump.

There is enough capacity remaining in the aforementioned Phase V/VI dumps to contain all of Phase VII’s bulk waste rock release, as these dumps were sized conservatively to account for uncertainties in the quantity of NP:AP<3 waste rock released by each pit.

Capacities for dumps as of December 1, 2017 are outlined in Table 4.

Table 4: Waste Rock Dump Capacities, as of December 1, 2017.

Dump Location	Dump Capacity (m^3)
Active	
Main Waste Dump Wrap	365,000
Main Pit Dump	579,000
Future	
Main Waste Dump Expansion	610,000
Ridgetop Waste Dump	3,416,000
Ridgetop South Backfill Dump	740,000
Total Capacity Waste Rock	**5,710,000**

The following sections present updates to these Phase V/VI waste rock facilities.

4.2.1 Main Waste Dump Expansion

Bulk waste rock haulage to the Main Waste Dump Expansion stopped with the completion of Minto North in October 2016. 610,000 m^3 of capacity remains, as the dump was sized to accommodate waste that was instead used to construct Stage 2 of the Mill Valley Fill Extension. The Main Waste Dump Expansion will become active again during Minto North Underground operations.

The Main Waste Dump Wrap is located to the south of the Main Waste Dump Expansion as shown in Figure 3. 365,000 m^3 of material remains to be placed at the toe of the dump as of December 1, 2017. This material will be placed to create a shallower final slope (ranging from 3H:1V to 4H:1V) on the MWDE, thus improving reclamation outcomes.

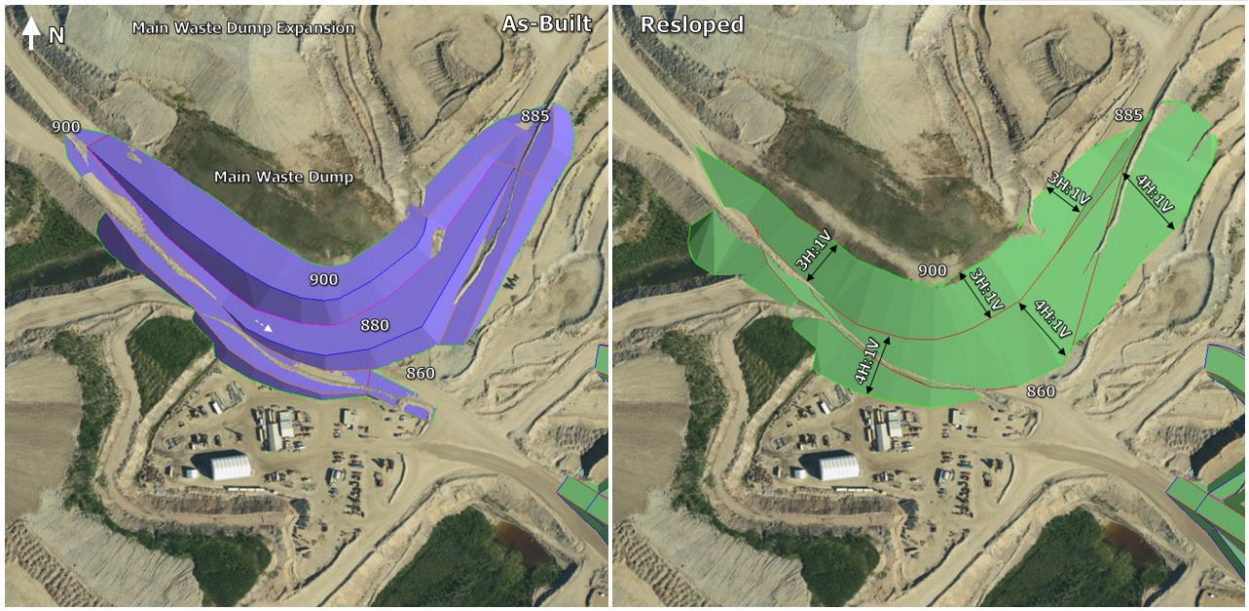

Figure 3: Plan view of the Main Waste Dump Wrap

4.2.2 Main Pit Dump

The Main Pit Dump has been redesigned relative to Phase V/VI so that it does not encroach on the area where NP:AP<3 rock was previously placed, as displayed in Figure 4. As of December 1, 2017, 579,000 m^3 of material remains to be placed at the Main Pit Dump.

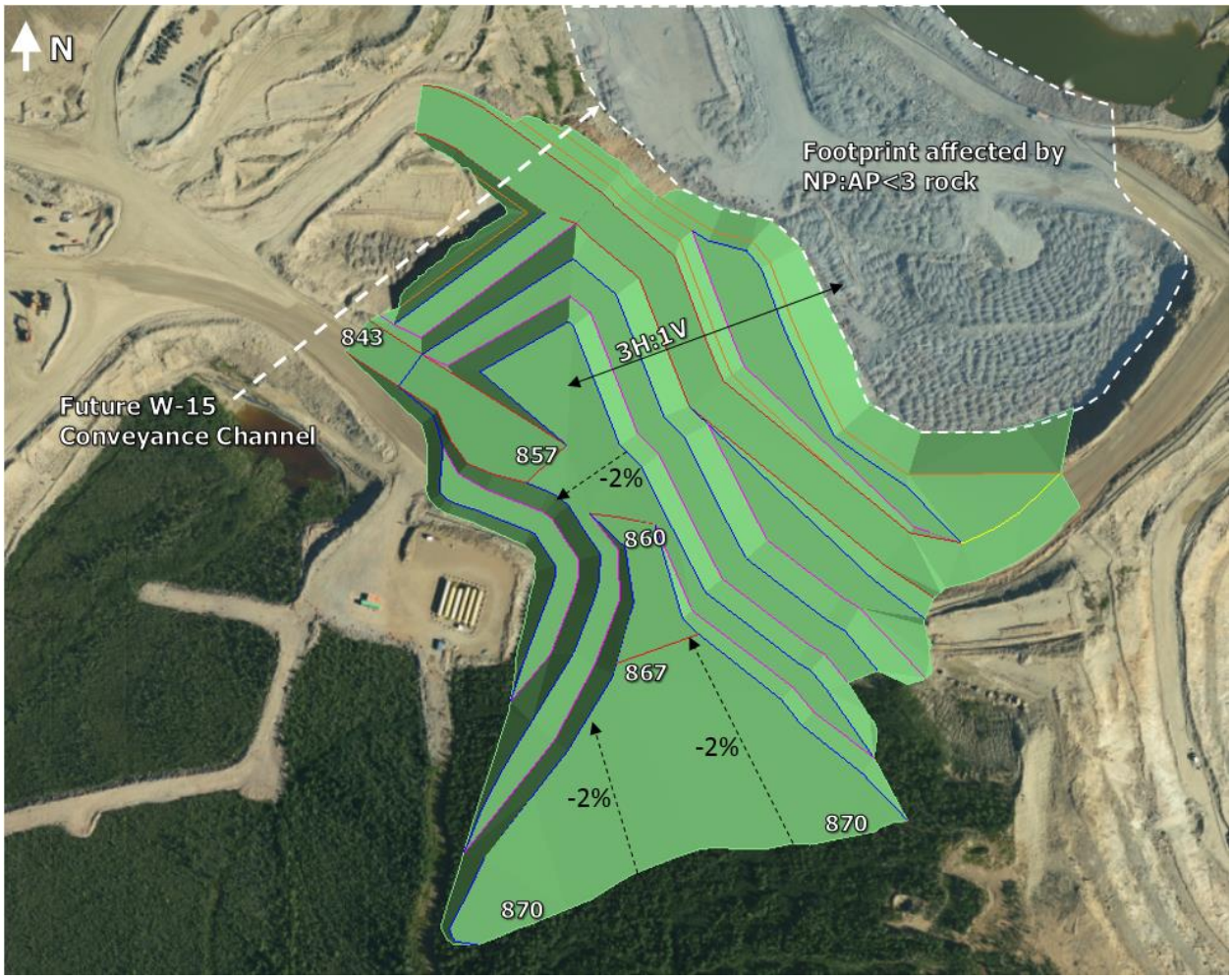

Figure 4: Plan view of the Main Pit Dump

The dump was designed to be resloped at a 3H:1V slope (or shallower) along all faces. A 26 m-wide access road along the front face of the dump is used to link the east and west sides of the mine. The entirety of the Main Pit Dump is above the Main Pit Tailings Management Facility spill elevation, thus maximizing volume available for tailings and NP:AP<3 waste in the Main Pit.

4.2.3 Ridgetop Waste Dump

The Ridgetop Waste Dump (RWD) design is unchanged from the design presented in the Phase V/VI Waste Rock and Overburden Management Plan.

The disturbance area of the reclaimed RWD is estimated to be 28.8 ha, of which 25.4 ha is located within the W15 catchment and 3.4 ha is within the W35 catchment. The RWD will have a capacity of 3.4 Mm^3 and is displayed in Figure 5.

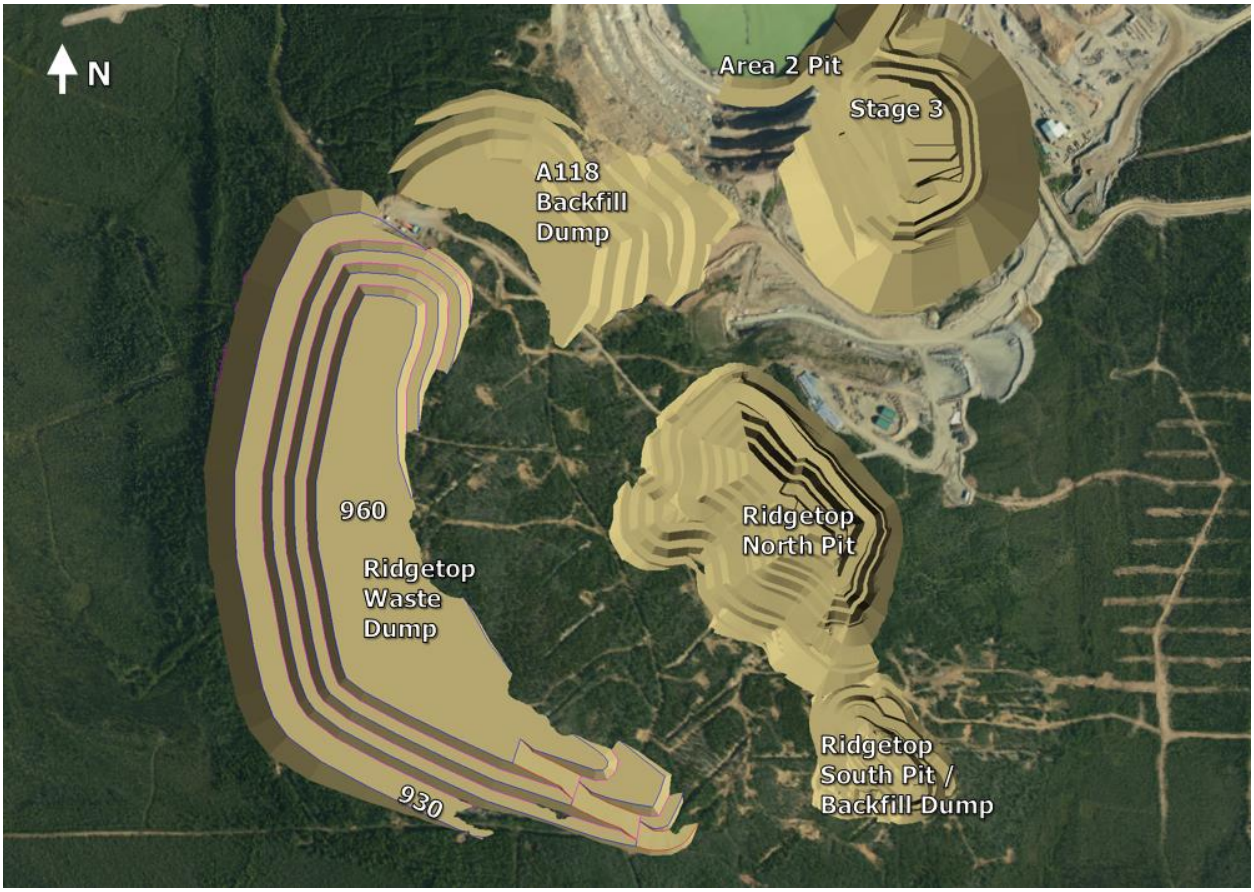

Figure 5: Plan view of the Ridgetop Waste Dump.

4.2.4 Ridgetop South Backfill Dump

The Ridgetop South Backfill Dump fills and builds upon the footprint of the Ridgetop South Pit. It is designed to contain 740,000 m^3. In Phase V/VI, this dump was designed to contain overburden; in this plan, it will instead contain waste rock. The redesign of the Main Pit Dump to preserve the footprint affected by previously placed NP:AP<3 waste rock has reduced its capacity, while more opportunituies have been identified to place overburden as part of progressive reclamation activities.

The Ridgetop South Backfill Dump will be mounded up above the pre-mining surface topography such that final side slopes will form 3H:1V (or shallower) surfaces. The mounding of backfill above the original topography:

- eliminates the Ridgetop South Pit as a long term surface feature at the site;
- avoids surface depressions that could result from settling of backfill;
- provides positive drainage and maximizes surface runoff during the post-closure period; and
- maximizes volume of waste stored within the footprint of the Ridgetop South Pit.

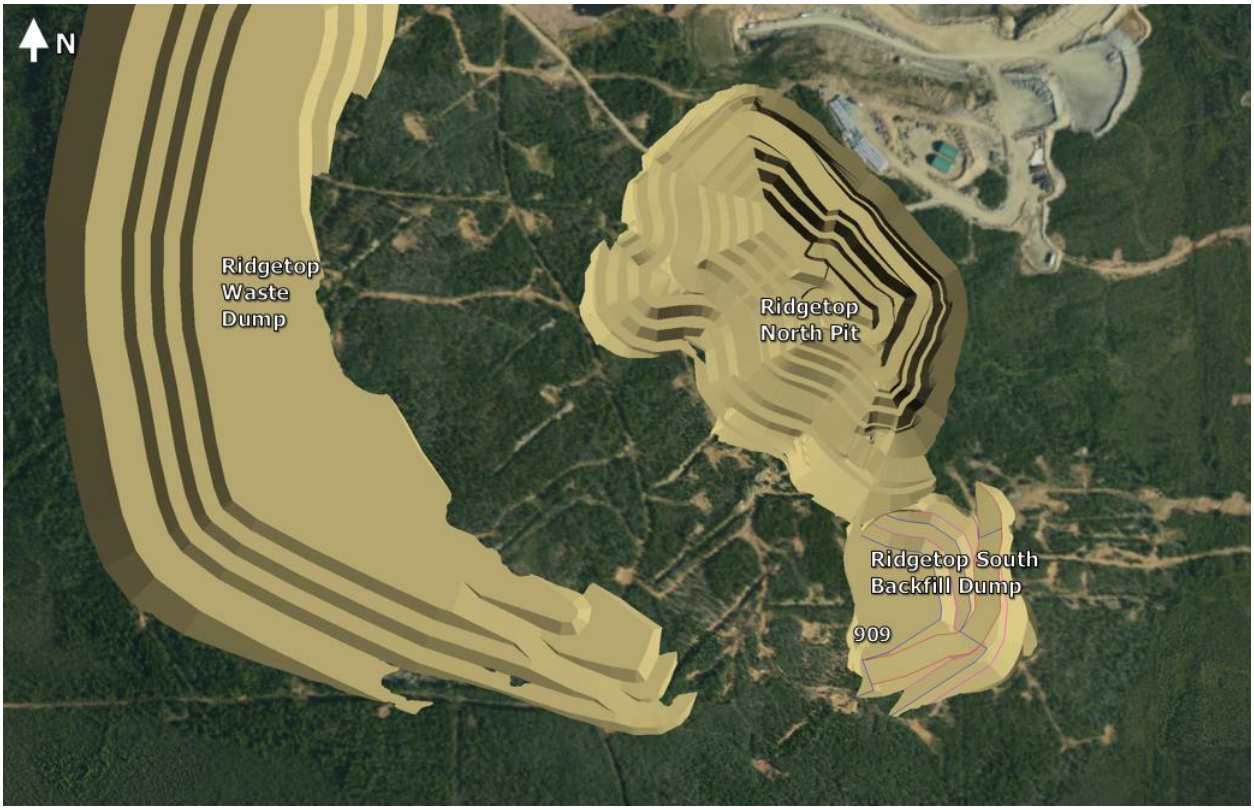

Figure 6: Plan view of the Ridgetop South Backfill Dump.

4.3 NP:AP<3 Waste Rock

4.3.1 Storage

As noted in Section 3.2, this plan provides for 898,000 BCM of saturated storage capacity for waste rock having NP:AP<3. For planning purposes, 20% of the waste rock from A2S3, Ridgetop North and Ridgetop South pits is assumed to have NP:AP<3, as well as 100% of the waste rock from underground. This material will be stored such that it is saturated post-closure. It is not necessary to saturate NP:AP<3 waste rock during the operational period—there is sufficient neutralization potential in the NP:AP<3 waste that any acid generated at the mineral grain scale will be neutralized by contact with nearby neutralizing minerals and by porewater that is in contact with those neutralizing minerals (SRK 2013a).

Minto plans to dispose of all rock with NP:AP<3 below the final water elevations of the Main Pit Tailings Management Facility and the Area 2 Pit Tailings Management Facility. Rock will be both free-dumped over dump crests, and end-dumped in lifts and spread by dozer. The Phase VII Tailings Management Plan further describes the disposal of both tailings and NP:AP<3 waste rock.

4.3.2 Classification and Segregation

Minto intends to continue the classification and segregation practices described in the Phase V/VI Waste Rock and Overburden Management Plan.

These practices are summarized as follows:

- Classification

1. Samples of cuttings from each blast hole are collected for grade control purposes. One sample is collected per hole.
2. Cuttings samples are split into aliquots for grade control (copper analysis) and for determination of total sulphur (S(T)) and total carbon (C(T)) content.
3. S(T) and C(T) are measured for each sample using an Eltra CS-800 induction furnace with infrared detectors.
4. Test results are imported into the mine's grade control software for processing by the mine geologists.
5. S(T) and C(T) values are converted into equivalent acid potential (AP-S(T)) and neutralization potential (NP-C(T)) values, and NP-C(T):AP-S(T) ratios are calculated for each sample.
6. NP-C(T):AP-S(T) values are plotted for each drill hole in a given blast pattern, and mine geologists use the mine's grade control software to define polygons outlining contiguous zones of waste rock types: either bulk waste or waste with an NP-C(T):AP-S(T) ratio less than 3.0.
7. Ore grade polygons are drawn for material above the mine's operational cutoff grade, with the result being that all material in a blast is classified as ore, bulk waste, or NP:AP<3 waste rock.
8. A map of the final ore and waste classifications is provided to the pit operations team to guide the dispatching of all rock released from the pit.

- Segregation
    1. The pit operations team uses the blast classification maps to stake out the boundaries of each ore and waste class. Each class is represented by stakes in different colours. The maps are also used to communicate the shift's plans with equipment operators and supervisors at the beginning of each shift.
    2. Haul trucks are loaded by a loader or excavator, the operator of which is responsible for knowing the material class being excavated and for communicating the class of each load to the haul truck operator.
    3. The haul truck driver then delivers the load to the crusher or to the appropriate stockpile (if ore) or waste storage facility (if waste).

4.4 Construction Rock

To limit potential metal leaching, waste rock that is used for general construction purposes (e.g. road building, armouring of ditches, road crush) will be restricted to rock with the following properties:

1. NP/AP > 3.0
2. Total Sulphur < 0.30%
3. Total Copper < 0.10%

These parameters will be measured on-site to allow for the short cycle times that are necessary for efficient dispatching of rock produced as part of mining operations. Sampling will be done using the same methodology described previously in Section 4.3.2.

5 Overburden Management

No overburden will be produced by Phase VII mining activities. The following section provides an update on overburden remaining to be released as part of Phase V/VI mining.

5.1 Progressive Reclamation

Minto will continue to carry out reclamation work on completed facilities during the remainder of Phase V/VI and during Phase VII mining activities. As indicated in Table 2, the largest quantity of overburden will be released during the mining of the Ridgetop North Pit. This material will be dispatched mainly to the following locations for use as reclamation cover:

- Ridgetop Waste Dump
- Southwest Dump
- Main Pit Dump

Direct placement on other dumps, roads, and laydowns is also expected to use some of the overburden remaining to be released. The remaining overburden volumes are listed in Table 5.

Table 5: Destinations for Overburden Released from the remaining Phase V/VI Mine Components.

Dump Location	Dump Capacity (m^3)
Active	
Southwest Dump	113,000
Main Pit Dump	75,000
A118 Backfill Dump	540,000
Additional Overburden Cover	221,000
Future	
Ridgetop Waste Dump	213,000
Total Capacity Overburden	**1,162,000**

5.2 Area 118 Backfill Dump

540,000 m^3 of capacity remains in the Area 118 Backfill Dump as of December 1, 2017. The dump is designed to be sloped at 3H:1V or shallower during closure and is shown in Figure 7.

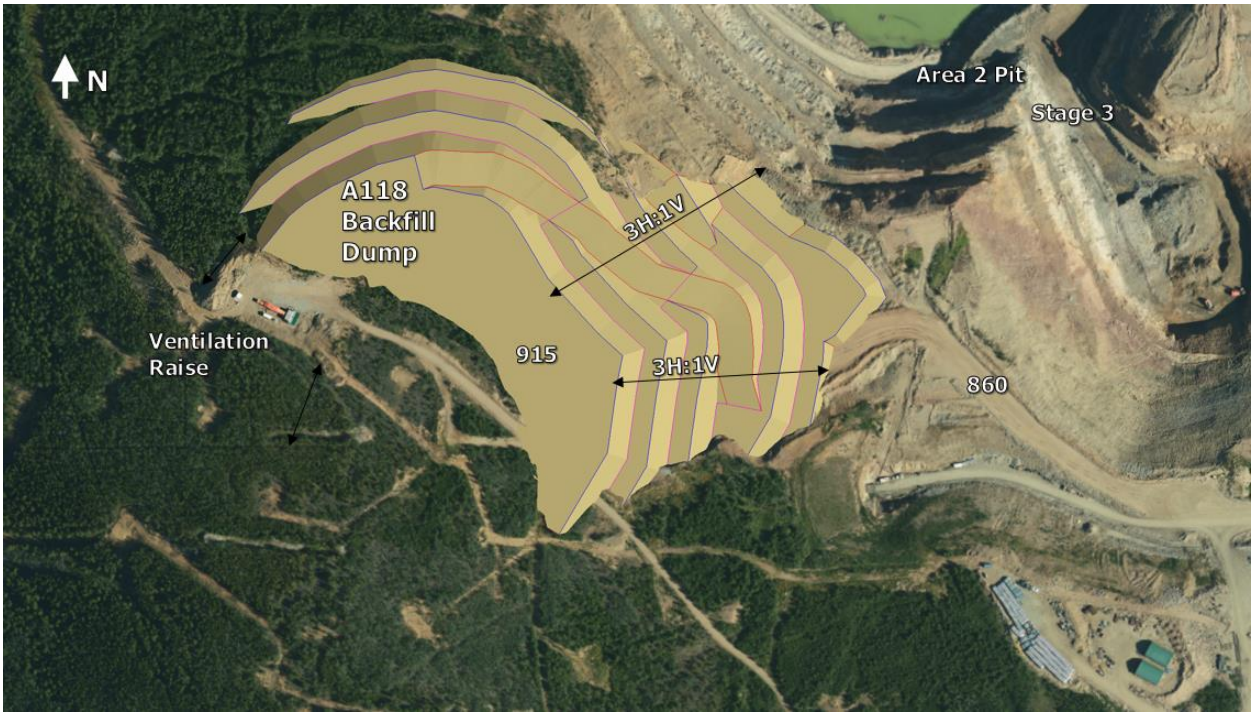

Figure 7: Plan view of the Area 118 Backfill Dump

5.3 Ice-rich Overburden

Minto manages ice-rich overburden separately from thaw-stable overburden to avoid the potential stability issues that could arise from thawing of ice-rich overburden that could otherwise be incorporated into storage facilities designed for bulk disposal.

Overburden that does not meet thaw-stable criteria will be designated 'ice-rich overburden' and will be placed together with thaw-stable overburden as part of the progressive reclamation work done on waste rock dumps. At the planned cover thicknesses of 0.50m, and with only a small proportion of overburden expected to be classified as ice-rich, any ice entrained in the cover layer is expected to thaw within one year of placement and any excess water that results will drain or evaporate. Recent experience with overburden sourced from Area 2 Stage 3 and placed on the Southwest Dump and Mill Valley Fill Extension has demonstrated that this is an effective management approach.

To date, Phase V/VI has yielded minimal amounts of ice-rich overburden.

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6 References

Minto Explorations Ltd. 2014. Minto Mine Phase V/VI Expansion - Waste Rock and Overburden Management Plan.

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