



Phase VII Underground Mine Development and Operations Plan

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1 Introduction

This document proposes the addition of two ore zones to Minto Mine's underground mine plan:

- Minto East 2, a continuation of the ore lenses that comprise the Minto East zone, accessed via the existing Minto South Portal;
- Minto North UG, a continuation of the ore lenses mined as part of the Minto North pit, which would be accessed via a new portal collared at the bottom of the completed pit.

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

Table 1-1: 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
		Minto East 2	Phase VII
		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
Minto North Underground	Minto North Portal	Minto North UG	Phase VII

The Wildfire Underground, which was presented in Phase V/VI, would have mined relatively shallow ore zones from a separate portal with its own dedicated infrastructure. Originally planned to be mined after the completion of the Minto South Underground, it is not currently in the mine plan and is not described in this document.

1.1 Background

Minto Mine has been in operation since 2007. Operations consisted solely of open pit mining from 2007 until 2012, at which time development of the Minto South Underground commenced. Development continued through early 2013.

In January 2014, through continued consultation with Yukon Government Department of Energy, Mines and Resources, Minto sought approval for changing the mining sequence such that the "M-zone," originally the final ore zone to be mined in the Phase IV plan, could be brought ahead in the schedule and accessed from a portal at the bottom of the completed Area 2 Stage 2 pit. Approval to proceed was granted on January 10, 2014.

The M-zone was completed in October 2014, at which time mining resumed in the Minto South Underground; specifically, the Area 118 zone. That zone was completed in April 2016.

Development aimed at accessing the next zone, Area 2, began in March 2016, and the first ore production from stoping activities occurred in June 2016. As of January 2018, mining of Area 2 is still under way, with completion

expected in Q2 2018. Driving of a ramp to Minto East is complete and development of level accesses is under way. Ramp development toward Copper Keel will begin in Q1 2018.

2 Mine Development and Design

The Minto East 2 zone is believed to be a continuation of the same foliated structures that define the Minto East zone. It is located approximately 0.5 km west of Minto East and 100m deeper, lying 400 m below surface directly underneath the Mill Valley Fill Extension.

Minto North UG is a small zone east of the Minto North pit. It may be related to the units of foliated granodiorite that hosted the copper-bearing mineralization in that pit. It is located approximately 20m from the east edge of the pit crest and 120m below the overlying ground surface.

This section presents development and stoping layouts for the Minto East 2 and Minto North UG zones.

2.1 Access – Minto South Underground

The main ramp of the Minto South Underground will be extended to access Minto East 2. The ramp layout, annotated with distances from the portal, is shown in the following figure.

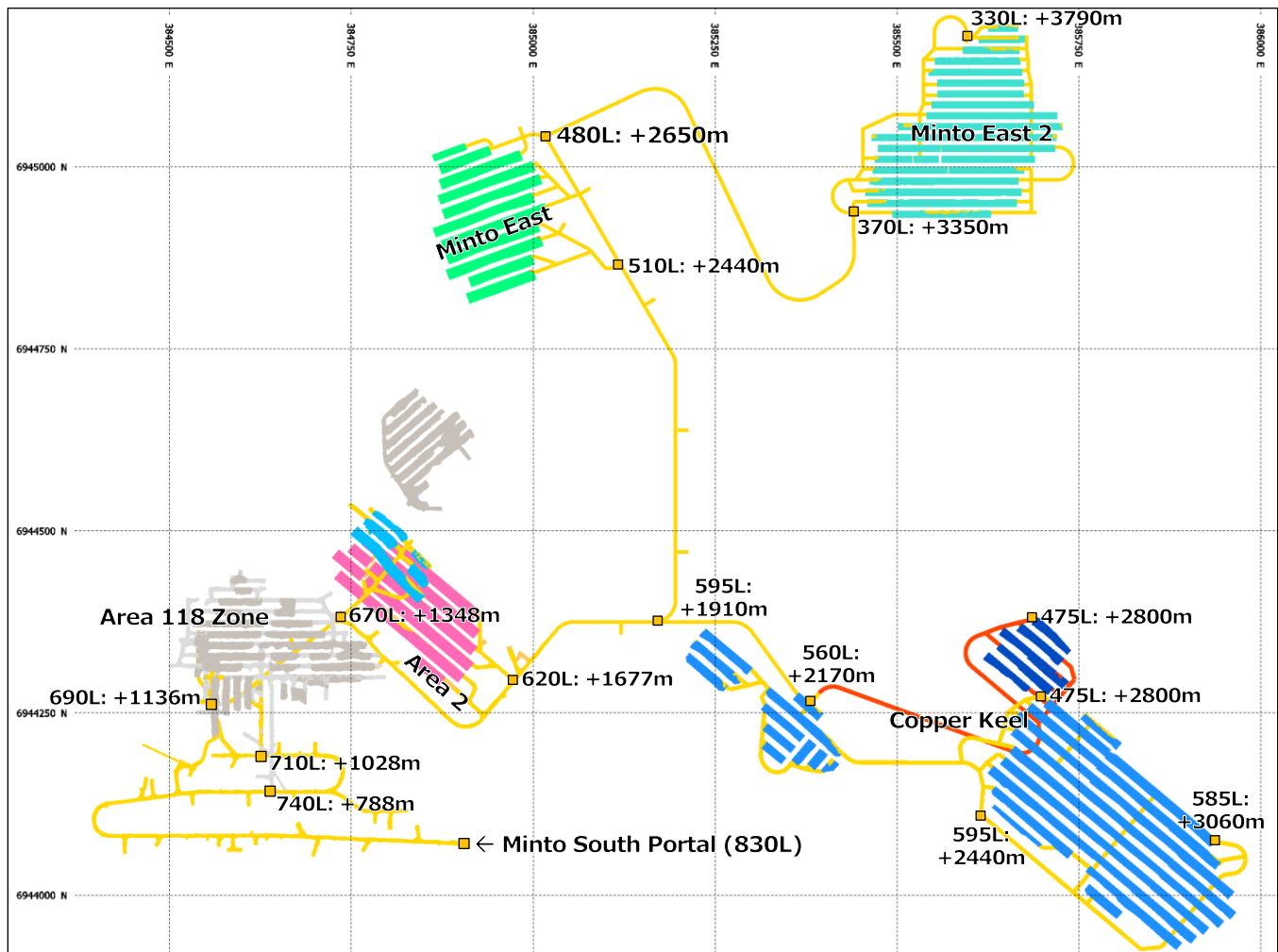


Figure 2-1: Main ramp configuration and haul distances.

The decline measures 5.0m wide and 5.0m high down to the 690 level, after which the back height is increased to 5.5m to provide additional clearance between vent ducting and haul trucks. This access is to be used for all ore and waste haulage, personnel/equipment access, and services.

Re-muck bays are typically developed every 150 m along the decline to improve the efficiency of the development cycle. The re-muck bays have the same dimensions as the decline and are generally 15 m in length. Once they are no longer needed for development, they are repurposed as equipment storage, pump stations, drill bays, service bays, etc.

2.2 Stope Layout – Minto East 2 Zone

The figure below shows a perspective view of the Minto East 2 stope design.

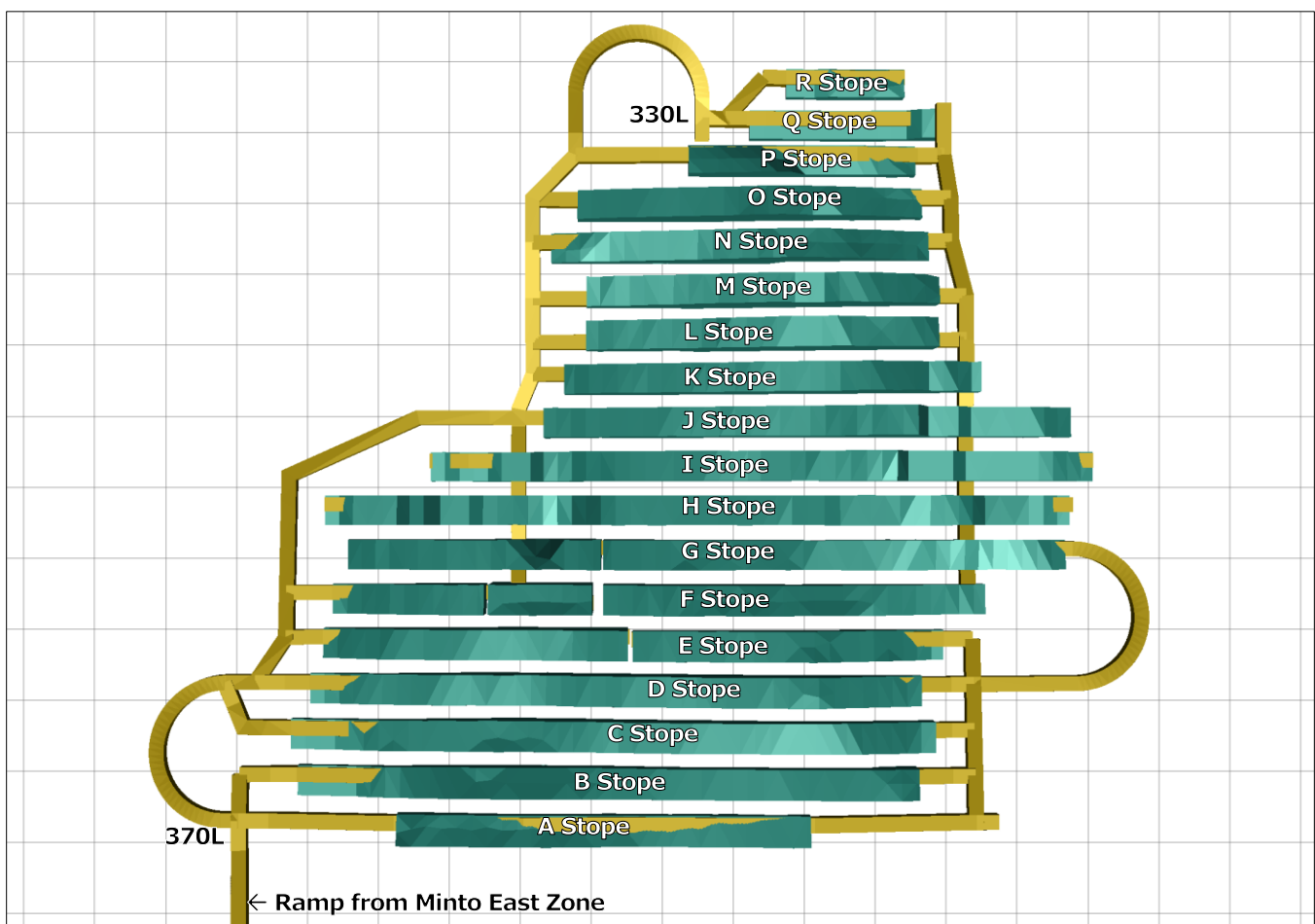


Figure 2-2: Top-down perspective view of the Minto East 2 zone.

2.3 Access – Minto North Underground

The Minto North Underground will be accessed via a portal cut into the east wall of the Minto North pit. The portal will be collared in a bench face at the 852m elevation, at the second switchback of the pit's main ramp. This location avoids direct exposure to the south highwall. The drift will be driven at 15% grade.

A second portal will be collared approximately 20m away; it will serve as a secondary egress and a fresh air intake.

The workings will be contained entirely within the completed Minto North pit. Ancillary facilities such as the surface fan, propane tank, shop, muster station, and air compressor will be located either within the pit or on the adjacent haul road, or on the Main Waste Dump Expansion that previously received a majority of the pit's waste rock. There will be no new surface disturbance.

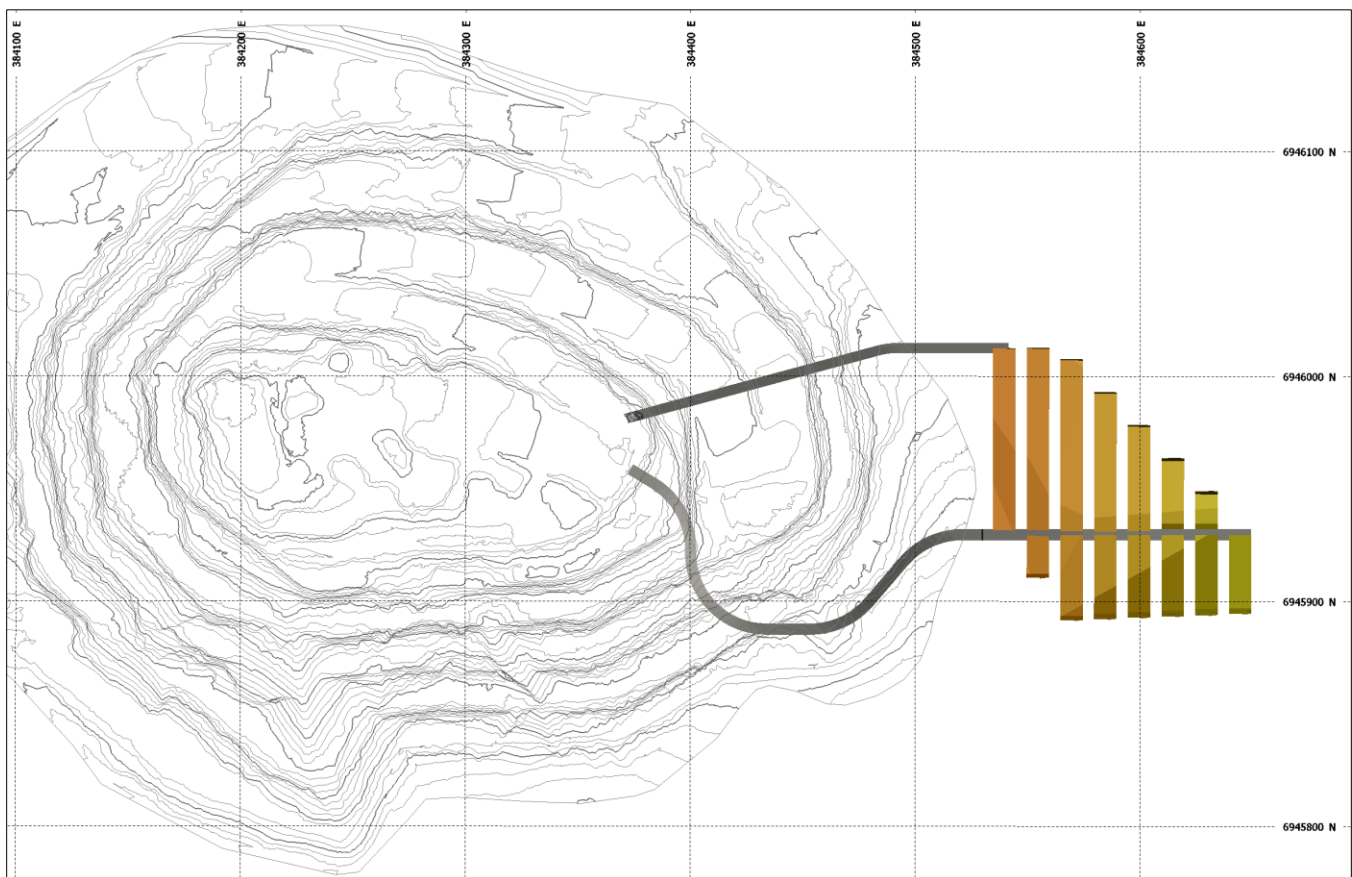


Figure 2-3: Minto North Underground accesses in relation to the adjacent Minto North Pit.

2.4 Stope Layout – Minto North UG Zone

The deposit is essentially flat along both east-west and north-south axes. This allows direct access into the middle of the orebody with minimal waste development.

The following figure shows a section through the seven stopes on the north side of the main access. The stope heights are designed conservatively, excluding low-grade ore near the hanging wall contact. No stopes are designed on the east edge of the deposit (on the right of the figure).



2.5 Mining Method

Significant variability in copper grades is seen within each ore zone; therefore, diamond drilling completed as part of earlier exploration is supplemented by infill drilling done from each sill using the production drilling equipment. Additional diamond drilling may also be done from the underground workings; campaigns were successfully completed in both Area 118 and Area 2 to better delineate ore on the edges of the zone.

The mining method does not use backfill; however, small quantities of development waste are sometimes placed in completed stopes to reduce haulage requirements.

2.6 Geotechnical

Ground support in development headings generally comprises 2.4m-long fully grouted resin rebar bolts on a 1.5m x 1.5m pattern, with 1.8m bolts installed in the walls. Welded wire mesh is installed to within 1.5 m from the floor. Additional support, comprising a pattern of 3.6m Super Swellex bolts, is installed in intersections.

Long-term development headings such as ramps, electrical substations, remucks, and sumps use galvanized welded wire mesh and coated Super Swellex to improve corrosion resistance, while stope sills and level accesses within each ore zone use uncoated steel.

Stopes in Area 118 were mined to 10m widths, with 5m rib pillars. In Area 2, stope width was increased to 15m while maintaining the same pillar thickness; this has improved the extraction ratio for the deposit. Based on numerical pillar stability modeling performed by Golder Associates, pillar thicknesses in Area 2 were increased in certain locations to provide adequate factors of safety. This variable-thickness pillar sizing approach will be continued in all remaining underground mining, supported by numerical geotechnical modeling.

At this time, numerical modelling of the Minto East 2 and Minto North Underground zones has not yet been undertaken. Both zones will require in-fill drilling both to better define the ore shape and to provide a basis for future pillar stability modeling.

3 Ore Resources, Reserves, and Scheduling

The Minto East 2 zone was extensively drilled in 2012 and is currently classified as an indicated resource. A preliminary design has been prepared for it, but detailed designs have not yet been completed; as a result, it is not currently included in the company's statement of reserves.

The Minto North UG zone was also drilled in 2012 and is classified as an inferred resource due to the low density of drilling in the area. While it is not formally classified as a reserve, this document presents a mine design for it with the expectation that the density of drilling will be upgraded before mining commences.

The following tables present the published resources for these ore zones.

Table 3-1: Resources for the Minto East 2 zone.

	Tonnes	Copper (%)	Gold (g/t)	Silver (g/t)	Contained Cu (M lbs)	Contained Gold (k oz)	Contained Silver (k oz)
Indicated	2,152,000	2.14	1.01	8.9	101.5	69.7	618.7
Inferred	1,506,000	1.64	0.66	5.4	54.5	31.9	262.5

Table 3-2: Resources for the Minto North UG zone.

	Tonnes	Copper (%)	Gold (g/t)	Silver (g/t)	Contained Cu (M lbs)	Contained Gold (k oz)	Contained Silver (k oz)
Inferred	688,000	2.06	0.82	6.5	31.3	18.1	143.9

The preliminary designs presented in this document comprise a subset of these resources.

3.1 Minto East 2

The design presented in this document will mine 1,040,000 tonnes of ore at 1.76% Cu, and 133,000 tonnes of waste to access the zone.

3.2 Minto North Underground / Minto North UG

The design presented in this document will mine 268,000 tonnes of ore at 1.66% Cu, and 35,000 tonnes of waste rock to access the zone.

3.3 Ore Production and Scheduling

The following graph shows the underground release schedule color coded by zone.

As Area 2 finishes, mining will transition to the Minto East zone. In late 2018, simultaneous mining in Copper Keel and Minto East will be used to increase the production rate from the underground mine so that it contributes approximately 70% of the mill feed. In July 2019, the first ore from Minto East 2 will begin to supplement ore from Copper Keel; by July 2020, it will begin to compensate for the drop in Copper Keel production as stopes are exhausted in that ore zone. Finally, Minto North underground will supplement the ore supply starting in late 2020, allowing steady production as the Minto East 2 zone is completed.

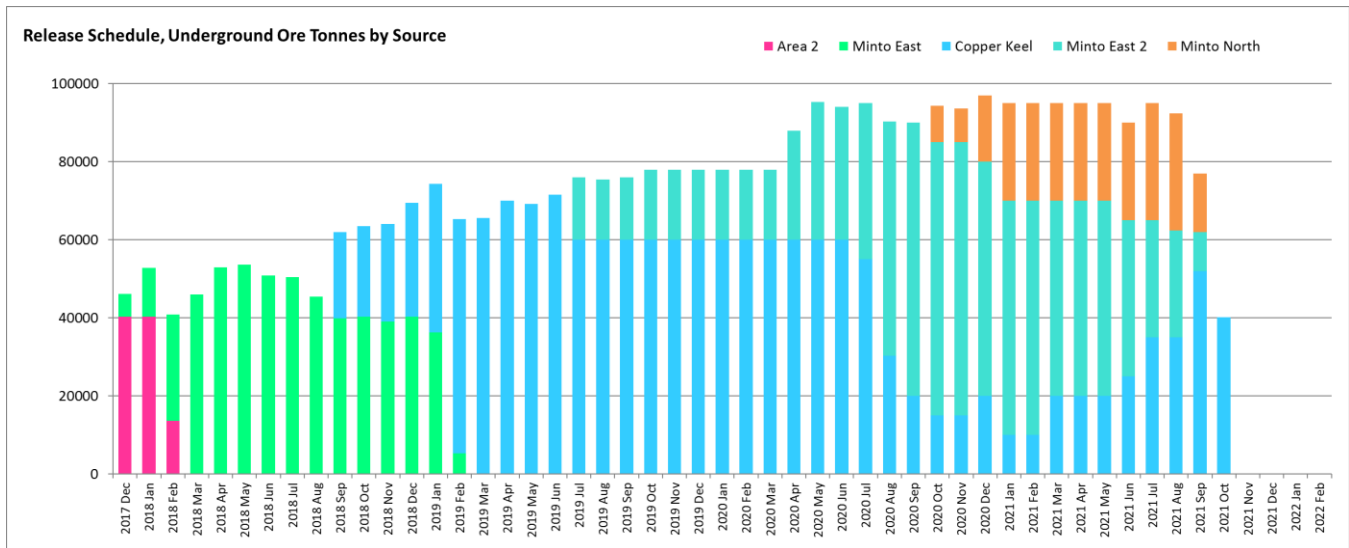


Figure 3-1: Ore release schedule by zone

The tonnages produced by the underground mine will change as detailed stope designs are prepared, taking into account the local ground conditions and optimizing the locations of stopes based on in-fill drilling.

4 Mine Operation

4.1 Material Handling

A combination of 7 and 10-yard LHD units and 42 tonne trucks are to be used for ore and waste haulage. The broken ore from the stopes will be mucked by LHDs to remuck bays, or loaded directly in to trucks, which will carry ore from the mine to a small stockpile near the portal.

The surface mining fleet will then take ore to open pit stockpiles or to the mine crusher on a daily basis.

Waste rock from development headings will be either hauled to surface in the same manner, or trammed to a mined-out stope and dumped there. The waste is moved to the appropriate waste dump as outlined in the *Waste Rock and Overburden Management Plan (WROMP)*.

4.2 Water Supply – Minto East 2

Inflow to the Minto South Underground through faults and un-grouted diamond drill holes has been found to provide an adequate quantity of water for drilling and dust control. The mine has had a net excess of water and has discharged to surface continuously since March 2016.

4.3 Water Supply – Minto North Underground

The Minto North pit lake currently contains 21,000 m³ of water. This will be the Minto North Underground's primary source of fresh water.

4.4 Dewatering – Minto East 2

Minto East 2 will form an extension of the Minto South Underground and will therefore use the infrastructure already in place to dewater previously developed ore zones. Water will be pumped, via a series of sumps, to a pump station adjacent to the Minto East zone, from which it will be pumped to surface via a borehole. Discharge will be into the Main Pit Tailings Management Facility.

4.5 Dewatering – Minto North Underground

Water flowing into the mine via diamond drill holes or through fractures and other natural water-bearing structures, as well as water from mine operations such as drilling and dust suppression, will be collected in small local sumps and pumped to the Minto North pit. The water from the pit will be re-circulated for use in mine operations. After the completion of mining in the Minto North underground, the water from the Minto North Pit will be pumped into the underground workings.

4.6 Mine Water Quality and Inflow Monitoring

The 2018 Environmental Monitoring, Surveillance and Reporting Plan (EMSRP) outlines the proposed monitoring and surveillance of the underground at the Minto South Portal and Minto North Underground Portal. UG1 has been assigned as a station number and monitoring frequency as part of the license for the Minto South Portal. Additional monitoring stations have been added to the monitoring network for Minto East, Copper Keel, Minto East 2, Minto North Underground and Wildfire. A representative sample of underground inflows is taken regularly.

Results of the monitoring work are presented in the monthly WUL reports and summarised in the QML and WUL annual report.

4.7 Ventilation

Air is currently supplied to the Minto South Underground by a surface installation commissioned in March 2015. The fan specifications are as follows:

Rated power	344 hp
Motor control	Variable frequency drive
Max rotation speed	880 rpm at 60Hz
Fan specifications	101.5" diameter with adjustable blade pitch
Air heating system	Four propane burners in two modular burner houses
Max air heating capacity	32 million BTU/h

Table 4-1: Surface fan specifications

Testing the system at full speed showed that it is capable of delivering 350,000 cfm through the ventilation circuit as it was configured in 2015. The actual quantity of air delivered to underground workings will vary with the resistance and length of the entire mine's network of ramps and exhaust airways.

Since mine startup in 2012, air has been exhausted via the Minto South Portal. A new exhaust raise, adjacent to the Minto East zone, will be commissioned in Q1 2018. Air will be forced up the raise by booster fans installed in a bulkhead at the base of the raise. This arrangement may be upgraded to a dedicated exhaust fan installed on surface, pending the results of further ventilation modeling.

Comprehensive ventilation modeling has not yet been undertaken for the Minto East 2 and Minto North Underground zones. Minto East 2 will require both a new secondary egress and an exhaust airway, which may take the form of bored raises to surface or internal raises that connect to the existing Minto East fresh air raise and escapeway. The Minto North Underground will be supplied with fresh air by a fan installed on the secondary escapeway / airway portal. Air will exhausted up the main haul ramp.

Air for the Minto South Underground is heated to maintain above-freezing temperatures year-round. The system comprises four burners and their ancillary infrastructure (blower motors, CO and temperature sensors, electronic controls). Six 30,000 gallon propane tanks supply the burners with fuel. A smaller propane-fired heater will be installed on the Minto North Underground surface fan.

Distribution of air from main airways to active development headings and stopes will be via 48" vent ducting. In-line electric booster fans are added as needed to maintain target airflows.

4.8 Explosive Storage and Handling

Blasting practices for the proposed mining will remain unchanged from current practices.

Emulsion is used for both longhole production and development. A bulk emulsion product known as Dyno Titan RU, formulated for underground use and having high viscosity, is used to load most blasts. This product is delivered via one of two dedicated mobile loading units – one for development rounds and a larger unit for longhole stope blasts.

In development, a perimeter blasting product (Dynosplit D) is used to reduce overbreak in the back, and Dyno AP (a cartridge emulsion) is used in wet lifter holes.

The following table lists the magazines on site:

License No.	Location	Magazine Contents – March 2016	Capacity
YT-535	Surface	Surface detonators	40,000 dets
YT-533	Surface	Surface explosives	30,000 kg
YT-541	Surface	Underground detonators	75,000 dets
YT-534	Surface	Underground explosives (perimeter control and boosters)	30,000 kg
YT-542	Surface	Surface explosives (pre-shear)	30,000 kg
YT-551	Surface	Underground explosives (packaged emulsion)	35,000 kg
YT-553	Underground	Underground detonators	4,000 dets
YT-550	Underground	Underground explosives	30,000 kg

Table 4-2: Explosives magazines.

The Minto South Underground has two magazines, one for detonators and one for bulk and packaged explosives. Both are equipped with concrete floors and lockable gates. The powder magazine is large enough to store and handle 1.5 tonne totes of emulsion used by the development loader. The larger longhole loading unit is parked on surface at Dyno Nobel's office / shop / silo complex.

The Minto North Underground will not have underground magazines; the small extents of the workings and the short duration of mining make it impractical to construct a magazine such that it meets Yukon OHS regulations for the 60m minimum clearance distance from the main ramp. The Minto North Underground will be serviced from the surface magazines listed in Table 7-3.

Non-electric caps are used to time and sequence blast holes in development blasts, while electronic detonators are used for longhole blasts. A single electric cap is used to tie each development blast into the mine's electric central blasting system.

4.9 Fuel Storage and Distribution

Haul trucks, LHDs, and service vehicles are fueled at station installed on surface near the Minto South Portal. This comprises a 50,000 liter double-walled EnviroTank, concrete barriers around the tank, and fuel dispensing equipment.

A tank of similar construction will be set up near the Minto North Portal when mining of that deposit begins.

5 Mine safety

5.1 General Mine Safety

Minto Mine and the development contractor, Dumas Mining, emphasize safety in all duties at the mine; this philosophy is shared by senior management and supervisors. Minto's safety program includes the following:

- Dumas *Zero Harm Safety System* and associated safety card, used and checked daily by supervisors.
- A central system for tracking incident reports and the corrective actions arising from them.
- Safe work practices (SWPs) for routine tasks that present a risk of injury.
- Job hazard assessments (JHAs) for non-routine tasks; these are used as the basis for SWPs if a job becomes routine.
- Routine job observations and workplace inspections by supervision and technical personnel.

5.2 Emergency Response

Portable refuge stations are maintained in the Minto South Underground with the goal of ensuring that miners can reach a refuge station or fresh air base with the oxygen supply available in the self-rescuers they carry. Additional refuge stations will be added to the mine as it expands. The Minto North underground will also be supplied with a refuge station.

The refuge stations are equipped with compressed oxygen cylinders, CO₂ scrubbers, potable water, first aid equipment, emergency lighting, emergency food rations, and chemical toilets. They are also equipped with a digital telephone line and a backup analog telephone (Femco).

Secondary egress for the Minto East 2 zone will be via either a dedicated ladderway to surface, or an underground raise connecting the ore zone to the Minto East ladderway. Secondary egress for the Minto North Underground will be via a second ramp and portal from the Minto North highwall.

All underground personnel are required to carry Ocenco M-20 self-contained self-rescuer (SCSR) devices, which provide oxygen from a compressed gas cylinder for 15 to 20 minutes (up to 32 minutes if the user is resting). In addition to the personal devices, units with longer durations of 60 minutes are available in two caches located near active mining faces. These caches also contain first aid supplies, an oxygen therapy unit, water, food, flashlights, and blankets.

A mine-wide stench gas warning system is installed at the surface fan to alert underground workers in the event of an emergency.

Minto has an emergency response team trained in underground mine rescue techniques.

5.3 Fire Suppression

Fire extinguishers are provided and maintained in accordance with regulations and best practices at electrical installations, pump stations, wash bays, and refuge stations. Every vehicle carries at least one fire extinguisher of adequate size and proper type. Heavy equipment is equipped with central fire suppression systems.

For the use of the mine's emergency response team, a trailer containing a foam sprayer, hoses, an inflatable bulkhead, and other firefighting supplies is parked near the fresh air raise.