Minto Mine
QML-0001

Underground Mine Development and Operations Plan Amendment
Copper Keel Zone
August 2018

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1 Introduction

This document amends the Underground Mine Development and Operations Plan (UMDOP) for the Minto South Underground to include the Copper Keel ore zone.

2 Operations Overview

As of August 2018, mining has concluded in the Area 2 zone, and is currently underway in Minto East. Development of the ramp to Copper Keel began in June 2018 and is ongoing.

The replacement Minto East escapeway was completed on April 24, 2018. Longhole drilling began on May 16 and the first production blast was taken on June 8. Development is still in progress on the 505 and 470 levels, but has been completed on 490 level. Production is currently underway on the 490 level.

Boring of the Minto East vent raise was completed in January 2018; however, unstable ground in the top 50m of the raise has necessitated rehabilitation and additional support before it can be put into use. To prevent further instability the raise is currently backfilled and remediation work is expected to be completed in September 2018.

Development of the ramp to Copper Keel began on June 9.

3 Deposits and Ore Reserves

The Copper Keel zone consists of a main lens, located approximately 450m southeast of the Minto East ramp, and two small satellite lenses (Copper Keel West and Copper Keel North).

Production will begin in the Main lens. At this time, it is expected that the West and North lenses will be deferred until later in the mine life, as they yield relatively small tonnages of ore. These lenses also require additional definition drilling, geological modeling, and design work to upgrade the geological confidence. The stope and access designs presented for these zones are preliminary.

Official reserves for Copper Keel are given in the following table.

	Ore (t)	Cu %	Au g/t	Ag g/t	Cu lbs x 10^6
CK Probable Reserve	1,616,000	1.73	0.63	6	61.6
CK Total Reserve	1,616,000	1.73	0.63	6	61.6

The design presented in this document mines 1.44 Mt from the Main lens, 87,000 tonnes from the North lens, and 297,000 tonnes from the West lens. These tonnages differ from the official reserves due to refinements made to the design since the last published technical report.

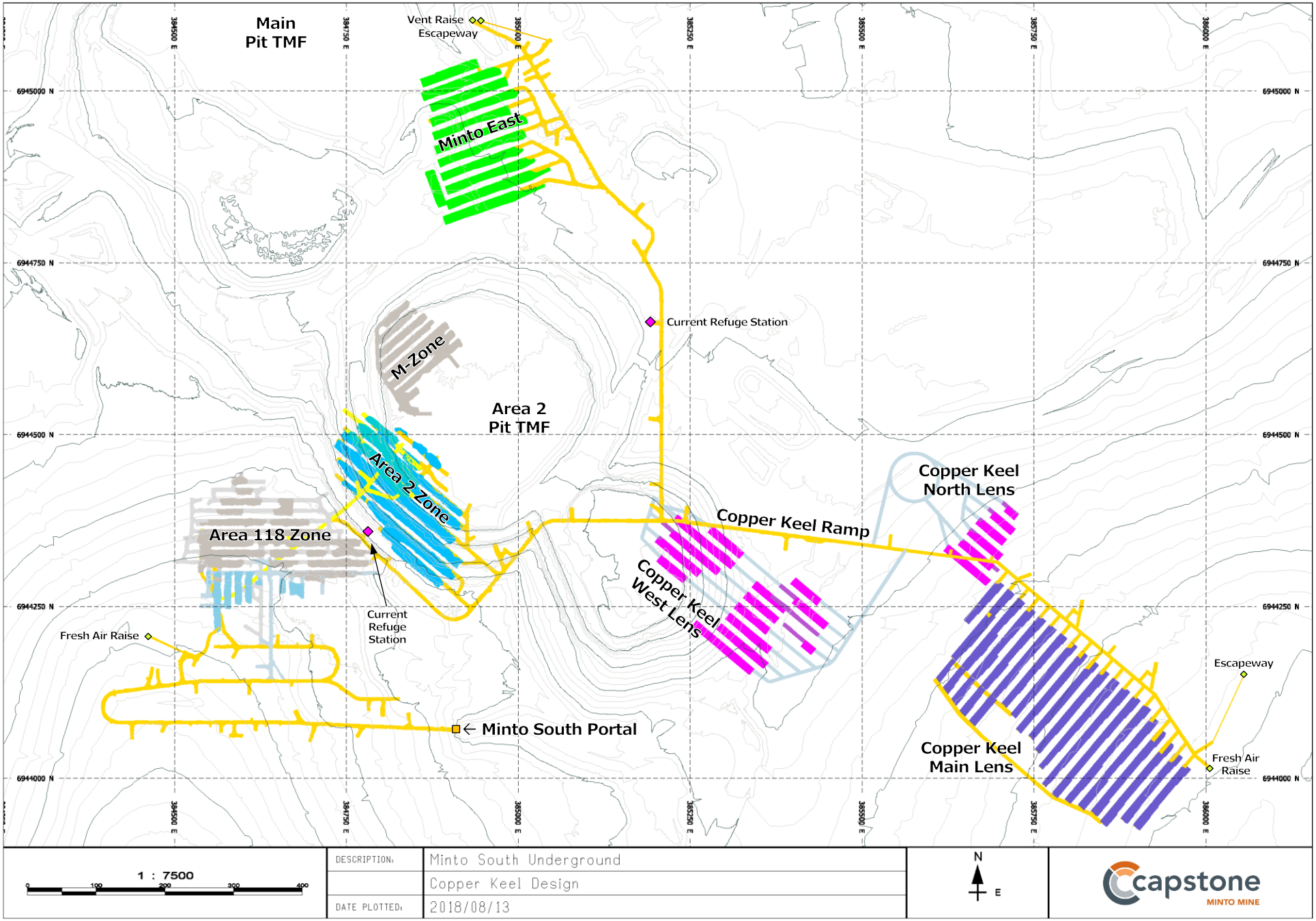


Figure 3-1: Plan view of underground development and ore zones.

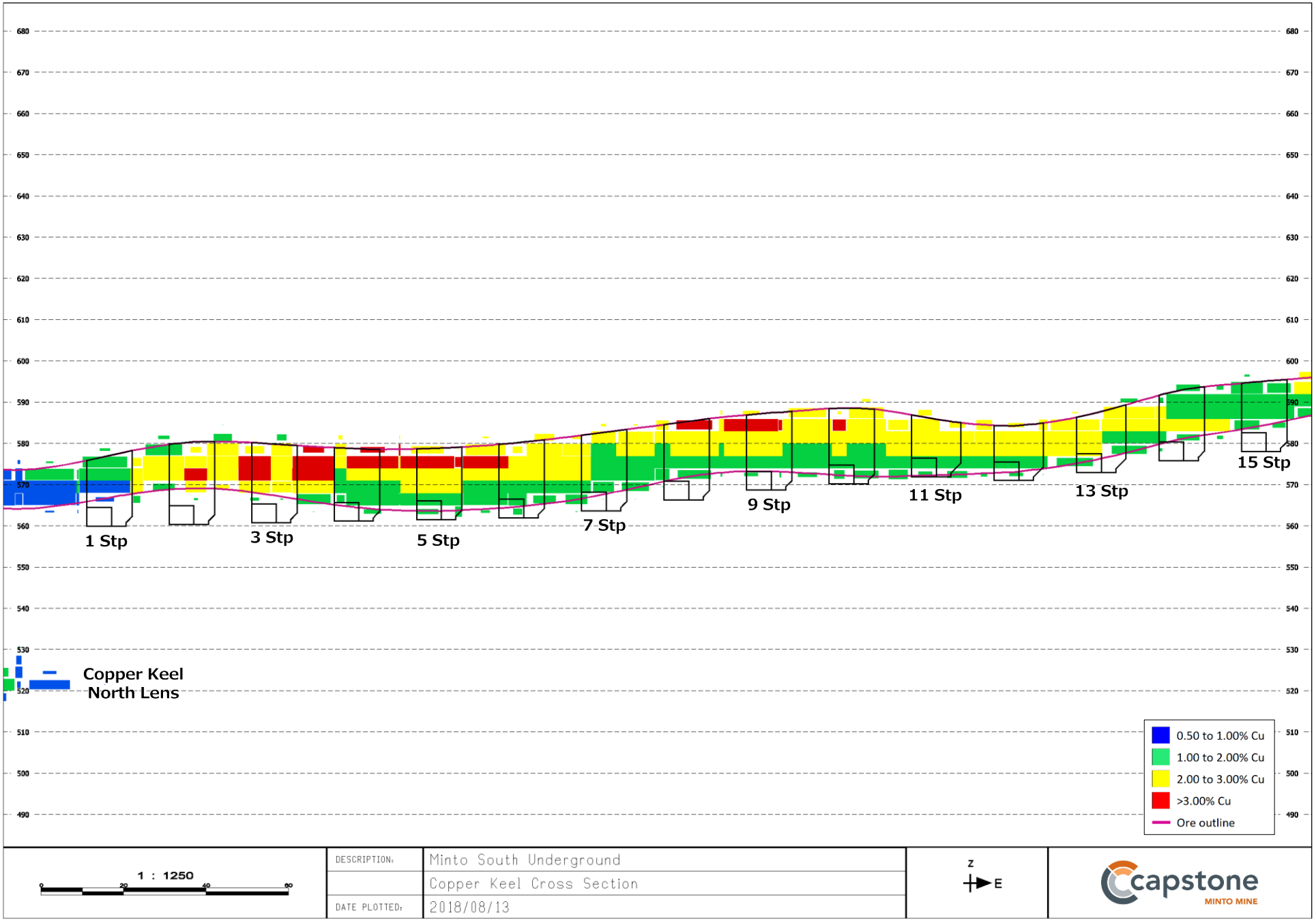


Figure 3-2: Section view through Copper Keel main lens.

4 Mine Development and Design

4.1 Ramp Development

The ramp is 5.0m wide and 5.5m high, consistent with the main ramp to the Area 2 and Minto East zones. It will be used for all ore and waste haulage, personnel/equipment access, and services running to the Copper Keel zone. The back height is increased to 6.5m at remuck intersections to provide the height necessary for the LHD units to load trucks.

Re-muck bays are developed every 150m to improve the efficiency of the development cycle; they are designed to hold two rounds of development muck. The re-muck bays have the same dimensions as the decline and are 20m in length. Additional cutouts for drill bays, sumps, etc. are developed as required. Safety bays are developed every 30m.

4.2 Main Lens Design

A design for Copper Keel is shown in Figure 3-1. A main access is driven along the northeast edge of the lens, from which 20 sill drifts are driven along the footwall contact of the ore zone. Sill drifts are spaced every 20m.

The drifts are typically driven at +13% grade. In most of the sill drifts, the footwall contact rises steeper than this; drifts start in ore but end in waste, necessitating that some waste be mined below the footwall contact. For some of the stopes, the ore zone is approached from two sides so that excessive footwall dilution need not be taken.

The constant positive gradient will simplify water management, while the grade has been selected as an acceptable compromise between LHD productivity and dilution.

4.2.1 Stope Width and Sill Drift Spacing

The design presented in this document features 20 sill drifts, spaced at 20m intervals.

The design is nominally based on 12m-wide stopes and 8m pillars, but geotechnical analysis indicates that the pillar width must vary as a function of stope height in order to maintain stability and maximize recovery. Pillar thickness is increased where the stope is tall and decreased where the stope is short.

The current design results in an extraction ratio of 56% for the main lens. In May 2018, Minto drilled three new geotechnical holes into the Copper Keel Main lens to verify rock quality parameters. Lab testing and geotechnical analysis is currently underway to verify assumptions used in stope and stope and pillar designs; the final extraction ratio may change based on the results of this work.

4.3 Truck Loadouts

Two truck loadouts are planned for Copper Keel to reduce LHD tram distance. Each consists of a truck bay, a scoop bay / remuck, and a connection between the two. The scoop bay is elevated relative to the truck bay so that the LHD can dump material into the truck box from above, improving fill factors.

4.4 Water Management

A single sump is planned at the lowest point in the main access. Sumps are typically 15m long and dip at -15%. Water collected in the sump will be pumped to the Minto East pump station, where it is pumped directly to surface through a sub-vertical pipe using multi-stage electric pumps.

4.5 Escapeway

An escapeway from the lowest workings of the mine was completed in the Minto East area in April 2018 and will remain active throughout Copper Keel mining. An additional escapeway will be created at the northeast corner of the Copper Keel Main lens, to serve as an additional escape route and reduce risk as production stopes in Copper Keel are retreated back towards the access. The planned location is presented in Figure 4-1. The east end of the deposit underlies the hillside west of Minto's airstrip where there is minimal overburden cover.

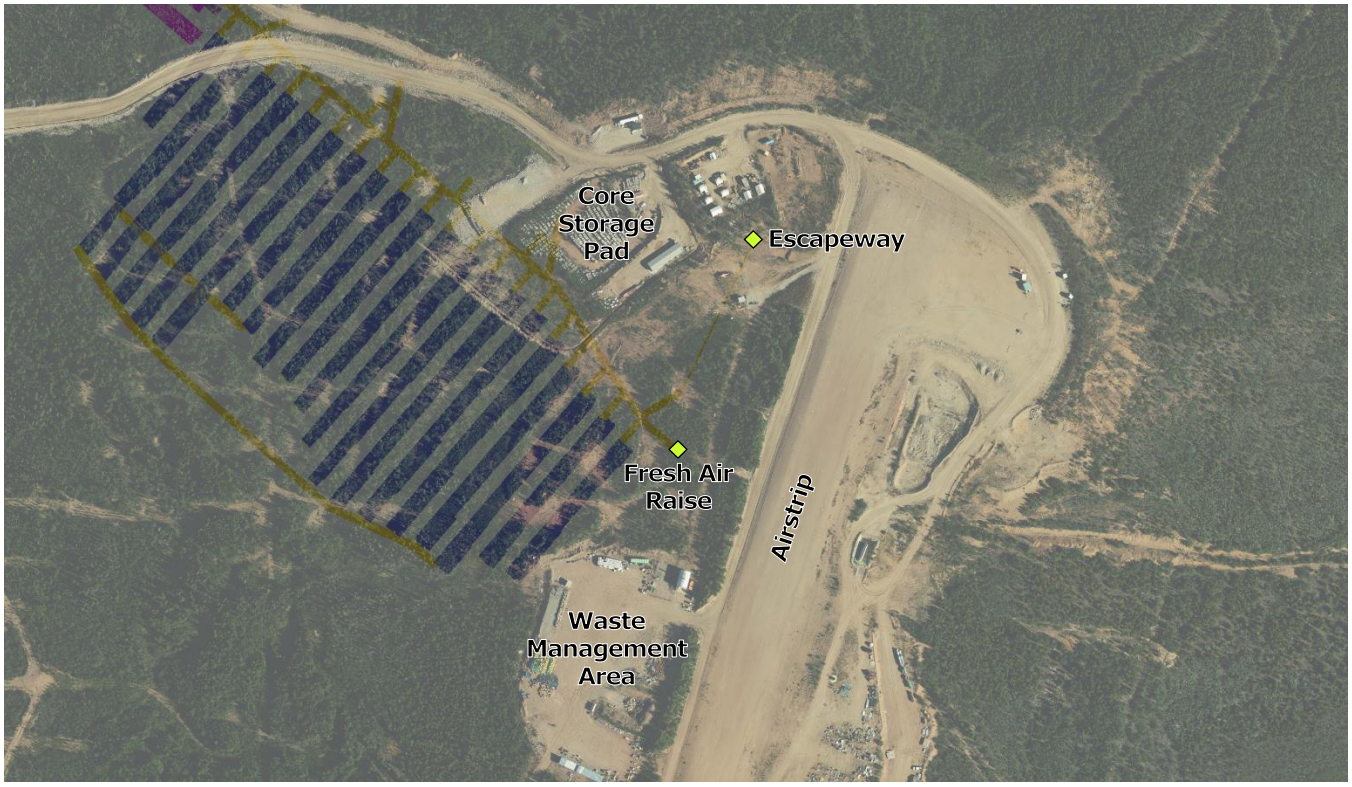


Figure 4-1: Escapeway and fresh air raise breakthroughs on surface.

Like the Minto East escapeway, the additional escapeway will consist of a ladder tube system in a dedicated bored raise.

4.6 Vent Raise

A vertical ventilation raise, measuring 288m to surface and 3.1m diameter, will be developed at Copper Keel. It will break through approximately 150m from the escapeway. Additional information on the proposed vent raise can be found in Section 8.

5 Scheduling

The ramp accessing the Main lens, followed by access along the Main lens, will be the primary development priority. As development progresses, intersection ground support for all 20 stope sills will be installed, and each will be stubbed in so that services (vent ducting, pipes, electrical cables, etc.) will not be damaged when stope sill development begins. Concurrently, a second development crew will work on truck loadouts, the electrical bay and sump, and stope sills. Once the main access passes the last stope sill intersection, an escapeway access drift will be developed so that the escapeway raisebore breakthrough will be >30m away from the main ramp. This will be followed by an extension of the main access by approximately 30m to provide a breakthrough location for the ventilation raise. The following are major milestones in the schedule for Copper Keel development and production activities. Note that these are estimates based on current development rates and can change based on crew productivity, ground conditions, equipment availability, and other factors.

2018

- June 9: ramp development began
- September: ramp development reaches first stope sill intersection; development begins on main access. Sill development begins as secondary priority.
- December: main access development reaches last stope sill.

2019

- January: escapeway and vent raise access drifts completed. Breakthrough of raisebore pilot hole to follow. Raise boring and ladder tube installation to take approximately three months.
- February: first pre-production longhole drilling begins.
- March: start of production stoping.

2020

- February: Main lens development complete. Development of the access ramp to the Minto East 2 zone begins, subject to approval of further amendments to the Underground Mine Development and Operations Plan.
- Production continues from Copper Keel Main.

2021

- May: Main lens production finishes.
- May: ramp to West lens begins development.
- July: ramp to North lens begins development.
- November: pre-production longhole drilling begins in West lens

2022

- March: North lens drilling begins
- May: West lens development completed
- June: North lens development completed
- July: West lens production longhole blasting begins
- August: North lens production longhole blasting begins.

- November: North lens production finishes.
- November: West lens production finishes.

6 Mine Operation

6.1 Material Handling

Material is mucked from stopes and development headings by a combination of 7- and 10-yard LHD units. Stope mucking operations are carried out via remote control from a stand set up at the open stope brow; the operator is not exposed to the unsupported ground in the open stope.

A fleet of four Atlas Copco 42 tonne trucks is currently used for haulage; the fleet size is expected to increase by up to three trucks as the ore production rate increases to 2,000 tonnes per day.

All haulage is through the Minto South ramp and portal.

Ore from both development and stoping is hauled to a surface stockpile adjacent to the portal, from which it is picked up by a separate fleet of surface haul trucks and loaders and taken to the crushing plant.

Waste rock from development headings is hauled to a surface stockpile adjacent to the portal. Development rounds are assayed and the waste is moved to the appropriate waste dump as outlined in the *Waste Rock and Overburden Management Plan (WROMP)*. The protocols for segregation and placement of waste materials are consistent with the protocols for surface mining.

7 Geotechnical

7.1 Orebody Geometry

The main lens of the ore body measures approximately 500m in length and is, on average, 190m wide. It strikes at 320 degrees and has an average dip of 13 degrees.

Table 7-1: Summary of Orebody Geometry

Parameter	Copper Keel Main	Copper Keel North	Copper Keel West
Depth (m)	220 - 300	300 - 360	200 - 250
Area (m)	390 x 170	110 x 60	280 x 150
Dip (degrees)	10 - 15	20 - 25	10 - 15
Vertical Thickness (m)	9 - 25	5 - 15	5 - 15

7.2 Excavation Dimensions

The following is a summary of the planned excavation and pillar dimensions.

Table 7-1: Summary of Excavation Dimensions

Excavation/Pillar	Copper Keel Main	Copper Keel North	Copper Keel West
Development drifts, ramps	5.0 m (W) x 5.5 m (H)	5.0 m (W) x 5.5 m (H)	5.0 m (W) x 5.5 m (H)
Production drifts	6.0 m (W) x 4.5 m (H)	6.0 m (W) x 4.5 m (H)	6.0 m (W) x 4.5 m (H)
Longhole stope (non-entry)	12 m (W) x 9-20 m (H)	11.5 m (W) x 5-10 m (H)	11.5 m (W) x 5-12 m (H)
Longhole pillar	8 m (W) x 9-20 m (H)	8.5 m (W) x 5-10 m (H)	8.5 m (W) x 5-12 m (H)

7.3 Rock Mass Characterization

7.3.1 Rock Mass Classification

Rock mass characterization is based on core logging and laboratory testing. Summaries of rock mass quality and strength and contained in Table 7-3, Table 7-4, and Table 7-5.

Table 7-3: Summary of RMR values for Copper Keel (Golder, 2015)

Simplified Lithology	Total Length Logged (m)	Minimum RMR	Maximum RMR	Weighted Average	Rock Mass Quality (avg)
Ore	489.43	33	89	72	Good
Hangingwall	156.29	40	89	71	Good

Table 7-4: Summary of Q' values for Copper Keel (Golder, 2015)

Simplified Lithology	Total Length Logged (m)	Minimum Q'	Maximum Q'	Weighted Average	Rock Mass Quality (avg)
Ore	513.43	0.154	100	17.8	Good
Hangingwall	165.29	.221	99.0	13.9	Good

Table 7-5: Summary of Q' values for 2018 core logging

Simplified Lithology	Total Length Logged (m)	Minimum Q'	Maximum Q'	Weighted Average	Rock Mass Quality (avg)
Ore	48.84	0.69	1066.7	29.2	Good
Hangingwall	68.81	0.35	1142.9	11.9	Good

7.3.2 Intact Strength

Laboratory testing of intact rock strength shows the rock in Copper Keel to be strong to very strong.

Further to the existing data, eighteen samples were taken from four diamond drillholes in 2018 for Unconfined Compressive Strength (UCS) testing. Six of the samples were from waste in close proximity to the hangingwall contact, and twelve were ore. Results for waste gave a range of 97 to 146 MPa, with an average of 110 MPa. Results for ore ranged from 81 to 195 MPa, with an average of 124 MPa. These strengths are similar to those in other lenses of the Minto South Underground. Table 7-6 summarizes the UCS test results.

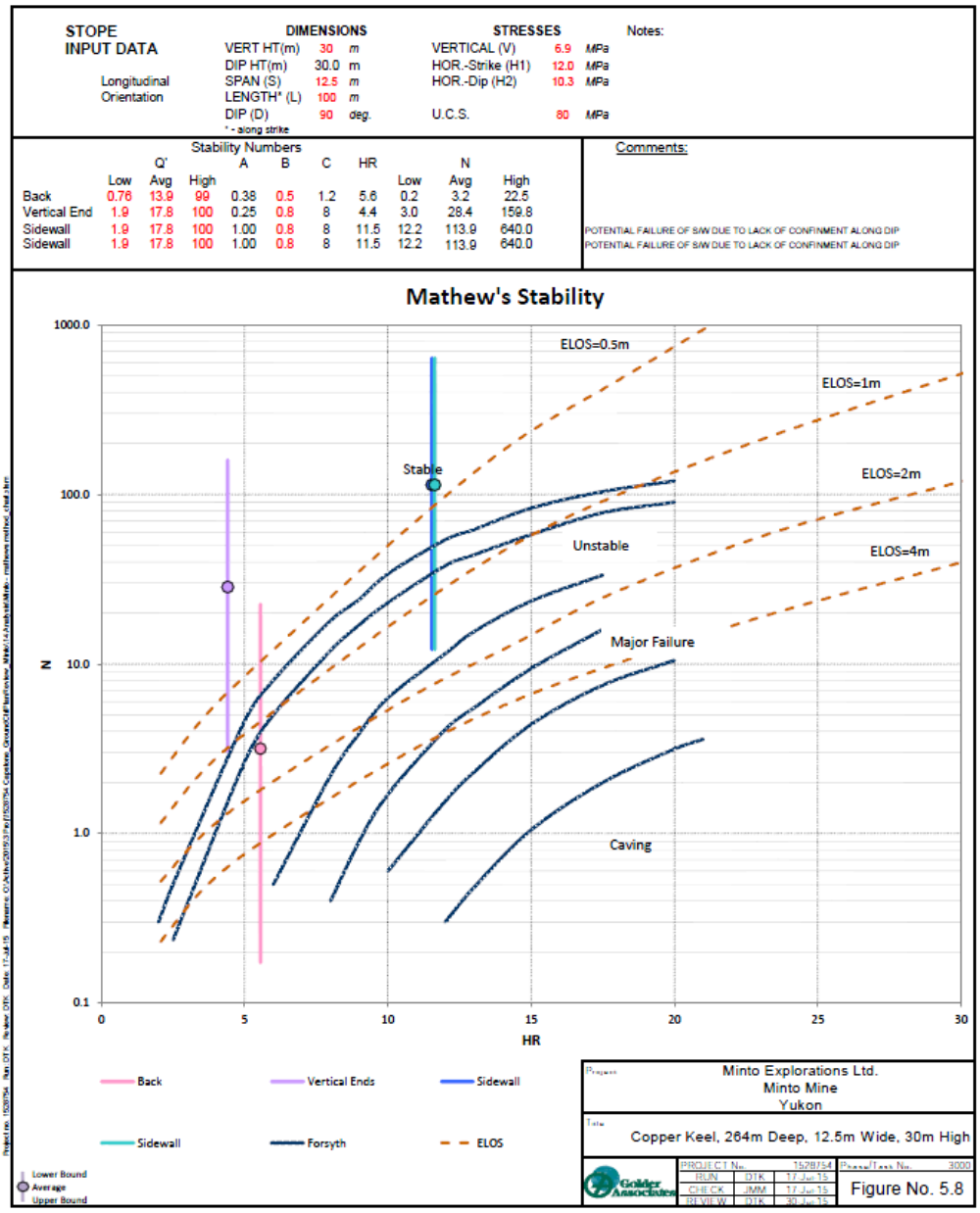
Table 7-6: Summary of 2015 and 2018 laboratory UCS test results

Simplified Lithology	No. of valid Samples	Minimum UCS (MPa)	Maximum UCS (MPa)	Average UCS (MPa)
Ore	7	81	195	124
Hangingwall	5	97	146	110

7.4 Stability Analysis

Stope spans for future mining areas were designed using a combination of empirical analysis, numerical modelling, and experience in the Minto underground to date. Figure 7-1 shows the stability graph for 12.5 m wide and 30 m high stopes for Copper Keel as per planned stope and pillar geometry.

Figure 7-1: Mathew's Method Stability analysis from Golder 2015:



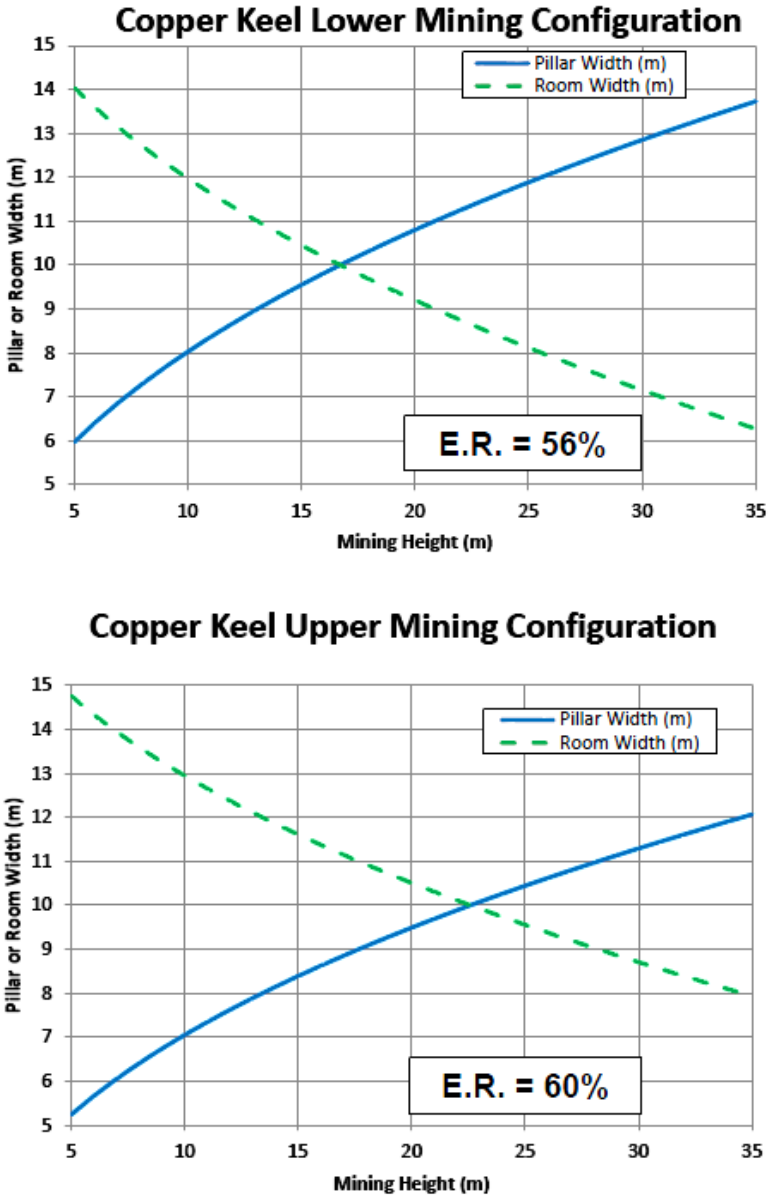
The following is an excerpt from Golder 2015:

The assessment suggests that 10 m wide stopes in typical ground are stable, but localised areas of poorer quality hanging wall waste could result in challenging back conditions and slough. Increases in stope span beyond 10m will result in increasingly challenging conditions and 15m wide stopes in typical ground would expected to exhibit

slough that will result in operational challenges. A change in mining approach whereby ground support would be installed in the stope backs would be required to provide confidence in back spans beyond 10 m to 12.5 m.

Pillar stability analyses were also carried out by Golder in 2015. Permissible stope and pillar widths were estimated for the range of mining heights in the Copper Keel deposit, shown in Figure 7-2 below. Average extraction ratios shown are based on the distribution of ore thickness. These analyses assumed an intact rock strength for ore of 80 MPa, which recent lab testing indicates is a conservative assumption. Analyses are updated as more information is gained during development of the deposit.

Figure 7-2: Summary of permissible stope and pillar widths (Golder, 2015)



7.5 Ground Support Requirements

Ground support requirements for underground development are contained in the Minto Underground Ground Control Plan. The following are summaries of ground support elements and requirements for development openings.

Table 7-8: Ground Support Elements

Support Element	Description	Minimum Breaking (tensile) Strength	Comment
Bolts	#6 (20mm) (3/4") threaded rebar bolt w/ full column resin	13 tonnes	-
	#6 (20mm) (3/4") forged head rebar bolt w/ full column resin	18 tonnes	Used for raise development.
	Super Swellex (36 mm)	24 tonnes	-
	Standard Swellex (27 mm)	12 tonnes	Used for face bolting.
	Split sets (35 mm)	6 tonnes	Used for face bolting.
Plates	Domed - 15 x 15 cm (6" x 6"), 6 mm (1/4")	-	-
Resin	30mm x 610mm cartridge 30 second (fast) 180 second (slow)	-	-
Mesh	6-gauge welded wire mesh	~ 2-3 tonnes bag strength	Galvanized for permanent excavations. Bright for short-term excavations.
Straps	0-gauge welded wire mesh straps	-	Used for stope brow support.

Table 7-9: Minimum Ground Support for Development and Production Openings

Type		Span (m)	Primary Support (minimum)	Comment
1	**Development Drifts (typical ground conditions)**	5.0	• 2.4 m (8 ft.) rebar in back around perimeter of mesh sheets • 1.8 m (6 ft.) rebar in back and walls to pin mesh at center • 1.8 m (6 ft.) rebar in walls to 1.5 m above floor • 1.5 x 1.5 m bolt spacing diamond pattern • Galvanized welded wire mesh to 1.5 m above floor	Life of mine infrastructure in typical ground conditions.
2	**Production Drifts (typical ground conditions)**	6.0	• 2.4 m (8 ft.) rebar in back around perimeter of mesh sheets • 1.8 m (6 ft.) rebar in back and walls to pin mesh at center • 1.8 m (6 ft.) rebar in walls to 1.5 m above floor • 1.5 x 1.5 m bolt spacing diamond pattern • Bright welded wire mesh to 1.5 m above floor	Non-permanent development (e.g. stope/production room crosscuts) in typical ground conditions.
3	**Poor ground – fault zones**	≤6.0	• 2.4 m (8 ft.) rebar in back around perimeter of mesh sheets • 3.6 m (12 ft.) Super Swellex to pin mesh at center • 1.8 m (6 ft.) rebar in walls to 1.5 m above floor • 1.5 x 1.5 m bolt spacing diamond pattern • Bright/Galvanized welded wire mesh to 1.5 m above floor	Poor ground, typical in fault zones.
Intersection Secondary Support				
All Types - Intersections		≤9.5	To be installed in addition to primary support patterns outlined above: • 3.6 m (12 ft.) Super Swellex in back and shoulders • 1.8 x 1.8 m bolt spacing - Installed at least two rows past the intersection in each direction.	Intersection support to be installed prior to taking wall slash.

7.6 Monitoring

Monitoring is described in detail in the Minto Underground Ground Control Plan. The following table summarizes the primary elements of the monitoring programs.

Table 7-10: Summary of Ground Control Monitoring

Element	Description
Inspections	• Daily inspections of active production openings by geotechnical engineer, Minto supervision and/or Dumas supervision • Monthly inspections of fresh air raise/manway • Quarterly inspections by the geotechnical engineer of all development and production openings • Ground control log book maintained by underground shifters and checked by geotechnical engineer
Geotechnical mapping	Rock quality and structure mapping is carried out regularly by geotechnical engineers/geologists to identify major structures and changing conditions for use in geotechnical analysis and mine design.
Cavity monitoring surveys (CMS)	Carried out in open stopes, typically after each blast.

7.7 Hydrogeological Assessment

A detailed hydrogeological assessment has not been completed to define the potential inflows in Copper Keel; however, with the development and production completed to date, Minto has extensive experience with the hydrogeological regime and operational requirements at the site. Inflows encountered to date in the Minto South Underground have been associated with discrete water-bearing faults and with un-grouted diamond drillholes. No unmanageable inflows have been intersected and a standard sump and pump dewatering system has been used without any curtain grouting required. The discharge rate from the mine averaged 300 m^3/day (55 gpm) in 2017-2018.

8 Ventilation

8.1 Ducting

Initially, Copper Keel will be ventilated by two 48” ducts suspended in the ramp. One duct will be composed of spiral-welded steel duct segments with in-line 150 hp 48” electric fans spaced approximately 450m apart. This will be hung on the north side of the ramp / main access. The second duct, on the south side of the ramp, will be composed of rigid plastic ducting. This ducting cannot withstand negative pressure, but has significantly lower leakage and friction factors than steel ducting, so two 150 hp 48” fans will be placed in series at the duct intake.

The north duct will ventilate the main ramp, remucks, and truck loadouts, while the south duct will ventilate stope sills. The two ducts will provide air for development and production until a permanent vent raise is established in Copper Keel.

8.2 Vent Configuration, Phase 1 (before completion of Minto East vent raise)

During the first phase, while Minto East is still ventilated using ducting, air for Copper Keel will be drawn from the main ramp that accesses the Minto East ore zone. Exhaust air currently comes up the ramp; the fan intake will pick up this exhaust air for use in Copper Keel. This arrangement is shown in Figure 8-1.

As Copper Keel uses return air from Minto East, the quantity of air supplied to Minto East will be used to determine the equipment that may operate in both areas. To ensure that the equipment running in the two zones does not exceed the total air available, Minto will use a ventilation tag board. The volume of air provided down-ramp of the board, based on the most recent vent survey, will be shown along with a table of air requirements for each piece of equipment in the fleet.

All personnel proceeding past the tag board will be required to tag in and add the volume of air used by their equipment to the total used. If the total used would exceed the volume available, they will not be allowed to proceed.

When a truck is hauling, its tag will remain on the board as it hauls to surface and returns. When multiple trucks are hauling, a tag for a single truck will be placed on the board, and truck drivers will use the mine’s radio system to coordinate their activities such that only one truck is past the tag board. If sufficient air is available and the shift plan calls for two trucks to be loaded simultaneously in two areas (one in Minto East and one in Copper Keel, for example), two tags will be placed on the board.

While two ducts will be installed in Copper Keel, the south line will not be active in Phase 1.

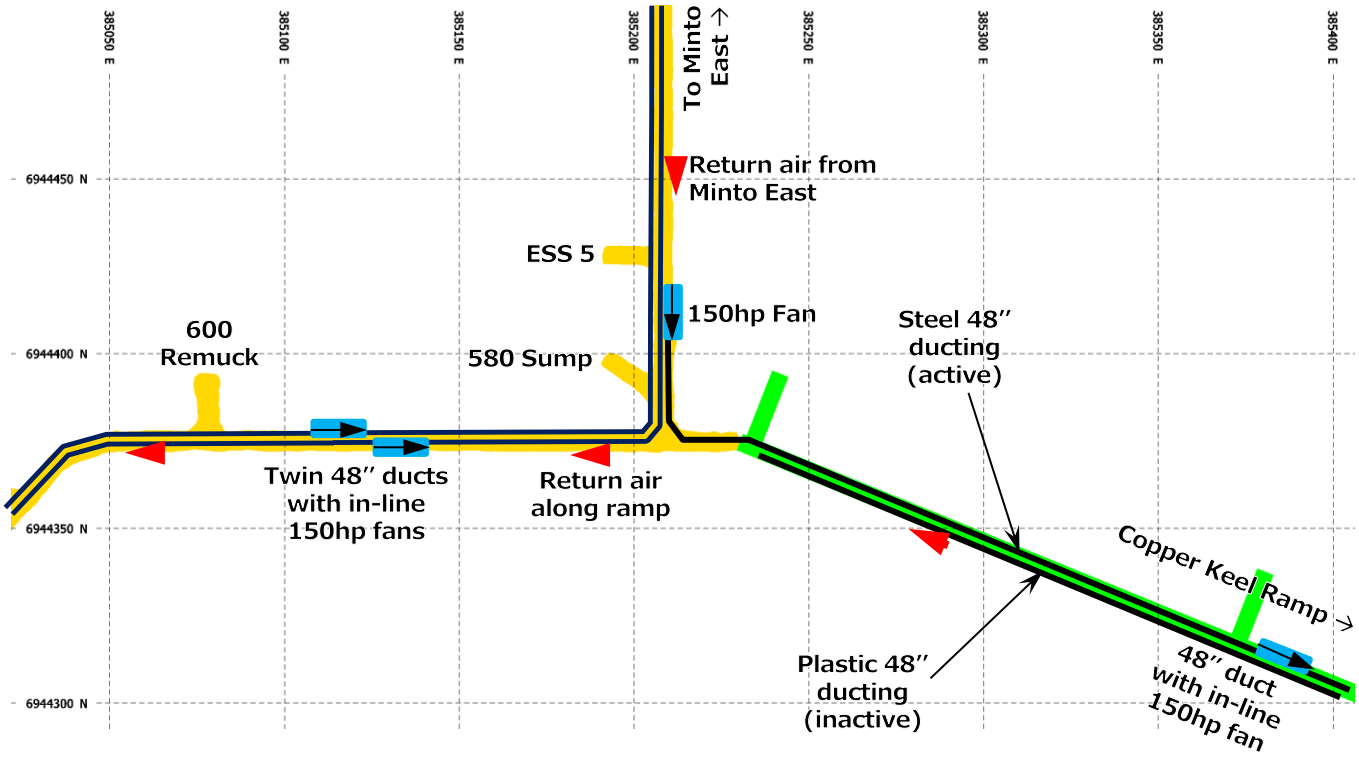


Figure 8-1: Ventilation configuration for Copper Keel Ramp prior to Minto East raise commissioning (Phase 1).

8.3 Vent Configuration, Phase 2 (after completion of Minto East vent raise)

Once the Minto East vent raise is completed, the airflow in the ramp to Minto East will be reversed, with fresh air traveling down the ramp. The fan and ducting supplying the Copper Keel Ramp will be moved, as shown in Figure 8-3, and the Copper Keel Ramp will be ventilated using fresh air rather than exhaust air from Minto East.

Minto East will receive the exhaust air from Copper Keel; however, the overall airflow on the main ramp will increase significantly; there will be sufficient airflow to meet the requirements of all equipment operating in both Minto East and Copper Keel. Modeling predicts an airflow of 246,000 cfm traveling down the ramp with the existing surface fan on the 760 Fresh Air Raise and three 150hp 48" fans exhausting at the Minto East Vent Raise.

Both the north and south ducts ventilating Copper Keel will be extended up-ramp to prevent recirculation. A 150hp fan will be installed on the south duct; as the duct lengthens or airflow requirements increase, a second fan will be added in series. Modeling of this approach has been validated by an external consultant; the predicted airflow as a function of distance is shown in the graph below.

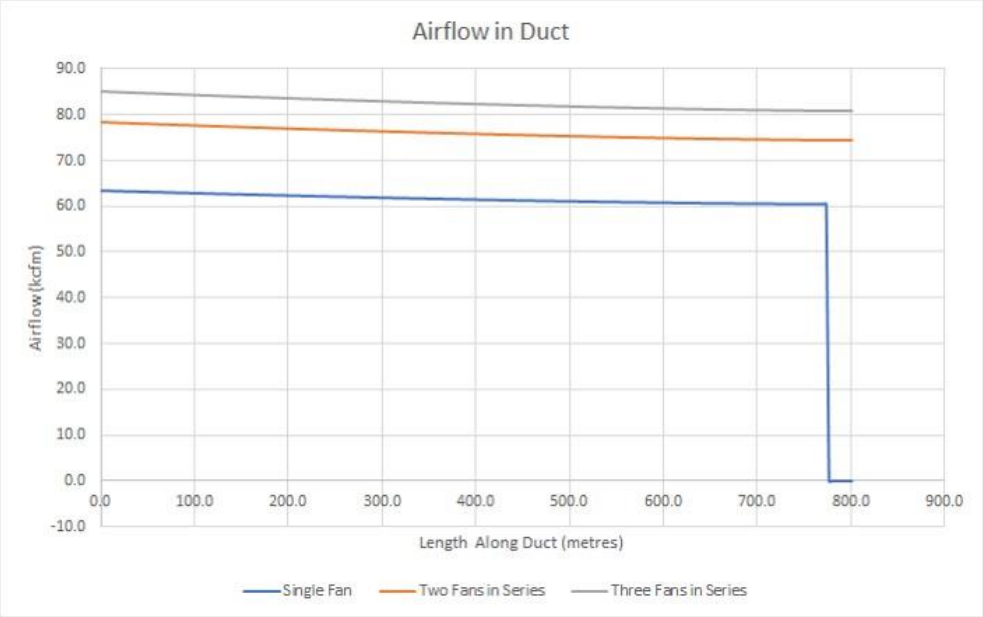


Figure 8-2: Airflow in 48" plastic duct as a function of length, for one / two / three fans in series at the duct intake.

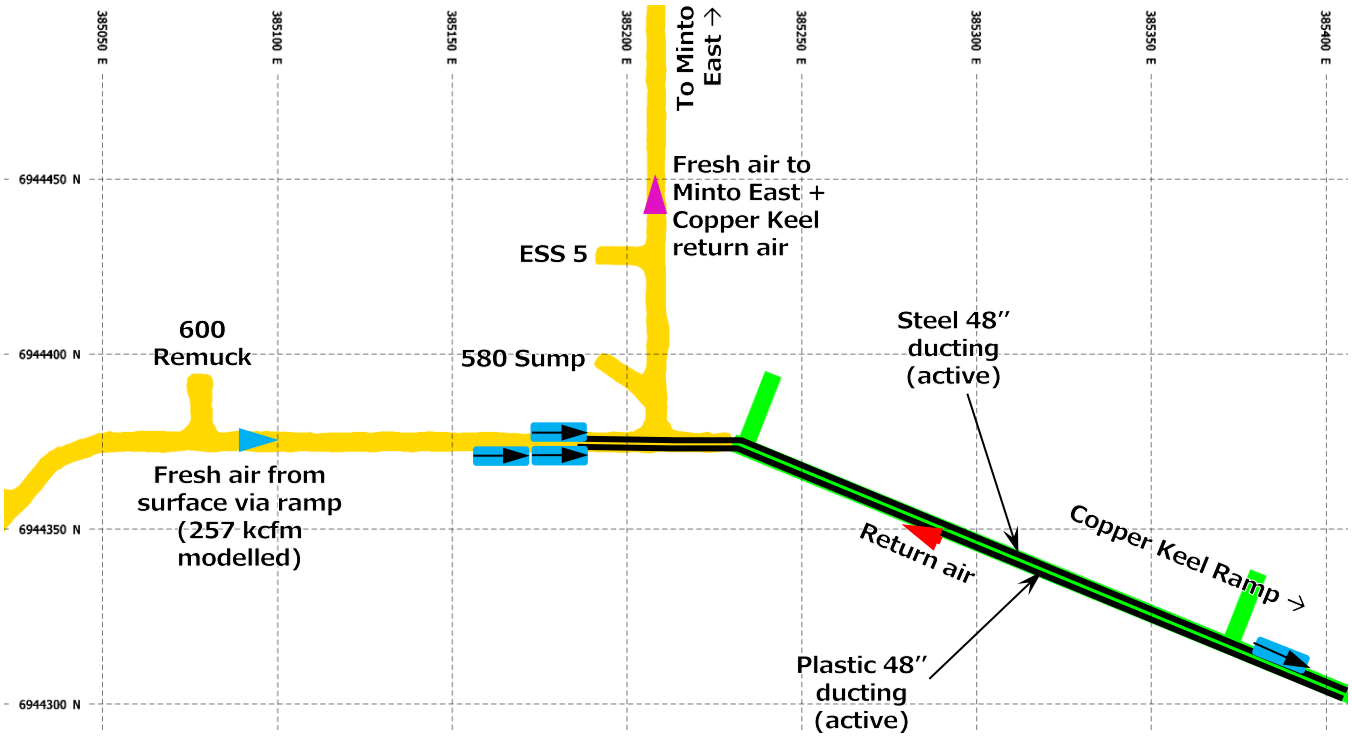


Figure 8-3: Ventilation configuration for Copper Keel Ramp after Minto East raise commissioning (Phase 2).

With two fans in series, the plastic duct can deliver 75 kcfm to the end of the Copper Keel main access. The steel duct, having a higher friction factor ($k = 21.8 \times 10^{-10}$ vs. $k = 11.5 \times 10^{-10}$ lb-min^2/ft^4), can deliver approximately 66 kcfm with two fans and 73 kcfm with three.

8.4 Ventilation Circuit, Phase 3 (after completion of Copper Keel raise)

Once the Copper Keel raise is completed, a new surface fan will be installed, along with air heaters and supporting infrastructure. This raise will deliver fresh air to Copper Keel to support mucking of three stopes simultaneously.

The ventilation raise will break through near the mine's air strip, as this location is likely to contain minimal overburden and weathered rock; however, a geotechnical assessment of the site will be completed before raise boring begins. A geotechnical diamond drill hole will be cored, including hydrogeological testing, and the results analyzed for suitability and support requirements.

The surface fan infrastructure will be similar to that currently installed at the top of the 760 FAR. It will feature direct-fired propane heaters and a single main fan with variable-frequency drive.

8.5 Equipment Airflow Requirements

The air volume required for the fleet currently in use is shown in the table below.

Table 8-1: Ventilation requirements for equipment operating in the Minto South Underground

Make / Model	Equipment Type	Fleet	Engine Power (hp)	CFM Required
Atlas Copco ST1520	LHD	3	400	27,200
Sandvik LH410	LHD	2	295	17,000
Atlas Copco MT42	Haul Truck	4	520	36,700
Sandvik Jumbo	Jumbo Drill	1	147	9,200
Atlas Copco M2C Jumbo	Jumbo Drill	1	150	8,100
Maclean MEM-928	Bolter	1	147	9,200
Maclean MEM-946	Bolter	1	150	8,100
Minecat UT100	Tractor w/ forklift, backhoe	2	99	7,000
Walden M-60	Scissor Lift	2	86	7,500
Getman	Emulsion Loader	1	99	7,000
Toyota Land Cruiser	Flatdeck, mancarrier	4	127	7,300

9 Ancillary Infrastructure

9.1 Compressed Air

The Copper Keel Ramp will be supplied with compressed air by extending the existing reticulated 4" air line network.

Minto currently has three Atlas Copco GA-315 (1811 cfm at 125 psi, 350hp) air compressors. One compressor operates steadily, a second automatically supplements the first during periods of high demand, and a third is kept on standby to provide redundancy. These compressors are located in the tailings filtration building adjacent to the mill. Air is piped underground via a borehole from surface to the underground workings in Minto East. An air dryer is installed on surface in the line supplying the underground operation.

Mobile electric equipment such as jumbos and bolters are equipped with their own compressors. The central compressors are needed only for longhole drilling, jackleg / stoper drilling, pneumatic dewatering pumps in development headings, and other minor uses.

9.2 Underground Electrical Power

Power enters the Minto South Underground at 4160V via the portal and is distributed with Teck cable, typically 350 MCM three-conductor. It is converted to the 600V working voltage of mobile equipment, pumps, and fans by one of four air-cooled skid-mounted substation units. Minto currently has two 750 kVA units and two 1000 kVA units.

During ramp development, the Copper Keel zone will be supplied with 600V power from an electrical bay located 50m down-ramp of the Minto East / Copper Keel intersection. A 1000 kVA substation is installed at this location, along with starter panels for fans, pumps, and mobile equipment. This infrastructure will be left in place to power fans until the Copper Keel vent raise is established.

As development advances, a new electrical bay will be created adjacent to the Copper Keel ore zone. One of Minto's 750 kVA substations will be relocated from Area 2; this will power mobile equipment.

9.3 Water Supply

The Copper Keel Ramp will be supplied with water for drilling and dust suppression by extending the existing reticulated 4" water line network.

9.4 Dewatering

Water will generally drain from each stope sill onto the main access. It will flow along the main access roadway to a sump created at its lowest point, from which it will be piped to the pumping station installed in Minto East.

The pumping station consists of a three-stage settling sump system and redundant high-pressure 125 hp pumps, which transfer water directly to surface via a pipeline installed in a borehole. From the surface breakthrough location, a short section of insulated and heat-traced pipe transfers water to the adjacent Main Pit Tailings Management Facility (MPTMF), which receives the underground water stream.

9.5 Communications

The mine-wide VHF leaky feeder radio system will be extended to Copper Keel. This provides three channels: one for ramp traffic, one spare, and one emergency channel. The latter is repeated on surface, providing a unified site-wide emergency channel.

Refuge stations are equipped with radios, telephones connected to the mine's internal communications network via a fiber optic network, and an analog emergency communication system (Femco phone).

Femco phones are installed inside and outside the refuge stations, the base of the fresh air raise at 760 level, the surface muster station adjacent to the portal, and the Dumas shop on surface.

9.6 Blasting Procedure and Infrastructure

The mine's electric central blasting system will be extended into Copper Keel. This typically fires a single electric blasting cap, which is used to initiate the network of non-electric caps that time and fire each hole in a development blast.

Stope blasts are timed and initiated by electronic detonators; namely, Dyno Nobel Digishot Plus. These are programmed and initiated via the same blast line network.

The mine is completely cleared of personnel for both production and development blasting. Every person entering the mine places a lock on a tag board. The key for the blast box is locked behind the board and can only be accessed when all personnel have removed their locks.

9.7 Explosive Storage and Handling

Emulsion is used for both longhole production and development. A bulk emulsion product known as Dyno Titan 7000, formulated for underground use and having high viscosity, is used to load 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 where required 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:

Table 9-1: Explosives magazines

License No.	Location	Capacity
YT-535	Surface	40,000 dets
YT-533	Surface	60,000 kg
YT-541	Surface	75,000 dets
YT-534	Surface	10,000 kg
YT-542	Surface	30,000 kg
YT-551	Surface	35,000 kg
YT-553	Underground	4,000 dets

YT-550	Underground	30,000 kg

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.

10 Mine safety

10.1 General Mine Safety

Minto Mine and its 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 procedures (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.

10.2 Emergency Response

Two portable refuge stations are currently maintained in locations shown on Figure 3-1. They are positioned to provide refuge for the Area 2 and Minto East zones. Once development of the Copper Keel main access is complete, a refuge station will be installed in this area.

Refuge stations are equipped with compressed oxygen cylinders, CO_2 scrubbers, potable water, first aid equipment, emergency lighting, emergency food rations, and chemical toilets. With Minto's air compressors moved to surface, they have also been connected to the compressed air system; this provides a second source of breathable air.

Refuge stations are equipped with a digital telephone line, a backup analog telephone (Femco), and mobile radios that can communicate with the mine's leaky feeder system. Each refuge station is equipped to supply oxygen to 16 people for 96 hours, independent of the compressed air now also available.

The mine currently has three escapeways:

1. The fresh air raise from surface to 760 level is equipped with ladders.
2. A sub-level escapeway with ladders connects the Area 2 ramp at the 685m elevation to the 710 level, which receives fresh air directly from surface via open stopes that connect to the 760 level.
3. An escapeway from the lowest point in the mine at Minto East directly to surface 300m above.

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, 22 devices with longer performance durations of 60 minutes are available split 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. This system can be triggered from the mill control room.

Minto has an emergency response team trained in underground mine rescue techniques. Details are contained in Minto's *Emergency Response Plan*.

10.3 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 760 fresh air raise.

10.4 Hours of Work

Minto holds an underground hours-of-work variance issued on April 24, 2018 (presented in Appendix A), permitting the following:

- A maximum of 11 hours of work underground for any worker during any 24 hours period if working in enclosed cabs with a HEPA-filtration system.
- A maximum of 10 hours of work underground for all other workers during any 24 hour period.
- A shift schedule of up to 12 hours/day, 7 days/week for up to 4 weeks on and 2 weeks off.

Underground hours of work are monitored using RFID cards issued to each worker, which are tagged in and out at the portal muster station at the beginning and end of each shift.

10.5 Industrial Hygiene and Fatigue Management Programs

An industrial hygiene (IH) consultant, EHS Partnerships Ltd., was engaged to assist Minto in the development of an underground IH plan and a fatigue risk management programs (acceptable to YWCHSB) for, but not limited to, air quality, noise and fatigue. Regular testing has taken place since underground operations commenced, and results of this program were included in the recent application for an hours of work variance. The Fatigue Management Plan is presented in Appendix B.

10.6 First Line Supervisory Training

The Contractor will comply with the Yukon Occupational Health and Safety (OH&S) regulation by maintaining First Line Supervisor's Certificates for all supervisors.

10.7 Diesel Equipment

All diesel equipment used in the underground operation is permitted and maintained to comply with sections 15.58, 15.59, 15.61 and all related sections of the Yukon Occupational Health and Safety Regulation.

10.8 Shotcrete

Shotcrete is not routinely used at Minto; to date, it has seen use as ground support in one section of ramp measuring approximately 10m in length. When required, it is sprayed wet using a unit mounted to a MineCat MC100F utility vehicle. A Marcotte M40 trans-mixer unit is used to mix shotcrete and transport it to the working face.

Appendix A – Hours-of-Work Variance

Yukon Workers' Compensation Health and Safety Board

401 Strickland Street
Whitehorse, Yukon
Y1A 5N8

tel: 867 667-5645
fax: 867 393-6279
claims fax: 867 667-8740
toll free: 1 800 661-0443
web: wcb.yk.ca

April 24, 2018

Mr. Yves Brouillette
General Mine Manager
Minto Explorations Ltd.
Suite 900-999 West Hastings Street
Vancouver, BC V6C 2W2

Dear Mr. Brouillette:

Re: Underground Hours of Work Variance Request

I am writing in response to your request for a variance as outlined in the letter from the previous Minto Mine General Manager, dated February 29, 2016. The variance requested is specifically to modify the hours of work scheduled in an underground mine as established in section 15.13 (1) of the Yukon Occupational Health and Safety (OHS) Regulations, Part 15 Surface and Underground Mines or Projects. Section 15.13(2) provides authority for the Director of OH&S to, "consider and approve an application for modified hours of work schedule in an underground mine if the director is satisfied that the risk to the health and safety of the workers is not increased".

In considering your request, I have reviewed the health and safety controls highlighted in the variance request letter along with inspection reports, correspondence and industrial hygiene reports from the date of the original underground hours of work variance approval on October 3, 2012 to the present. I am granting Minto Explorations Corp. the requested variance for extended hours underground during operation at the Minto Mine under the following conditions:

1.0 Hours of Work

- A maximum of 11 hours of work underground for any worker during any 24 hour period if working in enclosed cabs with a hepa-filtration system.
- A maximum of 10 hours of work underground for all other workers during any 24 hour period.
- A shift schedule of up to 12 hours/day, 7 days/week for up to 4 weeks on and 2 weeks off.

- Hours of work for all staff working underground must be monitored to ensure that the appropriate hours allowed underground is maintained. The records must be available for review.

2.0 Occupational/Industrial Health Requirements

2.1 Exposure Limits

- Use of the ACGIH threshold limit values (TLVs) for air contaminants.
- Use of the Ontario exposure limits for diesel particulate matter (DPM) of 400 micrograms per cubic meter.
- Hours of work can be adjusted using the Quebec IRSST model if the contaminant is included in Appendix IV of the IRSST Technical Guide T-22. If not, Section 27(4) of the Occupational Health Regulations must be used to adjust hours of work (e.g., diesel particulate matter).
- Hours of work must be adjusted based on the total work hours (12 hrs) and not only hours of work underground.

2.2 Occupational/Industrial Hygiene Program

- A robust occupational/industrial hygiene program must be in place that identifies the risks to worker health from underground mining, as well as a strategy for measuring and controlling exposure to harmful contaminants.
- A certified industrial hygienist or registered occupational hygienist must develop and guide the program.
- Any mine staff completing hygiene sampling must be trained and deemed competent by an industrial hygienist.
- Air sampling must be done at least quarterly for all identified air contaminants.
- The program must include a process for investigating and controlling exposures above 50% of the adjusted permissible concentrations (TLVs) for air contaminants. 50% of the TLV is commonly known as an action limit.
- The program must clearly identify the hierarchy of controls in managing exposures. Use of PPE such as respirators will not be accepted as a control strategy in the absence of reasonable engineering and administrative controls.
- Enclosed hepa-filtered cabs are required for any worker underground for 11 hours in any 24-hour period as a control for airborne contaminants.

2.3 Mine Ventilation

- All diesel equipment used underground must be permitted and maintained as outlined in 15.58 of the OH&S Regulations.
- An appropriate volume of air for all equipment working underground must be maintained at all times as outlined in section 15.61(2) of the OHS Regulations.
- Ventilation surveys must be completed weekly as outlined in 15.58 (4) (a) (b), (5) and 15.61(4)(a) of the OHS Regulations.
- Supervisors and operators must be trained and competent in understanding mine ventilation surveys compared to the equipment permitted to operate.

- On a daily basis, prior to each shift, ventilation surveys must be reviewed with operators and compared to equipment permitted to operate underground to ensure the required volume of air at each location where operators are working.
- All diesel equipment must be shut down immediately if there is an interruption of the main ventilation system, as outlined in Section 16.10 (2) of the OHS regulations.

2.4 Diesel Exhaust Emissions (Tailpipe) Testing for Carbon Monoxide (CO)

- The mine must have a documented procedure that outlines the process for completing mandatory CO tests in the tailpipe on a weekly basis and following engine repairs as outlined in 15.60(3) and (4)(b)(i)(ii) of the OHS Regulations.
- All tests must be logged and available on request.
- Tests must show less than 1000 ppm CO. If above 1000 ppm, the equipment must be tagged out of service until repairs are done and retesting complete.
- The mine must have a preventative maintenance plan for diesel operating equipment to ensure equipment is operating as outlined by the manufacturer's specifications.

2.5 Diesel Exhaust Testing for Exhaust Gases

- The mine must have a documented procedure that outlines the testing program for exhaust gases underground including a protocol for action to be taken when results show levels above 50% of the maximum permissible concentration.
- Tests must be done weekly for CO, NO^2 and LEL at operators position for a full shift as outlined in sections 15.61(4)(c)(d) and (5) of the OHS Regulations.
- Tests for aldehydes must be done every three months at the operator's position for a full shift as outlined in 15.61(4)(e) of the OHS Regulations.
- All tests must be logged, reviewed for overexposures and available upon request.
- Carbon Monoxide detection monitors must be placed in the compressed air utilized in the underground and checked at least monthly.
- Carbon Monoxide detection monitors must be placed in the air heating system utilized in the underground and checked at least monthly. CO monitors must be placed 15 meters downstream.

2.6 Dust Management

- Adequate dust suppression measures such as spray bars must be implemented at and near the muck piles or any other sources of any other activity that generates dust.
- Any shotcrete usage in the underground workings must be of the wet type of application, as outlined in your variance request letter of February 29, 2016.

2.7 Fatigue Risk Management

- A fatigue risk management plan must be maintained and followed. All staff must be trained in fatigue risk management.

2.8 Respiratory Protection Program

- A respiratory protection program must be in place that includes: a statement of purpose; outlines responsibilities, includes written procedures for selection, use, inspection, cleaning, maintenance and storage of respirators; instruction and training; fit testing; medical assessment, where required; documentation; and program review.

2.9 Medical Assessment and Biological Monitoring

- Medical exams and biological monitoring for exposure to lead and silica must be completed as outlined in sections 21 to 26 of the Occupational Health Regulations.
- An audiometric test program must be completed as outlined in section 6 of the Occupational Health Regulations.
- Certificate of medical fitness signed by the medical practitioner must be kept on file and available for review, as outlined in section 23(3) of the Occupational Health Regulations.

2.10 Quarterly Review of Industrial Hygiene Program Data and Reporting

- All industrial hygiene data collected needs to be reviewed by an industrial hygienist for analysis and recommendations with the expectation that recommendations will be implemented within a reasonable timeframe.
- A quarterly management report must be completed and provided to the Director of OH&S outlining results, exposures above the action level, remedial actions and follow-up test plans and sampling results.

3.0 Front line supervision

- Each shift must have a supervisor with a current First Line Supervisor's Certificate.

4.0 Emergency Response

- Emergency response equipment must be provided as described in the variance request letter of February 29, 2016.

5.0 Mine Rescue Capacity

- Mine rescue must be provided as described in the variance request letter of February 29, 2016.

This variance will expire on April 24, 2023. The Yukon Workers' Compensation Health and Safety Board, at its sole discretion, reserves the right to review this variance and the terms upon which it was granted at any time. A safety officer may establish additional conditions on this variance based on conditions at the mine site or results of industrial hygiene surveys. Failure to comply with the requirements of this variance will result in immediate revocation.

Regards,

Bruce Milligan,
Director, Occupational Health and Safety

Appendix B – Fatigue Management Plan

Minto Mine

Capstone Mining Corporation's

Fatigue Risk Management Plan (FRMP)

Table of Contents

Introduction

This policy was developed in consultation with Capstone management, supervisors, workers and contractors. It is reflective of current research and knowledge of fatigue and safety management systems, particularly fatigue risk management systems. It is designed to align closely with the existing safety management systems at Minto mine. It is based upon a five level fatigue risk management strategy that is designed to provide multiple layers of controls to assist in mitigating fatigue risk factors.

Scope of FRMP

This policy and supporting procedures apply to all supervisors and workers in the underground mine operations at Minto including direct Capstone employees, contractors or employees of contractors. Any worker who will, at any time, be spending more than 8 hours underground in the mine, shall comply with this Fatigue Risk Management Plan and procedures contained within to ensure they maintain the capacity to safely perform work.

Objectives

This Fatigue Risk Management Plan seeks to mitigate risk factors associated with fatigue in Minto Mine's underground mining operations.

The key objectives of this Fatigue Risk Management Plan are to ensure a safe and healthy working environment free of fatigue related injury or illness by:

- controlling work related fatigue risk factors to minimize the likelihood of a worker being fatigued;
- minimising the risks of persons presenting for work or conducting work while impaired by fatigue;
- establish appropriate steps to manage persons who are effected by fatigue; and
- reducing the likelihood of a fatigue related error or incident.

Communication Strategies

To ensure a common understanding of Capstone's fatigue risk management plan, a copy of the plan will be made available to all supervisors and workers involved in underground mining operations. The Minto Explorations Fatigue Management Policy Statement will be displayed in a visually accessible place to demonstrate Capstone's commitment to properly mitigating fatigue factors.

Minto Explorations Fatigue Management Policy Statement

Minto Explorations Ltd. believes that the health and safety of its employees is fundamental to its business operations. Work related injury or illness is unacceptable and the company is committed to the identification, elimination, or control of workplace hazards for the protection of all employees. The goal is to have zero lost time accidents. The company is committed to implementing operational improvements that offer superior safety and occupational health management.

The management of fatigue in the underground mines is an integral part of Capstone's "Fit for Duty" Policy and as such, is a shared responsibility between Capstone, its contractors and its employees. All employees in the underground mining operations must undertake their work in accordance with this policy to the best of their ability and to take all reasonable care for their own safety and health, as well as the health and safety of their work colleagues.

Capstone Mining Corp. understands fatigue is a risk factor and as such is committed to the following:

1. Zero harm to personnel due to fatigue related error.
2. Operating in accordance with industry standards, while meeting or exceeding compliance with all relevant legislative requirements.
3. Providing the expertise and resources needed to maintain a fatigue risk management system designed to recognize and manage fatigue risks to create safe systems of work and safe and healthy work environments.
4. Promoting fatigue awareness through appropriate training and education to ensure workers and supervisors are able to effectively manage fatigue and are able to communicate openly about fatigue related issues.
5. Ensuring employees understand their right and obligation to protect themselves from workplace hazards and alter or stop work if they believe fatigue is compromising the safety of themselves or others.
6. Ensuring all underground mine employees, sub-contractors and visitors are informed of, understand their obligations, and comply with this policy.
7. Measuring health and safety performance with regards to fatigue, the effectiveness of this policy in managing fatigue, and making improvements as warranted.
8. Investigating the causes of accidents and incident including reviewing fatigue factors, and developing effective and immediate preventative and remedial actions as needed.

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Mine Manger

Definitions

For the purpose of this document, the following definitions apply:

Fatigue: A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a worker's alertness and ability to safely perform their duties.
(This definition is modified from Aviation IFALPA IATA FRMS for Operators,2011).

A Fatigue Risk Management Plan (FRMP) is an integrated set of management practices, beliefs and procedures for monitoring and managing the risks posed to health and safety by fatigue. It is based in safety management system theory with an emphasis on risk management.

Capstone's FRMP incorporates:

> **The FRMP Document:** The FRMP document defines and details the way that fatigue-related risk is dealt with in the underground mine at Minto, and is the written version of the FRMP.
> **Risk Mitigation Strategies:** Contained within the FRMP are five levels of defenses designed to reduce the likelihood of a fatigue related error occurring. The FRMP includes tools, strategies and control measures for monitoring and managing fatigue-related risk.
> **Education and Training:** All underground mine employees need to be aware of the risks posed by fatigue, understand the importance of controlling fatigue risk factors and understand the individual and organisational strategies that are employed in managing that risk. This is facilitated through both supervisor and worker education and training programs.
> **Revision and Review Functions:** The system must be monitored for continuous improvement and to ensure it is flexible to changing work practices. The review function is essential and is therefore built into the Capstone FRMP framework.

Employee/Worker: Any person who works on the site, regardless of their employer. This includes direct Capstone employees, contractors and their employees.
Manager/Supervisor: Any person who is directly responsible for the supervision and well being of other employees.
Company/Employer: Capstone Mining Corporation or Minto Explorations Ltd.
Contractor: A company hired by Capstone Mining Corp. to complete work on site. Employees of the contractor are referred to as employees/workers or managers/supervisors.
FRMP: Fatigue Risk Management Plan
Shift: The hours between the start and finish of established daily work schedules.
Work Rotations/Cycles: The working period scheduled between any significant break away from work.
Work Schedules/Rosters: The hours to be worked for each day, shift, week, month or year, as scheduled by the employer.

A complete list of definitions and terms related to this document can be found in Appendix B.

Standards and Legislation

The following standards and legislation were consulted in the preparation of this FRMP.

O.I.C. 2006/178
YUKON OCCUPATIONAL HEALTH AND SAFETY ACT

REGULATIONS: PART 15 – SURFACE and UNDERGROUND MINES or PROJECTS

Hours underground 15.13

(1) A worker shall only remain underground in an underground mine or project for more than eight hours in any consecutive 24 hours, measured from the time the worker enters to the time the worker leaves the underground workings

(a) when an emergency causes an extension of the time,
(b) on one day of a week but only for the purpose of changing shift, or
(c) if the worker is a supervisor, pump worker, cage tender, or a person engaged solely in surveying or measuring or in emergency repair work.

(2) The director may consider and approve an application for a modified hours of work schedule in an underground mine if the director is satisfied that the risk to the health or safety of the workers is not increased.

"**underground mine or underground project**" means a mine or project that is not a surface mine and includes any work, undertaking or facility used in connection therewith.

Emergency Response

An Emergency is defined in Capstone's Safety Management System. In the event of an emergency, workers and supervisors may be required to work outside of normal shift hours and fatigue may become a key safety issue. In the case of an emergency, all efforts should be made to properly mitigate fatigue risk factors through risk management strategies contained within this FRMP. Supervisors should be extra diligent in monitoring fatigue and in assisting workers in being aware of and managing fatigue to the best of their abilities. If possible, the emergency response manager should conduct regular fatigue assessments to determine if fatigue will become a safety hazard. When the emergency situation has finalized, all workers should be allowed a sufficient period to rest prior to recommencing work duties.

Training

Improving supervisor and worker competency in understanding, assessing and controlling fatigue risk factors, is an integral component of Capstone's FRMP. Specific training programs have been designed and delivered to key Minto employees involved in the underground mining operations. All new workers who will be involved in the underground mining operations will be trained in fatigue competency as part of their on-boarding process. Training records will be kept up-to-date to ensure fatigue competency.

Roles and Responsibilities

Capstone and all of its underground mining personnel share in the responsibility to minimize and manage the adverse effects of work related fatigue. As with all safety management systems, the FRMP recognizes an integral role played by management, contractors and workers. Broadly, roles and responsibilities are outlined below.

Workers are responsible for:

- Obtaining sufficient sleep to be fit for work.
- Reporting when they have been unable to obtain sufficient sleep or when they feel at risk of making a fatigue related error.
- Complying with implemented Fatigue Risk Management Plans and policies including following all processes and completing all required documentation related to Capstone's FRMP.
- Participating in fatigue related education and training provided by Capstone.
- Participating in fatigue investigations as required.
- Seeking medical or other assistance with fatigue related health issues (such as illness or sleep disorders).
- Addressing any concerns regarding fatigue with a supervisor as required.

Supervisors are responsible for:

- Ensuring new workers are oriented and informed about issues relating to fatigue and the Capstone FRMP.
- Providing ongoing information and awareness to all underground mining workers regarding fatigue risk factors.
- Ensure workers are following procedures and processes outlined in Capstone's FRMP.
- Conducting regular health and safety meetings that periodically discuss fatigue risk management.
- Ensuring all observed and reported fatigue symptoms are properly addressed through consultation with workers and through agreed actions within the Capstone FRMP.
- Taking action if an employee is not fit for work due to fatigue.
- Reviewing and investigating all reports of fatigue related errors and incidents.
- Ensuring Capstone Fatigue Incident Investigation Information is gathered as part of any underground mine incident investigation.
- Setting a good example for workers by properly managing fatigue factors.
- Addressing any concerns regarding fatigue with workers and management as required.

Employer is responsible for:

- Creating and implementing a fatigue risk management plan and control strategies to mitigate fatigue related risk.
- Providing resources necessary for education and training to assist workers in building competency in identifying, assessing and controlling fatigue.
- Scheduling work to ensure adequate sleep opportunities for workers.
- Providing conditions that are conducive to managing fatigue, specifically providing adequately for nutritional, hydration and fitness needs of workers while at Minto camp site.
- Providing a proper sleep environment for workers when not on duty at Minto camp site.
- Ensuring resources are available to maintain and regularly review and revise the FRMP.
- Supporting employees with non-work fatigue related issues through existing health and safety programs.

Understanding Fatigue

Understanding fatigue is a key component of any fatigue risk management plan. It is essential for supervisors and workers to understand fatigue factors to be able to properly identify assess and mitigate fatigue risks.

Information required for understanding fatigue includes: circadian rhythms, sleep cycles, causes of fatigue, effects of fatigue, identifying signs of fatigue, and methods of controlling and managing fatigue. These key understandings are an integral part of the supervisor and worker training programs that are provided to all personnel involved in the underground mining operations. These training programs ensure all personnel involved have the understanding and competencies required to properly manage fatigue risk factors. A very brief summary of fatigue understandings is provided below.

Fatigue is an issue because it can impair a workers abilities and can significantly increase the risk of a safety incident occurring. Fatigue causes an increased risk of incidents because of reduced physical and mental abilities and an overall lack of worker alertness. When workers are fatigued they are more likely to have reduced awareness and reduced abilities to respond to changes in their working environment, to react emotionally and/or to exercise poor judgement. This leads to an increased likelihood of incidents occurring due to human error. Fatigue has also been positively linked to multiple long term health concerns such as: digestive issues, ulcers, obesity, diabetes, heart disease, stroke, and immune system deficiencies.

There are numerous factors that influence an individual's likelihood to become fatigued. Key risk factors include: quality and quantity of previous sleep obtained, disruption of circadian rhythms, time of day, age, overall health and nutrition, individual variations, sleep disorders, poor sleep hygiene, stress, family and social obligations, and drug or alcohol use.

Work factors can also greatly influenced fatigue. Key factors to consider include: shift work particularly length, timing, and frequency of shifts; physical and mental requirements of job tasks; working environment; and inadequate breaks.

There are a number of strategies that can be employed to assist in managing fatigue. These strategies include organizational, individual and team-based countermeasures. All three types of control strategies are employed in this FRMP.

Increased awareness of fatigue factors and increased competency in identifying and managing fatigue will reduce fatigue related risk and the likelihood of fatigue related errors and incidents.

Fatigue Risk Assessments Completed at Minto Mine

Risk management encompasses the identification, assessment, control and evaluation of hazards that pose a meaningful risk to the health and safety of employees/workers (including contractors) and visitors to the workplace.

To properly deal with fatigue risk factors, it is important to:

1. identify where fatigue is a hazard and may pose a risk; and
2. assess the level of risk that a given fatigue hazard represents; and
3. when necessary, put in place controls and mitigation strategies,
4. monitor to make sure that they manage the risk at an acceptable level; and
5. evaluate the implemented controls to ensure they have been successful.

Hazard assessments conducted at the Minto Mine site focused on reviewing hazards associated with fatigue. Assessments were conducted based on observations, consultation and discussions with workers, supervisors and contractors. The following areas were examined: mental and physical work demands; work scheduling and planning; environmental conditions; and individual and non-work factors. Risk assessments were based on both likelihood and severity. Results were graphed and quantified and may be viewed in their entirety in Appendix C. Results were used to create the Capstone 5 Level Fatigue Risk Management Plan. Below is a summary of the quantitative results of the initial hazard assessment conducted.

Table 1.1 Capstone's Minto Mine Fatigue Risk Assessment Results

Factor Grouping	Capstone Risk Points	Total Factor Points	Percent of High Risk Areas
Work Demands	18	30	**60%**
Work Scheduling - Hours	22	50	**44%**
Work Scheduling - Shifts	25	40	**63%**
Work Scheduling - Night Work	40	70	**57%**
Work Environment (listed as high as they are not currently fully assessed)	35	40	**88%**
Off Duty Factors	8	40	**20%**
Totals and Average %	**148**	**270**	**55%**

Fatigue risk factors and assessment have been taken from the following document (Fatigue Management Plan - A practical guide to developing and implementing a fatigue management plan for the NSW mining and extractives industry, 2009)

In the initial hazard assessment a number of high risk factors for fatigue were identified. These have been specifically outlined and addressed in the FRMP. An outline of some specific control measures used to assist in managing high risk areas are outlined below.

Table 1.2 High Risk Factor Contols

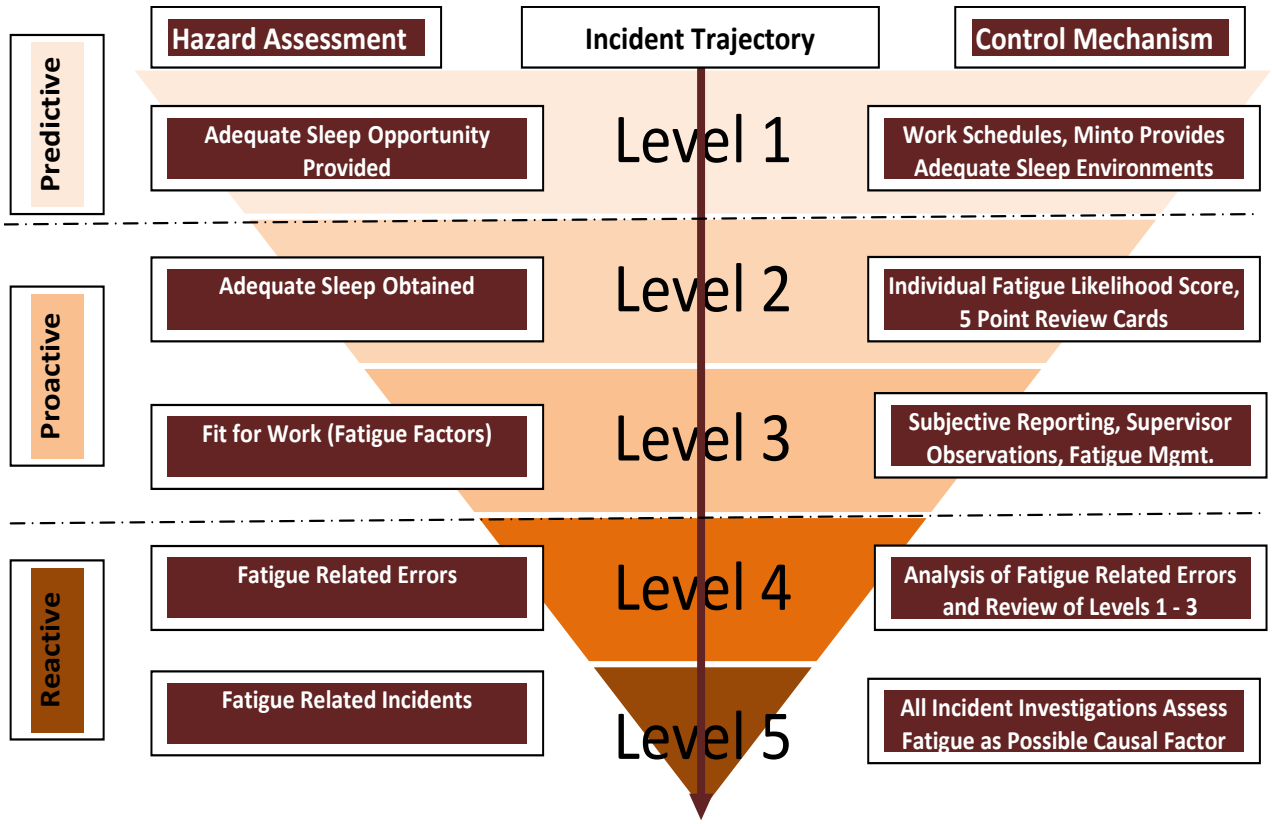
Risk Factor	Control Measures
Work Scheduling	**Increase Sleep Opportunities**
• 12 hour shifts • 14 consecutive shifts • 84 hours in a typical work week • Slow rotations - 2 weeks of day shifts, 2 weeks of night shifts • Night shifts	**Minimize Non-Work/Off Duty Factors to Increase Sleep Opportunities** • Camp provides limited commute and non-work responsibilities to allow for increased sleep opportunities for workers. • Minimal family and social obligations outside of work to reduce fatigue risks. • Food and lodging provided onsite to minimize obligations outside of work. **Ensure worker access to optimal health requirements to reduce fatigue risk** including: overall nutrition, hydration, recreation and exercise. • Camp menus are designed for optimal worker nutrition and health. A gym is onsite for worker fitness needs. A recreation facility is also available onsite for workers. A variety of bottled beverages and water are always available to workers. Drugs and alcohol are strictly forbidden at Minto Mine site. **Provide Proper Sleep Environment:** • Efforts are made to keep sleeping areas secluded and quiet. There are specific quiet areas set aside for night workers to rest during the day. • All rooms have blinds to reduce daylight. • New camp facilities are planned for the spring and sleep hygiene needs have been reviewed for these new facilities.
Start times before 6 AM	• Start times are being adjusted to 7 AM
Work Demands	
Certain job tasks are physically and mentally more demanding (Stoper, Jackleg)	Certain job tasks, such as Stoper and Jackleg Operators, will have mandatory 15 minute breaks after every 2 hours operating equipment.
Work Environment	
Work environmental factors - currently unknown. Possible exposure to hazardous substances, noise, temperatures, vibration, etc.	On-site industrial hygiene testing is being completed to assess work environmental factors. Control measures will be implemented as required.

Fatigue Management Plans

Addressing safety from the point of view of risk management has become an increasingly accepted way of allowing companies to integrate safety systems and reduce worker risk. There is a growing body of research that shows using a strictly prescriptive approach, relying on hours of service alone as a key mitigation factor for fatigue, is not comprehensive enough to fully insulate workers from the risks of fatigue. A worker can be given ample opportunity for sleep, but due to a variety of circumstances (ex. a sleep disorder, a new baby, an illness, etc) not actually obtain the necessary hours of sleep needed to be alert and fit for duty. Ensuring ample opportunities for workers to sleep is seen as only the first level of safety controls in a complete fatigue risk management plan.

Using a multileveled and comprehensive risk management approach allows companies to identify high risk situations, and then put into place countermeasures that can minimize the likelihood of an incident occurring. This type of system relies on hazard identification, assessment and control measures within a comprehensive safety management system. The Fatigue Risk Management Plan (FRMP) is designed to provide multiple opportunities to introduce countermeasures intended to minimize the possibility of a fatigue related error occurring.

Diagram 1.1 Diagram of Capstone's 5 Level Fatigue Risk Management Plan



Adapted from Centre for Sleep Research, University of Southern Australia

A Brief Overview of the 5 Level Fatigue Risk Management Plan

Capstone's FRMP is based on the 5 Level Fatigue Risk Trajectory and focuses on multiple levels of countermeasures, designed to be used in combination to minimize the risks associated with fatigue.

Details regarding the plan are outlined below.

An Overview of the Plan

Controls	Type	Details
Level 1	Organizational	Adequate sleep opportunity provided
Level 2	Individual/Workers	Self reporting (Fatigue Likelihood Scores)
Level 3	Team	Monitoring for fatigue signs
Level 4	All	Fatigue proofing the system
Level 5	Organizational	System review

- **Level 1 Controls** – Management ensures provision of adequate sleep opportunity through scheduling of work and appropriate sleep environments.
- **Level 2 Controls** – Workers verify that adequate sleep has been obtained through Fatigue Likelihood Assessment and self reporting.
- **Level 3 Controls** – Management and workers ensure behavioral indicators of fatigue are identified and managed.
- **Level 4 Controls** – All ensure the likelihood that errors becoming incidents are minimized – fatigue proofing.
- **Level 5 Controls** –Management ensures fatigue-related incidents are prevented from re-occurring unnecessarily. This is done through fatigue specific incident investigation.

Control s are focused in the following way:

i. Predictive - Level 1
ii. Proactive - Level 2 and 3
iii. Reactive - Level 4 and 5

Additionally:

Levels 1 - 3 require education and training for workers and supervisors to understand the need for sleep, the causes and effects of fatigue, the signs of fatigue, and the safety hazards fatigue can create.

Levels 2 - 5 require a culture that understands and accepts fatigue as a safety hazard, not a worker weakness. Workers must know there are no repercussions for self reporting fatigue.

Levels 4 -5 require a strong commitment from management to follow up on fatigue reports and examine any places in the system that are not properly mitigating fatigue related risks. To be effective the plan must be reviewed on a regular basis to ensure risk controls are effective.

Table 1.3 Details of the 5 Control Levels Including: Key Responsibilities, Assessment Strategies, Documentation Processes and Control Actions.

Level	Responsibility	Risk Factor	Initial Strategy	Assessed Through	Documentation Process	Control Actions Required
1	Supervisor	Adequate sleep opportunities for workers	Ensuring adequate sleep opportunity through work scheduling	Review of initial schedules, rosters, hours/types of shifts, etc and a new review conducted for any major changes	Existing shifts signed off by mine manager. New shifts approved by mine manager prior to implementation.	High risk factors in rostering, scheduling and shift lengths are recognized and mitigated through the many layers contained in this comprehensive FRMP
	Supervisor	Specific job tasks may increase fatigue risks	Review of work tasks and breaks scheduled for specific work tasks	Worker feedback, observed signs of fatigue	Specific tasks (scoper, jack lift) require scheduled breaks that are taken and documented each shift.	Scheduled breaks taken. Job task risk factors are also recognized and mitigated through the other layers contained in this comprehensive FRMP
	Employer	Proper nutrition, hydration and fitness needs for workers to maintain health	Ensuring camp conditions are adequate and can serve to reduce fatigue risks	Review of current camp conditions with regards to nutrition, hydration and fitness needs. Ensuring sleep hygiene is considered in current camp and as new camp is built.	Fatigue Factors: Minto Mine Checklist in Appendix D and part of cyclical review.	Specific efforts are made to ensure proper nutrition through camp menus, hydration through access to fluids and exercise through the onsite gym and various recreational opportunities (ex. hockey rink). Sleep hygiene factors are understood and all efforts are made to incorporate them at the camp. This includes, but is not limited to blinds in the rooms, quiet sleep areas, controlled temperatures in the rooms, etc.

Level	Responsibility	Risk Factor	Initial Strategy	Assessed Through	Documentation Process	Control Actions Required
2	Worker	Workers being fit for work in relation to fatigue factors	Obtaining adequate sleep during off hours and accurately reporting sleep obtained	Individual Fatigue Likelihood Assessment	On 5 Point Review	Follow agreed control strategies listed in Level 2
	Supervisor	Workers being fit for work in relation to fatigue factors	Ensuring workers have obtained adequate rest	Review of 5 Point Review Cards for Fatigue Factors	Fatigue scores found in 5 Point Review Cards are reviewed and recorded.	Follow agreed control strategies listed in Level 2
3	Worker	Ability to manage fatigue risk factors at work	Self-reporting and monitoring of any fatigue symptoms or risk factors	Samn-Perelli Scale	On 5 Point Review	Follow agreed control strategies listed in Level 3
	Worker	Ensuring coworkers are not affected adversely by fatigue factors	Observations for fatigue symptoms in co-workers	Fatigue Symptoms Checklist	Verbally report concerns to co-worker and supervisor. Document on 5 Point Review	Follow agreed control strategies listed in Level 3
	Supervisor	Ensuring workers are not affected adversely by fatigue factors	Observations for fatigue symptoms	Fatigue Symptoms Checklist	Document any observed symptoms, conversations regarding fatigue and control measures taken.	Discuss concerns with worker. Follow agreed control strategies listed in Level 3

Level	Responsibility	Risk Factor	Initial Strategy	Assessed Through	Documentation Process	Control Actions Required
4	Worker	Fatigue related error occurring - (indicates system error in levels 1 - 3)	Report fatigue related errors	Self-assessed based on fatigue levels and actions.	No-loss incident reporting form	Stop Work! Discuss with supervisor. Alter work duties to not include any safety sensitive tasks or do not continue until fit for work.
	Supervisor /Employer (Safety Team)	Fatigue related error occurring - (indicates system error in levels 1 - 3)	Follow up on all fatigue related errors reported.	Worker self-reporting, worker reporting of co-worker error, observations made by supervisor.	No-loss incident reporting form	Take seriously and stop worker immediately! Discuss with worker. Alter work duties to not include any safety sensitive tasks or do not allow worker to continue until fit for work. Post incident follow up to discover where Levels 1 - 3 were ineffective.
5	Worker	Fatigue related incident occurring	Report all Incidents	Incident Investigation	Incident Reporting Form	All work is stopped after an incident. Work does not commence until a supervisor deems it safe to continue.
	Supervisor / Employer (Safety Team)	Fatigue related incident occurring	Investigate all Incidents	Incident Investigation	Incident Reporting Form, Incident Investigation Report including Capstone's Fatigue Incident Investigation Information	If fatigue is in any way a causal factor, a thorough review to discover where levels 1 - 3 were ineffective is required. A review of the FRMP may be required.

Level 1 - 5 Supporting Processes and Procedures

Level 1 - Understanding Management Influences on Sleep Opportunities

Primarily level 1 controls involve organizing work to provide adequate sleep opportunities for workers. It also involves scheduling breaks as needed to avoid fatigue.

Key areas this focuses on are:

1. Work Scheduling
    a. Work shifts
    b. Schedules (including start times)
    c. Rotations
2. Camp Environment
    a. Camp nutrition, hydration and exercise opportunities
    b. Quiet, dark sleeping environments
3. Work Environment
    a. Testing underway
4. Work Tasks
    a. Worker Task Break Schedule

Key documents to assist in this are:

1. Fatigue Factors: Minto Camp Checklist (Appendix D)
2. Summary of Minto Mine's Underground Environment Testing

Level 1 Controls Brief Description:

There are a variety of scheduling factors that can be reviewed to reduce fatigue. These focus on applying what is known about human needs for rest and circadian rhythms to existing company needs for work to be scheduled. Where possible, schedules should be examined and altered to accommodate worker needs for proper rest. Where it is not possible to alter schedules for optimal worker alertness, levels 2 - 5 of the FRMP must be implemented to reduce worker risk of fatigue error.

Camp conditions should be designed, as much as possible, to support worker access to nutrition, hydration and exercise. Proper sleep environments should be available to workers.

Current environmental conditions in the underground Minto mine have not been assessed. Processes are under way to begin the testing and assessment. Until assessments have been completed, high-level controls will be put into place to ensure fatigue risk factors are controlled.

Certain work tasks have been identified as increasing a workers likelihood to become fatigued. As such work breaks have been scheduled that are specific to work tasks. The following table outlines work tasks and mandatory minimum breaks to be provided for workers completing those tasks.

Table 1.4 Worker Task Break Schedule

Job Designation and Key Tasks	Minimum Work/Break Schedule Required
Supervisor Jumbo Driller Scoop Operator (Mucker) Maclean Operator (Rock Bolt Machine) Truck Driver Welders, Electricians, Mechanics	Breaks should be taken as required with a minimum 30 minute break (or two 15 minute breaks) every 6 hours.
Stoper Operator Jackleg Drill Operator	Breaks should be taken as required with a minimum 15 minute break taken for every two hours of equipment operation.
Other non designated tasks or workers	Follow typical break schedule of taking breaks as required with a minimum 30 minute break (or two 15 minute breaks) every 6 hours unless work is physically or mentally demanding and/or the worker is experiencing fatigue. Then a minimum 15 minute break every two hours should be taken.

Currently, under the Dumas contracting system, underground miners work the following shifts:

> 14 day shifts of 12 hours each starting at 6 AM and finishing at 6 PM, a 24 hour break, followed by 14 night shifts for 12 hours each starting at 6 PM and finishing at 6 AM, followed by 2 weeks off.

Upon implementation of this FRMS, Dumas shifts will be altered to the following:

> 14 day shifts of 12 hours each starting at 7 AM and finishing at 7 PM, a 24 hour break, followed by 14 night shifts for 12 hours each starting at 7 PM and finishing at 7 AM, followed by 2 weeks off.

When Capstone moves from using Dumas as an independent contractor to having direct Capstone employees work in the underground mine, the following shift schedule is planned:

> 14 day shifts of 12 hours each starting at 7 AM and finishing at 7 PM, followed by 2 weeks off, followed by 14 night shifts for 12 hours each starting at 7 PM and finishing at 7 AM, followed by 2 weeks off.

Additional Level 1 Controls

Review of NSW controls and choosing appropriate ones to suggest and implement.

Level 2 Controls - Worker Self-Reporting of Sleep Obtained

Worker self-reporting of sleep obtained using the Individual Fatigue Likelihood Assessment. Agreed controls based on fatigue likelihood score.

Diagram 1.2 Individual Fatigue Likelihood Wallet Card (side 1)

Capstone Minto Mine

INDIVIDUAL FATIGUE LIKELIHOOD ASSESSMENT

Step 1. Sleep in prior 24 hours

Sleep	≤ 2h	3h	4h	5h+
Points	12	8	4	0

Step 2. Sleep in prior 48 hours

Sleep	≤ 8h	9h	10h	11h	12h+
Points	8	6	4	2	0

Step 3. Hours awake since last sleep

Add one point per hour awake greater than sleep in Step 2

Workers assess likelihood of fatigue based on previous sleep obtained. Score is determined by calculating sleep obtained in the last 48 hours and by assessing how long it has been since the worker last slept.

Scores are calculated by assigning points to sleep obtained in the last 24 hours (any sleep over 5 hours is 0 points) and adding it to sleep obtained in the previous 24 hours (an average of 6 hours a night or 12 hours in total is 0 points). The score is then compared to the number of hours the individual has been awake.

> Example 1: An individual slept 5 hours the night before their shift and 4 hours the night before that. They have been awake for 3 hours. Score (0 + 6 + 0 = 6) They should request supervisor monitoring.
>
> Example 2: An individual slept 6 hours the night before their shift and 5 hours the night before that. They have been awake for 12 hours. Score (0 + 2 + 1 = 3) They should self monitor for signs of fatigue and manage as needed.
>
> Example 3: An individual slept 3 hours the night before their shift and 3 hours the night before that. They have been awake for 8 hours. Score (8 + 8 + 2 = 18) They are not fit for duty and should not commence work. They should speak with their supervisor and obtain rest before starting a shift.

Note: This sleep scale does not accurately account for individual differences in sleep needs. It also does not account for accumulated sleep debt. Level 3 controls should still be used if needed even if a Fatigue Likelihood score is 0.

Diagram 1.3 Individual Fatigue Likelihood Wallet Card (side 2)

Capstone Minto Mine

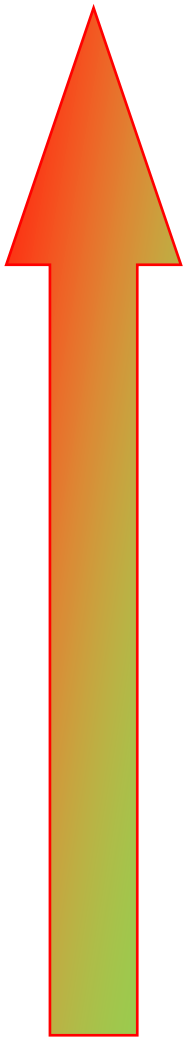
INDIVIDUAL FATIGUE LIKELIHOOD ASSESSMENT

Step 4. Add all points together to deterimine your score

Score	Agreed Control Strategies
1 to 4	Self Monitoring
5 to 11	Request Supervisor Monitoring
12+	Do NOT Commence Shift Until Fit For Work

Refer to FRMS policy for detailed explanation of controls

Table 1.5 Possible Symptoms and Agreed Controls for Fatigue Likelihood Scores



Score	Possible Signs and Symptoms	Agreed Control Strategies
12+	Difficulty staying awake and possibly experiencing microsleeps. Uncoordinated physically and experiencing difficulty staying focused. Significant impairment evident.	Document and report risk to supervisor. Do not engage in ANY safety critical work or behaviors. Do not recommence until fit for work.
10	Clear evidence of behavior impairment. Difficulty sustaining attention on simple tasks. Uncoordinated p.	Document and report risk to supervisor. Complete Samn Pernelli and Fatigue Symptoms Checklist. Engage in individual and team fatigue management strategies. Organize supervisory checks and work directly with a co-worker if possible. Nap if possible. Should not engage in safety critical work - task reassignment if necessary.
8	Clear loss of motivation and physically weak and listless. Significantly reduced situational awareness. Task performance impaired.	
6	Difficulty concentrating. Occasional lapses of attention. Poor judgement on complex tasks. Physically affected - sagging body posture, slow blinking, etc.	
4	Difficulty in maintaining extended concentration for complex tasks. Low energy levels and weakness apparent.	Document. Complete Samn Pernelli and Fatigue Symptoms Checklist. Take approved individual or team countermeasures. Self-monitor for symptoms, team monitor by co-workers, task rotation or other job alterations as required.
2	Slowed cognition. Occasional minor fatigue behaviors observed. Minor mood changes observable. Low energy levels or hyperactive.	Controls and fatigue management may be necessary. Assess and monitor for fatigue symptoms.
0	Able to perform tasks safely. Unlikely fatigue impairment, but monitor if required.	No controls unless otherwise indicated by other fatigue risk factors

Level 3 Controls - Team Controls to Ensure Fatigue Risks are Controlled.

Workers experiencing fatigue use level 3 checklists (Samn-Perelli Fatigue Checklist, Symptoms of Fatigue Checklist), report to supervisor and co-workers any fatigue concerns, and engage in individual and team controls as needed.

Supervisors check all recorded fatigue data, watch for signs of fatigue, and take all reports of fatigue seriously. Team controls are implemented as needed. Any worker not fit for duty is removed from safety sensitive work, given alternate tasks or removed from duty as required.

Diagram 1.4 Samn-Perelli Fatigue Checklist (side 1)

Samn-Perelli Fatigue Checklist	
1	Fully alert
2	Very lively
3	Okay
4	A little tired
5	Moderatly tired
6	Extremely tired
7	Completely exhausted

Diagram 1.5 Samn-Perelli Fatigue Checklist (side 2)

Samn-Perelli Fatigue Checklist Controls Based on Score	
1 to 3	Proceed with work, monitor if symptoms appear
4 to 5	Supervisor monitoring required, implement individual and team management strategies, alter work duties if needed
6 to 7	Stop work, obtain rest before beginning shift

This checklist can be used throughout a shift, triggered by the following:

- start of shift (routine assessment)
- start of night shift
- following a nap
- if shift is to be extended
- on call-in overnight shift
- if Level 2 assessment places the person in yellow or red zones
- coworker or supervisor notes symptoms
- individual experiences symptoms
- error committed or noticed
- incident

Supervisor Monitoring

The following is a list of fatigue symptoms to assist with monitoring. Workers should also be taught to monitor themselves and each other for signs of fatigue. Workers exhibiting signs should be approached and questioned regarding fatigue likelihood scores and feelings of fatigue. A mitigation strategy should be worked out with the worker. Remember, those who are fatigued often underestimate the level of their fatigue and are less able to make effective decisions. Err on the side of caution.

Diagram 1.6 Symptoms of Fatigue Checklist

Common Symptoms of Fatigue Checklist					
Physical	**Observed**	**Mental**	**Observed**	**Emotional**	Observed
Yawning		Difficulty concentrating		Quiet	
Slow blinking		Laspses in attention		Withdrawn	
Rubbing eyes or face		Memory lapses		Lethargic	
Aching muscles or headache		Difficulty communicating		Bored	
Uncoordinated movements		Lack of situational awareness		Lacking motivation	
Sagging body posture		Making mistakes		Irritable	
Weak and low energy		Confusion		Easily frustrated	

Individual and Team Fatigue Management Strategies

The following are examples of individual and team control measures that can be used depending on the level of fatigue.

Diagram 1.7 Individual Control Examples

Individual Control (Examples)
Controlled use of caffeine
Adequate hydration and food intake
Adjust working temperature
Adjust lighting
Take a break
Change tasks
Remove safety sensitive tasks from work
Take a 20- 30 minute nap
Increase social interaction
Defer to a second opinion
Increase supervision
Stand Down - do not proceed until fit for work

Diagram 1.7 Team Control Examples

Team Control (Examples)
Communicate fatigue status at morning safety meeting
Communicate high Fatigue Likelihood Score to supervisor and coworkers
Document high Fatigue Likelihood Score
Increase cross checking among coworkers (watching out for each other)
Increase supervision
Task reallocation or rotation (trading tasks when needed)
Delay safety sensitive work when possible
Take a collective break (encourage breaks when needed)
Work together with a co-worker where possible (chat to keep alert)
Engage in conversations and social interactions
Fatigue leave - all crew stand down

Level 4 - Fatigue Related Errors - Assessing the System

One of the key factors in Capstones 5 Level Fatigue Risk Management Plan is the reactive measures used to ensure the plan is working appropriately. Any report of fatigue related error should be immediately followed by an informal investigation to determine where levels 1 to 3 were inadequate in properly mitigating fatigue factors.

The following procedures should occur:

1. All fatigue related errors are reported immediately to a supervisor
2. All fatigue related errors are documented within that shift on no loss incident investigation forms.
3. No loss incident investigation forms are to be submitted to the safety committee for informal investigation.
4. Informal investigation will take place within one week of receiving the incident forms.
5. Informal investigation should include the following:
    a. Discussion with the worker to determine causal factors of fatigue
    b. The effectiveness of the reporting process used on the day of the incident
    c. The reasons that levels 1-3 were ineffective in assessing and mitigating the fatigue risk.
6. Formal fatigue incident investigation tools found in level 5 may be reviewed and used if necessary.

Level 5 - Fatigue Related Incidents - Fatigue Incident Investigation Information Required

All incidents investigated in the underground mining operations need to be assessed to determine if fatigue was a risk factor. Normal Capstone SMS incident investigation procedures are used. The addition of the fatigue incident investigation information will assist in determining if fatigue was a causal factor in the incident. Fatigue incident investigation information must be collected on all incidents occurring within the underground mining operations. All data collected as part of all incident investigations shown to have fatigue causal factors must be recorded and used as part of the fatigue risk management plan review process.

Capstone Fatigue Incident Investigation Information

1. **Date, time and place** of the accident. (not the time of the report) _____
_____

Level 1

2. **Work Schedule History (Schedule, Rotation, Shift Length, Breaks)**

Level 1

What was the actual work schedule (regular hours plus overtime) for the **four days** prior to the accident? (Please fill out by date and shift until all four days prior to the accidents are covered).

Work Shift -1:	Start time/Date: _____	End time/Date: _____
Work Shift -2:	Start time/Date: _____	End time/Date: _____
Work Shift -3:	Start time/Date: _____	End time/Date: _____
Work Shift -4:	Start time/Date: _____	End time/Date: _____

How many hours into the shift did the incident occur? (ex. 3 hours in) _____

How far into the work schedule was the individual involved?
Day #/Shift #: (ex. Day 12/28) _____

What shift was the individual working (day or night)? _____

How long from the last scheduled break? _____

How long in duration was the last scheduled break? _____

3. **Work Task and Work Environment**

Level 1

What task was being performed at the time of the incident? What was the work environment like? How mentally or physically stimulating was the task and work environment prior to the accident? (Refer to Capstone's FRMS for details on fatigue risk factors relating to work tasks and work environments).

Job Designation (Title) of individual(s) invlolved, task being preformed, and work environment described: _____
_____
_____
_____

Rate Mental Factors _____
(on a Scale of 1 - 5 with 1 being very stimulating and 5 being fatiguing)

Rate Physical Factors _____
(on a Scale of 1 - 5 with 1 being very stimulating and 5 being fatiguing)

Work Environment Rated: _____
(on a Scale of 1 - 5 with 1 being very stimulating and 5 being fatiguing)

4. **Number of hours of actual sleep** in previous 24, 48 and 72 hours (i.e. 3 days) prior to the accident.

Level 2

Day 1: _____
Day 2: _____
Day 3: _____
Number of hours awake (from previous sleep) when accident occurred. _____

5. **Overall quality of sleep** 24, 48 and 72 hours (i.e. 3 days) prior to the accident.

Level 2

First Day Prior:	Poor □	Fair □	Good □	Excellent □
Second Day Prior:	Poor □	Fair □	Good □	Excellent □
Third Day Prior:	Poor □	Fair □	Good □	Excellent □

6. Did any **health problems** affect the individuals sleep during the month leading up to the accident?

Level 2

Yes □ No □ Uncertain □ If Yes provide details:

_____
_____

7. Any **symptoms of fatigue** during the persons waking hours prior to the accident. (either self reported or observed by others)?

Level 3

Frequent Eye Closure □	Lethargic or Low Energy □	Fixed Gaze □
Distracted or Forgetful □	Excessive Yawning □	Head Nodding □

Other: (refer to Symptoms of Fatigue Checklist found in Capstone FRMS)

_____
_____

8. What **fatigue assessment** and documentation had occurred prior to and during the shift? (ex. Fatigue Likelihood score, self-reporting of fatigue, supervisor noting of symptoms, Samn-Perelli Scale, etc.)

Level 2 & Level 3

_____
_____
_____

9. Any other information relating to the incident or worker relating to fatigue that could be relevant to the investigation.

Level 1 to Level 3

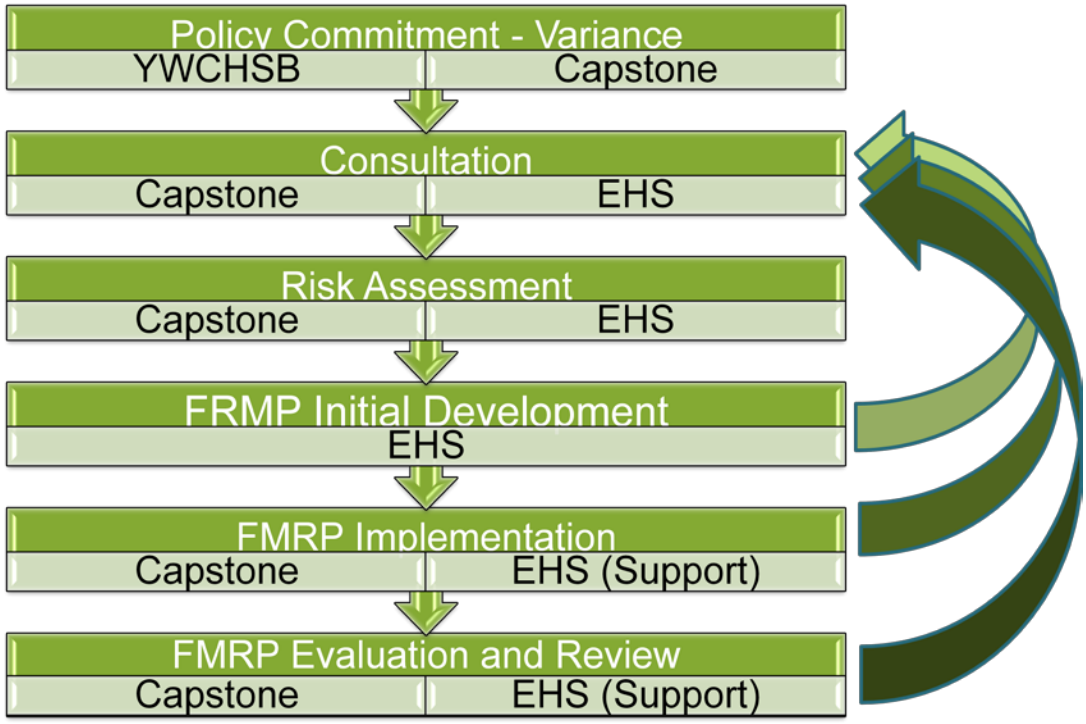
_____
_____
_____

Implementation Strategies

Implementation Role Clarification

Initial policy creation was based upon variance agreements between Capstone Mining Corp. and the Yukon Worker's Compensation Health and Safety Board. EHS Partnerships was brought in as a consultant to assist in identifying, assessing and controlling fatigue risks. The creation of the Fatigue Risk Management Plan has been a process based upon consultation with Capstone and YWCHSB.

Upon completion of the consultation and revision processes, the FRMP implementation process will be completed by the Minto Mine Safety Management Team at the direction of the Capstone Mine Corporation. Consultation and support for the implementation will be available, upon request, from EHS Partnerships.



Communication Strategies

To ensure a common understanding of Capstone's underground mining fatigue risk management plan, a copy of the policy will be made available to all supervisors and workers. The Capstone policy statement will be displayed in a visually accessible place to demonstrate capstones commitment to properly mitigating fatigue factors.

When final revisions are complete, a copy of this plan will be sent to the following:

i. YWCHSB
ii. Capstone Corporate
iii. Minto Mine Management
iv. Minto Safety Committee
v. Underground Mine Supervisors
vi. Underground Mine Workers
vii. Other Key Stakeholders (Contractors)

b. Participation Requirements
    i. All Underground mine contractors, supervisors, and workers are required to fully participate in the Capstone FRMP including the training provided and the policies and procedures contained within.
c. Supervision Responsibilities
    i. Overall implementation responsibilities fall to Capstone Mining Corp. These may be designated as required to Minto Mine Management and the Minto Safety Team.

Planned Audit and Review

The fatigue management procedure or plan must be reviewed at regular intervals to ensure the continual effectiveness of the controls. Review of control measures should be undertaken when methods, tasks, equipment, hazards, operations, procedures, rosters or schedules are introduced or the environment changes or there is any indication risks are not being controlled.

d. Specific Review Dates
    i. Capstone's FRMP should be reviewed on an annual basis (minimal standard) to ensure the plan is working to properly mitigate the risks of fatigue.
e. Review Roles and Procedures
    i. Annual review will led by the Minto Mine Safety Team and will include:
        1. Review of the FRMP document.
        2. Completion of the Fatigue Management Self Assessment Worksheet found in Appendix E.
        3. Review of all fatigue data including:
            a. Summary of fatigue information gathered during shifts.
            b. Summary of all fatigue related errors and no loss incidents and a review of the investigation information conducted on these.
            c. Summary of any Incident Investigation that identified fatigue as a causal factor.
            d. Specific review factors to consider include:
                i. have control measures been implemented as planned?
                ii. are they working?

iii. are there any new problems? and
iv. incidents, near misses, injuries and other data, such as absenteeism and staff turnover rates.

e. Further review of control measures should be undertaken when hazards, procedures, rosters or schedules are introduced or there is any indication risks are not being controlled.

4. Feedback Method (Internal)
    a. Solicitation of formal and/or informal feedback from workers, supervisors, contractors involved in the FRMP should be gathered.
        i. Specifically:
            1. Do they feel the plan is effectively controlling fatigue risks?
            2. Any ways they feel the plan could be improved.
5. Revision Process
    a. If required, necessary revisions and implementation of revisions should take place within 60 days of the annual review process.

Appendices

A. References
B. Definitions and Terms
C. Minto Mine's Initial Risk Assessment Results
D. Fatigue Factors: Minto Camp Checklist
E. FRMP Self Assessment Checklist

Appendix A: References

1. NSW Mine Safety Advisory Council & NSW Government (2009), *Fatigue Management Plan - A practical guide to developing and implementing a fatigue management plan for the NSW mining and extractives industry*
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Appendix B: Terms and Definitions

Term	Definition
Alertness	The opposite state of sleepiness, the state of cognitive and physiological arousal, and responsiveness to environmental/situation conditions.
Circadian Rhythm	A neural pacemaker in the brain that monitors the day/night cycle (via a special light input pathway from the eyes) and determines our preference for sleeping at night. Shift work is problematic because it requires a shift in the sleep/wake pattern that is resisted by the circadian body clock which remains 'locked on' to the day/night cycle.
Contractor	A company hired by Capstone Mining Corp. to complete work on site. Employees of the contractor are referred to as employees/workers or managers/supervisors.
Controls	System-level defensive strategies designed to minimize fatigue risk on an ongoing basis.
Cumulative Sleep Debt	Sleep loss accumulated when sleep is insufficient for multiple nights (or 24-hr days) in a row. As cumulative sleep debt builds up, performance impairment and objective sleepiness increase progressively, and people tend to become less reliable at assessing their own level of impairment
Employee/Worker	Any person who works on the site, regardless of their employer. This includes contractors.
Employer/ Company	Capstone Mining Corporation or Minto Explorations Ltd
Fatigue	Fatigue is a state of impairment. It is a physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a worker's alertness and ability to safely perform their duties.
Fatigue Countermeasures	Organizational, individual and team based fatigue management strategies to reduce the effects of fatigue.

Fatigue Likelihood Assessment	A quantitative measure of the amount of sleep an individual is able to obtain. It is used to determine the likelihood an individual will experience fatigue symptoms or reduced levels of alertness.
Fatigue Risk Management	The management of fatigue in a manner appropriate to the level of risk exposure and the nature of the operation, in order to minimise the adverse effects of fatigue on the safety of operations.
Fatigue Risk Management Plan (FRMP)	is an integrated set of management practices, beliefs and procedures for monitoring and managing the risks posed to health and safety by fatigue. It is based
Fatigue Symptoms Checklist	A list of fatigue symptoms that can be used to assist in identifying when an individual might be experience fatigue.
Five Level Fatigue Trajectory	model utilising multiple layers of defence to manage the occurrence of fatigue-related incidents. It is the major practical or day-to-day aspect of the FRMS and includes tools and controls for monitoring and managing fatigue-related risk. At each level there are opportunities to put in place control strategies to manage the fatiguerelated risk. For an incident to occur, each level must have failed in some part to allow the error to pass through.
FRMS Training	Competency-based training programs designed to ensure that all stakeholders are competent to undertake their responsibilities in the FRMS.
Manager/Supervisor	Any person who is directly responsible for the supervision and well being of other employees.
Micro Sleeps	A short period of time (seconds) when the brain disengages from the environment (it stops processing visual information and sounds) and slips uncontrollably into light non-REM sleep. Microsleeps are a sign of extreme physiological sleepiness.
Mitigations	System-level interventions designed to reduce a specific identified fatigue risk.

Nap	A brief period of sleep, usually defined as less than half of a full night time sleep period. Naps as short as 5 minutes have been shown to provide (temporary) relief from the cumulative effects of sleep loss
Performance	The observable/behavioural manifestation of alertness and sleepiness, and the combination of one's efforts and the results of those efforts.
Prior Sleep	The amount of sleep obtained prior to a specific time (eg. the start or end of a shift).
Prior Wake	The amount of time spent awake prior to a specific period (usually assessedat the start and end of a shift).
Risk	The potential for harm, a concept that denotes a potential negative impact to some characteristic of value that may arise from a future event. Risks are events or conditions that may occur, and whose occurrence, if it does take place, has a harmful or negative effect.
Risk Management	The process of identifying and managing the factors contributing to risk, errors and incidents, at an individual or an organisational level, and determining how to best handle such exposure.
Safety Management System (SMS)	A systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.
Samn-Perelli Checklist	A subjective checklist used to measure a worker's fatigue levels.
Shift	The hours between the start and finish of established daily work schedules.
Shift Worker	a person who works rotating shifts, irregular shifts, evening shifts, afternoon shifts, morning shifts or split shifts. Another term for this work is 'non-traditional work hours.'

Sleep Disorders	A range of problems that make it impossible to obtain restorative sleep, even when enough time is spent trying to sleep. More than 80 different sleep disorders have been identified, that can cause varying amounts of sleep disruption. Examples include obstructive sleep apnea, the insomnias, narcolepsy, and periodic limb movements during sleep
Sleep Inertia	Transient disorientation, grogginess and performance impairment that can occur as the brain progresses through the process of waking up. Sleep inertia can occur on waking from any stage of sleep but may be longer and more intense on waking from slow-wave sleep (non-REM stages 3 and 4), or after sleep periods or naps containing a high proportion of slow-wave sleep.
Sleep Need	The amount of sleep that is required on a regular basis to maintain optimal levels of waking alertness and performance. Very difficult to measure in practice because of individual differences.
Sleep Quality	Capacity of sleep to restore waking function. Good quality sleep has minimal disruption to the non-REM/REM cycle. Fragmentation of the non-REM/REM cycle by waking up, or by brief arousals thatmove the brain to a lighter stage of sleep without actually waking up, decreases the restorativevalue of sleep.
Sleep Quantity	The total amount of sleep that an individual is able to obtain. It is usually measured to the nearest hour.
Sleepiness	A state of increased motivation to sleep. Difficulty in maintaining the alert state so that if an individual is not kept active and aroused, they will fall asleep.
Subjective Fatigue	Self-reported levels of feelings of fatigue, assessed on a seven-point scale ranging from ‘fully alert, wide awake’, to ‘completely exhausted, unable to function’.
Work Rotations/Cycles	The working period scheduled between any significant break away from work.
Work Schedules/Rosters	The hours to be worked for each day, shift, week, month or year, as

Appendix C: Fatigue Hazard Assessment at Minto Mine

Hazard assessments conducted at the Minto Mine site focused on reviewing hazards associated with fatigue. Assessments were conducted based on observations, consultation and discussions with workers, supervisors and contractors.

The following areas were examined: mental and physical work demands; work scheduling and planning; environmental conditions; and individual and non-work factors.

Risk assessments were based on both likelihood and severity. Results were graphed and quantified . Below is a summary of the quantitative results of the initial hazard assessment conducted.

Table 1.1 Capstone's Minto Mine Fatigue Risk Assessment Results

Fatigue risk factors and assessment have been taken from the following document (Fatigue Management Plan - A practical guide to developing and implementing a fatigue management plan for the NSW mining and extractives industry, 2009)

Factor Grouping	Capstone Risk Points	Total Factor Points	Percent of High Risk Areas
Work Demands	18	30	60%
Work Scheduling - Hours	22	50	44%
Work Scheduling - Shifts	25	40	63%
Work Scheduling - Night Work	40	70	57%
Work Environment (listed as high as they are not currently fully assessed)	35	40	88%
Off Duty Factors	8	40	20%
Totals and Average %	**148**	**270**	**55%**

Appendix D: Fatigue Factors Minto Mine Checklist

Minto Mine Fatigue Factors Camp Checklist	Check
Accommodations	
Temperature - Rooms should be between 18 - 22 C	
Lighting - Room should be able to be darkened during daylight hours (ex. Effective window blinds, black our curtains, etc.)	
Bed should be firm but comfortable	
Sufficient blankets and comfortable pillow should be provided	
Noise	
Room should be able to block sound. Alternately, quiet areas created for night workers or white noise devices or ear plugs provided.	
Beds	
Matresses and pillows should be comfortable for workers. Adequate blankets provided.	
Nutrition	
Healthy food choices should be available to workers for both day and night shifts.	
Light protien, low fat snacks and meals should be available to night workers.	
Low glycemic index food (low sugar and carbohydrate content) should be available to all workers, especially night shift workers.	
Caffeine should be available at all times if needed.	
Exercise and Recreation	
Recreation opportunities should exist for both day and night workers.	
Exercise facilities should be available for workers on day or night shifts.	
Travel	
Travel to and from work site should be limited if working long night shifts.	
Drivers should be assessed (self checks or other) for signs of fatigue prior to transporting crews.	

Appendix E: Fatigue Management Plan Self Assessment Worksheet

Exercise 3

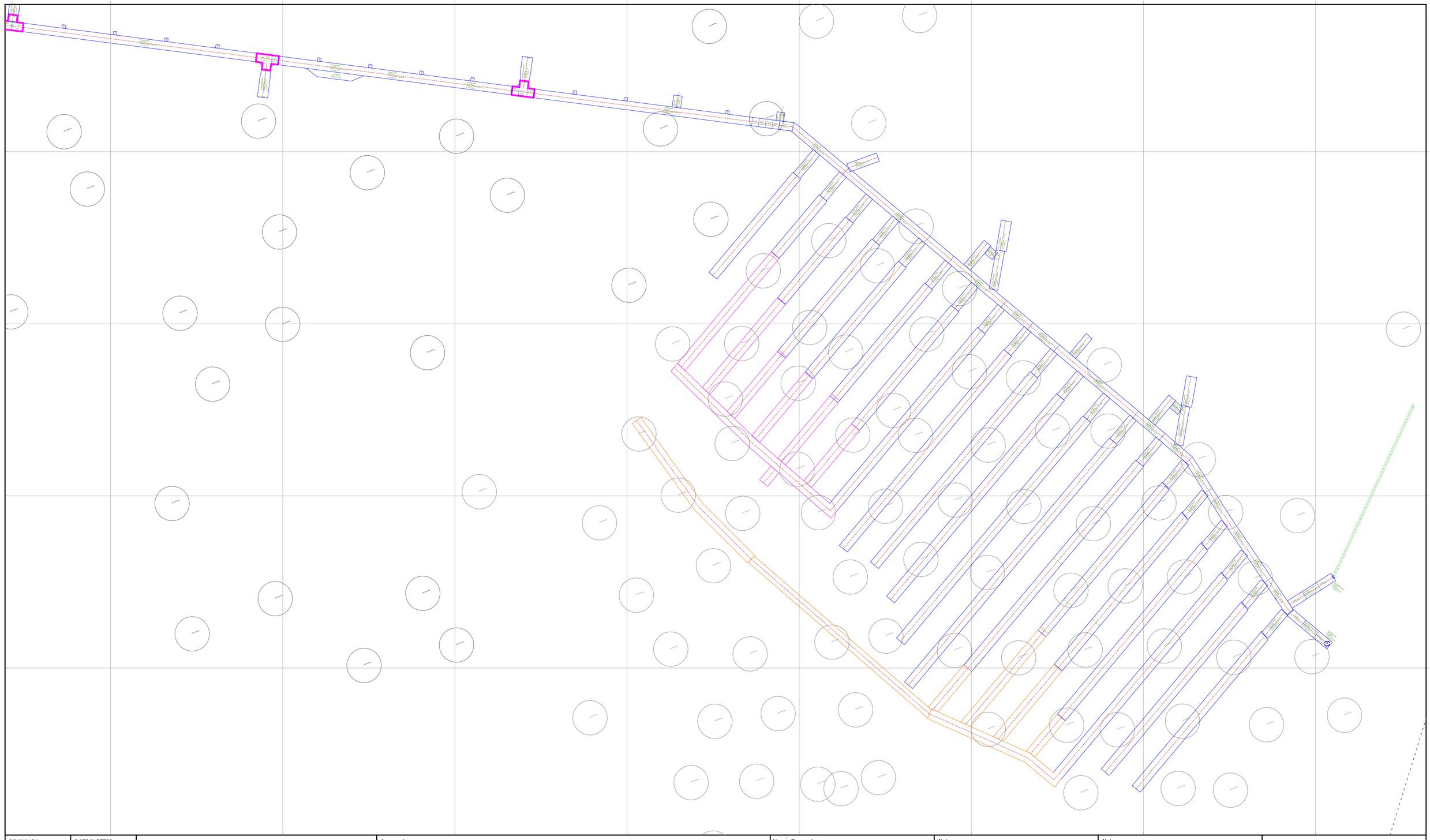
Fatigue management self assessment worksheet

Individually assess your mine's Fatigue Management Plan. Elements of the self-assessment correspond to elements that need to be addressed in a Fatigue Management Plan.

Mine name:		**Section:**	
Assessment Team Leader:		**Participants (names/positions):**	

QUESTIONNAIRE	RESPONSE						
	Not started	Just started		Progressing		Done	Averaged Score
CONSULTATION, COMMITMENT AND RESPONSIBILITES: Everybody is given sufficient opportunity, time and resources to participate in fatigue management and are clear about their roles and responsibilities.	0	1	2	3	4	5	
Fatigue management is reflected in the site's health and safety policy or there is a stand alone fatigue management policy. The policy has been developed in consultation with employees and contractors and is signed by the most appropriate senior person.	☐	☐	☐	☐	☐	☐	
Commitment to fatigue management is demonstrated by having fatigue management procedures (or plan) in place and allocating time, money and training resources.	☐	☐	☐	☐	☐	☐	
Roles and responsibilities for fatigue management are allocated to positions within the organisation.	☐	☐	☐	☐	☐	☐	
An education and communication strategy has been agreed.	☐	☐	☐	☐	☐	☐	
A consultative arrangement has been established to develop a joint approach to controlling fatigue risk.	☐	☐	☐	☐	☐	☐	
FATIGUE RISK MANAGEMENT: Everybody works together to identify the FATIGUE hazards and fix problems at the source before exposures occur.							
Workers are provided with necessary information about fatigue hazards and controls to enable meaningful participation in fatigue risk management.	☐	☐	☐	☐	☐	☐	
Work- related fatigue risks impacting on the amount and quality of sleep (such as work scheduling and planning) of employees and contractors are considered when carrying out fatigue risk management.	☐	☐	☐	☐	☐	☐	
The risk management process considers how mental and physical demands of the job and the work environment contribute/ impact the effects of fatigue.	☐	☐	☐	☐	☐	☐	
Fatigue related risks are controlled according to the "hierarchy of control" and controls are monitored and reviewed for their continued effectiveness.	☐	☐	☐	☐	☐	☐	
The health and safety reporting system allows employees to report themselves or others as fatigued without criticism.	☐	☐	☐	☐	☐	☐	
Fatigue-related information is captured in the incident reporting process.	☐	☐	☐	☐	☐	☐	
IMPLEMENTING FATIGUE MANAGEMENT: Everybody is competent to manage fatigue risks within their area of responsibility and supervisors are trusted and decisions are supported.							
Supervisors identify when fatigue is an issue and initiate immediate control measures and record concern for further review (as required).	☐	☐	☐	☐	☐	☐	
Employees and contractors are provided education and awareness about the site's fatigue management plan and procedures at induction and on a periodic basis. Consideration is given when communicating to those on shift work and contractors to ensure all have been informed on fatigue management issues.	☐	☐	☐	☐	☐	☐	
Unplanned changes to the work schedule (ie. maintenance, break downs, unexpected shortage of staff) are considered in fatigue risk management planning, for employees and contractors.	☐	☐	☐	☐	☐	☐	
Safety-critical tasks are not performed at times when fatigue is likely to be higher? If tasks need to be performed, fatigue related risks have been considered as part of the risk assessment/ work instructions and procedures.	☐	☐	☐	☐	☐	☐	
Sites have a system/ methods for monitoring hours of work of employees and contractors.	☐	☐	☐	☐	☐	☐	
IMPLEMENTING HEALTH MANAGEMENT - EVALUATION AND REVIEW: The fatigue management plan includes ongoing monitoring and evaluation for effectiveness.							
The fatigue management procedure or plan is reviewed at regular intervals to ensure the continual effectiveness of the controls.	☐	☐	☐	☐	☐	☐	
Review of control measures are undertaken when methods, tasks, equipment, hazards, operations, procedures, rosters or schedules are introduced or the environment changes or there is any indication risks are not being controlled.	☐	☐	☐	☐	☐	☐	

Appendix C – Copper Keel Block Plan



DRAWN BY:	DATE PLOTTED: 14-Aug-2018	COPPER KEEL BLOCK PLAN	Approvals:						
DESIGNED BY:	SCALE: 1:1000		MINE PLANNER	ROCK MECH. ENGINEER	GEOLOGIST	CHIEF ENGINEER	MINE MANAGER	DUMAS SUPER.	
CHECKED BY:									

Ver.	Change Log

Notes:

Notes:

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