**Volume 1 Annex V1-7 Type A Water Licence Applications**

# Package P5-12

## Hope Bay Project: Madrid and Boston Crown Pillar Recovery Concepts

MAC RESOURCES

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# Memo

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| **To:** | John Roberts, PEng, Vice President Environment<br>Oliver Curran, MSc, Director Environmental Affairs | **Client:** | TMAC Resources Inc. |
| **From:** | Cameron Hore, CPEng, PEng | **Project No:** | 1CT022.013 |
| **Reviewed By:** | Maritz Rykaart, PhD, PEng | **Date:** | November 30, 2017 |
| **Subject:** | Hope Bay Project: Madrid and Boston Crown Pillar Recovery Concepts | | |

# 1 Introduction

The Hope Bay Project (the Project) is a gold mining and milling undertaking of TMAC Resources Inc. The Project is located 705 km northeast of Yellowknife and 153 km southwest of Cambridge Bay in Nunavut Territory, and is situated east of Bathurst Inlet. The Project comprises of three distinct areas of known mineralization plus extensive exploration potential and targets. The three areas that host mineral resources are Doris, Madrid, and Boston.

The Project consists of two phases: Phase 1 (Doris project), which is currently being carried out under an existing Water Licence, and Phase 2 which is in the environmental assessment stage. Phase 1 includes mining and infrastructure at Doris, while Phase 2 includes mining and infrastructure at Madrid and Boston located approximately 10 and 60 km due south from Doris, respectively.

TMAC plans to daylight the underground mines such that the ore within the crown pillar of the Madrid and Boston mine can be recovered and processed. This process involves upward expansion of the underground mines. To ensure safe mining practices excavation from surface in the form of a trench is required. The safety and stability of the mining operations will be verified and approved by the mines inspector and are not in the scope of this memo. As per the existing mine plan and water license, the opened voids will be backfilled with waste rock. This memo presents the mining concept for the crown pillar recovery trenches and should be read in conjunction with the attached set of illustrative figures.

# 2 Concept

## 2.1 Approach

The overall concept for the crown pillar recovery method is based on the same principles as used for the existing Madrid-Boston mine and infrastructure. Mine voids will be backfilled with waste rock as part of the mining operations. All required pads and roads will be constructed either on

bedrock, or geochemically suitable rock fill pads designed to protect the permafrost. Surface works are designed to minimize the overall footprint and avoid disturbance of waterways.

## 2.2 Location

The approximate locations of the two Madrid crown pillar recovery trenches are shown on Figure 1. The approximate location of the Boston crown pillar recovery trench is shown on Figure 2.

## 2.3 Surface Conditions

### 2.3.1 Overburden

Detailed geotechnical site characterization studies have not been performed for the specific surface disturbance area. The encompassing Project area (Madrid and Boston) has however been well studied, and foundation conditions and geology in the crown pillar recovery trench areas are similar. For details on these conditions refer to SRK (2017a). The approximate area of all three proposed crown pillar recovery trenches are expected to have an overburden layer at surface of approximately 2 m thickness with a potential range of 0 m to 10 m thickness.

Permafrost at the Project area extends to depths of about 570 m and is absent beneath some large lakes. The ground temperature near the depth of zero annual amplitude ranges from −9.8 to −5.6°C, with an average of −7.6°C. Active layer depth based on ground temperatures measured in overburden soil averages 0.9 m with a range from 0.5 to 1.4 m. The average geothermal gradient is 0.021°C/m.

Permafrost soils are comprised mainly of marine clays, silty clay and clayey silt, with pockets of moraine till underlying these deposits. The marine silts and clays contain ground ice on average ranging from 10 to 30% by volume, but occasionally as high as 50%. The till typically contains low to moderate ice contents ranging from 5 to 25%.

Overburden soil pore water is typically saline due to past inundation of the land by seawater following deglaciation of the Project area. The salinity typically ranges from 37 to 47 parts per thousand which depresses the freezing point and contributes to higher unfrozen water content at below freezing temperatures.

General foundation conditions, material properties for geotechnical analysis, and development of the overburden isopach surface are described in more detail in SRK (2017a).

## 2.4 Environmental Setbacks

The following environmental setbacks have been applied when defining the surface disturbances:

- Minimum 31 m setback from waterbodies, 50 m setback where possible;
- Minimum 30 m buffer zone from known rare plants; and
- Minimum 30 m buffer zone from known archeological sites.

There are no known instances where these setbacks have not been upheld for all three of the crown pillar recovery trenches.

# 3 System Design

## 3.1 Crown Pillar Recovery Trench

### 3.1.1 Design Criteria

The design criteria for the crown pillar recovery trenches are as follows:

- Maximum slope angles and depths as approved by the Mines Inspector;
- Minimum base width of 8 m to allow safe access for inspection of drill and blast operations;
- Waste rock to be stored on existing approved storage pads;
- Overburden to be stored on existing approved overburden stockpiles for re-use as surface backfill;
- Reinstate permafrost of backfilled crown pillar recovery trench; and
- External surface water to be diverted as required.

### 3.1.2 Design

The size of each crown pillar recovery trench is dependent on the ore body, minimum widths for equipment and environmental setbacks and slope of the excavation in overburden. Two crown pillar recovery trenches are proposed for the Madrid mine; both are expected to be at least 15 m deep. The estimated size of the proposed Madrid crown pillar recovery trenches is approximately 200 m long and nominally up to 100 m wide at surface (20,000 $m^2$) and approximately 300 m long and nominally up to 50 m wide at the surface (15,000 $m^2$). The size and number of trenches to be excavated at Madrid and Boston will be based on further exploration and mine engineering prior to the activities. The waste rock removed from the Madrid crown pillar recovery trenches will be deposited on the Madrid North waste rock pad and the excavated overburden will be deposited on the Madrid overburden pile. The Madrid North waste rock pad has sufficient volume to accommodate the waste rock volumes as the mining of the crown pillar recovery trenches will not coincide with peak waste rock on surface.

The estimated size of the proposed Boston crown pillar recovery trench is approximately 300 m long on one side, 380 m long on the parallel side and approximately 100 m wide at surface (34,000 $m^2$). The waste rock removed from the Boston crown pillar recovery trench will be deposited on the Boston waste rock pad and the excavated overburden will be deposited on the Boston overburden pile. The Boston waste rock pad has sufficient volume to accommodate the waste rock volumes as the mining of the crown pillar recovery trenches will not coincide with peak waste rock on surface.

The mine void will be backfilled to ensure no long-term permafrost degradation of the surrounding area. The bulk of the backfill will be waste rock material with stockpiled overburden to be used at surface.

### 3.1.3 Timing and Seasonal considerations

The crown pillar recoveries are to be a brief and intensive mining operation. The total time from first surface excavation of a crown pillar recovery trench to mine void backfill is expected to be in the order of four to eight months. The crown pillar recovery trenches will not be opened earlier than necessary and the mine void will be backfilled as soon as possible following mining to minimize melting of the temporarily exposed slopes.

The seasonal timing of the crown pillar recovery trench excavations will be dependent on the mining operations. Should the mining operations occur in winter conditions (November – April) no surface water management will be required. Should the mining operations occur in non-winter conditions (May – October) surface water management will be required. Upstream diversion of surface run-off is provided by the access road, but additional management of melt-water from exposed slopes and direct precipitation within the crown pillar recovery trench would be required. The flows into the mine / crown pillar recovery trench would be managed as per the existing water management plan and would be treated as mine water inflows.

## 3.2 Access and Haul Roads

An access and haul road is required to provide equipment access to the Madrid crown pillar recovery trench. The road design and layout is addressed separately (SRK 2017b).

All other crown pillar recovery trenches are accessible by previously built roads and do not require an associated access road.

# 4 Mining Methodology

## 4.1 Crown Pillar Recovery Trench Development

The mining methodology for the crown pillar recovery is illustrated in Figure 3. As shown in Stage 1, underground mining will continue into the crown pillar as per existing mining operations. The crown pillar recovery trench will remove overburden, waste rock and some ore to expose the bulk of the crown pillar from surface (shown in Stage 2 and 3). The bulk of the crown pillar will be drilled and blasted from underground and collapsed into the existing mine void. The mined material, ore and waste rock will be brought to surface via the existing Madrid and Boston mine portal (shown in Stage 4). The final stage will be the void backfill from both underground and surface, with the upper section being entirely from surface.

The bulk of the backfill will be sourced from waste rock directly from underground mining operations or hauled from the designated waste rock pile. The overburden removed from the crown pillar recovery trench and stored in an overburden stockpile will be placed as the final layer(s) of backfill. Placement of the overburden backfill may require re-working and more than one summer of backfill activities due to the freezing of the overburden material in the stockpile.

## 4.2 Equipment

The equipment expected to be used in the mining and backfill operation includes underground long-hole drills for drilling and blasting, load-haul-dump units for mucking the ore, 30 T or 40 T haul trucks, dozers, excavator(s), and a vibrating smooth drum compactor.

## 4.3 Water Management

Surface water and any water inflows to the mine will be managed in accordance with the site-specific Water Management Plans.

There is no sediment or contact water pond associated with the crown pillar recovery trenches. Management practices including silt fences will be required during the first spring after construction.

# 5 References

SRK Consulting (Canada) Inc., 2017a. Geotechnical Design Parameters and Overburden Summary Report, Hope Bay Project. Report Prepared for TMAC Resources Inc. 1CT022.013. November 2017.

SRK Consulting (Canada) Inc., 2017b. Hope Bay Project: Madrid North Surface Infrastructure Preliminary Design. Memo Prepared for TMAC Resources Inc. 1CT022.013. November 2017.

Figures

N

7551500 N
7551000 N
7550500 N
7550000 N
7549500 N

433500 E
433000 E
432500 E

Patch Lake

Crown Pillar Recovery
Trench Area

200m

100m

Madrid North
Vent Raise

Madrid North
Vent Raise

31m Lake
Setback Line

Crown Pillar Recovery
Trench Access Road

Madrid North

50m

Crown Pillar Recovery
Trench Area

300m

Madrid South
All-weather Road

Doris-Windy
All-weather Road

Windy Lake

**NOTES**

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.

0 30 60 90 120 150
Scale in Metres

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SRK JOB NO.: 1CT022.013
FILE NAME: 1CT022.013 Madrid Boxcut Fig1.dwg

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Hope Bay Project

# Crown Pillar Recovery Trenches

## Madrid CPRT Location Plan

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| Sept. 2017 | CH | 1 |

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Aimaokatalok Lake

N

7505000 N

441500 E

Contact Water Pond #1
Access Road (8m wide)

Contact Water Pond #1

Waste Rock Pile
(Volume = 349,000 $m^3$)

Overburden Pile

Sediment Water Pond

To Madrid

Existing Airstrip

Heliport

Underground Workings
50m buffer

Madrid-Boston Road

Process Plant Haul Road

Ore Stockpile

Existing Camp Pad

Crown Pillar Recovery
Trench Area

300m

Portal

380m

100m

Vent Raise

Communications Tower

Existing
Vent Raise

31m Lake setback line

66

7505000 N

7504500 N

70

75

80

**LEGEND**

- 31m Stream / Lake Setback
- 50m Underground Workings Buffer

**NOTES**

1. The coordinate system is UTM Zone 13, NAD83.
2. Dimensions in metres unless noted otherwise.

0 10 20 30 40 50
Scale in Metres

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SRK JOB NO.: 1CT022.013

FILE NAME: 1CT022.013-Boston Box Cut.dwg

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Hope Bay Project

Crown Pillar Recovery Trenches

# Boston CPRT Location Plan

| DATE: | APPROVED: | FIGURE: |
|---|---|---|
| Sept. 2017 | CH | 2 |

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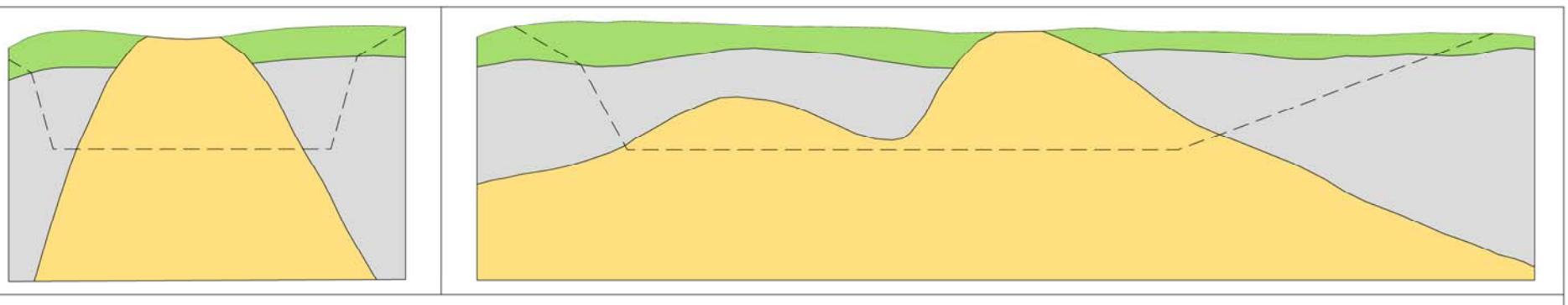
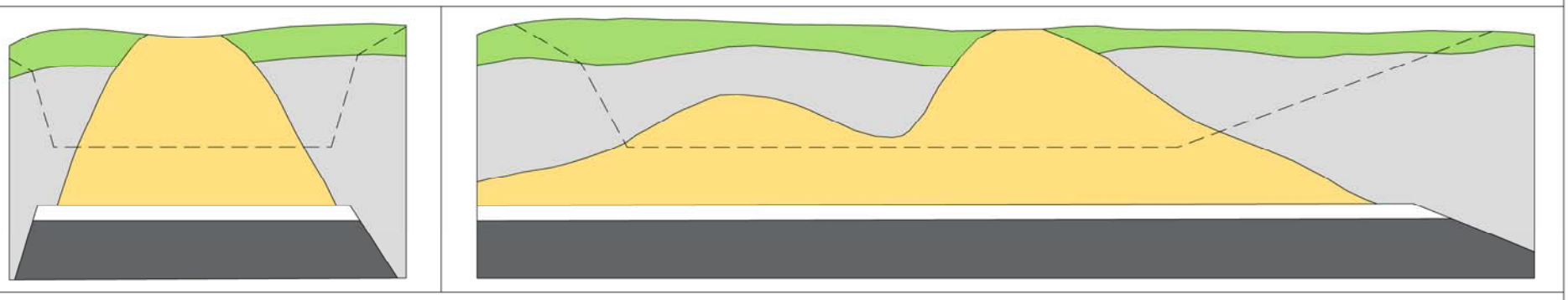
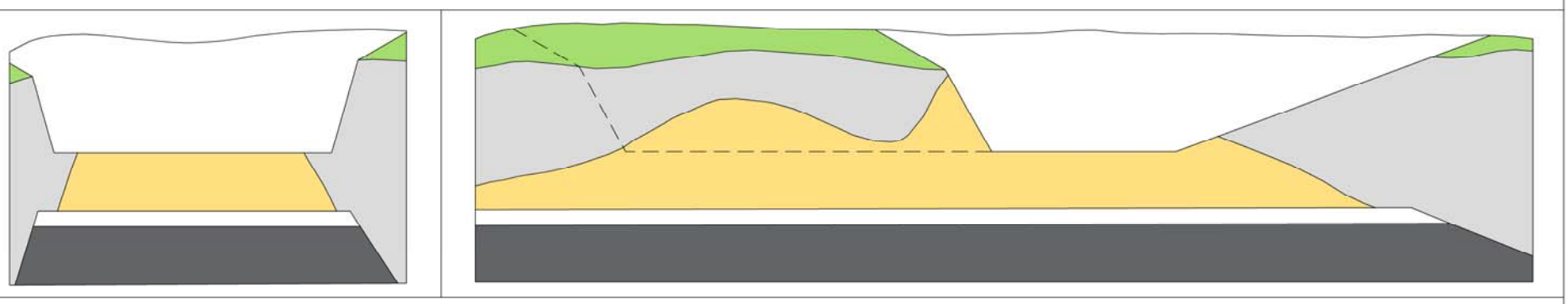


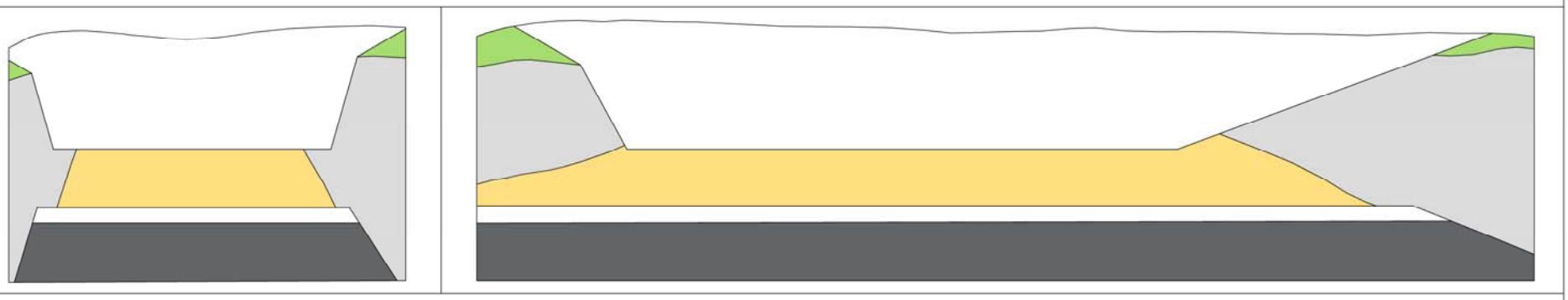
Stage 0: Pre-mining.



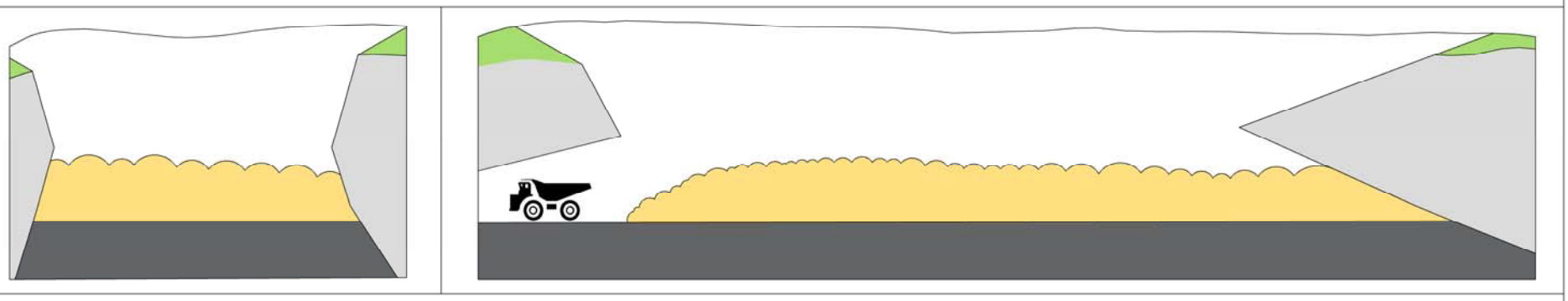
Stage 1: Underground mining complete up to crown pillar.



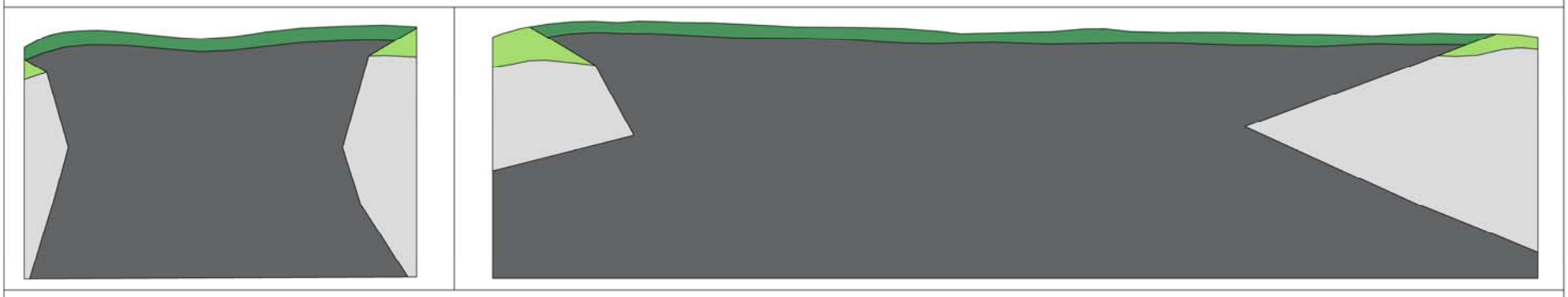
Stage 2: Excavation of crown pillar recovery trench. Materials hauled to surface from trench.



Stage 3: Crown pillar recovery trench excavation complete.



Stage 4: Crown pillar blasted and mined from UG workings. Material hauled to surface via mine portal.

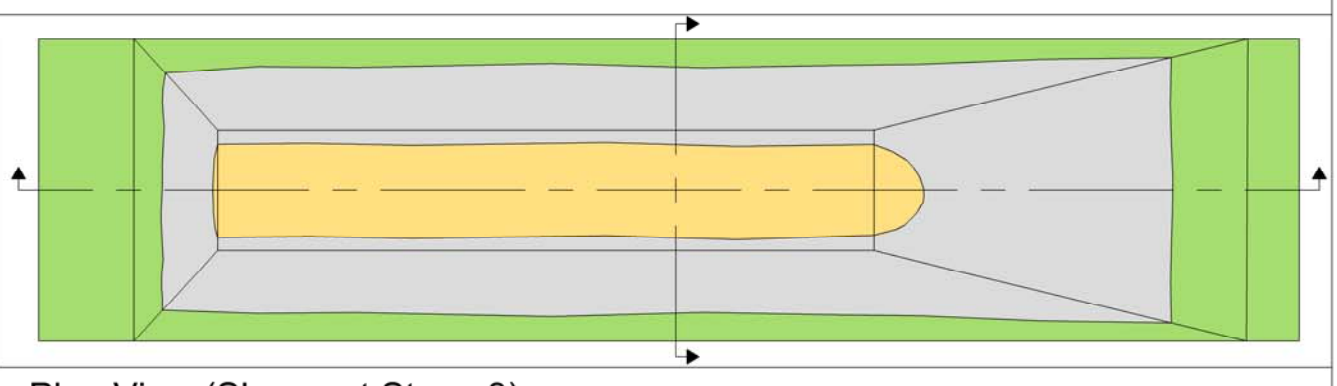


Stage 5: Backfilled mine void.

**LEGEND**

- Crown Pillar Recovery Excavation Plan
- Overburden
- Bedrock
- Ore Body
- Waste Rock Backfill
- Overburden Backfill
- Excavated Area

**NOT TO SCALE**



Plan View (Shown at Stage 3)

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Crown Pillar Recovery

Crown Pillar Recovery Concept Figures

| SRK JOB NO.: | 1CT0022.013 | Hope Bay | DATE: Oct 2017 | APPROVED: TS | FIGURE: 3 |
|---|---|---|---|---|---|
| FILE NAME: | CrownPillar_ConceptFigures.dwg | | | | |

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