Izok Corridor Project Proposal

SECTION 2

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2 PRELIMINARY PROJECT DESCRIPTION

2.1 Introduction

The Izok Corridor Project (‘the Project’) is a proposed mining development located in the Kitikmeot region of Nunavut. The Project includes development of the High Lake and Izok zinc-rich deposits. Ore mined from both deposits will be processed at a proposed mill to be located at the Izok Mine. The concentrate will be transported year round by truck on a ~350 km all-season road (Izok Road)to a port at Grays Bay on the Coronation Gulf. Concentrate will be stored at Grays Bay and shipped to smelters in Europe and Asia during the open-water season.

Temporary winter roads will be established between the proposed Izok Mine and to a point close the Tibbitt-Contwoyto Ice Road (TCWR)and between Grays Bay and the proposed High Lake Mine to facilitate construction. The Izok winter road will be used to bring construction equipment and materials into the site from Yellowknife. The High Lake winter road will be used to move construction equipment and materials from Grays Bay.

This Project description is based on a pre-feasibility study completed in early 2012 (MMG 2012a) that describes the preliminary Project infrastructure and activities. MMG is currently undertaking a feasibility study for the Project, which will result in a more detailed engineering design and costing, and resources and financial modelling. This feasibility study includes consideration of an alternate alignment for Izok Road. The feasibility study will provide more details as to the costs of construction, operation and closure and will allow MMG to make a final decision in mid to late 2013 regarding whether to move forward with construction of the Project.

2.1.1 Project Land Requirements

Development of the Izok Corridor Project will require land at Grays Bay for storage and port facilities and associated infrastructure, at the Izok and High Lake Mine sites for infrastructure, open pits, waste rock/overburden and tailings impoundment areas, and along the 347-km Izok Road corridor. The total estimated land requirement for the Project is 1,160 hectares (ha) (**Table 2.1-1**). These numbers are subject to revision during feasibility planning.

Table 2.1-1 Approximate Land Requirements for the Izok Corridor Project

Project Component	Area (ha)
Izok Mine Site and Infrastructure	290
High Lake Mine Site and Infrastructure	78
Izok Road	770
Grays Bay Port and Infrastructure	22
Total	**1,160**

2.1.2 Pre-Construction Staging

The construction and operation of major mining and infrastructure projects in the arctic requires substantial planning to deal with the logistical challenges associated with the lack of existing services and infrastructure, harsh winter conditions and the short summer season. Scheduling needs to consider the short open-water periods and limited winter road availability for strategic delivery of materials and equipment for early works until all-season facilities are developed. Delays of a few months for specific activities may result in up to a year delay to the Project schedule. Early planning is critical.

MMG intends to apply to the NIRB for an exception to the Project review process, pursuant to Article 12.102(b) of the Nunavut Land Claim Agreement (NLCA), for authorization to proceed with pre-construction works prior to completion of the Project review by the NIRB. Current plans for pre-construction works include early staging of equipment and materials and other preparatory activities necessary to facilitate commencement of construction as soon as the Project Certificate and relevant approvals are received from the NIRB and Authorizing Agencies.

The key milestones for pre-construction works are summarized below. This assumes that pre-construction staging activities will be authorized prior to completion of the NIRB Project Review and that MMG receives the Project Certificate and associated permits in Q1/Q2 of 2015. If construction permits are not issued until later in the year, timing windows for early works would be modified, but this would not change the intent of MMG plans for pre-construction works.

Anticipated Dates	Milestone
Q2 2014	MMG submits Application for Exception from Review for selected pre-construction activities to the NIRB
Q3 2014	NIRB authorizes exceptions allowing pre-construction activities to proceed; AANDC and KIA issues the associated land use permits
Q3 2014	Pre-construction activities commence
Q1/Q2 2015	NIRB issue Project Certificate authorizing commencement of construction

As required by the NIRB, MMG will undertake public consultation in relation to the specific pre-construction activities included in the application for exceptions, and will incorporate public input and local knowledge into the planning for these activities.

More detailed information regarding planned pre-construction staging activities, timing of activities and workforce requirements will be submitted to the NIRB as part of the Exceptions Application.

MMG also intends to submit applications to AANDC and KIA for land use permits required to proceed with the pre-construction works. If necessary, MMG will also submit an application for an amendment to its Type 'B' water license to allow for the use of water and deposition of wastes (i.e., sewage, grey water, non-hazardous wastes, waste oil and other waste) for pre-construction activities.

2.1.2.1 Izok Mine Site

The TCWR will be used to transport materials and equipment to the south end of the Izok Corridor Project. The entire road is available for only about two months each year (late January through late March), although the north end of the road can have an extended life depending on climatic conditions in any given year. Consequently, all construction equipment and materials required for the Project to March of the following year will need to be delivered during the January-March 2015 period. This supply route will be used for the first two years of the Project until construction of the all-season road from Izok Mine to Grays Bay is completed.

Materials transported during the first season will include camps, offices, earth moving equipment, construction equipment (e.g., cranes and forklifts), batch plants, tools, explosive supplies, crushing plant, fuel, transport, construction materials, rebar, steel, cement, warehousing, culverts, bridges and non-perishable goods.

The main staging area for this equipment will be at the Ham Lake camp, which is accessible by ice road from the main winter road. A secondary staging of earth moving equipment may be located at a point near the Jericho Mine.

The following is a list of specific pre-construction activities that MMG will apply for permission to proceed with as part of the Exception Application.

- Upgrade the airstrip at the Ham Lake camp or a nearby selected airstrip
- Build a winter road between Ham Lake camp and the northern end of the TCWR
- Build an all-season road from the Ham Lake airstrip to the Izok Mine site
    - If study of airport locations indicates that the Ham Lake airstrip cannot accommodate larger aircraft that will be required for the Project (Hercules), an alternate location east of Izok Lake may be selected. This would require construction of an all-season road between that location and the Izok Mine site.
- Construct temporary camps, prepare laydown areas, and establish a fuel depot at the proposed Izok Mine site
- Develop quarries to allow for construction of the above facilities and Izok Road

2.1.2.2 Grays Bay South to Jericho Mine

Marine transport of equipment and materials to Grays Bay is only possible during a three-month period when the Coronation Gulf is ice free.

Materials, equipment and supplies required for port and road construction will be transported to Grays Bay via barge in August-September 2014, where they will be offloaded onto the beach and moved to a new laydown area that will be within the planned footprint of the proposed port facility.

Early works will include:

- Construction of the temporary dock for barge off-loading
- Establishment of areas for the camp and laydown warehousing
- Set up temporary facilities such as camp, batch plant, quarries, crushing plants, fuel storage and warehousing
- Construction of an airstrip near Grays Bay
- Construction of the winter road from Grays Bay to the High Lake Mine site during winter 2014/2015

2.1.3 Project Schedule

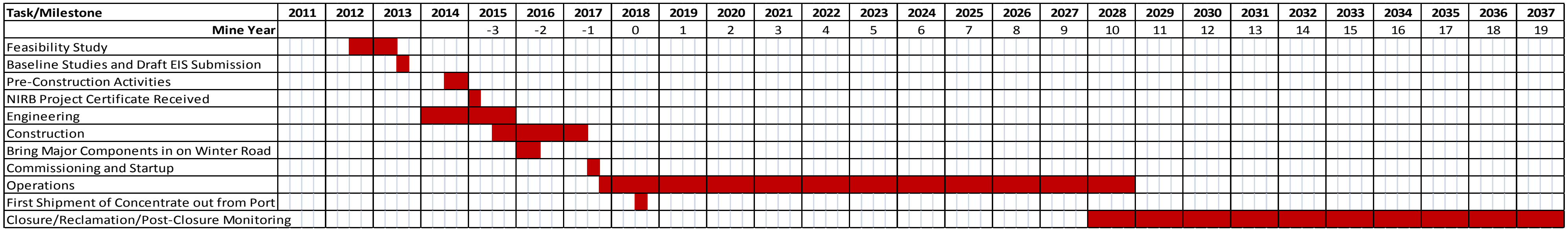
The preliminary Project schedule is provided in **Figure 2.1-1**. The schedule assumes that the pre-construction activities will occur in advance of receiving the Project Certificate and that the Project will receive the requisite permits, licenses and approvals by Q1/Q2 2015. Following regulatory approval, construction of the Grays Bay Port and Izok Road will begin.

Mining and ore stockpiling at the Izok and High Lake Mine sites will begin in 2017, when construction of the mill facility at the Izok Mine is complete. Ore concentrate production will begin in2017. The life of the Izok Mine is expected to be 11 years, and the life of the High Lake Mine is expected to be 12 years.

Current reserves indicate a mill operating life of approximately 12 years at an average production rate of approximately 2 million tonnes of ore per annum (Mtpa). While future exploration drilling may identify additional deposits in the Project area that could potentially extend the operating life of the mine, this is not considered part of the current Project. It is acknowledged that a separate Environmental Assessment and license amendments would be required prior to development.

Anticipated timing of the major Project phases is summarized as follows.

- Construction: anticipated to begin in 2015 and occur over a two-year period
- Operations: anticipated to begin in 2017and last 12years
- Progressive reclamation: ongoing over the life of the Project
- Closure and reclamation: anticipated to begin in 2028 and occur over two to three years
- Post-closure monitoring: anticipated to last 7 years after closure (closure and reclamation and post-closure monitoring will occur over a 10-year period)



Task/Milestone	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Mine Year					-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Feasibility Study		⬜⬜🟥🟥	🟥🟥⬜⬜																								
Baseline Studies and Draft EIS Submission			⬜⬜🟥⬜																								
Pre-Construction Activities				⬜⬜🟥🟥																							
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Bring Major Components in on Winter Road						🟥🟥⬜⬜																					
Commissioning and Startup							⬜⬜🟥⬜																				
Operations							⬜⬜⬜🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥									
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Closure/Reclamation/Post-Closure Monitoring																		🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥	🟥🟥🟥🟥

Figure 2.1-1 Project Schedule

2.2 Regional Geology

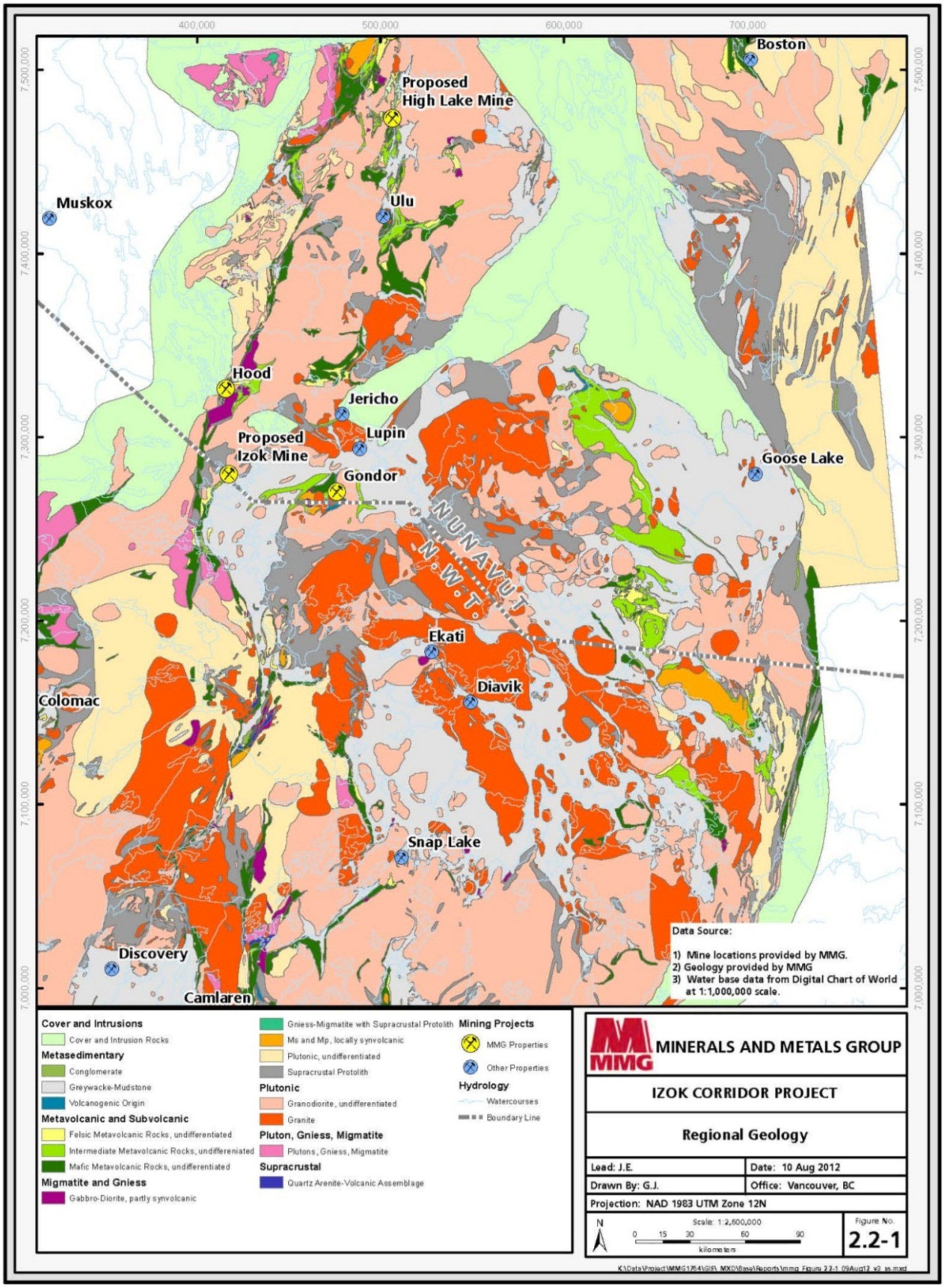
The Izok deposits are located within the western part of the Slave Structural Province, which is part of the Canadian Precambrian Shield. The area was last glaciated between 10,000 and 8,000 years ago. Erosion by the continental glaciation denuded the terrain into extensive areas of bare, fresh rock with a thin and discontinuous till cover.

Rocks are usually described from the oldest to the youngest and are often identified by major groupings and subgroups. The general bedrock in the Izok Lake area is composed of very old Precambrian rocks that were folded and metamorphosed during the Kenoran orogeny, some 2.5 billion years ago. This family of rocks belongs to the Point Lake Formation, a belt of mafic to felsic metavolcanic rocks that are part of the Yellowknife Supergroup.

The groups of rocks of interest, the deposits that contain the zinc rich ore under Izok Lake, are hosted by a complex of mainly felsic metavolcanic rocks in a partly submarine setting. The volcanic rocks are overlain by fine clastic, partly carbonate bearing sediments of the Contwoyto Formation. Synvolcanic intrusive activity emplaced sills of gabbroic composition as well as dacite dikes and sills. All of the above rocks have subsequently been intruded by granitic rocks and their pegmatitic derivatives.

The High Lake deposits are volcanogenic massive sulphide (VMS) deposits hosted within the High Lake greenstone belt in the northern part of the Slave structural province. Basement gneisses about 3.96-3.00 billion years ago (Ga) are overlain by sedimentary and volcanic rocks (2.69 Ga). Three phases of regional deformation are evident, and the province is intruded by batholiths ranging between 2.63-2.58 Ga. Generally, the supracrustal rocks trend north to northeast.

The High Lake greenstone belt extends 140 km from the Coronation Gulf coast southward (**Figure 2.2-1**). The belt exhibits greenschist grade metamorphism, and is intruded by syn-volcanic mafic to intermediate plutons and post tectonic felsic intrusions. Proterezoic age (1.27 Ga) northwesterly trending diabase dykes, which are part of the Mackenzie swarm, intrude the supracrustal sequence.



Data Source:

1) Mine locations provided by MMG.
2) Geology provided by MMG
3) Water base data from Digital Chart of World at 1:1,000,000 scale.

Figure 2.2-1 Regional Geology

2.3 Mining Overview

Both open pit and underground mining methods will be used for the Izok Corridor Project. Open pit mining is usually less expensive and therefore is usually the first method used. Underground mining is more expensive, and the extent and depth of underground mining is directly related to balancing the cost of recovery of the ore versus its value.

The majority of the Izok deposits will be open pit mined, while the Inukshuk deposit will be mined by underground methods.The deposits planned for open pit mining are located directly below Izok Lake. Therefore, Izok Lake will need to be drained, and the water diverted to allow extraction of the resource. The pit will be mined over 11 years in three phases.

Two deposits (AB and D) at High Lake will be open pit mined, and the West Zone deposit will be mined by underground methods.

The preliminary production schedule, presented in **Figure 2.3-1**, is based on a nominal 2 Mtpa.Approximately 1.4 Mtpa will come from the Izok Mine and 0.6Mtpafrom the High Lake Mine. These numbers may change in the next years as more information becomes available. First ore will be delivered to the mill in late 2017 to early 2018.

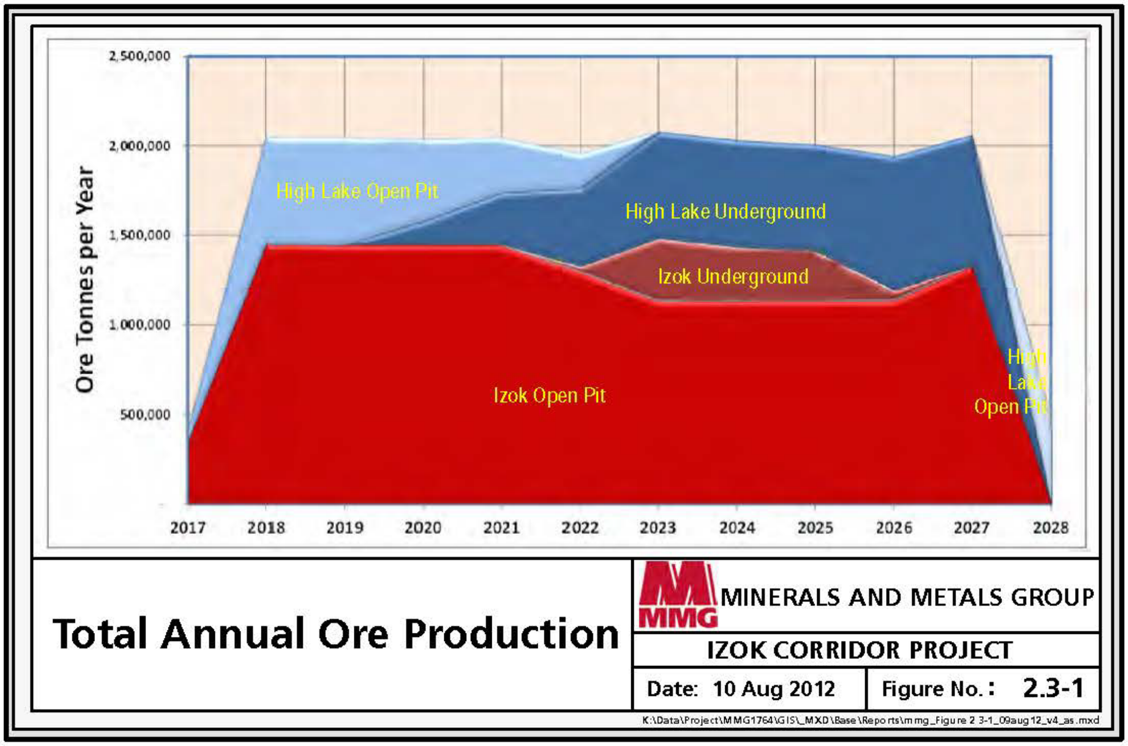


Figure 2.3-1 Total Annual Ore Production

2.4 Izok Mine Site

2.4.1 Izok Site Geology

Bedrock exposures in the immediate Izok Lake area consist of mafic to felsic metavolcanics, granitic intrusives, gabbro, and meta-sedimentary rocks. Bedrock outcrops vary from massive competent to fractured and moderately competent rock.

The Izok zinc-copper-lead deposits are VMS deposits hosted within and near the top of a succession of dominantly felsic volcanic (rhyolitic) rocks, with lesser intermediate (dacite) volcanics, and derived sediments. The deposits are overlain by a succession of felsic volcanoclastics, gabbroic intrusions, intermediate and mafic flows, iron formation, and turbidite sediments (**Figure 2.4-1**). This suite, collectively and informally named the “Izok Lake Belt,” is approximately 18 km in length and ranges from 1 km to 5 km in width.

Five sulphide deposits are known to exist under and near Izok Lake: Central, North, Northwest, Inukshuk, and South (**Figure 2.4-2**).

2.4.1.1 Central Deposit

The Central deposit forms a gently warped and east-plunging, trough-shaped composite lens. The deposit is 550 m in length (east-west), 200 m in width and up to 125 m in thickness. Depths range between bedrock surface and 160 m. The deposit is divided into two large pods referred to as the East Cup and the West Cup (**Figure 2.4-3**).

A steeply dipping north limb of the Central deposit projects to surface over most of its length and develops into the two bulbous accumulations of massive sulphides representing the East and West cups. In cross section, the bulbs resemble a giant “V” with a rounded base and a closed top that either dips to the south at a rather flat angle or is locally flat (**Figure 2.4-4**and **Figure 2.4-5**). On some sections of the West Cup, the walls of the “V” are inverted toward the outside. In longitudinal section, the top of the “V” rises from a depth of 80 m to 90 m below surface at its eastern limit to 50m to 60 m through the western part of the East Cup and the eastern part of the West Cup, finally outcropping in the western part of the West Cup (refer to **Figure 2.4-3**).

Open pit mining will start in the West Cup because it carries by far the highest grades of all Izok deposits and has the largest tonnage directly at bedrock.

2.4.1.2 Northwest Deposit

The Northwest deposit forms a shallow-dipping lens 400 m (NW-SE) x 250 m (NE-SW) x 20 m average thickness between a depth of 0 m and 130 m (**Figure 2.4-6**). The deposit is generally hosted within felsic rocks but is structurally overlain by gabbro, which appears to have cut into the underlying sulphides from above at an oblique angle in some instances. Two or more horizons containing disseminated sulphides occur lateral to the main lens on some sections, which suggests that multiple lenses may have coalesced.

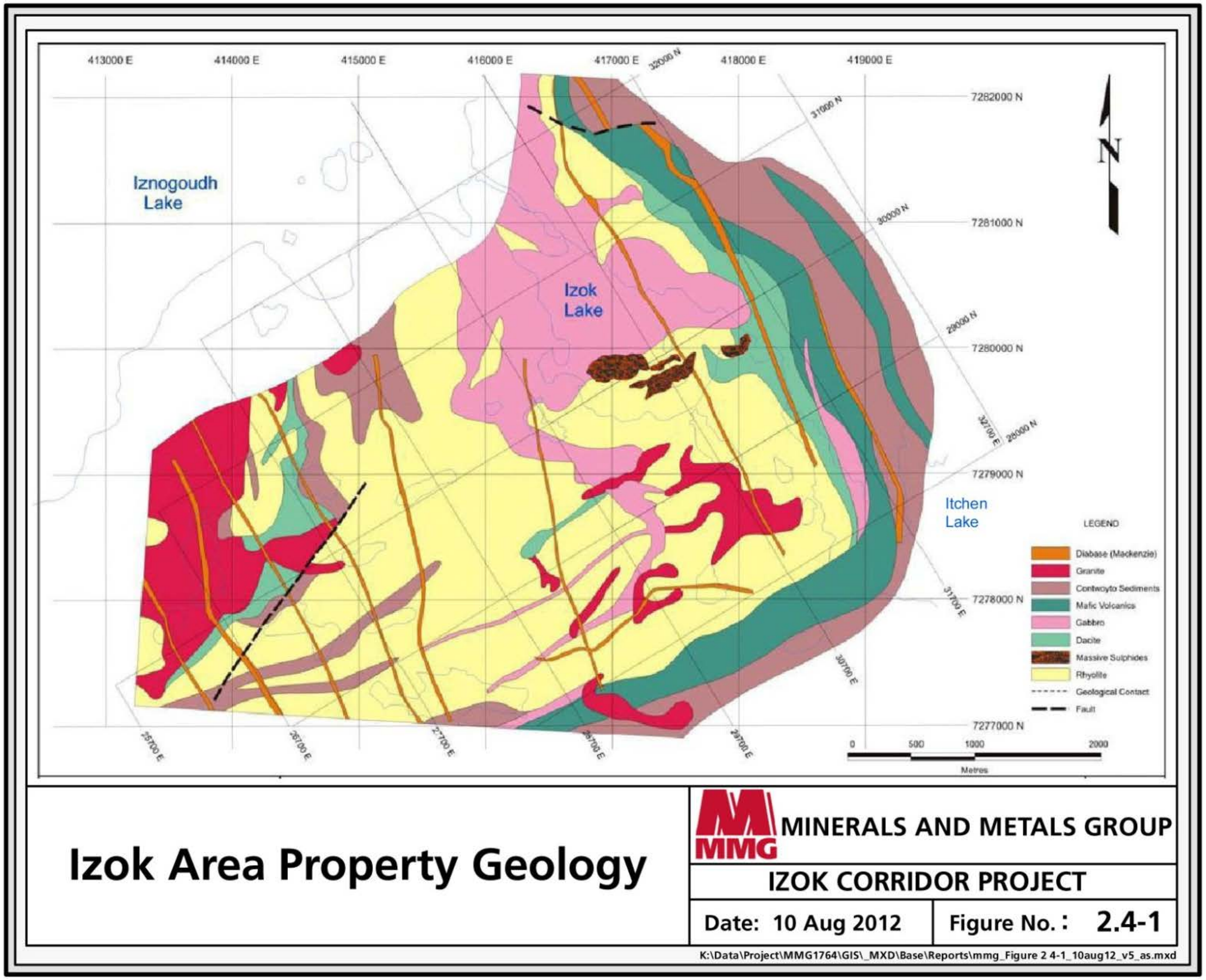


Figure 2.4-1 Izok Area Geology

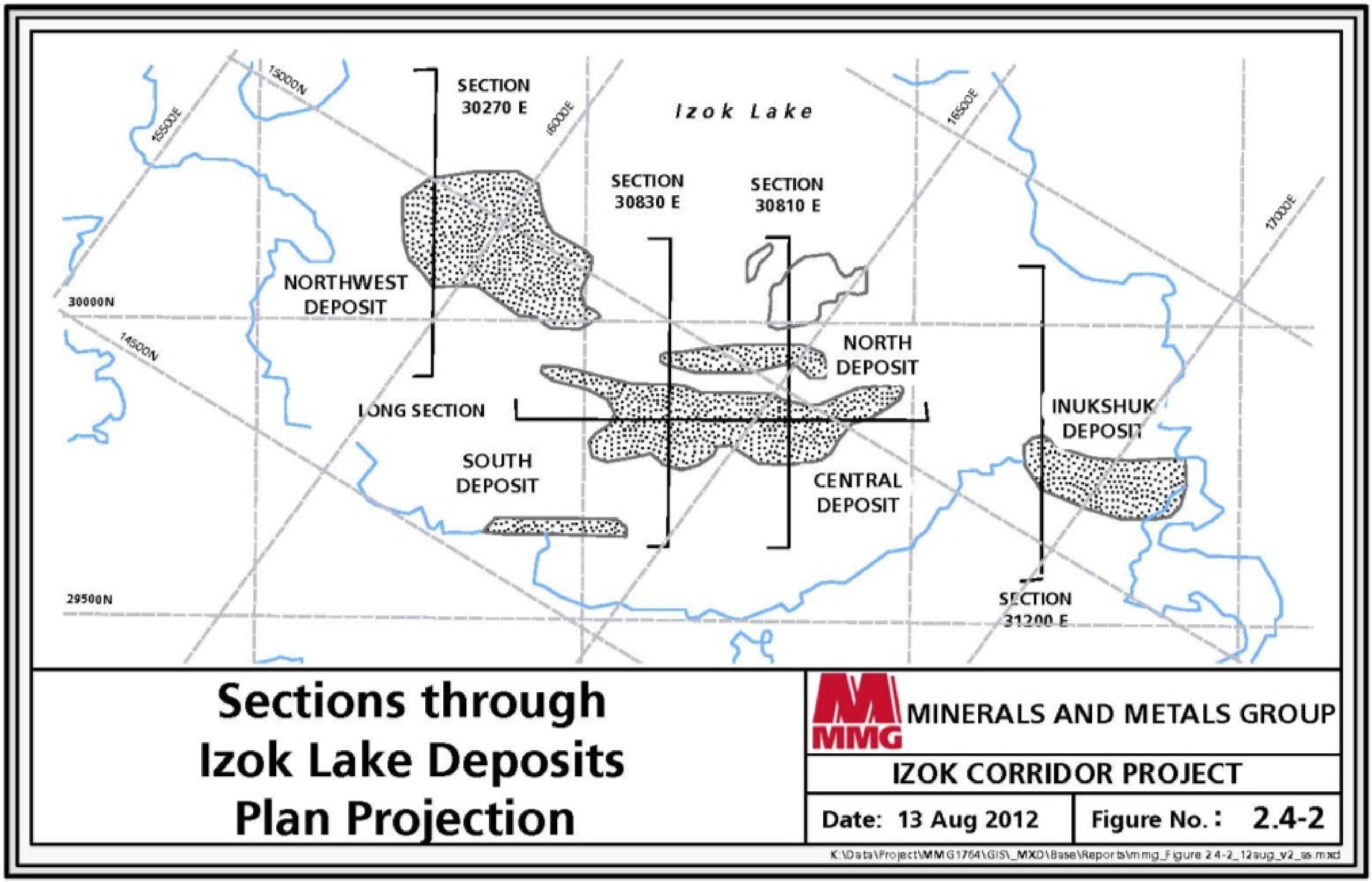
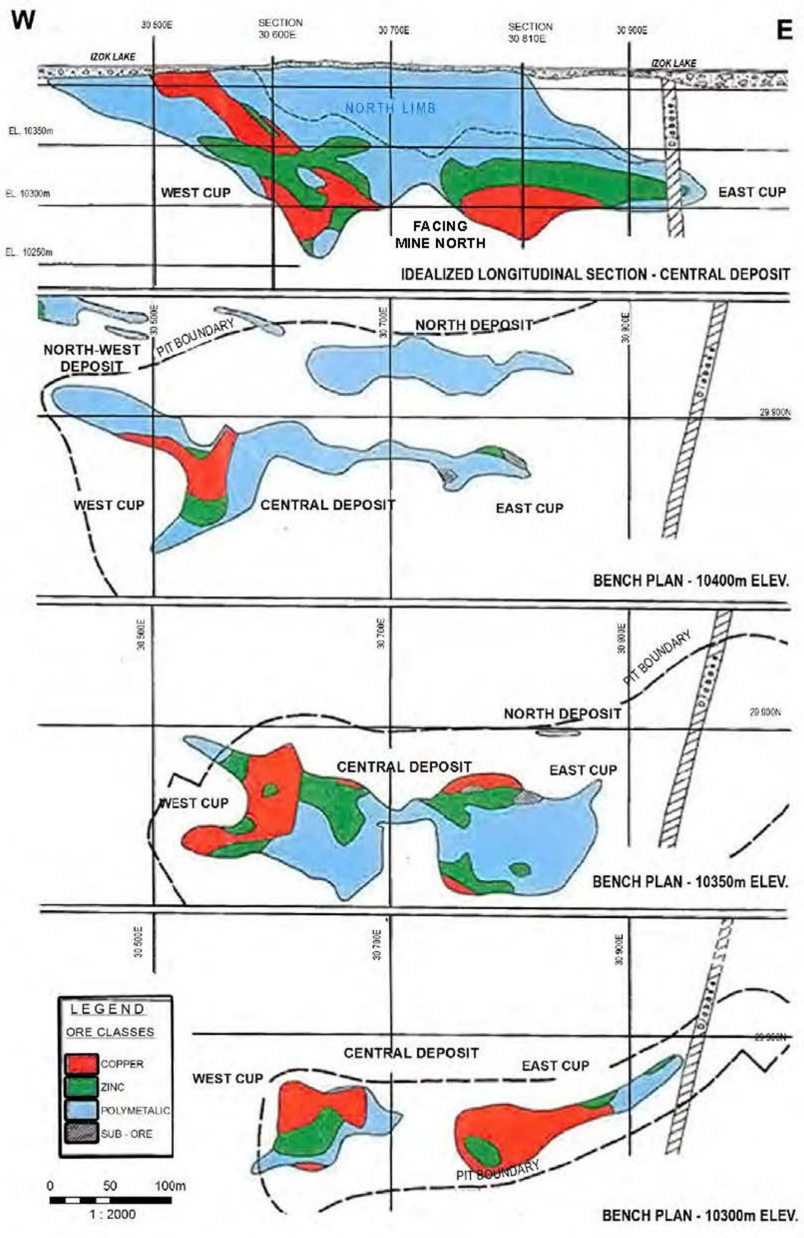


Figure 2.4-2 Sections through Izok Deposits – Plan Projection



Izok Resource Model
Idealized Long Section (top)
and Bench Plans (lower 3)

MINERALS AND METALS GROUP
IZOK CORRIDOR PROJECT
Date: 15 Aug 2012
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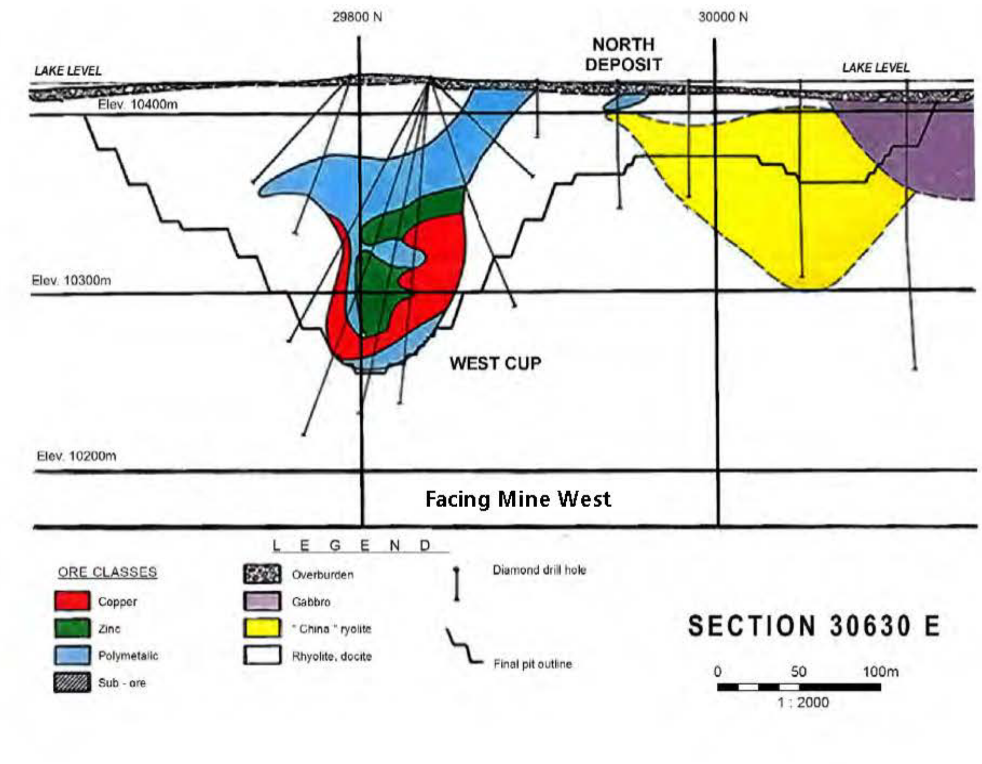
Figure 2.4-3 Idealized Long Section (top)and Bench Plans (lower 3)



Central Deposit – West Cup Section

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IZOK CORRIDOR PROJECT

Date: 10 Aug 2012

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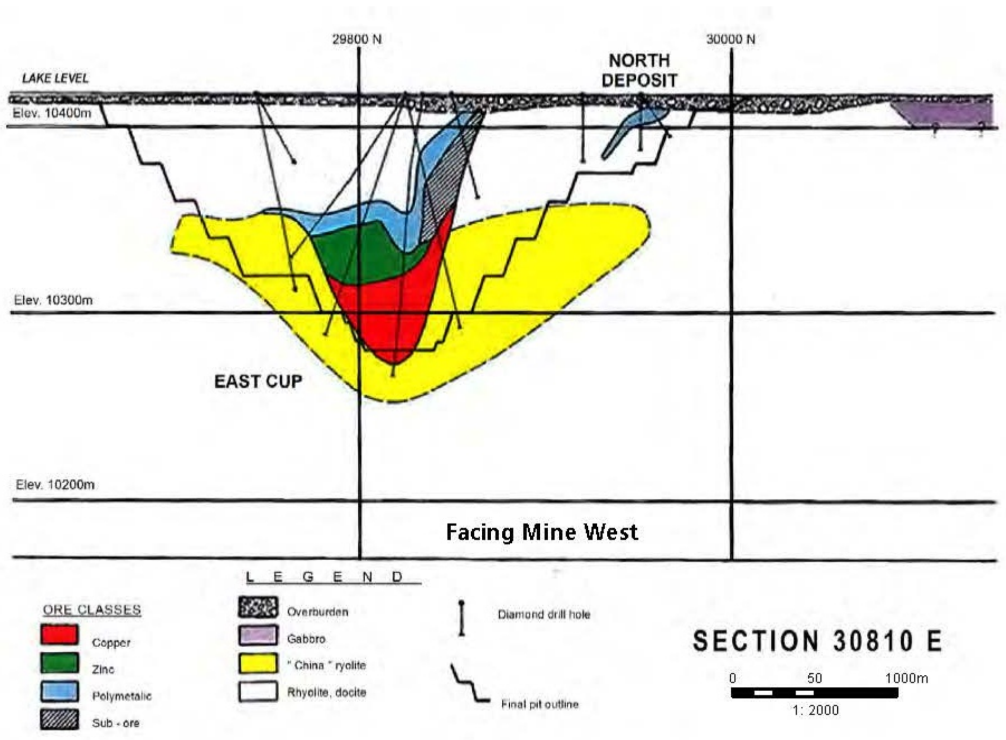
Figure 2.4-4 Central Deposit – West Cup



Central Deposit – East Cup

MINERALS AND METALS GROUP

IZOK CORRIDOR PROJECT

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Figure 2.4-5 Central Deposit – East Cup

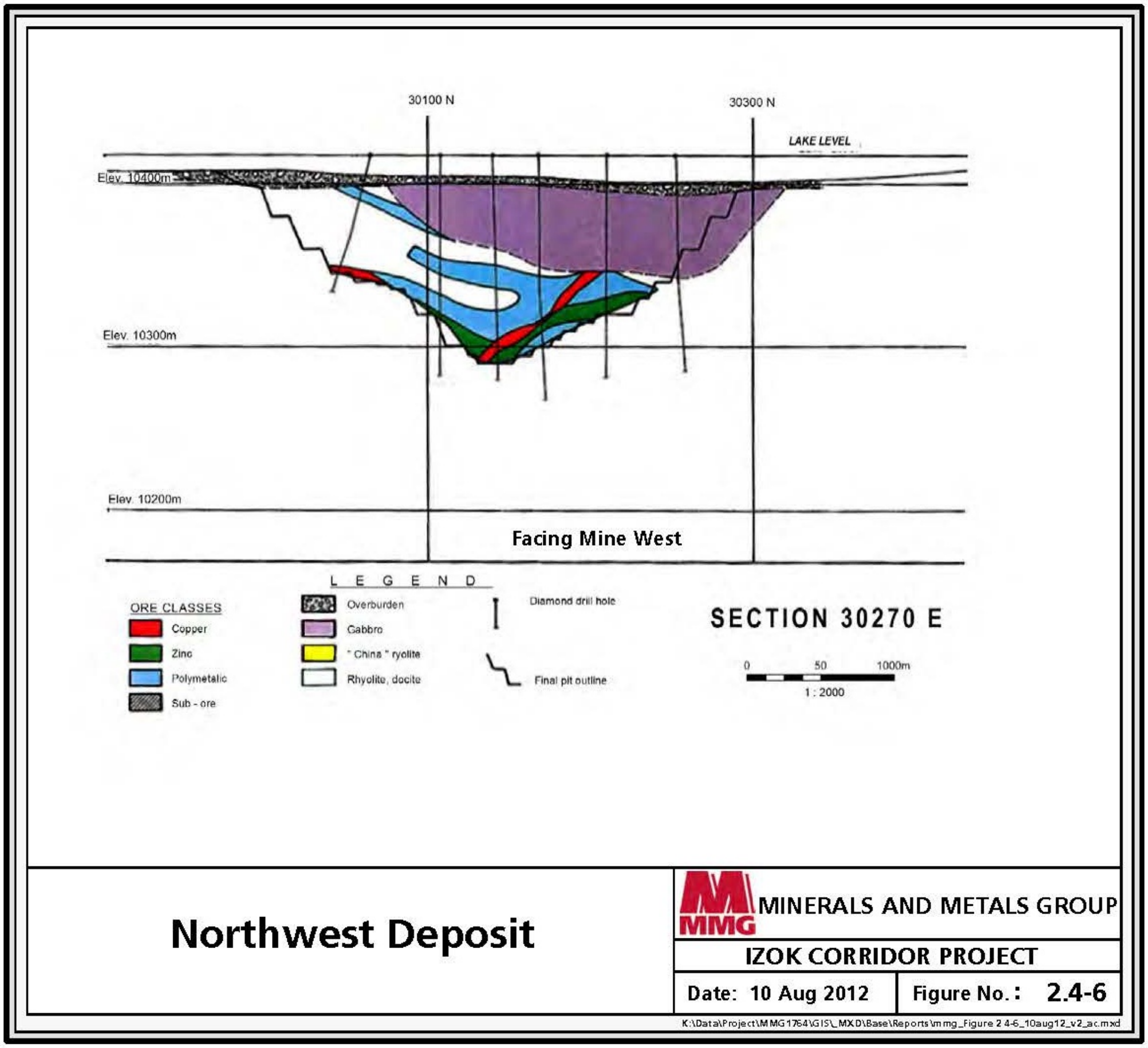


Figure 2.4-6 Northwest Deposit

2.4.1.3 North Deposit

The North deposit is a near-surface, elongate lens 350 m (E-W) x 50 m (N-S) x 15 m average thickness (refer to**Figure 2.4-6**). This deposit is an on-strike equivalent to the Northwest deposit and may represent the remnant keel of a larger, trough-shaped lens.

2.4.1.4 Inukshuk Deposit

The Inukshuk deposit is situated to the east of the East Cup of the Central Zone. Massive sulphides are found in a cigar-shaped zone, which starts 60 m below surface and plunges grid-east to 270 m below surface, some 200 m to the east for an overall plunge angle of 45°. In contrast, the footwall contact of the sulphides strikes grid northeast with a somewhat steeper dip toward grid southeast of 55°. The sulphides have a fairly constant grid north-south dimension of 80 m to 120 m. Like the other deposits at Izok, pronounced differences in thickness over relatively short distances are also found in the Inukshuk deposit. In addition, a general zoning is observed with thinner, zinc-rich material on the northern, up-dip side giving way to thicker, more copper-rich intersections toward the southern part of the deposit.

Three cross sections plotted at right angles to the changing strike of the zone show the average true thickness of the deposit to be approximately 10 m, with a maximum of 20 m (**Figure 2.4-7**).

2.4.1.5 South Deposit

Seven widely-spaced drill holes have yielded a number of intersections to a depth of 80 m in an area southwest of the West Cup (refer to **Figure 2.4-4**). Massive to semi-massive sulphide intersections appear to belong to a zone some 300 m long. Undiluted grades of five of the better drill intersections average 7% Zn, 0.7% Cu, 0.4% Pb, and 20 g/t Ag over a width of 5 m. A mineral inventory of approximately250,000 to 300,000 tonnes (t) is estimated.

2.4.2 Izok Mineral Resources and Reserves

Mineral resource estimates for the Izok deposits are outlined in **Table 2.4-1**. Additional exploration drilling will be undertaken during the life of the Project. These numbers may change as the Project advances.

Table 2.4-1 Preliminary Izok Mineral Resources as of 30 June 2010

Izok Mineral Resources									
2% Zn equivalent cut-off grade	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/tAg)	Contained Metal			
						Zinc (*000 t)	Copper (*000 t)	Lead (*000 t)	Silver (M oz)
Measured	-	-	-	-	-	-	-	-	-
Indicated	14.4	12.9	2.5	1.3	71	1,863.5	361.5	184.3	32.9
Inferred	0.4	6.4	3.8	0.3	54	23.6	14.0	1.0	0.6
Total Resources	**14.8**	**19.3**	**6.3**	**1.6**	**125**	**1,887.1**	**375.5**	**185.3**	**33.5**

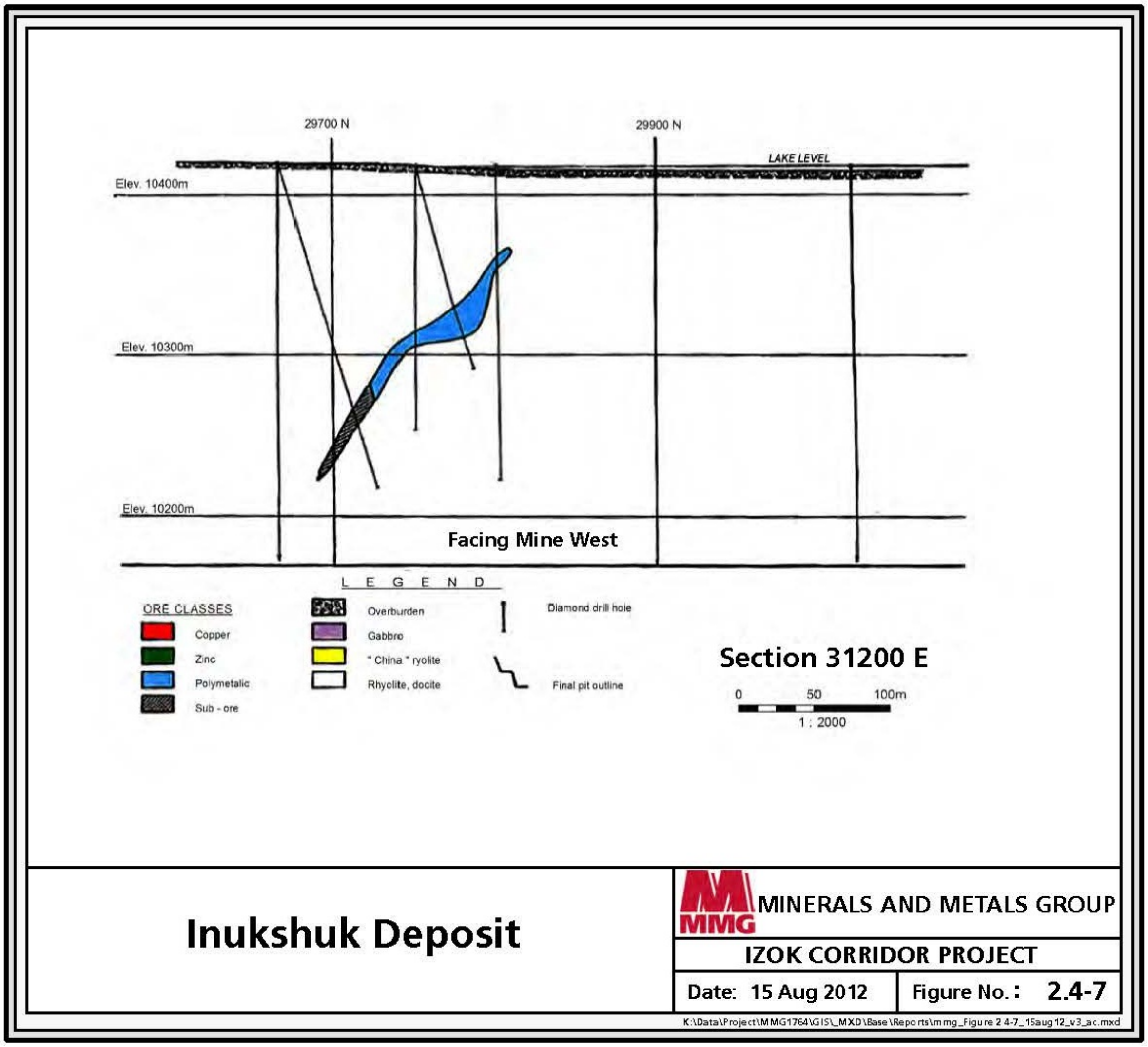


Figure 2.4-7 Inukshuk Deposit

2.4.3 Izok Lake Dewatering

Because the mineable Izok deposits are located beneath Izok Lake, draining the lake is a necessary first step in mine development. Izok Lake is located between Iznogoudh Lake (upstream) and Itchen Lake (downstream) (**Figure 2.4-8**; refer to section 5.6). It will be necessary to isolate flow from Iznogoudh Lake into Izok Lake and divert the water into Itchen Lake before starting to drain Izok Lake water into Itchen Lake. A diversion dam will be constructed to cutoff inflows from Iznogoudh Lake into Izok Lake. A diversion channel will be built to re-route this water around Izok Lake and into Itchen Lake downstream (see **Figure 2.4-9** for a preliminary typical cross section, plan and profile).

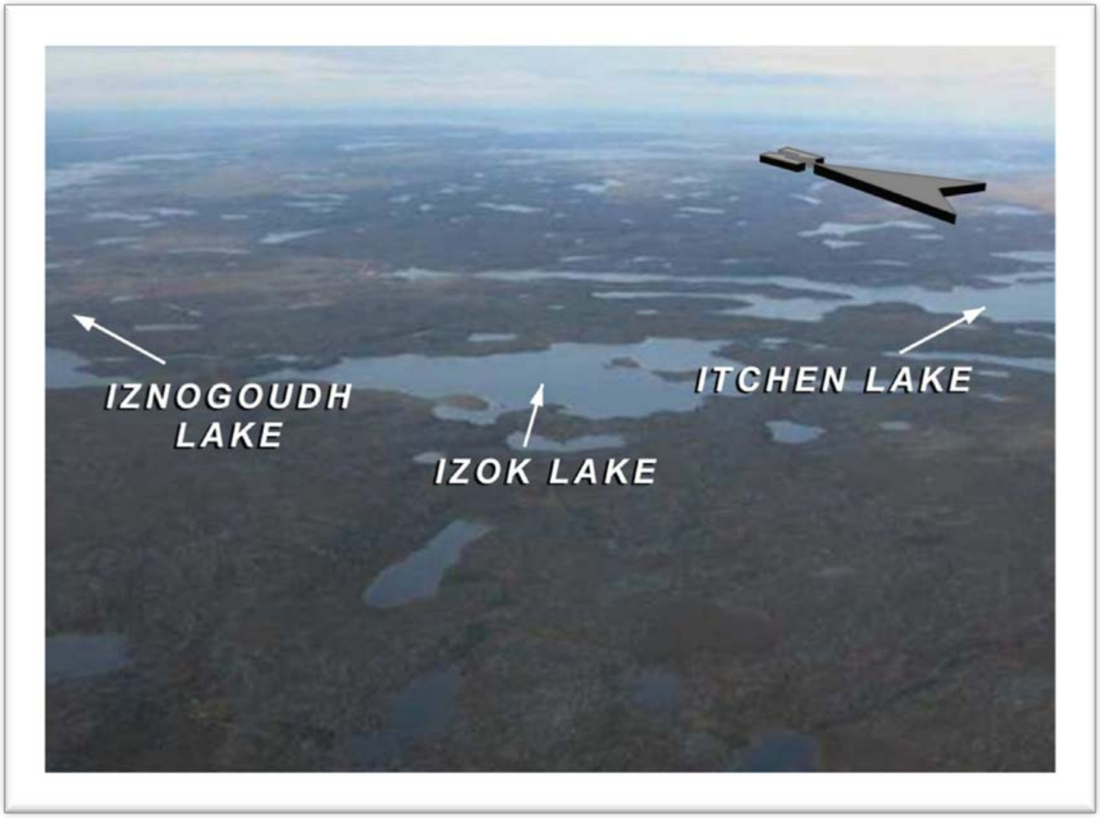


Figure 2.4-8 Izok Lake

Once inflowing water is diverted around Izok Lake, the lake will be drained. This will involve pumping approximately 6.4 Mm^3 of water into Itchen Lake, which will take several months.

Experience with draining several lakes at the Ekati Mine suggests that Izok Lake can be fished out during the summer and dewatered during the fall when there is some ice cover that will drape over mud slopes as the water level recedes, limiting re-suspension of lakebed solids as the water level drops. The upper half of Izok Lake water column is expected to beclear enough to be pumped directly to Itchen Lake, while the lower half will likely be turbid and require routing through a water holding pond for clarification before release to Itchen Lake.

Izok Lake dewatering will be guided by a detailed Water Management Plan. The objectives of the plan will be to ensure minimal to no changes in water quantity and quality of the upstream and downstream lakes. In addition, a Fish Management Plan and Fish Habitat Compensation Plan will also be prepared in collaboration with the Hunters and Trappers Organizations (HTOs) and Fisheries and Oceans Canada (DFO). Fish habitat compensation will be provided at an area ratio as agreed with DFO.

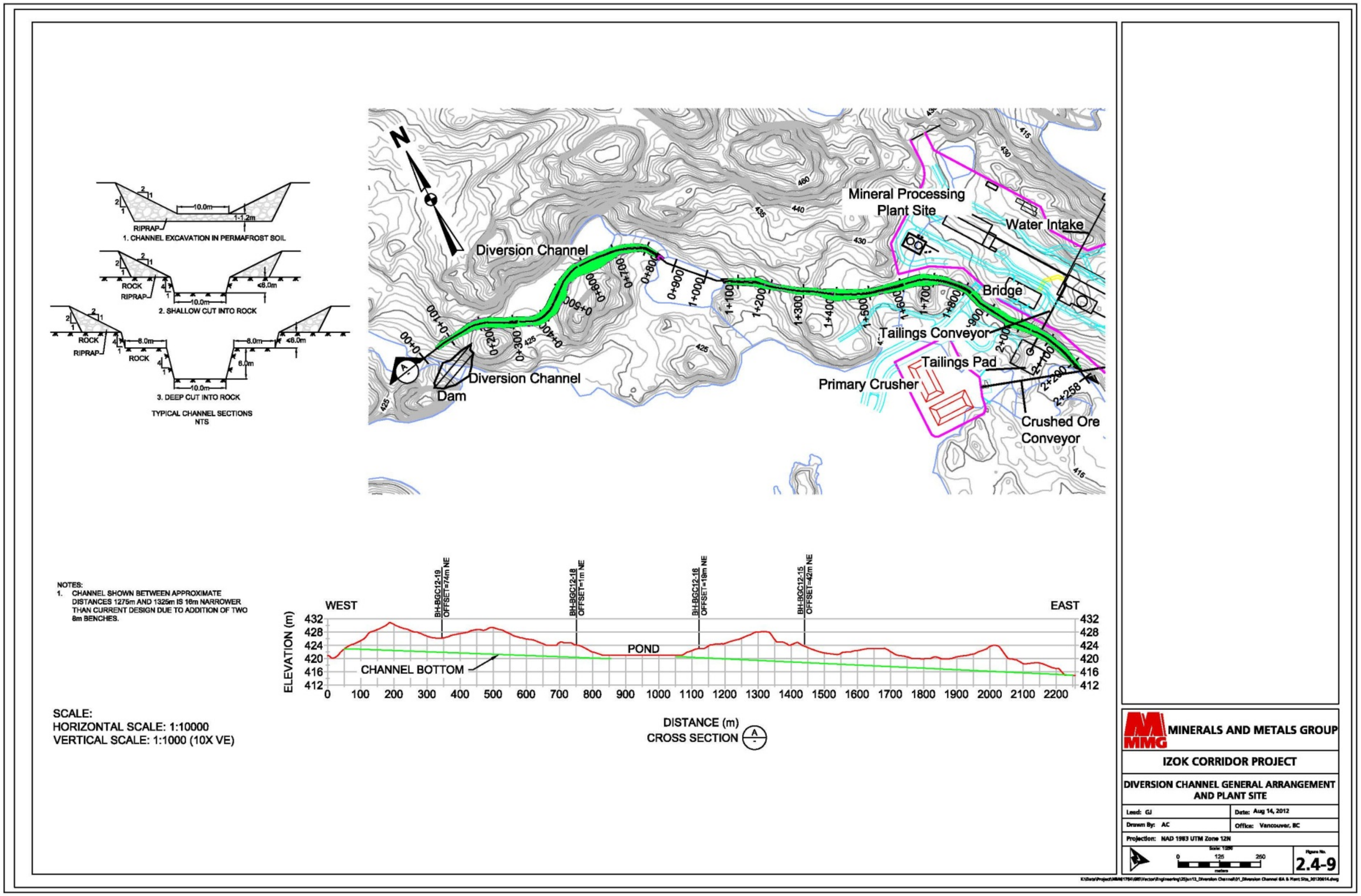


Figure 2.4-9 Diversion Channel General Arrangement and Plant Site

2.4.3.1 Diversion Dam and Diversion Channel Construction and Operation

The diversion channel, diversion dam and the water holding pond will be constructed using standard techniques typical of water containing structures in the north, and standard earthmoving and construction equipment. Blasting will be used where solid rock is encountered. MMG is conducting a sampling program to determine if acid rock drainage potential may be present.

Boulders and gravel will be placed in the bottom of the diversion channel in places to facilitate fish passage. Rock armouring will be installed where the channel is excavated in overburden to prevent erosion. Material excavated from the diversion channel will be used for berms and maintenance of a road running parallel to the channel and any excess material will be used in other areas of Project construction.

The diversion channel will be maintained through regular inspection and maintenance activities to keep the channel clear of ice, snow and debris.

2.4.3.2 Izok Lake Drainage Mitigation by Design

Waste rock and tailings will be deposited within the area of the drained lake bed not required for mining to minimize the Project footprint.

Dewatering of Izok Lake will occur during the fall when there is some ice cover on the shore that will limit re-suspension of lakebed solids. During draining of the lower half of the lake, water will be routed to a water holding pond for clarification prior to release. There will be no water loss, as water will be re-routed via the diversion channel into Itchen Lake.

The risk of contaminated water entering the diversion channel from the process plant and camp complex and making its way into Itchen Lake will be reduced by installing surface water control structures that will intercept surface run-off and pump it back to the process plant for re-use and recycling.

2.4.3.3 Drainage Alternatives

Alternative to Draining Izok Lake

The only alternative to draining Izok Lake to access the ore is to mine the ore from underground. This option was rejected because it would require a substantial thickness of solid rock in the form of a crown pillar to be left at the top of the ore body as a barrier between the lake and the underground mine workings. This would substantially reduce the percentage of the ore body available for mining and greatly diminish the economically viability Project.

Alternative Diversion Channel Routes

Several diversion channel routes were evaluated based on constructability, operability and environmental criteria (**Figure 2.4-10**). The selected option would cause the least amount of disturbance, require the least amount of excavation, and require the shallowest cuts through ridges and hills.

2.4.4 Izok Mining

Once Izok Lake is drained and lake bottom sediments removed, excavation of the Izok Mine open pit will begin. Mine planning has considered the materials that will be encountered during mine development, as well as the permafrost and groundwater regimes

2.4.4.1 Hydrogeology

Hydrogeology of the Izok Mine area is an important factor to be considered in the mine design and planning. A proper understanding allows for adequate provisions to be made to handle water seepage into the mine area, to develop methods to minimize water inflows, and to plan and manage for the treatment of inflow water. The current hydrogeologic understanding of the Izok Mine area is summarized below.

There are three hydrostratigraphic units that have been identified and characterized at the Izok Mine site.

- Overburden
- Weathered bedrock
- Fresh bedrock

The Izok Mine site lies within an area of continuous permafrost that acts as a barrier to surficial infiltration and groundwater flow. Preliminary data analysis indicates that:

- The active layer typically is between one and five metres thick
- The base of the permafrost ranges from 251 m to 300 m below ground surface
- An open talik, where permafrost is absent, exists beneath Izok Lake
- Shallow groundwater flow likely exists seasonally within the seasonal active layer above the permafrost and flow pathways are anticipated to follow surficial drainage patterns
- A portion of the groundwater beneath Izok Lake might flow downwards from surface of the deep regional groundwater system below the base of the permafrost
- Regional groundwater flows southeast towards Itchen Lake

2.4.4.2 Mining Optimization and Inventory

Mining optimization exercises performed during the pre-feasibility study resulted in an estimated mining inventory of material in all zones that could be mined economically (**Table 2.4-2**). Please note that these numbers may change as models are refined in 2012 and 2013.

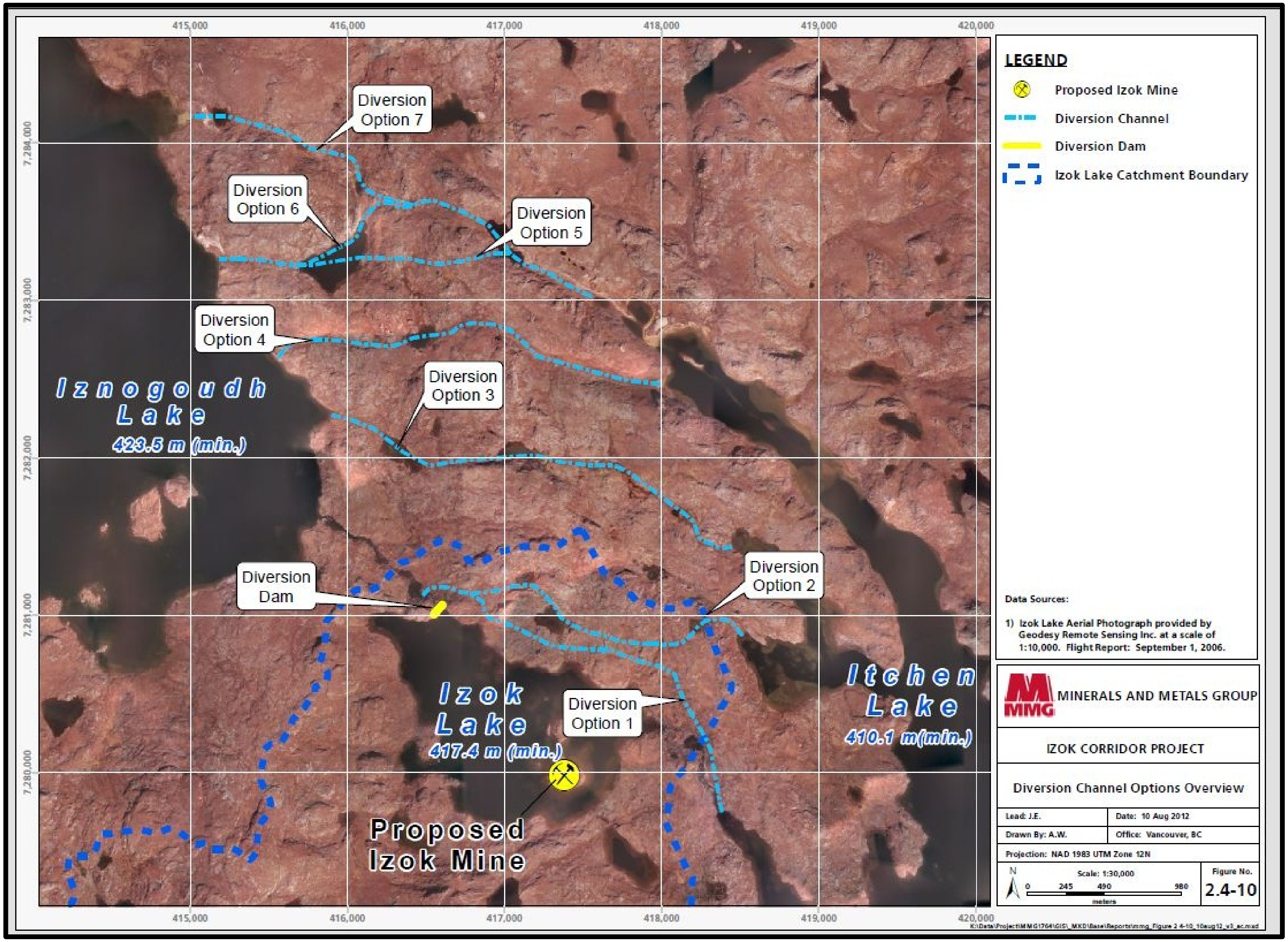


Figure 2.4-10 Diversion Channel Options Overview

Table 2.4-2 Preliminary Izok Mining Inventory

	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/t Ag)	Gold grade (g/ Au)	Zinc ('000 t)	Copper ('000 t)	Lead ('000 t)	Silver (M oz)
Open Pit	13.3	13.5	2.5	1.4	72	0.0	1,796	331	184	33.8
Underground	1.0	7.0	2.8	0.3	39	0.0	69	27	3	1.4
Total	14.3	13.1	2.5	1.3	70	0.0	1,865	359	186	35.1

Source:SNC-Lavalin, Prefeasibility Update(2011)

2.4.4.3 Bedrock Geotechnical Conditions

Geotechnical data indicates that rock at the Izok Mine site is very strong to extremely strong. The rock fabric has limited continuity but close spacing, which is a major consideration in mine design.

Geological models are being prepared for the Central, North, Northwest and Inukshuk deposits and a geotechnical model will be produced in 2012.At present, the geotechnical modeling has defined the rock mass based on distribution of rock lithologies at the Central, North, Northwest and Inukshuk deposits.

2.4.4.4 Preliminary Mine Design

Work carried out to date provides elementary design criteria for open pits, such as bench height, bench width, and slope angles and underground stopes. More detailed design criteria will be developed based on the new geological and geotechnical models currently being developed.

The open pit mine will be located within the talik and will not affect permafrost conditions.

The Inukshuk deposit will be mined by an underground method whereby horizontal slices, or "cuts", approximately five meters in thickness will be removed by drilling, blasting and truck haulage and once the zinc rich ore has been removed, backfilled with mining waste (**Figure 2.4-11**).Subsequent to backfilling the entire cut, the next higher cut will be mined, using the backfill previously emplaced as a working floor. This process will be repeated, working from the bottom upwards until the deposit is mined out.

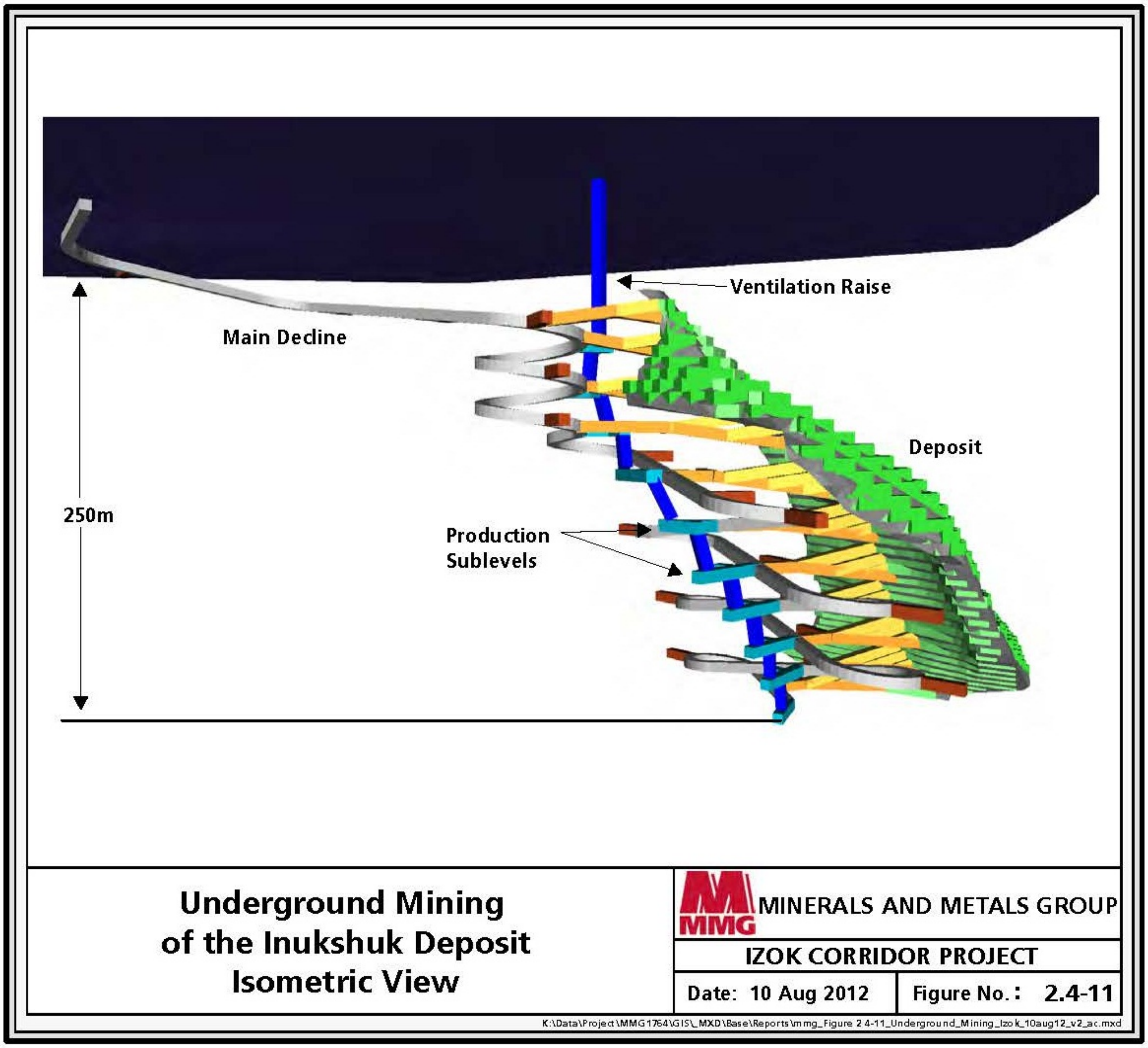


Figure 2.4-11 Underground Mining of the Inukshuk Deposit

The open pit and underground mining concepts at Izok are shown in **Figure 2.4-12**. Preliminary parameters of the open pit and underground mine are summarized in **Table 2.4-3**.

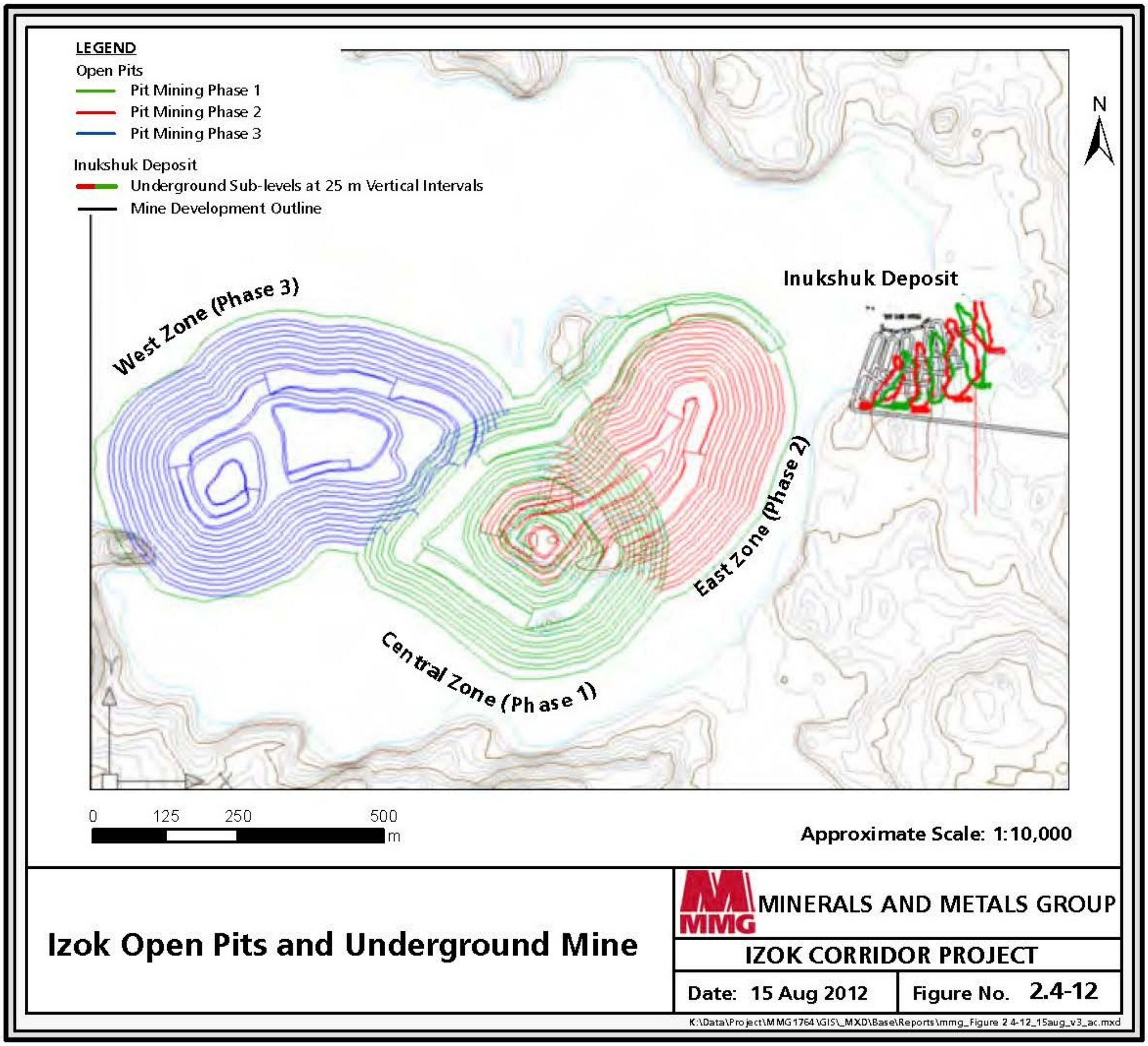


Figure 2.4-12 Izok Open Pits and Underground Mine

Table 2.4-3 Preliminary Mine Design Parameters for the Izok Deposits

Parameter	Pit Phase 1	Pit Phase 1 +2	Pit Phase 1 + 2 + 3	Inukshuk Underground
Excavated Volume			$21Mm^3$	$0.5Mm^3$
Maximum Depth (m)	160	180	180	280
Maximum Width (m)	415	435	726	80
Maximum Length (m)	435	740	1035	115

2.4.4.5 Mining Infrastructure and Processes

Underground Ventilation

The Inukshuk underground mine will not be in permafrost. There is currently an open talik under Izok Lake and once the lake is drained, it is expected that this talik will remain. Groundwater at depth will seep into the mine(refer to section 5.5.2.7).As such, the mine intake air will need to be heated to prevent inflowing water from freezing.

Mine Backfill

The Inukshuk underground mine will require backfill for mine stability. During underground mining, ore blocks (called stopes) will be excavated and the zinc rich ore brought to the plant for processing. To stabilize the large underground voids created during mining, mineral waste from surface will be crushed and trucked underground to be used to backfill the empty stopes. The backfill material may include tailings or waste rock.

Process Water Supply

At Izok, most process water will likely be drawn from groundwater inflows into the mine workings. Any requirements that exceed this source will be provided by heat-traced, insulated pipeline from the plant water supply.

Dewatering

Both the open pit and underground mines will require continuous dewatering due to their location in the talik zone. Information on groundwater inflows into the pit is being augmented by hydrogeological drilling and field testwork being conducted in 2012. The waste water will be piped to a central waste water handling facility for the Izok Mine. As all Izok Mine workings will be above sea level, no saline mine water is expected to be encountered.

Power Supply and Distribution

Electrical power will be fed from the main diesel-powered generator to a transformer and load centers located at the mines, where it will be distributed to surface and underground workings.

Fuel Supply

Fuel for mining equipment will be delivered to satellite fuel depots located at the Izok Mine or directly to the mining equipment in fuel trucks. At the Inukshuk underground mine, fuel storage will likely be located underground, protected from the weather. All fuel storage areas on surface and underground will be enclosed or bermed as per regulations in Nunavut.

Automation and Communication

Automation at the Izok Mine will be confined to systems onboard mining equipment. In the open pit, a dispatch system will be used to assist in prioritizing the deployment of equipment to working areas or for scheduled maintenance, and to collect operational data from onboard diagnostics systems.

The main communications systems will include one system for equipment and operating data collection and another for voice communications by radio sets carried by all personnel and equipment. In the underground mine, signals for communications will be carried by a leaky-feeder cable system that is run into all headings. Other systems will be used for ground movement and micro-seismic monitoring. GPS will be installed on most equipment that will operate on surface.

Services Buildings

The following central service and other buildings will be constructed at the Izok Mine.

- Accommodations
- Security
- Office & Dry Facility
- Waste Water Treatment Facility
- Maintenance Buildings
- Warehousing & Storage

Explosives Handling and Storage

Handling and storage of explosives will adhere to both the federal *Explosives Act* and the *Explosive Use Act of Nunavut*. Explosive accessories such as blasting caps, high explosive boosters and detonation cord will be transported to central storage facilities at the Izok and High Lake mines. Blasting agents, such as ammonium nitrate, fuel oil and emulsion ingredients will be transported to a central on-site facility at the High Lake Mine for the manufacture of the emulsion blasting agent. These materials will be further blended and loaded into blastholes in proportions appropriate to the wetness and temperature of the holes. Explosives and blasting agents will be transported to the work sites using purpose-built mobile equipment.

Drilling and Blasting

For the open pit, ore and waste benches have been designed on 10 m intervals. Blast holes and drill patterns will be sized to minimize dilution and ore losses.

Based on industry experience with operating mines in the NWT, it is expected that a high percentage of the blast holes will be wet. Consequently, blasts will employ emulsion explosives blended with ANFO. It has been assumed that 100% of the blastholes will be loaded with wet-hole product (a 70% emulsion/30% ANFO blend). Two mixing trucks are required at site to guarantee delivery of product to the blast holes.

Materials Handling

At this time, it is expected that two 200tonne diesel-powered hydraulic excavators (one with 8.0 m^3 and a second with 12 m^3 heavy rock buckets) will be used for ore and waste, respectively. The excavators have been matched to load 91tonnecapacity trucks. An 800 hp front-end loader with a 10.3 m^3 bucket will work at the ore stockpile to blend ore and tram feed to the crusher. The crusher loader will back-up the excavators for in-pit waste removal. Ore will be hauled from the open pit in 90 to 100 tonne trucks and hauled from underground in 40 to 60tonne trucks.

2.4.4.6 *Open Pit Mine Equipment*

Preliminary specifications for open pit mining equipment at the Izok Mine are listed in **Table 2.4-4**. These specifications will be refined during preparation of the feasibility study. This list includes the primary equipment for drilling, blasting, loading and haulage, as well as ancillary mine equipment for maintaining pit floors and roadways, moving equipment with limited mobility, equipment servicing, personnel transport and secondary ore and waste handling.

Table 2.4-4 Preliminary List of Izok Open Pit Equipment

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
DRILLING	225-mm Drill	3
	152-mm Drill	3
BLASTING	Bulk Powder Delivery Truck	2
	Explosive Accessories Delivery Truck	1
LOADING	200 t Hydraulic Excavator – 8m³	1
	200 t Hydraulic Excavator – 12m³	1
HAULING	Mechanical Drive Haul Trucks – 91t	9
CRUSHER FEEDER	Frontend Loader – 800 hp	1
SUPPORT EQUIPMENT	Crawler Dozer – 400 hp	4
	Motor Grader – 300 hp	2
MINE GENERAL	General Purpose Excavators – 350 hp	1
	Picker Truck (Large)	1
	Tractor/Lowboy (100+ tonne)	1
	Fuel Truck	1
	Fuel/Lube Truck	1
	Light Tower	8
ANCILLARY EQUIPMENT	Hydraulic Crane – 75 t	1
	Tire Manipulator	1
	Integrated Tool Carriers	2
	Mechanic/Welder Truck	2

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
	Vacuum Truck	1
	Tandem Truck	TBD
	F550 Flatdeck	3
	Crewcab	12
	Bus	2
	Suburban/Van/Ambulance	1

2.4.4.7 *Underground Mine Equipment*

Preliminary specifications for underground mining equipment at the Izok Mine are listed in **Table 2.4-5**. These specifications may change during preparation of the feasibility study. The list includes the primary equipment for drilling, blasting, loading, ground support and haulage, as well as ancillary mine equipment for equipment servicing, mine services and personnel transport.

Table 2.4-5 Preliminary List of Izok Underground Mine Equipment

Underground Mine Equipment		
Function	**Equipment Type**	**Estimated Quantity**
LOADING	R2900 LHD	2
DRILLING	Development Jumbo	1
HAULAGE	AD55 Truck	1
GROUND SUPPORT	Cablebolter	1
ANCILLARY	Light Vehicles	3
	Service Vehicles	2
	Agitator Truck	1

2.4.4.8 *Production Schedule*

The first ore produced at the Izok Mine will be from the open pit as open pit mining is usually the least expensive mining method. MMG will aim to recover construction costs as quickly as possible and will strive to truck as much concentrate as possible to the Grays Bay Port in time for the first shipping season.

Mining will start in the midsection of the Central Zone, with subsequent final wall push-backs first to the east and then to the west. Later in the mine life, the lower grade and higher cost Inukshuk deposit will be brought into production using underground methods. The preliminary production schedule for the Izok Mine is presented in **Table 2.4-6**.

Table 2.4-6 Preliminary Izok Production Schedule

Izok Open Pit	Waste Tonnes Mined	Ore Tonnes Mined	Cu grade (%)	Pb grade (%)	Zn grade (%)	Ag grade (opt)
2017	2,290,000	356,040	1.27%	2.06%	15.21%	62.41
2018	7,484,000	1,447,896	2.29%	1.43%	13.62%	58.43
2019	7,318,000	1,443,940	3.08%	1.60%	16.31%	69.78
2020	6,635,000	1,443,940	3.76%	1.34%	16.08%	73.25
2021	6,164,000	1,443,940	3.70%	1.14%	14.00%	80.63
2022	5,900,000	1,292,895	2.33%	1.22%	12.11%	54.71
2023	3,649,000	1,134,785	3.08%	0.61%	11.21%	53.85
2024	3,383,000	1,134,785	2.13%	1.32%	11.18%	84.77
2025	3,124,000	1,134,785	1.27%	1.94%	13.63%	93.43
2026	1,520,000	1,137,894	1.44%	1.79%	14.07%	85.99
2027	1,428,000	1,326,157	1.57%	1.29%	11.70%	72.07
TOTAL	**48,895,000**	**13,297,057**	**2.49%**	**1.38%**	**13.55%**	**71.99**
Inukshuk Underground	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Ag grade (opt)**
2021	13,895					
2022	171,410	27,791	2.94%	0.18%	6.65%	40.15
2023	146,993	342,821	2.65%	0.35%	6.70%	40.74
2024	135,284	293,987	2.63%	0.23%	6.32%	34.48
2025	26,111	270,567	3.16%	0.25%	7.94%	40.82
2026	26,111	52,222	2.44%	0.33%	8.36%	37.17
TOTAL	**519,804**	**987,387**	**2.78%**	**0.28%**	**7.01%**	**38.69**
IZOK TOTALS	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Ag grade (opt)**
2016	-	-				
2017	2,290,000	356,040	1.27%	2.06%	15.21%	62.41
2018	7,484,000	1,447,896	2.29%	1.43%	13.62%	58.43
2019	7,318,000	1,443,940	3.08%	1.60%	16.31%	69.78
2020	6,635,000	1,443,940	3.76%	1.34%	16.08%	73.25
IZOK TOTALS	**Waste Tonnes Mined**	**Ore Tonnes Mined**	**Cu grade (%)**	**Pb grade (%)**	**Zn grade (%)**	**Ag grade (opt)**
2021	6,177,895	1,443,940	3.70%	1.14%	14.00%	80.63
2022	6,071,410	1,320,686	2.35%	1.20%	12.00%	54.41
2023	3,795,993	1,477,606	2.98%	0.55%	10.16%	50.81
2024	3,518,284	1,428,772	2.23%	1.10%	10.18%	74.42
2025	3,150,111	1,405,352	1.63%	1.61%	12.53%	83.30
2026	1,546,111	1,190,116	1.48%	1.72%	13.82%	83.85
2027	1,428,000	1,326,157	1.57%	1.29%	11.70%	72.07
2028						
TOTAL	**49,414,804**	**14,284,444**	**2.51%**	**1.31%**	**13.10%**	**69.69**

2.4.4.9 Air Emissions

Mining operations at the Izok Mine will result in atmospheric emissions of gases and diesel particulate matter from combustion of diesel fuel, and fugitive dust emissions from power generation, processing equipment, and material handling and transport. Short-term dust emissions will occur during blasting. Overburden, waste rock and tailings stockpiles will also be a source of dust particles at certain times of the year.

The Izok Project is fossil fuel intensive, as alternative energy sources do not exist in the area. The combustion of diesel will produce greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4) and nitrogen oxides (NO_x). Emission factors will be used to calculate GHG emissions from the quantity of fuel consumed for a given fuel type and combustion source.

Features that have been incorporated into Project design to minimize air quality effects due to combustion of fossil fuels include:

- Use of low sulphur diesel
- Regular maintenance of all equipment (vehicles and power plant) to ensure efficient operation
- Selection of high efficiency power generators – both for minimizing operating costs and reducing emissions

Primary measures that will be implemented to manage fugitive dust emissions and minimize potential effects on air quality include:

- Speed limits for vehicular traffic on mine site roads
- Application of dust suppressants to roads and exposed soil or stockpile surfaces where fugitive dust could originate
- Installation of dust collectors at crushing and grinding facilities and conveyor transfer points
- Installation of NAG rock coverings on dewatered tailings to control wind erosion

Further mitigation measures will be implemented during the operational phase of the Project as emission or nuisance dust sources are identified.

2.4.4.10 Noise Emissions

The major sources of noise at the Izok Mine site will be from mine blasting and mine diesel-powered equipment. Other sources of noise will be from the operation of pumps, compressors, generators, front end loaders, grinding mills and service vehicles.

Measures that will be implemented to mitigate noise pollution will follow Nunavut Occupational Health and Safety standards and will include the following.

- Schedule noisy construction activities during normal working hours
- Conduct regular maintenance of construction and operations vehicles and equipment to ensure they emit the lowest noise possible for their design
- Install air inlet silencers and exhaust silencers on all combustion engines

- Construct noise baffles or enclosures for particularly noisy equipment
- Develop a noise monitoring program as an integral part of the company's Health and Safety Policy

2.4.4.11 Izok Mine Closure Plan

Planning for the Izok Mine is being driven by the goal of a mine closure plan that presents the lowest long-term environmental risk and the lowest risk of long-term maintenance and related costs. MMG is focused on designing Waste and Water Management plans that will support this goal. MMG is also committed to working with stakeholders to develop and refine the closure plan.

Even with the diversion of Iznogoudh Lake outflows around the mine pit, the surface and groundwater flows reporting to the pit from the reduced catchment are anticipated to be greater than evaporation and leakage in normal weather years. It is expected that over a period of several years, the pit would fill with water. This new water body would have a smaller surface than the original lake and would include the deep pits plus areas surrounding the pits and would likely reach the natural level of the former Izok Lake of 417 m above sea level. It is likely that eventually a natural net outflow into Itchen Lake would develop.

The quality of water in the filled pit is not expected to meet discharge criteria for a number of years after closure due to water contacting PAG rock faces in the mined-out open pit and the PAG waste rock deposited in the open pits, and ARD and ML seepage from PAG waste rock piles and tailings piles. Section 2.4.6.2 provides a discussion of the preliminary Waste and Water Management plans.

For several years, excess water in the flooded pit will be treated in place or pumped to an effluent treatment plant before being discharged into Itchen Lake. The water will be treated until the quality of untreated water is suitable for release. Water balance analyses and water quality modelling will be conducted to determine the time required for water quality to meet discharge criteria at closure.

The closure plan for the Izok pit will commence immediately after closure of the mines and will involve the following monitoring and maintenance activities to manage water levels and quality in the catchment area.

- Monitoring, collection, and treatment of water to meet discharge criteria as necessary once pumping ceases, and release of treated water to Itchen Lake begins.
- Maintenance of the water level between a high and a low limit. The high water level will be several metres below the outlet level of the lake to avoid the need for a closure dam to prevent discharge of waters from the post-closure flooded pit and surrounding area into Itchen Lake. The lower water level will be several metres above the top of the PAG waste rock deposited in the mined-out open pit to maintain the necessary water cover to prevent oxidation of waste rock.

At some time after closure when water quality at all points within the catchment area meets discharge criteria without treatment, the water body will be allowed to re-flood to its natural level and excess water will flow untreated out to Itchen Lake.

Once water quality within the catchment area meets discharge criteria naturally, a decision will be made whether to leave the new lake disconnected from Iznogoudh Lake or re-establish the natural flow of water from Iznogoudh Lake downstream. This decision will be made in consultation with DFO and other stakeholders.

2.4.5 Izok Mine Ore Processing

The processing plant will be located at the Izok Mine and will process ore from both the Izok and High Lake mines. All concentrates and related waste will be located at the Izok site as well.

Key considerations in processing of the ore will be:

- Efficient metal recovery in concentrates
- Reclaimed water management
- Engineered dry stack tailings

2.4.5.1 Milling Design Consideration and Selection

Ore Processing

The first phase of extracting the zinc or copper rich fragment of the rock is accomplished through a mechanical process. The ore is delivered to the plant as boulders, where it is crushed into very small gravel and sand size using conventional crushing and grinding systems. Once the ore is crushed and reduced to a fine sand size, it is processed chemically.

MMG will use well known and commonly used processes. The fine-grained crushed ore will under gomultiple stages of froth flotation to separate and recover mineral concentrates of chalcopyrite (copper-rich sulphide), sphalerite (zinc-rich sulphide) and galena (lead-rich sulphide). This process is entirely contained in the building itself, and all chemicals used in the process are handled according to strict safety and operational procedures.

The ore contains small quantities of payable silver and gold. Small amounts of silver will be present both in the copper and lead concentrates, and very small amounts of gold will be present in the copper concentrate. Silver and gold metal will be subsequently produced as a by-product in the off-site smelter operations. There will be no production of silver or gold bars in the processing plant.

The process plant will be located immediately to the east of the Izok Mine, and will include the following components.

- Two Run of the Mill (ROM) stockpiles (120,000 t capacity each)
- Primary jaw crusher
- Crushed ore stockpile
- Semi Autogenous Grinding mill (SAG) and ball mill
- Zinc, copper and lead flotation circuits, including a regrind mill within each flotation circuit
- Tailings thickener and filters
- Zinc, copper and lead concentrates thickeners and filters

- Process water, fire water, potable water tanks
- Reclaim water treatment facility
- Concentrate storage facility for the copper, lead and zinc concentrates
- Reagent storage and reagent mixing building

The jaw crusher will crush ore from the Izok Mine. A separate jaw crusher will crush the mined ore from the High Lake Mine prior to trucking to the Izok mill. The Izok crusher will be located in a partially enclosed building, together with the stockpile feed conveyor drive system. The coarse ore stockpile and mill feed conveyor will also be covered for protection from the elements.

Ore Processing and Grinding

The nameplate capacity of the mill will be 6,000 tonnes per day (tpd) of ore. Mill throughput rates will be approximately 6,000 tpd of ore. The maximum combined production rate of zinc, copper and lead concentrates will be approximately 670,000 tpa. Concentrate production varies mainly due to changes in the metal feed grades to the mill resulting from the mine production schedule.

The SAG mill circuit will include a cone crusher to crush the coarse pebbles that discharge from the mill. Crushed pebbles will be returned to the SAG mill. The ball mill will operate in closed circuit with a set of hydro-cyclone classifiers. The cyclone underflow product (the coarser fraction) is returned to the ball mill for further grinding. Thecyclone overflow slurry product, with an 80% passing size (p80) of 100 um, gravitates to the flotation circuit. Minerals will be recovered by sequential flotation in respective copper, lead and zinc flotation circuits. Each of these circuits includes a rougher stage to produce an intermediate quality concentrate, a regrind stage, and a cleaner flotation stage to ensure that both high recoveries and good quality final concentrate grades can be achieved.

Various chemicals are required to allow recovery of the copper, lead and zinc minerals into high quality final concentrate products. These include MIBC frother to stabilize the mineral froth, xanthate collector to help attach metal minerals to the air bubbles, copper sulphate to modify the surface of the zinc mineral and allow flotation, and lime to modify pH and depress the flotation rate of unwanted iron sulphide gangue minerals.

Tailings Dewatering and Disposal

The tailings will be dewatered to between 15% and 20% moisture content by mass and then will be stacked using an engineered dry stack tailings management system (refer to section 2.4.6 for more details).

To reduce the moisture content, the thickened flotation tailings will be pumped to a stock tank and fed through a pressure filter. The filter press will dewater the slurry to produce a filter cake, which will be conveyed outside the process plant to a tailings load-out point. The tailings will be loaded onto a truck using a front end loader and transported to the engineered dry stack tailings pad located to the southwest of the mill facility. A dozer and compactor will spread and compact the tailings on a continuous basis.

Concentrate Filtration

Zinc, copper and lead concentrates produced in the flotation sections will be thickened to 65-70% solids (w/w) and then filtered in pressure filters to 8% moisture. Filtrate will be recycled to the process water circuit and effluent treatment plant.

Concentrate Storage and Handling

Individual concentrate products in the form of filter cake will be discharged onto a conveyor and deposited in separate storage areas at the western end of the concentrator building. Concentrate will then be loaded onto concentrate trucks for delivery to a storage shed at the Grays Bay Port.

2.4.5.2 Process Alternatives

A metallurgical test program is underway. As there are some differences in ore characteristics between the different mining zones at the Izok and High Lake mines, the metallurgical performance of treated blends of ore types or campaign treating batches of separate ore types will be examined. The effects of these process strategies on Project economics and operability will be assessed.

2.4.6 Izok Mineral Waste Management

Mineral wastes are all wastes generated by mining operations that are not ore or mineral concentrate, and include PAG and NAG waste rock, tailings, overburden, and lake sediments and silts.

Closure is the foremost consideration in planning for Izok Mine mineral wastes. MMG has committed to expend capital early in the Project to devise and implement a mine closure plan that will be as close as possible to a minimum maintenance solution. Sub-aerial deposition of mineral wastes has been chosen as it most closely meets the minimum maintenance closure concept.

2.4.6.1 Waste Rock

Waste Rock Characterization

Waste rock is rock that is removed to access ore. Some waste rock types at the Izok site contains sub-economic amounts of sulphide mineralization. When these materials are exposed to air and water, they can oxidize, releasing acid and metals, referred to as acid rock drainage (ARD) and metal leaching (ML).

There are a variety of other minerals that are capable of neutralizing (buffering the acid) and removing the metals from the water. The relative proportions of acid generating and buffering materials and the reactivity of these materials determines whether acidic conditions and/or high metal concentrations are likely to develop in mineral waste produced by the Project.

MMG is working to ensure that the mineral wastes are adequately characterized prior to mining and that the results of this testing are used to develop appropriate prevention and mitigation strategies for managing the waste rock. These measures will minimize the potential for adverse effects on downstream water quality.

MMG has completed a preliminary geochemical testing program to characterize the potential for ARD and ML from the waste rock at Izok. Additional testing is in progress, including both short- and long-term tests that can be used to predict whether acidic conditions could develop in the rock, how fast this could occur, and whether there would be elevated concentrations of metals in water that comes into contact with the waste rock.

Some preliminary conclusions from the testing are as follows.

- The quantity of sulphide minerals can be determined by analyzing the sulphur content of the rock.At the Izok site, the sulphur content of the PAG rock ranged from very low (<0.1% S) to quite high (8% S), but median sulphur concentrations were typically between 0.1 and 1%, and most samples with a higher sulphur content were located in close proximity to the ore.
- The quantity of neutralizing minerals (neutralization potential or NP), can be determined by reacting the rock with acid and measuring how much of the acid was consumed by the rock (NP), or by measuring the amount of carbonates that are present in the rock (carbonate NP).The Izok Mine waste rock tends to have relatively low amounts of both NP (ranging from <1 to 76 kg $CaCO_3$eq/t, and typically below 20 kg $CaCO_3$eq/t) and carbonate NP(ranging from <1 to 32 kg $CaCO_3$eq/t, and typically below 5 kg $CaCO_3$eq/t).The difference observed between these measurements of NP suggest that the majority of the NP is present as silicate minerals.
- In the preliminary interpretations of ARD potential, samples were classified using the more conservative carbonate NP data. Based on these results, approximately 75% of the waste rock was classified as potentially acid generating (PAG), while 25% is considered to be non-acid generating (NAG). This preliminary estimate is considered conservative and will be refined based on further testing.
- Initial kinetic test results on the Izok Mine PAG samples indicate that the sulphides oxidize quite slowly in comparison to tests from other sites with similar amounts of sulphide. These tests have now been running for four months, and acidic conditions have not yet developed.
- Under field conditions with much lower temperatures, reaction rates could be up to five times slower, suggesting that there could be a delay of at least 20 months before acidic conditions could develop in the field. Additionally, given the slower than expected oxidation rates, it is possible that buffering by silicate minerals could prevent ARD from developing over the longer term in some of these materials. This has the potential to substantially reduce the amounts of PAG that will require special management. However, further testing is needed to assess the contribution of silicates to buffering over the longer term.

Geochemical testing of mineral wastes is ongoing to more closely characterize waste rock and associated leachate water, providing the inputs necessary for additional geochemical and water quality modelling.

Waste Rock Quantities

Approximately 49Mt of PAG and NAG waste rock, including overburden, will be removed from the open pit mine and underground mine over the life of the mine to access ore. For the first half of the mine life, this waste rock will be removed to waste dumps on surface. After Year 7, waste rock will be deposited into worked-out areas in the open pit.

Preliminary estimates of ore and waste rock generated at the Izok Mine are presented in **Table 2.4-7**. These are considered to be conservative estimates of PAG rock.

Table 2.4-7 Ore and Waste Rock Generated at Izok Mine

Ore (Mt)	PAG Waste Rock (Mt)	NAG Waste Rock (Mt)	Total Waste Rock (Mt)
14	37	12	49

Waste Rock Design Approach

There are two broad approaches that can be taken to deal with PAG mineral wastes to prevent or manage ARD and ML.

1. Place freshly mined PAG mineral wastes under water to prevent oxidation and thus prevent the generation of ARD and ML
2. Isolate PAG mineral wastes from water flows to immobilize such products of oxidation and metal leaching that might exist within the waste pile

The mining industry has typically used the first approach (subaqueous storage), which typically involves placement of PAG mineral wastes in a lake or a reservoir created by a dam. By maintaining a water cover over PAG mineral wastes, contact with air and oxidation are prevented and ARD cannot be generated. A drawback of this approach is that it requires maintenance of a water cover over the PAG mineral wastes, monitoring and possibly treatment of water overflowing the dam, and dam maintenance, all in perpetuity.

The second approach involves sub-aerial storage of the majority of PAG mineral wastes, isolating these materials from contact with water. This is the method that has been selected for tailings storage at the Izok Mine in order to avoid the shortcomings of subaqueous deposition. While sub-aerial deposition will be more complex to implement and more costly during operations, it has the very clear advantage of not requiring water cover maintenance, water quality management or dam maintenance in perpetuity.

Sub-aerial deposition of PAG mineral wastes has a sound environmental record at a number of northern mines such as Nanisivik, Raglan, Ekati, Minto, and Pogo. The tailings at Nanisivik Mine were successfully covered to maintain them in a frozen state (J. Cassie, BGC, pers. comm.). Post-closure monitoring has since confirmed that the tailings are in a permanently frozen and inert condition.

During operations, potential production and release of ARD and ML into the environment will be managed by keeping the PAG mineral wastes frozen. The climate is quite harsh with subzero temperatures dominant for a substantial portion of the year and mineral waste will be managed to maximize quick freezing in the cold months and maintain frozen layers near surface during the warmer months. Models will be developed using regional and site-specific climate data and with consideration to climate change predictions to inform the development of the Mineral Waste Management Plan. Maintaining sub-zero temperatures in the mineral wastes will provide the following benefits.

- Below 3 °C, bacterial action stops
- Below freezing, the chemical oxidation of sulphide minerals, which also causes ARD and generates heat, will be attenuated to the degree that it may be considered to have effectively ceased

- Freezing will convert any ARD or ML into ice and hence will lock them in place within the rock pile
- Freezing prevents the ingress and exit of rain water to the waste pile, which will further prevent the movement of ARD or ML out of the waste pile

Keeping mineral wastes frozen will be achieved by ensuring freezing occurs during or shortly after deposition, and maintaining them in a frozen condition in perpetuity. This will be achieved by the taking the following approach.

- Freezing PAG waste rock will be achieved during deposition by selecting appropriate deposition schedules and techniques such as depositing mineral wastes in thin layers and installing thermal barriers to maintain a frozen condition.
- Thermal protection covers will be installed progressively during operations and completed at closure to keep PAG mineral wastes frozen during summer thaw conditions.
- Seepage that occurs prior to complete freezing of the mineral waste piles will be monitored, and collected and treated if necessary during operations and after closure. Once the ARD/ML prevention measures become fully active (i.e., reduced ingress of air into mineral waste piles to inhibit oxidation, reduced ingress of water to avoid mobilization of any oxidation products, and ensured freezing), ARD and ML will no longer be produced and monitoring, collection, and treatment of seepage will no longer be required.

Waste Rock Management

The proposed mining schedule at Izok Mine is as follows (refer to **Figure 2.4-12**).

- Years 5 to 11 – open pits (three phases beginning with the central zone, then the east zone, and finally the northwest zone)
- Years 6 to 10 – Inukshuk underground operation

The main elements of the Izok Mine Waste Rock Management Plan are as follows.

- PAG and NAG waste rock will be placed largely within the outline of the drained Izok Lake to minimize the area of disturbance at closure.
- PAG waste rock will be placed to prevent contact with water after closure, by one or more of the following steps:
    - placing PAG waste rock above the re-flooded water level on a NAG waste rock pad
    - placing PAG waste rock directly on the surface of the area immediately close to the pit and within the area previously occupied by Izok Lake and installing an inert rock barrier between PAG waste rock and refilled pit and flooded area placing waste rock outside the previous lake footprint
- Towards the end of mine life, some PAG waste rock will be deposited at the bottom of the worked out pit, currently estimated at between 3 and 6 Mt.PAG waste rock deposited in this manner will be submerged by water at closure. Water cover over this PAG waste rock will be deep with no likelihood of PAG waste rock being exposed to air even during low rainfall years, thereby eliminating the need for post-closure maintenance of water cover.

- Sub-aerial deposition of PAG waste rock will be completed in a manner that promotes freezing at the time of deposition during winter, and to promote ultimate freezing of the complete rock pile at or shortly after closure. Techniques will be adopted such as depositing mineral wastes in thin layers which will be exposed to frigid air for extended periods before being covered by subsequent layers, and by installing thermal barriers as soon as possible to maintain rock in a frozen condition.
- Waste rock placed during the four summer months will not freeze, but will be deposited in a thin layer to promote freezing when temperatures drop the following winter. Waste rock deposited during the warmer summer months may have a higher potential to oxidize exothermically, and temperatures within the rock pile will be closely monitored. Material found to be heating due to exothermic reaction will be removed and cooled by immersing in water.
- Thermal barrier covers will be installed over PAG waste rock once the final pile elevation has been reached. Covers will be of sufficient thickness to accommodate seasonal thawing and the projected influence of long-term climate warming. Thermal covers will typically comprise a lower layer of finer material and an upper layer of coarser material to prevent wind and water erosion of the lower layer. Depending on the particle size distribution of these materials, the cover thickness typically ranges between one and three metres.
- Covers will be placed over the sides and the upper surfaces of the PAG waste rock pile progressively during operations and over the entire pile surface at closure. ARD and ML seepage from PAG waste rock piles is possible during the mine operational phase and for some time after closure until freezing is complete. Sources of seepage are water attached to the rock at time of deposition, melting snow and summer rains.
- Seepage is expected to diminish over time as water within the rock pile progressively drains out and freezes, and seepage will ultimately decrease to negligible amounts. Seepage will be collected and re-used in the process plant, or treated to meet discharge criteria and released to the environment. Seepage flows will be modelled to predict the quantity and quality of seepage over time and hence when water quality monitoring and water treatment may no longer be required after closure.
- Surface water contact with PAG mineral waste piles will be minimized by locating the piles within the topography at Izok Mine and by installing surface water diversion channels and berms as required to keep clean water clean.
- Airborne dust will be managed per the Dust Management Plan.
  - An Adaptive Mineral Waste Management Plan will be implemented to confirm design assumptions (e.g., negligible reactivity at sub-zero temperature, temperature distribution within the waste rock pile, quantity and quality of seepage, and airborne dust generation), and to identify where changes to the plan are required. As part of this plan, field trials of thermal protection covers will be conducted to confirm their performance under site conditions and a monitoring program will be established to track the following performance indicators.
    - Temperatures within the waste rock piles
    - Oxidation products such as sulphur dioxide within and around the waste rock pile
    - Seepage quantity and quality
    - Density of deposited rock (i.e., the effectiveness of compaction)

  - In-situ moisture content
  - Measurement of ARD potential and sulphur content in the waste rock pile
  - Kinetic testing of waste rock to determine reactivity under field and laboratory conditions
  - Dust and air quality parameters

- NAG waste rock piles will be generally deposited separately from PAG waste rock piles. The management plan for NAG waste rock is relatively straightforward and includes piling this material to promote freezing. However, NAG waste rock will not be covered or contoured at closure. The piles will be designed to prevent erosion by wind and water by the choice of appropriate slope angles and bench design. Erosion control measures installed during the operational phase will remain in effect after closure.

Waste Rock Disposal Alternatives

An alternative waste rock disposal plan that was considered involves placing all PAG waste rock within the Izok Lake basin and the worked-out open pit and then submerging it after closure by constructing a series of dams to raise the lake water level. This alternative was rejected as it would require water to be pumped into Izok Lake to maintain water cover over the submerged rock during low precipitation years, management of overflowing water quality during normal precipitation years, the potential for catastrophic release of mineral wastes and contact water should a dam fail, and maintenance of at least one large dam, all in perpetuity.

Waste Rock Mitigation by Design

Sub-aerial deposition of waste rock offers considerable advantages over the typical sub-aqueous approach, particularly after closure. The following studies will be performed to confirm design assumptions.

- Site investigations to more closely characterize subsurface conditions, geothermal regimes, and their effects on mine waste rock pile design
- Diamond drilling and block model review to more closely define NAG and PAG waste rock quantities
- Modelling of seepage and runoff rates and water quality from the PAG waste rock piles
- Modelling of shallow groundwater flows
- Modelling and laboratory testing at sub-zero temperatures to predict the geochemical and metal leaching characteristics of waste rock at the temperatures that will be encountered at Izok Mine
- Modelling of water quality after closure, and as basis of design of the effluent treatment process for affected water
- Collection of field data during the early operational phase to confirm the performance of thermal protection covers

Waste Rock Closure Plan

Most PAG waste rock will be deposited sub-aerially and the balance deposited subaqueous, deep in the worked out open pit. This approach has been chosen, as it most closely matches MMG's minimum maintenance closure concept.

- At closure, NAG waste rock piles will be left substantially as they have been constructed and will not be covered or contoured.
- The closure plan for PAG waste rock will commence immediately after closure and will involve monitoring, collection, and treatment if necessary of all contact water and seepage emanating from PAG waste rock piles to meet discharge criteria before release to Itchen Lake.
- The behaviour of PAG waste rock within the pile, such as measurement of temperature and sulphur dioxide will be monitored.
- The performance of thermal protection covers will be monitored.
- Critical performance of the cover includes:
    - the ability to withstand movement induced by waste pile settlement and frost heave and to continue to provide a seal against water and air ingress
    - effectiveness of the upper armour layer in preventing wind and rain erosion of the lower sealing layer

2.4.6.2 Izok Mine Tailings

The processing of the ore results in two products: the concentrate and the tailings. Tailings have the consistency of fine, damp sand, and often contain residual sulphides and metallic minerals that will be generally reactive when exposed to oxygen and water. The oxidation reaction that takes place is exothermic (produces heat) and may result in ARD and potential for ML.

Tailings Design Approach

The tailings design approach at the Izok Mine will be similar to that for PAG waste rock (section 2.4.6.1) and will involve sub-aerial frozen deposition. The main differences between tailings and waste rock handling are in the methods of placement, due to the finer size distribution of tailings.

Tailings Quantities

The total quantity of tailings at the Izok Mine is estimated at 16 Mt. This includes tailings generated from both High Lake and Izok ore.

Tailings Characterization

Tailings will be combined as process plant feed at approximately two parts Izok ore to one part High Lake ore. Differences in the geochemistry of tailings from the Izok and High Lake mines are as follows.

Izok Mine Tailings:

- The sulphur content ranges from 25% to 35% sulphur, mainly as pyrite
- There is a limited amount of neutralization potential (< 10 kg CaCO3/t)
- Acidic conditions are expected to develop within six months if fully exposed to atmospheric oxygen at 20 °C

High Lake Mine Tailings:

- The sulphur content of the tailings ranges from 3% to 10% sulphur
- The tailings contain a moderate amount of neutralization potential (15 to 20 kg $CaCO_3$/t)
- The tailings samples are PAG. However, because they contain some neutralization potential, exposed tailings are expected to remain pH-neutral for at least a few years due to buffering provided by the NP. Kinetic testing is underway to assess the time to onset of acidic conditions in these tailings under laboratory conditions.

Tailings Management

The following are the main elements of the Tailings Management Plan.

- After dewatering in the process plant, tailings will dumped into a small stockpile (**Figure 2.4-13**), and be conveyed and/or trucked to the site of the tailings pile. Dewatered tailings will contain between 15% and 20% water, and appear as fine damp sand.

Figure 2.4-13 Typical Dry Tailings Stockpile at Process Plant

- To minimize oxidation, tailings moisture content will be kept as high as possible compatible with trucks and loaders being able to drive on them after placement.
- Tailings will be dumped from haul trucks, flattened by bulldozer into thin horizontal lifts, and compacted by roller and haul truck traffic (**Figure 2.4-14**). Compaction is important for several reasons. Firstly, it will provide a smooth upper surface, which will limit airborne dust and rain water infiltration. Secondly, it will increase the structural stability of the dry stack pile, which is important for maintaining the integrity of the covers. Thirdly, compaction will minimize the volume of air voids within the tailings and aids in freezing of the material and hence reduce ARD potential.
- Freezing of tailings will be achieved by placing tailings in thin horizontal layers during the eight months of the year with sub-zero temperatures.
- Tailings placed during the four summer months will not freeze immediately after placement but will be deposited in a thin layer that will freeze when temperatures drop below zero. Tailings deposited during the summer months may have a higher potential to oxidize exothermically and therefore temperatures in the piles will be closely monitored.

Figure 2.4-14 Tailings Dry Stack

- Thermal protection covers will be installed over tailings to keep the tailings frozen once the final pile elevation has been reached. Thermal covers will be thick enough to ensure that seasonal thawing occurs within the cover and does not to extend down to the tailings. The design cover thickness will take into consideration long-term climate warming.

- Thermal covers typically include a lower layer of dense fine material and an upper layer of coarse material to prevent wind and water erosion of the lower layer. Depending on the particle size distribution of the cover material, cover thickness can range between one and three metres for finer grained substrates. Covers will be placed over the sides and the upper surfaces of the tailings dry stack progressively during operations (**Figure 2.4-15**)and will completely cover the pile at closure.
- To reduce ingress of precipitation, intermediate and final tailings surfaces will be sloped and contoured to minimize surface ponding of rain. This will also allow the installation of covers during operations to minimize airborne dust and precipitation ingress, minimizing the work involved in installing soil covers at closure.
- Run-off water and seepage from the dry stack facility will be captured in toe-drain ditches, berms and sumps, and will be pumped to the process plant as make-up water, or treated to meet discharge criteria and released to the receiving environment.

Figure 2.4-15 Example Waste Rock Cover for Dry Stack Tailings

- Melting snow and summer rains might infiltrate open voids in the surface of the tailings pile. This together with the moisture in the tailings at time of deposition can result in some seepage of ARD and ML from the pile.

- ARD and ML seepage from tailings piles is expected to occur during the mine operational phase and possibly for some time after closure. Seepage is expected to diminish over time as water within the tailings pile progressively freezes, ultimately reducing seepage to negligible amounts. Seepage will be collected and treated prior to release to the environment if it meets discharge criteria after treatment.
- Seepage and run-off water quality and quantity will be modelled to predict when non-compliant seepage will essentially cease and monitoring, collection, and treatment of seepage can be terminated.
- Airborne dust will be managed as per the Dust Management Plan. Airborne dust will be controlled by various means, including compaction with a smooth roller, placement of temporary rock covers over tailings surfaces, the application of dust suppressants, and the application of water in summer. Best practices at similar dry stack operations will be assessed and incorporated into the Dust Management Plan.
- Surface water contact with tailings piles will be minimized by locating the piles within the topography at Izok Mine and by installing surface water diversion channels and berms.
- An Adaptive Mineral Waste Management Plan will be implemented to confirm design assumptions (e.g., reactivity at sub-zero temperature, temperature distribution within the waste rock pile, quantity and quality of seepage, and airborne dust generation), and to identify where changes to the plan are required. As part of this plan, a monitoring program will be established to track the following performance indicators:
  - Temperatures within the tailings piles
  - Oxidation products such as sulphur dioxide within and around the tailings pile
  - Seepage quantity and quality
  - Density of deposited tailings (i.e., the effectiveness of compaction)
  - In-situ moisture content
  - Measurement of ARD potential and sulphur content in the tailings pile
  - Kinetic testing of tailings to determine reactivity under field and laboratory conditions
  - Dust and air quality monitoring
  - Field trials of thermal protection covers to confirm their performance under site conditions

Tailings Disposal Alternatives

Alternative tailings management options considered include:

- Sub-aqueous deposition of tailings in, Ham Lake, Itchen Lake, other adjacent lakes and in a dammed section of Izok Lake. This method of subaqueous tailings deposition was rejected as it would involve dams, maintenance of water cover, and monitoring and possible treatment of excess water overflow after closure (i.e., would not provide a minimum maintenance solution for closure).
- Sub-aerial deposition of tailings, half in the Izok Lake catchment area and half in the Itchen Lake catchment area. This location was rejected as it involves a risk of uncontrolled release of seepage and contact run-off water into Itchen Lake should any water control structures fail to operate.

2.4.6.3 Tailings Mitigation by Design

The Tailings Management Plan mitigates environmental risk through the following design features.

- Tailings will be deposited entirely within the former Izok Lake catchment area, eliminating the potential for release of seepage or contact water into Itchen Lake or Iznogoudh Lake.
- By eliminating the need for a tailings pond and associated dams, the risks of leakage or catastrophic failure of contained wastes is eliminated.
- ARD-causing oxidation will be minimized by keeping tailings moisture content close to the saturation point to fill air voids with water.
- ARD-causing oxidation will be minimized by compaction of tailings, which will reduce air voids.
- Tailings will be kept frozen by installation of a thermal protection cover.
- Thermal protection covers will be constructed and monitored in the early years of mine operation to confirm design assumptions.
- Ingress of ARD-mobilizing precipitation will be minimized by installing low-infiltration thermal protection covers over tailings piles as soon as practical.
- Ingress of precipitation will be limited by sloping and contouring tailings surfaces to prevent ponding of precipitation.
- Side slopes of the dry stack will be designed to allow the installation of thermal protection during operations to minimize airborne dust and rain water ingress.
- Ingress of ARD-mobilizing precipitation prior to installation of thermal protection covers will be minimized by compacting exposed tailings surfaces with a smooth roller. Structural stability of the tailings pile will be improved through compaction, which is important to maintaining the integrity of the thermal covers.
- Design of tailings piles and deposition sequences will ensure freezing of tailings, which will reduce permeability, inhibit oxidation and prevent mobilization of ARD and ML out of the pile.
- Tailings placed during the summer will be deposited in a thin layer to promote freezing when temperatures drop.
- Airborne dust will be controlled by various means, including compaction with a smooth roller, placement of temporary rock covers over tailings surfaces, application of dust suppressants, and application of water in summer.
- Run-off water and seepage from the dry stack will be captured in toe-drain ditches, berms and sumps, and will be pumped to the process plant as make-up water or treated to meet discharge criteria prior to release to the receiving environment.
- Seepage and run-off water quality and quantity will be modelled to predict when non-compliant seepage is expected to cease and forecast when collection and treatment of seepage can be discontinued.

- Temperatures and oxidation products such as sulphur dioxide will be monitored continuously by means of probes and instruments installed within or close to the tailings pile.
- An Adaptive Mineral Waste Management Plan (see section 12) will be implemented to confirm design assumptions (e.g., negligible reactivity at sub-zero temperature, temperature distribution within the dry stack, seepage flow quantity and quality, and airborne dust generation).
- The design cover thickness will consider the effects of long-term climate warming.

Tailings Closure Plan

The sub-aerial approach to depositing tailings has been chosen as it most closely meets the minimum maintenance closure concept.

The closure plan for tailings will be the same as that described for waste rock (refer to section 2.4.6.1), and will involve regular monitoring and maintenance to prevent ARD, ML and erosion of the dry stacks.

2.4.7 Izok Mine Surface and Groundwater Management

Surface water management will play a key role during all phases (construction, operation, and closure) of the Izok Mine. Practical and effective water management systems will be developed to minimize risks to mine operations and the environment.

The majority of surface run-off occurs during spring freshet and from short, intense summer rainfall events. Surface runoff that does not come in contact with operations and remains pristine (non-contact water) will be diverted wherever possible directly to receiving environments of Itchen and Iznogoudh lakes. Surface run-off that comes in contact with Project facilities, ore, the dewatered lakebed, waste rock or the tailings drystack (contact water) will be collected in sumps, ponds, and ditches and transferred to sediment ponds for removal of suspended solids and particulate/colloidal-phase contaminants, and oil and grease. After monitoring to ensure compliance with discharge criteria, contact water will be routed to receiving waterbodies.

The quantity and quality of runoff from these regions will be monitored to ensure it complies with applicable direct discharge limits. Best management practices such as silt fences, sediment traps, and regular monitoring will be implemented to minimize erosion where construction, mining and closure activities take place. This will reduce the potential for sediment transport to ambient receiving waterbodies.

2.4.7.1 Surface Water Management Plan

The Surface Water Management Plan at Izok Mine will include the following major components.

- Construction water management, including water diversion from Iznogoudh Lake to Itchen Lake around Izok Lake, draining of Izok Lake, construction of a large water holding pond and various smaller water holding ponds, construction of a surface water diversion berm/ditch system, erosion prevention structures, and fish relocation and habitat compensation

- Surface water management during mine operation to control and treat surface water collected from the disturbed areas within the former Izok Lake catchment area, including management of a surface water diversion berm/ditch system, a large water holding pond for water storage, and an effluent treatment plant
- Management of Project water requirements during mine operation including site-wide water balances
- Post-closure water management, including allowing the pit and surrounding area to refill primarily with surface water at closure, post-closure water quality monitoring and water treatment, and maintaining water cover over PAG rock faces and waste rock deposited in the worked-out open pits after closure

Key considerations in the Surface Water Management Plan include:

- Construction of water diversion structures and draining of Izok Lake
- Fish salvage and habitat compensation
- Re-filling of the pit and surrounding area at closure
- Water quality at closure

A conceptual water flow diagram is presented in **Figure 2.4-16**.

The following sections briefly describe each of the water management components. The conceptual features of some key water management systems are also described. The design of these systems will be further developed in the subsequent design phases.

Izok Mine Construction Surface Water Management

Primary water management activities during the construction phase of the Izok Mine include:

- Construction of Iznogoudh Lake to Itchen Lake Diversion Dam and Diversion Channel
- Draining of Izok Lake and construction of a water holding pond (as a sedimentation pond during the construction stage) and other water containment structures
- Construction and commissioning of surface water diversion system, including surface water diversion berms/ditches, and divider berms
- Construction and commissioning of an effluent treatment plant

Best practices for the control of sedimentation in run-off water during construction will be implemented during construction, including silt traps, silt fences, settling ponds and sumps, grease traps, and monitoring and pumping systems.

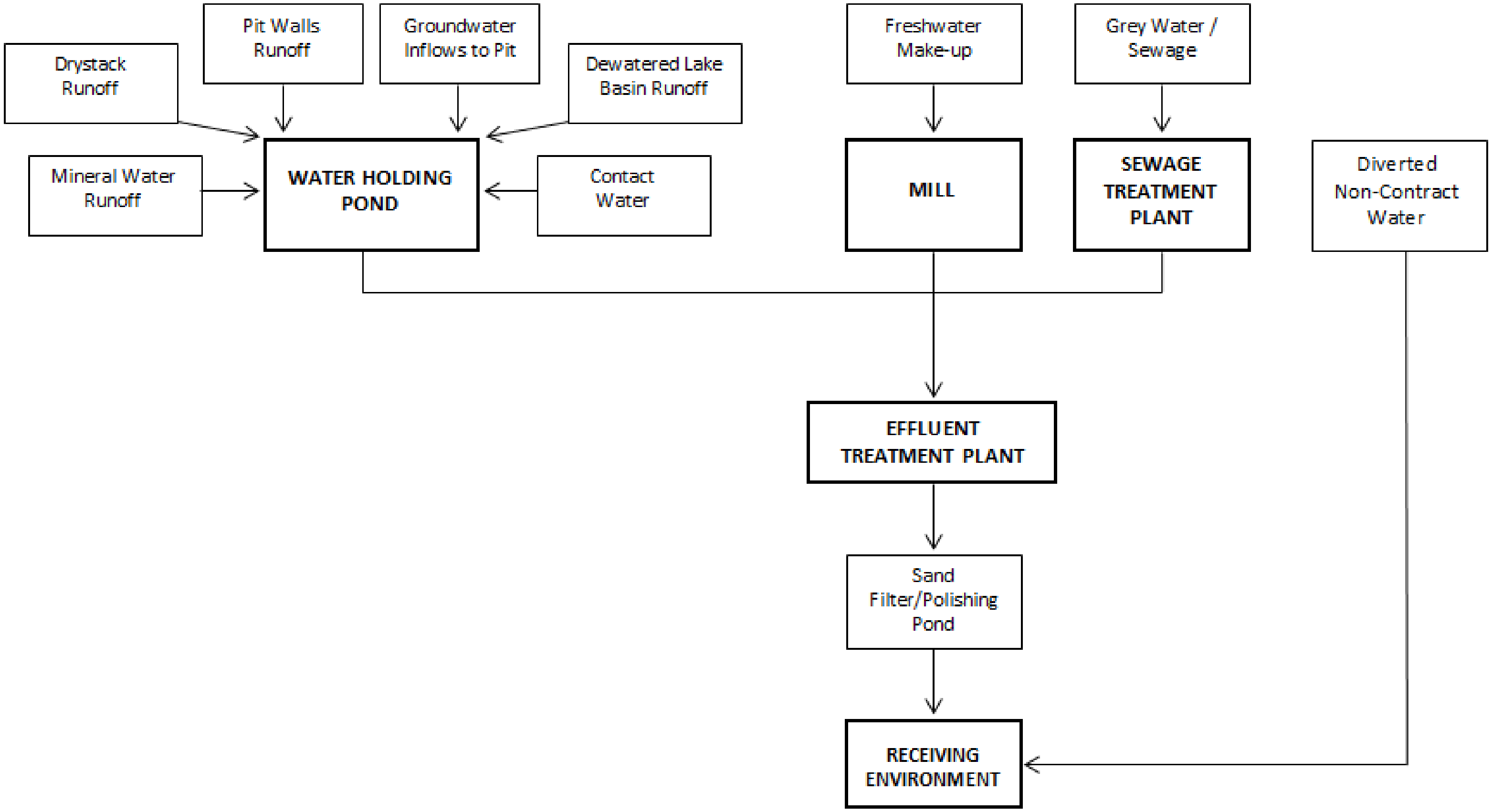


Figure 2.4-16 Conceptual Water Flows at Izok Mine

Non-Contact Water

To the extent practical, non-contact runoff water from undisturbed areas will be segregated and, when found to satisfy water quality standards, discharged directly to the receiving environment without treatment.

The conversion of non-contact water to contact water will be kept to a minimum by intercepting surface runoff water before it enters the mine site. This will be achieved through strategically located cut-off ditches and berms. Such diverted non-contact water will flow around the mine site area directly to the downstream receiving environment.

A surface water diversion berm/ditch system is proposed to divert natural run-on water from the undisturbed areas in the south of the former Izok Lake catchment area to Itchen Lake during construction and mine operation phases, as shown in the Izok Mine site plan (**Figure 2.4-17**). Without this, surface water would flow into the drained Izok Mine area and become contact water, increasing the volume of contact water management to be managed. A diversion berm/ditch will be constructed on the south side of the flooded area to divert natural run-on water from a portion (4.14 km^2) of the former Izok Lake catchment area (9.28 km^2).

Contact Water

Contact water will be collected and pumped to a water holding pond, which will have sufficient storage capacity to accommodate seasonal variations in surface water as well as groundwater inflows into the mine excavation.

The water holding pond will be used as a surface runoff water and pit water storage pond during mine operations, in addition to its function to remove suspended solids from water removed during the initial draining of Izok Lake.

Contact water will be tested periodically for contaminants, total suspended solids (TSS) and total dissolved solids(TDS) prior to treatment and/or release. Diversion ditches will be installed where necessary to route contact water to collection ponds or sumps for transfer to a water holding pond.

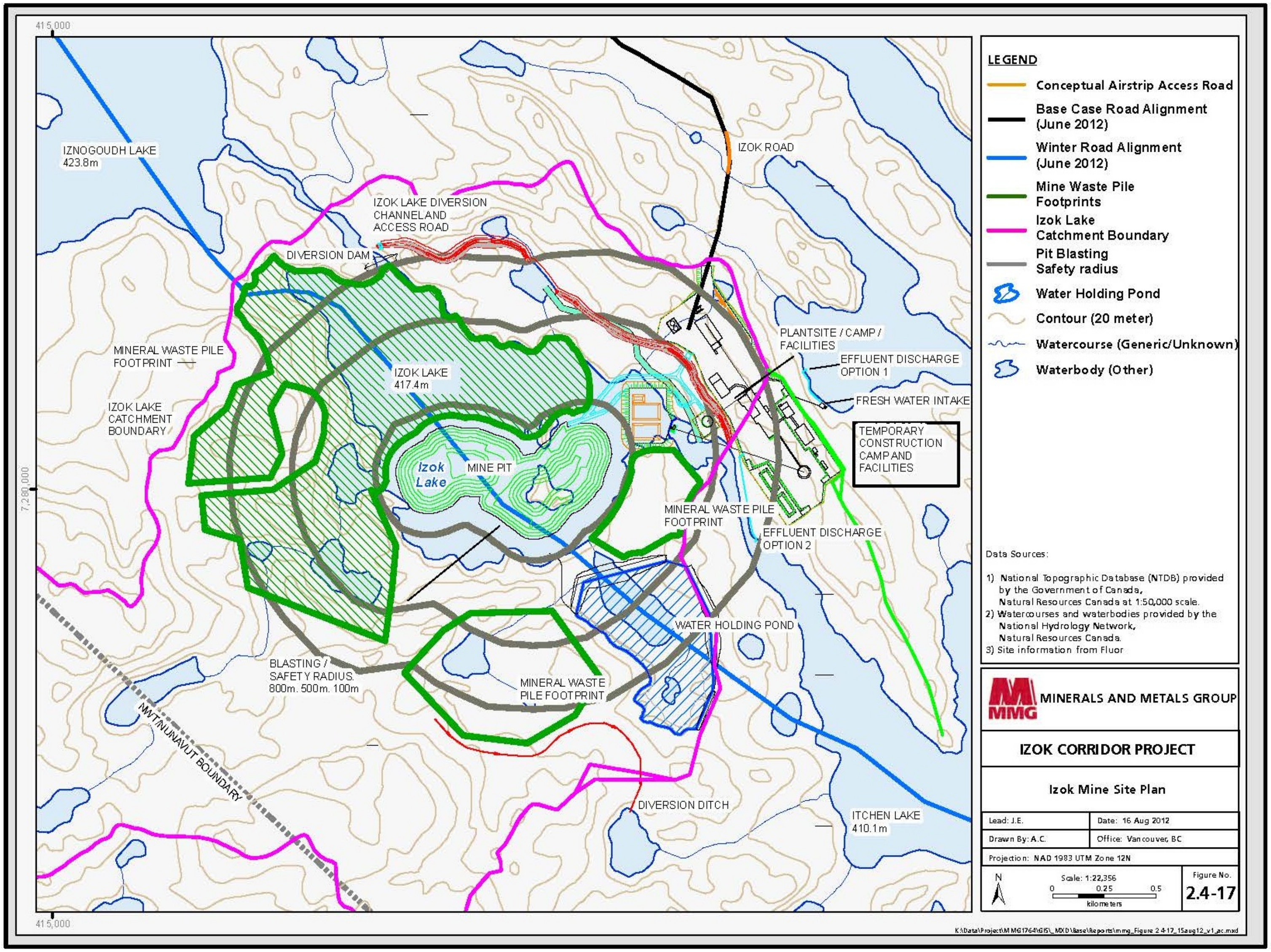


Figure 2.4-17 Izok Mine Site Plan

2.4.7.2 Surface Water Management Alternatives Considered

No alternatives to the proposed Surface Water Management Plan have been identified as it conforms to the highest industry standard best practices and regulations for protecting the environment.

2.4.7.3 Surface Water Management – Mitigation by Design

The Surface Water Management Plan mitigates the risk of uncontrolled release of contact water to the environment by intercepting, collecting, and treating such water by means of well-designed water control and containment structures.

All water retaining structures for managing contact water will be designed to handle the volumes of water resulting from exceptional weather events to ensure there is no possibility of uncontrolled release of contact water.

Water flow amounts used in design of water management systems are based on conservative assessments of global warming trends.

The volume of contact water generated at the Izok Mine will be minimized by intercepting and diverting the greatest amount of non-contact surface water around disturbed areas as the topography permits.

Liners will be installed in water retaining structures to eliminate seepage of contact water into groundwater regimes where necessary.

2.4.7.4 Surface Water Management Closure Plan

Post-closure water management at Izok Mine will commence immediately following closure and involve refilling that part of the Izok pit not filled with waste rock. Essentially, this will be where the worked-out open pits exist, plus a narrow border surrounding them (**Figure 2.4-18**).

During the post-closure phase, lake water will be allowed to rise from surface inflows, precipitation and groundwater inflows to a level that will cover waste rock deposited in the open pits. It will not, however, be allowed to rise to a level that might allow overflow from the re-flooded area to Itchen Lake. The lake water level will be kept between 5 m and 15 m below the lake outlet level by pumping excess water to a water holding pond and effluent treatment plant where it will be treated and then released into Itchen Lake. Treatment of excess water from the flooded pit and water body is expected to be necessary for several years after closure, as water quality will not meet discharge criteria until products of oxidized sulphide minerals have been washed out of the materials in the newly-flooded lake, and seepage from PAG waste rock and tailings stored above and outside the lake cease to flow into the lake.

The first source of ARD and ML in the flooded pit and area is the residual products of oxidation of sulphidic minerals from PAG waste rock submerged in the lake and exposed PAG rock faces in the open pits. Submerging these sources will effectively curtail the oxidation reaction, thus preventing the formation of new ARD and ML. The second source of ARD and ML is seepage from PAG waste rock and dry stack tailings. Once these dry stack tailings are completely frozen, ingress of precipitation and release of ARD and ML will diminish to negligible amounts, This is expected to occur within a finite time after closure (refer tosections2.4.6.1 and 2.4.6.2 for a full description of ARD and ML management from waste rock and dry stack tailings piles, respectively).

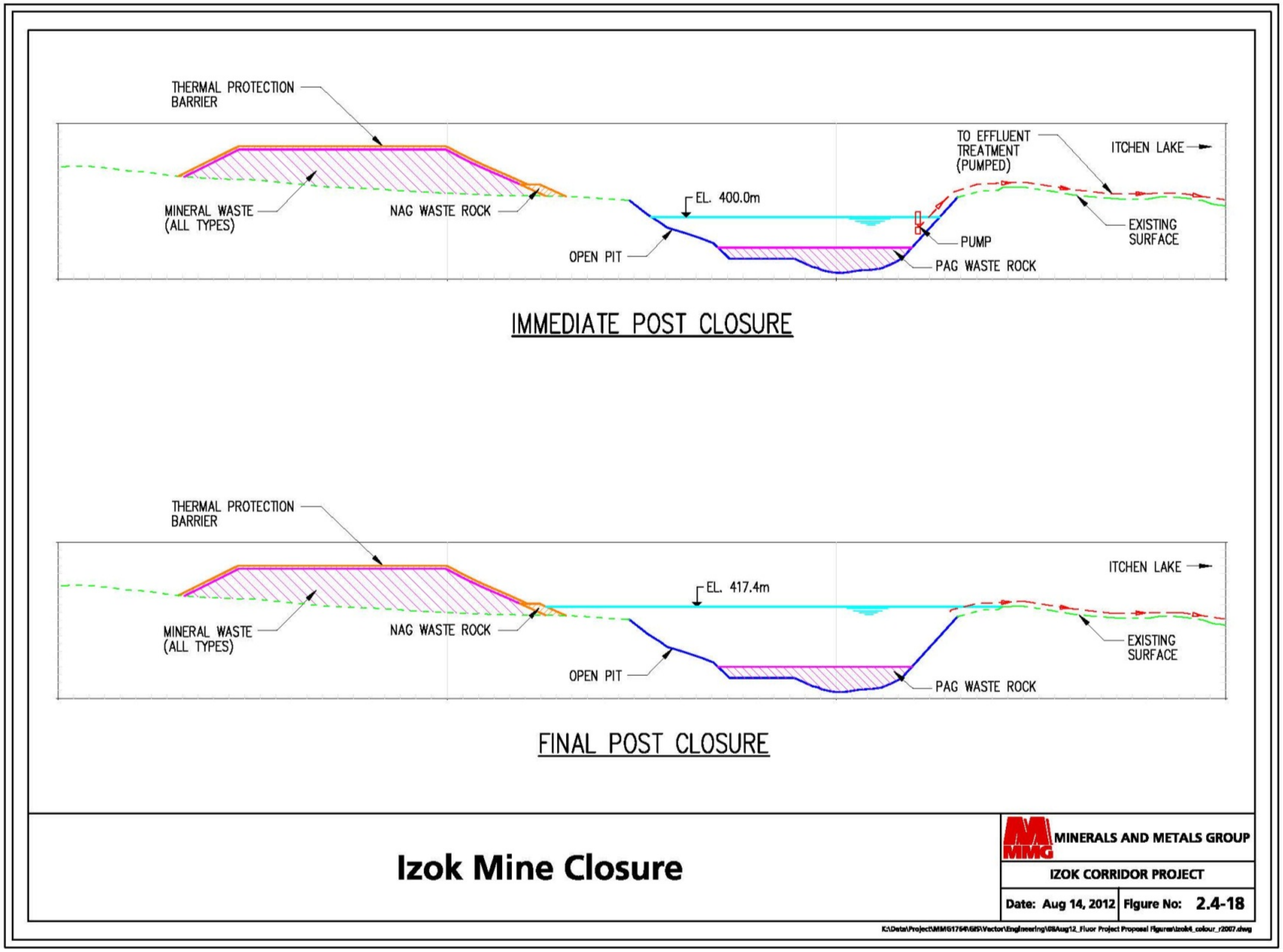


Figure 2.4-18 Izok Mine - Closure

Once production of ARD and ML has effectively ceased, eliminating the need to pump and treat water from the flooded pit and nearby area, the effluent treatment plant and associated infrastructure will be decommissioned and removed. Other water control structures such as the water holding pond and non-contact water diversion ditch system will also be decommissioned.

2.4.7.5 Groundwater Management Plan

Groundwater management measures implemented during mine operation will control, collect and treat groundwater inflows into the pits and from other mine site areas.

As described in section 2.4.4.3, the Izok Mine is situated within a talik in a region of continuous permafrost. Permafrost in the area extends to a depth of more than 300 m. Within continuous permafrost regions, groundwater flow may occur beneath the permafrost, within taliks (unfrozen ground beneath lakes and rivers within areas of continuous permafrost),in localized pockets within the permafrost zone, and in the seasonal shallow “active layer” (the surface layer above the permafrost that freezes and thaws seasonally). Shallow groundwater flows occur only in summer months within the “active layer”, which typically varies in thickness between one and five metres depending primarily on soil conditions. Bedrock geology, permafrost, and taliks are key factors that define the deep groundwater flow system.

During mine operation, groundwater that flows into the Izok Mine open pit and underground operation from the Izok Lake talik will be collected in sumps, and pumped to a water holding pond. From there, the groundwater will be pumped to a water treatment facility for treatment and re-cycled as process plant make-up water or released to Itchen Lake when discharge criteria have been met.

Inflow rates will tend to increase with depth of excavation, but decrease with time as the talik becomes dewatered and permafrost aggradation of the talik occurs. These effects will be modelled in subsequent phases of Project design and mine planning.

Groundwater flowing through the seasonal, shallow “active layer” within the disturbed Izok Lake catchment area will naturally flow towards and into the open pits. Shallow groundwater flows will intersect the pit walls and drain down to a mine sump. From there, it will be pumped to a water holding pond. The volume of this shallow groundwater is expected to be relatively small due to shallow overburden layers in the mine site area.

Seasonal shallow groundwater flows coming from the banks of the diversion channel (Iznogoudh to Itchen Lake) will be of good quality and will flow untreated into the diversion channel and through to Itchen Lake.

2.4.7.6 Groundwater Management Alternatives

Drilling a ring of large diameter perimeter dewatering wells around the pit limits is being considered during the feasibility study as an alternative to free inflow, collection in sumps and pumping of groundwater. By this means, pumps lowered into the perimeter holes could remove groundwater before it can reach the pit walls.

2.4.7.7 Groundwater Management – Mitigation by Design

No mitigation by design options have yet been identified that might eliminate or reduce groundwater flows into the mine openings.

2.4.7.8 Groundwater Management Closure Plan

At closure, once water quality has returned to acceptable levels, the new water body created by flooding the pit and surrounding area will be allowed to refill to its natural level (most likely the same level as the former Izok Lake) from inflows of precipitation, surface run-off, and groundwater inflows. Groundwater inflows post closure will cease when a natural water elevation has been reached.

2.4.8 Preliminary Izok Mine Water Requirements

Fresh water will be sourced from Itchen Lake. The location of the water inlet is shown in Izok Mine site plan (refer to **Figure 2.4-17**).

Fresh water intakes will either be submerged on the lake bed or on a barge. The inlet structure will be designed in accordance with DFO's Fresh Water Intake End-of-Pipe Fish Screen Guideline (1995).

2.4.8.1 Process Water

Process water is the term for water used in the mineral processing plant, and can be described in two ways; the circulating water within the plant, and the amount of water that needs to be continuously added to the process (i.e. makeup water) to balance water leaving the process in the form of moisture in the concentrate produced and other sources of loss.

Typically, two tonnes of process water (2 m^3) will be used for every tonne of ore processed. Process water will be predominantly composed of recycled water and supplemented with makeup water, which will be predominantly from water collected on other parts of the mine site (e.g. mine groundwater inflows and surface run-off water).

2.4.8.2 Potable Water

A potable water treatment unit will serve the plant complex and camp and will comprise self-contained, pre-assembled modules. In addition to meeting drinking water requirements for the plant complex, the treated potable water will also be used for safety showers and eye wash stations.

2.4.8.3 Fire-fighting Water

The fire-fighting water systems for the industrial complex and camp at Izok Mine will consist of a combined fire-fighting water and process water make-up tank with the lower portion holding fire-fighting water. Fire-fighting water distribution pumps (including a stand-by diesel powered pump for use during a power outage) and a distribution system of steel pipes will be installed within buildings and utilidors, and hydrants and fire hoses will be located throughout the plant site. In the camp, a dual-purpose fire-fighting water and fresh water tank will be installed, with the lower portion storing the fire-fighting water.

The fire-fighting water tanks will be carbon steel field-erected tanks provided with immersion heaters. Tanks will be designed to supply the fire-fighting system for two hours of operation.

2.4.8.4 Water Balance

A preliminary site-wide water balance has been developed for the Izok Mine, which includes the mill and effluent treatment plant.

2.4.8.5 Water Requirements Alternatives Considered

Sourcing fresh water from Iznogoudh Lake was considered and rejected, as this potential source is substantially further from the plant and camp than Itchen Lake, and associated costs of piping, pumping, and electrical lines are higher.

2.4.8.6 Water Requirements Mitigation by Design

The following processes have been incorporated into the mine design to mitigate effects on surface water quantity.

- Recycling contact water for re-use in the process plant and the mine
- Treating contact water in a effluent treatment plant
- Re-using treated water within the minesite rather than releasing itto Itchen Lake

2.4.8.7 Water Requirements Closure Plan

Water systems at Izok Mine will be decommissioned, dismantled and removed at closure.

2.4.9 Izok Mine Waste and Other Wastes

2.4.9.1 Process Water Treatment and Discharge

There will be times when the water balance will be in deficit and there will be a need for fresh make-up water, and times when the water balance will be in surplus and excess process water will need to be treated prior to release.

Excess process water will be directed to an effluent treatment plant installed inside the process plant. The effluent treatment plant will have the capacity to treat 1,000 m^3/hr of water, and will be fed with water from the concentrate and tailings thickener overflows. The treatment plant will precipitate oxidized metals, which will be removed by a high-density sludge system. The process will involve two tanks: one to receive input water and to inject air, and the other for lime addition to raise the pH to precipitate dissolved metals. Treated water will be pumped to sedimentation ponds for solid-liquid separation prior to release to Itchen Lake.

Water discharged to the environment will meet the water quality permit limits under the Metal Mining Effluent Regulations (MMER). Suitable sampling and flow measuring instruments will be installed to sample the quality of the effluent discharge. A range of values for water quality parameters will be established to ensure that the water treatment has been effective. The discharge will be regularly monitored to ensure conformity with environmental standards. Release of non-compliant water will be prevented by returning the water to the effluent treatment plant for re-treatment. Treated effluent meeting discharge criteria will be discharged under the surface of Itchen Lake.

Sludge generated in the effluent treatment plant and sediments from the sediment ponds or clarifiers will be pumped to the tailings filtration plant for co-disposal with the tailings.

2.4.9.2 Sewage Treatment and Discharge

Sewage from the camp, process plant and maintenance facilities will be conveyed in heat traced insulated pipes to a sewage treatment plant located either inside the process plant or close by it. A rotating biological contactor sewage treatment systems or similar will be used. During construction, sewage plant effluent meeting discharge criteria will be discharged to Itchen Lake. During the operational phase, sewage plant effluent will be re-cycled into the process plant as make-up water or used for other non-potable water uses such as dust suppression. If not re-used, it will be discharged into Itchen Lake.

Sludge from the sewage treatment plant will be disposed of with process plant tailings.

2.4.9.3 Grey Water Treatment and Discharge

Grey water will be pumped either to the process plant as make-up water, or treated to meet discharge criteria and either discharged to Itchen Lake, re-used in the process plant, or directed untreated to a land farm.

2.4.9.4 Solid Waste Treatment and Discharge

Combustible solid waste and non-combustible solid waste, including bulky items and scrap metal, will be collected and disposed of in a landfill within the Izok Lake catchment area. A site for the land fill will be selected during future studies.

Combustible solid wastes will be regularly collected and removed from source locations to areas where fire will not pose a hazard. Combustible solid waste may be incinerated.

Landfills will be engineered facilities to deal with leachate concerns and to ensure that only non-hazardous waste will be disposed. Domestic garbage will be collected on a daily basis, incinerated and the ash buried in a landfill. Transfer containers for solid waste collection will be located throughout the mine site; these will be kept closed with animal resistant lids to reduce scavenging. Incinerators will be located within an electric-fenced area to prevent access by wildlife.

Non-combustible materials may be placed into the waste rock piles.

2.4.9.5 Other Liquid Wastes Treatment and Discharge

Oils will be collected and incinerated or mixed with diesel to fuel the diesel generators.

Contaminated snow will be deposited in the water holding pond, where it will be pumped to the water treatment plan.

Empty barrels and fuel drums will be drained, cleaned and placed in a landfill.

2.4.9.6 Hazardous Waste Treatment and Discharge

Hazardous waste will be stored, handled and transported according to the Hazardous Waste Management Plan, which will be developed for the Izok Mine site. Hazardous materials will be placed in sealed metal containers, typical 40 gallon oil drums, and shipped off site to a hazardous material treatment facility.

2.4.9.7 Waste Water and Other Wastes Alternatives

The use of a clarifier for solid-liquid separation instead of sediment ponds and sand filters has been chosen as it will reduce the size of the sand filters and allow the underflow to be continuously recirculated until it becomes thick enough to be sent to the tailings filters.

2.4.9.8 Waste Water and Other Wastes Mitigation by Design

Designs that mitigate the effect of water treatment and discharge at Izok Mine include:

- Maximizing re-use of treated effluent within the process plant, which reduces the amount of fresh make-up water and effluent to be released to the environment
- To the extent possible, locating all point sources of waste water and other wastes within the former Izok Lake catchment, thus limiting the potential area affected by spills

2.4.9.9 Waste Water and Other Wastes Closure Plan

At closure, all water treatment and discharge infrastructure not required for the post-closure phase treatment of water will be decommissioned and removed.

Infrastructure required for water treatment during the post-closure phase will be decommissioned and removed once water quality meets discharge criteria without treatment.

Landfills will be totally enclosed with an armoured soil cover.

A conceptual water flow diagram at closure is presented in **Figure 2.4-19**.

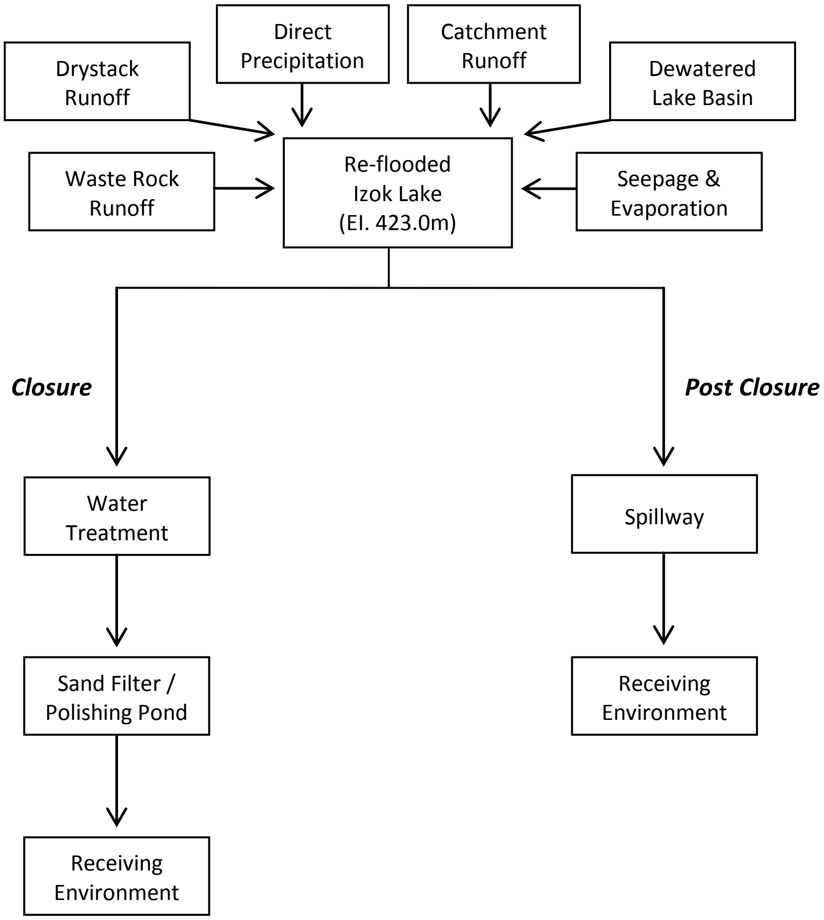


Figure 2.4-19 Conceptual Water Flows at Izok Mine at Closure

2.4.10 Izok Mine Facilities and Infrastructure

2.4.10.1 Infrastructure Elements

Permanent facilities and infrastructure at the Izok Mine will comprise the following main elements.

- Camp
- Offices
- Roads
- Surface water management structures
- Process plant
- Plant site services

- A truck shop for mobile equipment
- A warehouse
- A covered cold storage area and an open cold storage area
- Explosives storage facilities
- Process plant workshops
- Assay Laboratory
- Hazardous materials handling and storage facilities
- Container yard
- Diesel-electric generators
- Tank farm
- Power distribution system
- Airport
- Potable water treatment plant
- Sewage treatment plant
- Effluent treatment plant
- Concentrate storage building
- First aid services
- Emergency response services
- Landfill
- Land farm

The mine complex and plant site was selected for its proximity to the ore body and suitability for Project infrastructure foundations. The site is located approximately 600 m east of the pit on a ridge of exposed bedrock with thin overburden soils.

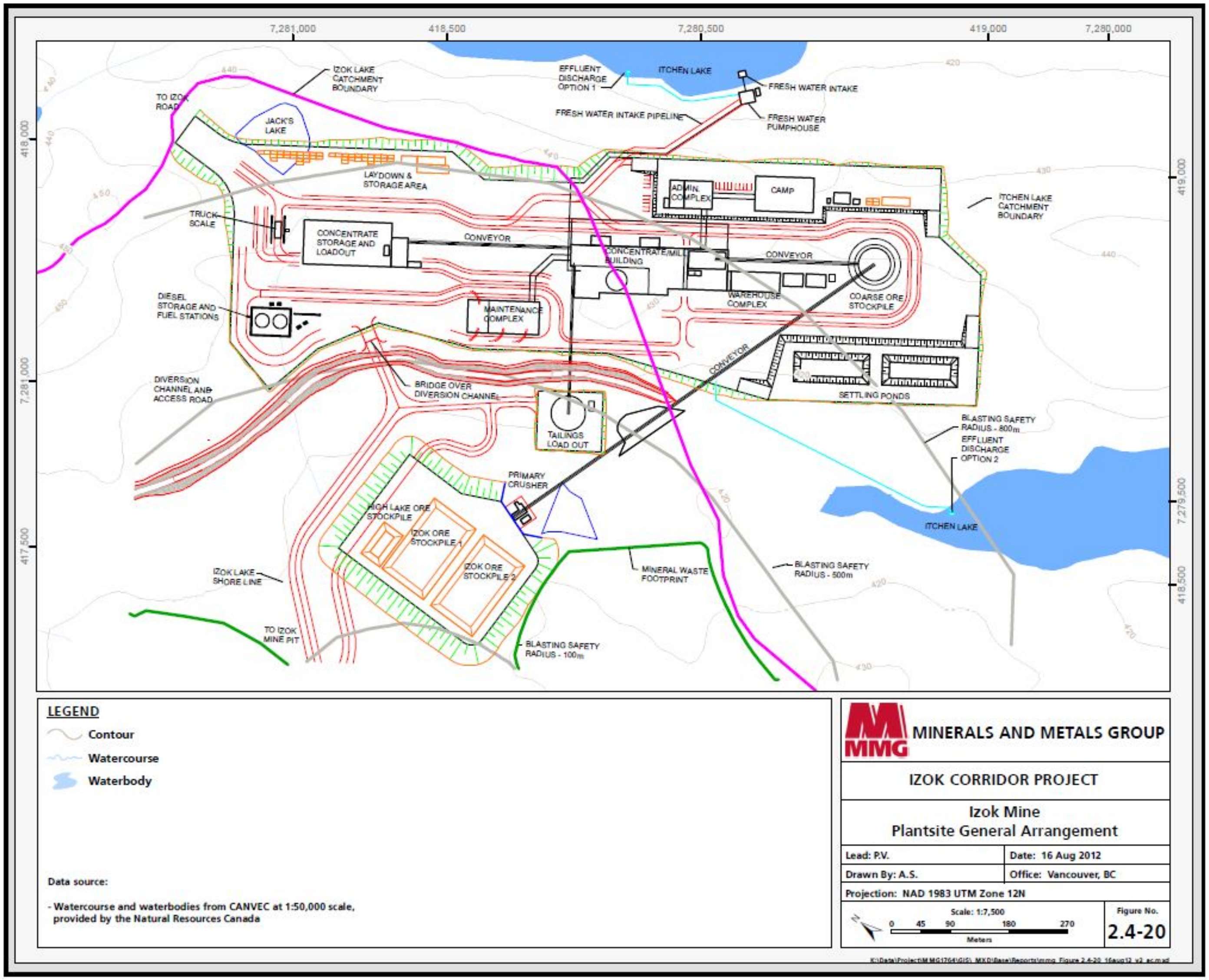
Figure 2.4-20shows the layout of the Izok Mine plant site and associated infrastructure.

2.4.10.2 Roads

Mine site roads will connect all parts of the mine, and will be constructed of quarried NAG rock and NAG waste rock and surfaced with screened gravel.

2.4.10.3 Mineral Processing Plant

The mineral processing plant (“mill building”) will be a steel-framed metal clad building thatwill house grinding mills, flotation sections, tailings filtration units, effluent treatment plant, reagent mixing units, concentrate and tailings filters. The mill building will be connected to the main buildings via utilidor.



Data source:

- Watercourse and waterbodies from CANVEC at 1:50,000 scale, provided by the Natural Resources Canada

IZOK CORRIDOR PROJECT

Izok Mine
Plantsite General Arrangement

Lead: P.V.
Date: 16 Aug 2012
Drawn By: A.S.
Office: Vancouver, BC
Projection: NAD 1983 UTM Zone 12N

Figure No.
2.4-20

K:\Data\Project\MMG1764\GIS_MXD\Base\Reports\mmg_Figure 2.4-20_16aug12_v2_ac.mxd

Figure 2.4-20 Izok Mine Plant Site General Arrangement

2.4.10.4 Concentrate Storage Building

Concentrate will be transferred from the mill building to the concentrate storage building by an enclosed conveyor system. The concentrate storage building will be located to the north of the process plant. It will be a stand-alone, enclosed building and will have a capacity between 50,000 tonnes and 200,000 tonnes of concentrate, or between one and four month's production to allow for road closures resulting from inclement weather conditions, seasonal closures during the caribou migration periods, and scheduled road maintenance. The ongoing feasibility study and particularly the development of the Traffic Management Plan will help to confirm on-site storage needs.

2.4.10.5 Electric Power Generation

Electric power for the mine will be provided by diesel electrical generating units located in the main power house located within the concentrator building. Power generation capability will be approximately 15 to 20 MW, including standby and back-up units. Diesel generators will be located adjacent to the camp complex for use in the event of a failure of the main system. Engine and exhaust heat will be recovered from the diesel generators for heating buildings.

2.4.10.6 Electric Power Distribution

Power will be distributed within the mine complex through insulated cable within utilidors. Power will be distributed outside the mine complex through insulated cable laid in shallow open ditches.MMG will follow best standard practice, as used at other mining developments in cold climates.

2.4.10.7 Fuel Systems

Approximately 35 Ml of low sulphur diesel will be required annually for operations at the Izok Mine. This is a preliminary number and may change as the feasibility study progresses. Diesel will be used for power generation and mobile equipment operation. Diesel will be supplied from diesel storage tanks located near the service building and the diesel generators. The fuel system will include at least two diesel storage tanks plus required containers of gasoline and lubricants, which will all be located within a bermed area as per Nunavut regulations.

Diesel will be transported by tanker trucks to the mine site from the bulk fuel storage at Grays Bay Port.

Facilities will be provided for metered delivery to vehicles through regular filling hoses. The dispensing station will have a 50,000 litre day tank in accordance with requirements of National Fire Code of Canada. Re-fuelling of vehicles will be conducted within a bermed area to contain any potential spills.

Diesel will be piped from the tank farm to a day tank at the power generation equipment, which will be located in a power house within the process plant building.

Other fuel types will include aviation fuel for helicopters. This will be stored in 45 gallon steel barrels. The annual consumption is estimated at 100,000 litres. Aviation fuel will be stored in a lined bermed area at the tank farm and moved on pallets as needed to a lined bermed area at the helicopter pad.

All fuel handling equipment, installations and procedures will comply with Environment Canada's fuel storage system regulations (Storage Tank System for Petroleum and Allied Petroleum Products).

2.4.10.8 Airport

The existing Ham Lake Airstrip is located about 11 km to the north west of Izok Mine. This is a 900 m all-weather gravel airstrip, which has been used for a number of years for exploration activities.

Two potential airstrips are being considered west of Izok Mine (**Figure 2.4-21).** Final selection of the airstrip location will be made during feasibility planning.

2.4.10.9 Accommodation

The camp at Izok Mine will be sized for the peak manpower loading, which will occur during construction of the diversion channel, sedimentation pond, cut-off dam and plant site rough grading activities. Camp capacity requirements will peak again when the concentrator plant is completed and commissioning takes place.

Temporary mobile camps of limited size (between 100 and 200 person capacity) will be installed for the initial part of the construction phase, and will be replaced by the permanent camp buildings when these are constructed.

The personnel accommodation complex (or permanent camp) will be located south east of the process plant, and will house approximately 700 to 800 workers during the construction phase and between 300 -500workers during the operations. These numbers are preliminary and will be improved by the time the Draft Environmental Impact Statement (DEIS) is delivered.

Permanent camp buildings will be pre-constructed modules that are assembled and erected on site. The permanent camp will include kitchen, laundry and recreation facilities. The camp will be installed early in the Project as part of the pre-construction schedule and will be of modular design to allow for expansion as the Project progresses through the various construction phases. The proposed location of the camp takes into account potential sources of noise and dust emissions, distance from blasting in the mine, and the predominant wind direction.

The permanent camp will include fitness and recreational facilities to attract and retain employees and to promote their health and well-being. There will be areas dedicated to training, computer access, and other dedicated spaces. MMG will be consulting with other operators and with communities on how to design camps that will maintain a healthy and balanced lifestyle while away from home, and provide opportunities for hobbies, training and learning while on site. MMG is also looking at room configuration and size, as well as other amenities currently provided by other operators to inform the planning process.

2.4.10.10 Communications

MMG is investigating a variety of options to provide secure and reliable communication on site. At this time, the pre-feasibility studies suggest that communications between Izok Mine and external locations will be via satellite. Communication within the Izok site will be by radio and a local phone system will be used within the mine complex.

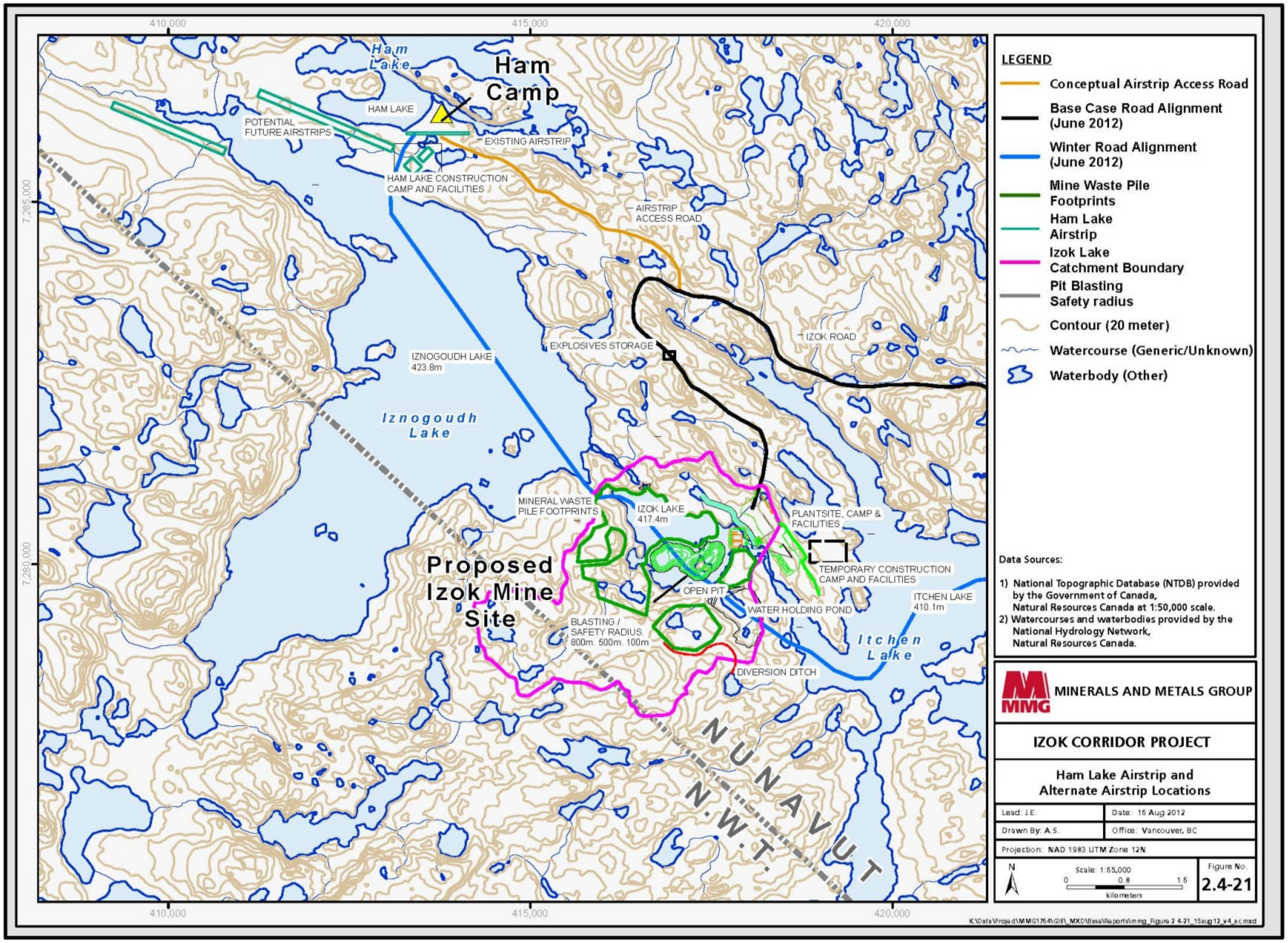


Figure 2.4-21 Ham Lake Airstrip and Alternate Airstrip Locations

2.4.10.11 Explosives Storage and Handling

Explosives and blasting agents will be transported to Izok Mine by road from the main storage depot and manufacturing facility at High Lake. Transportation, storage and handling of explosives will comply with all relevant regulations and Acts (i.e., federal *Explosives Act* and the *Explosive Use Act of Nunavut)*.

Exact quantities and descriptions of explosives and components of explosives are being currently being developed.

Explosives magazines at Izok Mine will consist of a fenced area sized to handle standard 6 m containers and 80,000 kg silos containing emulsion. Blasting accessories are classed as an explosive and bullet proof magazines will be installed and located approximately 1 km from buildings or roads; the exact distance determined by regulation and dependent on the amount and type of explosive being stored.

Based on the experience of operating mines in the Northwest Territories and Nunavut, a high percentage of the blast holes will be wet. In these cases, an emulsion based explosive mixed with ANFO (ammonium nitrate and fuel oil) will be used.

Emulsion consists of ammonium nitrate prills, water and emulsifiers. Ammonium nitrate will be handled in specially constructed containers of 20 t capacity.

2.4.10.12 Hazardous Materials

The Izok Mine and processing plant will use a variety of chemicals and reagents that are classified as hazardous but are standard in the mineral processing industry.

A full description of types, quantities, method of storage and containment, secondary containment measures, method of chemical transfer, and description of spill control measures for hazardous materials will be developed during the next stage of Project planning.

Hazardous materials will be packaged in drums or bulk bags and shipped to mine in sea containers via barge or ocean bulk-carrier ships. All hazardous materials will be stored within the shipping container and will be placed adjacent to the process plant, allowing ready access and just-in-time removal of hazardous materials from safe storage in containers.

2.4.10.13 Infrastructure Alternatives Considered

Alternative Airstrip Locations

An alternate airstrip location west of Izok Mine is considered potentially viable(refer to **Figure 2.4-21**). It will be further investigated during the 2012 field season. This location would eliminate the need to construct approximately 5 km of road to access the Ham Lake airstrip, but will likely incur higher construction costs as the ground is exposed rock, whereas Ham Lake airstrip is located on lake and river sediment material.

2.4.10.14 Infrastructure – Mitigation by Design

With exception of the Ham Lake airstrip and a small portion of the mine complex, all infrastructure elements will be located within the Izok Lake catchment to avoid downstream environmental effects in the event of an accidental release of contact water or spilled material, or a catastrophic failure of a water retaining structure.

In addition, the general arrangement and juxtaposition of infrastructure elements will minimize the disturbed area.

2.4.10.15 Infrastructure Closure Plan

At closure, all infrastructure elements will be decommissioned and removed.

2.5 High Lake Mine

2.5.1 High Lake Site Geology

The central part of the High Lake property is underlain by north-trending Archean aged (2.69-2.60 Ga) basaltic to rhyolitic flows and fragmental volcanics (**Figure 2.5-1**). A large mass of Late Archean plutonic rocks intrudes the supracrustal units in the western part of the property. Several prominent northwest and north-south trending brittle faults, including the regional High Lake fault, variably displace granitoid and volcanic units before the emplacement of the diabase dikes.

The High Lake VMS deposits are within the felsic volcanic sequence with the B and D zones at or near the contact with granodiorite intrusion. Past drilling has focused on the areas of mineralization. These comprise the recent West zone discovery and the previously outlined AB and D zones. The largest zone (West_100 zone) is about 275 m long, extends about 900 m down dip and is up to 40 m thick.

The D zone is about 560 m south of the AB zone. It is a banded polymetallic massive sulphide comprising four separate lenses of mineralization. The largest is about 150 m long, dips down 320 m and is up to 35 m thick. The deposit strikes about 30 degrees and dips steeply to the west-northwest and faces northwest. Copper rich stringer mineralization occurs to the east. The north end of the deposit may be truncated by the High Lake Fault, while the southern portion appears to be cut off by the diorite/granodiorite complex.

The A zone is larger and made of stringer type sulphide mineralization stratigraphically below the more massive sulphide B zone mineralization. The A zone is also discordant with the host felsic lapilli tuffs interbedded with ash tuffs and crystal tuffs. The alteration assembly consists of chlorite, sericite, cordierite, anthophyllite and silicification, with minor amounts of biotite, talc and amphibole. Copper rich areas are associated with massive sulphide lenses in the core of the zone.

The B zone is stratigraphically above the A zone. The deposit is in altered ash and crystal tuffs. The zone is bounded on the east by the A zone and the southern end appears to be cut off by the diorite/granodiorite complex. Mineralization consists of pyrite, magnetite, pyrrhotite, chalcopyrite, sphalerite and galena, and occurs as bands and pods.

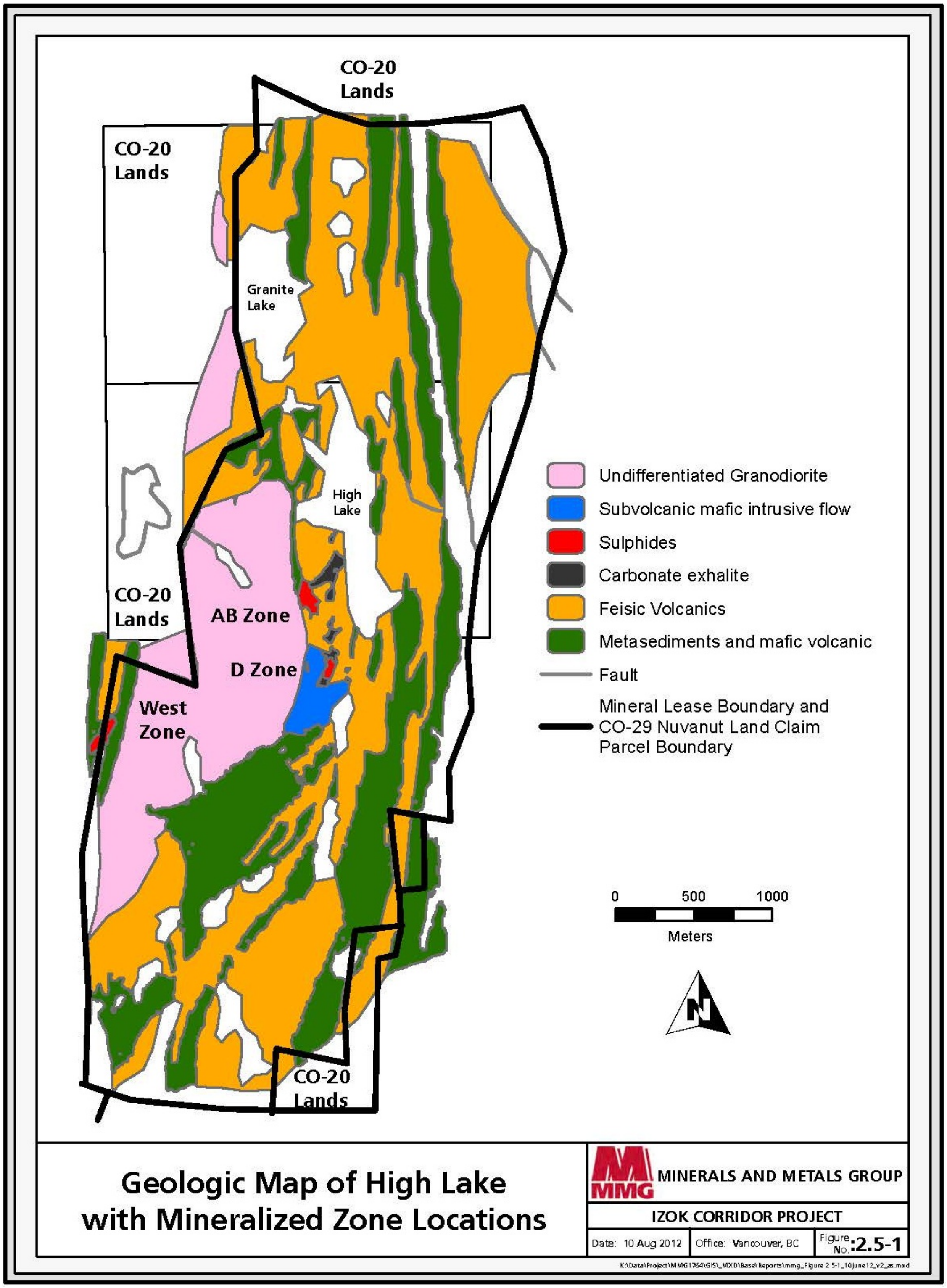


Figure 2.5-1 Geological Map of High Lake with Mineralized Zone Locations

2.5.2 High Lake Mineral Resources and Reserves

Mineral resource estimates for the High Lake deposits are outlined in **Table 2.5-1**.

Table 2.5-1 Preliminary High Lake Mineral Resources as of 30 June 2010

High Lake Mineral Resources									
2% Cu equivalent cut-off grade	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/tAg)	Gold grade (g/tAu)	Contained Metal		
							Zinc (*000 t)	Copper (*000 t)	Lead (*000 t)
Measured	-	-	-	-	-	-	-	-	-
Indicated	17.2	3.4	2.3	0.3	70	1.0	576.2	387.0	53.3
Inferred	0.0	2.4	0.5	0.4	122	0.2	1.0	0.2	0.2
Total Resources	17.2	3.3	2.2	0.3	70	0.9	577.2	387.2	53.5

2.5.3 High Lake Site Overview

The High Lake Mine site is located approximately 300 km north of the Izok Mine and approximately 1,500 m west of the Kennarctic River. High Lake is approximately 0.7 km^2, with a water volume of approximately 7.3 Mm^3 and an average mean depth of 10.25 m. There are mineral deposits on the land adjacent to High Lake that are exposed at surface, and any surface run-off over these areas becomes highly acidic, containing high levels of dissolved minerals. As a consequence, High Lake does not support aquatic life.

Some hydrogeological test hole drilling has been carried out at High Lake. The depth of permafrost in the area of the High Lake deposits has been measured at 440 m. As such, mining excavations above this horizon are not expected to encounter groundwater inflows. Based on the current mine design, maximum mining depths for the High Lake deposits, where open pit mining will occur, are well above this horizon. In the West Zone (underground), the maximum mining depth will extend to approximately 540 m below surface; however, the lowermost economic limit has not been confirmed. At this depth, the lowermost 100 m of mining excavations might be exposed to contact with potential aquifers.

2.5.3.1 Mine Geotechnical Conditions

Geological and geotechnical models will be prepared for the AB, D and West Zone deposits in 2012.In lieu of structural and geological models, the current geotechnical model is based upon general knowledge of the distribution of the lithologies at the AB, D and West zones, instead of individual geotechnical domains.

Geotechnical Mine Design Criteria

Work carried out to date provides elementary design criteria for open pits such as bench height, bench width, and slope angles, and underground stopes. More detailed design criteria will be developed based on the new geological and geotechnical models being produced.

Mining Optimization and Inventory

Optimization exercises performed during the pre-feasibility study resulted in an estimated mining inventory of material in all zones that could be mined economically (**Table 2.5-2**).

Table 2.5-2 Preliminary High Lake Mining Inventory

	Tonnes (Mt)	Zinc grade (% Zn)	Copper grade (% Cu)	Lead grade (% Pb)	Silver grade (g/t Ag)	Gold grade (gt/ Au)	Zinc ('000 t)	Copper ('000 t)	Lead ('000 t)	Silver (M oz)
Open Pit	2.7	1.3	3.6	0.1	33	0.6	35	96	3	3.1
Underground	4.2	3.8	2.7	0.4	104	1.4	160	113	17	15.4
Total	6.9	2.8	3.0	0.3	76	1.1	195	210	20	18.6

Mining at High Lake will commence with the two relatively small and short-lived open pits, and continue to the end of mine life by underground methods at the High Lake West zone. The underground mining operation will be developed through access from a ramp driven in the footwall with cross-cuts accessing the ore. During the final stage of mine life, the small and lower grade D pit will be mined.

The open pits (AB and D) and underground mining (West Zone) at High Lake are shown in **Figure 2.5-2**.Current parameters of the open pit and underground mine are summarized in **Table 2.5-3**.

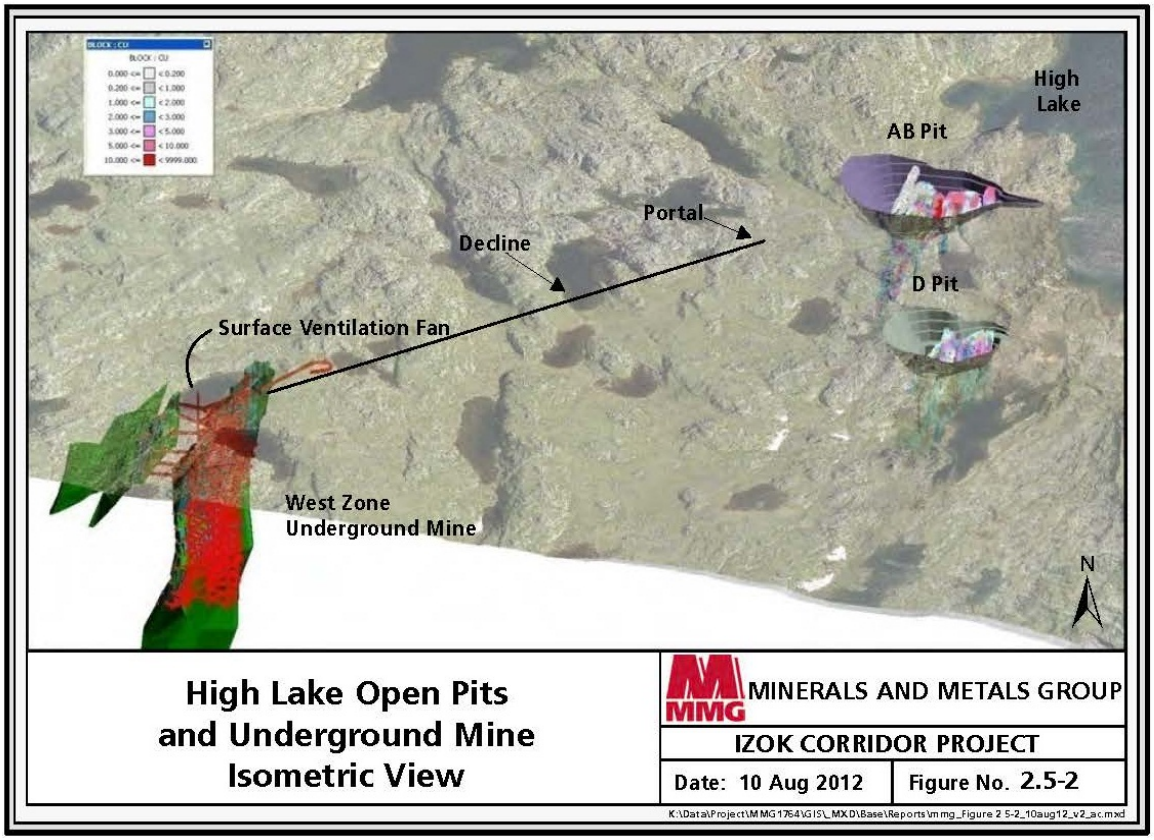


Figure 2.5-2 High Lake Open Pits and Underground Mine Isometric View

Table 2.5-3 Preliminary Mine Design Parameters for the High Lake Mine Deposits

Parameter	AB Pit	D Pit	West Zone
Excavated Volume	4.9M m^3	1.1 Mm^3	2.1 Mm^3
Maximum Depth (m)	155 m	90 m	540 m
Maximum Width (m)	290 m	165 m	70 m
Maximum Length (m)	400 m	260 m	210 m

2.5.3.2 Mining Infrastructure and Processes

Underground Ventilation

In the early years of mine operation, the West Zone underground mine will be in permafrost and as such the mine intake air will not be heated. This will preserve ground stability by maintaining frozen ground conditions. During later years, the mine may extend beneath the permafrost and groundwater will seep into the mine. During this period, the mine intake air may need to be heated to prevent inflowing water from freezing.

Mine Backfill

Wasterock will likely be used to backfill mined out stope excavations. It has yet to be decided if cement will be added to consolidate the backfill material. In this eventuality, the waste rock may have to be warmed to above freezing.

Dewatering

The High Lake open pits and the uppermost 440 to 450 m of the West Zone underground mining are expected to be in permafrost conditions and no groundwater inflows are anticipated. In the open pits, water from precipitation and spring snow melt will be pumped to a central waste water handling facility for the High Lake site. In the underground mine, the brine solution used for drilling and dust suppression will be collected and re-circulated after use. Much of this solution will be removed from the mine as moisture adhering to the broken ore and waste, which will require additional solution to replenish this loss. Minimal amounts of mine water due to spring runoff inflows will be pumped to surface and piped to the central site waste water handling facility.

Power Supply and Distribution

At High Lake, power will be fed from the main site generation and distribution system to a transformer and load centres located at the mine, from there it will be distributed to surface and underground workings.

Fuel Supply

Fuel for mining equipment will be delivered to satellite fuel depots located at the open pits or directly to the mining equipment in fuel trucks. At the underground mine, fuel storage will likely be located underground, protected from the weather. All storage areas on surface and underground will be enclosed or bermed.

Automation and Communication

Automation in the High Lake Mine is expected to be confined to systems on board the mining equipment. A dispatch system will be used in the open pit to assist in prioritizing the deployment of equipment to working areas or for scheduled maintenance, and to collect operational data from onboard diagnostics systems.

The main communications systems will consist of one system for equipment and operating data collection and another for voice communications by radio sets carried by all personnel and equipment. In the underground mine, signals for communications will be carried by a leaky-feeder cable system that is run into all headings. Other systems will be used for ground movement and micro-seismic monitoring.GPS will be installed on most equipment that will operate on surface.

All MMG sites will be connected either by satellite or other means.

Services Buildings

The following central services and other buildings will be constructed at the High Lake Mine.

- Accommodations
- Security
- Office & Dry Facility
- Waste Water Treatment Facility
- Maintenance Buildings
- Warehousing & Storage

Explosives Handling and Storage

Handling and storage of explosives will adhere to both the federal *Explosives Act* and the *Explosive Use Act* of Nunavut. Explosive accessories such as blasting caps, high explosive boosters and detonation cord will be transported to a central storage facility at the mine. Blasting agent materials such as ammonium nitrate, fuel oil and emulsion ingredients will be transported to a central on-site facility for the manufacture of ANFO and emulsion at High Lake. These will be further blended and loaded into blastholes in proportions appropriate to the wetness and temperature of the holes. Explosives and blasting agents will be transported to the work sites using purpose built mobile equipment.

Drill and Blast

All underground production drilling in permafrost will be done with 89 mm ITH units, and ANFO based explosives will be used for all production blasting. If mining extends beneath the permafrost, a wet hole product of 70%Emulsion/30%ANFO blend will be used.

In the open pits, 152 mm blast holes will be drilled in ore and 225 mm diameter blast holes will be drilled in waste. ANFO based explosives will be used for all production blasting.

Materials Handling

Two 200-tonne diesel-powered hydraulic excavators will be used to handle ore and waste. The excavators have been matched to load 91-tonne trucks. The difference in bucket capacity is an adjustment of minable material in-situ density to the lifting capacity of the excavator; ore being 3.96 t/m^3 and the three waste components averaging 2.63 t/m^3. The average estimated maximum productivity is 1,106 tonnes per operating hour.

An 800 hp front-end loader with a 10.3 m^3 bucket will work at the ore stockpile to blend ore and tram feed to a jaw crusher. The crusher loader will back-up the excavators for in-pit waste removal.

Ore will be hauled from the open pits in 90 to 100 tonne trucks. Ore will be hauled from underground in 40 - 60 tonne trucks.

2.5.3.3 Open Pit Mine Equipment

Preliminary specifications for open pit mining equipment at the High Lake site are listed in **Table 2.5-4**.These specifications may change during development of the feasibility study. The list includes the primary equipment for drilling, blasting, loading and haulage, as well as ancillary mine equipment for maintaining pit floors and roadways, moving equipment with limited mobility, equipment servicing, personnel transport and secondary ore and waste handling.

Table 2.5-4 Preliminary High Lake Open Pit Equipment

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
DRILLING	225-mm Drill	1
	152-mm Drill	1
BLASTING	Bulk Powder Delivery Truck	1
	Explosive Accessories Delivery Truck	1
LOADING	200 t Hydraulic Excavator – 8m^3	1
	200 t Hydraulic Excavator – 12m^3	1
HAULING	Mechanical Drive Haul Trucks – 91t	3
CRUSHER FEEDER	Frontend Loader – 800 hp	1
SUPPORT EQUIPMENT	Crawler Dozer – 400 hp	2
	Motor Grader – 300 hp	1
MINE GENERAL	General Purpose Excavators – 350 hp	1
	Picker Truck (Large)	1
	Tractor/Lowboy (100+ tonne)	1
	Fuel Truck	1
	Fuel/Lube Truck	1
	Light Tower	4

Open Pit Equipment		
Function	**Equipment Type**	**Estimated Quantity**
ANCILLARY EQUIPMENT	Hydraulic Crane – 75 t	1
	Tire Manipulator	1
	Integrated Tool Carriers	1
	Mechanic/Welder Truck	1
	Vacuum Truck	1
	Tandem Truck	TBD
	F550 Flatdeck	2
	Crewcab	4
	Bus	2
	Suburban/Van/Ambulance	1

2.5.3.4 Underground Mining Equipment

Current specifications for underground mining equipment at the High Lake Mine are listed in **Table 2.5-5**.These specifications may change during preparation of the feasibility study. The list includes the primary equipment for drilling, blasting, loading, ground support and haulage, as well as ancillary mine equipment for equipment servicing, mine services and personnel transport.

Table 2.5-5 Preliminary High Lake Underground Mine Equipment

Underground Mine Equipment		
Function	Equipment Type	Estimated Quantity
LOADING	R2900 LHD	4
DRILLING	Development Jumbo	3
HAULAGE	AD55 Truck	3
GROUND SUPPORT	Bolter	3
ANCILLARY	Light Vehicles	8
	Service Vehicles	4
	Agitator Truck	3

2.5.3.5 Production Schedule

The overall preliminary production schedule is based on a nominal 2 Mtpa. Approximately 600 ktpa of this will come from the High Lake Mine. First ore will be produced from the AB Pit. Simultaneously, portal excavation and construction will commence at the West Zone deposit, which will be mined using underground methods, with first ore to be produced in late 2019.The low-grade, low-tonnage D Pit will be developed and mined at the end of the mine life. The preliminary production schedule for the High Lake Mine is shown in **Table 2.5-6**.

Table 2.5-6 Preliminary High Lake Production Schedule

AB Open Pit	Waste Tonnes Mined	Ore Tonnes Mined	Cu grade (%)	Pb grade (%)	Zn grade (%)	Au grade (g/t)	Ag grade (g/t)
2017	3,751,552	54,702	2.37%	0.10%	1.03%	0.80	20.72
2018	4,119,191	595,209	4.08%	0.10%	0.74%	0.65	24.19
2019	2,021,579	597,654	4.23%	0.10%	0.47%	0.66	28.76
2020	1,290,486	450,457	3.65%	0.10%	0.19%	0.56	25.25
2021	738,421	302,306	3.80%	0.10%	0.18%	0.53	28.15
2022	264,185	185,695	3.23%	0.10%	0.91%	0.54	31.02
TOTAL	**12,185,413**	**2,186,023**	**3.88%**	**0.10%**	**0.50%**	**0.61**	**26.70**

D Open Pit	Waste Tonnes Mined	Ore Tonnes Mined	Cu grade (%)	Pb grade (%)	Zn grade (%)	Au grade (g/t)	Ag grade (g/t)
2028	2,833,487	486,308	2.17%	0.10%	5.05%	0.39	63.41
TOTAL	**2,833,487**	**486,308**	**2.17%**	**0.10%**	**5.05%**	**0.39**	**63.41**

West Zone Underground	Waste Tonnes Mined	Ore Tonnes Mined	Cu grade (%)	Pb grade (%)	Zn grade (%)	Au grade (g/t)	Ag grade (g/t)
2018	251,550						
2019	467,550	720	2.11%	0.22%	2.96%	1.62	89.32
2020	456,075	134,337	3.18%	0.49%	4.10%	1.40	102.00
2021	508,800	294,478	2.90%	0.47%	3.35%	1.30	98.76
2022	328,650	443,253	2.65%	0.34%	3.39%	1.21	96.44
2023	137,625	600,000	2.66%	0.33%	3.59%	1.52	115.98
2024	103,875	600,000	2.57%	0.38%	4.09%	1.49	108.40
2025	89,325	600,000	2.61%	0.38%	4.07%	1.44	103.50
2026	64,350	750,000	2.71%	0.36%	3.79%	1.37	99.85
2027	55,426	732,726	2.82%	0.34%	3.62%	1.42	101.23
TOTAL	**2,463,226**	**4,155,514**	**2.71%**	**0.37%**	**3.75%**	**1.41**	**103.81**

HIGH LAKE TOTALS	Waste Tonnes Mined	Ore Tonnes Mined	Cu grade (%)	Pb grade (%)	Zn grade (%)	Au grade (g/t)	Ag grade (g/t)
2017	3,751,552	54,702	2.37%	0.10%	1.03%	0.80	20.72
2018	4,370,741	595,209	4.08%	0.10%	0.74%	0.65	24.19
2019	2,489,129	598,374	4.23%	0.10%	0.47%	0.66	28.83
2020	1,746,561	584,793	3.54%	0.19%	1.09%	0.75	42.88
2021	1,247,221	596,784	3.36%	0.28%	1.74%	0.91	62.99
2022	592,835	628,947	2.82%	0.27%	2.65%	1.01	77.13
2023	137,625	600,000	2.66%	0.33%	3.59%	1.52	115.98
2024	103,875	600,000	2.57%	0.38%	4.09%	1.49	108.40
2025	89,325	600,000	2.61%	0.38%	4.07%	1.44	103.50
2026	64,350	750,000	2.71%	0.36%	3.79%	1.37	99.85
2027	55,426	732,726	2.82%	0.34%	3.62%	1.42	101.23
2028	2,833,487	486,308	2.17%	0.10%	5.05%	0.39	63.41
TOTAL	**17,482,126**	**6,827,845**	**3.05%**	**0.26%**	**2.80%**	**1.08**	**76.24**

2.5.4 High Lake Mine Waste Rock Management

2.5.4.1 Waste Rock Quantities

Accessing ore at High Lake Mine will require excavating 25 Mt of waste rock, approximately 60% of which is predicted to be potentially acid generating (PAG).Approximately 2 Mt of waste rock might be placed underground as backfill in the underground mine in the West Zone, leaving 23 Mt of waste rock to be deposited on surface.

2.5.4.2 Waste Rock Characterization

A comprehensive geochemical testing program was completed in 2007 to characterize the potential for ARD/ML from the waste rock at High Lake. Additional testing is in currently in progress to supplement this dataset. The objectives of the characterization program were essentially the same as the ones described for the Izok Mine (section 2.4.6.1). Some preliminary conclusions from this program are:

- The sulphur content ranges from very low (0.1%) to high (10%), with the majority of samples containing less than 1% sulphur. Samples with higher amounts of sulphide are typically found in close proximity to the ore zones and in the footwall of the deposit.
- The neutralization potential (NP) ranges from low (<10 kg $CaCO_3$eq/t) to moderate (40 kg $CaCO_3$eq/t), with a few rock units having NP values greater than 100 kg $CaCO_3$eq/t. Carbonate NP values are slightly lower than NP values but unlike waste rock from Izok, carbonates were present in most of the samples. All samples had neutral to alkaline paste pH values.
- Based on ARD classification using the more conservative carbonate NP data, 60% of the waste rock from the AB and D zone pits at High Lake has been classified as PAG. Kinetic testing has demonstrated that the silicate-NP is capable of maintaining neutral pH conditions. Therefore, it is possible that the proportion of PAG rock will reduce as further interpretation of the data progresses.
- The neutralizing potential present in most samples is expected to result in a substantial delay (up to 4 years longer) to the onset of ARD. Kinetic test results on the PAG samples were run for 40 weeks. Results indicate that the sulphides oxidize quite slowly in comparison to tests from other sites with comparable amounts of sulphide. Acidic conditions did not develop in any of these samples over the 10 month test period.
- Under field conditions with much lower temperatures, reaction rates could be up to 5 times slower, suggesting that there could be a delay of at least 4 years before acidic conditions could develop in the field. Additionally, given the slower than expected oxidation rates, it is possible that buffering by silicate minerals could prevent ARD from developing over the longer term in some of these materials. This may substantially reduce the amounts of PAG that will require special management strategies.

Geochemical testing is ongoing to more closely characterize waste rock and associated leachate water, providing the inputs necessary for further geochemical and water quality modelling.

2.5.4.3 Waste Rock Design Approach

As described for the Izok Mine (section 2.4.6.1), the majority of PAG mine wastes from High Lake will be sub-aerially deposited. While sub-aerial deposition will be more complex and costly during the operational phase, it has clear advantages over subaqueous deposition, as it does not require that a water cover and dam be maintained in perpetuity.

During operations at High Lake, the production and release of ARD/ML will be managed by ensuring that freezing of the PAG waste rock occurs during or shortly after deposition, and that this material remains frozen year round in perpetuity. This objective will be achieved by selecting appropriate deposition schedules and techniques as described for waste rock management at the Izok Mine site (refer to section 2.4.6.1).

2.5.4.4 Waste Rock Management Plan

The proposed mining schedule at High Lake Mine is as follows.

- Years 1 to 6 – open pits (AB Zone)
- Years 2 to 11 – underground mine (West Zone)
- Year 12- open pit (D Zone)

Approximately 2 Mt of PAG waste rock will be used for backfill of the underground mine and therefore will not require special consideration at closure.

The remaining 23 Mt of waste rock will be sub-aerially placed on sloping ground immediately to the west of High Lake. The foundation is anticipated to be relatively thin overburden located over bedrock that is frost shattered to some near-surface depth. Permafrost is expected to a depth of 400 m in this region.

The main elements of the High Lake Mine Waste Rock Management Plan will be the same as those described earlier for the Izok Mine (section 2.4.4.6).

2.5.4.5 Waste Rock Alternatives

An alternative Waste Rock Management Plan that was considered involved submerging PAG waste rock in High Lake. This alternative was rejected, as it might require water to be fed into High Lake to maintain water cover over the submerged rock during low precipitation years, management of overflowing water quality during normal precipitation years, and possibly maintenance of one or more dams; all in perpetuity.

2.5.4.6 Waste Rock Mitigation by Design

Sub-aerial deposition of waste rock offers considerable advantages over the typical sub-aqueous approach, particularly after closure. The following studies will be performed to confirm design assumptions.

- Site investigations to more closely characterize subsurface conditions, geothermal regimes, and their effects on mine waste rock pile design

- Diamond drilling and block model review to more closely define NAG and PAG waste rock quantities
- Modelling of seepage and runoff rates and water quality from the PAG waste rock piles
- Modelling of shallow groundwater flows
- Modelling and laboratory testing at sub-zero temperatures to predict the geochemical and metal leaching characteristics of waste rock at the temperatures that will be encountered at High Lake Mine
- Collection of field data during the early operational phase to confirm the performance of thermal protection covers

2.5.4.7 Waste Rock Closure Plan

The waste rock closure plan for the High Lake Mine involves depositing the majority of PAG waste rock sub-aerially. A small amount may be placed underground. This approach was selected because it most closely meets the minimum maintenance closure concept. Key elements of the closure plan are the same as that described earlier for Izok Mine waste rock.

2.5.4.8 Air Emissions

Mining operations at the High Lake Mine will result in atmospheric emissions of gases and diesel particulate matter from combustion of diesel fuel, and fugitive dust emissions from material handling and transport. Short-term dust emissions will occur during blasting, and overburden and waste rock piles will also be a source of dust particles at certain times of the year.

Features that have been incorporated into Project design to minimize air quality effects due to combustion of fossil fuels include:

- Use of low sulphur grade diesel
- Regular maintenance of all equipment (vehicles and power plant) to ensure efficient operation

Primary measures that will be implemented to manage fugitive dust emissions and minimize potential effects on air quality include:

- Reduced speed limits for vehicular traffic on roads.
- Application of dust suppressants to roads and all open surfaces and/or stockpile surfaces
- Regular application of dust suppression watering to control dust emissions during dry periods

Mitigation measures will be implemented during the operational phase of the Project as emission or nuisance dust sources are identified.

2.5.4.9 Noise Emissions

The major sources of noise at the High Lake Mine will be blasting and mine diesel-powered equipment. Other sources of noise will be operation of pumps, compressors, generators, front end loaders and service vehicles. Measures that will be implemented to mitigate noise pollution will follow applicable occupational health and safety standards and will include the following.

- Schedule noisy construction activities during normal working hours, as practicable
- Conduct regular maintenance of construction and operations vehicles and equipment to minimize noise emissions
- Install air inlet silencers and exhaust silencers on all combustion engines
- Construct noise baffles or enclosures for particularly noisy equipment

2.5.5 High Lake Surface and Groundwater Management

2.5.5.1 Surface Water Management Plan

The three key components of the water management system at High Lake include:

- surface water diversion system, including surface water diversion berms/ditches, and divider berms
- water holding pond
- water treatment plant

Best practices for the control of sedimentation in run-off water will be implemented during construction, including silt traps, silt fences, settling ponds and sumps, grease traps, and monitoring and pumping systems.

Non-Contact Water

Contact water will be minimized by intercepting surface runoff water before it enters the mine site. This will be achieved through strategically located cut-off ditches and berms. Non-contact water will be diverted around the mine site area and discharged directly to the downstream receiving environment.

Contact Water

Surface run-off that comes in contact with operations (contact water) will be collected in sumps, ponds, and ditches and transferred to a water holding pond to settle out suspended solids, particulate/colloidal-phase contaminants, and oil and grease. The holding pond will have sufficient storage capacity to accommodate seasonal variations in surface water as well as groundwater inflows to the mine excavation.

All contact water will be tested for contaminants prior to treatment and/or release. The quantity and quality of runoff will be monitored to ensure it complies with applicable direct discharge limits. Best management practices such as silt fences, sediment traps, and regular monitoring will be implemented to minimize erosion where construction, mining, and closure activities take place.

MMG is still investigating the potential discharge location and management plans options as well as environmental effects for a discharge point in either the Kennarctic River or High Lake. Any water will be treated before discharge.

2.5.5.2 Surface Water Management Alternatives

No alternatives to the proposed Surface Water Management Plan have been identified as it conforms to the highest industry standard best practices and regulations for managing surface water.

2.5.5.3 Surface Water Management Mitigation by Design

The Surface Water Management Plan will mitigate the risk of uncontrolled release of contact water to the receiving environment by intercepting, collecting, and treating such water by means of well-designed water control and containment structures (refer to section 12).

2.5.5.4 Surface Water Management Closure Plan

Post-closure water management at the High Lake Mine will commence immediately following closure and will involve collecting all contact water that flows from waste rock piles, both in the form of surface run-off and surface and shallow seepages. Contact water will be pumped to a holding pond where it will be treated in an effluent treatment plant and released to the receiving environment once it meets discharge criteria.

Once ARD/ML has ceased, the effluent treatment plant and associated infrastructure will be decommissioned and removed. Other structures such as the water holding pond, contact water collection ditch and sump system, and non-contact water diversion ditch system will also be decommissioned and removed.

2.5.5.5 Groundwater Management Plan

Groundwater management during mine operation will control, collect and treat groundwater inflows into the pits and underground workings and from other mine site areas.

The High Lake Mine is situated within a region of continuous permafrost, generally more than 400 m thick. Within continuous permafrost regions, groundwater flows may occur beneath the permafrost, within taliks (unfrozen ground beneath lakes and rivers within areas of continuous permafrost), in localized pockets within the permafrost zone, and in the seasonal shallow “active layer” (the surface layer above the permafrost that freezes and thaws seasonally). Shallow groundwater flows only occur in summer months within the “active layer”, which typically varies in thickness between 0.5 m to 4 m depending primarily on ground conditions. Localized groundwater pockets within the permafrost zone will tend to contain a small amount of water, and to drain out quickly and not to re-charge. Bedrock geology, permafrost, and taliks play a critical role in defining the deep groundwater flow systems.

Open pit mining at High Lake will be within permafrost and therefore only negligible groundwater flows into the excavation are anticipated.

The upper part of the underground mine at High Lake will be in permafrost, with no substantive inflow of groundwater expected to occur. Below 400 m, permafrost conditions do not exist and groundwater inflows are anticipated. Inflow quantity is likely to increase with depth of excavation, and decrease with time as local dewatering occurs. These effects will be modelled in subsequent phases of design and mine planning.

Based on experience from other northern sub-permafrost mining operations, groundwater quality is expected to be saline below sea level and to contain various dissolved metals.

Groundwater that flows into the open pits during mine operation will be collected in mine sumps, pumped to a water holding pond, and then pumped to a water treatment facility for treatment and release to the Kennarctic River or High Lake when discharge criteria are met.

Water pumped from the underground mine will be directed to a holding pond and then the effluent treatment plant. All discharge from the effluent treatment plant will meet discharge criteria prior to release to the receiving environment.

2.5.5.6 Groundwater Management Alternatives

No alternatives are known for managing groundwater at High Lake Mine.

2.5.5.7 Groundwater – Mitigation by Design

No mitigation by design has been identified that might eliminate or reduce groundwater flows into the mine openings.

2.5.5.8 Mine Groundwater Closure Plan

At closure, pumping and collection of inflowing groundwater to the underground mine will cease. Localized groundwater pockets will be depleted in advance of closure. Shallow groundwater inflows into the open pit from the active layer will be minimal and will tend to freeze quickly and are expected to remain frozen permanently.

2.5.6 High Lake Mine Water Requirements

Fresh water will be sourced from Lakes 4, 5 and 15 at High Lake Mine. Fresh water will be pumped through HDPE insulated and heat traced pipelines. Water will be received into a steel tank located inside a building at the mine complex. The upper half of the tank will supply potable and general mine water needs, while the lower half will contain fire-fighting water.

2.5.6.1 Potable Water

Potable water will be generated by treating fresh water in a potable water treatment system. The effluent treatment plant will consist of self-contained, pre-assembled modules.

2.5.6.2 Water Requirements Alternatives

No alternatives have been identified to meet water requirements at the High Lake Mine.

2.5.6.3 Water Requirements Mitigation by Design

The following features have been incorporated into the design of the Project to mitigate effects on surface water quantity:

- Recycling contact water for re-use in the crushing and screening plant and other operations at the mine
- Treating contact water in an effluent treatment plant and re-using treated water within the mine site rather than release to the Kennarctic River or High Lake

2.5.6.4 Water Requirements Closure Plan

Water management systems at the High Lake Mine will be decommissioned, dismantled and removed at closure.

2.5.7 High Lake Mine Waste Water and Other Wastes

2.5.7.1 Contact Water Treatment and Discharge

Contact water will be directed toan effluent treatment plant, which will precipitate oxidized metals and remove them by means of a high-density sludge system. The process will involve two tanks: one to receive input water and inject air, and the other for lime addition to raise the pH to precipitate dissolved metals. Treated water will be pumped to sedimentation ponds for solid-liquid separation prior to release to the receiving environment. As mentioned earlier, both High Lake and the Kennarctic River are considered a potential discharge point.

2.5.7.2 Sewage Treatment and Discharge

Sewage from the camps and maintenance facilities will be conveyed in heat traced insulated pipes to a pre-packaged sewage treatment plant. A rotating biological contactor sewage treatment system or similar system will be used.

During construction, treated effluent will be discharged to the Kennarctic River.

During the operational phase, treated effluent will be re-cycled within the mine operations for dust suppression and other non-potable uses or discharged to receiving waters. Sludge from the sewage treatment plant will be dewatered and either incinerated at High Lake mine or transported to Izok Mine and co-disposed with the dry stack tailings.

2.5.7.3 Grey Water Treatment and Discharge

Grey water will be directed either to an effluent treatment plant where it will be treated for re-use in the process plant as make-up water or treated and discharged to the receiving environment.

2.5.7.4 Solid Waste Treatment and Discharge

Domestic garbage will be collected on a daily basis, incinerated and buried in a landfill. Transfer containers for solid waste collection will be located throughout the mine site; these will be kept closed with animal resistant lids to reduce scavenging. Incinerators will be located within an electric-fenced area to prevent access by wildlife. A Waste Management plan will be prepared for the mine site.

Non-combustible solid waste including bulky items and scrap metal will be collected and disposed of in the waste rock pile or an engineered landfill within the High Lake catchment area. A site for the landfill will be selected during future studies.

2.5.7.5 Other Liquid Wastes Treatment and Discharge

Waste oil will be collected and incinerated or mixed with diesel that will fuel the diesel generators. Any contaminated snow will be transported to the water holding pond and then pumped to the water treatment plant. Empty barrels and fuel drums will be drained, cleaned and placed in a landfill.

2.5.7.6 Hazardous Waste Treatment and Discharge

Hazardous waste will be stored, handled and transported according to the Hazardous Waste Management Plan (refer to section 12). Hazardous materials will be placed in sealed metal 40 gallon oil drums, and shipped off site to a hazardous material treatment facility.

2.5.7.7 Water Treatment and Other Wastes Alternatives

No alternatives have been identified for water treatment or management of other wastes.

2.5.7.8 Water Treatment and Other Wastes Mitigation by Design

Design elements that mitigate the effects of water treatment and discharge at High Lake Mine include:

- Re-use of sewage treatment plant effluent, which will reduce make-up water requirements

2.5.7.9 Water Treatment and Other Wastes Closure Plan

At closure, all water treatment and discharge infrastructure not required for the post-closure water treatment will be decommissioned and removed. Infrastructure required for continued treatment of contact water during the post-closure phase will be decommissioned and removed once water quality meets discharge criteria without treatment.

2.5.8 High Lake Mine Facilities and Infrastructure

2.5.8.1 Infrastructure Elements

Permanent facilities and infrastructure at the High Lake Mine will consist of the following:

- Camp
- Offices
- Site Access Roads
- Surface water management structures
- Plant site services
- A truck shop for mobile equipment
- A warehouse
- A covered cold storage area and an open cold storage area
- An explosives storage and manufacturing plant
- Hazardous materials handling and storage facilities
- Container yard
- Diesel-electric generators
- Tank farm
- Power distribution system
- Airport
- Potable water treatment plant
- Sewage treatment plant
- First aid facility
- Emergency response facility

The mine complex was selected for its proximity to the ore body and suitability for Project infrastructure foundations. The site is approximately 600 m west of the open pits on a ridge of exposed bedrock with thin overburden soils.

Figure 2.5-3shows the layout of the High Lake Mine site and associated infrastructure.