Atlantic Gold

Appendix P.2

draft Reclamation and Closure Plan
Completed for the Updated 2021 Beaver Dam Mine EIS

Atlantic Gold

Beaver Dam Mine Project
Reclamation and Closure Plan
Version 2
October 2021

Atlantic Mining NS Inc.

REVISION HISTORY

Version	Date	Notes/Revisions
Version 1	May 2021	Submitted with the Beaver Dam Mine Project Mineral Lease Application. This reclamation and closure plan will be updated and refined during various phases of the project and will adhere to adaptive management.
Version 2	October 2021	Re-submitted to Nova Scotia Department of Energy and Mines (DEM) in response to DEM questions in letter dated July 26th, 2021.

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1 INTRODUCTION

Atlantic Mining NS Inc. (AMNS) is proposing to construct, operate and reclaim the Beaver Dam Mine Project (Project), which is situated in Marinette, Nova Scotia. The Project is approximately 18 kilometres (km) from Sheet Harbour, Nova Scotia (NS) and 30 km northeast of the community of Mooseland within the Halifax regional municipality (Figure 1-1). The Project is an open pit gold mine that will transport a maximum of 2.1 million tonnes (Mt) of ore per year for processing and tailings deposition at the Touquoy Mine. Tailings will be deposited sub-aqueously in the Touquoy mined-out pit, which will not result in any increase in the mine footprint. The Beaver Dam Mine Site will disturb approximately 218 hectares (ha), which include the following major components as depicted in Figures 1-2 and 1-3:

- administrative and ancillary buildings/areas (i.e., fuel storage, truck shop, parking areas, explosive storage area).
- an open pit.
- a waste rock storage area (WRSA) that includes non-acid generating (NAG) stockpile and a low grade ore stockpile (LGO).
- potential acid generating (PAG) stockpile.
- four topsoil piles.
- two till piles.
- organic stockpiles.
- water management structures (i.e., settling ponds, evaporation pond and water diversion ditches); and
- mine site roads.

The Project will upgrade existing forestry roads and construct 4 km of new road as part of the approximately 30 km haul road route to transport ore from the Beaver Mine Site to the Touquoy Mine for processing (Figure 1-4).

The Haul Road consists of the following four main segments:

- 7.2 km existing AMNS Beaver Dam Mine Road, that extends east from the proposed mine site to highway 224, which will be upgraded to support ore transport and will include a bypass road.
- 4 km of new constructed road west of Highway 224 to connect the Haul Road to an existing forestry road, this section will not include a bypass road.
- 8.2 km existing forestry road that extends east to the Mooseland Road, referred to locally as the Dump Road, will be upgraded to support ore transport truck and will include a bypass road.
- 10.7 km Mooseland Road that will be upgraded by Department of Transportation and Infrastructure Renewal (TIR) extends north along the Mooseland Road to the existing Touquoy Mine. By-pass roads crossing and parking area is currently being considered in the design to address safety concerns by local residents.

At Touquoy, tailings from Beaver Dam Mine ore will be deposited sub-aqueously in the mined-out pit. The Project will operate for four years following one year of construction. Active closure, consisting of major earthworks and the majority of reclamation activities, is expected to be two years, and flooding of the open pit will take approximately 13 years. Construction of a passive water treatment system is planned prior to flooded pit overflow therefore monitoring will continue after the pit has flooded. Water quality monitoring and adaptive management during pit flooding will inform the water treatment requirements and expected duration of monitoring.

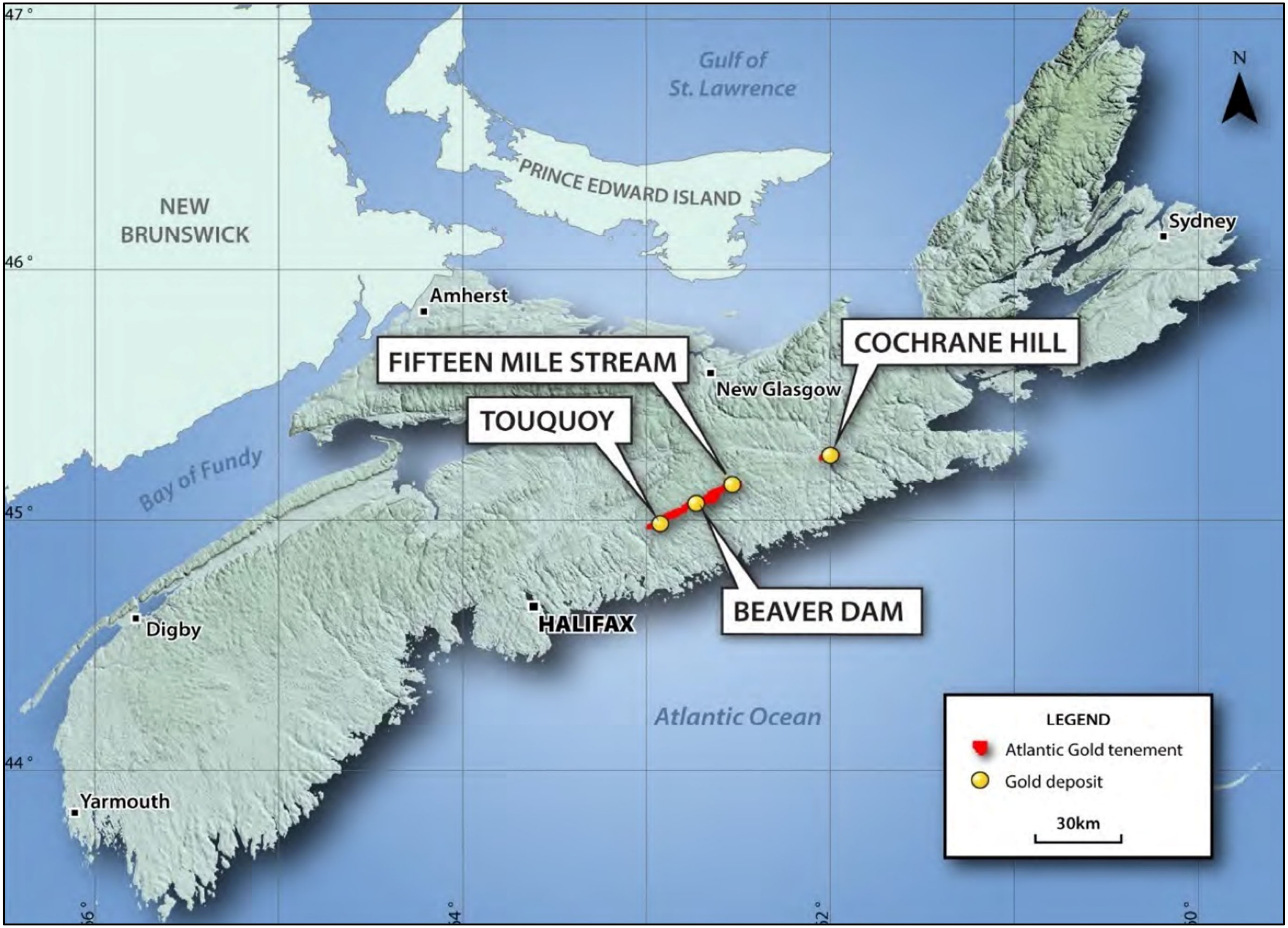
Concerns raised during public and Indigenous engagement regarding access limitation created the need to construct bypass road adjacent and parallel to the Haul Road (Figure 1-4). The bypass roads will be approximately 6 metres (m) wide to allow recreational and light trucks to maintain access into the area while the mine is operational. Bridges and culverts will be upgraded as part of Haul Road construction to accommodate the necessary hauling weight requirements. Currently, there is no plan to reclaim the Haul Road or bypass roads following operations. The Haul Road and bypass roads conform with future land use in the area, which is anticipated to be forestry, recreation, and traditional land uses based on engagement undertaken to date (Section 7). AMNS is committed to ongoing engagement throughout the life of mine including establishing an ad hoc advisory group on reclamation. Additional information on public and Mi'kmaq of Nova Scotia engagement are provided in the Updated 2021 EIS (AMNS 2021a).

The Project is currently undergoing a joint federal and provincial Environmental Impact Assessment process and an Updated 2021 EIS (AMNS 2021a) was submitted to provincial and federal agencies in June 2021. AMNS plans to apply for an Industrial Approval as well as other necessary provincial and federal permits and authorizations to allow construction, operation, and closure of the mine following approval of environmental assessment.

This Reclamation and Closure Plan (the Plan) is largely conceptual since the mine is awaiting final approval and permitting. Engineer designs of mine components are in the process of being completed as part of the next stage of detailed engineering. As noted above, there are no plans to reclaim the Haul Road including the bypass roads, therefore this plan is focused on the Beaver Dam Mine Site. A separate reclamation plan for Touquoy Mine has been developed as part of its permitting. The most recent Touquoy Reclamation Plan (Rev. 4) developed by Stantec, was submitted in November 2020 (Stantec 2020) and is currently under final review with Nova Scotia Environment and Climate Change Canada and Department of Energy and Mines. **This Reclamation and Closure Plan, therefore, is only focused on the Beaver Dam Mine Site and has been developed to support the Beaver Dam Mine Project EIS, Mineral Lease, Crown Lease, and Industrial Approval.**

This Plan has been developed to address the regulatory requirements of the *Nova Scotia Mineral Act*, which are detailed in Section 1.2.

Figure 1-1: Beaver Dam Mine Project Location



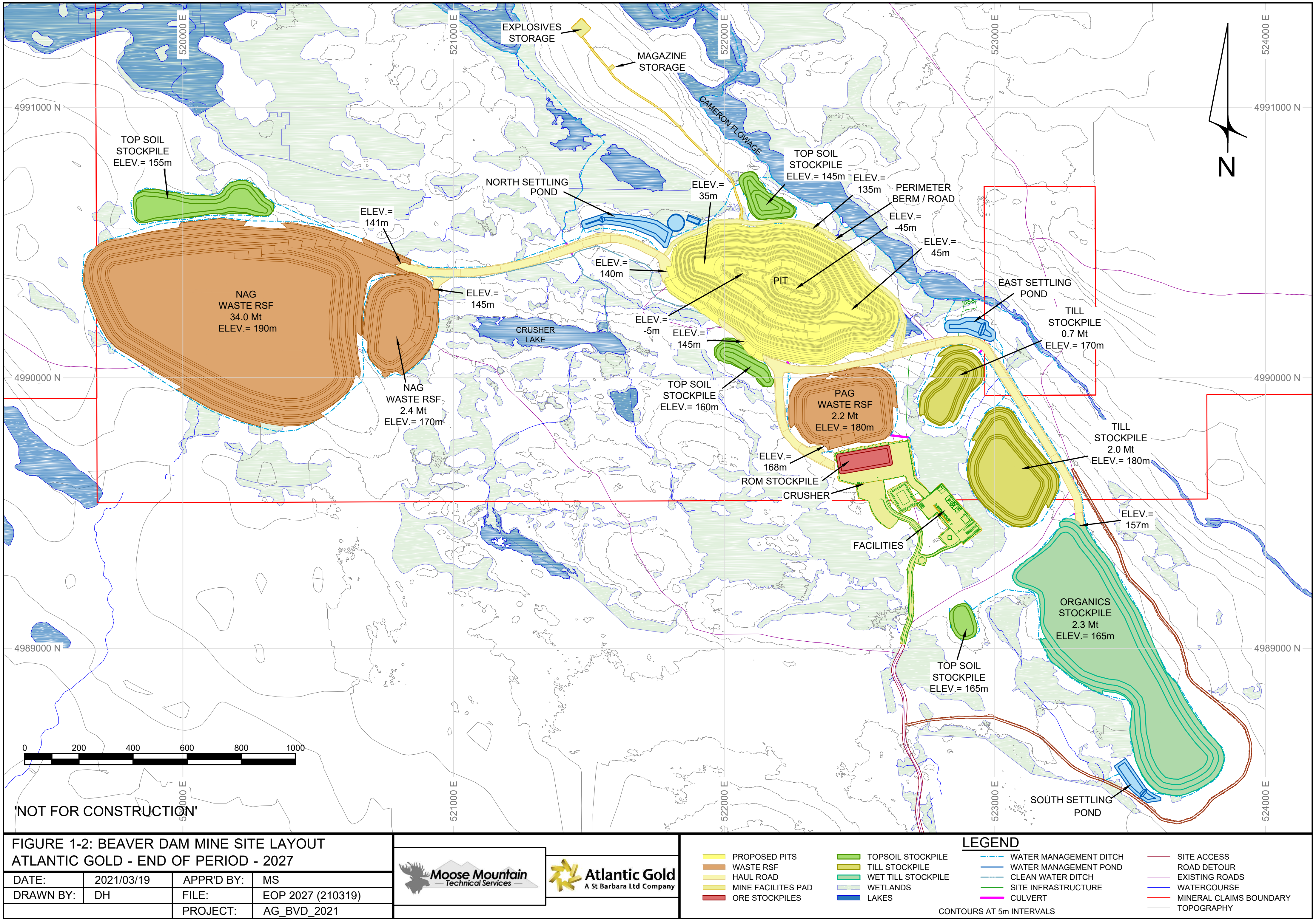


FIGURE 1-2: BEAVER DAM MINE SITE LAYOUT
ATLANTIC GOLD - END OF PERIOD - 2027

DATE:	2021/03/19	APPR'D BY:	MS
DRAWN BY:	DH	FILE:	EOP 2027 (210319)
		PROJECT:	AG_BVD_2021

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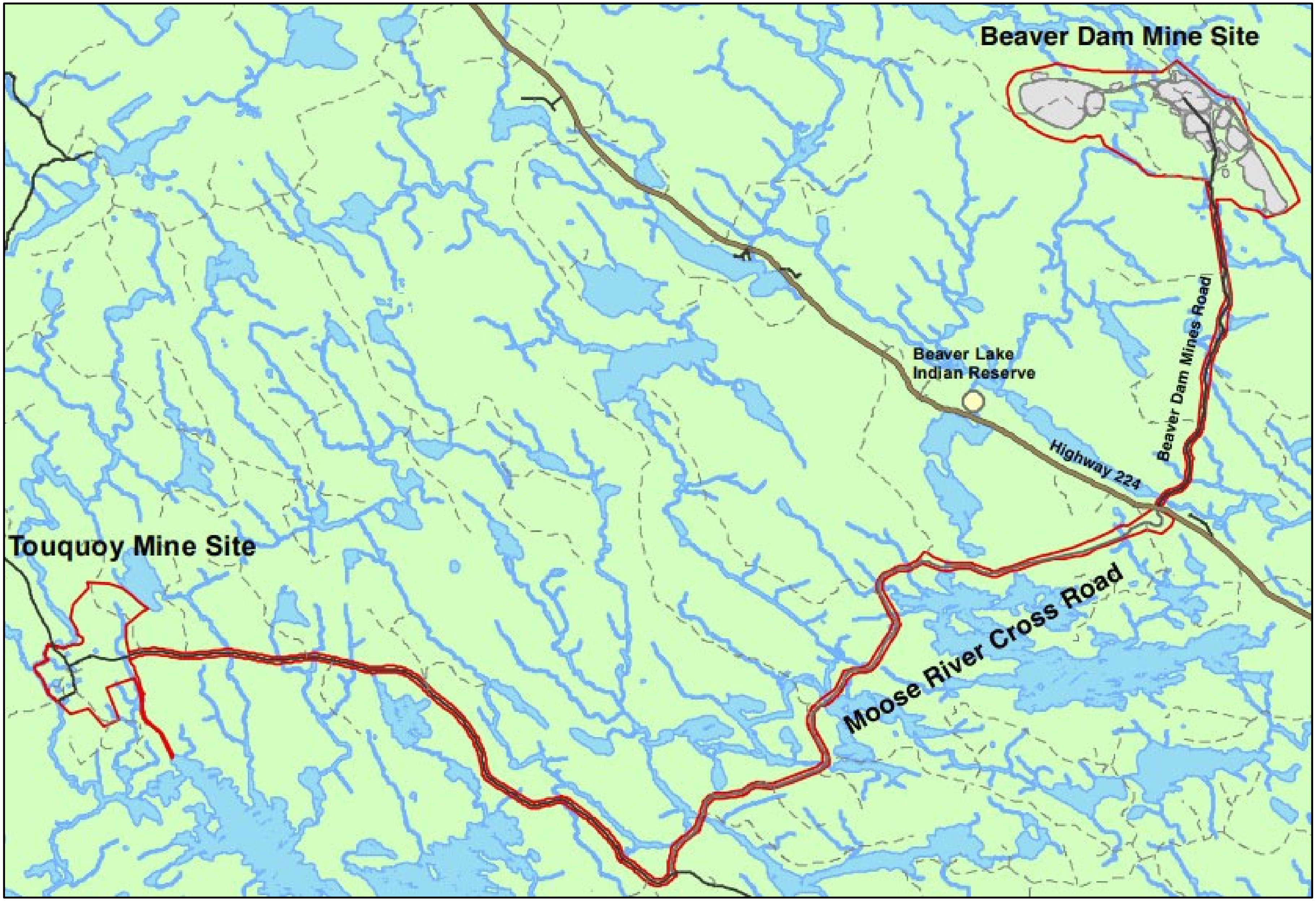
Figure 1-3: Beaver Dam Mine Site Facilities Layout

Figure 1-4: Haul Road Route and Proposed Bypass Roads



1.1 Project Ownership

AMNS, a wholly owned subsidiary of St Barbara Limited, is the Project owner and has, or is in the process of acquiring, property ownership/lease rights for the Project. Currently, AMNS does not hold any of the surface titles for the land on which the Beaver Dam deposit occurs. The primary landholder in the area is Northern Timber Nova Scotia Corporation, which owns several parcels of land comprising a large portion of the Beaver Dam property. The remaining parcels of land which make up the Beaver Dam property are owned primarily by the Crown, with some smaller land leases or ownership already in place for sections of the haul road. Negotiations, which could take the form of purchase and/or lease arrangements, are ongoing with the surface rights holders and will be concluded prior to any mining development.

1.2 Regulatory Requirements

The *Mineral Resources Act* (Act) states that the reclamation plan include actions necessary to do all of the following:

(a) protect the environment against adverse effects resulting from operations in the area;

(b) minimize the detrimental impact of operations on adjoining lands;

(c) minimize hazards to public safety resulting from operations;

(d) leave the area in a state that is compatible with adjoining land uses and that conforms to:

(i) any zoning by-law or development plan applicable to the area, and

(ii) the specifications, limits, terms and conditions of any licence, lease, non-mineral registration or surface access rights issued under the Act in respect of the area.

The Mineral Resources Regulations Section 74(1) provides the prescribed content reclamation plan, which is provided Table 1-1 as well as the corresponding sections/appendices within this document where the information is addressed.

Table 1-1: Content of Reclamation (from *Mineral Resources Regulation*)

Content	Sections/Appendices
(a) the final use for the land after reclamation	Section 4.1.
(b) identification of any existing features of social, environmental, or ecological significance that would be affected by the reclamation activities	Section 2
(c) a brief description of the existing and planned mine property, outlining the items to be reclaimed and including the size, area or volume of the infrastructure or disturbances created	Section 3
(d) all equipment, infrastructure, fixed plant material and refuse and any chemical or other hazardous industrial materials that will be disposed of	Section 4.2
(e) disposition of buildings and foundations, to be done in accordance with the Minister's requirements	Section 4.2.1
(f) disposition of petroleum storage tanks on property	Section 4.2.1.1
(g) disposition of potential and known hydrocarbon or metal contamination of soils	Section 4.2.1.3
(h) disposition of potential and known refuse dumps	Section 4.2.1.2
(i) open pit and underground openings, with subsidence mitigation plans	Section 4.2.3
(j) overburden or waste rock dumps or stockpiles	Section 4.2.4, 4.2.5, and 4.2.6

Table 1-1: Content of Reclamation (from *Mineral Resources Regulation*) (continued)

Content	Sections/Appendices
(k) tailings management	Section 1.0 (Tailings will be deposited sub-aqueously in the mined-out Touquoy pit. Reclamation planning is described in the Touquoy Reclamation Plan (Stantec 2020).
(l) bodies of water on site	Section 2.3
(m) mitigation plan for acid rock drainage	Section 4.2.4, 4.2.5 and 4.3
(n) surface water management planning	Section 3.6, 4.3, and 5.2
(o) geotechnical assessments or dam safety reviews of all slopes, structures or dams	Section 5.1 and Appendix 5
(p) design for long term slopes or open pit to be flooded	Section 5.1
(q) revegetation plans	Section 5.3
(r) public safety measures	Section 4.2.1
(s) post-reclamation monitoring plan	Section 5
(t) community engagement and consultation plan, with periodic community update schedule	Section 4.1.1
(u) drawings at an adequate scale to show the property before mining and at closure the for the following intervals: (i) during reclamation, (ii) at the point of peak disturbance, (iii) at the end of mining, (iv) as reclaimed	Sections 1, 3 and 4, and Appendix 1.
(v) schedule for reclamation work, including all planned progressive reclamation activity and post-reclamation monitoring plan	Section 6
(w) cost estimate for reclamation work and post-reclamation monitoring, inclusive of a contingency and project management and professional fees	Section 8
(x) any additional information that the Registrar considers necessary for the purposes of ensuring the site is reclaim	Appendix 5

1.3 Location

The Project is in Marinette, within the Regional Municipality of Halifax, NS. The site is approximately 85 km northeast of Halifax, NS, approximately 17 km north-northwest from Sheet Harbour and 30 km from Mooseland (Figure 1-1). There are no dwellings within 5 km of the Beaver Dam deposit. The Beaver River IR 17 is located approximately 5 km from the Beaver Dam Mine Site and 5 km from the Haul Road at intersection with Highway 224 (Figure 1-4). The Project can be accessed by the Beaver Dam Mine Road, an unpaved secondary road branching northeastward from Provincial Highway 224. The Beaver Dam Mine Road is a well-maintained and frequently travelled road used by forestry companies actively operating in the area. Goods and services needed are generally sourced from Halifax/Dartmouth. The closest international airport is the Halifax Stanfield International Airport about 25 km north of Halifax. Where needed, supplies can be shipped through the Port of Halifax.

The Beaver Dam Mine Site is centered on 521319 E/4990700 N (UTM NAD 83 Zone 20). It is situated on NTS map sheet 11E/2A and is about 85 km northeast of Halifax (Figure 1-1).

2 BASELINE CONDITIONS

The Project is located within the Eastern Drumlins ecodistrict, a further subdivision of the Eastern ecoregion of NS. The ecodistrict is characterized by drumlin fields with generally north-south oriented drumlins. The area has relatively low relief with frequent drumlins and numerous lakes, ponds, streams, and wetlands. The Project catchment areas drain to the Cameron Flowage/Killag River, Cope Brook and Tent Brook watersheds.

The Beaver Dam Mine Site is in an area with low topographic relief. Average elevations are approximately 140 metres above sea level (masl) with scattered drumlins reaching approximate elevations between 165 to 175 masl. The terrain consists of a mosaic of mature, immature, regenerating and disturbed mixed wood forest, wetlands, and vegetation.

There are four mapped waterbodies located within the Beaver Dam Mine Site. Crusher Lake is in the western section of the Beaver Dam Mine Site, Mud Lake is located in the northwestern corner, and Cameron Flowage/Killag River is located in the northeast corner, near the location of the proposed open pit. The fourth mapped waterbody (unnamed) is located in the southwest corner, as a headwater open water wetland draining to Paul Brook. Five mapped watercourses are located within the Beaver Dam Mine Site. Within the Haul Road footprint, there are 16 mapped watercourses, including two major rivers: West River Sheet Harbour River and Morgan River. Five small mapped waterbodies are documented along the Haul Road just west of Lake Alma. During field assessments, however, these small waterbodies were confirmed to be wetland habitat.

Geographical restrictions have been applied to the designs for development of the Beaver Dam Mine to minimize disturbance to environment. The open pit is at least 50 m away from the Cameron Flowage/Killag River to the north. Waste and till storage facilities will be at distant from all lakes, 500 m from all surveyed Boreal Felt Lichen, 50 m from all surveyed Boreal Felt Lichen habitats, and 100 m from all surveyed Frosted Glass Lichen..

2.1 Geology

The proposed Project lies largely within the sandstone turbidites and slate continental rise prism (in places metamorphosed to schist and gneiss) of the Goldenville Formation, with some granitoid in the west (Keppie 2000). The Beaver Dam deposit is hosted in the southern limb of a north-dipping overturned anticline that hosts the vein gold mineralization. Based on available surficial geology maps, the native surficial soils in the area consist of glacial till organic deposits (bogs and swamps), hummocky ground moraine, stony till plain, and silty drumlin (Stea 1992). The Beaver Dam deposit is hosted in the southern limb of a north-dipping overturned anticlinal fold. The Moose River Formation is relatively thick in the vicinity of the Beaver Dam deposit.

The host stratigraphy is offset into segments by two northwest trending faults: the sinistral Mud Lake Fault and the dextral Cameron Flowage Fault. The Mud Lake Fault truncates, and forms the eastern boundary to, the Main Zone mineralization.

Lithologies at Beaver Dam have been metamorphosed to amphibolite facies (biotite grade) increasing to higher (staurolite) grade with proximity to the River Lake Pluton, the contact of which is about 2 km west of the Beaver Dam deposit.

Gold mineralization at Beaver Dam has been recognized over a strike length of approximately 1.4 km, extending from the Main Zone northwest to the Mill Shaft Zone. Historic drilling has shown that mineralization weakens between the Main Zone and Mill Shaft Zone. The eastern end of the main zone is controlled by the Mud Lake Fault and possible offsets to the mineralization have been identified between the Mud Lake and Cameron Flowage faults and in the Northeast Zone, immediately east of the Cameron Flowage Fault.

2.2 Climate

The Mine Site is located inland and somewhat removed from the immediate climatic influence of the Atlantic Ocean. It is characterized by warmer summers and cooler winters. Daily rainfall, snowfall and mean temperature data were obtained from the Environment Canada Middle Musquodoboit Climate Station (Climate ID 8203535) for a 41-year period between 1968 to 2016. Monthly lake evaporation normals were obtained from the Environment Canada Truro Climate Station (Climate ID 8205990), which is the closest climate station to the Site that collects lake evaporation data.

The average monthly temperature at the Site ranges from a low of -6.2°C in January to a high of 18.5°C in July. The lowest average total monthly precipitation occurs in June (94.8 millimetres [mm]), while the highest occurs in November (137.1 mm). Hurricanes are also possible in this region. The largest hurricane on record, recorded at Halifax International Airport (approximately 80 km west of the Site), was Hurricane Beth in 1971 with 296.4 mm of rainfall over 48 hours.

Nova Scotia Environment and Climate Change (NSECC) provides climate change projections across the province (NSE 2020). The two climate regions nearest the Site (i.e., Halifax Regional Municipality and Truro, NS) project a 5% increase in short period rainfall intensity for the 2020s according to NSE (2020). As such, a 5% increase to the historic Intensity, Duration and Frequency (IDF) curve was incorporated into the design of water management structures that are sized to address this climate related effects Updated 2021 EIS (AMNS 2021a).

2.3 Surface Water and Groundwater

The Cameron Flowage/Killag River, Crusher Lake, Mud Lake, Tent Brook and Cope Brook (Beaver Dam Mine Site area) and associated drainage are the watercourses that will receive direct discharge and/or their catchment areas have potential to be impacted by Project water management activities, such as non-contact water diversions (Figure 1-2, Appendix 1 and Appendix 3). Drainage in the area generally flows to the southeast along poorly drained streams, shallow lakes, and wetlands that eventually drain into Cameron Flowage and the Killag River (AMNS 2021a). A drainage divide is present within the proposed Beaver Dam Mine Site, with drainage towards the south through Paul Brook (AMNS 2021a). Locally, water in the eastern portion of the Site is directed toward an artificial historical settling pond with the remains of a dam which is maintaining the water level in the pond. Overflow from the historical settling pond is directed into Cameron Flowage and the Killag River (AMNS 2021a).

Groundwater flow systems in Nova Scotia are relatively shallow, with the majority of groundwater flow occurring in the upper 150 m. Large scale groundwater flow between watersheds has not been observed, likely due to the geology present throughout the Province (i.e., low permeability faulted/folded bedrock) that does not lend itself to the development of large regional aquifer systems (Kennedy et al., 2010).

The bedrock sequence forms a fractured rock aquifer system, which is overlain by a thin intermittent water bearing unit in the overburden (Peter Clifton & Associates, 2015). The degree of hydraulic connection amongst the smaller bedrock fracture systems is probably poor to moderate (Peter Clifton & Associates, 2015).

At the Site, the groundwater table is close to ground surface (typically within 2 to 5 m below ground surface [bgs]) and has been observed to respond rapidly to precipitation events. Seasonal variations in groundwater levels in Nova Scotia aquifers are usually less than approximately 3 mbgs, which is consistent with seasonal groundwater level variations of approximately 1 to 2 mbgs observed at monitoring wells throughout the Mine Site.

Local groundwater flow in the till overburden is a function of topographic relief with recharge occurring in areas of high elevation and discharge occurring to low lying streams, rivers, and bogs. Groundwater elevation data collected at the Site supports that overburden groundwater flow mimics topographic relief and locally discharges to low lying surface water features. Cameron Flowage likely is the most significant surface water body receiving groundwater discharge at the Site.

Regional groundwater flow in the fractured crystalline bedrock is controlled by secondary permeability and fracturing. In general, the permeability of the fractured crystalline bedrock decreases with depth moving from the shallow weathered fractured crystalline bedrock to the deeper more competent fractured crystalline bedrock. Bedrock groundwater flow is expected to be predominantly southeastward along the dominant fault trends, with a lesser component of groundwater flow occurring in the northeast and east directions (Jacques, Whitford & Associates Ltd, 1986). Regionally, bedrock groundwater flow is from northwest to southeast, along dominant fault trends and consistent with regional topographic relief from a topographic high of over 200 m Above Mean Sea Level (AMSL) in central Nova Scotia to sea level at the southeast shore of Nova Scotia (AMNS 2021a).

Groundwater monitoring will be continued during construction, operation and closure to confirm impact predictions and provide insight on future reclamation plans so adaptive management can be applied.

2.4 Vegetation and Wetlands

The mine site is located in the Eastern Ecoregion of the Acadian Ecozone and lays within the Eastern Interior Ecodistrict (previously subdivided into the Eastern Interior and Eastern Drumlins Ecodistricts). Habitat surveys confirmed 12 different ecosites with the dominant ecosites consisting of spruce-pine and spruce-hemlock forest groups, with some associated with a natural disturbance regime. Habitat within the mine site is largely disturbed because of timber harvesting, historic mining and/or road and trail networks. An interior forest analyse was conducted to quality Project impacts through habitat fragmentation.

A total of 295 vascular plant species were identified, five of which were considered priority species: lesser rattlesnake plantain (*Goodyera repens*, S3), southern twayblade (*Neottia bifolia*, syn. *Listera australis*, S3) appalachian polypody (*Polypodium appalachianum*, S3), and highbush blueberry (*Vaccinium corymbosum*, S3S4). No SAR vascular plants were observed. Eleven priority lichen species were observed, three of which were SAR: boreal felt lichen (*Erioderma pedicellatum*), blue felt lichen (*Pectania plumbea*, frosted glass whisker lichen (*Sclerophora peronella*). AMNS has adjusted the project to avoid impacts to rare lichens and where lichens cannot be avoided a lichen transplant monitoring program will be implemented. The monitoring of rare lichens is expected to extend into post closure monitoring. A description of vegetation and wetlands is detailed in the Updated 2021 EIS (AMNS 2021a).

Wetlands including swamps, bog, fens, and marshes or wetland within the Bever Dam Mine Site. Attempts have been made to avoid direct impacts to wetland habitat however approximately 117 ha of wetlands will be disturbed (AMNS 2021a).

2.5 Wildlife and Species at Risk

Baseline surveys confirmed presence of ten mammalian species, including coyote, black bear, white-tailed deer, mainland moose (NSESA Endangered, S1), American red squirrel, porcupine, snowshoe hare, beaver, eastern chipmunk and racoon. Nine species of herpetofauna were observed during file surveys, either directly or indirectly (through vocalizations, egg masses, cast snake skins, etc.). In addition, a snapping turtle (SARA/COSEWIC SC, NSESA V, S3) and nest were observed within the Beaver Dam Mine Site.

2.6 Land Use

2.6.1 Historic Land Use

The proposed Project is in an area of historic gold mining, where exploration and mining activities have occurred intermittently since gold was first discovered in 1868. There is evidence of human use and historical mining at the site, including access roads/laydown areas, abandoned cabins, hunting blinds, old mine workings, dam structures, apparent building foundations and an historic underground and open pit mining excavations. There are currently no permanent buildings in use and the site is not serviced.

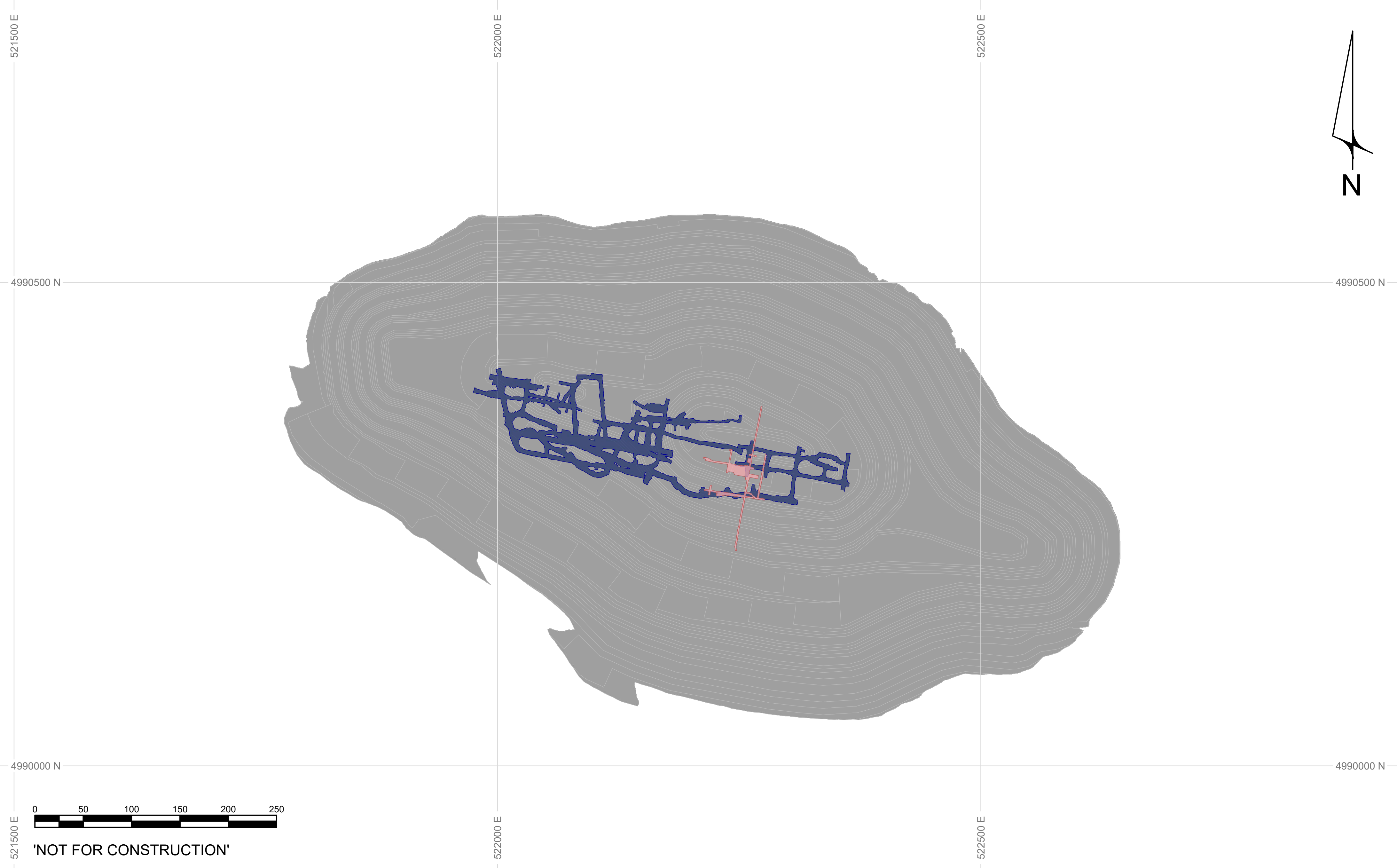
A historical underground mine was exploited between 1871 and 1935 (Austen Shaft area) with two development levels at elevations 110 and 70 masl. Between 1985 and 1988, Seabright Resources Inc. constructed underground developments over a strike length of 400 m and a maximum depth of 110 m. The proposed open pit encompasses the area of historical mine workings and is located immediately south of the Cameron Flowage in the vicinity of an historical shaft (former Austen shaft) and northwest of an historical two-stage settling pond and associated earthen dam (AMNS 2021a). During soil investigations apparent waste rock was located in the historic mine workings (AMNS, 2021a). The dam has the remains of a control structure with a discharge to Cameron Flowage (AMNS 2021a). The underground workings are in the centre of the planned Beaver Dam pit area and they will be entirely mined out by the Beaver Dam ultimate pit. Figure 2-1 presents a plan view of the historical underground workings in relation to the planned Beaver Dam open pit (underground workings within Beaver Dam Interim and Ultimate pit shells). The small Seabright's Papke Pit located approximately 400 m west of the Austen Shaft was excavated in 1926.

AMNS is committed to managing the historic tailings (discussed further in Section 3.5) at the Beaver Dam in the same manner as the potential acid generating waste rock to be generated as part of the Beaver Dam mine operation.

The Touquoy Gold Mine (located near the proposed Project) lies approximately 19 km away from the Beaver Dam Mine Site (straight line) and was officially opened on October 11, 2017 with commercial production achieved in March 2018 and an anticipated life of mine of five years. The proposed Project involves open pit mining of gold ore, which will be crushed on site and then trucked (approximately 30 km) to the Touquoy Gold Mine for processing.

The Project site consists of portions of several properties currently owned by Northern Timber Nova Scotia Corporation although a leasing or ownership arrangement is currently under negotiation by AMNS. Toward the western end of the site, the property crosses a portion of provincial Crown land (AMNS 2021a). Logging has been widely carried out somewhat recently including clear cutting in the immediate area of the proposed footprint.

The Project lies between Cameron Flowage to the east, which is part of the Killag River, and Crusher Lake to the west. Constructed or remains of various dams are present along local water ways (AMNS 2021a).



ATLANTIC GOLD - CLOSURE PLAN
HISTORICAL UNDERGROUND WORKINGS IN RELATION TO PLANNED OPEN PIT

DATE:	2021/10/14	APPR'D BY:	MS
DRAWN BY:	DH	FILE:	FIGURE 2-1
		PROJECT:	AG_BVD_2021

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LEGEND

- ULTIMATE PIT
- UNDERGROUND WORKINGS - SEABRIGHT
- UNDERGROUND WORKINGS - SEABRIGHT 2

CONTOURS AT 5m INTERVALS

2.6.2 Current Land Use

The Project occurs within an area used for forestry with existing road used to access logging areas. The area is used by recreational hunters and fishers. The existing roads are used by light vehicles and recreational vehicles to access areas lakes and rivers as well as access east of the Killag River where there are camps and gathering sites. AMNS has and continues to undertake geological and geotechnical drilling to support the EIS and mine plans. Environmental monitoring is ongoing to support the Project.

The Nova Scotia Salmon Association (NSSA) leads the West River Sheet Harbour Acid Mitigation Project, which involves the operation and maintenance of automated lime dosers on both the Killag River and the West River (NSSA 2020). The lime doser on the Killag River is situated downstream from the proposed Project. The lime dosers are intended to buffer the naturally low pH of river water downstream to a more suitable pH to support Atlantic salmon and brook trout (NSSA 2020). In addition to these liming efforts, the NSSA conducts monitoring of Atlantic salmon (e.g., annual smolt monitoring, adult monitoring, electrofishing surveys) as well as other ecosystem components, such as invertebrates and water chemistry (NSSA 2020).

2.6.3 Traditional Land Use

The Confederacy of Mainland Mi'kmaq (CMM) was retained in 2009 by GHD Limited on behalf of the AMNS to complete a Mi'kmaq Ecological Knowledge Study (MEKS) for the proposed Project at the Beaver Dam Mine Site. In 2015, CMM was retained to update the MEKS, due to changes in the Haul Road to include approximately 4 km of new construction. CMM was then retained again in 2016 to finalize the MEKS to include the revised Project Area (PA) and any additional information.

In addition to the MEKS cited above, in 2018, a Traditional Land and Resource Use Study (TLRUS; MFC 2019) was undertaken by Millbrook First Nation to document historical and current use of the Project Area and surrounding areas by the Millbrook First Nation. This document was shared with AMNS under a confidentiality agreement. AMNS has integrated information obtained from the TLRUS, with permission from Millbrook First Nation, in appropriate sections of the EIS.

There are a number of activities associated with the harvest and use of plants, animals and fish within the PA and in the Local Assessment Area (LAA) that relate to historical traditions and customs of the Mi'kmaq that are still practiced today. As described, the TLRUS (MFC 2019), the MEKS and indigenous residents of the Beaver Lake identify trapping and hunting activities, plant and berry gathering, and fishing in, near and surrounding the PA for purposes of sustenance, spiritual and cultural practice. The TLRUS (MFC 2019) described the frequency of use within the LAA which can be summarized as regular: weekly to annually across all seasons. This means the area was, and still is, an important resource area for the Millbrook First Nation community members and by extension, all Mi'kmaq of Nova Scotia, and any Project activities may have potential impacts on the ability of the Mi'kmaq of Nova Scotia to access certain areas to practice their rights where species with important cultural relevance may be found. Wild meat was traditionally a staple of the Millbrook First Nation diet, and a few of the harvesters interviewed for the TLRUS (MFC 2019) indicated they rely mainly on this food source, and they share their food with other community members, rather than purchase their meat at a local supermarket.

Some Mi'kmaq community members have camps on Crown land where they go to enjoy peaceful recreational and traditional activities with family and community members. There are five camps documented within 1 km of the Haul Road and multiple other camp locations throughout the LAA (MFC 2019).

2.7 Assessment of Reclamation Activities

As described throughout the EIS (AMNS 2021a), Project-environment and social interactions are expected to occur throughout the life of the Project during the construction, operations, active closure, and post-closure phases. These interactions are expected, manageable and are typical of environmental impacts associated with quarry and mineral extraction projects in the region. A summary of residual effects and associated significance for each valued component during the closure phases is provided in Table 2-1. In summary, the Project is not expected to result in any significant residual adverse environmental effects once mitigation measures have been applied. Additional information on the identification of valued environmental and social components, the assessment of project effects on these components during active closure, and post-closure phases is provided in the updated EIS. AMNS is committed to implementing the planned mitigative measures and monitoring programs, as well as ongoing stakeholder and Mi'kmaq engagement as outlined in this submission.

Table 2-1: Summary of Residual Effects and Associated Significance for Each Values Component During Decommissioning

Valued Component Affected	Potential Effects of the Project on the Environment	Residual Effect	Significance of Residual Effect
Surface Water Quality & Quantity			
Surface Water Quality	Changes to surface water quality as a result of Project activities, including construction, operations, and decommissioning.	Disturbance Habitat loss	Not Significant
Surface Water Quantity	Direct and indirect surface water body alteration due to infilling, draining, flooding, altering function, and altering groundwater recharge capacity on the mine site	Habitat Loss Disturbance	Not Significant
Groundwater Quality & Quantity			
Groundwater Quality at Beaver Dam	Effects on groundwater quality due to change in chemistry or reduced infiltration due to disturbance	Disturbance	Not Significant
Groundwater Recharge / Discharge	Hydrological effects on recharge/discharge due to construction, water body alteration and dewatering, and operations.	Disturbance	Not Significant
Terrestrial and Aquatic Environment			
Wetland Hydrology	Hydrological changes due to direct and indirect wetland alteration	Disturbance	Not Significant
Priority Fish Species; Fish Habitat	Disturbance to fish habitat due to construction and operation of the mine site, including increased sediment, impacts to water quality from dust, introduction of invasives, and wetland alteration	Habitat Loss Disturbance	Not Significant
Priority Vascular Flora and Lichens	Habitat loss or damage due to construction and operation of the mine site, including increased sediment, clearing and grubbing, and wetland alteration	Habitat Loss Disturbance	Not Significant
Indigenous Peoples			
Physical and Cultural Heritage	Direct effect on archaeological resources or burial site which is not in Project area	None	Not applicable
Traditional uses	Loss of plant specimens of significance to the Mi'kmaq for medicinal, food, beverage or art and craft purposes	Disturbance	Not Significant
Traditional uses	Loss of habitat including wetlands and other habitat supporting current use of land and resources for traditional uses	Habitat Loss	Not Significant
Economic opportunities	Benefits to the Mi'kmaq including employment opportunities, economic development, and capacity building	Economic Benefits	Not Significant
Physical and Cultural Heritage			
Physical and Cultural Heritage Resources	Damage to cultural/physical heritage resources during the construction phase	None	Not Applicable
Human Health & Socio-Economics			
Recreational Activities	Restriction of recreational activities within the Project area during construction and operation of the mine site	Disturbance	Not Significant
Employment	Direct and indirect employment opportunities throughout the construction, operation, and decommissioning phases	Creation of Employment Opportunities	Not Significant

3 MINE PLAN AND INFRASTRUCTURE

The proposed Beaver Dam Mine is an open pit mine with a maximum ore production of approximately 2.1 million tonnes per year (MT/year). The ore will be processed at the existing Touquoy mine with tailings deposited sub-aqueously in the mined-out pit.

The Project components have been separated into four sections based on the areas of the site and are detailed in the following subsections. The site components are shown on Figures 1-2 and 1-3 with additional drawings showing details of each area in Appendix 1 and 2.

3.1 Administration and Ancillary Areas

The Administration and Ancillary Areas are located in the northwest area of the site as shown on Figures 1-2 and 1-3. This 10 ha area contains most of the buildings at the site. The components include:

- Administration/Security Building;
- Truck Shop/Truck Wash;
- Crusher Structure and Conveyor (optional);
- Stormwater/Evaporation Retention Pond;
- Various Trailers;
- Septic and Propane Tanks; and
- Petroleum and Hazardous Material Storage.

The Explosive Storage Area (1 ha) is also associated with the ancillary areas. These areas are used to maintain mining operations.

3.2 On-site Mine Roads

3.2.1 On-site Mine Haul Roads

Mine haul roads, external to the open pit, are designed to transport ore and waste materials by mine haulers from the open pit to the scheduled destinations. The total disturbance of on-site mine haul roads is approximately 14ha. The on-site mine haul roads were designed with the following inputs:

- 27 m wide haul roads that incorporate dual lane running width and berms on both edges of the Haul Road;
- 10% maximum grade;
- primarily constructed using pit run non acid generate/ metal leaching waste rock, hauled from pit, then dumped out, with final contouring done by dozers;
- running surface capped by 0.5 m crushed rock layer;
- balanced cut and fill areas built by dozers;
- areas with excess cut handled by excavators and construction haulers; and
- Density for cut and fill as per the Table 3-1.

Table 3-1: Haul Road Material Design

Material	Bank Cut Density (t/m^3)	Swell Factor	Placed Density (t/m^3)
On-site Haul Road Rock	2.78	30%	2.10

Source: AMNS (2021a).

Notes: t/m^3 = tonnes per cubic metres; % = percent.

The on-site haul roads run from the open pit entrances on the west side of the pit:

- west towards the Non-acid Generating (NAG) Waste Rock Storage Area (WRSA) and Low Grade Ore (LGO);
- switch-backing southeast at the exit towards the Run of Mine (ROM) pad and PAG; and
- east and south towards the till stockpiles from the east side of the pit. (The depth of the pit during till excavation will not require exiting to the west.)

3.2.2 Additional Mine Roads

Additional mine roads surround the west, north and east limits of the open pit, as well as connect to the explosives and magazine storage pads. The disturbance area of the pit perimeter road is approximately 2 ha. The remaining roads have been included in the ancillary disturbance area. The following design criteria were used for these additional roads.

Pit perimeter road:

- 2 m in height;
- 12 m wide top surface to fit berms on both sides, and sized for travel by highway class vehicles as well as one way travel for articulated hauler;
- 10% maximum grade; and
- primarily fill constructed using pit run non acid generate/ metal leaching waste rock, hauled from pit, then dumped out, with final contouring done by dozers.

Explosive access road and pads:

- 6 m wide for on-highway class vehicle traffic;
- following existing on site road paths;
- magazine pad dimensions of 20 m x 15 m as per supplier recommendations;
- explosive storage pad dimensions of 50 m x 50 m as per supplier recommendations; and
- balanced cut/fill construction by dozers.

Other on-site roads include:

- In-plant access road within the Infrastructure Area;
- Low-volume haul road between the ROM pad and the Infrastructure area; and
- Dosing Station bypass road to allow external traffic to access the NSSA Lime Dosing.

The onsite roads at the Beaver Dam Mine Site will be built during the construction phase and initial pit development of the Project. The following table lists the cut and fill quantities estimated to construct the designed Beaver Dam on-site mine haul roads, as well as the pit perimeter berm and the explosives access roads. Fill volumes for the haul road and pit perimeter berms are sourced as NAG rock from the open pit. The explosives storage road and pad are balanced cut to fill.

Table 3-2: Haul Road Construction Quantities

Road	Cut Volume (kBCM)	Fill Volume (kLCM)
Ex-Pit Haul Roads	42	140
Pit Perimeter Berm	0	43
Explosives Roads and Pads	1	2

Source: AMNS (2021a).

Notes: kBCM = kilo bank cubic metre; kLCM = kilo loose cubic metre.

3.3 Open Pit

The Open Pit is located to the northeast of the site as shown on Figure 1-2. Figure 3-1 shows the plain view of the open pit and Appendix 2 shows the cross-sectional views. The total disturbance footprint of the open pit at the end of operations is approximately 32 ha in plan view. Approximately 51.9 million tonnes (Mt) of material (i.e., ore, non-ore bearing waste rock, till, and organic material) will be excavated from the open pit over the life of mine. The final pit geometry will remain within the limits outlined in the permits governing operation of the mine and the final pit geometry will be updated for the final closure plan.

The pit design includes 5 m bench heights with minimum 8 m wide berms placed every four benches, or quadruple benching. The maximum vertical separation between catch-berms is therefore 20 m. Bench face angles and subsequent inter-ramp angles are varied based on prescribed azimuths and depth from surface. Table 3-3 show the bench face angles and inter-ramp angles that are used for mine planning. A geotechnical stability assessment indicates that the pit slopes are stable (Golder 2021a). The open pit will be monitored for stability during development through ongoing visual inspection and survey monuments.

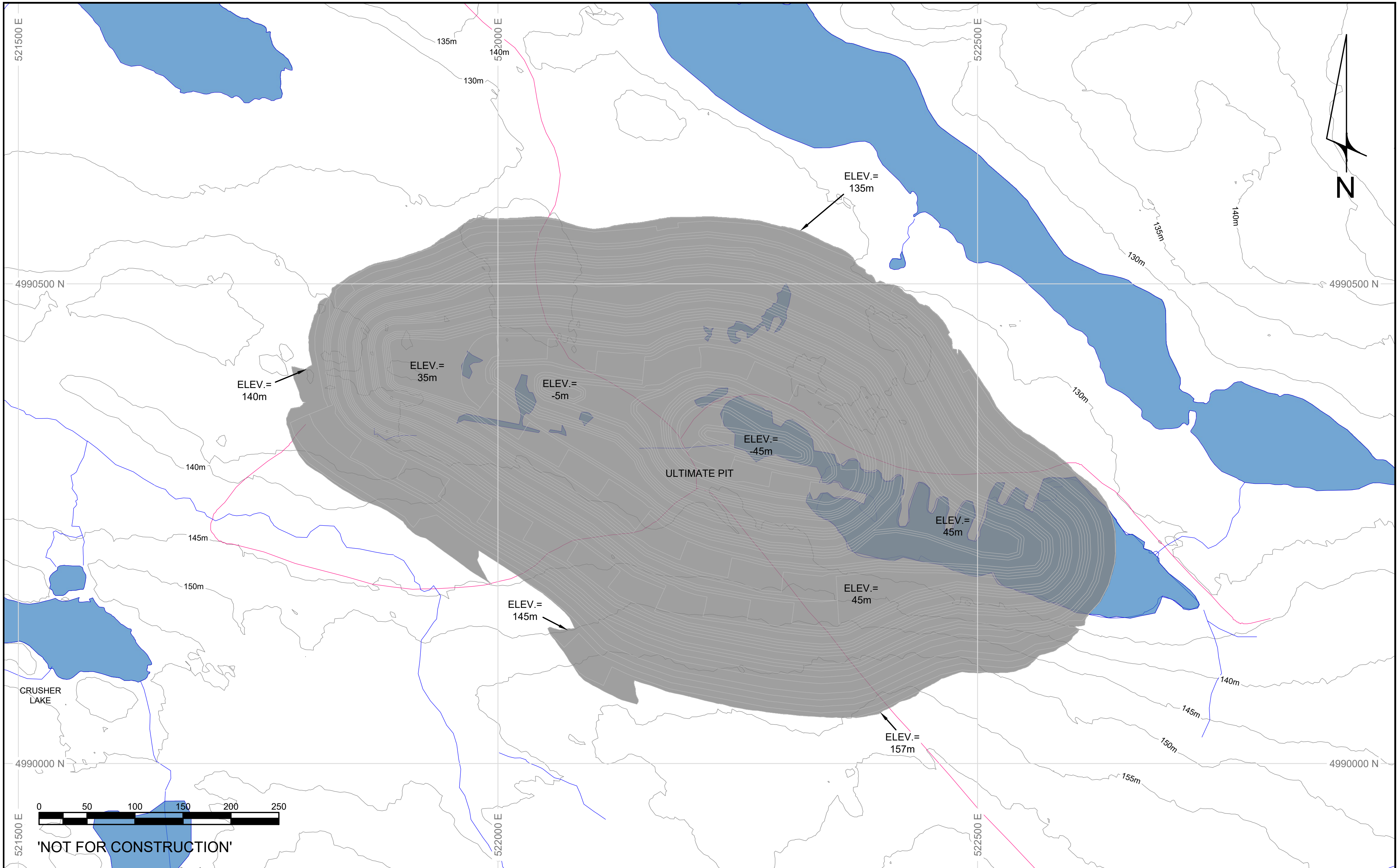
Table 3-3: Beaver Dam Mine Pit Slope Design Inputs

Domain	Elevation	Bench Face Angle (º)	Inter-ramp Angle (º)
Northwest	Overburden	37.0	27.0
Northwest	20 m below Overburden	60.0	46.0
Northwest	Main Zone Argillite	60.0	46.0
Northwest	Main Zone Greywacke	60.0	46.0
Northeast	Overburden	37.0	27.0
Northeast	20 m below Overburden	60.0	46.0
Northeast	Main Zone Argillite	60.0	46.0
Northeast	Main Zone Greywacke	60.0	46.0
East	Overburden	37.0	27.0
East	20 m below Overburden	60.0	42.0
East	Main Zone Argillite	60.0	46.0
East	Main Zone Greywacke	60.0	46.0
South	Overburden	37.0	27.0
South	20 m below Overburden	55.0	42.0
South	Main Zone Argillite	65.0	49.0

Table 3-3: Beaver Dam Mine Pit Slope Design Inputs

Domain	Elevation	Bench Face Angle (º)	Inter-ramp Angle (º)
South	Main Zone Greywacke	60.0	46.0
West	Overburden	37.0	27.0
West	20 m below Overburden	70.0	49.0
West	Main Zone Argillite	70.0	53.0
West	Main Zone Greywacke	70.0	53.0

Notes: m = metre; º = degree.



ATLANTIC GOLD - CLOSURE PLAN OPEN PIT PLAN VIEW			
DATE:	2021/10/14	APPR'D BY:	MS
DRAWN BY:	DH	FILE:	FIGURE 3-1
		PROJECT:	AG_BVD_2021

Moose Mountain Technical Services

Atlantic Gold
A St Barbara Ltd Company

LEGEND

- ULTIMATE PIT
- EXISTING ROADS
- LAKES
- WATERCOURSE
- TOPOGRAPHY

CONTOURS AT 5m INTERVALS

The pit will be actively dewatered during operation with the water from the pit pumped to the north settling pond. Details on water management during construction and operations are described in Section 3.6.

3.4 Permanent and Temporary Stockpiles

The stockpiles on the Beaver Dam Mine site consist of the following:

- NAG WRSA;
- PAG Stockpile;
- LGO stockpile;
- Topsoil Stockpiles;
- Till Stockpiles (TLS); and
- Organic Material Stockpile (OMS).

Table 3-4 summarizes the proposed stockpile locations including the waste rock storage area, potential acid generating stockpile and reclamation material stockpiles. Stockpiles are located to avoid water courses, surveyed lichen and lichen habitat buffer zones and the Crusher Lake buffer zone. They are also sited to minimize disturbance of surveyed wetland areas. The stockpile locations are shown on Figure 1-2. The following sections describe the general features and geotechnical stability considerations for each stockpile.

Table 3-4: Stockpile Locations and Design Criteria

Stockpile	General Description	Design Criteria				Bulk Density (t/m³)	Swell Factor	Placed Density
		Area (ha)	Maximum Crest Elevation (m)	Weight (Mt)	Volume (Mm³)			
Waste Rock Storage Area								
NAG Stockpile	Located in the most Western extent of site, accessed by existing public roadways off Beaver Dam Road.	60	190	34.28	16.32	2.73	30%	2.10
LGO Stockpile	Located in the Western portion of site directly East in near proximity to the NAG stockpile, accessed by existing public roadways off Beaver Dam Road.	12	170	2.45	1.17	2.73	30%	2.10
PAG Stockpile Area								
Potential Acid Generating (PAG) Stockpile	Located in the North-Central section of site, directly North of the originally proposed crusher pad, accessed by Beaver Dam Road.	10	180	2.19	1.04	2.73	30%	2.10

Table 3-4: Stockpile Locations and Design Criteria

Stockpile	General Description	Design Criteria				Bulk Density (t/m³)	Swell Factor	Placed Density
		Area (ha)	Maximum Crest Elevation (m)	Weight (Mt)	Volume (Mm³)			
Temporary Stockpiles								
Topsoil Stockpiles	Four small topsoil stockpiles are planned for the site. They are spaced across the site near areas requiring topsoil stripping.	10	165	1.10	0.55	2.00	0%	2.00
TLS	Two till stockpiles are planned. They are both located East of the in the Central-East end of site.	15	180	2.66	1.73	2.00	30%	1.54
OMS	Located on the South-East section of site, accessed by public roads off Beaver Dam Road.	31	165	2.29	1.49	2.00	30%	1.54

Source: Golder 2021b and AMNS 2021a.

Notes:

ha = hectares; m =meters Mt = million tonnes; Mm³ = million cubic metres; t/m³ = tonnes per cubic metre; % = percent; N/A = not applicable.
Totals values may not match lifts details in Table 3-5 due to significant figure rounding

3.4.1 Waste Rock

Waste rock generated during open pit development and will be used during operations for grading and construction of embankments, roads and other infrastructure. The waste rock stockpiles locations are located in areas to avoid water courses, surveyed lichen and lichen habitat buffer zones and the crusher lake buffer zone (AMNS 2021a). Stockpiles are also sited to minimize disturbance of surveyed wetland area. Waste rock not used for site development is stored permanently in the WRSA to be reclaimed at closure. The NAG WRSA stockpile is located to the northwest of the Beaver Dam Mine Site as shown on Figure 1-2. A PAG stockpile, situated immediately south of the pit (Figure 1-2), is designed to allow for closure drainage to be directed towards the pit. Preliminary waste rock characterization has been completed, with pit excavated materials tagged as PAG vs. NAG based on block model codes defined by 3D solids delineating PAG materials (AMNS 2021a).

During construction phase (< 1 yr), the waste rock stockpile will be used for storing LGO, which will then be reclaimed and sent to the ROM pad/Touquoy within Y1 or Y2 of the project. Afterwards, the footprint area will be filled with NAG waste rock.

3.4.1.1 NAG Stockpile

The NAG rock stockpile will consist of benches 10 m in height with approximate 4 m horizontal benches between each lift during construction. To facilitate stockpile development, the waste rock areas will have a 21 m wide dual lane haul road wrapping around the sides of facility for progressive access to all lifts, suitable for 64 t payload haulers. A 10% maximum grades on access haul ramps is included in the design. The waste rock slopes (between 4 m wide benches every 10 m vertical lift) will be graded during stockpile development to the closure slope of 3H:1V resulting in a final overall slope from crest to toe approximately 3.4H:1V. The footprint of the NAG stockpile depicted in Site layout figures (e.g., Figure 1-2) will increase slightly (expected to be approximately

10%) as a result of the design optimization and changes in the overburden/bedrock ratios. The footprint expansion will avoid environmentally sensitive areas and minimize changes to the water management associated with the piles. Slope stability analysis of the WRSF indicates that the overall crest to toe slope of the waste rock stockpiles should be 3.1H:1V or flatter (Golder, 2021b). The slope stability report recommended that the stockpile could be constructed to elevation 190 masl using the geometry above and satisfy the stability requirements. In accordance with the Golder (2021b) recommendations, development of the stockpile to the final design elevation will require monitoring and surveillance during construction. Stability analysis will be completed by a professional engineer and provided to NSECC/DEM if the stockpile exceeds elevation 190 masl.

The NAG WRSA size is sufficient to store all the NAG waste rock associated with the current Mineral Reserve estimate. As operational infill drilling and economic parameters of the project evolve some of this NAG waste rock may be converted to Mineral Reserve. The current sizing of the NAG WRSA reflects estimates of this conversion, based on experience learned at the Touquoy operations. As the project evolves, the quantity of this conversion may not match this estimate but the size of the NAG WRSA should not be exceeded. If currently defined waste rock is converted to Mineral Reserves, then the LGO footprint will be used to store this material, and it may eventually be transported to Touquoy for final processing.

3.4.1.2 Potential Acid Generating Stockpile

The PAG stockpile is located in the north-central section of site south of the open pit (Figure 1-2). As noted above, preliminary waste rock characterization has been completed, with pit excavated materials tagged as PAG vs. NAG based on block model codes defined by 3D solids delineating PAG materials. The PAG stockpile has been designed to store 2.19 Mt of PAG within 10 ha footprint (Table 3-4). The design includes a 180 masl maximum crest elevation (Table 3-4). Similar to the NAG waste rock stockpile, the PAG stockpile will constructed with 4 m wide benches every 10 m vertical lift with 3H:1V inter-bench slopes resulting in an overall crest to toe slope approximately 3.4H:1V. Slope stability analysis indicates that the overall crest to toe slope of the waste rock stockpiles should be 3.1H:1V or flatter (Golder, 2021b). The footprint of the PAG stockpile depicted in Site layout figures (e.g., Figure 1-2) will increase slightly (expected to be approximately 10%) as a result of the design optimization and changes in the overburden/bedrock ratios. The footprint expansion will avoid environmentally sensitive areas and minimize changes to the water management associated with the piles.

During construction, historic tailings and waste rock (if any) designated as PAG will be either temporarily or permanently stored in the footprint of the PAG area. It is anticipated that the historic tailings mixed with overburden will be removed stored in the mined-out Touquoy Pit. Additional details on historic tailings are provided in Section 3.5.

3.4.2 Temporary Stockpiles

3.4.2.1 Low Grade Ore Stockpile

The LGO stockpile is located adjacent to the NAG Stockpiles with a footprint of 12 ha and is designed to achieve a maximum elevation of 170 masl (Table 3-4). When ore is mined from the pit it will either be delivered to the ROM pad or the "low grade ore" stockpile footprint. During the initial stages of pit development, ore encountered will be stockpiled within the LGO stockpile footprint. This material, <200 kilo tonnes (kt) estimated, is planned to be rehandled to the ROM pad. The LGO stockpile will then be covered with NAG waste rock mined later in the mine life.

3.4.2.2 Topsoil Stockpile

Four topsoil stockpiles are planned for the site and are spaced across the site near areas requiring topsoil stripping (Figure 1-2). Topsoil will be salvaged as required from all disturbed areas and stockpiled in designated areas. An average topsoil thickness of

0.3 m has been assumed for all disturbed areas. The total disturbance for topsoil stockpiles is 15 ha with a design crest height maximum of 165 m and total storage capacity of 1.10 Mt and 0.55 Mm^3 (Table 3-4). The topsoil lifts will be 5 m and 3:1 slope.

Table 3-5 provides a summary of the capacity of each topsoil stockpile, which are designed to store materials salvaged from the waste and ore stockpile footprints, as well as from the haul road footprints. Where possible, the topsoil materials will be temporarily windrowed directly outside the design footprints, rather than hauled to these stockpiles. The windrow locations will be determined based on field conditions at the time of excavation to minimize the haulage and rehandling of material. An annual or light seeding will be applied to limit erosion and potential suspended solids. Drainage ditches will be established around the stockpile and water collect will be directed to settling ponds, which are described in Water Management (Section 3.6). The topsoil stockpiles will be partially reused for reclamation activities.

Table 3-5: Topsoil Storage Capacities

Source	Area (m^2)	Topsoil Volume (BCM)	Placed Volume (MLCM)	Planned Pile
Open Pit	314,000	94,200	0.11	North Pit Pile
Non-acid generating stockpile Haul Roads	829,000	248,700	0.34	North SP Pile
PAG SP	98,000	29,400	0.07	South Pit Pile
Crusher Area	120,300	36,100	0.03	South Site Pile

Note: m^2 = square metres; BCM = bank cubic metres; MLCM = million loose cubic metres; SP = stockpile; PAG = potential acid generating.

3.4.2.3 Till Stockpiles

Two till stockpiles are planned (i.e., west and east) and they are both located east of the in the Central-East end of site (Table 3-4 and Figure 1-2). Till is defined as all materials between the topography surface and the bedrock contact surface, minus estimates for topsoil. Updates to bedrock contact surface have recently been made that will be included in future designs. The altered surface will be incorporated into an updated till quantity estimate during the detailed mine planning stage of the Project. The planned lifts for till stockpiles will be 10 m and a 17 m berm allowances for access around each lift. An overall slope range of 3:1 will be established once berms and ramps are completed. Table 3-6 provides the lift top elevation, volume, and capacity. A portion of the till materials, related to the historic tailings and contamination from historic workings, is planned to be stored in the PAG stockpile location, however, the majority of historic tailings, as discussed in Section 3.5, will be managed on site with the PAG waste rock generated at the Beaver Dam site.

An annual or light seeding will be applied to limit erosion and potential suspended solids. Drainage ditches will be established around the stockpile and water collect will be directed to settling ponds, which are described in Water Management (Section 3.6). The till stockpiles will be partially reused for reclamation activities.

Table 3-6: Till Storage Capacities

Lift top Elevation (m)	West Till Capacity (Mt)	West Till Cumulative Capacity (Mt)	East Till Capacity (Mt)	East Till Cumulative Capacity (Mt)
150	0.15	0.15		
160	0.30	0.45	0.27	0.27
170	0.24	0.69	0.96	1.24
180			0.73	1.97

Notes: m = metre; Mt = million tonne.

3.4.2.4 Organic Material Stockpile

One organic stockpile is planned for the site, which is located on the south-east section of site. Organics will be salvaged as required from all disturbed areas and stockpiled in designated areas. The total disturbance for topsoil stockpiles is 31 ha with a design crest height maximum of 165 m (Table 3-7). The organic lifts will be 5 m and 7:1 slope. A 20 m berm allowance is included in the design. Table 3-8 provides a summary of the organic lift capacities. The organic material stockpile will be partially reused for reclamation activities.

An annual or light seeding will be applied to limit erosion and potential suspended solids. Drainage ditches will be established around the stockpile and water collected will be directed to settling ponds, which are described in Water Management (Section 3.6).

Table 3-7: Organic Storage Capacities

Lift top Elevation (m)	Organic Till Capacity (Mt)	Organic Till Cumulative Capacity (Mt)
160	0.85	0.85
165	1.45	2.30

Notes: m = metre; Mt = million tonne.

3.5 Historic Tailings

Historic tailings have been deposited within the footprint of the open pit and will be excavated early in the mine life. Estimated quantities of 50,000 tonnes of historic tailings are described in AMNS (2021a) Historic Tailings Quantities Estimate. Based on historical records 50,000 tonnes past ore were extracted from the Site. However, DEM (email dated June 15, 2021) indicated that 41,119 tonnes of ore extracted from 1986-89 were milled off site at Gays River. Therefore, the initial estimate of ore processing, and resulting tailings production, on-site is estimated at 10,000 tonnes. Based on the field survey completed by Nova Scotia Department of Natural Resources the tailings area is 9,150 m^2 and using an assumed depth of 2.5 m of mixed tailings and overburden within this area and a deposited density of 2.0 t/m^3 the historic tailings mixed with overburden is estimated to be approximately 50,000 tonnes. The actual mass of tailings mixed with overburden will be further delineated and confirmed during excavation.

The estimated volume of historic tailings (up to 50,000 tonnes, although could be less according to DNRR) represents approximately 2.3 % of the PAG waste rock by mass. Historic tailings will be placed temporarily on the PAG stockpile, then re-handled to Touquoy pit within the first few years of Beaver Dam operation.

This quantity occurs above the bedrock contact surface and therefore has been measured as part of the overall till quantities coming out of the open pit. An allowance has been made for a further 350,000 tonnes of till materials to be potentially affected by the historic tailings and historic mine operations.

An Historic Tailings Management Plan and a Potential Acid Generating Management Plan have been prepared for the Project to monitor and update estimates when construction and operations commence.

3.6 Water Management

3.6.1 Water Management Objectives and Strategies

The objective of the water management plan is to support and guide mine water management through the construction, operation, and closure stages of Mine development. The primary objectives of water management at the Mine Site are to reduce operational risks and environmental impacts of the Mine. The following strategies are planned to achieve the primary objectives:

- mitigate water quality and quantity impacts on receiving waters;
- reduce the water inventory at the Mine Site through off-site drainage of non-mine contact water;
- incorporate system flexibility to manage water under variable climatic conditions;
- reduce water quality monitoring requirements through the establishment of minimal effluent discharge points; and
- provide an effective adaptive monitoring program to manage mine water quantity and quality, throughout various stages of Mine Site development and maintain the Mine in compliance with regulatory requirements and approval conditions.

The Mine Water Management Plan provides an overview of the water supply source, water management, and water treatment associated to the Mine Site.

3.6.2 Natural Waterbodies and Water Courses Considerations

There are a number of sensitive receptors on or adjacent to the Beaver Dam Mine Site that require protection from sediment-laden runoff generated during Mine Site development and operations. The sensitive receptors include:

- Cameron Flowage and the Killag River System;
- Mud Lake;
- Crusher Lake;
- Tent Brook; and
- Cope Brook.

These receptors are to be protected from sediment impacts due to development of the Beaver Dam Mine Site.

3.6.3 Water Management Facilities

The mine water management plan encompasses the main water management facilities is depicted on Figure 3-2 and described in further detail below:

- **Runoff Collection Ditches and Culverts |** The surface water lined ditches include contact water ditches that collect runoff from all mine infrastructure, and clean water unlined ditches that collect water from adjacent undisturbed lands and direct it away from the Mine Site. Culverts are located throughout the Mine Site to convey stormwater below roads and mine infrastructure. The contact water ditches drain to one of four settling ponds located across the Mine Site.
- **North Settling Pond |** The north settling pond is located northwest of the open pit and will collect mine contact surface water runoff and seepage from the crusher pad and administrative areas, the LGO, NAG, and PAG

stockpiles, two topsoil stockpiles, and the site roads surrounding these facilities. It will also receive the pumped water from the historic tailings area during the construction phase and the pumped pit dewatering during operations.

- **Mine Infrastructure Area (MIA) Runoff Pond |** The runoff pond is located between the administrative areas and ROM/crusher pad. Contact water run-off from the plant pads will be collected and diverted to the collection pond. Stormwater run-off that does not come in contact with the plant pads, is considered clean and is directed away from the plant site. The MIA Runoff Pond is sized to contain the run-off from the MIA Pad, Loading Pad and Trucking Contractor's Laydown and delays the peak flow into the project's overall water management network. The runoff pond reports to the North Settling Pond.
- **East Settling Pond** | The east settling pond is located southeast of the open pit next to Cameron Flowage, and will collect surface water runoff and seepage from the till stockpiles and a portion of the organic material stockpile. The primary purpose of the east settling pond is to reduce the total suspended solids (TSS) levels to acceptable limits, and control stormwater runoff.
- **South Settling Pond** | The south settling pond is located at the southeastern edge of the Mine Site and will collect surface water runoff and seepage from a portion of the organic materials stockpile and one topsoil stockpile. The primary purpose of the south settling pond is to reduce the TSS levels to acceptable limits, and control stormwater runoff.
- **Pumping Systems |** There will be several portable back up pumps located across the Mine Site to deal with any potential pooling of water. The pumps will be moved around the Mine Site as needed to dewater ponded water.
- **Water Treatment System** | The WTS is located immediately downstream of the north settling pond and will be the primary location for water treatment of mine contact water for the Mine Site at each stage of the Mine. Discharge from the WTS will meet the regulatory requirements for end-of-pipe discharge.

The Water Management Plan is provided in (GHD 2021a), attached as Appendix 3 and summarized below. The settling ponds cover a surface area of approximately 4.5 ha.

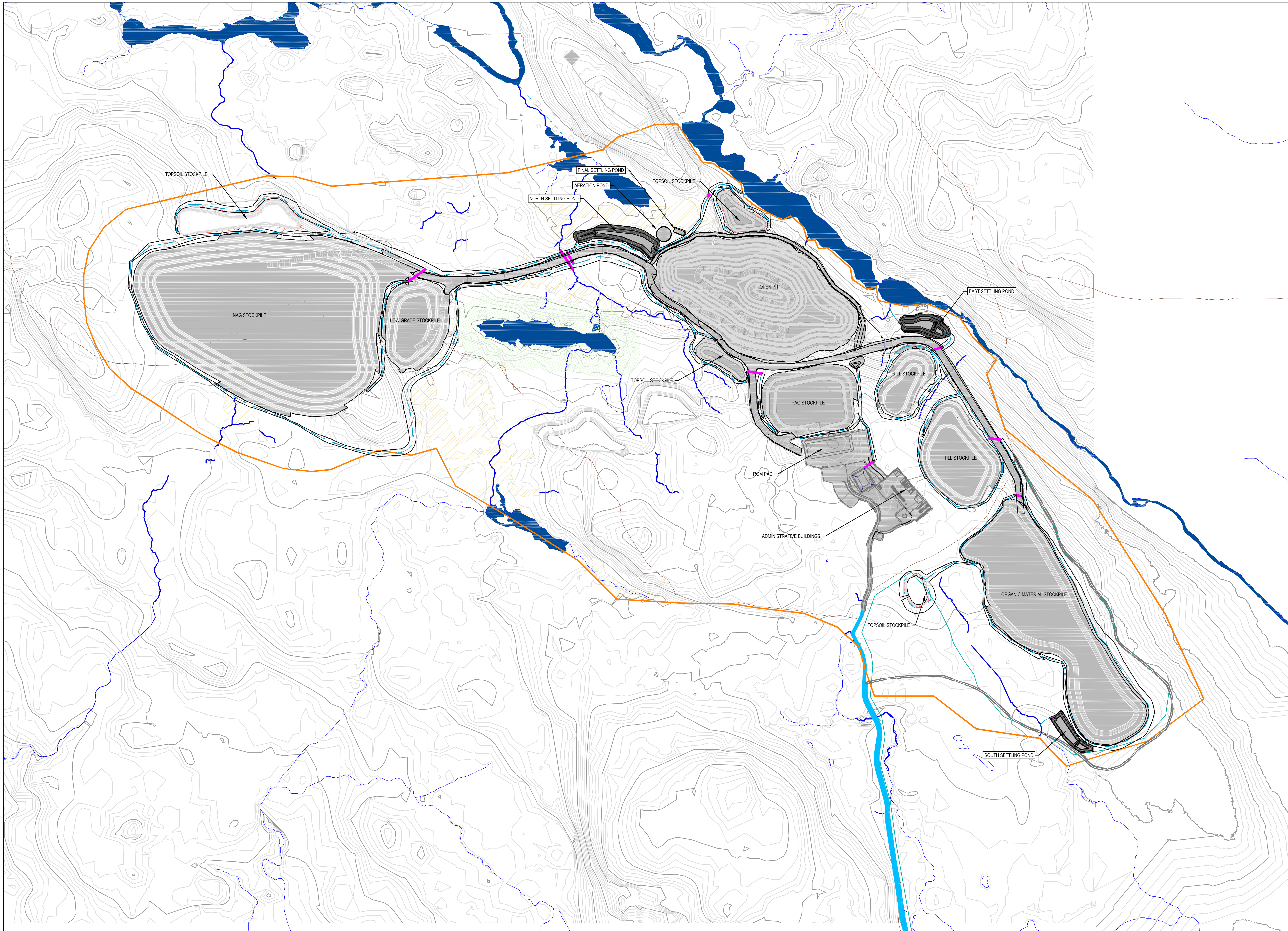
3.6.3.1 Collection Ditches and Culverts

A series of surface water ditches and culverts collecting all Site stormwater runoff. The surface water ditches include contact water ditches (approximately 15 ha), which collect runoff from all mine infrastructure, and clean water ditches (approximately 2 ha). The surface water ditches all include clean water diversion ditches, which collect water from adjacent undisturbed lands and direct it away from the Site. Culverts are dispersed throughout the Site to convey stormwater below mine infrastructure (i.e., haul roads). The contact water ditches drain to one of three settling ponds located across the Site.

Each ditch will be trapezoidal in section with 3H:1V side slopes and bottom widths and depths ranging from approximately 0.5 to 2 mbgs. Ditch slopes range between 0.3% and 7.5% depending on the location across the Site. Ditches will be excavated into the existing overburden and/or bedrock or formed by grading existing surface material to form the required channel cross-section. All excess material used to grade the channel to the required cross-section will be sloped to existing ground at a 3H:1V slope. The exposed slopes will be covered with a bio-degradable erosion control matting and seeded upon reaching finished grade to prevent erosion of these previously disturbed areas.

Contact water ditches will be lined with an HDPE liner followed by a layer of sand and a layer of riprap to prevent infiltration of stormwater into the surficial groundwater and protect the ditch from erosion. The riprap layer in the liner system will be sized appropriately to prevent erosion during the 1 in 100-year 24 hour climate change adjusted storm event. Detailed riprap requirements will be determined during later design stages. Rock check dams will be put in place on ditches that have a slope of greater than 3% in addition to the riprap layer to prevent erosion. Rock check dams reduce the overall slope of the water surface, reducing the potential for erosion. Rock check dams also allow time for suspended sediment to settle out prior to reaching the settling pond. The ditches leaving the settling ponds will contain clean water following TSS removal and any additional required water treatment via the WTS in the case of the north settling pond. The outlet of the effluent ditch into the receiving watercourse will be lined with riprap to prevent erosion. Detailed outlet design will be determined during later design stages.

Culverts are to be circular corrugated steel pipe (CSP) culverts with diameters ranging from 600 mm to 1600 mm and lengths between 30 m and 50 m. Culvert slopes range between 0.5% and 7% across the Site. Each culvert will include a riprap apron on the upstream and downstream sides of the culvert to prevent erosion around the inlet and outlet. The outlet riprap aprons are designed to include an energy dissipation basin. The energy dissipation reduces velocities in the downstream ditch, reducing the potential for erosion. The energy dissipation basin is to be lined with riprap specifically sized to withstand culvert exit velocities and reduce flow velocity downstream of the culvert.



SOURCE: EXISTING SURFACE FROM FILE "DEM_10m.thw" - DATED 2018, MINE INFRASTRUCTURE REC'D FROM CLIENT MULTIPLE FILE - DATE RANGING FROM JAN 11, 2021 TO MARCH 11, 2021.

Plot Date: 7 July 2021 - 1:10 PM Plotted By: Jason Spenler CAD File: N:\CA\Waterloo\Legacy\CAD\drawings\88000s\88664\88664-reports\88664-50(000)\88664-50(000)CI\88664-50(000)CI-WA003.dwg

LEGEND

- HAUL ROUTE
- BEAVER DAM MINE PROPERTY BOUNDARY
- PROPOSED CONTACT WATER DITCH
- PROPOSED CLEAN WATER DITCH
- PROPOSED CULVERT
- SETBACK

Scale: 1:7500	Bar is 20mm on original size drawing 0 20mm
Original Size: ANSI D	

ATLANTIC MINING NS INC.
BEAVER DAM, NOVA SCOTIA

Project

BEAVER NAM MINE PROJECT

Figure

3-2. Planned Water Management

Figure Reference:

Figure created originally by GHD Limited
Feasibility Study
Site Plan Proposed Condition Figure.
July 7, 2021

The Site haul road crosses over top of WC-5, the watercourse leading from Crusher Lake to Mud Lake. In order to prevent disruption of the natural flow path, clean water ditches will collect surface water runoff on the south side of the haul road and drain this runoff back towards WC-5. WC-5 will be channelized in a culvert below the haul road for 50 m. The outlet of the WC-5 culvert will have an energy dissipation basin to reduce channel velocities and promote fish passage through the culvert. The contact water ditches will pass overtop of the WC-5 culvert. As with all other sections of the ditch, the contact water ditch in this area will be lined with an HDPE liner to prevent infiltration of contact water into the adjacent watercourse.

A cost review near the conclusion of the study has resulted in the following two optimizations:

- Reduced rock and sand layers in locations less likely to see sediment accumulation; and
- Use of SmartDitch in non-permanent contact water ditch between PAG and North Settling Pond.

There also remains an opportunity to use clay-lined ditches in place of HDPE lined ditches, with potential for cost savings. This concept requires further study before potential implementation.

3.6.3.2 Settling Ponds

Settling ponds will be constructed to collect and treat contact water prior to discharging to Cameron Flowage. Collection ponds are included for runoff from the NAG Waste Rock Stockpile, PAG Waste Rock Stockpile, Till Stockpile, LGO Stockpile, Organics Stockpile and Crusher Pad/administrative building area. The ponds were designed to maintain a 0.3m freeboard during the 1 in 100-year 24-hour climate change adjusted design storm event. All ponds were also designed with an emergency overflow spillway sized to convey Hurricane Beth sized storm event.

It is anticipated that the settling ponds will be excavated into the existing overburden. Due to the depth to bedrock in the areas of the settling ponds (approximately 4 o 7 mbgs depending on location) it is not anticipated that drilling or blasting into the bedrock will be required. The settling ponds will be lined with a similar liner to the contact water ditches including an HDPE liner and a sand and riprap layer. Due to the high groundwater elevation near the settling ponds (slightly above the bottom of pond invert in the east settling pond) the riprap layer will also act as a ballast to prevent the liner from being impact by buoyancy forces of the nearby groundwater. The ponds will be trapezoidal in cross-section with 3H:1V side slopes. The maximum depth in the ponds varies between 3.5 m and 5.5 m, depending on the location. Settling pond dimensions vary from 45 m to 60 m in width and between 200 m and 325 m in length. Two of the settling ponds (north settling pond and east settling pond) will be classified as dams due to the north embankment berm exceeding the 2.5 m height threshold.

To assist with the removal of TSS from the stormwater runoff, each settling pond is to contain a gravel filter berm. The filter berm will consist of a gravel core with an outer riprap layer to provide erosion protection. Geotextile will be placed between the riprap layer and the gravel core to assist with TSS removal and separate the two material layers. In addition, the settling ponds have been designed to contain the 25mm 4-hour storm event, 1 in 10 year 24-hour climate change adjusted design storm and 1 in 100-year 24-hour climate change adjusted design storm events for a minimum of 24 hours. A detention time of 24 hours allows for suspended particles to settle prior to discharge from the settling pond into the natural environment.

The settling ponds each consist of a concrete outlet structure and emergency overflow spillway. The concrete outlet structure will control storm events up to and including the 1 in 100-year, 24 hour climate change adjusted design storm event through a series of orifices and an overflow weir. The concrete outlet structures will be surrounded with a layer of riprap in order to recue exit velocities and further assist with TSS settling. The emergency overflow channel will convey flows resulting from storm events greater than the 1 in 100 year, 24-hour climate change adjusted design storm event, up to and including Hurricane Beth. The north settling pond will direct the emergency overflow spillway towards the open pit. Directing the overflow spillway towards the open pit will ensure no uncontrolled discharges occur from the Site. Effluent from the north settling pond will pass through the water treatment system prior to discharge into Cameron Flowage. All settling ponds will discharge effluent at concentrations below the federal MDMER regulations as per the Fisheries Act.

3.6.3.3 Pump Systems and Pipelines

A collection pond will be situated on the northeast side of the PAG stockpile. A pump and pipeline system will convey stormwater from the collection pond to the north settling pond. In addition to the PAG stockpile pump and pipeline system there will be portable back up pumps located across the site to deal with any potential pooling of water. The pumps will be moved around the Site as needed to dewater ponded water. The PAG stockpile pump system will consist of a single permanent pump, sized to convey the runoff generated from up to a 1 in 2-year 24-hour climate change adjusted storm event. In the event that a storm event greater than the 1 in 2-year climate change adjusted storm event occurs then back up pumps will be brought to the PAG stockpile collection pond to assist with pumping. Mine water from dewatering the open pit will be collected in In-Pit sumps and pumped to the north settling pond.

3.6.3.4 Erosion and Sediment Control Measures

Erosion control measures in the contact water ditches and settling ponds are to be maintained during operations including replacement of riprap, restoration of check dams if damaged and general visual inspection of the ditches and settling ponds. Experience at the Touquoy Mine indicates that significant sediment build up could occur in the collection ditches. The contact water ditches should be inspected regularly and cleaned out as needed to ensure sediment does not build up within the ditches or travel directly into the settling pond, reducing the available storage volume of the settling pond itself.

3.6.3.5 Contact Water Treatment

All potentially impacted water will be directed towards the north settling pond and the associated WTS. The water quality assessment also indicated that nitrite level will be the only exceeded CCME guideline parameter for the EOM scenario. The east and south settling ponds are not anticipated to experience water quality concerns, however, regular monitoring will take place in these ponds as a part of federal MDMER regulations. If water quality exceedances occur in the east or south settling pond, a shut off valve on the pond outlet will be closed and the water will be pumped to the north settling pond and WTS for treatment.

3.6.3.6 Construction Water Treatment System Alternative

It is expected that metals such as aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, mercury, lead, and zinc may be among the elements that potentially need treatment during the construction stage. Also, most of the metals are likely attached to suspended solids, suggesting that a significant fraction of the metals could be removed by physical filtration. Aeration, lime softening, followed by coagulation, media and GAC filtration is proposed as the alternative WTS for the construction phase. This system includes an aeration phase at the beginning of the treatment train, which will help to oxidize metals and will reduce chemical demand in the downstream units.

In the first step, collected contaminated water will be stored in a Frac tank sized to provide an approximate one-hour retention time for aeration purposes. The effluent will be monitored for pH, turbidity, and its flow recorded prior to discharge. There will be a sample port at the final effluent discharge line for sampling and monitoring purposes. The selected alternative technology will be tested in a bench-scale study before implementing the full-scale treatment system to identify optimum chemical conditioning parameters such as aeration rate and chemical dosing rates. This will inform the Standard Operating Procedures that will be developed before implementation.

3.6.3.7 Operation Water Treatment System Assessment

The proposed aeration treatment pond for nitrate reduction would consist of three ponds. The first Settling Pond will act as an equalization pond and capture the high influent water volumes during storm events. Furthermore, this pond will help to reduce total suspended particles by allowing settling. A coagulant injection point will be considered at the influent stream to the first pond to be used in case of high suspended solids concentrations or during large storm events to help accelerating precipitation of suspended solids. Water will then flow by gravity to an aeration pond, the air will be introduced by electrically powered surface agitators to oxidize nitrite, as well as metals. Next, the water will flow by gravity to the third pond for resettling of suspended particles that are generated as the results of oxidation in the second pond.

It is expected that the concentration of nitrite and metals will be below discharge limits during large storm events. For that reason, a bypass ditch will be designed to directly discharge the water from the first pond after removal of suspended particles. The selected nitrite removal technology will likely be tested in a bench-scale or pilot-scale before designing the full-scale treatment system. In addition, to address elevated arsenic concentration during operation phase, the water treatment system of construction phase will be used as contingency in case of higher metals concentrations during operation phase. If the aeration treatment pond's final effluent does not meet the discharge objectives, the water could be pumped into the water treatment train to address high metal concentrations.

3.7 Mine Development Stages

3.7.1 Construction

Spanning a duration of one year, activities are mainly focused on Mine Site preparation and construction. Mine Site preparation includes clearing, grubbing, and grading, drilling and rock blasting, establishment of temporary stockpiles (i.e., topsoil, till, and organics) and waste rock stockpiles (i.e., NAG, and PAG), LGO stockpile and the dewatering of the existing settling pond. Construction activities include watercourse and wetland alteration, Mine Site road construction, surface infrastructure construction and installation, pit pre-stripping and surface water ditch and settling pond construction.

Construction is when the majority of the Mine Site development outside of the open pit is to occur including clearing, grubbing, and stockpiling of overburden soils. During this time not all mine water infrastructure will be constructed. To prevent discharge of sediment laden water from the Mine Site during construction the first piece of site infrastructure to be constructed will be the north settling pond. All site water will be directed towards the north settling pond (via an expanding network of surface water ditches or pumping) prior to discharge until the east settling pond and south settling pond have been constructed. The north settling pond is to be constructed prior to any clearing or grubbing in preparation for construction of other components of the Mine Site.

Following the development of the north settling pond, other aspects of the Mine will be developed including the open pit, administrative areas, and site roads. Prior to the development of other aspects of the Mine the associated mine water infrastructure components are to be developed as well. For example, prior to clearing, grubbing and development of the till and organics stockpile areas the east and south settling ponds must be developed first. The contact water ditch network is to be developed in conjunction with the stockpile and road development, starting at the downstream end and working upstream.

3.7.2 Operations

Spanning a duration of four years, activities are mainly focused on mining and maintenance activities. These include drilling and rock blasting, pit dewatering, ore management, waste rock management, surface water management, dust and noise management, petroleum products management and Mine Site maintenance and repairs.

Water management during the operations phase will mainly include collection and management of mine water (surface and open pit). The surface water at the Mine Site will be managed so that runoff from all project component areas, including the crusher pad, material stockpiles and open pit, are collected and diverted to one of four settling ponds on-site.

Open pit mine water will be collected in In-Pit sumps and pumped to the north settling pond where it will be treated and tested to ensure it meets discharge criteria prior to release into the environment.

4 CLOSURE PLAN

Specific objectives, criteria, planned reclamation activities and performance monitoring to achieve the closure goals are also outlined in Table 4-1. Final land use is discussed in Section 4.1 and Sections 4.2, 4.3 and 4.4 provide a more detailed description of the closure activities, progressive reclamation opportunities and planned research studies, and post-closure monitoring.

4.1 Final Land Use

The objective / goal of the reclamation is to return the physical, chemical, and biological qualities of the land and water regimes disturbed by the Project to a state that is safe, stable, and compatible with the surrounding landscape. At present a final land use for the site has not been identified, nor has it been determined if the land will be leased or purchased from Northern Timber. The plan is to establish an ad hoc committee to confirm the final land use and provide input into final closure. Table 4.1 presents an overview of preliminary closure objectives and criteria for each of the major mine components as well as the post closure activities and monitoring that will be required to achieve these objectives.

AMNS acknowledges that the final land use of the Crown lands will require approval and the acceptance by Nova Scotia Department of Lands and Forestry (NSLF), Nova Scotia Environment and Climate Change (NSECC) and the Nova Scotia Department of Energy and Mines (NSDEM).

4.1.1 Engagement

Initial land use activities identified by stakeholders for the post-mining landscape included outdoor recreation, commercial forestry and traditional land uses (AMNS 2021a). Specific engagement is summarized below.

Continued engagement with the public and traditional land users regarding the mine's operational and closure planning will be undertaken through a combination of groups, including but not limited to:

- Millbrook First Nations;
- Mi'kmaq of Nova Scotia;
- Community Liaison Committee (CLC); and
- Reclamation and Closure working group that is anticipated to include representatives from members of the public, ATV association and other stakeholder groups.

It is anticipated, based on the results of this ongoing engagement, that the final land use concepts during post-closure will continue to evolve. It should be noted that future land use will need to comply with some restrictions related to minimizing disturbance and maintaining the structural, chemical and biological integrity of some of the closure measures. A description of the current closure vision for each major mine component is included in Table 4-1 below.

AMNS acknowledges that changes to this reclamation plan will require review and approval by DEM and ECC, as well as Lands and Forestry should the changes affect crown lands.

4.1.2 Signage and Public Safety

Once operations at the Beaver Dam Mine is complete and final reclamation plan is approved signage will be placed on site to alter the public that the site is actively being reclaimed. The signage will be posted at all entry locations (roads and trails) as well as at the locations where active reclamation is being undertaken. The signage will include a contact telephone number, email and website address to address questions or concerns. In addition to signage and a berm will be placed to prevent vehicular entry and or pedestrian access to areas where there are excessive slopes and or exposed excavations during active closure activities as the pit shell is refined based on additional information on the overburden and bedrock elevations. For the purpose of the closure cost estimate a berm around the full pit perimeter has been assumed.

Table 4-1: Overview of Preliminary Closure Objectives/Criteria

Mine Component	Closure Vision	Closure Objective	Closure Criteria	Primary Reclamation Activity	Post-Closure Inspection/Monitoring	Notable Uncertainty/ Research
Administration and Ancillary Areas	The Mill Site will have all buildings, equipment, and related items removed, and the area will be revegetated. The area will be safe for the public to use for potentially outdoor recreation.	Physical Stability	Buildings and equipment removed. Soil capping and revegetation treatments demonstrate early succession has been successful. No signs of significant erosion or sloughing prior to revegetation cover establishment.	Buildings demolished and removed from site. Equipment and other infrastructure removed from site. Surfaces graded and seeding/planting to allow drainage and prevent erosion.	Periodic inspections by a professional engineer will be completed.	No major uncertainties.
		Chemical Stability	Confirmatory soil sampling and ESA (as required) have been completed and results accepted by NSE. Runoff water quality is suitable for discharge to surrounding area.	Removal of impacted soils (if required) as recommended by the confirmatory soil sampling program and/or ESA.	Confirmatory soil sampling and ESA (as required) have been completed. Surface water quality monitoring completed in adjacent watercourses.	
		Ecological and Land Use	Wildlife and the public can travel across the area safely.	Following building removal, area is graded, soil cover placed and revegetated.	Vegetation and soil monitoring will be completed.	
Open Pit and Spillway	The Open Pit will flood, and overflow will discharge to Cameron Flowage/Killag River via an engineered spillway. The shoreline will be designed with shallow grading at the predicted water level to allow safe egress for wildlife, and a shallow water zone that can provide riparian and wetland habitat. The existing mine ramp at the northeast shoreline will be maintained to allow safe access to the pit lake. The presence of self- sustaining fish populations is not intended and will be limited. The riparian zone and shallow water may provide habitat for avifauna, amphibians, and other species.	Physical Stability	Final conditions of the open pit walls, overburden slopes and spillway (once constructed) are confirmed to be within approved design constraints by a professional engineer. No visual indications of significant deformation and degradation is observed during a final inspection by a professional engineer.	Annual geotechnical inspections will be completed during the mine's operation to manage pit wall stability prior to final closure. The overburden bench and barrier berm materials will be re-sloped.	Periodic inspections by a professional engineer will be completed.	No major uncertainties.
		Chemical Stability	Water quality in the Pit Lake demonstrates a stable and/or decreasing trend and meets approved criteria. Decant elevation is suitable for discharge to Cameron Flowage/Killag River.	Dewatering will cease at the end of mining and the pit will be allowed to flood, eventually discharging via spillway to Cameron Flowage/Killag River.	Pit water quality and water levels will be monitored during flooding, and after discharge to Cameron Flowage/Killag River via spillway.	Pit flooding timelines and the Pit Lake water quality are uncertain. These processes will be assessed as part of ongoing monitoring and updated predictions completed prior to closure and during flooding.
		Ecological and Land Use	Safe access and egress options are available where practical to the Pit Lake once flooding is complete. Shallow water zones (< 5 mbgs) are created along the Pit Lake perimeter where practical.to provide options for ecosystem restoration design.	Retreat blasting and benching and waste rock deposition is completed to allow construction of a shallow water zone where practical along the Pit perimeter. Final Pit slopes and shoreline are approved by a professional engineer.	Periodic inspections by a professional engineer will be completed.	The post-closure aquatic habitat quality and quantity is uncertain. As predictions for post-closure pit lake water quality are refined, options for riparian and littoral zone habitat enhancement will be considered for various flora and fauna.
Waste Rock Storage Area	The WRSA will consist of benched outer slopes and be revegetated, likely resembling a grass/shrub land and/or open meadow condition.	Physical Stability	Inspection and monitoring results indicate structures are stable and performing as intended. Soil cover is stabilized by means of a sustainable vegetative cover. Acceptable rates of erosion are observed, soil/vegetation cover is not adversely affecting the surrounding environment.	Design and construction of the WRSA within the approved design. Geotechnical stability analysis to be updated as required as part of the detailed design. Detailed design is signed by a professional engineer. The WRSA will be re-sloped progressively during mining, the final lift will be completed at closure. A soil cover is placed and revegetated to reduce erosion concerns to acceptable levels. Detailed design includes surface grading and drainage structures that will prevent erosion.	Periodic inspections by a professional engineer and vegetation specialist will be completed.	Desktop studies are planned to complete numerical simulations for runoff on the existing WRSA shape and identify any areas of erosion concern during construction and closure. Vegetation Trails at Touquoy and Beaver Dam will inform effective methods for establishing a vegetated cover.
		Chemical Stability	Water quality of runoff and seepage discharging from WRSA to perimeter ditches and WC-4 demonstrates a stable and/or decreasing trend and meets approved criteria.	Deposition of waste rock will occur as designed. Construction of a revegetated soil cover, properly graded, will reduce infiltration rates and water-rock interactions.	Surface water and groundwater monitoring will be completed through operations and following final sloping and soil cover placement.	Water quantity and quality of the runoff and seepage discharge from the WRSA are uncertain. These processes will be assessed as part of ongoing monitoring and updated predictions prior to closure.
		Ecological and Land Use	Wildlife travel and forage, and public use for safe outdoor recreation activities that can be conducted across the WRSA.	Construction of a revegetated soil cover at the WRSA surface.	Periodic inspections by a professional engineer and vegetation specialist will be completed.	No major uncertainties.

Table 4-1: Overview of Preliminary Closure Objectives/Criteria (continued)

Mine Component	Closure Vision	Closure Objective	Closure Criteria	Primary Reclamation Activity	Post-Closure Inspection/Monitoring	Notable Uncertainty/ Research
Site Wide Revegetation	The various disturbed areas will have a soil cover placed and be revegetated to promote a mix of habitats suitable for the post-mining landscape (e.g., grassland/open meadow, shrubland, forest). The composition of habitats may be unique relative to surrounding area due to the changed landforms. Native seed mix will be used suitable to the area will be applied. Potentially traditional shrub species will be considered. Vegetation Trails at Touquoy and Beaver Dam will inform revegetation efforts.	Physical Stability/ Land Use[a]	Soil cover and revegetation treatments demonstrate early succession has been successful. Soil cover quality does not pose an elevated risk to humans and wildlife compared to surrounding areas.	Salvaged material stockpiling and management during operations. Revegetation trial plots will be completed to assess practical post-mining ecosystems possible and determine effective treatment applications prior to final closure. A soil cover and seeding/planting treatments will be applied to all disturbed sites as designed in the Final Plan.	Vegetation, soil and biodiversity monitoring.	Vegetation Trails at Touquoy and Beaver Dam will inform revegetation efforts. at each of the mine areas. An ad hoc committee will be established to confirm final land uses and provide input into final closure

Notes: [a] Additional land uses may be identified through ongoing engagement efforts with the Millbrook First Nations, the Mi'kmaq of Nova Scotia, CLC and Reclamation and Closure Working Group. Final approval of land uses requires the approval of NS Crown Lands, and acceptance by NSECC, DEM, and NSL.

4.2 Infrastructure and Mine Reclamation

4.2.1 Administration and Ancillary Areas

The reclamation of the Administration and Ancillary Areas consists of removal of buildings and other infrastructure, grading and revegetation.

The buildings will be removed during the first year of reclamation and either demolished, sold or re-used at other sites. Fuel, reagents, hazardous materials, chemicals etc. will be removed from structures prior to demolishing or removed from site. The wood-frame structures will be dismantled, with reusable parts being salvaged for recycling or re-use. The steel-frame and fabric-covered structures can be dismantled and removed from site. Trailer/mobile office units will be hauled from site. Crushing infrastructure, if used, will be dismantled, and removed from site.

All non-impacted concrete foundations and slabs will be broken up into pieces with a maximum size of 0.5 m, protruding reinforcing steel will be removed. The non-impacted broken concrete will be placed in the open pit. Concrete known to be impacted by hydrocarbons will be evaluated at the reclamation phase and be considered differently than the clean non-impacted concrete (e.g., cleaned and covered onsite or disposed of offsite in a licensed facility).

The raw water pumping infrastructure at Crusher Lake will be removed. The pipeline will be sealed and left in place. The carbon steel tank water tank, as well as the fire water tank, will be demolished, sold or re-used at other sites.

Above-ground water management pipelines will be removed and transported offsite for disposal in a licensed landfill in accordance with all applicable governmental regulations.

The septic systems will be emptied, the waste will be hauled by a licensed carrier to an appropriate disposal facility. The tanks will be excavated, shipped off site for disposal and the excavation backfilled. The septic beds will be allowed to drain naturally and then they will be abandoned in place.

Following the removal of buildings and burial of foundations, the Administration and Ancillary area will be covered with 0.3 m of salvaged overburden and 0.25 m of topsoil, graded to re-establish drainage thereby prevent pooling, and revegetated.

The on-site transmission line will be maintained for 2 years during active closure to support implementation of rehabilitation activities. After this 2-year active closure phase, the transmission lines will be removed and supporting infrastructure will be demolished. Overhead power lines will be taken down, wires will be recycled as scrap and timber poles will be salvaged. After timber poles are removed, the power line corridor area will be scarified and revegetated.

4.2.1.1 Petroleum and Hazardous Waste

Petroleum tanks on the mine site will include:

- fueling station - a 50,000 litre tank owned by a third-party vendor who will rent to the site as part of the fuel contract;
- diesel generators – two 13,200 litre fuel tank, will be owned and filled by the third party vendor; and
- propane - stored in two 7,500 litre tanks which will be owned and filled by a third party vendor.

Petroleum products and waste fuel, diesel and oil will be removed from site at closure by a recognized waste management company. Unused fuel will be returned to the supplier or disposed through a recognized waste management company. The contents of all fuel tanks will be pumped out by the fuel distributor or a waste management contractor. The petroleum and propane tanks owned by the suppliers will be removed form site by the supplier at the time of reclamation.

Reagents and other chemicals used in the mining/milling process remaining on site will be returned to the supplier or disposed of offsite at an approved facility.

4.2.1.2 Non-Hazardous Waste

Non-hazardous waste such as domestic waste will be removed from site. There will be no landfilling on site.

4.2.1.3 Contaminated Soils

During active closure, a soil survey will be completed to assess potential metal and hydrocarbon contamination in the vicinity of sites used for storing or transferring petroleum products, chemicals, or waste during operations. If contamination is found, a management plan consisting of a risk assessment and remedial action plan for the clean-up of contaminated soils will be implemented.

4.2.1.4 Explosive Storage

Explosives onsite will be managed by contractors and will be removed from site once no longer required. Infrastructure associated with explosive storage will be removed following removal of explosives and the area will be covered with 0.3 m of salvaged overburden and 0.25 m of topsoil and revegetated.

4.2.2 On-site Mine Roads

During active closure, mine site roads will remain in place. On-site mine roads will be scarified and re-contoured to allow for drainage to re-established and covered with 0.15 m of salvaged overburden and 0.25 m topsoil and then revegetated to manage potential erosion and sedimentation. Final mine road reclamation is dependant on final land use, however at this time the final land use is to focus on the re-establishment of natural ecosystems.

4.2.3 Open Pit

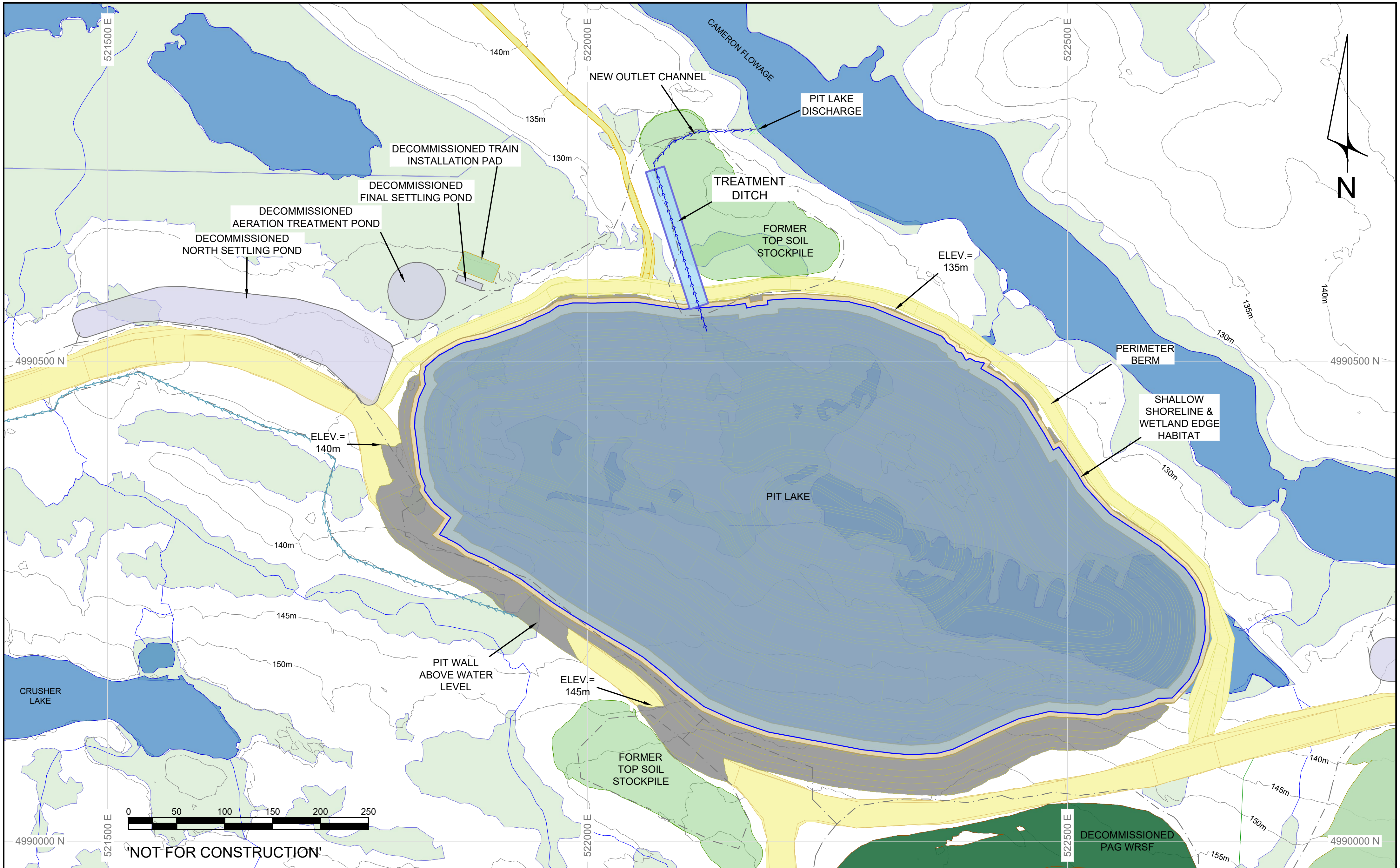
The open pit will be excavated in a manner that targets closure objectives. An extra wide bench (15 m horizontal) will be left behind at the planned final pit water level (130 m) that will allow for development of a shallow shoreline and wetland edge habitat with natural connection and a spillway to Cameron Flowage/Killag River. The pit configuration is shown on Appendix 2 including plan view and typical cross sections. It is anticipated to maintain the design ramps for closure with the addition of safety berms for safe vehicular access to the pit lake during pit flooding and for post-closure monitoring. Geotechnical stability of the slopes within the pit on the design criteria are assessed by Golder Associated Ltd. (Golder 2021a,) which confirmed the long-term stability for the above noted geometry. Final slopes will be approved by geotechnical engineer prior to final closure to confirm that minimum factors of safety in the long term are achieved.

At the end of open pit operations, this extra wide bench can be ripped and graded to create a shoreline 2 m below and 1 m above the final pit water level to promote end use goals for the open pit area (Figure 4-1). Along the south side of the pit, anywhere the vertical relief between the pit crest and the final pit water level is expected to be greater than 10 m, this shoreline is not planned to be established. The end use objectives for the open pit would not be served by establishing a shoreline connection so far below the planned pit crest, and establishment of a shoreline via pit enlargement may also result in additional disturbance to wetland and lichen habitat.

At closure, the open pit will be allowed to flood naturally over time with a combination of groundwater inflow, direct precipitation, and surface run-off to create a permanent lake with a shallow shoreline and a wetland edge habitat with natural connection and a spillway to Cameron Flowage/Killag River. Access to the pit will be maintained by existing ramps to allow safe access during pit flooding and post-closure phases. The closure activities for the pit consists of the following:

- Ripping and grading, or blasting if necessary, to create a 5.0H:1V shoreline 2 m below and 1 m above the estimated final pit water level of 130 m. Areas where modifying the pit geometry would interfere with buffer from Cameron Flowage/Killag River will not be modified for closure.
- Maintain the pit ramps with the addition of safety berms.
- Provide vegetative cover on the 1 m of shoreline above the final water elevation (refer to Sections 4.2.1 and 5.3).
- Grading exposed overburden to final slopes of 2.0H:1V.
- Constructing a 2 m high barrier berm with 1.0H:1V slopes around the perimeter of the pit.
- Constructing a spillway and conveyance channel to the Cameron Flowage/Killag River.

Water levels in the pit will rise quickly in the initial years following cessation of operations but will slow as water reaches wider areas of the pit and a greater volume is required to increase water level. Flooding of the pit will create a lake with a shallow water wetland along its perimeter. This will re-establish a connection between the newly formed lake and Cameron Flowage. Based on the water balance presented in the Water Management Plan (GHD, 2021b, Appendix 3) the pit will be fully flooded in 13 years.



ATLANTIC GOLD - CLOSURE PLAN
PLANNED POST CLOSURE OPEN PIT WATER MANAGEMENT PLAN

DATE:	2021/10/14	APPR'D BY:	MS
DRAWN BY:	DH	FILE:	FIGURE 4-1
		PROJECT:	AG_BVD_2021

Moose Mountain Technical Services

Atlantic Gold
A St Barbara Ltd Company

LEGEND

- ULTIMATE PIT
- DECOMMISSIONED PAG WRSF
- FORMER HAUL ROAD
- DECOMMISSIONED TILL STOCKPILE
- FORMER TOP SOIL STOCKPILE
- DECOMISSIONED WATER MANAGEMENT POND
- TREATMENT DITCH
- NEW OUTLET CHANNEL
- PIT LAKE DISCHARGE
- FORMER WATER MANAGEMENT DITCH
- CLEAN WATER DITCH
- WETLANDS
- LAKES
- WATERCOURSE
- TOPOGRAPHY

CONTOURS AT 5m INTERVALS

4.2.3.1 Subsidence Potential

Historic underground workings are present in the centre of the planned Beaver Dam pit area and they will be entirely mined out by the Beaver Dam ultimate pit. Adjustments or backfilling may be required on interim phases where underground intersects ore zones that are located close to interim walls and pit floor.

As discussed in Section 3.3, a geotechnical stability assessment indicates that the planned pit slopes are stable (Golder 2021a). The open pit will be monitored for stability during development and flooding through ongoing visual inspection and survey monuments.

4.2.4 NAG Waste Rock Storage Area

The closure plan and cost estimate assume closure activities to include:

- re-sloping of the final lift of the waste rock pile;
- contouring the ultimate top surface of the pile; and
- providing a vegetated cover for closure, including construction of runoff channels to prevent erosion.

Geotechnical stability of the slopes within the waste rock area are consistent with the design criteria assessed by Golder Associates Ltd. (Golder 2021b, Appendix 5). The originally proposed 1.5H:1V inter-bench slopes and 21 m wide benches for the waste rock stockpile geometry resulted in an overall slope of 3.1H:1V, which achieved the required factor of safety values. Flattening the inter-bench slopes to 3H:1V and decreasing the bench width to 4 m every 10 m vertical height will result in an overall flatter slope approximately 3.4H:1V, which will also achieve the required factor of safety values (i.e., Golder's reported slope stability analysis is applicable).

Contouring of the top lift, placement of a 0.5 m overburden and 0.25 m topsoil cover and revegetation treatments will be completed following end of mining (see Section 5.3). After the waste rock cover is fully built, surface water run-off will continue to be directed towards the North Settling Pond, with final discharge occurring only after water quality meets applicable criteria. This is further outlined in Section 5.2 of this plan. At that point, the water can be released to the environment.

4.2.5 Potential Acid Generating Stockpile

The PAG stockpile will be developed and graded for closure similar to the NAG waste rock stockpile. The PAG stockpile will have inter-bench slopes at 3H:1V and 4 m wide benches every 10 m vertical height resulting in an overall slope approximately 3.4H:1V, which will achieve the required factor of safety values.

The closure plan and cost estimate assume closure activities to include:

- re-sloping of the final lift of the waste rock pile;
- contouring the ultimate top surface of the pile;
- providing a vegetated cover for closure, including construction of runoff channels to prevent erosion; and
- directing surface water run-off from the covered PAG rock pile to the open pit.

Given the highly porous natural of the waste rock, a HDPE geomembrane, underlain with geotextile, has been included in the closure cost. The geomembrane will be covered with 0.5 m topsoil and hydroseeded. Based on monitoring, the closure cover design for the PAG stockpile may be reconsidered. Before the site completes operation, monitoring data will be reviewed and detailed design studies completed to determine the most suitable closure approach.

4.2.6 Temporary Stockpiles

Temporary Stockpiles (Till, Topsoil and Organics) will be used in reclamation. The remaining material will be re-contoured to re-establish natural drainage. The area will be seeded with native seeds and potentially native and or traditional shrub species, as appropriate. Field trails will be undertaken before closure to determine suitable re-vegetation within these areas. The revegetation program will be designed to limit erosion, re-establish natural drainage, which allow native vegetation and succession encroachment. Topsoil piles will that have native seed bank will be used in progressing and final reclamation.

The LGO stockpile will be incorporated into the NAG waste rock storage area and included in rehabilitation of the waste rock storage area.

4.3 Closure Water Management

Closure consists of two-years of active closure, which occurs following completion of the Beaver Dam Mine, and post-closure stages. Active closure activities are mainly focused on reclaiming the areas affected by the Mine and directing covered PAG stockpile runoff to the open pit for refilling. Active closure activities specifically include the removal of all mine facilities (including pipes and culverts which could plug over time), rehabilitation of the East and South Settling ponds, flooding the pit with water to form a pit lake, capping of stockpiles and revegetation of disturbed areas (Figure 4-2 and Figure 4-3). Fences surrounding the infrastructure area will be removed once majority of closure activities are completed. During active closure water from the rehabilitated NAG stockpile will continue to pass through the North Settling Pond and water management system and discharge location into the Killag River. During this period, site roads will remain in place.

Upon flooding of the open pit, the North Settling Pond will be rehabilitated and drainage will be directed into the flooded pit. Overflow from the open pit will be directed through a passive water treatment system before discharge into the Killag River.

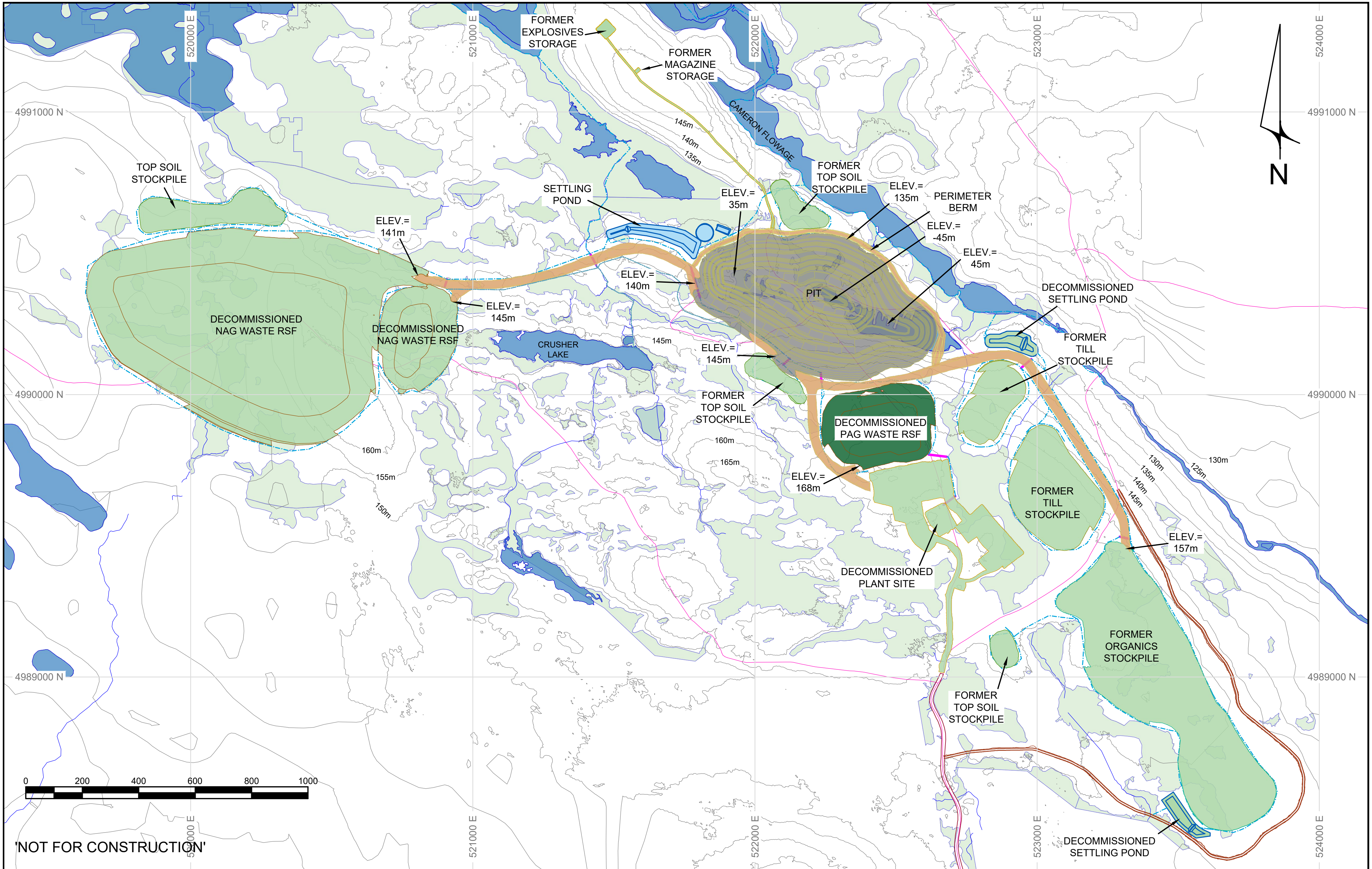
A detailed description of the water management plan, including figures depicting the proposed configuration, is provided in GHD (2021a), attached in Appendix 3.

4.3.1 Water Management Ponds and Ditches

The South and East settling ponds and runoff pond will be decommissioned at the end of the active closure after mine site area have been reclaimed. The ponds will be drained, the HDPE liner and concrete outlet structure removed, and the perimeter berms pushed in and the remaining depression regraded and the area revegetated. The HDPE liner and concrete will be placed in the open pit.

During post-closure the east PAG stockpile collection ditch will be regraded to discharge directly to the open pit. The Smart Ditch that directed PAG stockpile to the North Settling Pond will be removed and placed in the pit. The remaining ditches will be left in place.

Due to the drawdown of baseflow from the open pit, discharge from the North Settling Pond to Cameron Flowage during low flow summer months must be maintained during pit filling. The North Settling Pond will remain until the open pit has flooded at which time the pond will be drained, the HDPE liner and concrete outlet structure removed and the perimeter berms pushed in and the remaining depression regraded to direct runoff towards the open pit and the area revegetated. The HDPE liner and concrete will be disposed of offsite.



ATLANTIC GOLD - CLOSURE PLAN END OF ACTIVE CLOSURE			
DATE:	2021/10/14	APPR'D BY:	MS
DRAWN BY:	DH	FILE:	FIGURE 4-2
		PROJECT:	AG_BVD_2021

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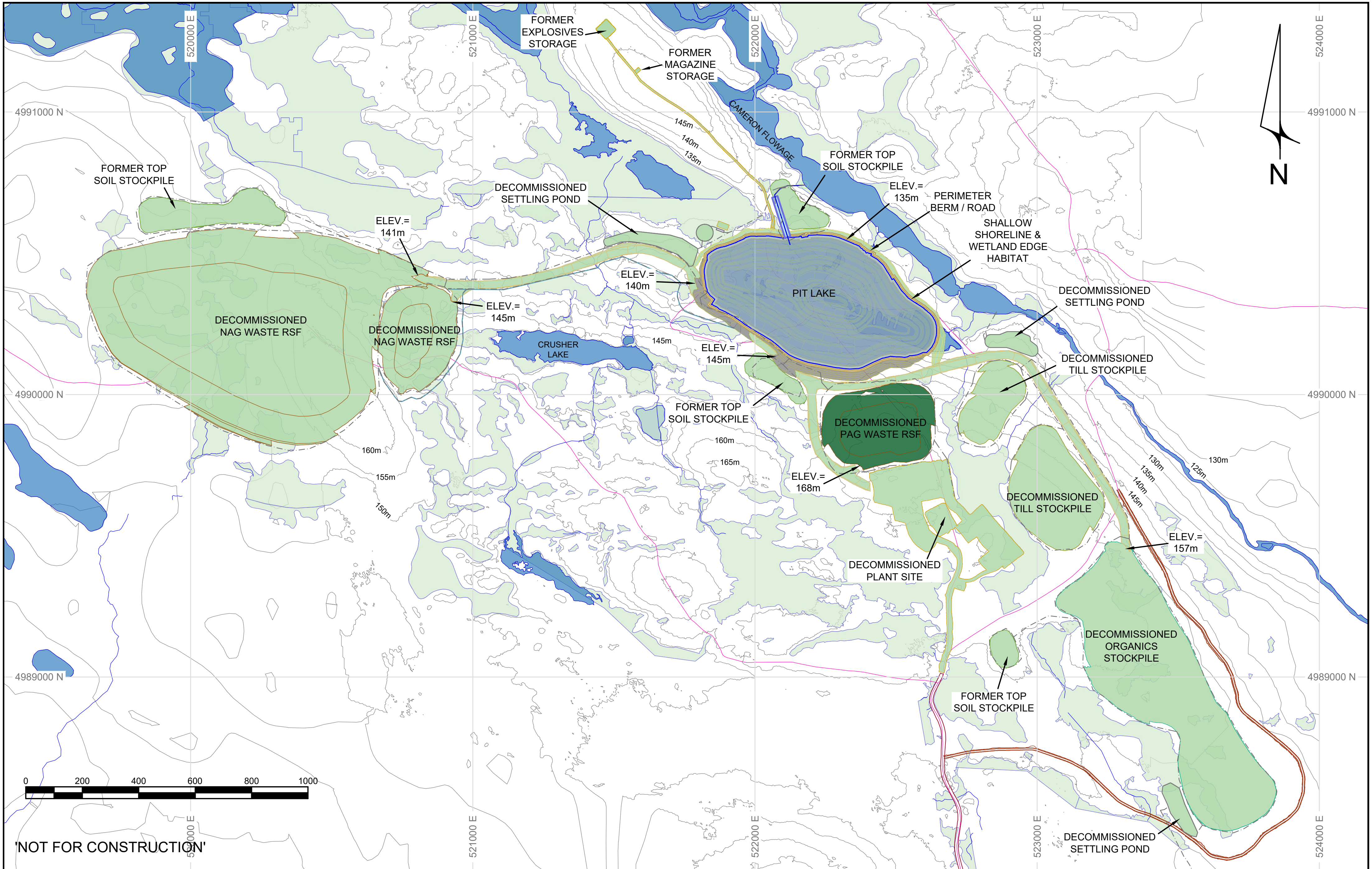
LEGEND CONTOURS AT 5m INTERVALS

- PROPOSED PITS
- DECOMMISSIONED NAG WASTE RSF
- DECOMMISSIONED HAUL ROAD
- DECOMMISSIONED MINE FACILITES PAD
- FORMER TOPSOIL STOCKPILE
- FORMER TILL STOCKPILE
- FORMER ORGANICS STOCPILE
- WATER MANAGEMENT DITCH
- WATER MANAGEMENT POND
- CLEAN WATER DITCH
- CULVERTS
- SITE ACCESS
- ROAD DETOUR
- EXISTING ROADS
- WETLANDS
- LAKES
- WATERCOURSE
- TOPOGRAPHY



ATLANTIC GOLD - CLOSURE PLAN POST CLOSURE PLAN			
DATE:	2021/10/14	APPR'D BY:	MS
DRAWN BY:	DH	FILE:	FIGURE 4-3
		PROJECT:	AG_BVD_2021

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LEGEND
CONTOURS AT 5m INTERVALS

- ULTIMATE PIT
- DECOMMISSIONED NAG WASTE RSF
- DECOMMISSIONED PAG WASTE RSF
- DECOMMISSIONED HAUL ROAD
- DECOMMISSIONED MINE FACILITES PAD
- FORMER TOPSOIL STOCKPILE
- PIT LAKE
- NEW OUTLET CHANNEL
- FORMER TILL STOCKPILE
- FORMER ORGANICS STOCPILE
- DECOMMISSIONED WATER MANAGEMENT DITCH
- DECOMMISSIONED WATER MANAGEMENT POND
- CLEAN WATER DITCH
- TREATMENT DITCH
- SITE ACCESS
- ROAD DETOUR
- EXISTING ROADS
- WETLANDS
- LAKES
- WATERCOURSE
- TOPOGRAPHY

4.3.2 Post Closure Water Treatment Criteria

The predicted water quality data were screened against two potential discharge criteria, Metal Diamond Mining Environmental Regulation (MDMER) objectives and Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life. MDMER regulations are used to assess End-Of-Pipe discharge concentrations while CCME and Site-Specific guidelines were used to assess concentrations within the Killag River after considering downstream mixing effect

4.3.3 Post-Closure Water Treatment System

A predictive water quality assessment and mass balance model was completed which shows that zinc and cobalt are the only exceeded parameters CCME guidelines during the PC phase (GHD 2021a, attached in Appendix 3). However, the exceedances are not significantly higher than the guideline and a passive water treatment system could reduce the concentration of these elements below discharge criteria. Post-closure passive treatment systems are presented in the GHD, 2021b (Appendix 4) and depicted in Figure 4-4. Anoxic limestone drains (ALDs) and successive alkalinity producing systems (SAPS) are potential passive alternatives for addressing concentrations of metals in impacted water during the Post-closure phase (GHD, 2021b).

4.3.3.1 Aeration System and Settling Pond

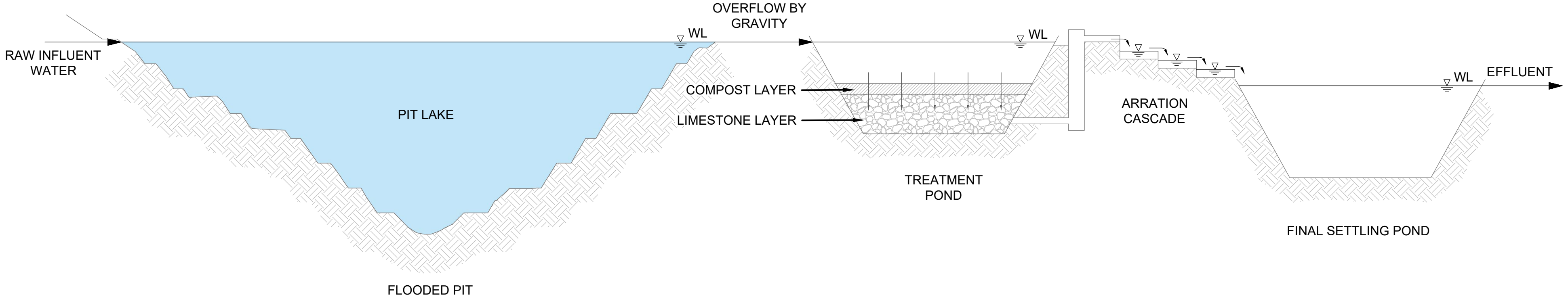
In this treatment approach, impacted water will initially pass through a settling pond for the removal of suspended solids. Then, water will pass through a trench ALDs. ALDs generate alkalinity and increase the pH of the impacted water. By increasing the pH, metals such as zinc and cobalt will precipitate in their hydroxide forms. The ALDs will be followed by an aeration cascade, pond, or aerobic wetland that oxidizes and removes the precipitated metals. A settling pond will then provide adequate hydraulic retention time to let those formed metal hydroxides precipitate. This treatment system is proposed due to its passive nature and the fact that utilities are not required for implementation. The success of an ALD depends on site-specific conditions, primarily on low dissolved oxygen, and minimal ferric iron and aluminum concentrations in the drainage.

The operation and maintenance of this alternative is minimal as no labour or power is required. The primary maintenance would be replacing depleted limestone which is dependent on-site condition and water chemistry. In suitable conditions, limestone could work efficiently for several years.

4.3.3.2 Successive Alkalinity Producing Systems followed by Settling Pond

Successive alkalinity producing systems (SAPS) combine an ALD and a permeable organic substrate into one system that creates anaerobic conditions prior to water contacting the limestone. Anaerobic conditions help to remove organics and nitrite which is predicted to exceed the regulatory limit during the dry season at PC condition. At anaerobic condition, nitrite compounds are converted to nitrogen gas and is released into the atmosphere. Mine drainage enters at the top of the pond, flows down through the compost where the drainage gains dissolved organic matter and becomes more reducing, and then flows onto the limestone below, where it gains alkalinity. Dissolution of the limestone raises the pH of the water, resulting in the precipitation of metals such as zinc and cobalt. The precipitated metals collect at the base of the SAPS system and in the downstream settling pond.

The selection of a final alternative will depend on chemistry of the impacted water. The proposed alternatives are made of an anoxic alkalinity producing basin followed by an aeration cascade and final settling pond, with no need for electrical power sources. The purpose of the final settling pond is to provide retention time for settling of suspended solids generated as the result of anoxic alkalinity producing basin (AMNS 2021a).



ATLANTIC GOLD - CLOSURE PLAN
POST CLOSURE WATER TREATMENT SYSTEM

DATE:	2021/10/14	APPR'D BY:	MS
DRAWN BY:	DH	FILE:	FIGURE 4-4
		PROJECT:	AG_BVD_2021

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5 POST CLOSURE MONITORING AND INSPECTIONS

Post-closure monitoring will initially be an extension of the current mine operation monitoring programs. These programs include monitoring physical and chemical parameters for air, surface water, groundwater, vegetation, and soils, as well as environmental effects monitoring, and are outlined in the Project Industrial Approval.

As part of developing a Final Plan leading up to closure, an adaptive post-closure monitoring plan will be prepared. This monitoring program would be informed by the monitoring results compiled over operations to focus on areas of concern identified during mining, and/or aspects of closure with high uncertainty/risk.

Post-closure monitoring will include inspections of reclaimed structures such as the open pit, waste rock storage areas and temporary stockpiles for erosion or settlement and to assess whether surface water runoff has returned to near pre-development flow patterns. Adaptive management thresholds and response plans will be developed for the monitoring program to ensure that any deficiencies are addressed in a timely fashion, and reclamation measures enhanced as required. This will also prescribe a structure for monitoring efforts to increase/reduce activities based on observed trends and triggers.

AMNS acknowledges that the elements of post-reclamation monitoring presented and agreed upon as part of this plan will not be reduced or terminated without DEM and ECC consent.

5.1 Physical/Structural Stability Monitoring

Following final reclamation of slopes, ditches and dams, physical stability monitoring will begin as an annual program and run for a period of thirteen years. Inspection will be completed annually until pit flooding is complete. AMNS commits to conducting geotechnical assessments of all as built slopes. If physical stability of administrative and ancillary areas, WRSA and Open Pit are stable with no evidence of instability, then monitoring frequency can be reduced or eliminated.

5.2 Surface and Groundwater Water Monitoring

The surface water and groundwater monitoring programs are planned to continue based on a similar scope as during operations, with reduced frequency from operational monitoring for the duration of active decommissioning and earthworks closure. Once these closure activities are completed, it is expected that surface water and groundwater conditions will stabilize, and monitoring can be reduced. This is expected to occur first for the Mill Site and Admin Area, followed by the WRSA and temporary stockpiles and eventually the Open Pit due to the timelines associated with passive pit flooding (approximately 13 years). Monitoring of the pit lake during flooding is expected to be much reduced from the program during mining operations and will include an In-Pit location to assess water chemistry and flooding rates. Monitoring of the post closure water quality overflow will continue for at least 5 years after the pit has flooded, or until water quality concentrations indicate that treatment is no longer required. Specific compliance points will be proposed in a final Plan and based on industry standards (e.g., mixing zone length within the Cameron Flowage/Killag River).

Groundwater monitoring will be completed semi-annual during the first 5 years of closure.

5.2.1 Environmental Effects Monitoring

The EEM Program, required by the Metal and Diamond Mining Effluent Regulations, Schedule 5, focuses on determining if the discharge of effluent to the receiving environment results in environmental effects to fish and fish habitat. The Beaver Dam Mine will become subject to MDMER including EEM once operations commence and EEM requirements will continue until the mine receives recognized closed mine status under MDMER (Section 32). Final EEM studies will be undertaken for effluent from all final discharge points during a three-year period after the proponent submits a notice of intent to close to the Minister of Environment and Climate Change Canada (ECCC). This will include the Open Pit discharge via the constructed spillway to Cameron Flowage/Killag River if this is active before the mine achieves recognized closed mine status.

At present, the Open Pit is not planned to receive PAG mine waste. Current water quality predictions and operational monitoring results suggest that when flooded, the Open Pit discharge will be suitable for release to Cameron Flowage. As reclamation planning advances, an appropriate monitoring program for Open Pit discharge and receiving waters will be developed in consultation with provincial regulators and informed by ongoing monitoring data.

5.3 Revegetation Plan

The various disturbed areas will have a soil cover placed using the salvaged materials stockpiled during the construction and operation of the mine site. Following final grading and placement of the soil material cover on the mine disturbance areas revegetation prescriptions will be applied to promote a mix of habitats suitable for the post-mining landscape (e.g., grassland/open meadow, shrubland). The composition of habitats may be unique relative to surrounding area due to the changed landforms. Native seed mix suitable to the area will be applied. Potentially traditional shrub species will be considered. Revegetation trial plots will be completed to assess practical post-mining ecosystems possible and determine effective treatment applications prior to final closure and the trials at Touquoy and Beaver Dam will also help inform revegetation efforts.

After the covered areas are revegetated, vegetation monitoring will begin as an annual program, then reduce in frequency as targets for coverage and quality are reached. A minimum of three monitoring/sampling events over the post-closure monitoring program period is assumed. Vegetation monitoring may include the following:

- vegetation survival and establishment;
- consideration of traditional plants;
- percent vegetation cover and species composition;
- biodiversity indicators such as richness and evenness;
- growth rates;
- biomass productivity;
- plant health/condition;
- metal levels in vegetation foliage; and
- soil capping material nutrient and metals levels.

6 RECLAMATION SCHEDULE

The reclamation and post-closure monitoring schedule is presented in Table 6-1.

Table 6-1: Preliminary Reclamation Schedule

Mine Area/Component		Reclamation Phase																		
		Progressive Reclamation	Active Closure		Pit Flooding											Post Closure Monitoring				
			Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15	Y16	Y17	Y18
Plant Site and Administration Area	Administration / Security Buildings																			
	Truck Shop, Gate House, and Crusher Plant																			
	Septic Tanks and Field, Fuel Tanks; and Fencing, Transmission lines and Runoff Pond.																			
	Contaminated Soils Survey																			
	Scarifying, Soil Cover, Seeding, Planting																			
Open Pit and Haul Roads	Signage																			
	Construct Safety Berms																			
	Re-sloping for Pit Shoreline/Till Slopes																			
	Soil / Topsoil Cover on Shoreline																			
	Seeding / Planting on Shoreline																			
	Scarifying Surfaces/Roads																			
	Soil / Topsoil Cover on Roads																			
	Seeding Planting Roadways																			
	Shape Spillway																			
	Erosion Protection for Spillway																			
	Pit Flooding																			
NAG Closure	NAG Lift Sloping Final Shape																			
	NAG Area Ditching																			
	Scarifying Surface and Roads																			
	Water Management / Ditching and Culvert Removal																			
	Soil Cover, Seeding and Planting																			

PAG Closure	PAG Lift Sloping Final Shape
	PAG Area Ditching
	HDPE or Bituminous Cover of PAG
	Water Management / Ditching and Culvert Removal
	Soil Cover, Seeding and Planting
Water Management Components	North Settling Pond
	East Settling Pond
	South Settling Pond
	Smart Ditching
	Clean Water Ditches
	Contact Water Ditches
Permitting and ESA	Confirmatory Sampling at Fuel Storage Areas
	ESA, CSR Reporting
	Prediction of Water Quality in Flooded Open Pit
Closure Monitoring	Physical Stability Inspection and Monitoring
	Surface and Groundwater (quality and quantity) Monitoring
	Re-vegetation and Soil Monitoring
	Ambient Air Monitoring
	Biological Monitoring (Including EMM Program)
	Post Closure Maintenance / Repairs
Engagement	

7 ENGAGEMENT PLAN

AMNS is committed to a public, stakeholder, and Indigenous engagement program based on open, forthright, and responsive communication with the public, regulatory agencies, other stakeholders, and the Mi'kmaq of Nova Scotia. The objectives of the engagement program (AMNS 2021b) are to:

- provide information about reclamation planning to members of the general public, the Mi'kmaq of Nova Scotia, stakeholders and interested parties, and seek their input;
- identify, document, and monitor issues and concerns arising from the engagement process;
- identify the need for planning, design and management measures that will mitigate or resolve the issues raised through the engagement process; and
- understand stakeholder concerns and requests for end land-use activities.

An engagement program on reclamation issues as been ongoing with the Touquoy Community Liaison Committee (CLC) since 2016, and is an important vehicle for the identification, scoping, and resolution or mitigation of potential issues or concerns, and for the exchange of information in respect of the Project.

8 RECLAMATION CLOSURE COST ESTIMATE

As part of this Reclamation Plan, an estimate of $18,355,061 was prepared for the total cost of closure and reclamation activities at Beaver Dam. This closure and reclamation cost estimate was developed from first principles, using estimated quantities and a similar costing basis as recently developed for the updated Touquoy Mine reclamation estimate. The resulting cost estimate, as summarized in Table 8-1 and 8-2, includes the cost of closure monitoring, contingency, and engineering and project management.

Updates to the reclamation cost estimate will be provided as part of revisions to this plan over development and operations.

Table 8-1: Reclamation and Closure Cost Estimate

Rehabilitation Component	General Description	Estimated Quantity	Units	Unit Cost	Costs	Notes	Quantity Source	Cost Source
Plant Site / Admin Area								
Mine Dry and Offices, Security Administration and Lunch/Breakout Room Structure	Wooden Structure demo and removal	488	square meters	$ 14.96	$ 7,300		AMNS	Costworks 024116130700
Mine Dry and Offices, Security Administration and Lunch/Breakout Room Concrete	Breaking up of concrete slab and foundation	488	square meters	$ 10.68	$ 5,212		AMNS	Estimated
Truck Shop Fabric Building	Disassembly and re-use / sale	1	Allowance	$ 30,000.00	$ 30,000		AMNS	Estimated
Truck Shop Slab	Breaking up of reinforced slab	320	cubic meters	$ 305.79	$ 97,853		AMNS	Costworks 024113304320
Truck Shop Foundation	Breaking up of reinforced foundation	105	meters	$ 52.16	$ 5,477	Quantity assumed	AMNS	Costworks 024116171080
Truck Wash Slab	Breaking up of reinforced slab	104	cubic meters	$ 305.79	$ 31,802		AMNS	Costworks 024113304320
Truck Wash Foundation	Breaking up of reinforced foundation	27	meters	$ 52.16	$ 1,408	Quantity assumed	AMNS	Costworks 024116171080
Water and Generators Concrete	Breaking up of reinforced slab	187	cubic meters	$ 305.79	$ 57,183	Quantity assumed	AMNS	Costworks 024113304320
Security Gatehouse Trailer	Trailer removal	1	Allowance	$ 5,000.00	$ 5,000		AMNS	Estimated
Septic Tank Removal	Pump out contents and remove tanks	3	each	$ 2,000.00	$ 6,000	Waste to be removed and hauled off site by a licensed carrier	AMNS	Estimated
Septic Tank Backfill	Backfill with overburden and regrade	375	cubic meters	$ 7.25	$ 2,719	125 m^3 assumed for each tank		
Fence	Remove fence around facilities area	1	Allowance	$ 10,000.00	$ 10,000		AMNS	Estimated
Utilities Area	Demolish & remove mechanicals (above-ground piping, firewater, water tanks, filtered water, etc).	1	Allowance	$ 25,000.00	$ 25,000	Remove and transport offiste for disposal at licensed landfill	AMNS	Estimated
Fuel, Diesel and Propane Tanks	Tanks and unused products to be removed offsite by suppliers				$ -	Remove waste offsite by supplier	AMNS	Estimated
Non-hazardous Waste	Remove offsite	1	Allowance	$ 50,000.00	$ 50,000	Remove and transport offiste for disposal at licensed landfill	AMNS	Estimated
Contaminated Soils Survey - Phase 1 ESA	Allowance for inspection, targeted sampling and brief summary report.	1	Allowance	$ 20,000.00	$ 20,000	Phase 1 ESA	AMNS	Estimated
Contaminated Soils Survey - Phase 2 ESA	Allowance for inspection, targeted sampling and brief summary report.	1	Allowance	$ 50,000.00	$ 50,000	Phase 2 ESA	AMNS	Estimated
Effluent Treament Plant	Removed off site to CH etc	1	Allowance	$ 10,000.00	$ 10,000		AMNS	Estimated
Generators	Transferred to CH or alternative	1	Allowance	$ 5,000.00	$ 5,000		AMNS	Estimated
Runoff Pond (MIA Collection Pond)	Drain pond	1	Allowance	$ 5,000.00	$ 5,000		AMNS	Estimated
	Remove and dispose GCL and HDPE	6,540	square meters	$ 4.00	$ 26,160	Remove and dispose in the pit	AMNS	Estimated
	Regrade area and promote possitive drainage	6,600	square meters	$ 1.46	$ 9,636		AMNS	Contractor Quotes
	Placing and grading topsoil	1,650	cubic meters	$ 9.25	$ 15,263	Entire area, 0.25 m thick	AMNS	Contractor Quotes
	Native grass seeding and fertilizing	6,600	square meters	$ 0.57	$ 3,762	Entire area	AMNS	Contractor Quotes / Estimated
Scarifying	Scarifying areas	100,000	square meters	$ 0.50	$ 50,000	Entire disturbed plant site (facilities plus ROM and explosives area)	AMNS	Contractor Quotes
Soil Cover	Placing and grading soil cover	30,000	cubic meters	$ 7.25	$ 217,500	Entire disturbed plant site, 0.30 m thick	AMNS	Contractor Quotes
Topsoil	Placing and grading topsoil	25,000	cubic meters	$ 9.25	$ 231,250	Entire disturbed plant site, 0.25 m thick	AMNS	Contractor Quotes
Seeding/Fertilizing	Native grass seeding and fertilizing	50,000	square meters	$ 0.57	$ 28,500	50% disturbed plant site	AMNS	Contractor Quotes / Estimated
Planting	Planting topsoil capping with native species related to foresty	50,000	square meters	$ 0.99	$ 49,500	50% disturbed plant site	AMNS	Contractor Quotes / Estimated
Demo Landfill Tipping Fees	Demo materials	50	tonnes	$ 90.00	$ 4,500		AMNS	2020 Trucking Rates, Tipping Fees from Pictou
				Subtotal Plant Site / Admin Area	**$ 1,061,024**			
Open Pit & Haul Roads								
Signage	Signage	1	Allowance	$ 5,000.00	$ 5,000	Signs warn of open pit	AMNS	Estimated
Construct Safety Berm	Construct Safety Berm	13,620	cubic meters	$ 7.25	$ 98,745	6 m3 per m of berm, 2,270 m	AMNS	Contractor Quotes
Resloping for Pit Shoreline	Ripping and grading to create 5H:1V slopes at water line	88.5	hours	$ 190.79	$ 16,885	Rip and push current 15m berm on bench elev. 130m at 5:1 slope to create a beach surrounding the north, east and west sides of the pit (1,170 m). Grade to final slope	AMNS	Estimated
Resloping of Till slopes	Reslope till slopes around perimeter for closure	56,750	cubic meters	$ 5.50	$ 312,125	Quantity assumed	AMNS	Contractor Quotes
Soil cover on shoreline	Cover on shoreline above water level	1,800	cubic meters	$ 7.25	$ 13,050	6,000 m2 x 0.3 m thick overburden (1 m of shoreline above elev. 130m)	AMNS	Contractor Quotes
Topsoil on shoreline	Placing and grading topsoil	1,500	cubic meters	$ 9.25	$ 13,875	6,000 m2 x 0.25 m thick growth media (1 m of shoreline above elev. 130m)	AMNS	Contractor Quotes
Seeding shoreline	Native grass seeding and fertilizing	3,000	square meters	$ 0.57	$ 1,710	50% of shoreline	AMNS	Contractor Quotes / Estimated
Planting shoreline	Planting topsoil capping with native species related to foresty	3,000	square meters	$ 0.99	$ 2,970	50% of shoreline	AMNS	Contractor Quotes / Estimated
Scarifying Surfaces/Roads	Scarifying Surfaces/Roads	140,000	square meters	$ 0.50	$ 70,000	Roads and haul roads near pit; culverts are covered under water management item	AMNS	Contractor Quotes
Soil Cover on roads	placing and grading soil cover	21,000	cubic meters	$ 7.25	$ 152,250	0.15 m thick overburden	AMNS	Contractor Quotes
Topsoil on roads	placing and grading topsoil	35,000	cubic meters	$ 9.25	$ 323,750	0.25 m thick growth media	AMNS	Contractor Quotes
Seeding roads	Native grass seeding and fertilizing	70,000	square meters	$ 0.57	$ 39,900	50% Roads around pit area	AMNS	Costworks
Planting roads	Planting topsoil capping with native species related to foresty	70,000	square meters	$ 0.99	$ 69,300	50% Roads around pit area	AMNS	Contractor Quotes / Estimated
Shape Spillway	Excavate spillway	-	-	-	$ -	Covered in Water Management sustaining costs.	AMNS	Contractor Quotes
Erosion Protection for Spillway	Rip rap channel	-	-	-	$ -	Covered in Water Management sustaining costs.	AMNS	Contractor Quotes / Estimated
				Subtotal Open Pit & Haul Roads	**$ 1,119,560**			
Waste Rock Storage Area (NAG)								
Reslope Last Lift of Waste rock pile	Re-slope last lift at closure	43,125	cubic meters	$ 5.50	$ 237,188	10 m heigh bench, 2,300 m perimeter	AMNS	Contractor Quotes
Regrade Top Area of Waste rock pile	Regrade top area at closure to promote possitive drainange	341,000	square meters	$ 1.46	$ 497,860		AMNS	Contractor Quotes
Ditches/chutes excavation	Last lift and top area	7,538	cubic meters	$ 8.50	$ 64,070		AMNS	Contractor Quotes
Ditches/chutes geotextile	Last lift and top area	13,819	cubic meters	$ 5.40	$ 74,623		AMNS	Contractor Quotes
Ditches/chutes riprap	Last lift and top area	4,146	cubic meters	$ 57.10	$ 236,722		AMNS	Contractor Quotes
Scarifying Surfaces/Roads	Scarifying Surfaces/Roads	-	square meters	$ 0.50	$ -	Covered under haul roads separately	AMNS	Contractor Quotes
Soil Cover	placing and grading soil cover	367,960	cubic meters	$ 7.25	$ 2,667,710	0.5 m thick overburden	AMNS	Contractor Quotes
Topsoil	placing and grading topsoil	183,980	cubic meters	$ 9.25	$ 1,701,815	0.25 m thick growth media	AMNS	Contractor Quotes
Seeding	Native grass seeding and fertilizing	367,960	square meters	$ 0.57	$ 209,737	50% of WRSA surface	AMNS	Contractor Quotes / Estimated
Planting	Planting topsoil capping with native species related to foresty	367,960	square meters	$ 0.99	$ 364,280	50% of WRSA surface	AMNS	Contractor Quotes / Estimated
Ditching/Water Management	Filling ditches, demo of ponds, grading, revegetation	-	-	-	$ -	Covered under water management item	AMNS	Contractor Quotes
Culvert Removal	remove culverts along ditching	-	-	-	$ -	Covered under water management item	AMNS	Estimated
				Subtotal Waste Rock Storage Area (NAG)	**$ 6,054,005**			
PAG Closure								
Reslope Last Lift of PAG rock pile	Re-sloping last lift at closure	16,875	cubic meters	$ 5.50	$ 92,813	10 m heigh bench, 900 m perimeter	AMNS	Contractor Quotes
Regrade Top Area of Waste rock pile	Regrade top area at closure to promote possitive drainange	52,500	square meters	$ 1.46	$ 76,650		AMNS	Contractor Quotes
Ditches/chutes excavation	Last lift and top area	3,125	cubic meters	$ 8.50	$ 26,564		AMNS	Estimated
Ditches/chutes geotextile	Last lift and top area	13,819	cubic meters	$ 5.40	$ 74,623		AMNS	Contractor Quotes
Ditches/chutes riprap	Last lift and top area	4,146	cubic meters	$ 57.10	$ 236,722	0.3 m assumed	AMNS	Contractor Quotes
HDPE or Bituminous Cover over PAG	HDPE or Bituminous Cover over PAG	102,000	square meters	$ 15.00	$ 1,530,000	100% of PAG surface. $8 HDPE supply/freight, plus $7 install per m2.	AMNS	Estimate
Geotextile	to protect liner	102,000	square meters	$ 5.40	$ 550,800		AMNS	Contractor Quotes
Topsoil	placing and grading topsoil	51,000	cubic meters	$ 9.25	$ 471,750	0.5 m thick	AMNS	Contractor Quotes
Seeding	Native grass seeding and fertilizing	102,000	square meters	$ 0.57	$ 58,140	100% of PAG surface	AMNS	Contractor Quotes / Estimated
				Subtotal PAG Rock Storage Area	**$ 3,118,061**			
Organic Stockpile								
General Rehabilitation	Assumed no rehabiliation is necessary	-	square meters	$ -	$ -		AMNS	Unclear if any rehabilitation would be necessary.
				Subtotal Organic Stockpile Area	**$ -**			

Table 8-1: Reclamation and Closure Cost Estimate (continued)

Till and Topsoil Areas								
Till Stockpile Areas	Native grass seeding and fertilizing	150,000	square meters	$ 0.57	$ 85,500		AMNS	Contractor Quotes / Estimated
Topsoil Stockpile Areas	Native grass seeding and fertilizing	100,000	square meters	$ 0.57	$ 57,000		AMNS	Contractor Quotes / Estimated
				Subtotal Till and Topsoil Areas	**$ 142,500**			
Other Areas								
Removal and disposal of culverts	removal of 10 culverts	10	Allowance	$ 2,000.00	$ 20,000		AMNS	Estimated
Removal of powerlines	removal of powerlines	1	Allowance	$ 25,000.00	$ 25,000	Remove and transport offiste for disposal at licensed landfill	AMNS	Estimated
Removal of Magazine storage etc.		1	Allowance	$ 10,000.00	$ 10,000	Remove and transport offiste for disposal at licensed landfill	AMNS	Estimated
Roadways	Scarifying Surfaces/Roads	24,000	square meters	$ 0.50	$ 12,000	1.2 km of road not covered in other areas, 10 m wide. Doubled to make allowance for explosives area as well.	AMNS	Contractor Quote
	placing and grading soil cover	3,600	cubic meters	$ 7.25	$ 26,100	0.15 m overburden	AMNS	Contractor Quote
	placing and grading topsoil	6,000	cubic meters	$ 9.25	$ 55,500	0.25 m growth media	AMNS	Contractor Quote
	Native grass seeding and fertilizing	12,000	square meters	$ 0.57	$ 6,840	50% of total area	AMNS	Contractor Quotes / Estimated
	Planting topsoil capping with native species related to foresty	12,000	square meters	$ 0.99	$ 11,880	50% of total area	AMNS	Contractor Quotes / Estimated
Seal buried raw water pipeline	Seal and leave in place	1	Allowance	$ 5,000.00	$ 5,000	Remove pipe to 1 m below grade, cap and leave in place		Estimated
Removal and disposal of above-ground Pipelines		1	Allowance	$ 75,000.00	$ 75,000	Remove and transport offiste for disposal at licensed landfill	AMNS	Professional Experience
				Subtotal Other Areas	**$ 247,320**			
Water Treatment System								
Construction of post closure WTS - ditch, pond, spillway, channel	construction of closure WTS and conveyance	1	Capex	$ 374,347.00	$ 374,347		Ausenco	Contractor Estimate for FS study
				Subtotal Other Areas	**$ 374,347**			
Other Water Management Components								
North Settling Pond	Drain pond	1	Allowance	$ 5,000.00	$ 5,000		AMNS	Estimated
	Remove and dispose concrete outlet structure	1	Allowance	$ 5,000.00	$ 5,000	Remove and dispose offsite	AMNS	Estimated
	Remove and dispose geotextile, HDPE & Sand/Rirap layer	18,177	square meters	$ 15.00	$ 272,654	Remove and dispose offsite, unit rate includes tipping fee	AMNS	Estimated
	Regrade area and promote possitive drainage to the pit	16,000	square meters	$ 1.46	$ 23,360		AMNS	Contractor Quotes
	Placing and grading topsoil	4,000	cubic meters	$ 9.25	$ 37,000	Entire area, 0.25 m thick	AMNS	Contractor Quotes
	Native grass seeding and fertilizing	16,000	square meters	$ 0.57	$ 9,120	Entire area	AMNS	Contractor Quotes / Estimated
East Settling Pond	Drain pond	1	Allowance	$ 5,000.00	$ 5,000		AMNS	Estimated
	Remove and dispose concrete outlet structure	1	Allowance	$ 5,000.00	$ 5,000	Remove and dispose in the pit	AMNS	Estimated
	Remove and dispose geotextile, HDPE & Sand/Rirap layer	11,962	square meters	$ 5.00	$ 59,812	Remove and dispose in the pit	AMNS	Estimated
	Regrade area	11,000	square meters	$ 1.46	$ 16,060		AMNS	Contractor Quotes
	Placing and grading topsoil	2,750	cubic meters	$ 9.25	$ 25,438	Entire area, 0.25 m thick	AMNS	Contractor Quotes
	Native grass seeding and fertilizing	11,000	square meters	$ 0.57	$ 6,270	Entire area	AMNS	Contractor Quotes / Estimated
South Settling Pond	Drain pond	1	Allowance	$ 5,000.00	$ 5,000		AMNS	Estimated
	Remove and dispose concrete outlet structure	1	Allowance	$ 5,000.00	$ 5,000	Remove and dispose in the pit	AMNS	Estimated
	Remove and dispose geotextile, HDPE & Sand/Rirap layer	10,488	square meters	$ 5.00	$ 52,440	Remove and dispose in the pit	AMNS	Estimated
	Regrade area	11,000	square meters	$ 1.46	$ 16,060		AMNS	Contractor Quotes
	Placing and grading topsoil	2,750	cubic meters	$ 9.25	$ 25,438	Entire area, 0.25 m thick	AMNS	Contractor Quotes
	Native grass seeding and fertilizing	11,000	square meters	$ 0.57	$ 6,270	Entire area	AMNS	Contractor Quotes / Estimated
SmartDitch	Remove and dispose SmartDitch (HDPE)	1	Allowance	$ 25,000.00	$ 25,000	Remove and dispose in the pit	AMNS	Estimated
	Placing and grading topsoil	1,422	cubic meters	$ 9.25	$ 13,151	Entire area, 0.25 m thick	AMNS	Contractor Quotes
	Native grass seeding and fertilizing	5,687	square meters	$ 0.57	$ 3,242	Entire area	AMNS	Contractor Quotes / Estimated
Clean Water Ditches	Left in place				$ -			
Contact Water Ditches	Left in place				$ -			
Water management to pit from PAG stockpile (divert water to pit)	Excavation	1,200	cubic meters	$ 11.42	$ 13,704	Assumed	AMNS	Contractor Quotes
	Geotextile	1,100	cubic meters	$ 5.40	$ 5,940	Assumed	AMNS	Contractor Quotes
	Riprap	330	cubic meters	$ 57.10	$ 18,843	0.3 m assumed	AMNS	Contractor Quotes
				Subtotal Water Diversion to Pit	**$ 659,800**			
Permitting, ESA								
Confirmatory Sampling at Fuel Storage/Handling Areas		1	Allowance	$ 10,000.00	$ 10,000	Allowance for inspection, targeted sampling and brief summary report.	AMNS	Estimated
Environmental Site Assessment (ESA), CSR Reporting	Assumes moderate impacts to soil under/around fuel storage/handling areas	1	Allowance	$ 40,000.00	$ 40,000	Allowance for assessment and reporting at 1-2 areas with limited complexity (e.g. limited to PHCs in shallow soil)	AMNS	Estimated
IA Amendment - End of Mining or 2027	Scope of amendment would include modification to monitoring program.	1	Allowance	$ 40,000.00	$ 40,000	Allowance for development, submission and approval of a post closure adaptive monitoring program.	AMNS	Estimated
Prediction of Water Quality in Flooded Open Pit	Water balance and mixing model (CQUAL or similar)	1	Allowance	$ 40,000.00	$ 40,000	Allowance	AMNS	Estimated
				Subtotal Permitting	**$ 130,000**			
Closure Monitoring								
Physical/Geotechnical Monitoring and Inspections	See Monitoring & Maintenance Table				$ 165,000			Estimated
Water Quality	See Monitoring & Maintenance Table				$ 513,360			Estimated
Revegetation Monitoring	See Monitoring & Maintenance Table				$ 115,000			Estimated
Ambient Air Monitoring	During active closure 2-year period	1	Allowance		$ 22,500			Estimated
Biological Monitoring (including EEM Program)	See Monitoring & Maintenance Table				$ 246,000			Estimated
Post Closure Maintenance / Repairs	See Monitoring & Maintenance Table				$ 150,800			Estimated
				Subtotal Closure Monitoring	**$ 1,212,660**			
				Subtotal	**$ 14,119,278**			
				Contingency (20%)	**$ 2,823,856**			
				Engineering and Project Management (10%)	**$ 1,411,928**			
				Total	**$ 18,355,061**			

Table 8-2 Closure Monitoring and Maintenance Cost Estimate

ACTIVITY/MATERIAL	UNITS	YEAR 1			YEAR 2			YEAR 3			YEAR 4			YEAR 5		
		QUANTITY	UNIT COST	COST	QUANTITY	UNIT COST	COST	QUANTITY	UNIT COST	COST	QUANTITY	UNIT COST	COST	QUANTITY	UNIT COST	COST
1 ***PHYSICAL STABILITY***																
Annual inspection by qualified engineer																
Open Pit and WRSF Stability, spillways	Inspection	1	$5,000	$5,000	1	$5,000	$5,000	1	$5,000	$5,000	1	$5,000	$5,000	1	$5,000	$5,000
Geotechncial assesment	Report							1	$50,000	$50,000						
2 ***CHEMICAL STABILITY***																
Environmental Monitoring - Final Effluent + 5 yrs after pit flooding																
1 person x 1hr = 1hr x $120/hr = $120 per sampling event	Each event	52	$120	$6,240	52	$120	$6,240	52	$120	$6,240	52	$120	$6,240	52	$120	$6,240
laboratory analytical costs (1 station x $210/station) = $210	Each event	52	$210	$10,920	52	$210	$10,920	52	$210	$10,920	52	$210	$10,920	52	$210	$10,920
Environmental Monitoring - Surface Water																
Monthly sampling of covered PAG waste rock pile + upstream and downstream in receiver for the first five years																
1 person x 4hr @ $120/hr = $480 per sampling event	Each event	12	$480	$5,760	12	$480	$5,760	12	$480	$5,760	12	$480	$5,760	12	$480	$5,760
laboratory analytical costs (3 stations x $210/station) = $630	Each event	12	$630	$7,560	12	$630	$7,560	12	$630	$7,560	12	$630	$7,560	12	$630	$7,560
Monthly upstream and downstream																
laboratory analytical costs 2 stations x $210/station) = $420	Each event		$420	$0		$420	$0		$420	$0		$420	$0		$420	$0
Semi-annual pit flooding starting 5 years prior to flooding																
laboratory analytical costs (1 stations x $210/station)	Each event		$210	$0		$210	$0		$210	$0		$210	$0		$210	$0
Environmental Monitoring - Groundwater																
Semi-Annual sampling events for 5 wells for 5 years																
2 people x 10hrs= 2x10hrx$120/hr= $3840 per sampling event	Each event	2	$3,840	$7,680	2	$3,840	$7,680	2	$3,840	$7,680	2	$3,840	$7,680	2	$3,840	$7,680
laboratory analytical costs (5 stations x $210/station) = $1,050	Each event	2	$1,050	$2,100	2	$1,050	$2,100	2	$1,050	$2,100	2	$1,050	$2,100	2	$1,050	$2,100
Others																
Reporting including QA/QC costs	Annual	1	$5,000	$5,000	1	$5,000	$5,000	1	$5,000	$5,000	1	$5,000	$5,000	1	$5,000	$5,000
3 ***REVEGETATION MONITORING***																
Semi-annual inspection of the revegetated areas	L.S.	2	$2,500	$5,000	2	$2,500	$5,000	2	$2,500	$5,000	2	$2,500	$5,000	2	$2,500	$5,000
Annual soil analyses for nutrient and pH	L.S.	1	$1,000	$1,000	1	$1,000	$1,000	1	$1,000	$1,000	1	$1,000	$1,000	1	$1,000	$1,000
Allowance of application of nutrients/fertilizer and additional broadcast seeding	L.S.							1	$20,000	$20,000	1	$20,000	$20,000	1	$20,000	$20,000
4 **ENVIRONMENTAL EFFECTS MONITORING**																
Toxicity sampling (including monthly and semi-annual) for initial 5 yrs + 5 yrs after pit flooding	Per year	1	$4,600	$4,600	1	$4,600	$4,600	1	$4,600	$4,600	1	$4,600	$4,600	1	$4,600	$4,600
One final study as per MMER requirements																
Final EEM Study and Report	L.S.									$0						
5 ***MAINENTANCE***																
General Site Monitoring																
Removal of debris from ditches	Each	1	$600	$600	1	$600	$600	1	$600	$600	1	$600	$600	1	$600	$600
Maintenance																
Road and cover maintenance	L.S.	1	$10,000	$10,000	1	$10,000	$10,000	1	$20,000	$20,000	1	$20,000	$20,000	1	$20,000	$20,000
TOTALS				**$71,460**			**$71,460**			**$151,460**			**$101,460**			**$101,460**

Note: 1. Thrice weekly sampling will be completed by site personnel on-site.

Costs are reported in 2021 Canadian dollars.

Table 8-2 Closure Monitoring and Maintenance Cost Estimate

	ACTIVITY/MATERIAL	UNITS	YEAR 6 - 13			YEAR 14-18			TOTAL COST
			QUANTITY	UNIT COST	COST	QUANTITY	UNIT COST	COST	
1	***PHYSICAL STABILITY***								
	Annual inspection by qualified engineer								
	Open Pit and WRSF Stability, spillways	Inspection	8	$5,000	$40,000				$65,000
	Geotechncial assesment	Report	1	$50,000	$50,000				$100,000
2	***CHEMICAL STABILITY***								
	Environmental Monitoring - Final Effluent + 5 yrs after pit flooding								
	1 person x 1hr = 1hr x $120/hr = $120 per sampling event	Each event	52	$120	$6,240	52	$120	$6,240	$43,680
	laboratory analytical costs (1 station x $210/station) = $210	Each event	416	$210	$87,360	260	$210	$54,600	$196,560
	Environmental Monitoring - Surface Water								
	Monthly sampling of covered PAG waste rock pile + upstream and downstream in receiver for the first five years								
	1 person x 4hr @ $120/hr = $480 per sampling event	Each event		$480	$0		$480	$0	$28,800
	laboratory analytical costs (3 stations x $210/station) = $630	Each event		$630	$0		$630	$0	$37,800
	Monthly upstream and downstream								
	laboratory analytical costs 2 stations x $210/station) = $420	Each event	96	$420	$40,320	60	$420	$25,200	$65,520
	Semi-annual pit flooding starting 5 years prior to flooding								
	laboratory analytical costs (1 stations x $210/station)	Each event	10	$210	$2,100		$210	$0	$2,100
	Environmental Monitoring - Groundwater								
	Semi-Annual sampling events for 5 wells for 5 years								
	2 people x 10hrs= 2x10hrx$120/hr= $3840 per sampling event	Each event		$3,840	$0		$3,840	$0	$38,400
	laboratory analytical costs (5 stations x $210/station) = $1,050	Each event		$1,050	$0		$1,050	$0	$10,500
	Others								
	Reporting including QA/QC costs	Annual	8	$5,000	$40,000	5	$5,000	$25,000	$90,000
3	***REVEGETATION MONITORING***								
	Semi-annual inspection of the revegetated areas	L.S.				2	$2,500	$5,000	$30,000
	Annual soil analyses for nutrient and pH	L.S.				1	$0	$0	$5,000
	Allowance of application of nutrients/fertilizer and additional broadcast seeding	L.S.				1	$20,000	$20,000	$80,000
4	**ENVIRONMENTAL EFFECTS MONITORING**								
	Toxicity sampling (including monthly and semi-annual) for initial 5 yrs + 5 yrs after pit flooding	Per year				5	$4,600	$23,000	$46,000
	One final study as per MMER requirements								
	Final EEM Study and Report	L.S.				1	$200,000	$200,000	$200,000
5	***MAINENTANCE***								
	General Site Monitoring								
	Removal of debris from ditches	Each	8	$600	$4,800	5	$600	$3,000	$10,800
	Maintenance								
	Road and cover maintenance	L.S.	4	$10,000	$40,000	2	$10,000	$20,000	$140,000
	TOTALS				**$310,820**			**$382,040**	**$1,190,160**

Note:
1. Thrice weekly sampling will be completed by site personnel on-site.
The monitoring phase is 10 years to align with the length for time for flooding of the underground workings.
It is assumed that IGM will operate in state of activity for 5 years and 5 years of post-closure monitoring.
Costs are reported in 2021 Canadian dollars.

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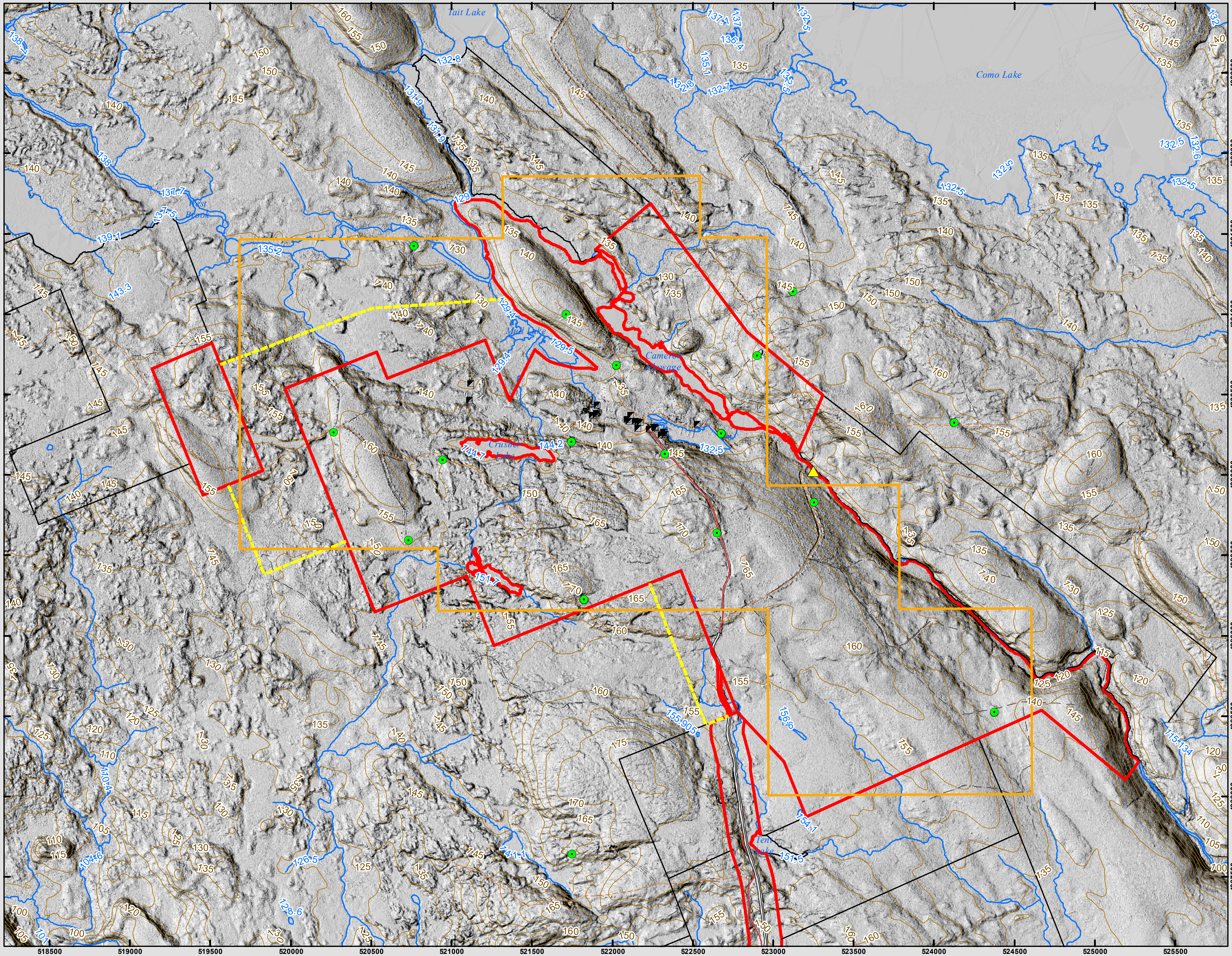
Appendix 1

Mine Development Phases (Pre-Development, Construction, and Operation)



Prepared For:

Atlantic Gold

Appendix A- Mine Development Phases

Figure 1: Site Prior to Development

Marinette, NS

- NSSA Lime Doser
- Historical Mine Workings
- Monitoring Wells
- Mineral Lease Boundary
- Property Boundary - Northern Timber
- Property Boundary - Crown land Lease
- PID Boundary
- Local Road
- Dry Weather / Seasonal Road
- Track
- Topo Line - 5m contour
- Watercourse/Waterbody - with elevation

Note: No buildings exist within the proposed Mineral Lease Boundary

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

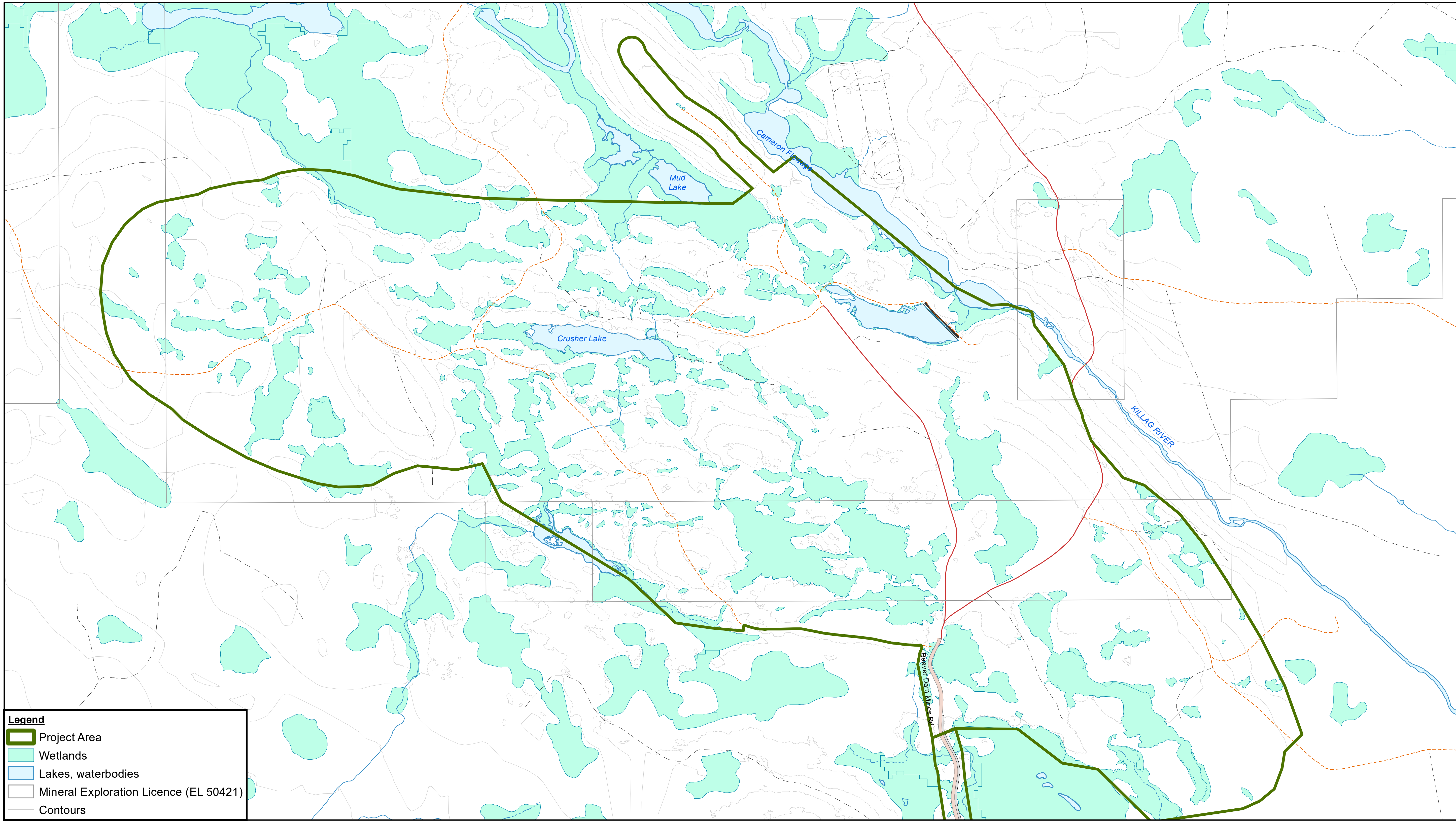
0 300 600 1,200 m

1:22,000 Scale when printed @ 11" x 17"

Drawn By: LP

Date: 2021-06-18

McCallum Environmental Ltd.



Source: Atlantic Gold, Service Nova Scotia, NS Natural Resources, NS Environment

0 140 280 420
Metres

Coordinate System:
NAD 1983 CSRS UTM Zone 20N

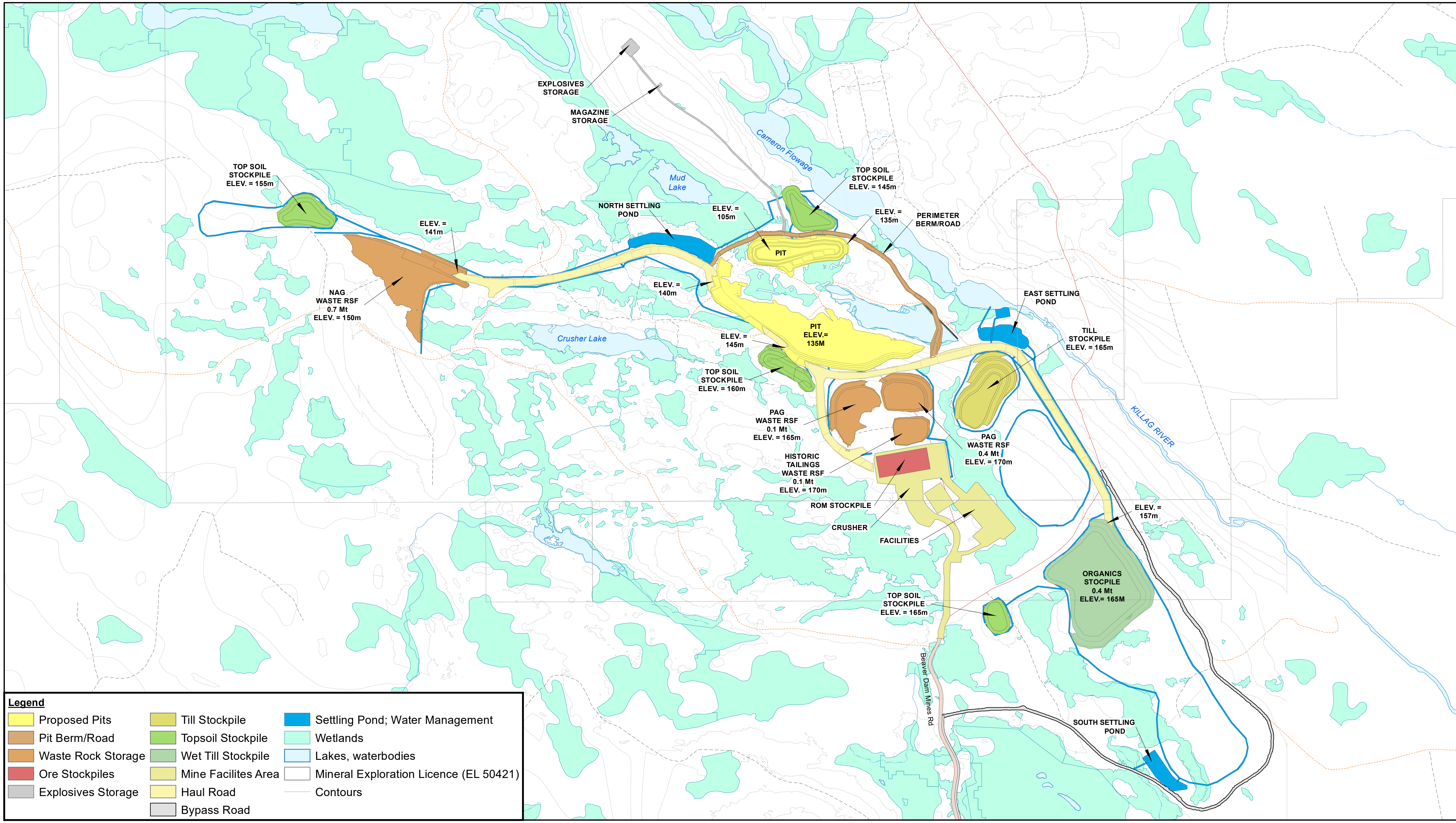
ATLANTIC MINING NS INC
MARINETTE, HALIFAX CO., NOVA SCOTIA
ENVIRONMENTAL IMPACT STATEMENT - BEAVER DAM MINE

RECLAMATION PLAN
PROJECT AREA

088664
May 11, 2021

FIGURE 2

GIS File: I:\GIS_DATA\Projects\6-chars\08----\088---\088664 Atlantic BD\088664(004)\Revised 2021\088664(004)GIS-DA070.mxd



Source: Atlantic Gold, Service Nova Scotia, NS Natural Resources, NS Environment

0 140 280 420
Metres

Coordinate System:
NAD 1983 CSRS UTM Zone 20N

N

GHD

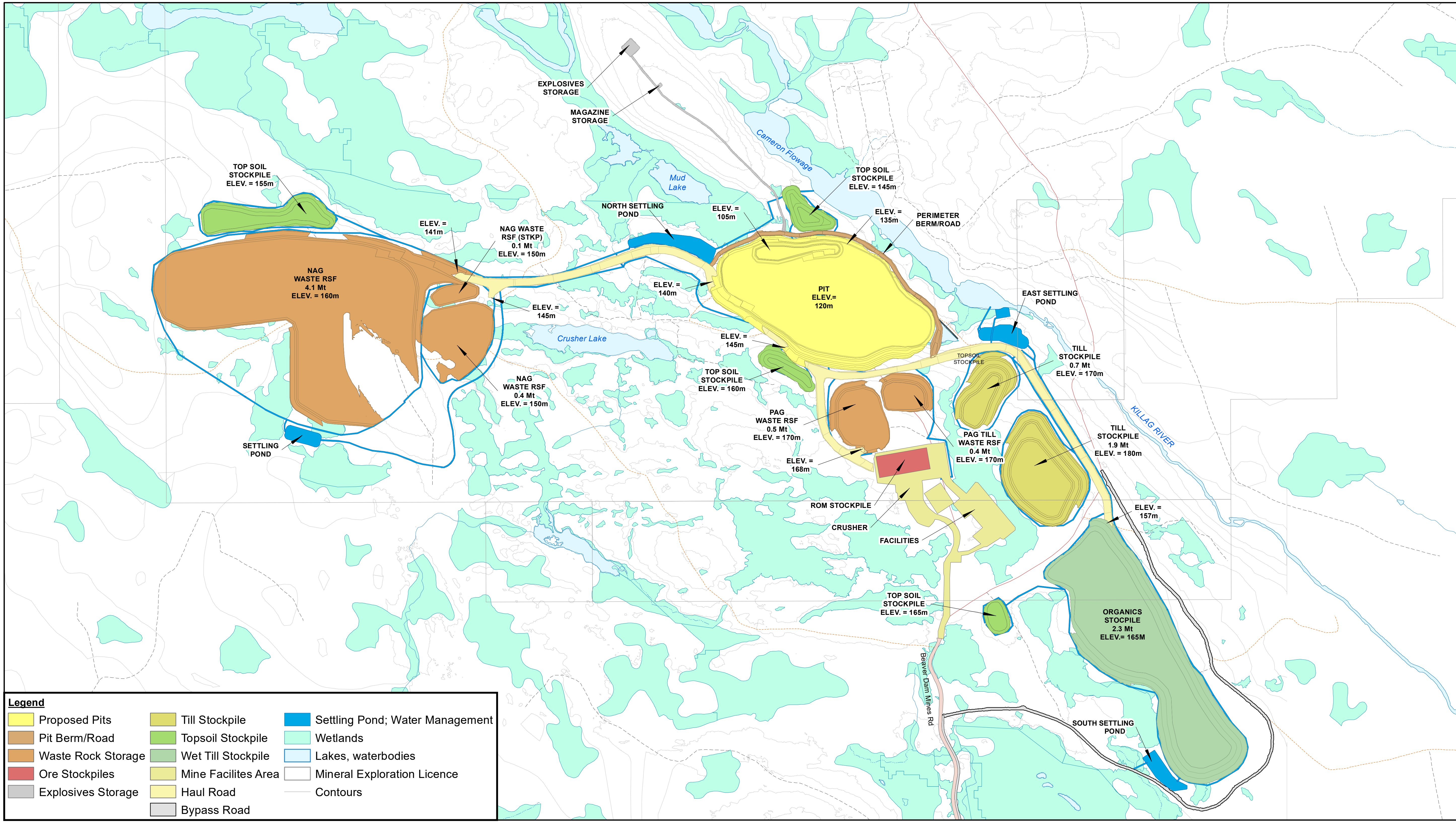
ATLANTIC MINING NS INC
MARINETTE, HALIFAX CO., NOVA SCOTIA
ENVIRONMENTAL IMPACT STATEMENT - BEAVER DAM MINE

END OF PERIOD - Q4 2022

088664
May 11, 2021

FIGURE 3

GIS File: I:\GIS_DATA\Projects\6-chars\08----\088---\088664 Atlantic BD\088664(004)\Revised 2021\088664(004)GIS-DA067.mxd



Source: Atlantic Gold, Service Nova Scotia, NS Natural Resources, NS Environment

0 140 280 420
Metres

Coordinate System:
NAD 1983 CSRS UTM Zone 20N

N

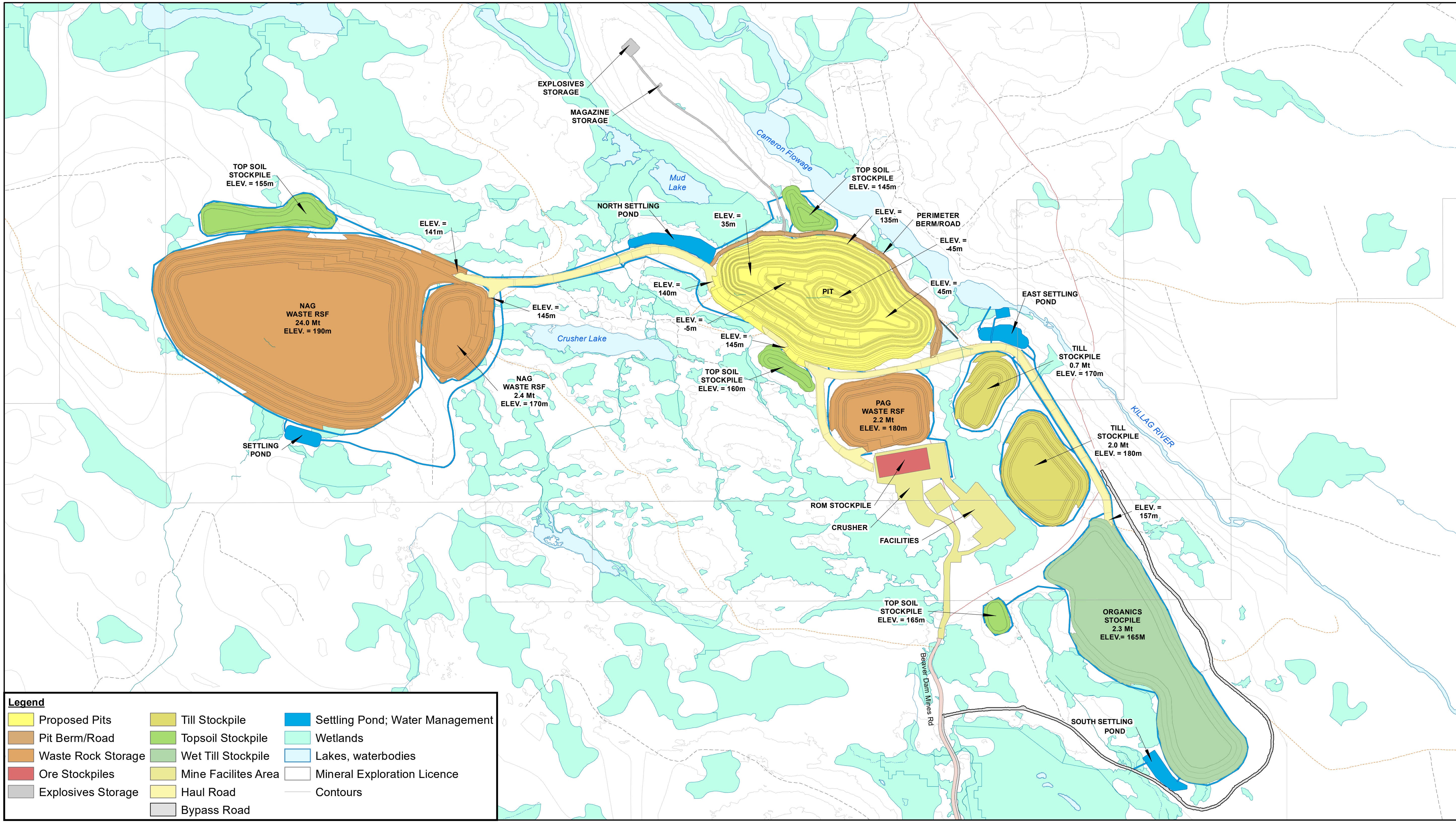
ATLANTIC MINING NS INC
MARINETTE, HALIFAX CO., NOVA SCOTIA
ENVIRONMENTAL IMPACT STATEMENT - BEAVER DAM MINE

MINE DEVELOPMENT
END OF PERIOD - Q2 2023

088664
May 11, 2021

FIGURE 4

GIS File: I:\GIS_DATA\Projects\6-chars\08----\088---\088664 Atlantic BD\088664(004)\Revised 2021\088664(004)GIS-DA068.mxd



Source: Atlantic Gold, Service Nova Scotia, NS Natural Resources, NS Environment

0 140 280 420
Metres

Coordinate System:
NAD 1983 CSRS UTM Zone 20N

N

GHD

ATLANTIC MINING NS INC
MARINETTE, HALIFAX CO., NOVA SCOTIA
ENVIRONMENTAL IMPACT STATEMENT - BEAVER DAM MINE

MINE DEVELOPMENT
END OF PERIOD - 2027

088664
May 11, 2021

FIGURE 5

GIS File: I:\GIS_DATA\Projects\6-chars\08----\088---\088664 Atlantic BD\088664(004)\Revised 2021\088664(004)GIS-DA069.mxd

Appendix 2

Open Pit Design and Cross-Sectional Drawings

1 DETAILED PIT DESIGN RESULTS

The following section describes the Beaver Dam detailed pit designs including Figures showing plan and section views.

1.1 Phase 0, P610, Starter Construction Phase

P610 targets the northwest portion of the ultimate pit limits, is sized to provide waste rock for the various Project construction activities and sited to avoid existing water features and predicted arsenic and historic tailings affected surface areas. This phase contains no resource. The pit exit at the 135 m elevation is located line up with existing on site roads, minimizing preparation work for development of this pit phase. The bottom of the phase, at the 105 m elevation, is accessed via a ramp on the south side of the pit running counter-clockwise from the pit exit.

1.2 Phase 1, P611, West Phase

P611 targets the west portion of the deposit and contains about 1.5 years of mill feed. It mines from the pit exit at the 135 m elevation, down to the pit bottom at the -55 m elevation. The in-pit ramp will run counter-clockwise down from the pit exit in the west end of the pit. The pit exit is chosen to face the waste rock stockpiles as most of the excavated material will run in this direction. An ex-pit road will run along the southern side of the pit, accessing the ROM and till stockpiles. At the 85 m bench, the pit splits into two separate pit bottoms, the western side will be mined to the bottom before the eastern side is progressed below the 85 m bench. From the top of the pit to the 125 m bench, the pit ramp is common with the Phase 2 pit. The western and northwestern sides of this phase are at the ultimate pit limits, with sufficient room for pushbacks to ultimate limits in all other directions. This phase will mine into the arsenic impacted areas of the pit as well as through the historic tailings. It is anticipated that these areas of the pit will be excavated as the Phase 0 pit is being mined.

1.3 Phase 3, P612, Ultimate Phase

P612 pushes the northeast, east and south wall to the ultimate limits and extends the bottom of the pit below the first pit phase. This phase contains about 2.0 years of mill feed and mines from the pit exit at the 135 m elevation, down to the pit bottom at the -45m elevation. The ramp will run counter-clockwise down from the pit exit in the west end of the pit and switchback at the 75 m bench elevation, running clockwise down to the bottom of the pit. The ramp location has been chosen to avoid the Mud Lake fault running along the north side of the pit, the ramp running underneath this contact. An ex-pit road is located on the south side of this phase, with portions of the road incorporated into the pit's upper benches.

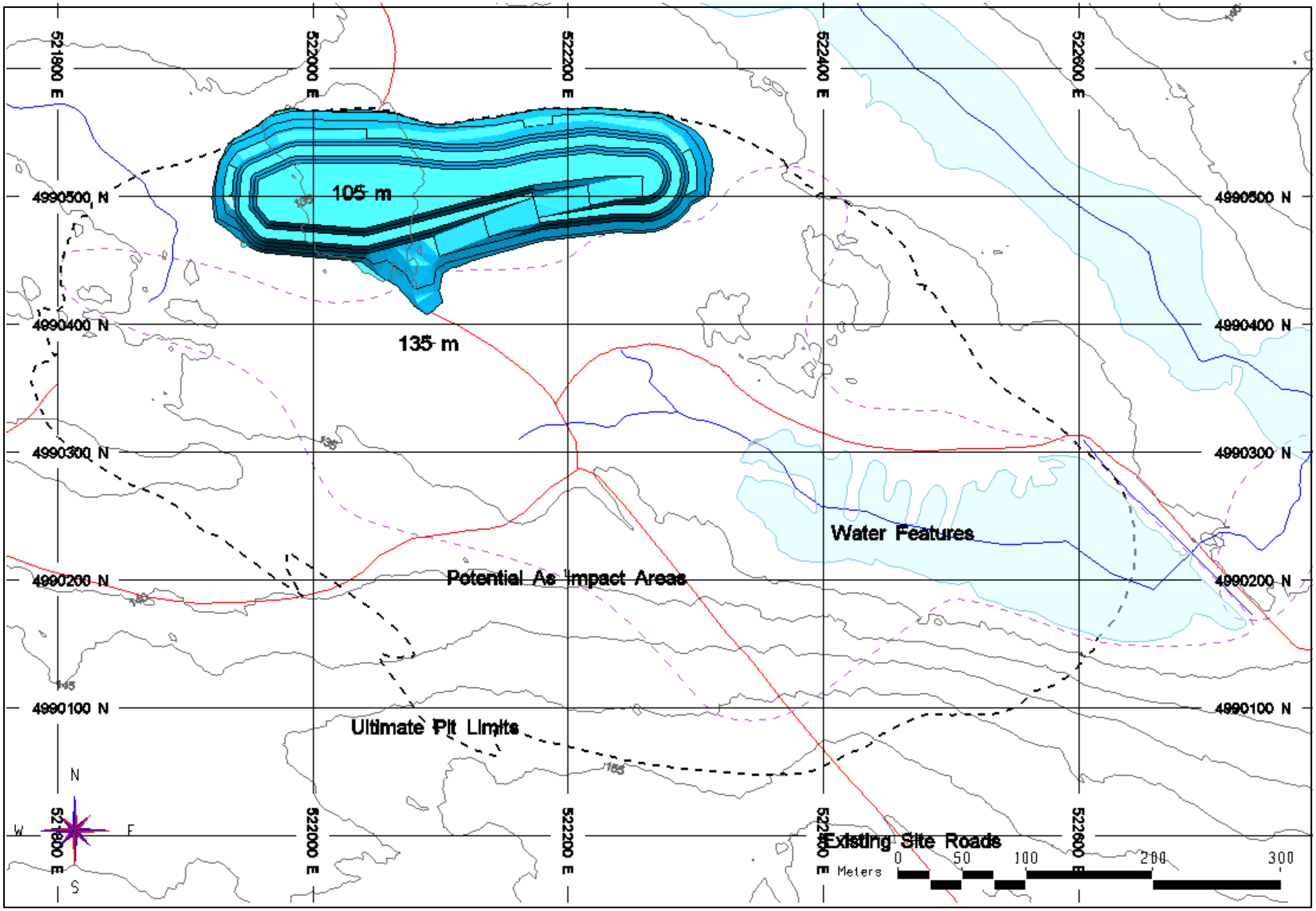


Figure 1: Phase 0 Detailed Pit Design, P610, Plan View (not for construction)

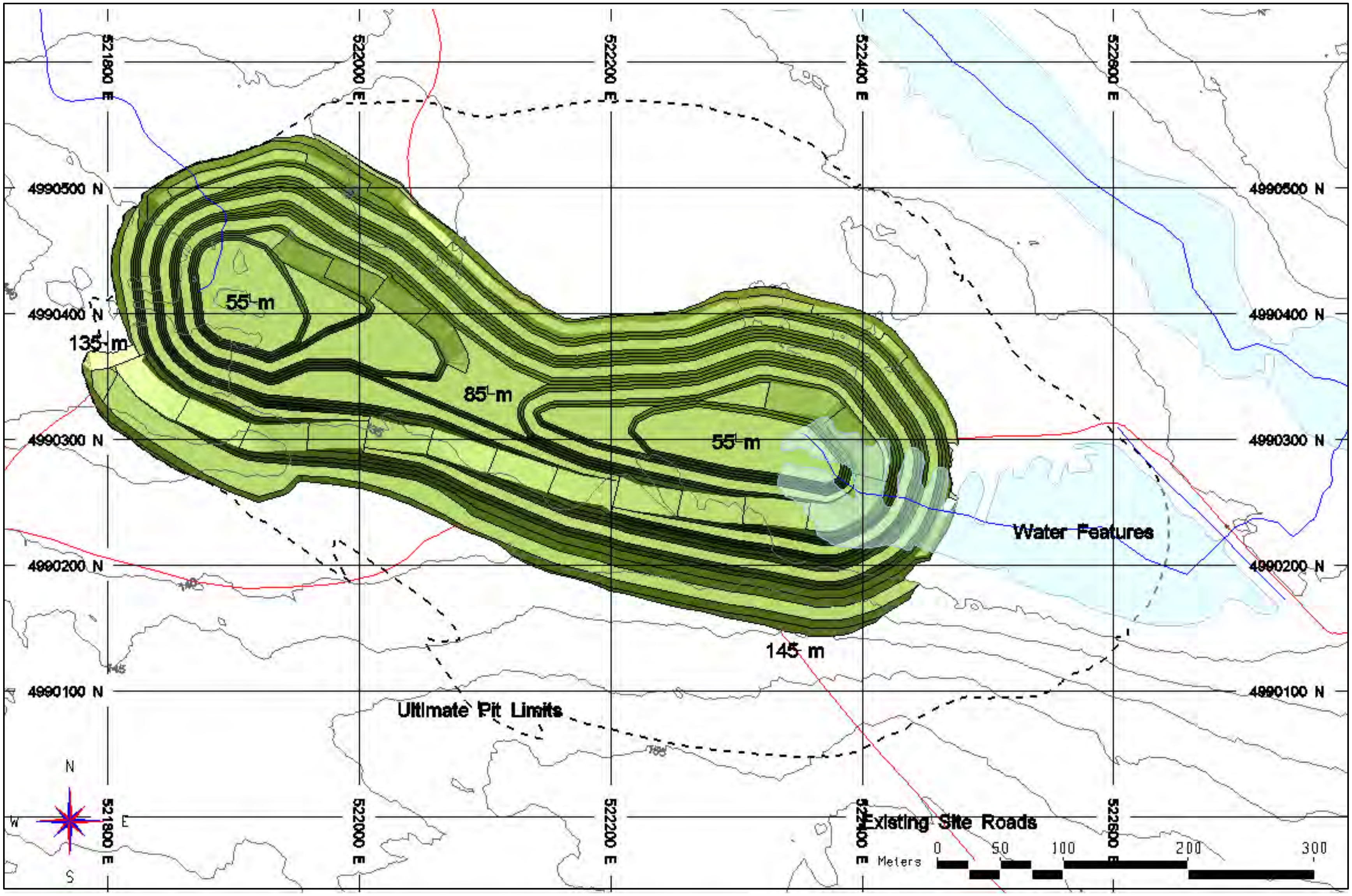


Figure 2: Phase 1 Detailed Pit Design, P611, Plan View (not for construction)

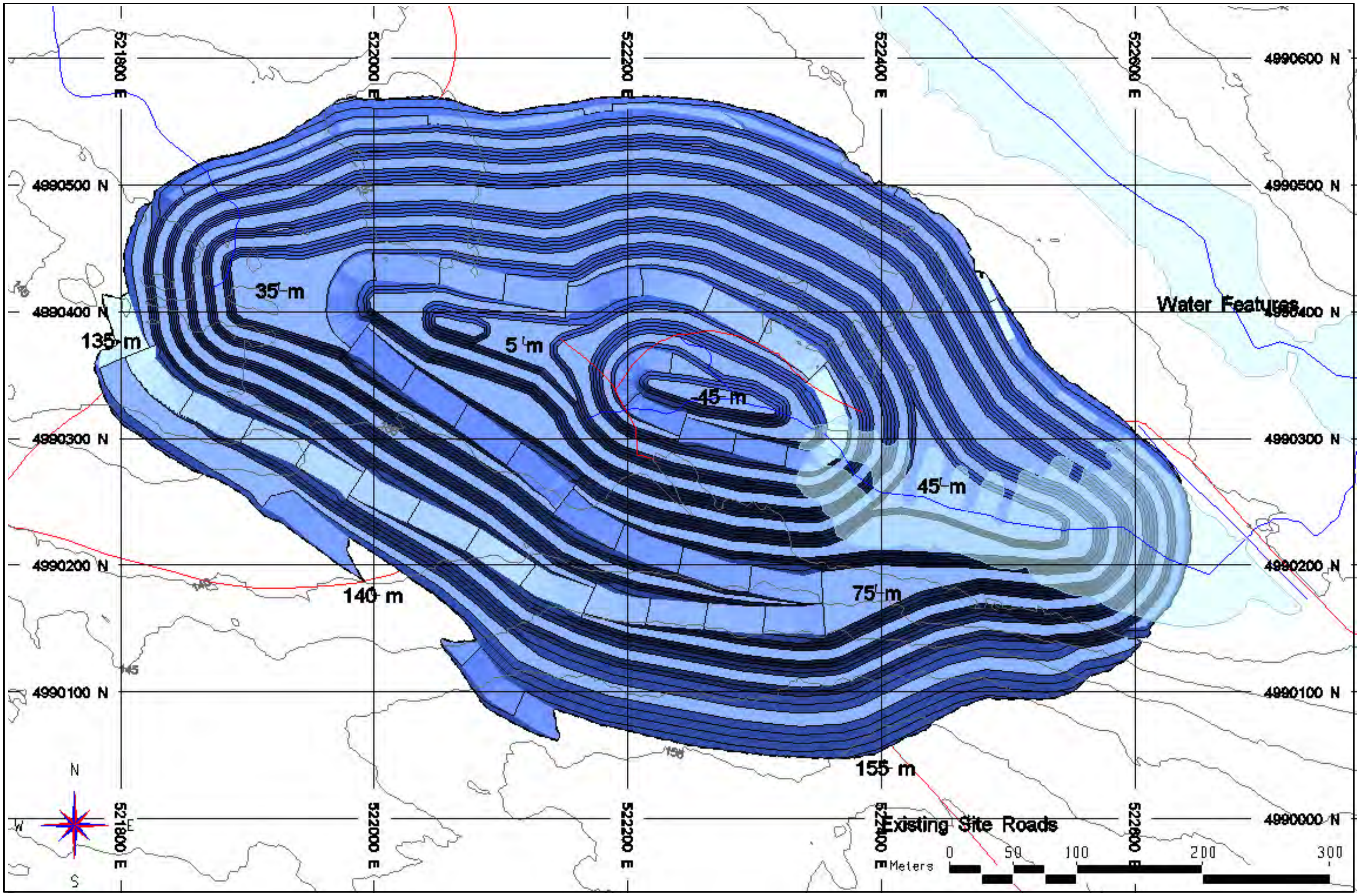


Figure 3: Phase 2 Detailed Pit Design, P612, Plan View (not for construction)

1.4 Nested Phases and Section Views

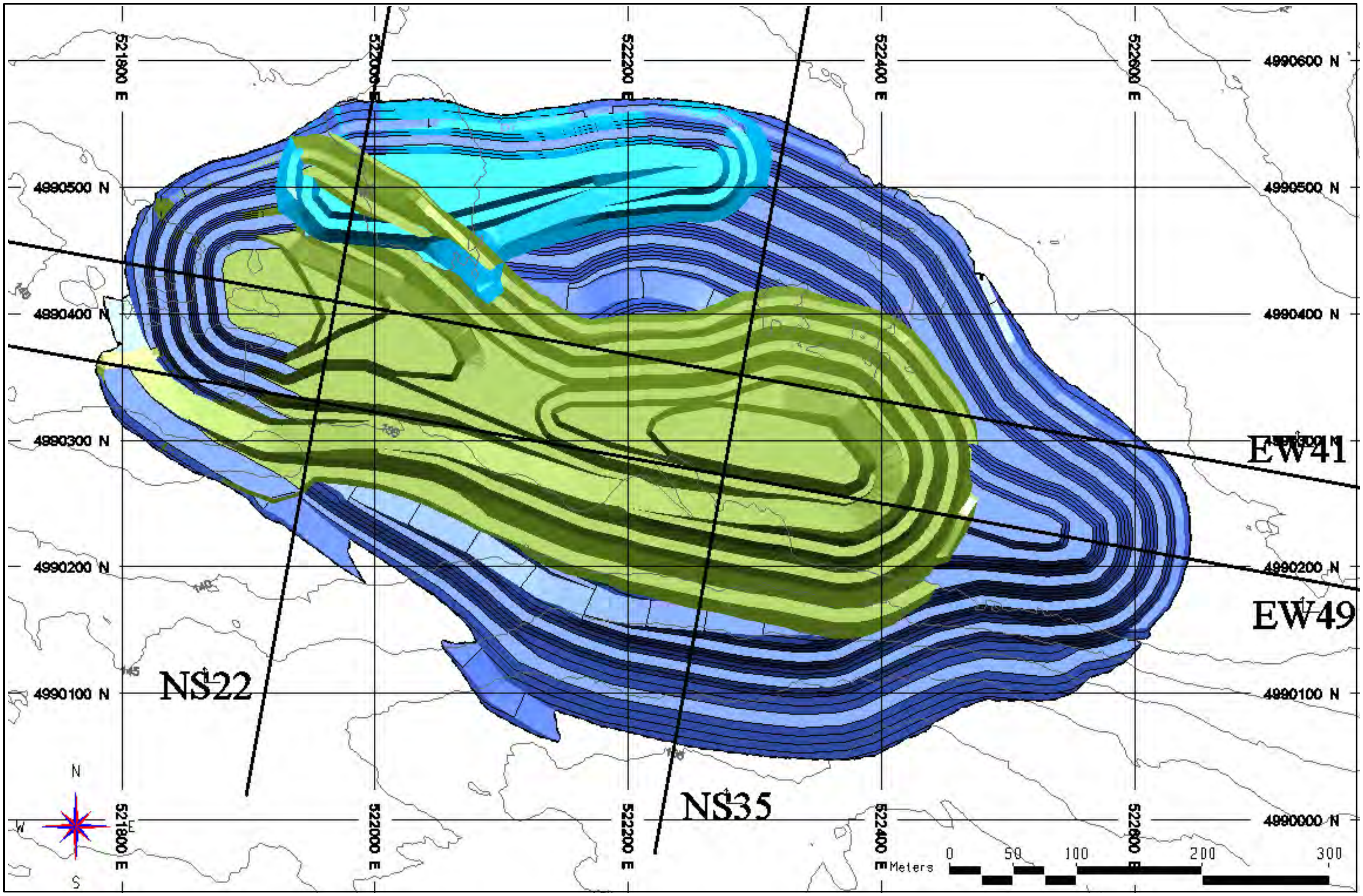


Figure 4: Nested Detailed Design Pit Phases, Plan View, P610 in cyan, P611 in green, P612 in blue (not for construction)

Blocks in the section views show gold grade in all blocks above a 0.40 g/t gold cut-off. Inferred blocks are shown as hatched. Block sizing is relative to the mineralized portion of the block. A block that is 50% mineralized appears half as large as a block that is 100% mineralized.

Green and brown lines in the section views represent the topography and till surfaces, respectively.

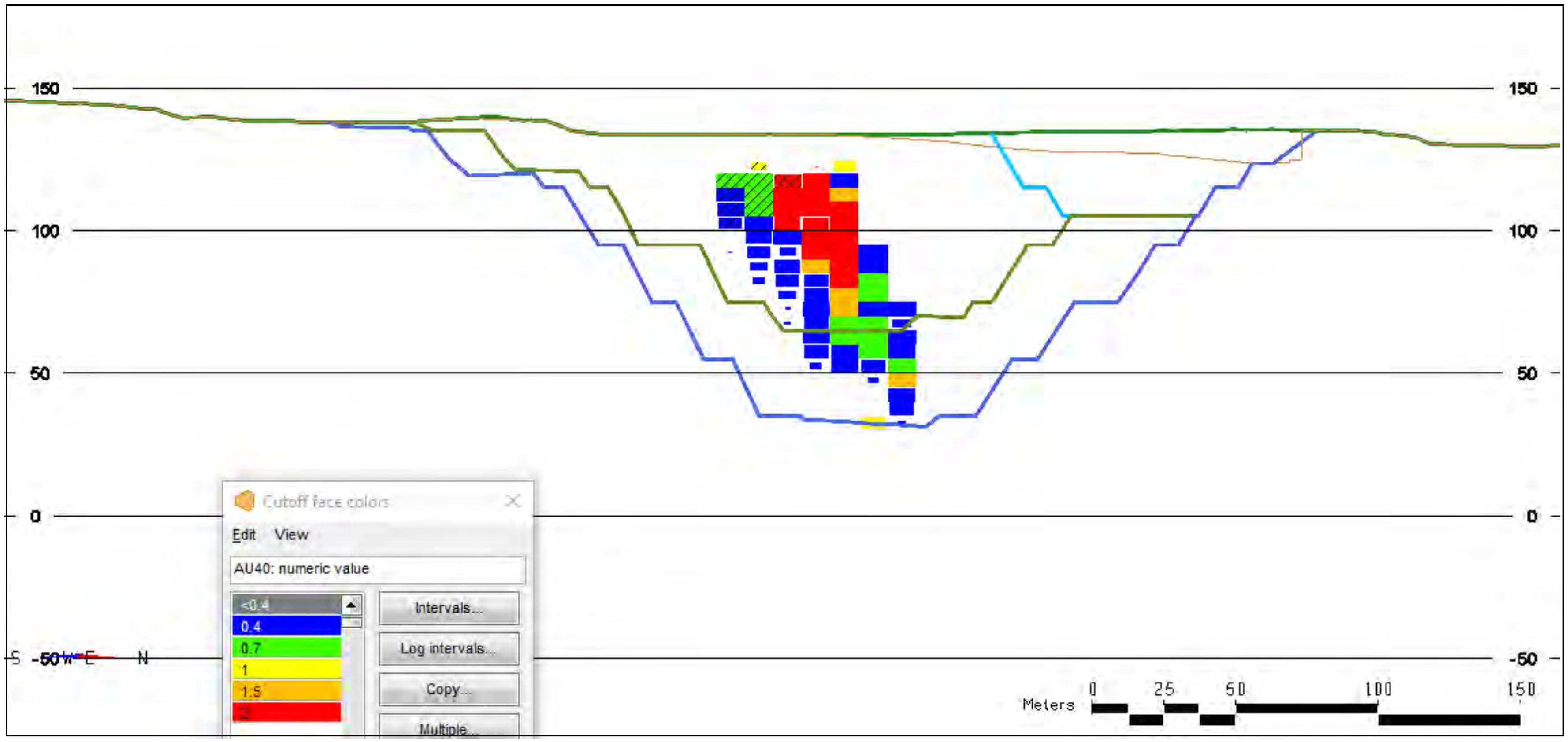


Figure 5: Detailed Design Pits, Section NS22, looking west, P610 in cyan, P611 in green and P612 in blue (not for construction)

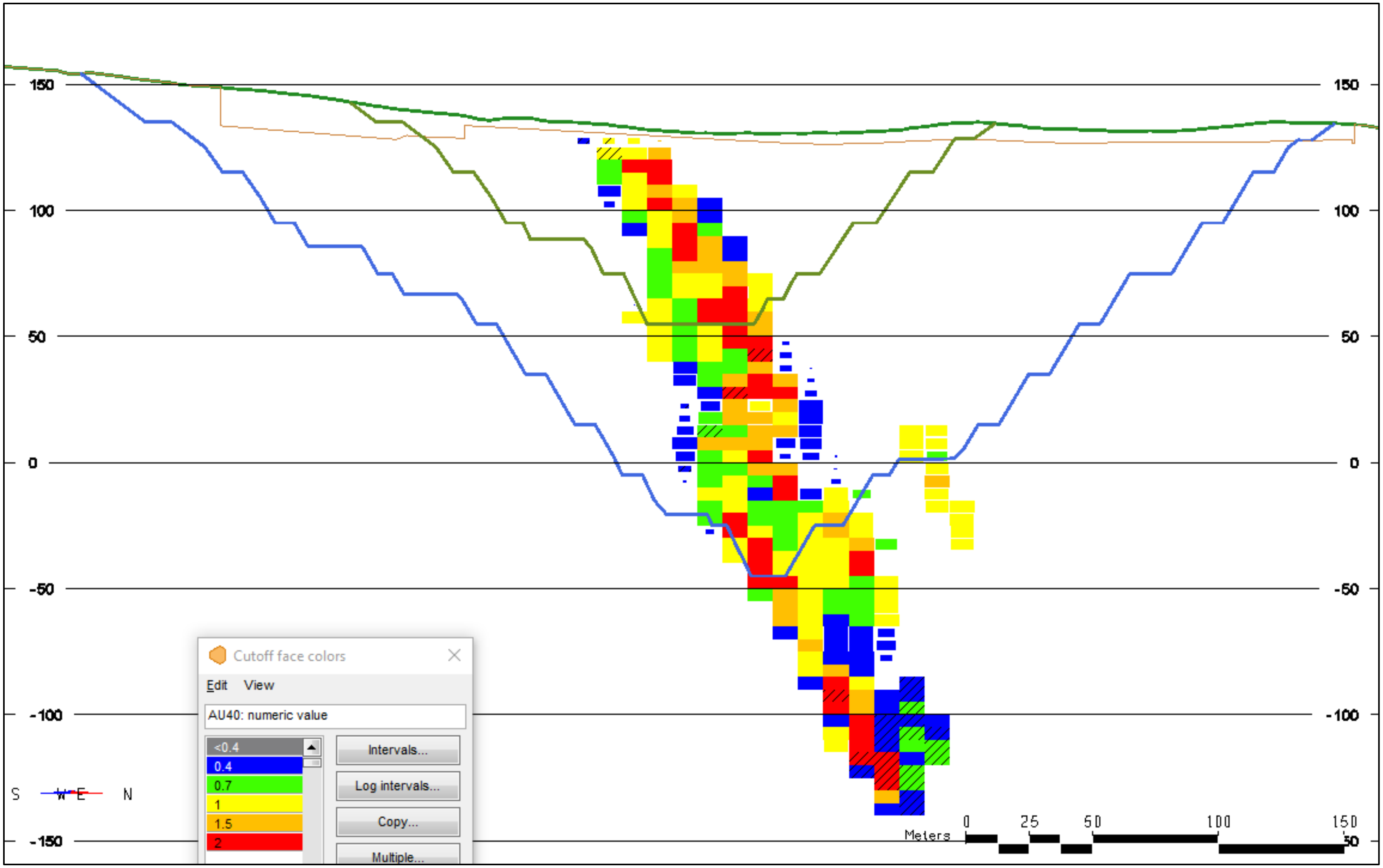


Figure 6: Detailed Design Pits, Section NS35, looking west, P611 in green and P612 in blue (not for construction)

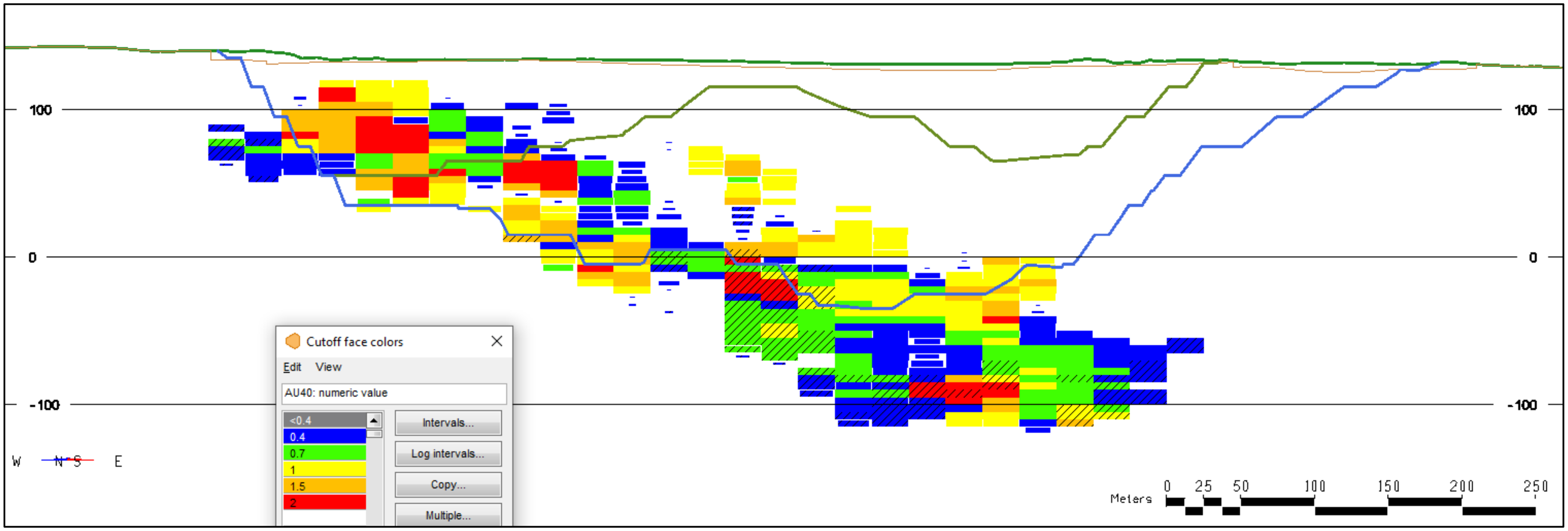


Figure 7: Detailed Design Pits, Section EW41, looking west, P611 in green and P612 in blue (not for construction)

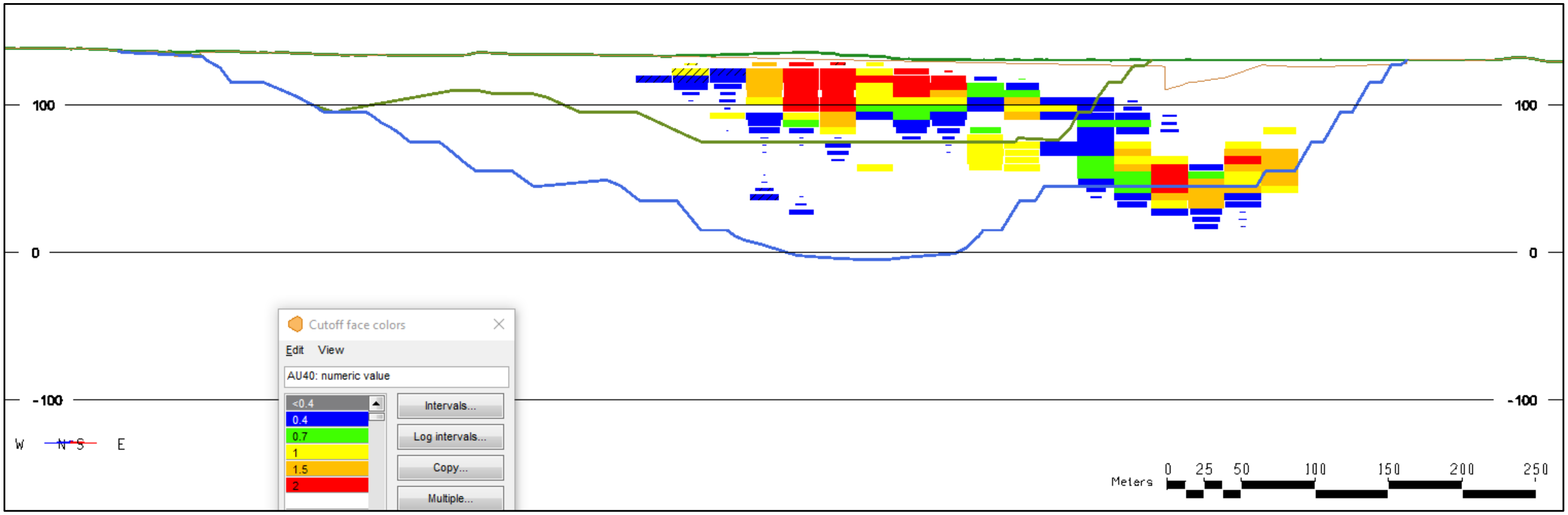


Figure 8: Detailed Design Pits, Section EW49, looking west, P611 in green and P612 in blue (not for construction)

Appendix 3

GHD Mine Water Management Plan Assessment

Not included in this copy of the Reclamation Plan to avoid replication: See EIS Appendix P4

Appendix 4

GHD Post Closure Phase Water Treatment Assessment

Post-Closure Phase

Water Treatment Assessment

Beaver Dam Gold Mine

Draft for Review

This document is in draft form. A final version of this document may differ from this draft. As such, the contents of this draft document shall not be relied upon. GHD disclaims any responsibility or liability arising from decisions made based on this draft document.

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1. Introduction

GHD Limited (GHD) was retained by Atlantic Mining Nova Scotia (previously Atlantic Gold) to develop a technical memorandum to identify and evaluate potential water treatment alternatives for the Beaver Dam Gold Mine (Project) in Marinette, Halifax County (Site), Nova Scotia during construction, operation, and post-closure (PC) phases. GHD already has developed a Water Assessment Report for the construction and operation phases. This report provides alternatives for water treatment system during the post-closure (PC) phase of the Project. GHD also has developed a Mine Water Management Plan (MWMP) in support of the Environmental Impact Statement (EIS). As part of the MWMP, GHD has completed a predictive water quality assessment for two life cycle stages of the mine development, including End-Of-Mine (EOM) and PC stages. For each life cycle, the potential effects of mine contact water on the water quality in the Killag River were assessed. These results show that zinc and cobalt are among exceeded parameters and need to be treated during the PC phase. The focus of this report is to identify and evaluate potential treatment techniques to address elevated metal concentrations during the PC phase of the Project in order to meet Metal and Diamond Mining Environmental Regulation (MDMER) objectives, as well as the Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life and Nova Scotia Environment (NSE) criteria at Killag River.

2. Site Background

The Project Site comprises approximately 145 hectares of lakes, rivers and forested lands that are in varying degrees of re-growth due to historical logging. The Project will operate as a satellite surface mine to the existing and fully permitted Touquoy Gold Mine, located nearby in Moose River Gold Mines, Nova Scotia. The ore that is mined from the Site will be processed at the existing Touquoy plant. The Project is anticipated to begin construction in 2021, come into production in 2022, cease operations in 2026, and then be reclaimed.

As part of the Project Site reclamation plan, the stockpiles will either be removed, vegetated, or capped and vegetated, to limit the potential need for treatment as determined through the Predictive Water Quality Analysis (GHD, 2021b). As a result, the East and South Settling Ponds will be decommissioned post-mine closure immediately, and the North Settling Pond will remain active until the open pit has been filled.

The non-acid generating (NAG) and potentially acid generating (PAG) waste rock stockpiles will remain in place, and the PAG waste rock stockpile will be capped and vegetated to reduce infiltration and seepage of contact water. The low-grade ore (LGO) stockpile will be removed and surface runoff from the area previously occupied by the LGO stockpile will be redirected to Mud Lake (Figure 2.1). The open-pit will be filled with water from direct precipitation, surface runoff, and groundwater inflows. Most of the surface runoff that was collected in the North Settling Pond during operating conditions will be diverted to the open pit to reduce the pit filling time. Once the pit has filled with water, overflow will be directed to the Killag River through an engineered outfall as it shown in Figure 2.1.

The till and organic stockpiles will also be removed during PC conditions. Surface runoff from these areas will continue to drain to the Killag River and Tent Lake drainage systems through Site ditches.

The Site is currently undeveloped and as such, power sources and utilities will be implemented on an as-needed basis depending on the Site requirements.

3. Treatability Criteria

The available water quality data were screened against two potential discharge criteria, Diamond Mining Environmental Regulation (MDMER) objectives and Canadian Council of Ministers of the Environment (CCME) guidelines for the Protection of Aquatic Life. MDMER regulations are used to assess End-Of-Pipe discharge concentrations while CCME and Site-Specific guidelines were used to assess concentrations within the Killag River after considering downstream mixing effect.

4. Data Review

4.1 Post-Closure (PC) Impacted Water Volume

The average monthly precipitation was obtained from the Environment Canada Middle Musquodoboit Climate Station (Climate ID 8203535) from 1961 to 2017. The station was selected based on its proximity to the Project Site and relatively long, complete, and current record. Furthermore, the flow of Killag River was used during different months of the year to back-calculate the maximum discharge concentrations from the Site while meeting CCME and NSE criteria at Killag River.

Table 4.1 summarizes the monthly total runoffs at the Site. The snow precipitation was converted to mm of rain and the results are presented as m of rain throughout the entire year.

Table 4.1 Monthly Site Runoff Flow Estimates

Month	Runoff to Pit (m^3/month)
January	109,511
February	95,107
March	144,861
April	126,351
May	78,022
June	62,071
July	57,873
August	63,512
September	76,472

Table 4.1 Monthly Site Runoff Flow Estimates

Month	Runoff to Pit (m^3/month)
October	106,263
November	133,016
December	119,015

4.2 Water Quality

A water balance model was developed for the Beaver Dam Mine Site in order to determine the predicted monthly and annual stream flows between the three mine development stages at five locations where the Site will discharge or impact flows in the natural environment (GHD, 2021a). The flows predicted in the water balance model were used as inputs, along with stockpile source terms and background water quality concentrations, into a predictive water quality assessment to determine the projected water quality of the Site effluent and within the Killag River, downstream of the Site (GHD, 2021b).GHD has developed a mass balance model for PC condition and found that Cobalt (Co) and Zinc (Zn) are among exceeded elements for a specific period of the year. In the months of July and August, both Cobalt and Zinc are predicted to exceed regulatory limits in the Killag River. In order to meet regulatory limits, the concentrations in the pit must be decreased from the untreated concentration to the treated concentration requirement as per Table 4.2.

Table 4.2 Concentrations of Exceeded Elements at Post-Closure Phase

Constituent	July – Untreated Concentration (µg/L)	July – Treated Concentration Required (µg/L)	August – Untreated Concentration (µg/L)	August – Treated Concentration Required (µg/L)
Co	4.70	4.23	35.34	32.40
Zn	4.66	3.45	35.01	26.84

The difference between concentrations at the discharge point and for the Killag River is because of the mixing effects of other streams that contribute to the river flow downstream of the discharge location.

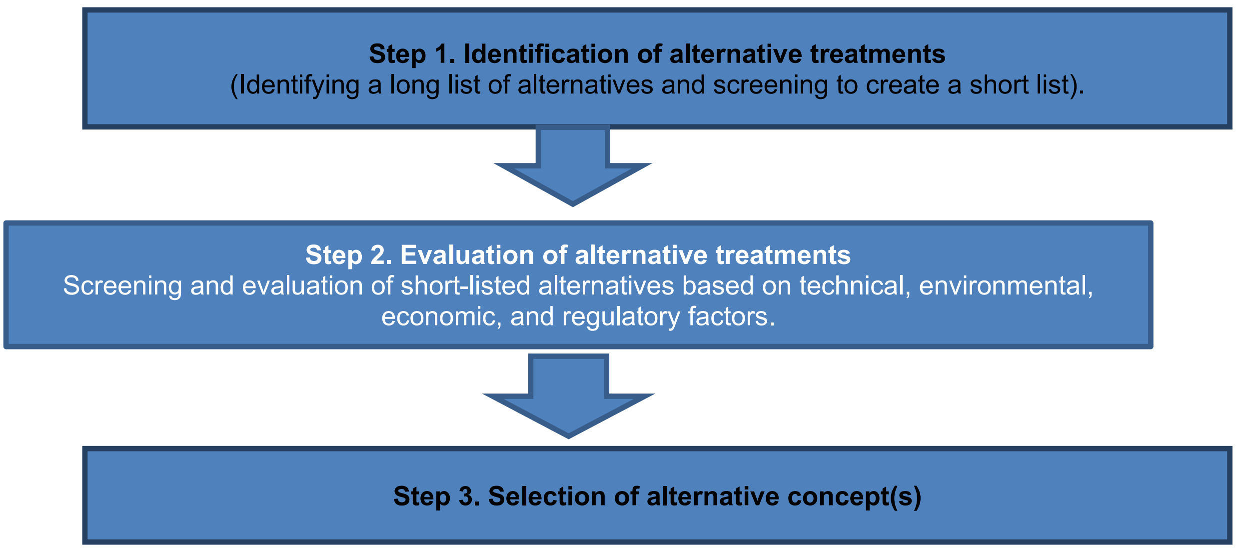
GHD also ran a worst-case scenario for the PC phase, once the precipitation is minimal and concentrations of metals are higher in impacted water. It was predicted that cadmium, nickel, lead, and nitrite will be among exceeded elements during the worst-case scenario at the PC phase that will need treatment. The focus of this memo is to address elevated concentrations of cobalt and zinc during the PC phase.

5. Treatability Technology Review

5.1 Methodology

The development of feasible alternatives for cobalt and zinc removal is based on a three-step process:

1. Identification of alternative treatments.
2. Evaluation of alternative treatments.
3. Selection of alternative concepts.



This approach allows for discussion and evaluation of alternatives, including reviewing the drawbacks and positive aspects of each alternative, as well as evaluating the feasibility of implementing each treatment option for impacted water during the PC phase of the Project. In the next step, alternatives were then subjected to a detailed evaluation based on technical, environmental, financial, regulatory considerations. This evaluation was subsequently used to identify the preferred alternative treatment system.

5.2 Long List of Alternatives

The following technologies were identified as potential alternatives:

- Anoxic Limestone Drains (ALDs)
- Successive Alkalinity Producing Systems (SAPS)
- Constructed Wetland
- Coagulation/Flocculation
- Aeration lagoon/Oxidation

- Adsorption
- Membrane filtration
- Evaporation
- Ion Exchange.

Further discussion regarding each technology is provided below:

Anoxic Limestone Drains (ALDs)

Anoxic limestone drains (ALDs) involve the burial of limestone in oxygen-depleted trenches. Impacted water is conveyed into these trenches. ALDs generate alkalinity and increase pH and must be followed by a unit such as an aeration cascade, pond, or aerobic wetland that oxidizes and removes the precipitated metals. Limestone is a low-cost and effective way to generate alkalinity and increase pH. However, it must be used in appropriate conditions to ensure its effectiveness.

ALDs are a form of hydroxide precipitation, which is one of the common techniques for the removal of heavy metals from wastewater. Metal solubility is a function of wastewater pH. As the pH of the water increases, dissolved metals start to react with hydroxide and become insoluble metal-hydroxides. Experience indicates that hydroxide precipitation techniques such as lime softening (hydroxide precipitation) can remove heavy metals up to 95 percent (Narasimhan & Lowry, J., 2003).

Available information shows that metals such as zinc and cobalt are among exceeded elements. Hydroxide precipitation is a feasible approach to reduce the concentration of such metals significantly. Hydroxide precipitation is a proven technology, for the reduction of zinc and cobalt concentrations, and it is a potential treatment step for impacted water at the PC phase.

An ALD consists of a trench containing limestone encapsulated in a plastic liner that is covered with clay or compacted soil. Surrounding the limestone with an impervious plastic liner also helps maintain anoxic conditions in the drain. The cap also prevents water infiltration and helps prevent carbon dioxide from escaping. Prior to the development and installation of an ALD, influent water must be characterized to ensure effective system design. This includes looking at seasonal variations. In addition to flow rate, important influent characteristics include dissolved oxygen content, acidity and alkalinity, and contaminant concentrations. Limestone used in ALDs is usually in the form of pebbles or rocks, with a particle spectrum ranging from 1.5 to 4 inches. Small-size particles provide more surface area for more rapid dissolution and alkalinity generation, while the larger-size particles will dissolve more slowly and provide system longevity and maintain distributed water movement through the drain.

ALDs can be installed in remote areas due to their passive nature and the fact that utilities are not required for implementation. ALDs may also be used to treat a wide range of flow rates. About 15 hours of contact time is necessary to achieve a maximum concentration of alkalinity. To achieve 15 hours of contact time within an ALD, 2,800 kilograms of limestone are required for each litre per minute (L/min) of peak flow. Therefore, ALD design typically involves calculating the size and mass needed to create an effective system based on the flow rate (EPA, 2014). Once the water exits the drain, a sufficient area must be provided for metal oxidation, hydrolysis, and precipitation to occur. Settling basins or ponds can be used for this purpose.

Successive Alkalinity Producing Systems (SAPS)

Successive alkalinity producing systems (SAPS) combine an ALD and a permeable organic substrate into one system that creates anaerobic conditions prior to water contacting the limestone. A SAPS contains a combination of limestone and compost overlain by several feet of water. Mine drainage enters at the top of the pond, flows down through the compost where the drainage gains dissolved organic matter and becomes more reducing, and then flows into the limestone below, where it gains alkalinity. Dissolution of the limestone raises the pH of the water, resulting in the precipitation of metals. The precipitated metals collect at the base of the SAPS system and in the downstream settling pond. Regular maintenance is required to prevent system clogging and replenish the compost material. Monitoring for overflows and the pressure on the influent side of the system can indicate system clogging and serve as an indicator that the limestone media may need to be replaced.

Constructed Wetland

Constructed wetlands are built on the land surface using soil or crushed rock/media and wetland plants. Constructed wetlands can be designed as aerobic wetlands, anaerobic horizontal-flow wetlands, and vertical-flow ponds (vertical-flow wetlands). Constructed treatment wetlands are designed to treat contaminants over a long period and can be used as the sole technology, where appropriate, or as part of a larger treatment approach. Contaminants are removed through plant uptake, volatilization, and biological reduction. The soil- and water-based microbes remove dissolved and suspended metals from acid mine drainage. The primary advantages of wetland treatment are low capital and operation and maintenance costs (EPA, 2014).

Constructed wetland systems are generally easy to maintain. Monitoring for saturation, spillover and sedimentation is needed. Periodic dredging of sediments may be necessary. Wetlands work well in remote locations or situations where constant monitoring or maintenance may be impractical. The main disadvantage of a wetland is the periodic release of captured contaminants during high-flow periods or periods when vegetation decomposes. The other drawback is low removal efficiency during cold temperatures.

Coagulation/Flocculation

Coagulation is another form of precipitation that involves the addition of a coagulant such as alum or an iron-based coagulant to wastewater. Ferric salts can remove metals in soluble, complexed, chelated, colloidal, emulsified, and particulate form. iron-based coagulants like ferric chloride are more effective at removing arsenate than aluminum-based counterparts. Ferric chloride is also one of the least expensive forms of ferric salt. Iron flocs settle faster than aluminum flocs. Ferric chloride is also effective over a wider range of pH than aluminum derivatives.

Coagulation/flocculation is usually followed by a clarification step. Clarification could take place by using gravity settling or forced filtration using a geomembrane or other type of filtration. The most common type of clarification is using a lamella clarifier, which would occupy less area than a settling pond for a given flow rate and could potentially improve the settling efficiency. Sludge would thicken to 1% to 3% solids in the gravity thickening section (sump) of the clarifier, where it could be drawn off for further dewatering (for instance, in a vacuum filter or a dewatering bag such as a geomembrane). The supernatant from the sludge dewatering would be recycled back into the treatment system influent. Overflow from the clarifier would be relatively clear of suspended solids and would be suitable for further processing.

TSS is one of the parameters that need to be monitored and potentially need to be addressed by any alternative water treatment system. Coagulation and flocculation are effective for the removal of turbidity/suspended solids from wastewater. Considering a coagulation/flocculation as one of the initial steps of the treatment system would significantly improve the efficiency of the treatment system and will increase the life span of the potential downstream adsorption units. Such clarification as the initial step of the treatment train will reduce the frequency of backwash events and will reduce the risk of potential membrane fouling. The operation cost of this alternative is significantly higher than passive alternatives because of chemical consumption. Furthermore, this method generates a significant amount of sludge that needs to be handled.

Oxidation

Oxidation can be used to reduce metals to a small degree. Aeration is one of the most applied oxidation methods in water and wastewater treatment systems. Surface agitation with air blowers is among the most common methods for introducing air to the water to increase the oxygen level and improve oxidation reactions. The problem with aeration is its slow reaction rate compared to other oxidants such as ozone or hydrogen peroxide. Aeration could oxide iron, manganese and to some degree heavy metals. The drawback of using aeration as an oxidation method is its low reaction rate, which makes it unsuitable for a high flow treatment system. Furthermore, the operation cost of this technique is significantly higher than passive treatment alternatives.

Adsorption

Adsorption is one of the simplest and low-tech treatment technologies for the removal of metals such as zinc and cobalt from impacted water (Deliyanni et al, 2015). Adsorption is a process where a chemical (usually in ionic form) is attached to the surface of a fixed bed of material and is removed from the flow of wastewater. There are different types of adsorbent material such as activated carbon (AC), activated alumina, zeolite, greensand, biosorbents, organoclay, etc. Adsorbents can also be selective for the removal of a certain species from the wastewater. Different forces affect the adsorption process and efficiency such as dipole-dipole interaction, van der waals, hydrogen bonding, and surface charge.

Adsorption units are usually located at the back end of the treatment systems as a polishing step for the removal of residual organic compounds as well as metals. High TSS could rapidly foul an adsorption column and there would be the need for more frequent backwashing or replacement of media. For that reason, adsorption usually follows a clarification/media filtration step.

It is expected that the TSS level may be high enough such that adsorption units must be protected by a pre-filtration step. Activated carbon (AC) has shown significant performance for the removal of metals such as arsenic from wastewater (Chang & Lin, 2009). Furthermore, adsorption is a safe technique that does not require sophisticated equipment. The main drawback of this technique is the need to periodically change out the adsorbent after it is exhausted. The cost of replacement and disposal is significant compared to passive alternative techniques.

Membrane processes

Membrane separation is a physical separation technique in which feed water is forced to pass a semi-permeable membrane at a high pressure to separate specific materials such as suspended solids, organic compounds, and even ions from the feed water. Based on membrane pore size, there are different types of membrane processes such as microfiltration, ultrafiltration, nanofiltration, and reverse osmosis (RO).

Micro, Ultra and Nano Filtration (MF, UF, NF)

Particles larger than 0.1 micrometer (µm) could be removed by microfiltration. The required feed pressure for microfiltration is usually less than 2 bar. Macromolecules and particulates which have sizes less than 0.1 µm, but greater than 2 nanometers (nm) could be removed by ultrafiltration. The feed pressure for an ultrafiltration membrane is between 1 to 10 bar.

For separation of particles/molecules with sizes between 1 to 2 nm, nanofiltration is a potential treatment option used in water treatment with low total dissolved solids (TDS). High TDS means there is a high risk of fouling if membrane technology is applied without any pre-treatment.

Reverse osmosis (RO)

In RO systems, a membrane with pore sizes less than 1 nm is used. RO filtration is used to remove salt, ions, and small organic molecules from feed water. In reverse osmosis (RO), a pressure greater than the osmotic pressure is applied to force a solvent through a semi-permeable membrane, leaving solutes behind. This process is capable of producing nearly de-ionized water.

Each RO unit produces an enriched side stream of “reject” water, which must be disposed of and may constitute 20% to 40% of the influent volume, or more. The efficiency of a RO system depends on variables such as the feed pressure and the ionic strength of the influent. The applied pressure required in an RO system is a function of the ionic strength of the influent.

The risk of RO fouling is high, and RO units are relatively expensive to operate as it requires regular membrane cleaning and/or exchange. For the feed water with high TDS levels, the life span of the membranes is even lower and there is a risk of membrane fouling. For such risk, membrane water treatment will not be a good choice for the PC phase.

Evaporation

Evaporation is an energy-intensive treatment for water and wastewater treatment. However, it is a feasible option for treatment trains with lower flow rates. Evaporation could produce near to deionized condensed water. There are enhanced mechanical vapour recompression (MVR) units that exploit the latent heat of compression to enhance evaporation. This technique will not be feasible for the PC phase because of high maintenance and operation cost.

Ion exchange

Ion exchange is the reversible exchange of contaminant ions with more desirable ions of a similar charge adsorbed to solid surfaces known as ion exchange resins. The active process provides hardness removal, desalination, alkalinity removal, radioactive waste removal, ammonia removal and metals removal. Typical ion exchangers are ion-exchange resins (functionalized porous or gel polymer), zeolites, and clay. Ion exchangers are either cation exchangers, which exchange positively charged ions (cations), or anion exchangers, which exchange negatively charged ions (anions). Some amphoteric exchangers can exchange both cations and anions simultaneously. However, the simultaneous exchange of cations and anions can be more efficiently performed in mixed beds, which contain a mixture of anion- and cation-exchange resins or passing the treated solution through several different ion-exchange materials. The operation cost of this alternative is relatively high. The resin needs periodic regeneration, which generates a concentrated stream that needs to be treated or hauled off-site.

5.3 Screening of Feasible Alternatives & Development of Short List

It is expected that there will be a level of metals such as cobalt and zinc in the impacted water that exceed the required concentrations in the PC phase of the project. Any alternative water treatment will consist of three main steps:

1. Pre-treatment and conditioning (mostly for TSS removal).
2. Metal remediation/removal.
3. Polishing/settling pond.

The screening of the long list of treatment technologies was conducted by considering:

- The removal efficiency of each technology and the ability of the treatment technology to achieve the discharge limits for each COC.
- The feasibility and ease of implementation.
- Any operational limitations.
- Capital and operational costs.

Table 5.1 presents the evaluation matrix for all potential treatment alternatives included in the long list of alternatives. Alternatives are colour-coded: green represents options that are good to very good in general, gray means fair to moderate options, and orange represents the least favourable (i.e. poor) options.

Table 5.1 Summary of initial screening of potential treatment options

Technology	Target COCs	Efficiency/ performance	Operational cost and maintenance	Health and Safety	Feasibility of Implementation	Overall evaluation	Comments
Anoxic Limestone Drains (ALDs)	Metals	High	Low	Low risk	Extensive	Good to very good	○ Very effective for metal removal. ○ Neutralization might be needed afterwards. ○ Excessive iron and aluminum precipitation in an ALD will reduce the effective lifetime of the bed by armouring the stone, resulting in reduced permeability and calcite dissolution rate.
Successive Alkalinity Producing Systems (SAPS)	Metals	High	Low	Low risk	Extensive	Good	○ Longevity is a concern for SAPS, especially in terms of water flow through the limestone.
Constructed Wetland	Metals, organics	Moderate	Low	Low risk	Extensive	Fair	○ Require a large amount of land per unit volume of water. ○ Wetland removal efficiencies may decline during winter. ○ Periodic release of captured contaminants may occur during high-flow periods or periods when vegetation decomposes.
Coagulation/Flocculation	TSS, metals	Limited	High	Low risk	Extensive	Poor	○ Generates sludge that needs management.

Table 5.1 Summary of initial screening of potential treatment options

Technology		Target COCs	Efficiency/ performance	Operational cost and maintenance	Health and Safety	Feasibility of Implementation	Overall evaluation	Comments
								○ High operation cost due to coagulant and polymer consumption.
Oxidation/Aeration		Metals	Limited	Low	Low risk	Extensive	Fair	○ Effective for metals and organics oxidation. ○ It is a slow process. And usually needs high hydraulic retention time.
Adsorption	AC	Organic compounds, metals	High for organics and metals	High	Low risk	Extensive	Fair	○ Disposal issues could develop in the GAC treatment media after the contaminants are concentrated within the media. ○ Requires pre-treatment to remove TSS.
	Zeolite	TPHs, organic compounds, metals	Limited	Low	Low risk	Only common for specific applications	Poor	○ Low exchange capacity which will force more frequent backwashing. ○ Limited chemistry stability.
	Organoclay	TPHs, organic compounds	Limited	Low	Low risk	Growing application	Poor	○ Effective on removal of organic compounds.
Membrane filtration	Microfiltration	TSS	Limited	Moderate	Low risk	Extensive	Poor	○ Effective on TSS removal, not soluble
	Ultrafiltration	TSS	Limited	Moderate	Low Risk	Extensive	Poor	○ Effective on TSS removal, not soluble compounds

Table 5.1 Summary of initial screening of potential treatment options

Technology		Target COCs	Efficiency/ performance	Operational cost and maintenance	Health and Safety	Feasibility of Implementation	Overall evaluation	Comments
	Nanofiltration	TSS, organic compounds	Limited	High	Low risk	Extensive	Poor	○ Susceptive to fouling ○ Not effective on removal of dissolved compounds
	Reverse Osmosis (RO)	Metals, organic compounds	High	Very High	Low risk	Extensive	Poor	○ Susceptible to fouling. ○ High operation and maintenance costs. ○ Generates concentrate
Evaporation		Metals, organic compounds	High	Very High	Moderate risk	Extensive	Poor	○ Energy-intensive treatment option. ○ Generates brine solution that needs further handling. ○ Good for smaller flow rates.
Ion exchange		Metals, organic compounds	High	Very High	Moderate risk	Extensive	Poor	○ High operation and maintenance costs. ○ Good for smaller flow rates.

6. Potential Treatment Methods

Reviewing estimated water quality data for the PC phase indicates that zinc and cobalt are the only exceeded elements. However, the exceedances are not significantly higher than the discharge limit and a passive water treatment system could reduce the concentration of these elements below discharge criteria. In mine-related settings, passive treatment systems are often designed to neutralize acidity and remove metals in drainage waters. Such systems do not require continuous chemical inputs because they are sustained by naturally occurring chemical and biological processes. Over the past years, a variety of passive treatment systems have been developed. The screening of a long list of alternatives technologies indicates that anoxic limestone drains (ALDs), and successive alkalinity producing systems (SAPS) are potential passive alternatives for addressing high concentrations of metals in impacted water during the PC phase. More details of each alternative are presented below.

6.1 Alternative 1. Anoxic limestone drains (ALDs) followed by aeration cascade and settling pond

In this treatment approach, impacted water will pass through a settling pond initially for the removal of suspended solids. Then, water will pass through a trench ALDs. ALDs generate alkalinity and increase the pH of the impacted water. By increasing the pH, metals such as zinc and cobalt will precipitate in their hydroxide forms. The ALDs will be followed by an aeration cascade, pond, or aerobic wetland that oxidizes and removes the precipitated metals. A settling pond then will provide enough hydraulic retention time in order to let those formed metal hydroxides precipitate. This treatment system is proposed due to its passive nature and the fact that utilities are not required for implementation. The success of an ALD depends on site-specific conditions, primarily on low dissolved oxygen, and minimal ferric iron and aluminum concentrations in the drainage.

The operation and maintenance cost of this alternative is minimal as no labour or power is needed. The main maintenance cost would be replacing depleted limestone which will depend on site condition and water chemistry. In the suitable condition, limestone could work efficiently for several years.

6.2 Alternative 2. Successive Alkalinity Producing Systems (SAPS) followed by settling pond

Successive alkalinity producing systems (SAPS) combine an ALD and a permeable organic substrate into one system that creates anaerobic conditions prior to water contacting the limestone. Anaerobic condition helps to remove organics and nitrite which is predicted to exceed the limit during the dry season at PC condition. At anaerobic condition, nitrite compounds are converted to nitrogen gas and is released into the atmosphere. Mine drainage enters at the top of the pond, flows down through the compost where the drainage gains dissolved organic matter and becomes more reducing, and then flows into the limestone below, where it gains alkalinity. Dissolution of the limestone raises the pH of the water, resulting in the precipitation of metals such as zinc and cobalt. The precipitated metals collect at the base of the SAPS system and in the downstream settling pond.

6.3 Footprint and Material Requirement

Th required footprint for both proposed alternatives are the same. The only difference would be a layer of organic material that might be needed to provide nutrition for bacterial activity. The selection of final alternative will depend on general chemistry of impacted water. A daily flow rate of 5000 m^3/day was assumed to size the water treatment system for the PC phase. The treatment proposed treatment system for PC phase will include an ALD, followed by an aeration cascade and final settling pond. A retention time of 12 hours was assumed to size the ALD. This time is selected in order to make sure maximum amount of alkalinity is generated in the ALD. Considering the design flow of 5000 m^3 per day, the volume of ALD is calculated equal to 2500 m^3. This volume will need to be filled with limestone rocks in order to provide alkalinity in an anoxic condition. To size the final settling pond, a retention time of 2 hours was assumed. Same calculation was performed and the size of final settling pond calculated at 420 m^3. Assuming a width of 20 meters, the length of treatment drain (including aeration cascade and final settling pond) would be around 150 meters. Figure 2.1 shows the proposed location for constructing this drain. This location (north to north-west of open pit) is selected in order to make sure there is enough space to construct the water treatment system, as well as having a better mixing downstream of Killag river.

7. Conclusions and Recommendations

It is expected that metals such as cobalt and zinc may be among elements that need treatment during the PC phase of the Project. This report summarizes alternative water treatment options to address elevated concentrations of these metals in impacted water. The alternative water treatment options were screened against capital and operational cost, maturity of technology, feasibility, and efficiency on removal of target contaminants. Two passive alternative treatment options are proposed for further evaluation, which include ALDs and SAPS. It is suggested that a cost-benefit analysis be conducted to select the most applicable option. The selection of final alternative will depend on chemistry of the impacted water. However, both proposed alternatives will need the same footprint and the only difference would be the organic layer that needs to be added for SAPS. The proposed alternatives are made of an anoxic alkalinity producing basin followed by an aeration cascade and final settling pond and there is no need for electricity power sources. The purpose of final settling pond is to provide retention time for settling of suspended solids generated as the result of anoxic alkalinity producing basin. A schematic of proposed alternative is shown in Appendix A.

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All of Which is Respectfully Submitted,

GHD

Name

Name

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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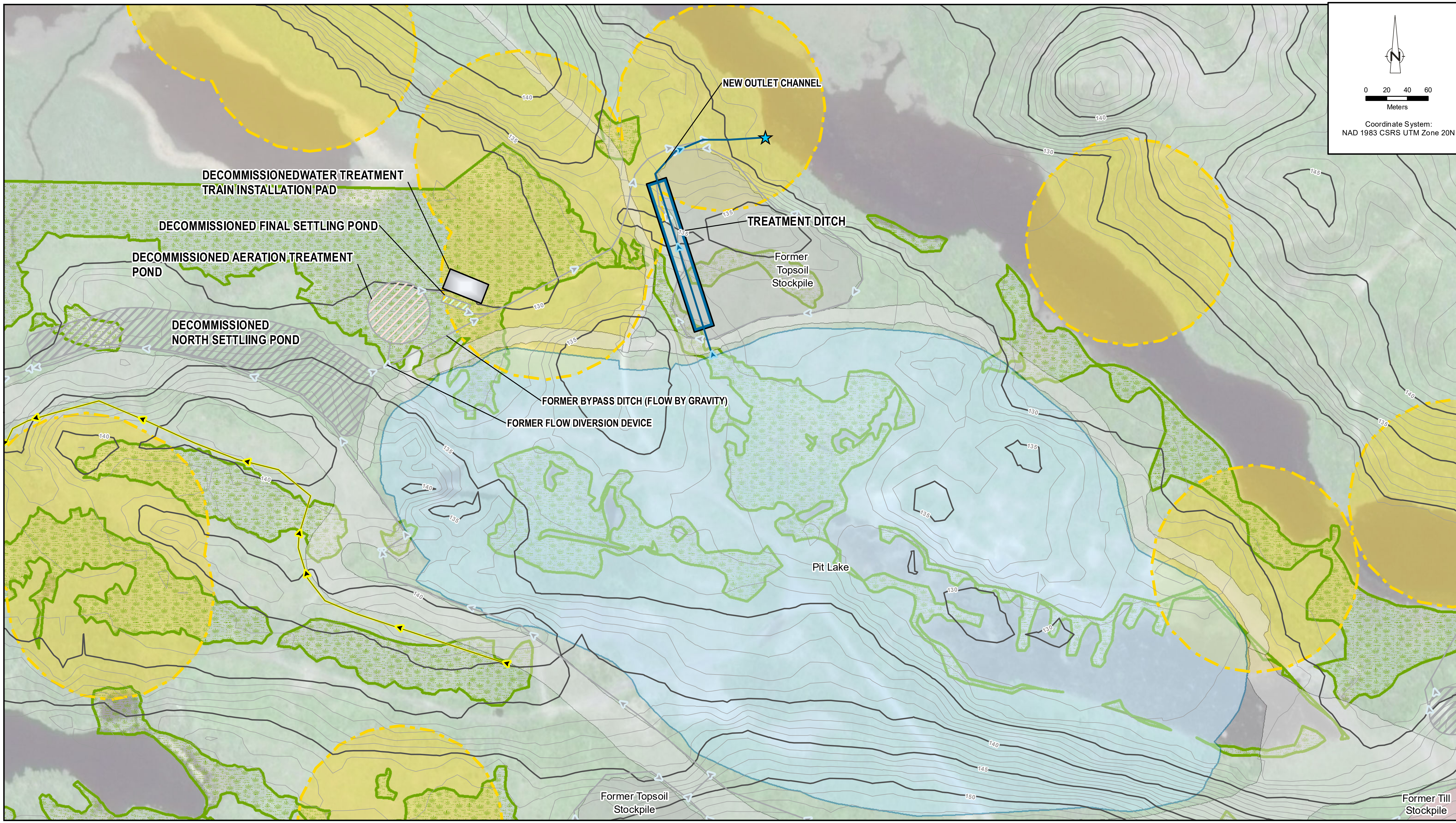


LEGEND

- DECOMMIOSNED NORTH SETTLING POND
- DECOMMIOSNED AERATION TREATMENT POND
- DECOMMIOSNED FINAL SETTLING POND
- DECOMMIOSNED TRAIN INSTALLATION PAD
- NEW OUTLET CHANNEL
- TREATMENT DITCH
- FORMER CONTACT WATER DITCH
- CLEAN WATER DITCH
- PIT LAKE DISCHARGE
- CONTOURS (5M)
- CONTOURS (1M)
- PRIORITY LICHEN BUFFERS
- WETLANDS

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
WATER TREATMENT ASSESSMENT

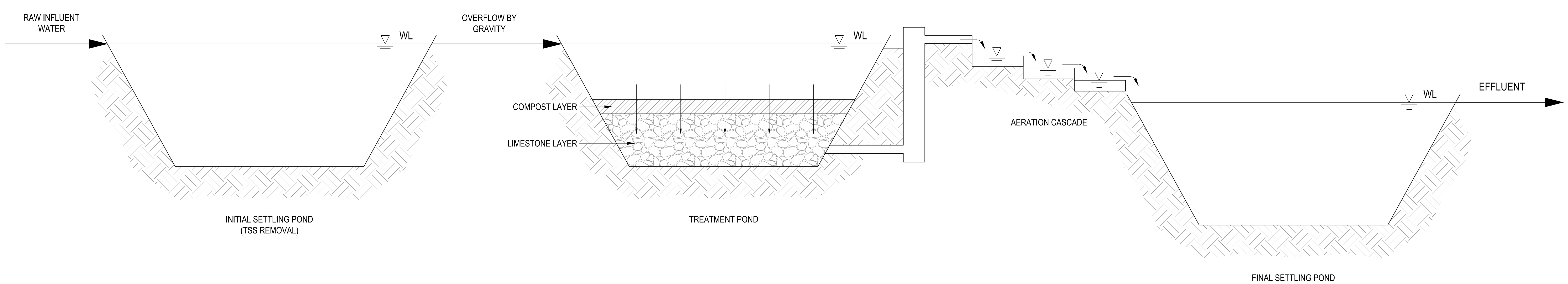
POST-CLOSURE POTENTIAL WATER TREATMENT INFRASTRUCTURE LOCATIONS

088664
Mar 8, 2021

FIGURE 2.1

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\20200915_WaterTreatmentAssessment\088664_20210302_WaterTreatmentAssessment_GIS003.mxd

Appendix A
Schematic Figure of Treatment Ponds



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Client
ATLANTIC MINING NOVA SCOTIA

Project
BEAVER DAMN GOLD MINE WATER TREATMENT ASSESSMENT CONSTRUCTION PHASE

No.	Issue	Drawn	Approved	Date
1	CONCEPTUAL PFD	JS	HS	02/23/2021

Drawn	JS	Designer	HS
Drafting Check	MW	Design Check	HB
Project Manager	AB	Date	Feb 23, 2021
This document shall not be used for construction unless signed and sealed for construction.		Scale	NTS

Original Size
ANSI D

Bar is 20mm on original size drawing
0 20mm

Project No. **88664**

Title
WTS SUCCESSIVE ALKALINITY PRODUCING SYSTEMS (SAPS) FOLLOWED BY AERATION POST-CLOSURE PHASE

Sheet No.
P-02

Sheet 2 of 3

Appendix 5

Mine Waste Stockpile Geotechnical Design

REPORT

Mine Waste Stockpile Geotechnical Design

Beaver Dam Mine

Submitted to:

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20142100-008-Rev0

April 1, 2021

Distribution List

1 e-copy - Atlantic Mining NS Inc.

1 e-copy - Golder Associates Ltd.

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Atlantic Mining NS Inc., a wholly owned subsidiary of St. Barbara Ltd. (Atlantic), has retained Golder Associates Ltd. (Golder) to provide geotechnical design of mine waste material stockpiles for the proposed Beaver Dam Mine Project (Beaver Dam site) located in Marinette, Nova Scotia.

The current mine plan proposes six material stockpiles on site to manage the following materials: non-acid generating waste rock (NAG), low grade ore (LG), potentially acid generating waste rock (PAG), till overburden, organic material, and topsoil. The topsoil stockpiles have been proposed on site to facilitate stripping and site preparation activities. Because of the small size and height of the topsoil stockpiles, their slope stability was not assessed in this report. Figure 1 provides a general arrangement plan of the proposed stockpile locations at the Beaver Dam site.

This report presents a summary of geotechnical subsurface conditions at the site, liquefaction analyses, slope stability analyses, stockpile hazard classifications, and geotechnical stockpile construction recommendations.

2.0 OBJECTIVE

The objective of the Geotechnical Stockpile Design Report is to provide geotechnical recommendations for the proposed stockpiles on site. The scope of the work presented in this report includes the following:

- Summary of subsurface conditions
- Seismic site classification and seismic hazard parameters
- Assessment of liquefaction potential
- Geotechnical design parameters for foundation and stockpiled materials
- Limit equilibrium slope stability analyses for static and seismic (pseudo-static) loading conditions
- General recommendations for site preparation and stockpile material placement

3.0 SUBSURFACE CONDITIONS

Borehole and test pit investigation locations in the stockpile areas are illustrated in plan on Figure 1. A summary of the geotechnical investigation, including Record of Borehole and Test Pit sheets, is presented in the *Preliminary Infrastructure Engineering Report, Beaver Dam Mine* (Golder, 2021). In general, the overburden across the site consists of a thin layer of organic topsoil over dense to very dense sand and gravel with silt and some cobbles and boulders over bedrock.

4.0 PROPOSED STOCKPILE LOCATIONS

Table 1 summarizes the proposed stockpiles locations.

Table 1: Stockpile General Locations

Stockpile	General Location Description
Non-Acid Generating Stockpile (NAG)	Located in the most Western extent of site, accessed by existing public roadways off Beaver Dam Road.
Low Grade Stockpile (LGS)	Located in the Western portion of site directly East in near proximity to the NAG stockpile, accessed by existing public roadways off Beaver Dam Road.
Topsoil Stockpiles (TSS)	Four small topsoil stockpiles are planned for the site. They are spaced across the site near areas requiring topsoil stripping.
Till Stockpiles (TLS)	Two till stockpiles are planned. They are both located East of the originally proposed crusher pad in the Central-East end of site.
Potential Acid Generating Stockpile (PAG)	Located in the North-Central section of site, directly North of the originally proposed crusher pad, accessed by Beaver Dam Road.
Organic Material Stockpile (OMS)	Located on the South-East section of site, accessed by public roads off Beaver Dam Road.

5.0 SEISMIC SITE CLASSIFICATION

The level of importance of seismic loading at any site is related to factors such as the subsoil conditions and their soil behaviour during an earthquake, the magnitude, duration, and frequency level of strong ground motion, and the probable intensity and likelihood of occurrence of an earthquake.

The *Canadian Foundation Engineering Manual* (CFEM, 2006) contains seismic analysis and design methodology. The seismic Site Class value, as defined in Table 6.1A (CFEM, 2006), depends on the average shear wave velocity and/or average standard penetration testing (SPT) N-values of the upper 30 m of soil and/or rock below founding level. The CFEM permits the Site Class to be specified based solely on the stratigraphy and in-situ testing data.

For the upper 30 m of soil and/or rock below founding level, average of SPT N-values is more than 50; and results of Vertical Seismic Profiling (VSP) performed at the location of Borehole BH2020-03B also suggest an average shear wave velocity of 413 m/s, which both suggest a Site Class C for seismic design analysis. Based on the in-situ testing data, this site can be assigned a Site Class of C for seismic design purposes.

Table 2 summarizes seismic parameters for the site, based on a 10% probability of exceedance in 50 years and a 2% probability of exceedance in 50 years from the NBCC (2015).

Table 2: 2015 National Building Code Seismic Hazard Calculation (NBCC, 2015)

Probability of Exceedance	PGA	Sa(0.05)	Sa(0.1)	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)
10% in 50 years (475 AEP)	0.023 g	0.025 g	0.039 g	0.042 g	0.036 g	0.023 g	0.012 g
2% in 50 years (2,475 AEP)	0.061 g	0.075 g	0.105 g	0.105 g	0.079 g	0.051 g	0.028 g

Notes: AEP = annual exceedance probability
PGA = peak ground acceleration
g = acceleration due to gravity
Sa = spectral acceleration

6.0 GEOTECHNICAL DESIGN PARAMATERS

Geotechnical soil parameters were obtained from laboratory testing results following the geotechnical investigation (Golder, 2021) and from typical soil parameters based on previous project experience.

A summary of geotechnical parameters that were used in the effective stress slope stability analyses are summarised in Table 3. Effective stress parameters are considered appropriate to represent the geotechnical behaviour of the till overburden foundation, which is generally comprised of silt, sand, gravel and cobbles (i.e., non-cohesive granular material).

Table 3: Effective Stress Geotechnical Material Parameters Used in the Slope Stability Analyses

Material Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Organics/Topsoil (In-Situ)	18	0	10
Organics (Stockpiled)	16	0	10
Till (In-Situ)	22	0	34
Till (Stockpiled)	21	0	34
Waste Rock	22	0	38
Bedrock	N/A	Impenetrable	Impenetrable

Stockpile slope stability was also checked using total stress parameters for the foundation till. Although the till can be generally described as a non-cohesive material (i.e., silt, sand, gravel and cobbles), there may be stockpile foundation areas with higher fines content (i.e., clayey or cohesive material) that are more appropriately modelled using total stress parameters. A summary of total stress parameters that were used for the till overburden foundation in the slope stability analyses are summarised in Table 4. Stability analyses were carried out modelling the till with a fixed undrained shear strength (S_u) and also using the SHANSEP method (Stress History and Normalized Soil Engineering Properties) to determine the minimum FOS.

Table 4: Total Stress Soil Parameters Used in the Slope Stability Analyses

Material Type	Unit Weight (kN/m^3)	Undrained Shear Strength (kPa)	SHANSEP (Ladd and Foote, 1974)	
			Shear Strength Ratio (Tau/Sigma)	Minimum Shear Strength (kPa)
Till (In-Situ)	22	100	0.25	50 kPa

7.0 STOCKPILE DESIGN PARAMETERS

The total projected mine waste material quantities to be placed in each stockpile are summarized in Table 5.

Table 5: Life of Mine Material Quantities[1]

Material Type Life of Mine Material Quantities	Weight (Mt)	Volume (Mm^3)
Organics	2.29	1.49
Topsoil	0.82	0.41
West Till Pile (1)	0.69	0.45
East Till Pile (2)	1.97	1.28
NAG	34.28	16.32
Low Grade Ore	2.48	1.17
PAG	2.50	1.19

Proposed stockpile maximum crest elevations and approximate height are summarised in Table 6.

Table 6: Proposed Stockpile Maximum Crest Elevations and Approximate Height[1]

Stockpile	Maximum Crest Elevation (m)	Approximate Height (m)
Organics	165	5
West Till	165	10-20
East Till	165	3-10
NAG	190	30-50
Low Grade (LG)	170	14-25
PAG	180	20

[1] Provided by Atlantic in MS Excel file titled "*Waste and Road Design Specifications (210128)*".

8.0 STOCKPILE DESIGN CRITERIA

8.1 Stability Analysis Factors of Safety

Based on the framework discussed in the *Guidelines for Mine Waste Dump and Stockpile Design* (Hawley and Cunning, 2017), a hazard (i.e., consequence of failure) and confidence level were assigned for each stockpile. The organics and till stockpiles were assessed as low hazard level based on overall fill slope angles less than 25 degrees, maximum stockpile height less than 50 meters, and no critical infrastructure present within the potential runout zone in the event of a slope failure. The waste rock stockpiles (i.e., PAG, NAG, and LG) were assessed as low to moderate hazard level based on the potential for moderate environmental impacts, in the event of a slope failure due to the presence of downstream lakes. Based on the available geotechnical investigation data and understanding of the stockpile foundation conditions, a moderate to high confidence level rating was assigned to all stockpiles. The assigned hazard and confidence levels are summarized in Table 7.

Table 7: Stockpile Hazard and Confidence Level

Stockpile	Hazard Level	Confidence Level
Organics	Low	Moderate to High
East Till	Low	Moderate to High
West Till	Low	Moderate to High
NAG	Low to Moderate	Moderate to High
Low Grade (LG)	Low to Moderate	Moderate to High
PAG	Low to Moderate	Moderate to High

Table 8 summarizes target and minimum factor of safety (FOS) values that were used for the stockpile design. The target FOS values (middle column of Table 8) are suggested design values from the *Mined Rock and Overburden Piles Investigation and Design Manual – Interim Guidelines* (BCMWRPRC, 1991). The minimum FOS values (third/right column of Table 8) are for a “Moderate” stability analysis rating based on the *Guidelines for Mine Waste Dump and Stockpile Design* by Hawley and Cunning (2017). The stockpile designs attempted to achieve the target FOS values (middle column of Table 8) but the minimum FOS values (third/right column of Table 8) are considered acceptable for stockpiles with a “Low” or “Moderate” Hazard Classification (discussed further in Sections 10 and 11 below). It should be noted that the minimum FOS values (third/right column of Table 8) assume that there is at least a moderate level of confidence in the input parameters, which is the case for this site, and that the stability analysis results are credible.

Table 8: Target and Minimum Factor of Safety (FOS) Values

Loading Condition	Target FOS Values (Case A - BCMWRPRC, 1991)	Minimum FOS Values (Moderate Stability Rating - Hawley and Cunning, 2017)
Dump/spoil surface short-term	1.0	-
Dump/spoil surface long-term	1.2	-
Overall global stability short-term (static)	1.3	-
Overall global stability long-term (static)	1.5	1.2
Pseudo-static (earthquake)	1.1	1.05

8.2 Design Earthquake

A design earthquake with a 2% probability of exceedance in 50 years (i.e., return period of 2,475 years) and peak ground acceleration (PGA) of 0.061 g (NBCC, 2015) was selected for design of the stockpiles.

9.0 LIQUEFACTION ASSESSMENT

Liquefaction is a phenomenon whereby seismically induced shaking generates shear stresses within the soil under undrained conditions. These stresses tend to densify the soil (i.e., leading to potentially large surface settlements) and under undrained conditions, generate excess pore pressures. The excess pore pressures can also lead to sudden temporary losses in strength. Where existing static shear stresses are present, the loss of strength can lead to significant lateral movements also referred to as “lateral spreading” or under certain conditions, even catastrophic failure of a slope also referred to as “flow slides”. Lateral spreading and flow slides often accompany liquefaction along rivers and other shorelines.

The liquefaction susceptibility of granular foundation soils was evaluated by comparing the penetration resistance required to trigger liquefaction with the available penetration resistance. Liquefaction is predicted to occur when the available penetration resistance is less than the resistance required. The susceptibility of the cohesive soils to cyclic mobility was also assessed.

The methodology used to assess liquefaction potential at the site is consistent with the approach outlined in Boulanger and Idriss (2014). It involves comparing the cyclic shear stresses applied to the soil by the design earthquake, represented as the cyclic stress ratio (CSR), to the cyclic shear strength, represented as the cyclic resistance ratio (CRR) provided by the soil.

Assessment of liquefaction susceptibility was carried out using the recommended procedure presented by Boulanger and Idriss (2014), which is a stress-based approach based on available geotechnical investigation data. The stress-based approach compares the earthquake induced cyclic stress with the cyclic strength of the foundation material. The earthquake-induced stresses and the cyclic resistance are normalized with respect to the vertical effective consolidation stress to obtain the induced CSR and the CRR. The factor of safety against liquefaction (FS_{Liq}) is calculated as follows:

$$FS_{Liq} = \frac{CRR}{\mathrm{CSR}}$$

If FS_{Liq} is less than 1, the foundation soils are considered to be susceptible to liquefaction.

The CRR of the foundation soil at each depth were calculated using the borehole SPT data collected as part of the investigation. The results of the liquefaction analyses indicate that the foundation soils at the site are not liquefiable during the 2,475-year design earthquake.

9.1 Earthquake-Induced Cyclic Stress Ratio

One-dimensional ground response analyses were carried out for the representative soil profiles at each stockpile to estimate the CSR. The input parameters for the ground response analyses were estimated using field shear wave velocity measurements at BH2020-03B and SPT data. Further details on the development of the spectrum-compatible input acceleration time histories, and the one-dimensional ground response analyses are included in the following sections.

The earthquake-induced CSR was estimated at a given depth using results of one-dimensional ground response analysis and the Seed and Idriss procedure, as described in Idriss and Boulanger (2008) and Boulanger and Idriss (2014).

$$CSR_{M,\ \sigma'_v} = 0.65\frac{\tau_{max}}{\sigma'_v}$$

Where τ_{max} is the maximum earthquake induced shear stress estimated from dynamic response analyses and σ'_v is vertical effective stress. CSR is calculated for earthquake moment magnitude of M and in-situ vertical effective stress (σ'_v).

9.1.1 One-Dimensional Ground Response Analysis

One-dimensional ground response analyses were undertaken to assess the ground response at the site. Two stratigraphic profiles were selected for analysis that are representative of stockpile foundation conditions (i.e., borehole locations) with lowest SPT N-values (Table 9) and deepest overburden thickness (Table 10).

Based on the results of the field investigation, representative index properties and shear wave velocity variations of the overburden soil were developed for the two representative soil profiles and are summarized in the table below. The bedrock quality is variable across the site and includes fresh to highly weathered, medium bedded, weak to strong zones. As a result, Site Class C for soft rock (NBCC, 2015) was considered to be appropriate for this site, and an average shear wave velocity of 560 m/s was selected for the bedrock.

Table 9: Summary of Representative Stratigraphy and Material Properties for Profile TLS-BH20-03 (Vs values correlated from SPT N-values)

Soil Unit	g (kN/m^3)	Depth (m)	Vs (m/s)
TOPSOIL (OH) ORGANIC SILT	17	0 – 0.4	228
(ML) CLAYEY SILT	18	0.4 – 2.3	216 - 222
(CL) gravelly SILTY CLAY	19	2.3 – 9.6	244 - 378
Bedrock	23	> 9.6	560

Table 10: Summary of Representative Stratigraphy and Material Properties for Profile NAG- BH20-07 (Vs values correlated from SPT N-values)

Soil Unit	g (kN/m^3)	Depth (m)	Vs (m/s)
TOPSOIL (CL) SILTY CLAY	17	0 – 0.6	222
(CL) SILTY CLAY	18	0.6 – 2.9	278 - 302
(ML) gravelly sandy CLAYEY SILT	19	2.9 – 8.9	334 - 368
(CL) SILTY CLAY	18	8.9 – 9.6	356
(CL) gravelly SILTY CLAY	19	9.6 – 12.6	305 - 342
(CL) SILTY CLAY	18	12.6 – 13.3	305
Bedrock	23	> 13.3	560

Where required for analysis, the small-strain shear modulus (G_{max}) for the site soils were estimated using the site-specific shear wave velocity (V_s) measurements obtained from the results of the VSP testing or correlated from SPT N-values. The values of G_{max} and V_s are related through the following expression:

$$G_{max} = \rho\,(V_s)^2, where\ \rho = material\ density$$

9.1.1.1 Target Spectrum

In accordance with NBCC (2015) seismic hazard data for the site and underlying soft bedrock at depth, the Site Class C seismic hazard values for the 2% probability of exceedance in the 50-year design earthquake event given in Section 5.0 were used as the target spectrum for the input ground motions.

9.1.1.2 Spectrum-Compatible Earthquake Time Histories

To develop time histories compatible with the target firm-ground spectrum, a hazard de-aggregation was first carried out to identify the primary contributors of earthquake magnitude and hypocentral distance for the 2,475-year design earthquake event. A suite of representative seed time histories that matched the primary contributors were selected for each design earthquake. The time histories were then linearly scaled to match the Site Class C target spectra to represent the site-specific design firm-ground accelerations, for use in the site-specific ground response analyses. Time histories were obtained from either the Engineering Seismology Toolbox (EST) or the Pacific Earthquake Engineering Research (PEER) databases.

A summary of the earthquake records used in the site-specific ground response analyses for each design earthquake are provided in the table below. The earthquake mean magnitudes and hypocentral distances are also provided for reference.

Table 11: Summary of Input Time History Earthquake Events – 2,475-Year Design Earthquake

Database	Event Name	Event Year	Station / Suite Name	Mag.	Dist. (km)	Scaling Method
EST	Motion # 31	-	East6c2 Suite	6.0	26	Linear Scaling
EST	Motion # 7	-	East7a2 Suite	7.0	45	Linear Scaling
EST	Motion # 11	-	East7c2 Suite	7.0	50	Linear Scaling
EST	Motion # 16	-	East7c2 Suite	7.0	63	Linear Scaling
EST	Motion # 30	-	East7c2 Suite	7.0	48	Linear Scaling
EST	Motion # 35	-	East7c2 Suite	7.0	100	Linear Scaling
EST	Motion # 36	-	East7c2 Suite	7.0	100	Linear Scaling
EST	Motion # 37	-	East7a2 Suite	7.0	96	Linear Scaling
EST	Motion # 41	-	East7a2 Suite	7.0	94	Linear Scaling
EST	Motion # 44	-	East7a2 Suite	7.0	99	Linear Scaling
PEER	Sparks	2011	Sparks	5.7	60	Linear Scaling

9.1.1.3 SHAKE Analysis

The one-dimensional soil columns and soil parameters described above were used for the ground response analyses. For all soil columns, the input motions established for the site were applied at the top of the bedrock as outcropping motions to account for the overburden effects. All ground response analyses were carried out using the software Shake2000 (Version 10.1.1, November 2018, part of the Professional Suite of ground response software by GeoMotions, LLC).

The shear modulus reduction and damping versus shear strain curves used for the main soil strata are as follows:

- Clayey Silt: Vucetic and Dobry (1991) for Plasticity Index (Ip) = 0%
- Silty Clay: Vucetic and Dobry (1991) for Plasticity Index (Ip) = 15%
- Bedrock: EPRI, 1993

The ground response (SHAKE) analysis results were an input to calculate CSR values with depth and used for the liquefaction assessment described below.

9.2 Cyclic Resistance Ratio

The CRR of non-plastic soils is generally obtained with semi-empirical relationships developed from in-situ testing compiled from case histories where liquefaction has or has not been observed. Idriss and Boulanger (2008) and Boulanger and Idriss (2014) provide details of the procedure to estimate the CRR of non-plastic soils using SPT data, which is formulated as follows:

$$CRR_{M=7.5,\sigma'_{vc}=1\text{atm}} = exp\left(\frac{(N_1)_{60cs}}{14.1} + \left(\frac{(N_1)_{60cs}}{126}\right)^2 - \left(\frac{(N_1)_{60cs}}{23.6}\right)^3 + \left(\frac{(N_1)_{60cs}}{25.4}\right)^4 - 2.8\right)$$

Where $CRR_{M=7.5,\sigma'_{vc}=1\text{atm}}$ is the cyclic resistance of the soil subjected to a magnitude M7.5 earthquake, and normalized to vertical effective stress, $\sigma'_{vc} = 1\text{atm}$; $(N_1)_{60cs}$ is the penetration resistance corrected for SPT hammer efficiency, overburden pressure, and soil fines content.

The correction for fines content is based on Idriss and Boulanger (2008) using average fines content measurements from laboratory testing of samples collected during field investigation.

The CRR can be extended to other values of earthquake magnitude and effective overburden stress by using correction factors to adjust for the site characteristics:

$$CRR_{M,\sigma'_{vc}} = CRR_{M=7.5,\sigma'_{vc}=1} \cdot MSF \cdot K_\sigma$$

Where $CRR_{M,\sigma'_{vc}}$ is the cyclic resistance ratio at the specific values of earthquake magnitude M and overburden effective stress σ'_{vc}. MSF is the magnitude scaling factor and K_σ is the overburden correction factor. Values for these factors are presented in Idriss and Boulanger (2008) and Boulanger and Idriss (2014).

CRR values calculated in accordance with the above method were used for the liquefaction assessment described below.

9.3 Results of Liquefaction Susceptibility Assessment

Liquefaction susceptibility assessment results for the foundation materials are presented in Appendix B. The liquefaction susceptibility of the two representative soil profiles was assessed by comparing earthquake induced CSR and CRR values to calculate factor of safety against liquefaction (FSL) with depth.

The liquefaction assessment indicates that the stockpile foundation soils at the site are not expected to liquefy following the 2,475-year return period design earthquake event.

10.0 SLOPE STABILITY ANALYSIS

Slope stability analyses were completed for each stockpile using the program SLOPE/W™ Ver. 2019, which is a two-dimensional limit equilibrium computer software program developed by Geo-Slope International Ltd. The Morgenstern-Price method of slices was employed to analyse potential failure surfaces through the stockpile slopes and underlying foundations. The analyses were conducted to locate the most critical failure surfaces, resulting in the most conservative FOS. Slope stability analyses were conducted using both effective and total stress analysis parameters. Slope stability analysis results for each stockpile are included in Appendix C.

Post-earthquake analyses (i.e., using residual shear strengths for liquefied foundation materials) were not carried out for any of the stockpiles because none of the foundation soils were determined to be susceptible to liquefaction under the design earthquake (as outlined in Section 9). Pseudo-static analyses were carried out for all stockpiles because the foundation materials are not expected to experience liquefaction. The pseudo-static analyses were carried out in accordance with the method proposed by Hynes-Griffin and Franklin (1984). In this method, a horizontal acceleration coefficient of 0.0305 g (equal to half of the bedrock PGA) is applied.

Table 12 summarizes the results of slope stability analyses for each stockpile. All values meet the minimum FOS values (outlined in Table 8 above) for a “Moderate” slope stability rating in accordance with the *Guidelines for Mine Waste Dump and Stockpile Design* by Hawley and Cunning (2017). The calculated FOS values are considered sufficient to accommodate some variability in foundation conditions and material properties (i.e., moderate confidence level).

Slope stability analysis of the organics stockpile was initially checked for the proposed 7H:1V slope, which calculated a FOS below 1.0 (i.e., a 7H:1V organics slope would not meet the design criteria). However, stability analyses determined that the organics stockpile slope could achieve the required FOS (see Table 12) with a 10 m wide zone of till on the exterior slope and be steepened to 3H:1V (see Figure C-7 in Appendix C).

Slope stability analysis of the West Till (1) stockpile was initially checked for the proposed 3H:1V overall slope (e.g., 7 m high inter-bench slopes and 21 m wide benches) which calculated acceptable FOS values (outlined in Table 8). The West Till (1) stockpile slopes were then optimized by checking stability with 9 m high inter-bench slopes and 16 m wide benches (as illustrated in Cross-Section A on Figure 2). The revised West Till (1) stability analysis results calculated acceptable FOS values (as summarized in Table 12 and presented in Appendix C). The updated West Till (1) stockpile stability analyses indicate that bench widths for the East Till (2) stockpile can also be reduced from 21 m to 16 m (as illustrated in Cross-Section B on Figure 2).

Slope stability of the NAG stockpile north and south slopes was checked with bench geometry that achieved an overall 3H:1V slope. The NAG stockpile slopes were analysed with 10 m high inter-bench slopes at 1.5H:1V and 21 m wide benches (as illustrated in Cross-Sections E and F on Figure 3). These bench dimensions and overall slopes for the NAG stockpiles calculated acceptable minimum FOS values (as summarized in Table 12 and presented in Appendix C).

Slope stability analyses indicate that a 3H:1V overall slope for the other mine waste stockpiles will meet minimum factor of safety requirements (as outlined in Table 12 and presented in Appendix C). Recommended slope configurations (e.g., bench heights, inter-bench slopes, and overall slopes) for each stockpile are summarized in Table 13 and illustrated in cross-section on Figures 2 and 3. The north slope of the NAG stockpile has the lowest FOS values (e.g., static FOS = 1.35 and pseudo-static FOS = 1.19), which meet the minimum FOS values for a “Moderate” stability rating based on the *Guidelines for Mine Waste Dump and Stockpile Design* by Hawley and Cunning (2017).

Table 12: Stockpile Slope Stability Analysis Results

Stockpile	Minimum Static FOS	Calculated Static FOS	Minimum Pseudo-Static FOS	Calculated Pseudo-Static FOS
Organics	1.20	1.85	1.05	1.64
West Till (1)	1.20	1.74	1.05	1.58
East Till (2)	1.20	1.80	1.05	1.62
NAG (South Slope)	1.20	1.49	1.05	1.31
NAG (North Slope)	1.20	1.35	1.05	1.19
LG	1.20	1.94	1.05	1.73
PAG	1.20	1.61	1.05	1.44

11.0 STOCKPILE HAZARD CLASSIFICATION

Waste dump and stockpile stability rating and hazard classification (WSRHC) assessments were carried out for the proposed NAG, PAG, LG, West Till (1), East Till (2), and Organics stockpiles in accordance with the *Guidelines for Mine Waste Dump and Stockpile Design* by Hawley and Cunning (2017). All stockpiles were assessed as waste dump and stockpile hazard classification (WHC) III Moderate Hazard, except for the LG stockpile, which was assessed as WHC II Low Hazard (just above the WHC III Moderate Hazard line). Appendix D presents the stockpile hazard classification assessments.

12.0 GROUND PREPARATION AND STOCKPILE DEVELOPMENT

12.1 Ground Preparation and Initial Lift Placement

Recommendations for ground preparation and stockpile development are summarized in Table 13. Cross-sections of each stockpile illustrating the recommended topsoil stripping width are shown on Figure 2 and Figure 3. Topsoil should be stripped from the specified width within the perimeter of the stockpile footprints prior to placing the initial lift of waste, to improve slope stability and prevent shear failures through the weak organic topsoil layer. The initial lift of waste placement should be limited to 2 m in height to confirm foundation stability and should extend across the entire stockpile footprint prior to placing the next vertical lift above.

Table 13: Recommendations for Ground Preparation and Stockpile Development

Stockpile	Topsoil Stripping Width	Inter-bench Slope (H:V)	Steepest Overall Slope (H:V)	Maximum Vertical Bench Height (m)	Minimum Bench Width (m)	Development Recommendations
Organics	10 m	N/A	3:1	N/A	N/A	10 m wide till exterior slope required for stability
West Till (1)	45 m	1.5:1	2.4:1	9	16	At least one mid-slope bench
East Till (2)	40 m	1.5:1	2.6:1	7	16	At least one mid-slope bench
NAG	100 m wide (South slope) 160 m wide (North slope)	1.5:1	3:1	10	21	Topsoil stripping width = ultimate stockpile height x 3.2 = 100 to 160 m wide
LG	40 m	1.5:1	3:1	10	21	At least one mid-slope bench
PAG	70 m	1.5:1	3:1	7	21	At least one mid-slope bench

12.2 Surface Water Management

A surface water management plan should be developed for all stockpile areas that ties into the site-wide water management plan. Surface water management should include upstream diversions to prevent run-on to the stockpiles and downstream water collection systems. Surface water management and/or sediment control measures should be implemented prior to beginning stockpile ground preparation and waste placement.

12.3 Stockpile Dumping Operations

The stockpiles should be developed from the bottom up, in 2 to 3 m thick lifts to achieve the overall slopes summarized in Table 13. Each lift shall extend across the entire stockpile footprint before starting the next lift. Figures 2 and 3 illustrate cross-sections and typical bench dimensions for each stockpile slope. Bench heights should be reduced, where required, to ensure that the specified overall (i.e., crest to toe) stockpile slope is maintained. Vertical bench heights should be limited to 5 m where the total stockpile height is 10 m or less (e.g., East Till stockpile). Vertical bench heights should be limited to 7 m where the total stockpile height is between 10 and 25 m (e.g., East Till and PAG stockpiles), except at the West Till stockpile where the vertical bench height can be up to 9 m. Stockpiles with an ultimate height greater than 25 m can be constructed with 10 m vertical bench heights. All stockpiles, other than the organics stockpile, shall have at least one mid-slope bench.

Waste materials should be dumped well away from the bench crest edge and pushed with a bulldozer to achieve the recommended bench dimensions and slopes. Safety berms should be maintained on all dump crests and haul roads of sufficient height, to prevent the largest mine equipment from inadvertently driving over the crest. The height of the safety berms should be no less than half the height of the largest haul truck tire.

Safety berms should not be used as a wheel stop when backing up to dump. Haul trucks should dump short of the crest and the dumped materials pushed over the crest with a dozer. Some of the dumped material should be retained on the crest for ongoing safety berm construction.

The condition of the dump platform must be monitored visually for any signs of instability. The dozer operator responsible for spreading dumped waste materials should ensure that the surface of the dump and dump platform is maintained in good condition. The dump platform should be maintained with an uphill grade to the crest. A grade of not less than 2% should be maintained to facilitate surface water drainage away from the crest edge.

The dumping sequence should consider haul road configuration and stockpile foundation conditions. In addition, foundation conditions may require that waste materials be placed preferentially in particular areas to achieve adequate slope stability.

Stockpile stability is influenced by many factors, including dump height, dump materials, dump geometry, climatic conditions, foundation materials, and surface and groundwater conditions. However, the rate of crest edge (horizontal) and stockpile height (vertical) advancement have a significant influence on slope stability. Maximum rates of horizontal and vertical advancement should be defined based on available site-specific foundation conditions, design information, and dump operational experience.

12.4 Stockpile Visual Monitoring

Regularly scheduled inspections and monitoring of the stockpiles is critical to early detection of concerns relating to physical stability. The visual inspection program should include informal observations by operations staff, formal monthly inspections by a site engineer, and annual external visual inspections by a qualified geotechnical engineer. Visual inspection of ramps and haul roads near dump crests or slopes should be carried out on a frequent basis during stockpile development operations. Haul truck operators, dozer operators, and any others who routinely visit the dumps should be trained in the recognition of hazards and reporting procedures. Operations staff, equipment operators, surveyors, and other personnel that regularly visit the waste dumps should be trained to recognise the following potential indications of instability:

- excessive or abnormal cracking
- excessive crest deformation or settlement
- excessive over-steepening of the crest
- abnormal platform tilting
- seepage breakout on the face
- bulging of the face
- toe spreading

Observations of any of these indicators should be evaluated to determine if there is a developing slope instability issue.

12.5 Geotechnical Monitoring Instrumentation

Monitoring of the physical performance of stockpiles is recommended to confirm that performance is consistent with design assumptions. The monitoring program should consider potential failure mechanisms. Foundation instability is the primary potential mechanism of stockpile failure. Consideration should be given to the installation of vibrating wire piezometers in clayey foundation materials that may be susceptible to excess pore water pressure generation during loading (i.e., fill placement). In addition, installation of slope inclinometers could be considered to monitor slope and foundation deformation. A trigger action response plan (TARP) should be established for the piezometers and slope inclinometers.

12.6 Operational Guidelines

The operation of a waste dump or stockpile must be consistent with the design basis and assumptions. Operational guidelines or standard operating procedures should be developed using the design basis and reviewed by the design engineer.

13.0 IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development, and purpose described to Golder by the Client: Atlantic Mining NS Inc. The factual data, interpretations, and recommendations pertain to a specific project, as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations, and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then the client may authorize the use of this report for such purpose by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process, provided this report is not noted to be a draft or preliminary report, and is specifically relevant to the project for which the application is being made. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings, and other documents, as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration, and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations, and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations, and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety, and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional, rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling, and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical, and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal, and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying, or frost. Unless otherwise indicated, the soil must be protected from these changes during construction.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans, and documents, prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations, and opinions contained in Golder's report. Adequate field review, observation, and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately, the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required, either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage, unless specifically involved in the detailed design and construction monitoring of the system.

Signature Page

Golder Associates Ltd.

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Geotechnical Engineer

Craig Kelly, P.Eng.
Project Manager, Geotechnical Engineer

Darrin Johnson, P.Eng.
Associate, Geotechnical Engineer

BG/NN/CK/DCJ/MM/sm

https://golderassociates.sharepoint.com/sites/125672/project files/6 deliverables/20142100-008-p200-wsra stockpile design/final report_01apr2021/20142100-008-r-rev0_stockpile design report_01apr_2021.docx

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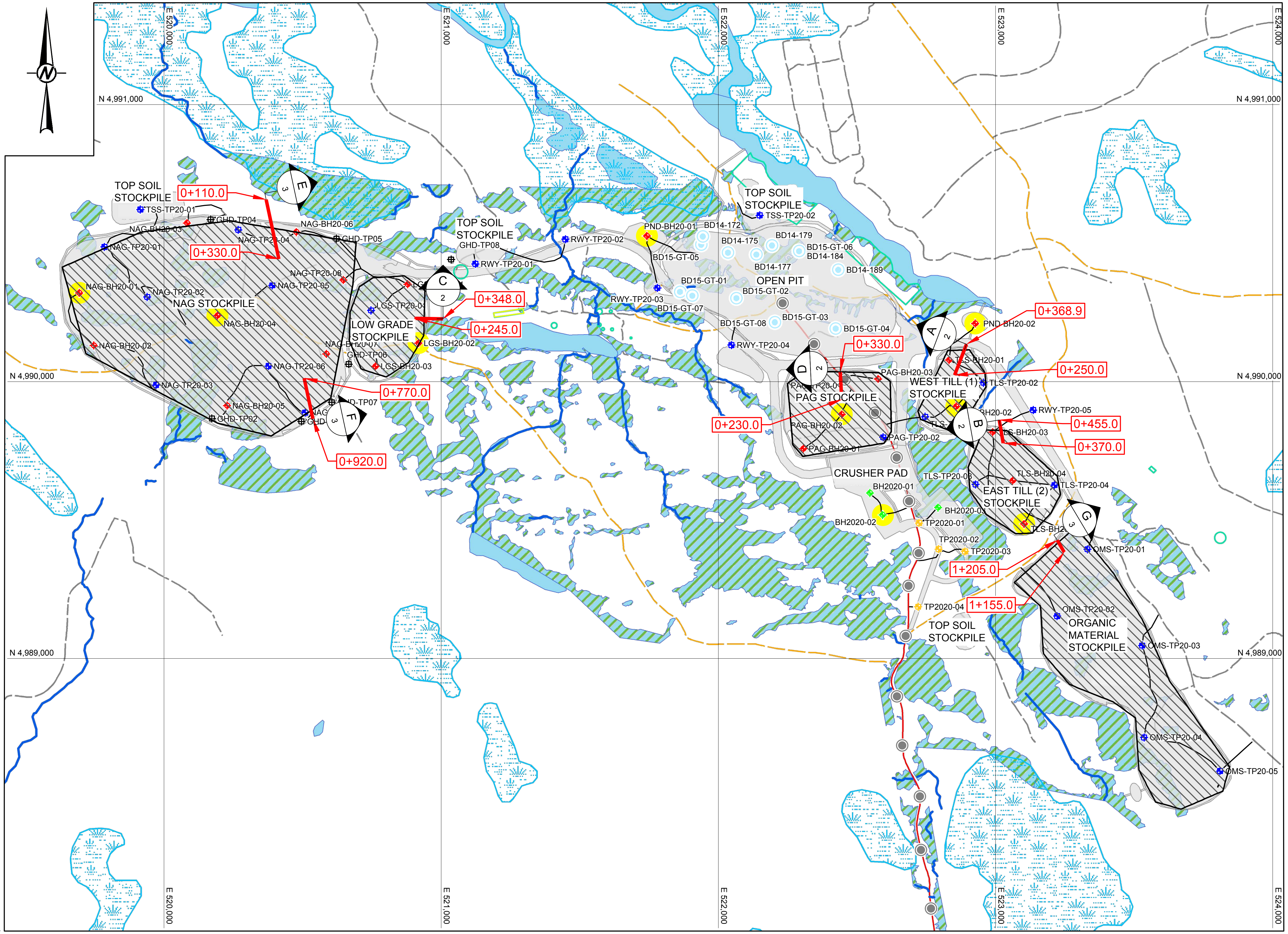


KEY MAP

LEGEND

- TESTPIT LOCATION (GOLDER)
- BOREHOLE LOCATION (GOLDER)
- TESTPIT LOCATION (AUSENCO)
- BOREHOLE LOCATION (AUSENCO)
- TESTPIT LOCATION (GHD)
- PREVIOUS INVESTIGATION LOCATION (WSP)
- PREVIOUS INVESTIGATION LOCATION (AMNS)
- NSE WATERCOURSE
- ARCHEOLOGY SITES
- PROPOSED TRAILS
- PRELIMINARY PROPERTY BOUNDARY
- NSE WETLANDS
- FIELD DELINEATED WETLANDS
- OPEN WATER
- LOCAL ROAD
- DRY WEATHER/SEASONAL ROAD
- TRACK/FORESTRY
- PROPOSED STOCKPILE
- STOCKPILE SECTION LOCATION

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE.

REFERENCE(S)

1. BOREHOLE AND TEST PIT LOCATIONS AND BASE INFORMATION PROVIDED BY MCCALLUM ENVIRONMENTAL LTD. ON SEPTEMBER 24, 2020.
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 20.

0 250 500
1:15,000 METRES

CLIENT
ATLANTIC MINING NS CORPORATION

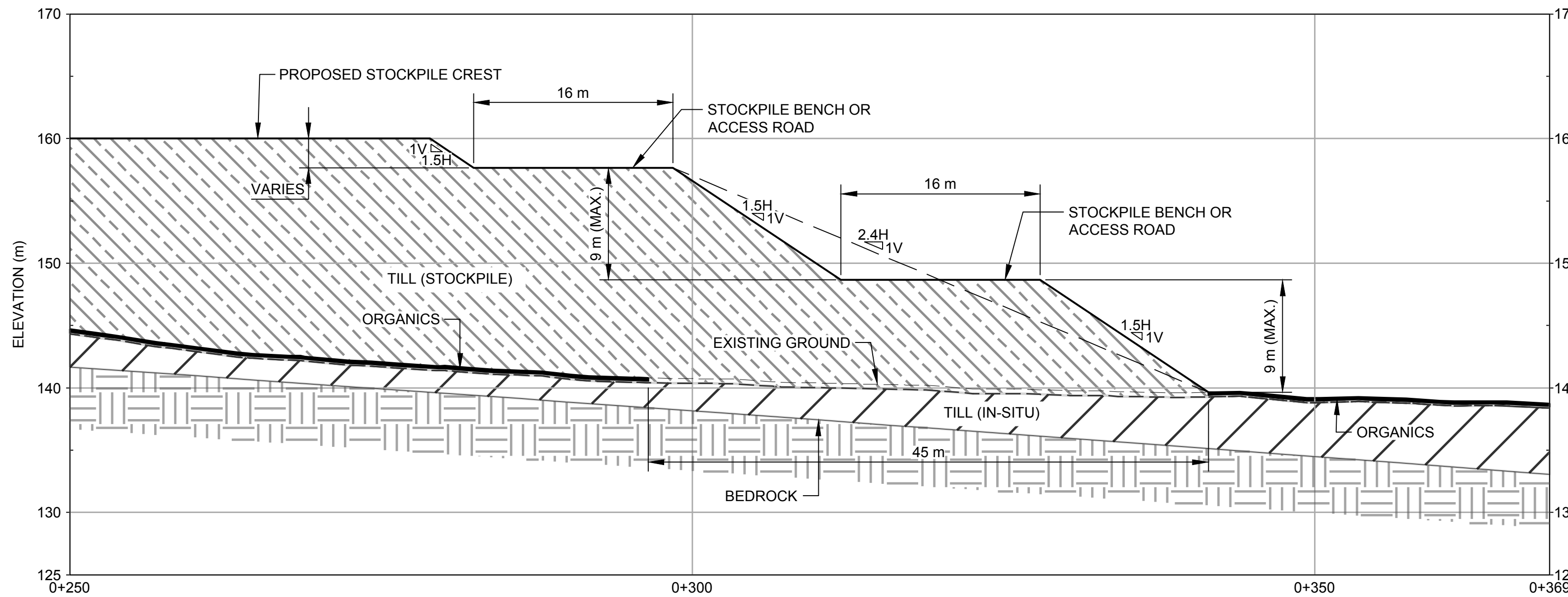
CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-30
DESIGNED	BG
PREPARED	WS
REVIEWED	MGM
APPROVED	DCJ

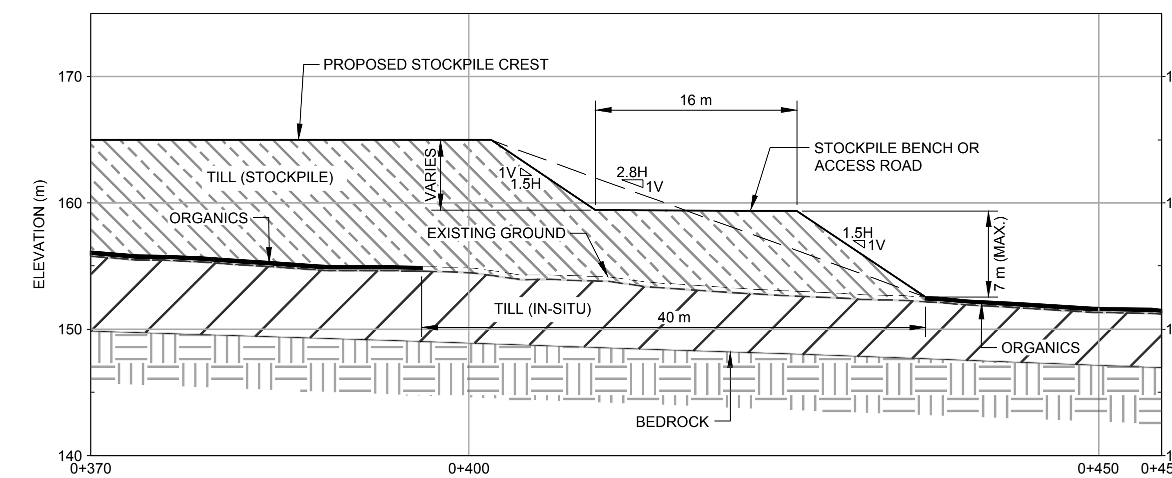
PROJECT
BEAVER DAM MINE WASTE STOCKPILE GEOTECHNICAL DESIGN

TITLE
MINE WASTE STOCKPILE LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
20142100	0001	0	1



SCALE 1:600 m (A/2) CROSS SECTION - WEST TILL (1) STOCKPILE NORTHEAST SLOPE



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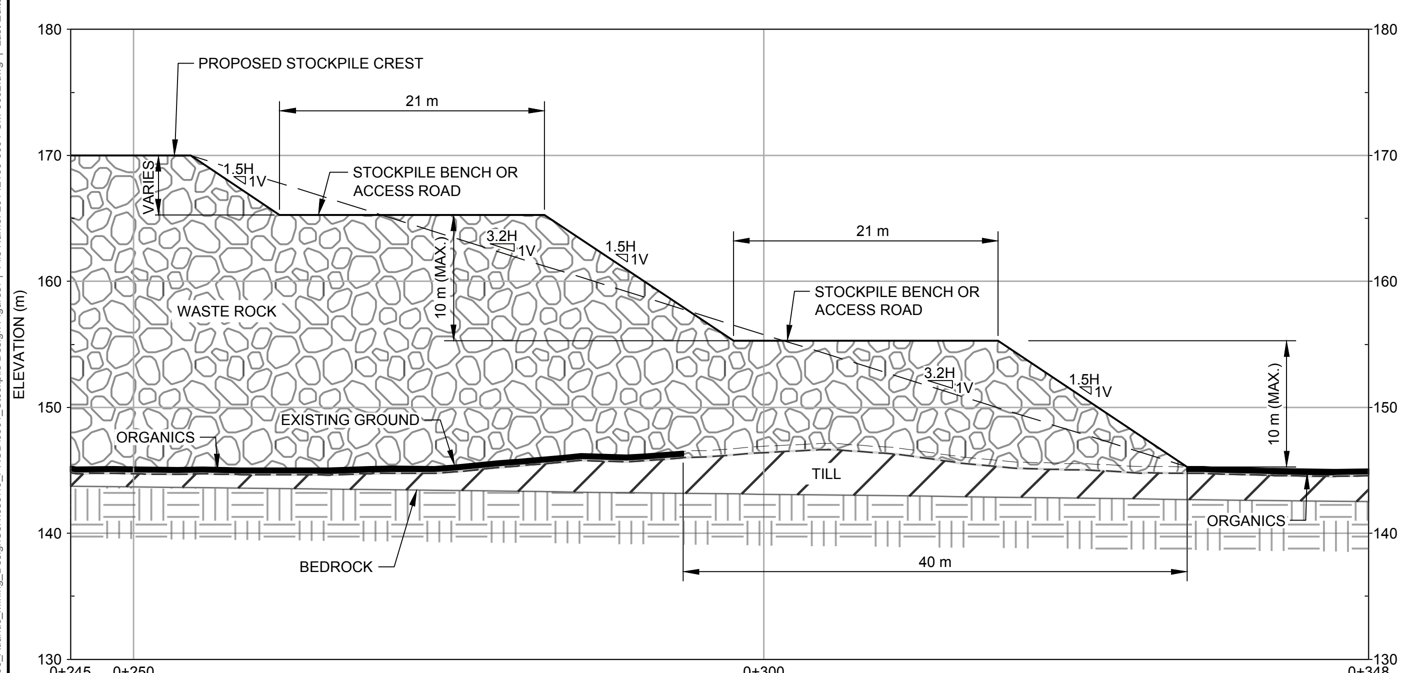
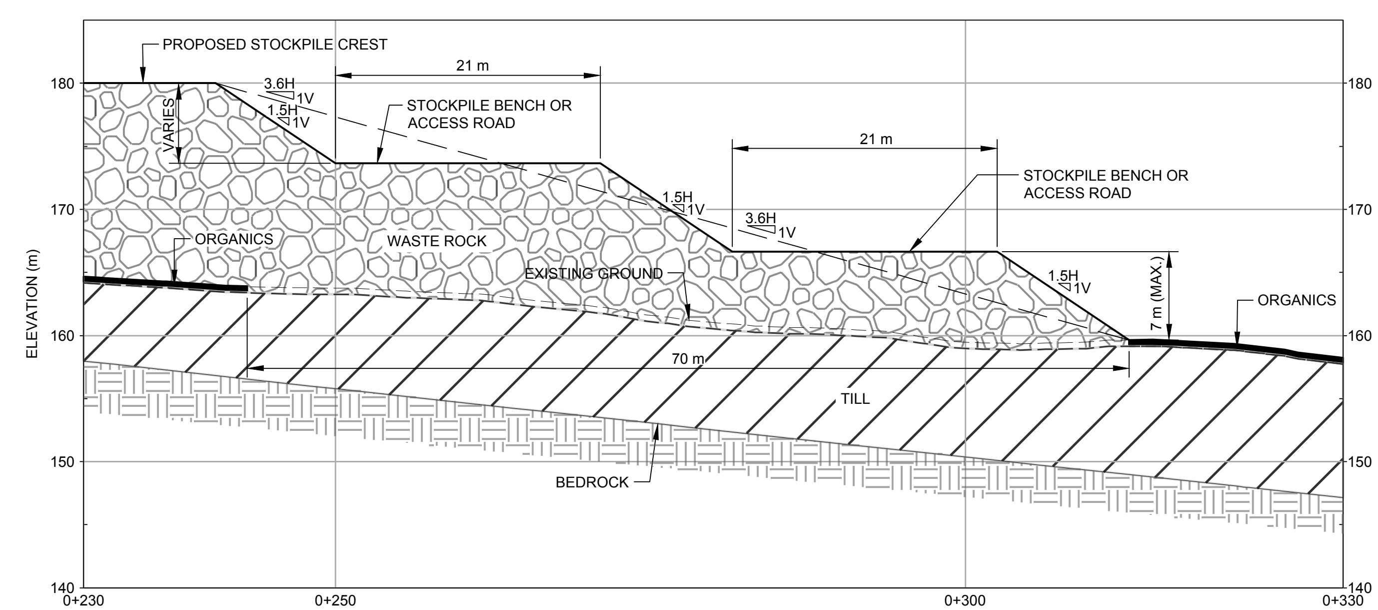


SCALE 1:600 m (C/2) CROSS SECTION - LOW GRADE STOCKPILE EAST SLOPE



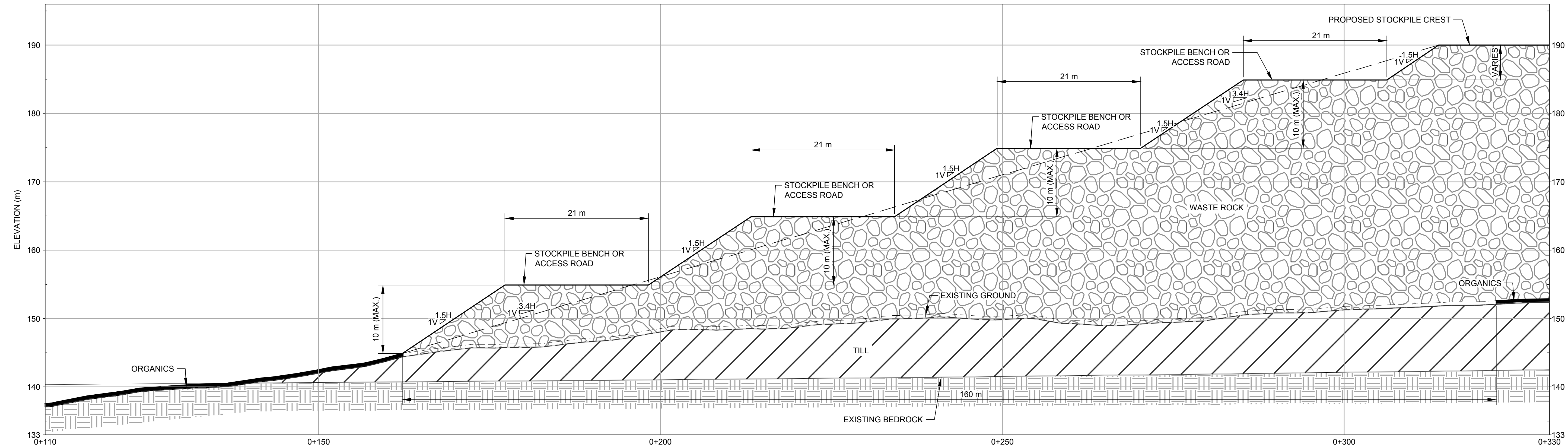
SCALE 1:600 m (D/2) CROSS SECTION - PAG STOCKPILE NORTH SLOPE

0 10 20
1:600 METRES

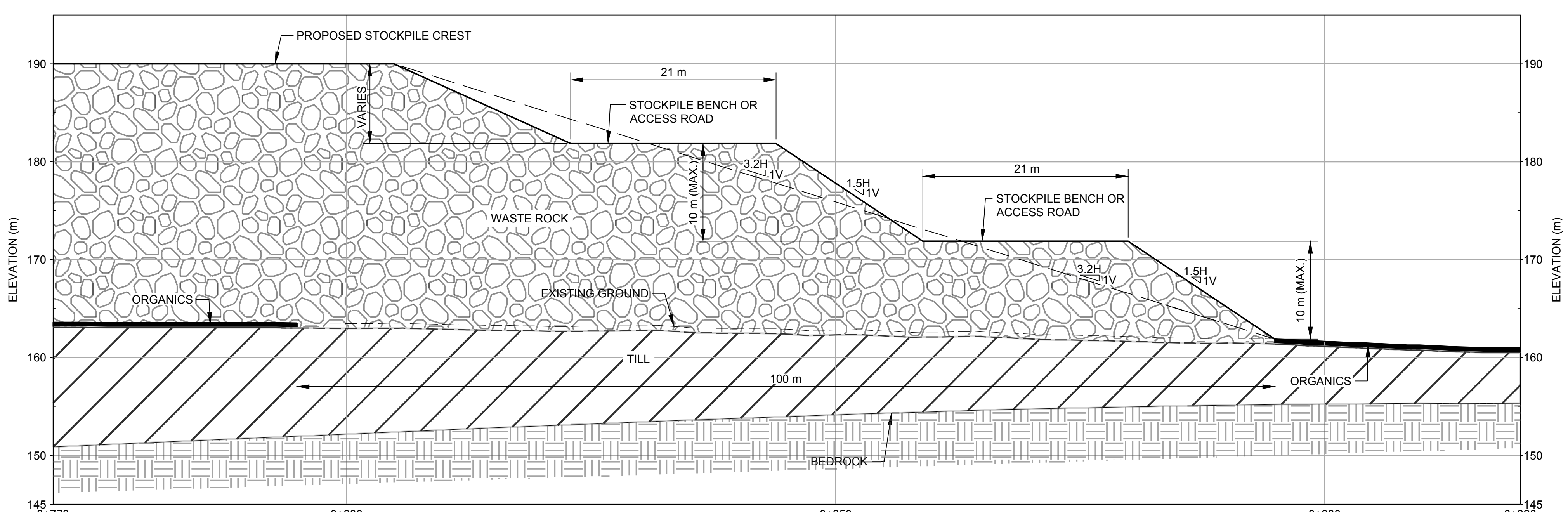
MATERIALS

- BEDROCK
- TILL (IN-SITU)
- ORGANICS
- TILL (STOCKPILE)
- WASTE ROCK

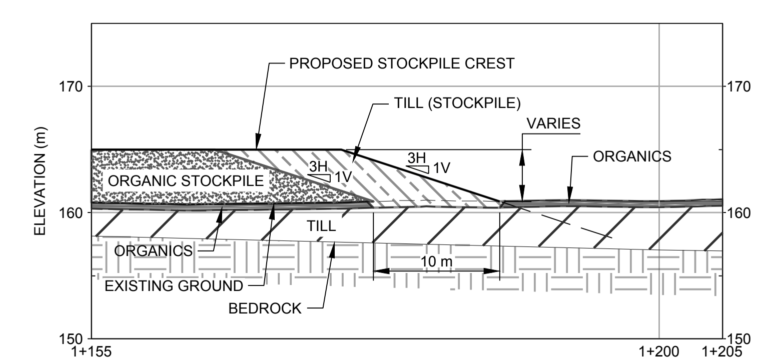
CLIENT	ATLANTIC MINING NS CORPORATION
PROJECT	BEAVER DAM MINE WASTE STOCKPILE GEOTECHNICAL DESIGN
CONSULTANT	GOLDER
YYYY-MM-DD	2021-03-30
DESIGNED	BG
PREPARED	WS
REVIEWED	MGM
APPROVED	DCJ
TITLE	MINE WASTE STOCKPILE CROSS SECTIONS AND DETAILS 1
PROJECT NO.	20142100
CONTROL	0001
REV.	0
FIGURE	2



SCALE 1:600 m (E/3) CROSS SECTION - NAG STOCKPILE NORTH SLOPE



SCALE 1:600 m (F/3) CROSS SECTION - NAG STOCKPILE SOUTH SLOPE



SCALE 1:600 m (G/3) CROSS SECTION - ORGANIC STOCKPILE NORTH SLOPE

0 10 20
1:600 METRES

MATERIALS

BEDROCK	TILL (STOCKPILE)
TILL (IN-SITU)	WASTE ROCK
ORGANICS	ORGANIC STOCKPILE

CLIENT
ATLANTIC MINING NS CORPORATION

CONSULTANT
GOLDER

YYYY-MM-DD	2021-03-30
DESIGNED	BG
PREPARED	WS
REVIEWED	MGM
APPROVED	DCJ

PROJECT
BEAVER DAM MINE WASTE STOCKPILE GEOTECHNICAL DESIGN

TITLE
MINE WASTE STOCKPILE CROSS SECTIONS AND DETAILS 2

PROJECT NO.	CONTROL	REV.	FIGURE
20142100	0001	0	3

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APPENDIX A

Seismic Hazard Calculation

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.066N 62.718W **User File Reference:** Beaver Dam Mine 2021-01-19 12:40 UT

Requested by: Craig Kelly, Golder Associates

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.075	0.041	0.025	0.009
Sa (0.1)	0.105	0.061	0.039	0.014
Sa (0.2)	0.105	0.064	0.042	0.017
Sa (0.3)	0.092	0.058	0.040	0.016
Sa (0.5)	0.079	0.052	0.036	0.014
Sa (1.0)	0.051	0.034	0.023	0.008
Sa (2.0)	0.028	0.018	0.012	0.004
Sa (5.0)	0.007	0.004	0.003	0.001
Sa (10.0)	0.003	0.002	0.001	0.001
PGA (g)	0.061	0.035	0.023	0.008
PGV (m/s)	0.067	0.042	0.027	0.008

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

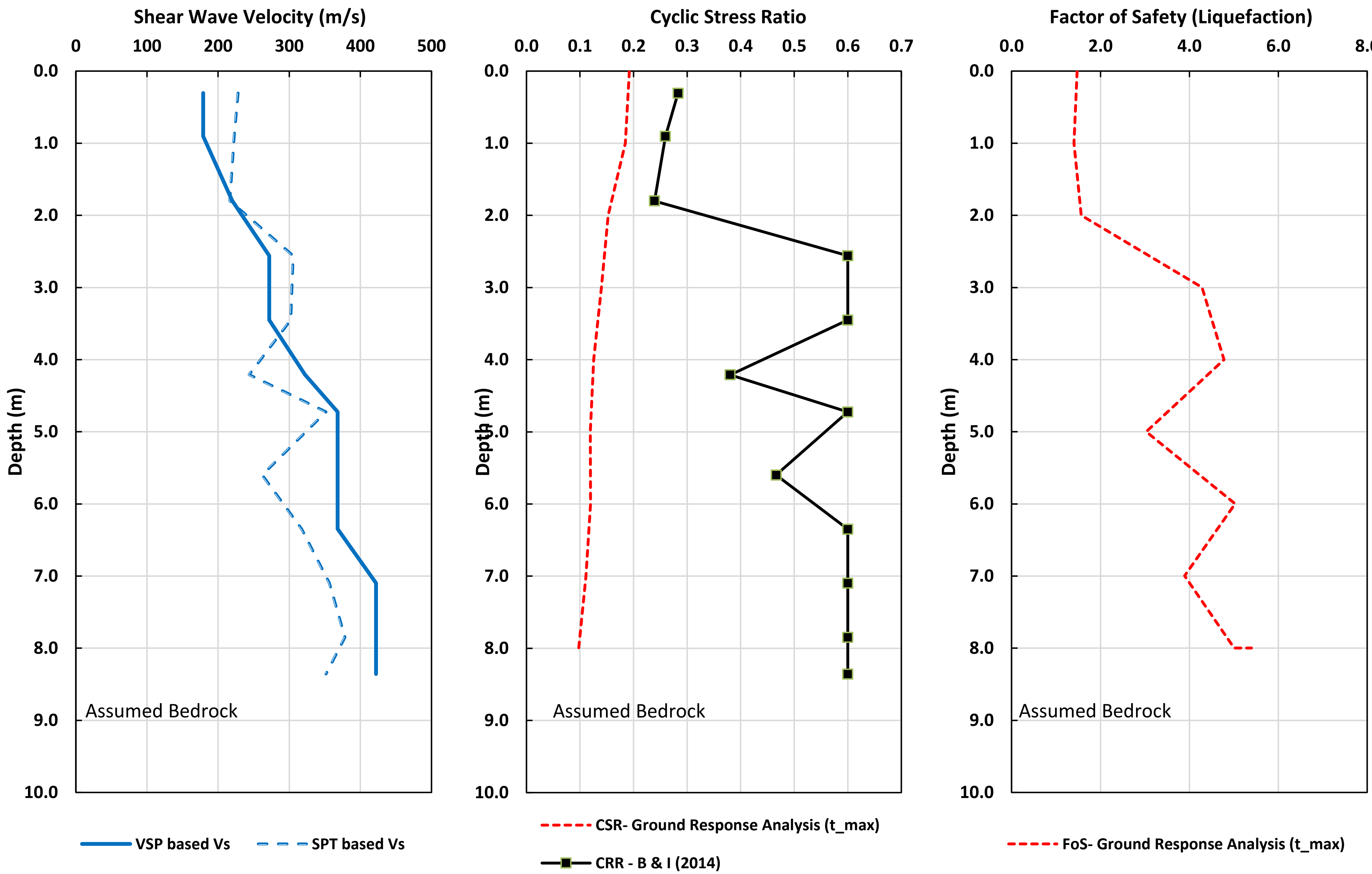
See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Natural Resources Canada Ressources naturelles Canada

Canada

APPENDIX B

Liquefaction Assessment Results



CLIENT

ATLANTIC MINING NS Inc.

PROJECT

MINE WASTE STOCKPILE GEOTECHNICAL DESIGN
BEAVER DAM MINE

CONSULTANT

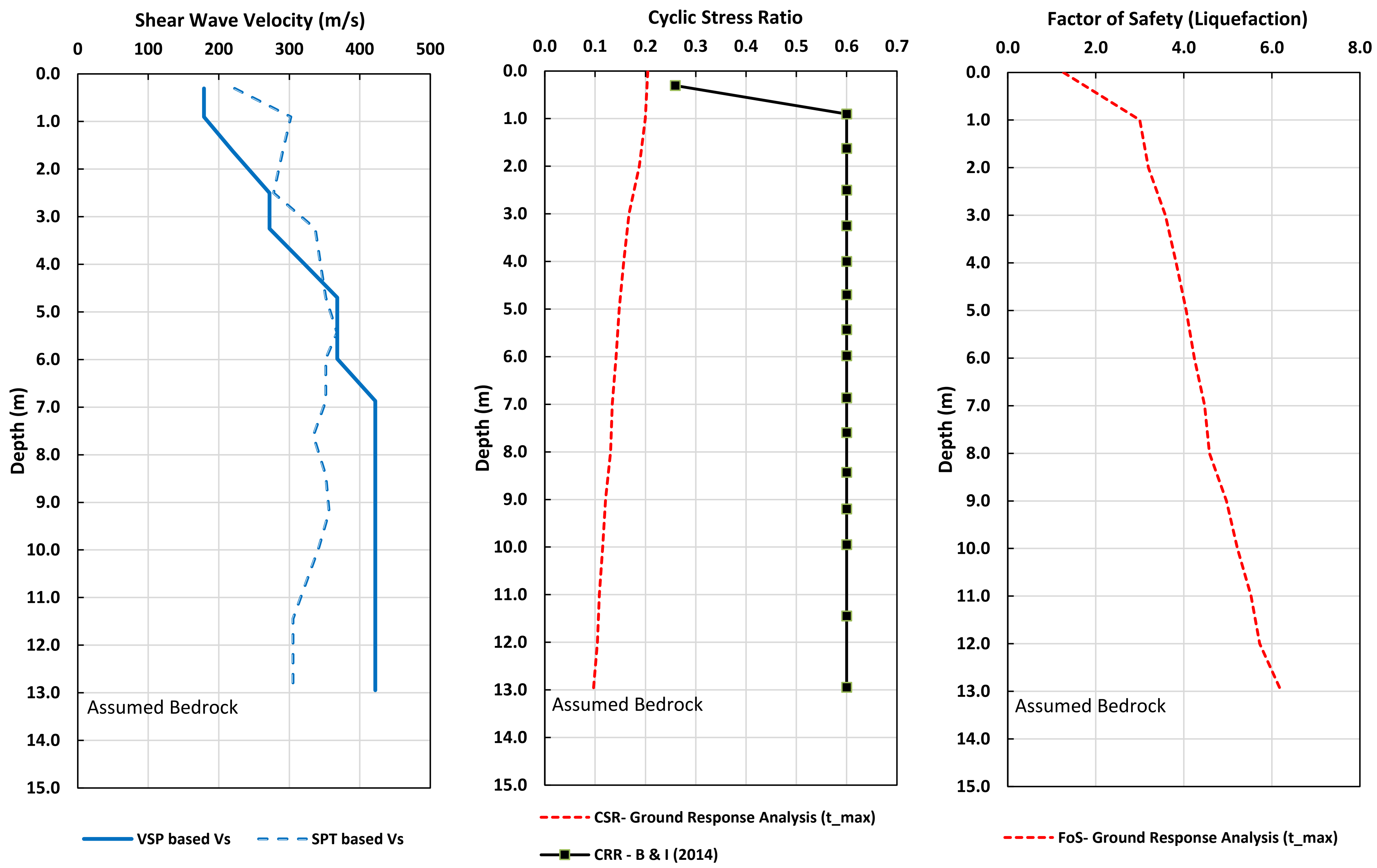
GOLDER

YYYY-MM-DD	2021-03-17
DESIGNED	NNA
PREPARED	NNA
REVIEWED	DCJ
APPROVED	DCJ

TITLE

SPT-based Liquefaction Assessment at TLS BH20-03
1:2475 AEP, Mw=6.6, PGA=0.061g

TITLE	PHASE	REV	FIGURE
20142100		A	B-1



CLIENT
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TITLE
SPT-based Liquefaction Assessment at NAG BH20-07
1:2475 AEP, Mw=6.6, PGA=0.061g

TITLE	PHASE	REV	FIGURE
20142100		**A**	**B-2**

APPENDIX C

Slope Stability Analysis Results

Table C-1: Summary of Stability Analyses

Stockpile	Loading Condition	Crest Level (m)	Max Material Height (m)	Minimum Calculated FOS	Target FOS	Minium FOS	Figure No
NAG	Long-term (steady-state) - Effective Stress	190	45	2.21	1.5	1.2	-
(South Slope)	Long-term (steady-state) - Total Stress			1.49	1.5	1.2	C-1
	Pseudo-Static - Effective Stress			1.98	1.1	1.05	-
	Pseudo-Static - Total Stress			1.31	1.1	1.05	C-1
	Post Seismic			N/A	N/A	N/A	N/A
NAG	Long-term (steady-state) - Effective Stress	190	45	2.02	1.5	1.2	-
(North Slope)	Long-term (steady-state) - Total Stress			1.35	1.5	1.2	C-2
	Pseudo-Static - Effective Stress			1.83	1.1	1.05	-
	Pseudo-Static - Total Stress			1.19	1.1	1.05	C-2
	Post Seismic			N/A	N/A	N/A	N/A
LG	Long-term (steady-state) - Effective Stress	170	25	2.25	1.5	1.2	-
(North Slope)	Long-term (steady-state) - Total Stress			1.94	1.5	1.2	C-3
	Pseudo-Static - Effective Stress			2.05	1.1	1.05	-
	Pseudo-Static - Total Stress			1.73	1.1	1.05	C-3
	Post Seismic			N/A	N/A	N/A	N/A
PAG	Long-term (steady-state) - Effective Stress	180	20	2.06	1.5	1.2	-
(North Slope)	Long-term (steady-state) - Total Stress			1.61	1.5	1.2	C-4
	Pseudo-Static - Effective Stress			1.86	1.1	1.05	-
	Pseudo-Static - Total Stress			1.44	1.1	1.05	C-4
	Post Seismic			N/A	N/A	N/A	N/A
West Till (1)	Long-term (steady-state) - Effective Stress	160 (Northeast)	20	1.74 (1.54 bench)	1.5	1.2	C-5
(Northeast Slope)	Long-term (steady-state) - Total Stress	165 (Southwest)		1.90	1.5	1.2	-
	Pseudo-Static - Effective Stress			1.58 (1.27 bench)	1.1	1.05	C-6
	Pseudo-Static - Total Stress			1.71	1.1	1.05	-
	Post Seismic			N/A	N/A	N/A	N/A
East Till (2)	Long-term (steady-state) - Effective Stress	165	10	1.80	1.5	1.2	C-7
(North Slope)	Long-term (steady-state) - Total Stress			2.21	1.5	1.2	-
	Pseudo-Static - Effective Stress			1.62	1.1	1.05	C-7
	Pseudo-Static - Total Stress			2.01	1.1	1.05	-
	Post Seismic			N/A	N/A	N/A	N/A
Organic	Long-term (steady-state) - Effective Stress	165	5	1.85	1.5	1.2	C-8
(North Slope)	Long-term (steady-state) - Total Stress			1.93	1.5	1.2	-
	Pseudo-Static - Effective Stress			1.64	1.1	1.05	C-8
	Pseudo-Static - Total Stress			1.69	1.1	1.05	-
	Post Seismic			N/A	N/A	N/A	N/A

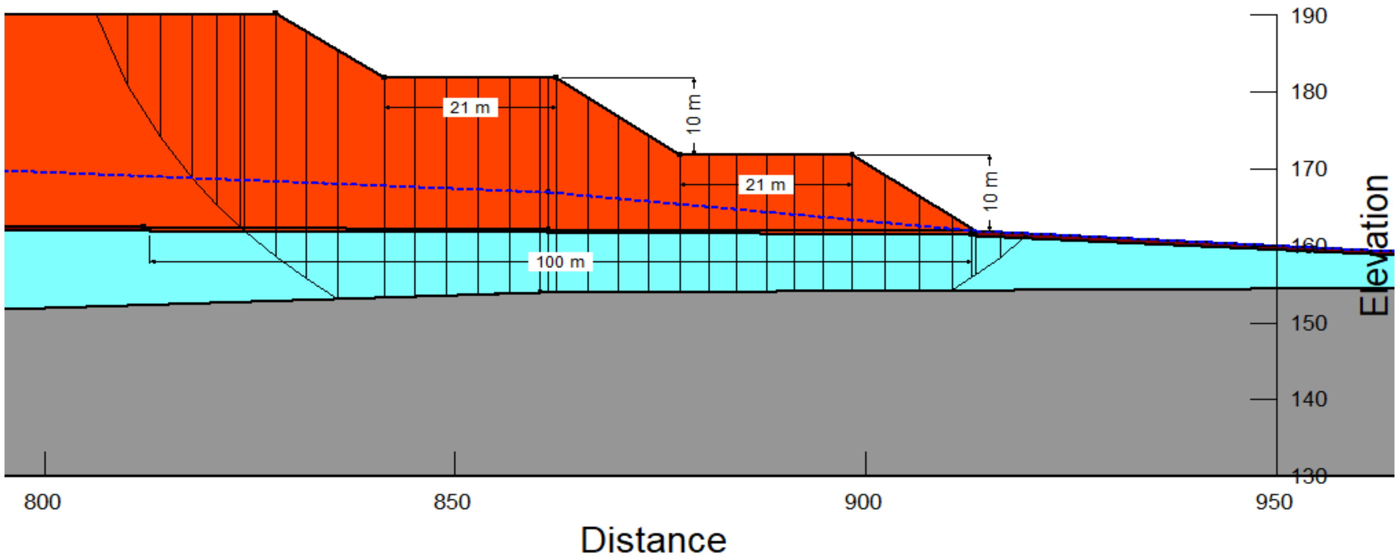
Notes:

1. Ground topography survey provided by Atlantic Gold.
2. Overburden thicknessed inferred from borehole and test pits data from 2020 geotechnical investigation program.
3. Material strength paramaters based on results obtianed from geotechnical investigation and typical soil parameters from previous project experience.
4. This table should be read in conjunction with the accompanying report.

Long Term (steady-state)

1.49

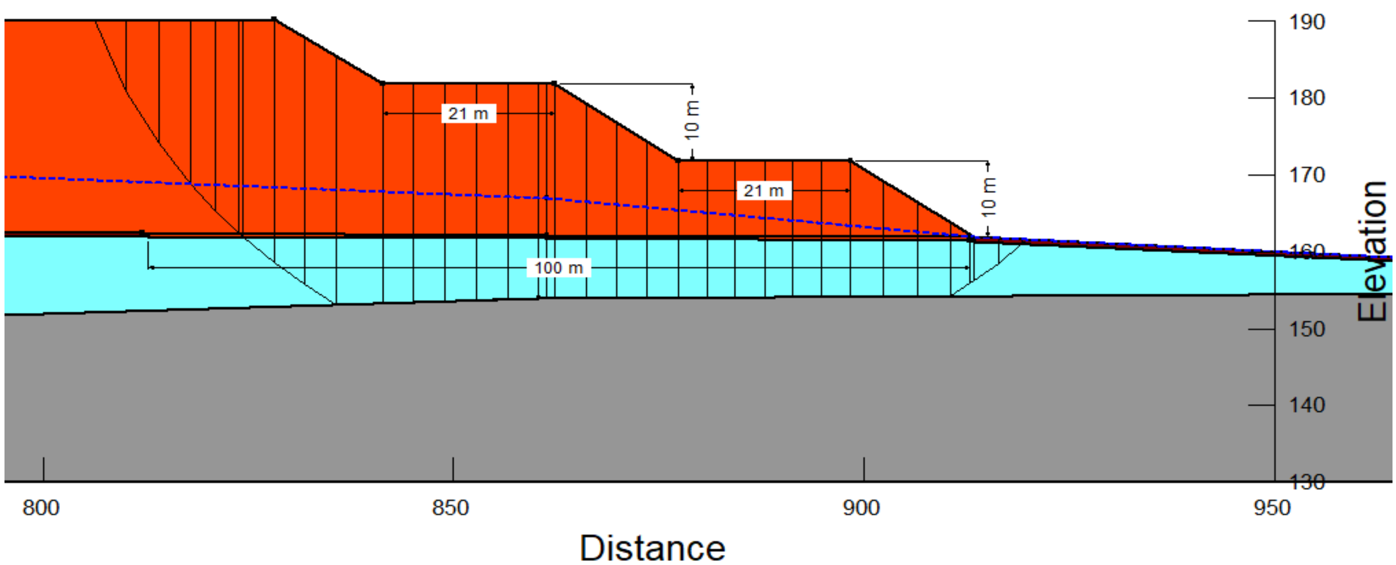
Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics (In-Situ)	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38



Pseudo-Static

1.31

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics (In-Situ)	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38



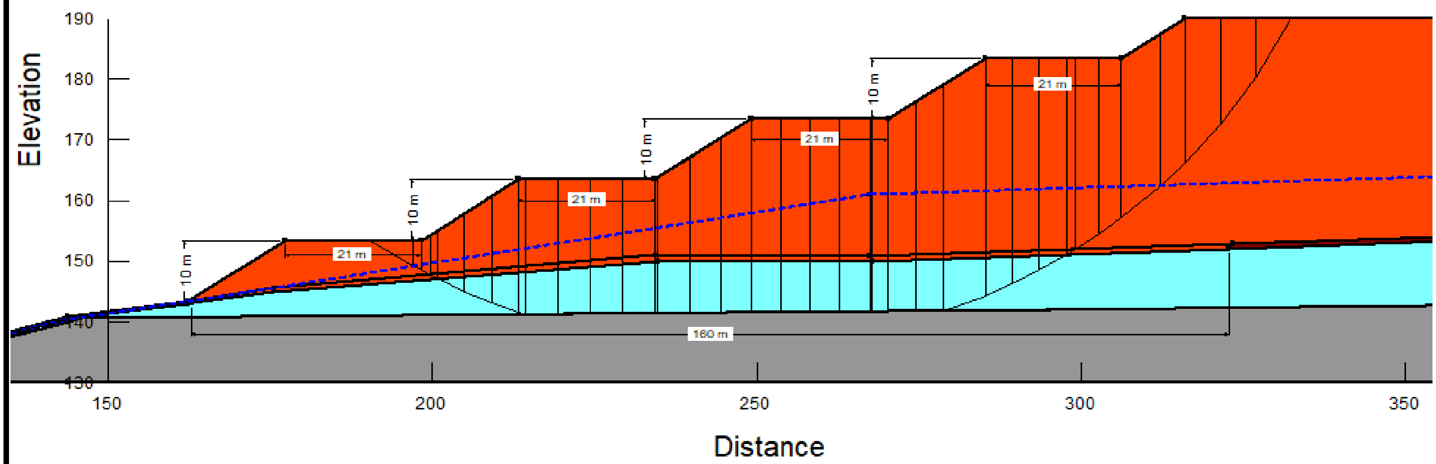
GOLDER		Scale:	N.T.S	Stability Analysis - Total Stress	
		Date:	Mar-21	NAG Stockpile South Slope (Crest El. 190 m)	
		Design:	MM		
File Name	AppC_Stability Analyses Figures.x	Check:	NN	ATLANTIC GOLD - BEAVER MINE	Figure #: C-1
Project No.	20142100 Version 1	Review:	DCJ		

Golder Associates

Long Term (steady-state)

1.35

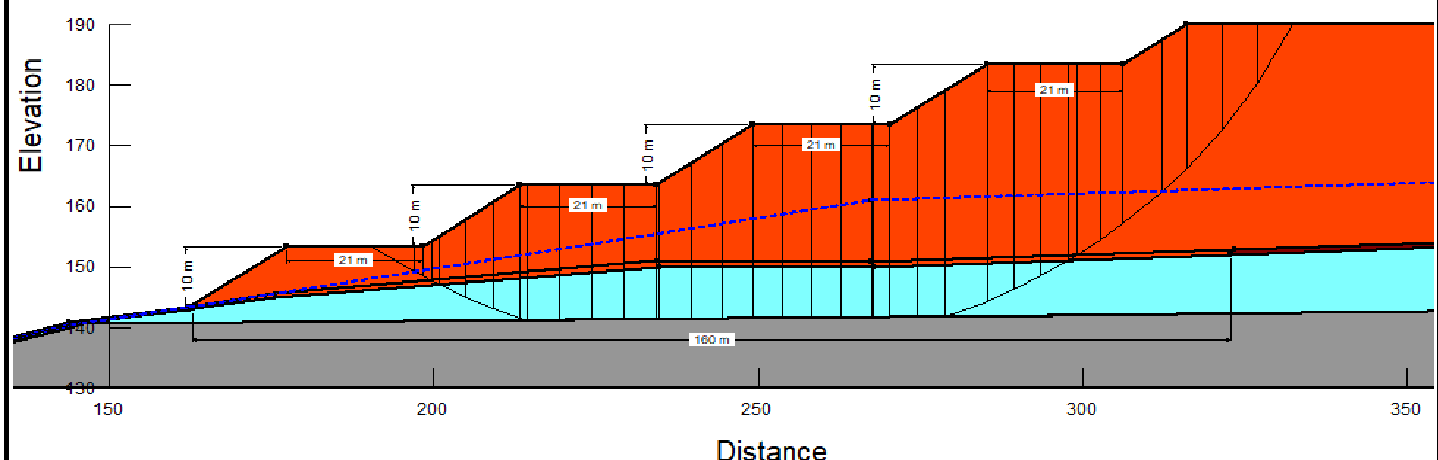
Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics (In-Situ)	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38



Pseudo-Static

1.19

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics (In-Situ)	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38



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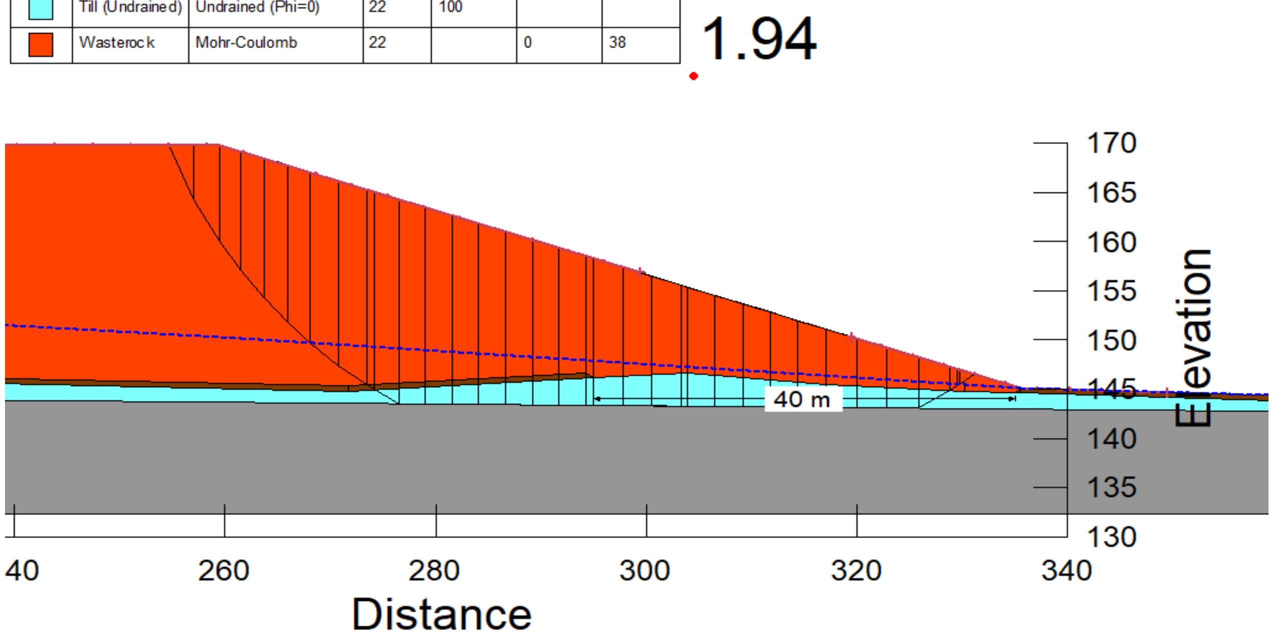
	Date: Mar-21			
	Design: MM			
File Name: AppC_Stability Analyses Figures.x	Check: NN	ATLANTIC GOLD - BEAVER MINE	Figure #:	C-2
Project No.: 20142100 Version 1	Review: DCJ			

Golder Associates

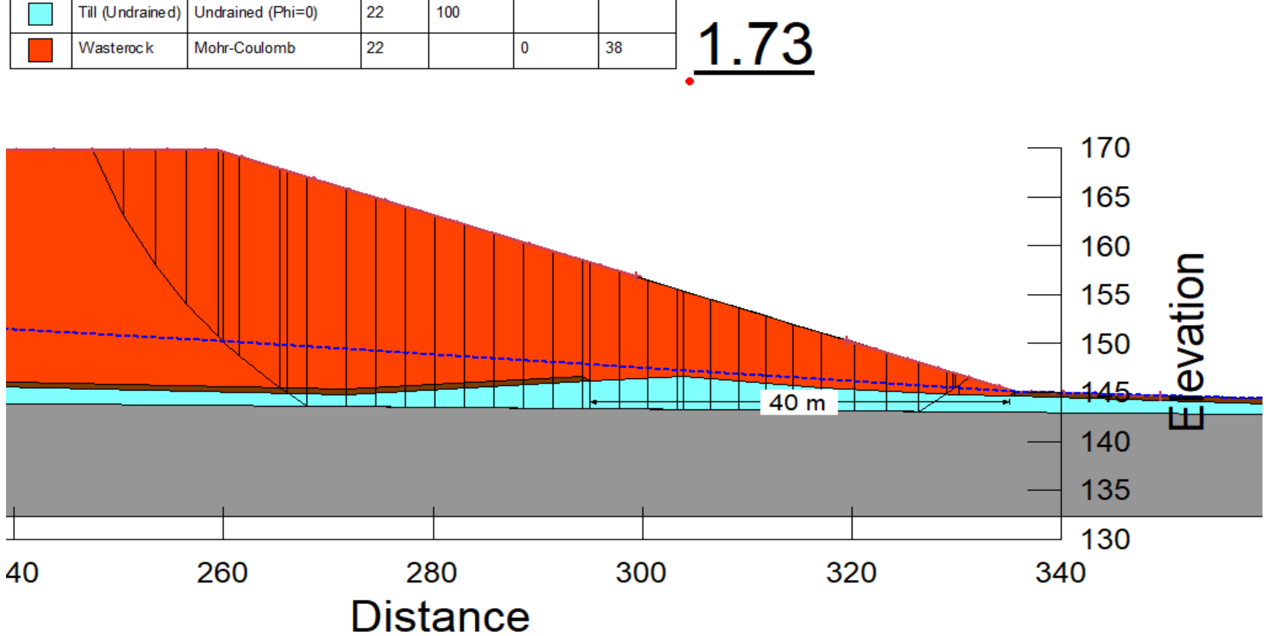
Long Term (steady-state)

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38



Pseudo-Static

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38



GOLDER

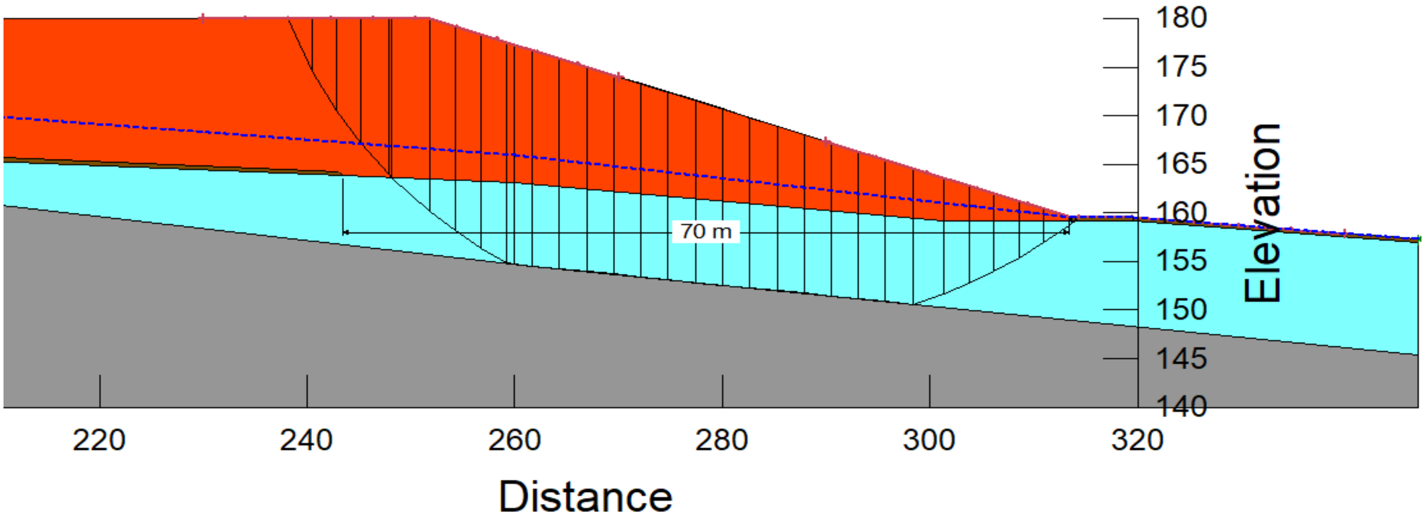
Scale: N.T.S	Stability Analysis - Total Stress		
Date: Mar-21	LG Stockpile East Slope (Crest El. 170 m)		
Design: MM			
File Name: AppC_Stability Analyses Figures.x	Check: NN	ATLANTIC GOLD - BEAVER MINE	Figure #: C-3
Project No.: 20142100 Version 1	Review: DCJ		

Golder Associates

Long Term (steady-state)

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38

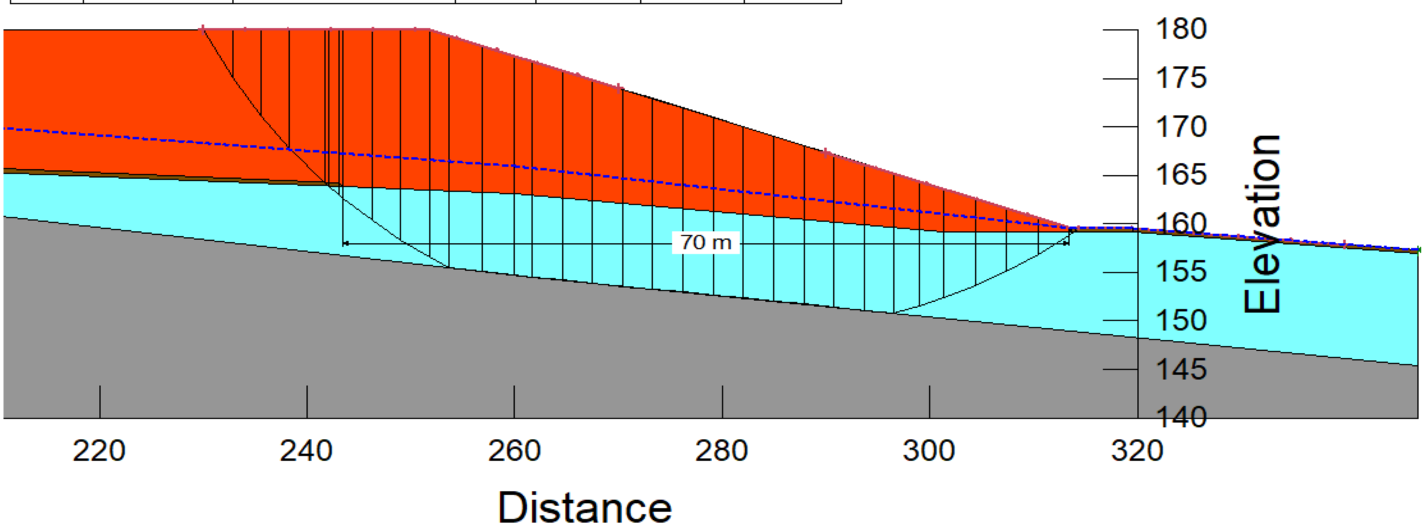
1.61



Pseudo-Static

Color	Name	Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)				
	Organics	Mohr-Coulomb	18		0	10
	Till (Undrained)	Undrained (Phi=0)	22	100		
	Wasterock	Mohr-Coulomb	22		0	38

1.44



GOLDER

Scale:	N.T.S	**Stability Analysis - Total Stress**	
Date:	Mar-21	**PAG Stockpile North Slope (Crest El. 180 m)**	
Design:	MM		
Check:	NN	**ATLANTIC GOLD - BEAVER MINE**	Figure #: C-4
Review:	DCJ		

File Name	AppC_Stability Analyses Figures.x		
Project No.	20142100	Version	1

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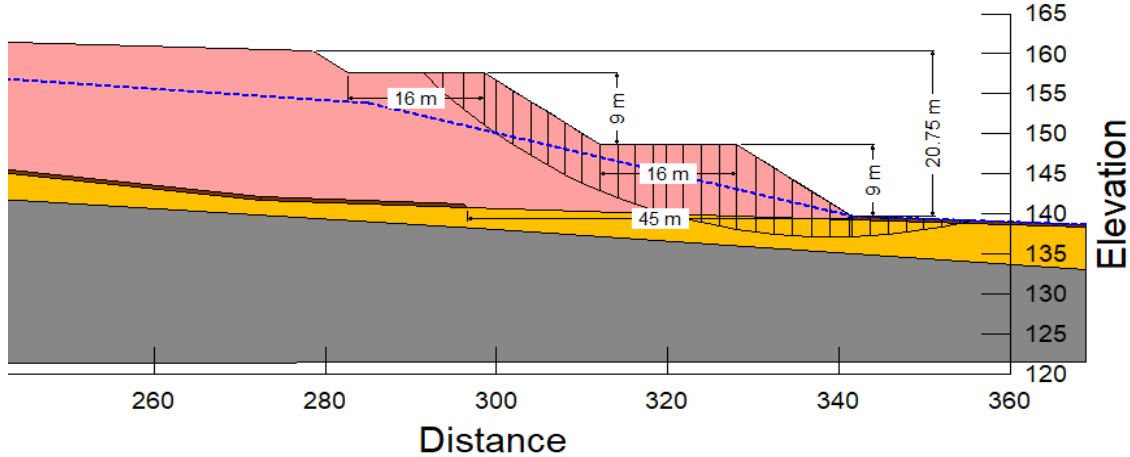
Overall Slope Failure

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Organics	Mohr-Coulomb	18	0	10
	Till (In-Situ)	Mohr-Coulomb	22	0	34
	Till (Stockpile)	Mohr-Coulomb	21	0	34

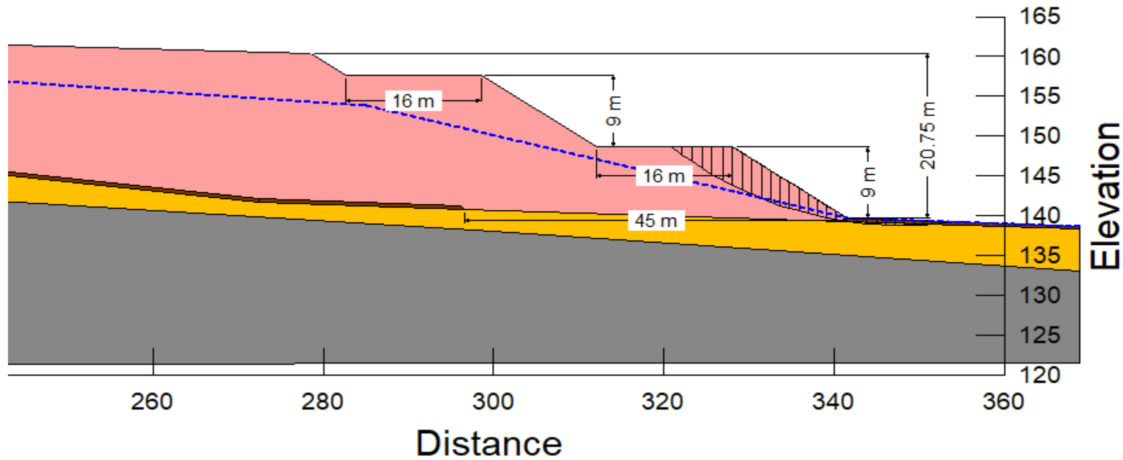
1.74



Localized Bottom Bench Failure

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Organics	Mohr-Coulomb	18	0	10
	Till (In-Situ)	Mohr-Coulomb	22	0	34
	Till (Stockpile)	Mohr-Coulomb	21	0	34

1.54

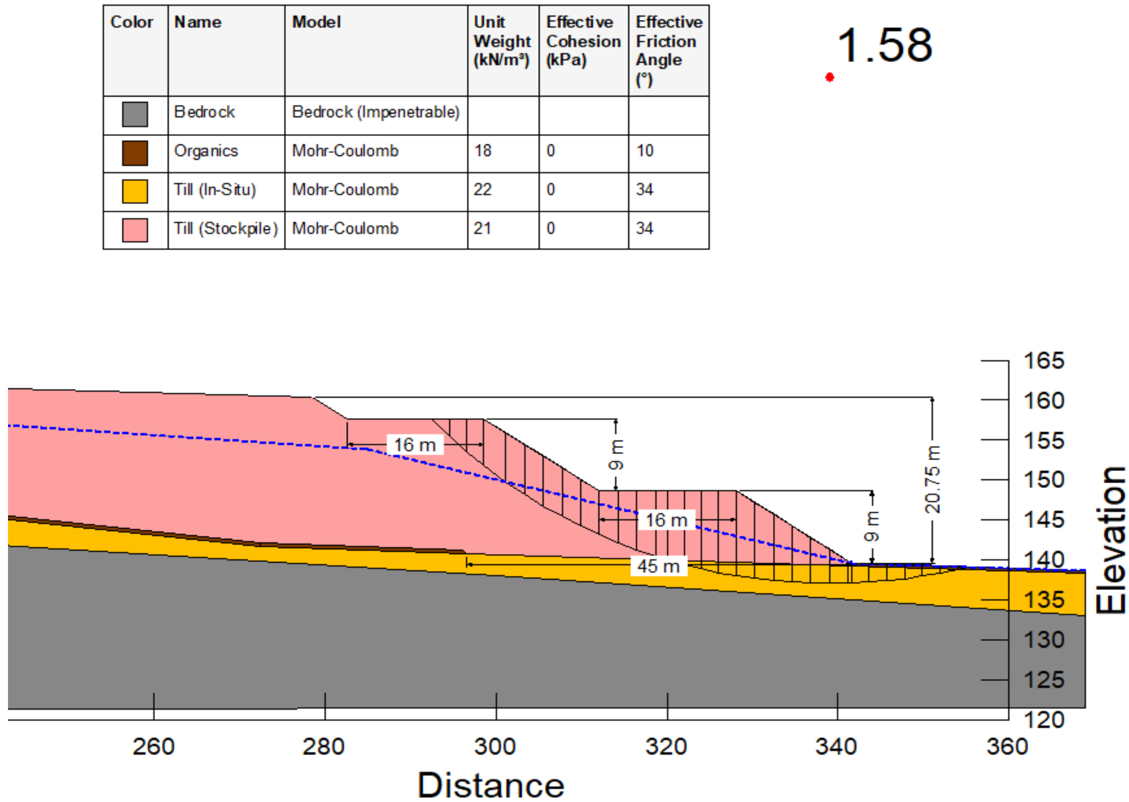


GOLDER	Scale: N.T.S Date: Mar-21 Design: MM	**Stability Analysis - Effective Stress** **Long Term (steady-state)** **West Till (1) Stockpile Northeast Slope (Crest El. 160 m)**	
File Name: AppC_Stability Analyses Figures.x Project No.: 20142100 Version 1	Check: NN Review: DCJ	**ATLANTIC GOLD - BEAVER MINE**	Figure #: C-5

Golder Associates

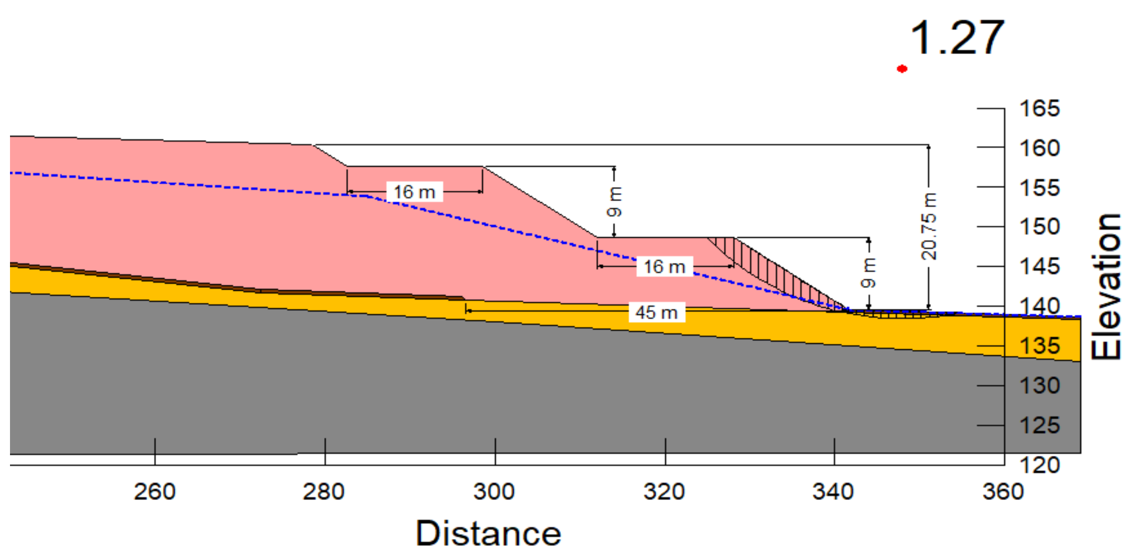
Overall Slope Failure

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
(grey)	Bedrock	Bedrock (Impenetrable)			
(brown)	Organics	Mohr-Coulomb	18	0	10
(yellow)	Till (In-Situ)	Mohr-Coulomb	22	0	34
(pink)	Till (Stockpile)	Mohr-Coulomb	21	0	34



Localized Bottom Bench Failure

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
(grey)	Bedrock	Bedrock (Impenetrable)			
(brown)	Organics	Mohr-Coulomb	18	0	10
(yellow)	Till (In-Situ)	Mohr-Coulomb	22	0	34
(pink)	Till (Stockpile)	Mohr-Coulomb	21	0	34



GOLDER	Scale: N.T.S Date: Mar-21 Design: MM	Stability Analysis - Effective Stress Pseudo-Static West Till (1) Stockpile Northeast Slope (Crest El. 160 m)	
File Name: AppC_Stability Analyses Figures.x	Check: NN	ATLANTIC GOLD - BEAVER MINE	Figure #: C-6
Project No. 20142100 Version 1	Review: DCJ		

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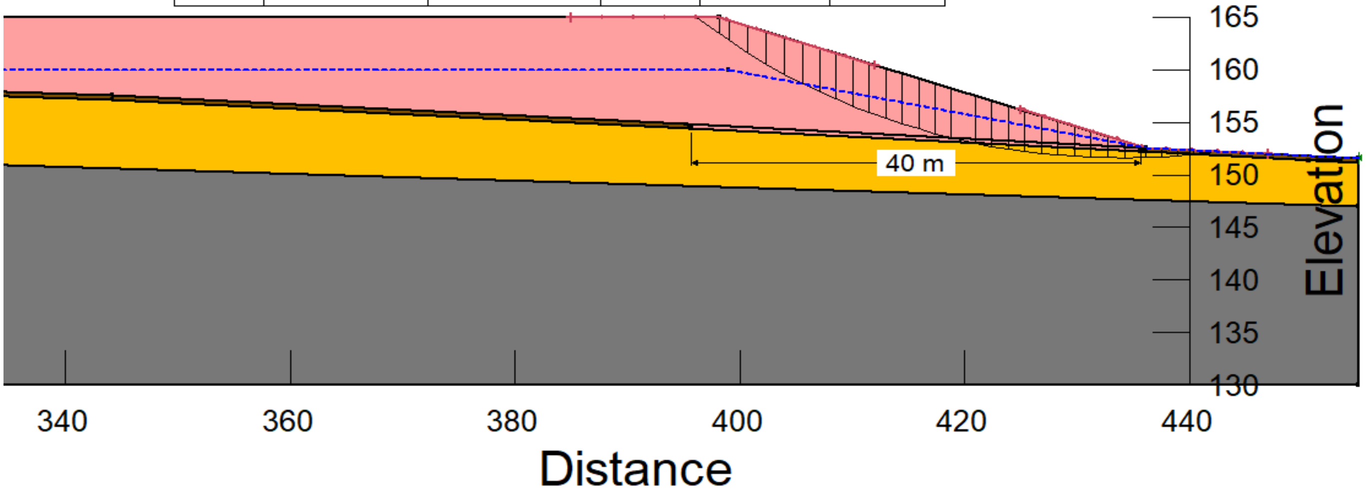
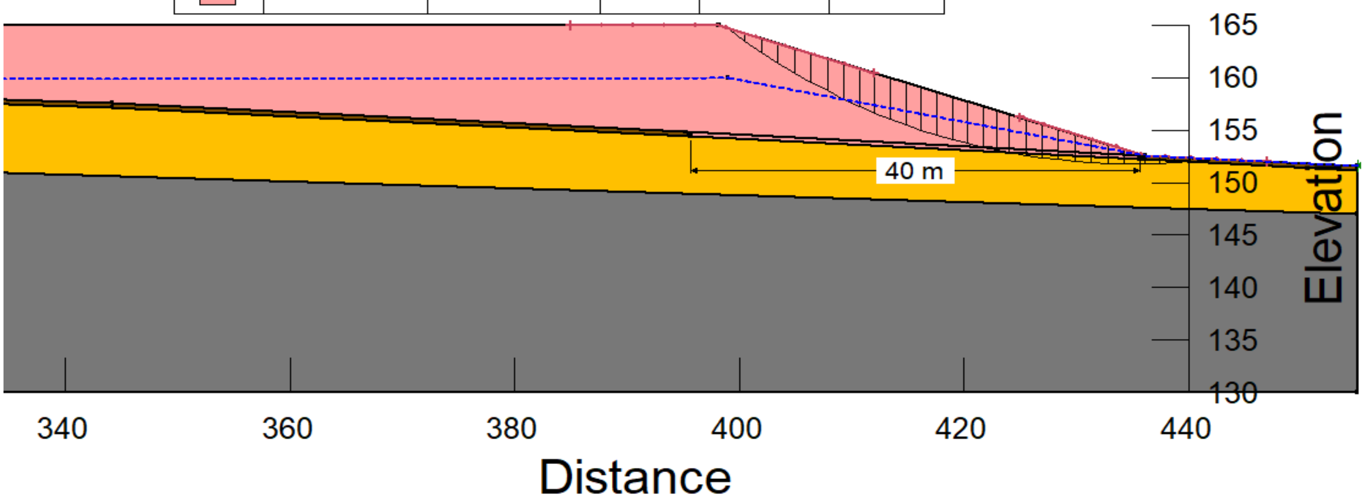
Long Term (steady-state)

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
(grey)	Bedrock	Bedrock (Impenetrable)			
(brown)	Organic	Mohr-Coulomb	18	0	10
(yellow)	Till (In-Situ)	Mohr-Coulomb	22	0	34
(pink)	Till (Stockpile)	Mohr-Coulomb	21	0	34



Pseudo-Static

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
(grey)	Bedrock	Bedrock (Impenetrable)			
(brown)	Organic	Mohr-Coulomb	18	0	10
(yellow)	Till (In-Situ)	Mohr-Coulomb	22	0	34
(pink)	Till (Stockpile)	Mohr-Coulomb	21	0	34



GOLDER

Scale:	N.T.S	**Stability Analysis - Effective Stress**	
Date:	Mar-21	**East Till (2) Stockpile North Slope (Crest El. 165 m)**	
Design:	MM		
Check:	NN	**ATLANTIC GOLD - BEAVER MINE**	Figure #: C-7
Review:	DCJ		

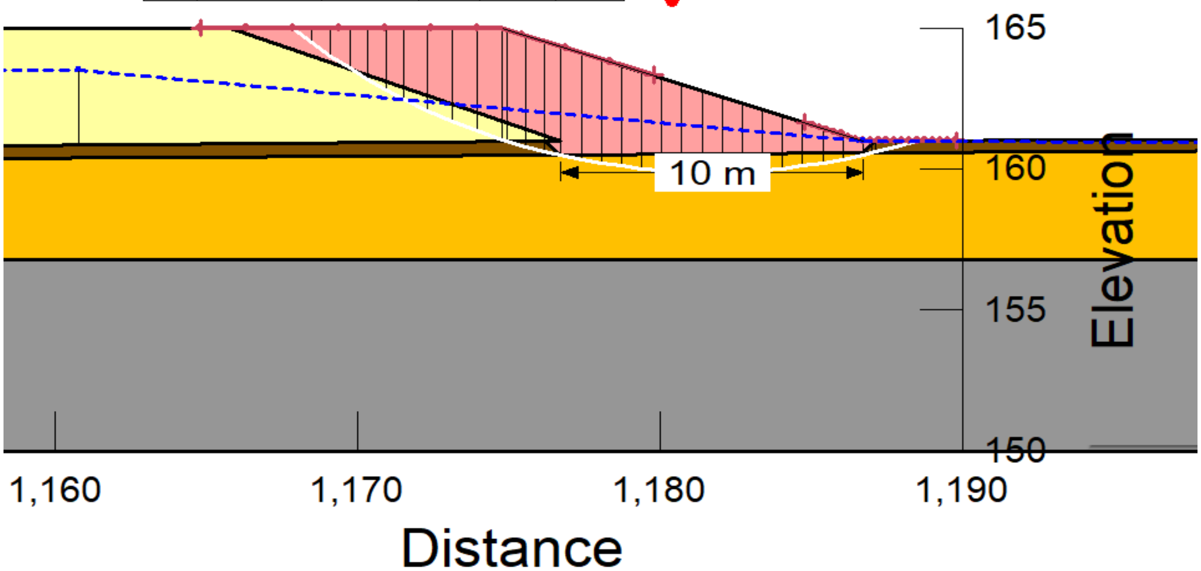
File Name: AppC_Stability Analyses Figures.x

Project No.: 20142100 Version: 1

Golder Associates

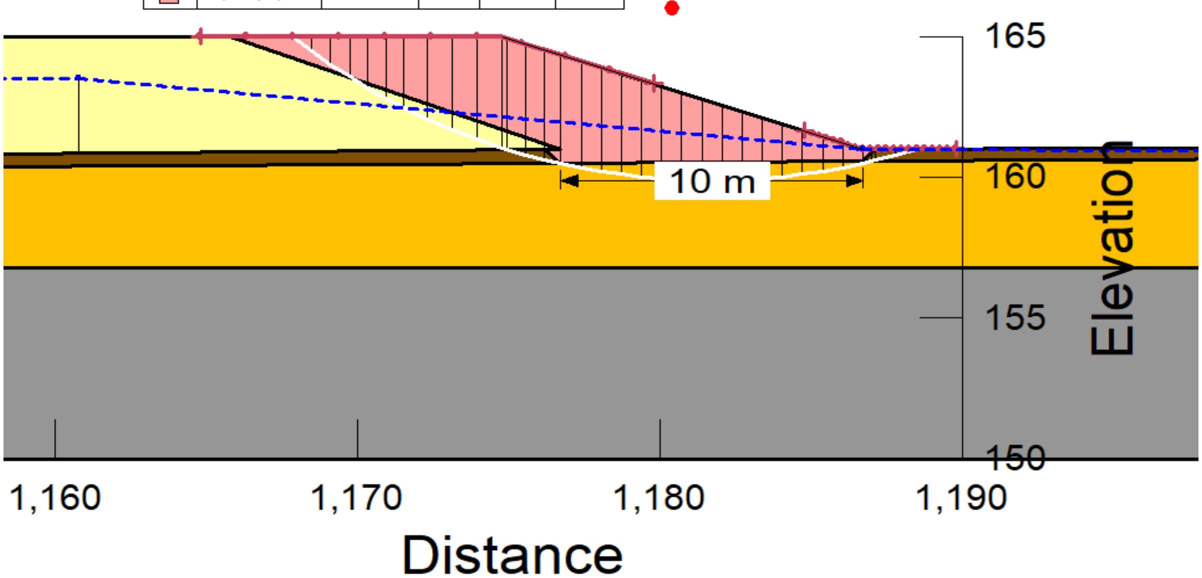
Long Term (steady-state)

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Organic (In-Situ)	Mohr-Coulomb	18	0	10
	Organic (Stockpile)	Mohr-Coulomb	16	0	10
	Till (In-Situ)	Mohr-Coulomb	22	0	34
	Till (Stockpile)	Mohr-Coulomb	21	0	34



Pseudo-Static

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Bedrock	Bedrock (Impenetrable)			
	Organic (In-Situ)	Mohr-Coulomb	18	0	10
	Organic (Stockpile)	Mohr-Coulomb	16	0	10
	Till (In-Situ)	Mohr-Coulomb	22	0	34
	Till (Stockpile)	Mohr-Coulomb	21	0	34

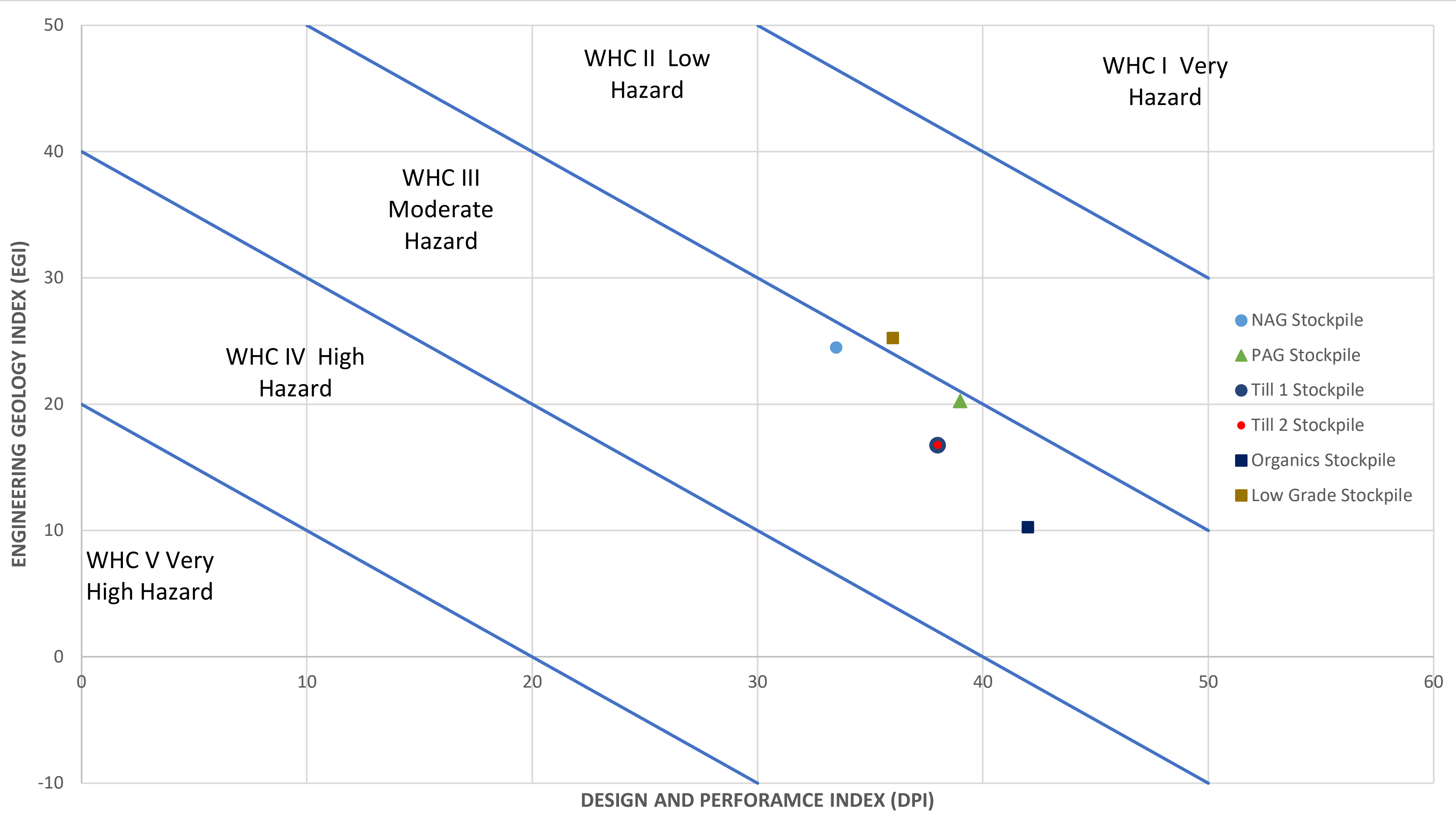


GOLDER

Scale:	N.T.S	Stability Analysis - Effective Stress Organic Stockpile North Slope (Crest El. 165 m)	
Date:	Mar-21		
Design:	MM		
File Name	AppC_Stability Analyses Figures.x	Check:	NN
Project No.	20142100	Version	1
Review:	DCJ	ATLANTIC GOLD - BEAVER MINE	Figure #: C-8

APPENDIX D

Stockpile Hazard Classification



GOLDER

STOCKPILE HAZARD CLASSIFICATION

PROJECT NO:	20142100	DATE:	MAR 2021
BY:	BG	Review:	DCJ

Atlantic Gold Beaver Dam Mine, Nova Scotia

Figure D-1

Engineering Geology Index (EGI)

NAG Stockpile

Group	Factor	Value	Index	Rating
Regional Setting	Seismicity	PGA=0.027g (10 % in 50 years)	Very Low	2
	Precipitation	1981-2010 weather normal: 1357.6mm	High	2
Foundation Conditions	Foundation Slope	~5 degrees (from CAD and field observations)	Gentle (5-15)	4
	Foundation Shape	Planer to concave	Planar/Concave	1.5
	Overburden Type	Glacial Till (moderately dense)	Type IV	3
	Overburden Thickness	2-13 m	>5	0
	Undrained Failure Potential	Borehole logs (WC~PL)	Moderate	-5
	Foundation Liquefaction Potential	Well graded, dense, non-liquefiable soils	Negligible	0
	Bedrock	Moderately competent; slightly weathered	Type C	2
	Groundwater	Groundwater less then 3 m below surface	Moderate	1
Material Quality(1)	Gradation	Assumed: Based 50-75 % greater than 75 mm	Coarse Grained	5
	Intact Strength and Durability	Assumed: Based on Type C bedrock	Type 3	4
	Material Liquefaction Potential	Waste rock, well graded	Negligible	0
	Chemical Stability	Non-acid generating rock	Neutral	5
			Total	24.5

Note: 1) Material characteristic for waste rock estimated

Design and Performance Index (DPI)

NAG Stockpile

Group	Factor	Value	Index	Rating
Geometry & Mass	Height	46 meters	Very Low	4
	Slope Angle	18 degrees	Flat	3
	Volume and Mass	34 million tonnes	Medium	1
Stability Analysis	Static Stability	Static FOS = 1.35	1.3-1.5	5
	Dynamic Stability	Pseudo-static FOS = 1.19	>1.15	3
Construction	Construction Method	Ascending placement on gentle slopes	Method V	8
	Loading Rate (1)	114 t/d/m	High	2
Performance	Stability Performance	Assumed: Stable	Good	7.5
			Total	33.5

Note: 1) Mass loading rate assumes bulk density of 2.00 t/m3

Engineering Geology Index (EGI)

LG Stockpile

Group	Factor	Value	Index	Rating
Regional Setting	Seismicity	PGA=0.027g (10 % in 50 years)	Very Low	2
	Precipitation	1981-2010 weather normal: 1357.6mm	High	2
Foundation Conditions	Foundation Slope	2-10 degrees (from CAD and field observations)	Gentle (5-15)	4
	Foundation Shape	Planer to concave	Planar/Concave	1.5
	Overburden Type	Glacial Till (moderately dense)	Type IV	3
	Overburden Thickness	On average 3.5 m. Greater then 3.5 in some areas.	3 to 5 m	1
	Undrained Failure Potential	Borehole logs (WC~PL)	Moderate	-5
	Foundation Liquefaction Potential	Well graded, dense, non-liquefiable soils	Negligible	0
	Bedrock	Fresh to slightly weather (RQD 75-100)	Type C	2
	Groundwater	Ground water (0.5 to 2.9 mbgs)	Moderate/High	0.75
Material Quality(1)	Gradation	Assumed: Based 50-75 % greater than 75 mm	Coarse Grained	5
	Intact Strength and Durability	Assumed: Based on Type C bedrock	Type 3	4
	Material Liquefaction Potential	Waste rock, well graded	Negligible	0
	Chemical Stability	Non-acid generating rock	Neutral	5
			Total	25.25

Note: 1) Material characteristic for waste rock estimated

Design and Performance Index (DPI)

LG Stockpile

Group	Factor	Value	Index	Rating
Geometry & Mass	Height	Approx. height 14-26 m	Very Low	4
	Slope Angle	18 degrees	Flat	3
	Volume and Mass	2.48 million tonnes	Small	1.5
Stability Analysis	Static Stability	Static FOS = 1.94	>1.5	7
	Dynamic Stability	Pseudo-static FOS = 1.73	>1.15	3
Construction	Construction Method	Ascending placement on gentle slopes	Method V	8
	Loading Rate (1)	Assumed	High	2
Performance	Stability Performance	Assumed: Stable	Good	7.5
			Total	36

Note: 1) Mass loading rate assumes bulk density of 2.00 t/m3

Engineering Geology Index (EGI)

PAG Stockpile

Group	Factor	Value	Index	Rating
Regional Setting	Seismicity	PGA=0.027g (10 % in 50 years)	Very Low	2
	Precipitation	1981-2010 weather normal: 1357.6mm	High	2
Foundation Conditions	Foundation Slope	10-15 degrees (from CAD and field observations)	Gentle (5-15)	4
	Foundation Shape	Planer to concave	Planar/Concave	1.5
	Overburden Type	Glacial Till (moderately dense)	Type IV	3
	Overburden Thickness	On average 2 m, in areas >4.0 m	3 to 5 m	1
	Undrained Failure Potential	Borehole logs (WC~PL)	Moderate	-5
	Foundation Liquefaction Potential	Well graded, dense, non-liquefiable soils	Negligible	0
	Bedrock	Fresh to slightly weather (RQD 35-90)	Type C	2
	Groundwater	Groundwater (0.7 to 1.5 mbgs)	Moderate/High	0.75
Material Quality(1)	Gradation	Assumed: Based 50-75 % greater than 75 mm	Coarse Grained	5
	Intact Strength and Durability	Assumed: Based on Type C bedrock	Type 3	4
	Material Liquefaction Potential	Waste rock, well graded	Negligible	0
	Chemical Stability	Potential for generation of ARD	Moderately Reactive	0
Note: 1) Material characteristic for waste rock estimated			Total	20.25

Design and Performance Index (DPI)

PAG Stockpile

Group	Factor	Value	Index	Rating
Geometry & Mass	Height	Approx. height 14-26 m	Very Low	4
	Slope Angle	18 degrees	Flat	3
	Volume and Mass	2.5 million tonnes	Small	1.5
Stability Analysis	Static Stability	Static FOS = 1.61	>1.5	7
	Dynamic Stability	Pseudo-static FOS = 1.44	>1.15	3
Construction	Construction Method	Ascending placement on gentle slopes	Method V	8
	Loading Rate (1)	18 t/d/m	Low	5
Performance	Stability Performance	Assumed: Stable	Good	7.5
Note: 1) Mass loading rate assumes bulk density of 2.00 t/m3			Total	39

Engineering Geology Index (EGI)

Till 1 Stockpile

Group	Factor	Value	Index	Rating
Regional Setting	Seismicity	PGA=0.027g (10 % in 50 years)	Very Low	2
	Precipitation	1981-2010 weather normal: 1357.6mm	High	2
Foundation Conditions	Foundation Slope	10-15 degrees (from CAD and field observations)	Gentle (5-15)	4
	Foundation Shape	Planer to concave	Planar/Concave	1.5
	Overburden Type	Glacial Till (moderately dense)	Type IV	3
	Overburden Thickness	Till between 0.5 to 10 m	>5	0
	Undrained Failure Potential	Borehole logs (WC~PL)	Moderate	-5
	Foundation Liquefaction Potential	Well graded, dense, non-liquefiable soils	Negligible	0
	Bedrock	Fresh (RQD 52-89)	Type C	2
	Groundwater	Groundwater b/w 0.2 m to 3.5 m below ground	Moderate/High	0.75
Material Quality	Gradation	Average fines content from lab samples 29-59	Fine Grained/ Mixed Grain	2
	Intact Strength and Durability	Fine/mixed grain size overburden	Type 2	2
	Material Liquefaction Potential	Low liquefaction potential but cannot be discounted	Low	-2.5
	Chemical Stability	Neutral	Neutral	5
			Total	16.75

Design and Performance Index (DPI)

TILL 1 Stockpile

Group	Factor	Value	Index	Rating
Geometry & Mass	Height	Approx. height 10-25 m	Very Low	4
	Slope Angle	18 degrees	Flat	3
	Volume and Mass	0.69 million tonnes	Very Small	2
Stability Analysis	Static Stability	Static FOS = 1.74	>1.5	7
	Dynamic Stability	Pseudo-static FOS = 1.58	>1.15	3
Construction	Construction Method	Ascending placement on gentle slopes	Method V	8
	Loading Rate (1)	55 t/d/m	Moderate	3.5
Performance	Stability Performance	Assumed: Stable	Good	7.5
			Total	38

Note: 1) Mass loading rate assumes bulk density of 2.00 t/m3

Engineering Geology Index (EGI)

Till 2 Stockpile

Group	Factor	Value	Index	Rating
Regional Setting	Seismicity	PGA=0.027g (10 % in 50 years)	Very Low	2
	Precipitation	1981-2010 weather normal: 1357.6mm	High	2
Foundation Conditions	Foundation Slope	4-10 degrees (from CAD and field observations)	Gentle (5-15)	4
	Foundation Shape	Planer to concave	Planar/Concave	1.5
	Overburden Type	Glacial Till (moderately dense)	Type IV	3
	Overburden Thickness	O/B thickness 7 to 9 m	>5	0
	Undrained Failure Potential	Borehole logs (WC~PL)	Moderate	-5
	Foundation Liquefaction Potential	Well graded, dense, non-liquefiable soils	Negligible	0
	Bedrock	Fresh (RQD 62-100)	Type C	2
	Groundwater	Groundwater b/w 1.8 m to 3.0 m below ground	Moderate/High	0.75
Material Quality	Gradation	Average fines content from lab samples 29-59	Fine Grained/ Mixed Grain	2
	Intact Strength and Durability	Fine/mixed grain size overburden	Type 2	2
	Material Liquefaction Potential	Low liquefaction potential but cannot be discounted	Low	-2.5
	Chemical Stability	Neutral	Neutral	5
			Total	16.75

Design and Performance Index (DPI)

TILL 2 Stockpile

Group	Factor	Value	Index	Rating
Geometry & Mass	Height	Approx. stockpile height 3-10 m	Very Low	4
	Slope Angle	18 degrees	Flat	3
	Volume and Mass	1.97 million tonnes	Very Small	2
Stability Analysis	Static Stability	Static FOS = 1.80	>1.5	7
	Dynamic Stability	Pseudo-static FOS = 1.62	>1.15	3
Construction	Construction Method	Ascending placement on gentle slopes	Method V	8
	Loading Rate (1)	46 t/d/m	Moderate	3.5
Performance	Stability Performance	Assumed: Stable	Good	7.5
			Total	38

Note: 1) Mass loading rate assumes bulk density of 2.00 t/m3

Engineering Geology Index (EGI)

Organics Stockpile

Group	Factor	Value	Index	Rating
Regional Setting	Seismicity	PGA=0.027g (10 % in 50 years)	Very Low	2
	Precipitation	1981-2010 weather normal: 1357.6mm	High	2
Foundation Conditions	Foundation Slope	3-6 degrees (from CAD and field observations)	Gentle (5-15)	4
	Foundation Shape	Planer to concave	Planar/Concave	1.5
	Overburden Type	Glacial Till (moderately dense)	Type IV	3
	Overburden Thickness	O/B thickness 1 to >4.9 m	>5	0
	Undrained Failure Potential	Borehole logs (WC~PL)	Moderate	-5
	Foundation Liquefaction Potential	Well graded, dense, non-liquefiable soils	Negligible	0
	Bedrock	No boreholes, assume Type C	Type C	2
	Groundwater	Groundwater 0.1 to 3.7 m below ground surface	Moderate/High	0.75
Material Quality	Gradation	Very fined grained organics	Very fined grained	0
	Intact Strength and Durability	Extremely weak	Type I	0
	Material Liquefaction Potential	Moderate or unknown liquefaction potential	Unknown	-5
	Chemical Stability	Assumed neutral	Neutral	5
			Total	10.25

Design and Performance Index (DPI)

ORGANIC Stockpile

Group	Factor	Value	Index	Rating
Geometry & Mass	Height	Approx. height 4 m	Very Low	4
	Slope Angle	8 degrees	Very Flat	4
	Volume and Mass	2.29 million tonnes	Small	1.5
Stability Analysis	Static Stability	With till exterior slope, static FOS = 1.85	>1.5	7
	Dynamic Stability	With till exterior slope, pseudo-static FOS = 1.64	>1.15	3
Construction	Construction Method	Ascending placement on gentle slopes	Method V	8
	Loading Rate (1)	1 t/d/m	Very Low	7
Performance	Stability Performance	Assumed: Stable	Good	7.5
			Total	42

Note: 1) Mass loading rate assumes bulk density of 2.00 t/m3

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