Appendix P.4

Mine Water Management Plan

Appendix A Water Balance Analysis
Appendix B Stormwater Management Assessment – Hydrologic Modelling
Appendix C Erosion and Sediment Control Plan
Appendix D Predictive Water Quality Assessment
Appendix E Hydrogeological Modelling Report
Appendix F Water Treatment Assessments
Appendix F.1 Construction Phases
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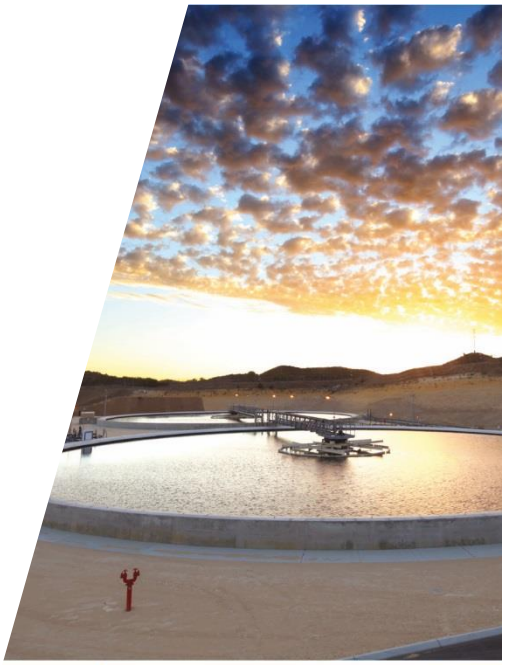
Appendix G Proposed Groundwater Monitoring Plan
Appendix H Baseflow Mitigation Assessment

Completed for the Updated 2021 Beaver Dam Mine EIS



Mine Water Management Plan

Beaver Dam Mine Site

Atlantic Mining NS Inc.

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Appendix F Water Treatment Assessments

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Appendix F.3 Post-Closure Phase. Report 22, GHD 2021

Appendix G Proposed Groundwater Monitoring Plan. Report 19, GHD 2021

Appendix H Baseflow Mitigation Assessment. Memo 9, GHD 2021

Abbreviations

Abbreviation	Definition
AGC	Atlantic Gold Corporation
ALD	Anoxic Limestone Drain
AMNS	Atlantic Mining NS Inc.
AWBM	Australian Water Balance Model
BFI	Baseflow Index
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Agency
COC	Constituents of Concern
CSP	Corrugated Steel Pipe
ECCC	Environment and Climate Change Canada
EIS	Environmental Impact Statement
EEM	Environmental Effects Monitoring
EQS	Environmental Quality Standards
ESCP	Erosion and Sediment Control Plan
ESC	Erosion and Sediment Control
EOM	End of Mine
FDP	Final Discharge Point
FWAL	Freshwater Aquatic Life
GCDWQ	Guidelines for Canadian Drinking Water
GHD	GHD Limited
HDPE	High Density Polyethylene
IA	Industrial Approval
IDF	Intensity Duration Frequency
LGO	Low Grade Ore
MDMER	Metal and Diamond Mining Effluent Regulations
MEL	McCallum Environmental Limited
MWMP	Mine Water Management Plan
NAG	Non-Acid Generating
NSECC	Nova Scotia Environment and Climate Change
PA	Project Area
PAG	Potentially-Acid Generating
PC	Post Closure
QA/QC	Quality Assurance/Quality Control
SAPS	Successive Alkalinity Producing Systems
SWM	Stormwater Management
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WBM	Water Balance Model
WC	Watercourse
WTS	Water Treatment System

1. Introduction

1.1 Background

GHD Limited (GHD) was retained by Atlantic Mining NS Inc. (AMNS), formerly Atlantic Gold Corporation (AGC) to develop a Mine Water Management Plan (MWMP) for the Beaver Dam Gold Mine (Mine) in Marinette, Halifax County (Site), Nova Scotia. The MWMP has been developed in support of the Environmental Impact Statement (EIS). It is a 'living' document, which may require updating and will be adaptively managed throughout the lifecycle of the Mine.

The proposed Beaver Dam Mine Site (Mine Site) comprises approximately 592 hectares (ha) of lakes, rivers, and forested lands that are in varying degrees of re-growth due to historical logging. The Mine 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 will be mined using an open pit mining method and ore will be crushed and transported by road to the existing Touquoy plant where it will be processed. The current mine plan indicates that a maximum of approximately 2 million tonnes of ore will be extracted from the Mine annually over a period of five years.

The main proposed mine facilities include an open pit, materials storage facilities (i.e., waste rock, topsoil, till and organic materials), mine access roads, mine infrastructure for crushing, water management, hauling, truck maintenance, administration, and road upgrades.

1.2 Purpose

The MWMP describes the strategies proposed for water and sediment management throughout the main stages of the Mine, including construction, operations, and closure. Construction of the Mine is anticipated to take one year. The Mine will be in operation for five years, followed by closure, which includes two years of active closure/reclamation and an additional ten years of monitoring.

The MWMP has been prepared during the preliminary design stage. The proposed infrastructure layout is preliminary; therefore, the final alignments and dimensions will be confirmed during the next stages of design and may be subject to change based on ongoing data collection, regulatory and community engagement, and design iterations. The MWMP will continually be reviewed and updated as the Mine proceeds into detailed design, construction, operations and closure, and as additional information becomes available from ongoing field investigation programs and monitoring activities.

The objective of the MWMP is to mitigate the operational risks and environmental impacts of the Mine on the surrounding environment including the receiving watercourses. This plan will serve as the primary guidance document for mine water monitoring and management at the Beaver Dam Mine Site and is complementary to the Erosion and Sediment Control Plan (GHD, 2021). Design details of the surface water management components are included in the following documents:

- Water Balance Analysis (GHD, 2021)
- Predictive Water Quality Assessment (GHD, 2021)
- Hydrogeologic Modelling Report (GHD, 2021)
- Proposed Groundwater Monitoring Plan (GHD, 2021)

- Stormwater Management Assessment - Hydrologic Modelling (GHD, 2021)
- Construction Phase: Water Treatment Assessment (GHD, 2021)
- Operation Phase: Water Treatment Assessment (GHD, 2021)
- Post-Closure Phase: Water Treatment Assessment (GHD, 2021)
- Proposed Groundwater Monitoring Plan (GHD, 2021)

The MWMP is organized as follows:

- **Section 1 – Introduction:** Introduces the project, purpose, and roles and responsibilities of the MWMP for the Beaver Dam Mine Site.
- **Section 2 – Summary of Physical Conditions:** Briefly summarizes the physical site characteristics, and local climate, surface water and groundwater conditions.
- **Section 3 – Water Management:** Presents an overview of the water management objectives and strategies, facilities, stages of Mine development and applicable site water management during these stages.
- **Section 4 – Water Balance:** Summarizes the outcomes of the water balance assessment.
- **Section 5 – Water Quality:** Describes the water quality criteria and outcomes of the predictive water quality assessment.
- **Section 6 – Design of Water Management Facilities:** Presents the basis of design of the mine water management facilities.
- **Section 7 – Water Treatment System (WTS):** Provides an overview of the WTS selection process and uses the predictive water quality assessment to determine appropriate treatment during each stage of Mine development.
- **Section 8 – Water Monitoring:** Overviews the proposed surface water and groundwater quality and quantity monitoring plan for each stage of Mine development.
- **Section 9 – References:** Lists the references cited in this Report.

2. Physical Setting

2.1 Site Characteristics

The Site comprises approximately 592 hectares (ha) of lakes, rivers, and forested lands that are in varying degrees of re-growth due to historical logging. The Mine 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. It is anticipated that once all permits are received construction will commence and will take one year to complete. Operations will take place over five years and active closure will take two years to complete, with post-closure monitoring extending an additional ten years. Post closure monitoring may be extended based on monitoring outcomes, which will be reviewed and document as part of reclamation and closure plans.

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.

To characterize the local climate, 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 – 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 Mine Site that collects lake evaporation data. This data was used as input to the water balance, predictive water quality, and hydrogeological studies. Further details are available in Appendix A.

The average monthly temperature at the Mine 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 kilometres [km] west of the Mine Site), was Hurricane Beth in 1971 with 296.4 mm of rainfall over 48 hours.

Impacts due to climate change were considered when developing design storms and have been addressed with additional contingencies (Table 2-1 and Appendix B). Nova Scotia Environment and Climate Change (NSECC) provides climate change projections across the province (NSE 2020). The two climate regions nearest the Mine Site (i.e., Halifax Regional Municipality and Truro) 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 to account for potential impacts due to climate change. Table 2-1 provides a summary of the design storms. Further information may be found in Appendix B.

Table 2-1 Design Storm Events

	25mm 4-hour	10-year + 5% CC	100-year + 5% CC	Hurricane Beth
Precipitation (mm)	25.0	87.3	113.8	296.4
Duration (hr)	4	24	24	48

2.3 Surface water

The Mine Site lies within the West River Sheet Harbour drainage basin, which is directly east of the Musquodoboit River Valley system. The watershed occupies an area of roughly 576 km^2.

The area is characterized by rolling till plains, drumlin fields, extensive rockland, and numerous freshwater lakes, streams, bogs, and wetlands having relatively low relief and hummocky type terrain.

The West River Sheet Harbour drainage basin discharges to the West River and its tributaries from north to south. Elevations within the catchment vary from approximately 135 to 165 metres above sea level (masl) in the headwater areas and gradually decrease to sea level at the final outlet located at Sheet Harbour. The headwaters of the drainage basin are located along the topographic divide separating the Musquodoboit River Valley to the northwest. The Killag River (including

Cameron Flowage) is the main mapped linear watercourse of the Mine Site, and Crusher Lake and Mud Lake are the major mapped lakes. The complex system of streams, lakes, bogs, and wetlands is a direct result of the underlying bedrock geology of greywacke and argillite found in the region. The basin ultimately drains to the south via the West River. Peak discharge is attenuated by the numerous lakes and wetlands through which runoff is routed. The tertiary basins affected by the Mine Site include the Killag River, Tent Brook, and Cope Brook basins.

2.4 Groundwater

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 Mine 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 m, which is consistent with seasonal groundwater level variations of approximately 1 to 2 m observed at monitoring wells throughout the Mine Site (GHD, 2021d).

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 Mine 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 Mine 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 AMSL in central Nova Scotia to sea level at the southeast shore of Nova Scotia.

During operations, the proposed open pit will be excavated to a maximum depth of approximately 175 to 200 m below ground surface. As the pit is excavated to its maximum depth, groundwater will enter the pit through the overburden, upper zone of weathered fractured crystalline bedrock and through the deeper fractured crystalline bedrock. Due to the low permeability of the fractured crystalline bedrock, groundwater flow into the pit at depth will likely be limited to enhanced

permeability zones created by fractured rock zones and/or faults. To date, major identified faults have been filled with a low permeability gouge material that may limit groundwater inflow along faults. Packer testing across major fault zones has confirmed that the fault zones and associated gouge material are of similar low permeability to that of the surrounding fractured crystalline bedrock. However, this does not preclude the future identification of higher permeability features related to fractured rock zones and/or faults. Groundwater may also discharge to water management structures including ditches which are not lined with an impermeable liner where there is a connection to the groundwater flow system. Unlined ditches do not receive mine contact water but are designed to manage run-off from off-site areas. Details regarding mine water collection is provided in Section 3.

3. Water Management

This section provides a description of the proposed MWMP for the Mine Site, including the water management objectives and strategies, a brief description of the proposed water management facilities and the proposed water management plan through different stages of the project.

3.1 Water Management Objectives and Strategies

The objective of the MWMP 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
- 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 MWMP provides an overview of the water supply source, water management, and water treatment associated to the Mine Site.

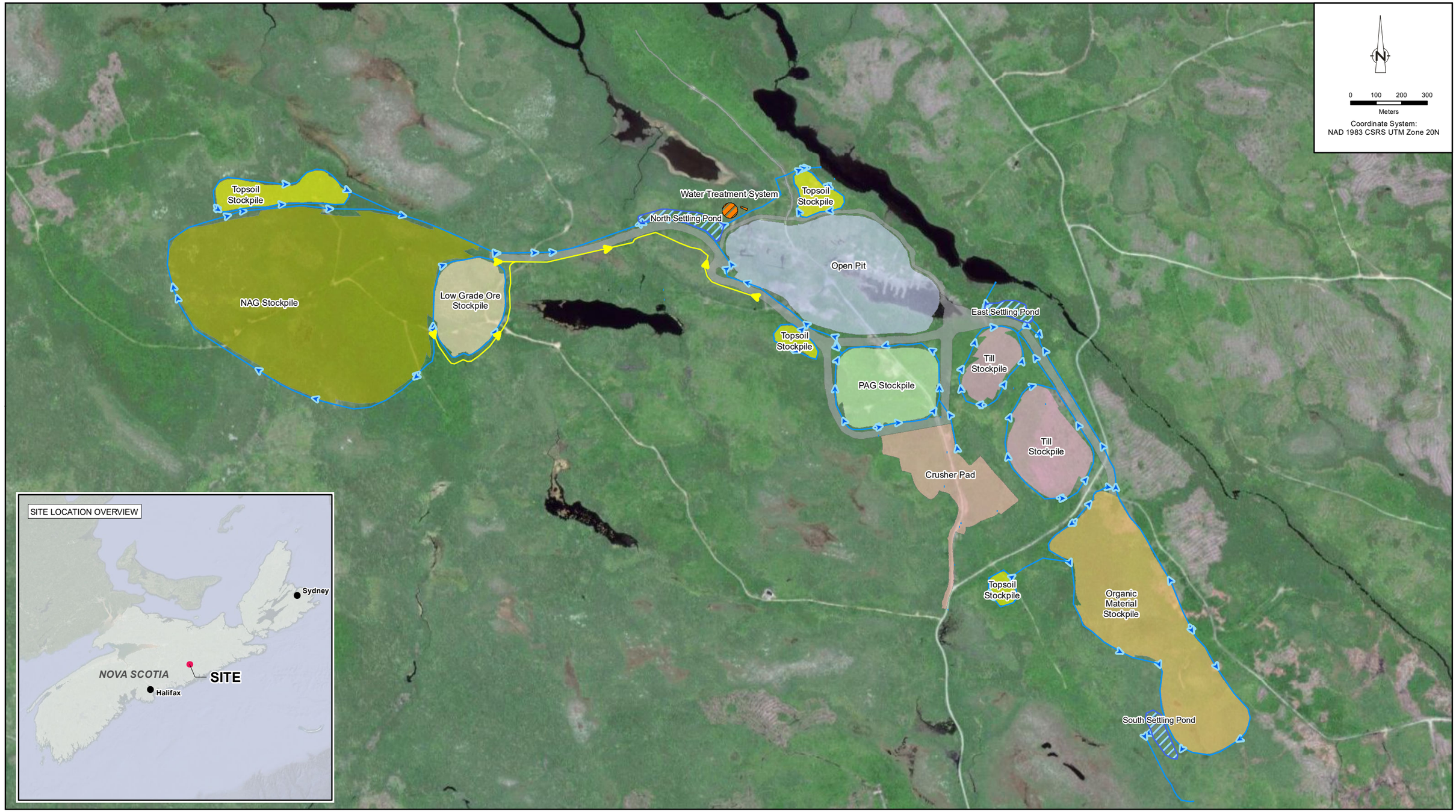
3.2 Water Management Facilities

Facilities at the Mine Site include an open pit, materials storage facilities, site roads, mine infrastructure for crushing, water management (i.e., settling ponds, ditches, culverts, water treatment systems [WTSs]), hauling, truck maintenance, administration, and road upgrades. The mined ore will be crushed and transported off-site to be processed.

Figure 3-1 shows the proposed layout of the facilities used to manage the mine water at the Mine Site. This includes the network of surface water ditches and culverts leading the three settling ponds and the WTS.

The mine water management plan encompasses the main water management facilities described in further detail below:

- **Rock and Soil Material Storage |** The rock and soil material storage at the Beaver Dam Mine will include four topsoil stockpiles, two till stockpiles, an organic material stockpile, a low-grade ore (LGO) stockpile and two non-ore bearing waste rock stockpiles. The non-ore bearing waste rock will be separated into one potentially acid generating (PAG) stockpile and one non-acid generating (NAG) stockpile. The till and organic material stockpiles will be located on the eastern side of the Mine Site. The LGO and NAG stockpiles will be located to the west of the open pit, while the PAG stockpile will be located just south of the open pit.
- **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.
- **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.
- **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.



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- Contact Water Ditch
- Clean Water Ditch
- Settling Pond
- Water Treatment System
- Road
- Bypass Road
- Crusher Pad
- Low Grade Ore Stockpile
- NAG Stockpile
- Open Pit
- Organic Material Stockpile
- PAG Stockpile
- Till Stockpile
- Topsoil Stockpile
- Water Pump Intake

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN

088664
Mar 26, 2021

SITE PLAN

FIGURE 3-1

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3.3 Stages of Mine Development

The Mine development plan for the Beaver Dam Mine comprises of the following stages:

3.3.1 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 topsoil, till, organic and waste rock stockpiles, 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.

3.3.2 Operations

Spanning a duration of five 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.

3.3.3 Closure

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 water to the open pit for refilling. Active closure activities specifically include the removal of all mine facilities, flooding the pit with water to form a pit lake, capping of stockpiles and revegetation of disturbed areas. During and following active closure, activities are mainly focused on monitoring and adaptive management, as required. During this period, site roads will remain in place, and ultimately will be returned to the land-owner for forestry and recreational use. The Haul Road will be returned to the land-owners in an upgraded condition with habitat and wetland improvements. Water treatment at the discharge location into the Killag River from the pit will continue as required and monitoring programs will be on-going. Fences will be removed once majority of closure activities are completed.

3.3.4 Water Management during Mine Stages

The main water management infrastructure and activities throughout the different stages of the Mine include the following:

- **Construction Stage:** Dewatering, treatment (as required) and discharging of the existing settling pond, watercourse and wetland alteration, construction of three settling ponds (north, south and east) and the installation of surface water ditches
- **Operations Stage:** Maintaining settling ponds (north, south and east), surface water management of surface water ditches, pumps and pipelines for pit dewatering and operation of the WTS
- **Closure Stage**: Settling pond removal (south and east) during active closure and north after the pit lake has formed, and the flooding of open pit. Water treatment will be in place to address post closure water quality concerns however monitoring undertaken during operations and

active closure will inform final treatment requirements. Site Water Management During Construction

As described in the Erosion and Sediment Control Plan (ESCP) (Appendix C), the approach for mine water infrastructure is to emphasize erosion control techniques in an effort to eliminate and/or minimize the amount of sediment mobilized due to earthwork activities conducted during construction. Sediment control best management practices (BMP) will be implemented in case of erosion of the mine water infrastructure or other site infrastructure such as stockpiles or site roads. The main principles of erosion and sediment control included in the ESCP are as follows:

- Keep Clean Water Clean
- Minimize Exposed Soil
- Minimize Time of Exposure
- Keep Sediment on Site

When erosion does inevitably occur, sediment will be prevented from leaving the Mine Site. This will occur through a series of sediment control practices such as settling ponds, check dams and other BMPs discussed in Appendix C.

There are a number of sensitive receptors on or adjacent to the 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
- Cope Brook

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

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.

Effective monitoring of erosion and sediment control measures is vital to the success of the ESCP. Early detection of deficiencies can prevent the need for drastic repair measures and overall improve the outcomes of the ESCP. Standard Operational Policies (SOPs) will developed and maintained to provide an overall schedule of site inspections for sediment controls. The SOPs will also include site preparation and inspections before and after storm events.

Monitoring of the erosion and sediment control measures will take place daily during each day of active construction. A detailed examination of erosion and sediment control measures will be carried out prior to and immediately after a rainfall event, snowmelt event or a combination of the two where the total event is greater than 15 mm.

3.3.4.1 Site Water Management During Operation

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 at the bottom of the pit and pumped to the north settling pond where it will be treated and tested to ensure if meetings discharge criteria prior to release into the environment.

Once the mine water infrastructure has been constructed on-site, the erosion and sediment controls will function using a treatment train approach. The treatment train approach begins in the drainage ditches. Each ditch will be lined with an appropriately sized granular channel lining (riprap or gravel). Surface water runoff will then discharge from the surface water ditches into one of three settling ponds. Each settling pond consists of a forebay, filter berm, main pond, and outlet structure. The settling ponds have been designed to remove suspended sediment, and to control discharge for all storm events up to and including the 100-year design storm event over a minimum of duration of 24 hours. A detention time of 24 hours allows for any remaining suspended sediment to settle out of the water column prior to discharge into the downstream receiving environment. A summary of the water infrastructure design criteria is provided below. Section 6.1 provides additional design criteria and dimensions.

- **North Settling Pond |** The pond has been designed to safely pass the Hurricane Beth design storm through an emergency spillway that is directed to the open pit. The pond is controlled by a multi-orifice concrete outlet structure to detain the 4-hour 25mm, 10-year and 100-year climate change adjusted storms, for a minimum of 24 hours. The outlet structure drains to the WTS. Flows larger than the 100-year climate change adjusted storm will also be directed from the WTS to the open pit through an emergency spillway. This design configuration mitigates the risk of uncontrolled releases of untreated contact water to the environment. Further details on the north settling pond including design criteria, dimensions and performance, are available in Appendix B. Contingency measures such as adding flocculating agent to the north settling pond will be put in place on an as-needed basis to ensure the pond discharge meets all water quality objectives.

- **Water Treatment System |** Discharge from the WTS will meet regulatory requirements for end-of-pipe discharge. The WTS will consist of aeration (oxidation), lime softening, coagulation/flocculation and multimedia and granular activated carbon (GAC) filtration as required based on the predictive water quality modelling and water quality monitoring on-site.
- **East Settling Pond |** The primary purpose of the east settling pond is to reduce the TSS levels to acceptable limits, and control stormwater runoff. The pond will have an overflow spillway designed to safely pass the Hurricane Beth design storm, and a multi-orifice outlet structure to detain up to the 100-year climate change adjusted storm for a minimum duration of 24 hours. The pond will be equipped with an emergency shut-off valve that will be closed in the event the discharge criteria cannot be met. Further details on the east settling pond including design criteria, dimensions, and performance, are available in Appendix B.
- **South Settling Pond |** The primary purpose of the south settling pond is to reduce the TSS levels to acceptable limits, and control stormwater runoff. The pond will have an overflow spillway designed to safely pass the Hurricane Beth design storm, and a multi-orifice outlet structure to detain up to the 100-year climate change adjusted storm for a minimum of 24 hours. The pond will be equipped with an emergency shut-off valve that will be closed in the event the discharge criteria are not met. Further details on the south settling pond including design criteria, dimensions and performance, are available in Appendix B.
- **Open Pit |** Mine water from dewatering the open pit will be collected in sumps and pumped to the north settling pond.

3.3.4.2 Site Water Management During Post-Closure

3.3.4.2.1 Post-closure Pit Flooding

At the end-of-mine (EOM) operations at the Mine Site, the dewatering pumps from the open pit will be decommissioned, and the pit will be allowed to flood with site runoff directed as dispersed flow into the pit to decrease filling time. Based on the water balance (Appendix A) the filling of the pit will take approximately 13 years. The reclamation plan will be submitted as part of an Industrial Approval process and will detail information relative to pit security measures for public and animal safety during the filling period. These measures require the input of multiple agencies to meet regulatory and corporate requirements.

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 reestablish a connection between the newly formed lake and Cameron Flowage.

Runoff from remaining waste rock and till stockpiles will be directed to the pit prior to release to the environment. It is expected that progressively capping and re-vegetating the waste rock pile will reduce erosion and limit the potential for acid rock drainage; therefore, inhibiting the mobility of any potentially deleterious substances.

3.3.4.2.2 Stockpiles

As part of active closure/reclamation plan, the stockpiles will either be reclaimed, vegetated, and/or capped, to limit the potential need for treatment as determined through the Predictive Water Quality Analysis (Appendix D). As a result, the east and south settling ponds will be decommissioned post-closure immediately, and the north settling pond will remain active until the open pit has been filled. Water quality monitoring throughout operations and active closure will inform final timelines for remove of the settling ponds.

The NAG and PAG waste rock stockpiles will remain in place, and the PAG waste rock stockpile will be capped with an engineered cover (i.e.,HPDE) and vegetated to reduce infiltration and seepage of contact water. The LGO stockpile will be removed and surface runoff from the area previously occupied by the LGO stockpile will be redirected to Mud Lake. The open pit will be filled with water from a combination of 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.

Till and organic materials from stockpiles, if deemed suitable, will be used for progressive reclamation or during active closure. Materials remaining in the stockpiles will be recontoured and vegetated. Surface runoff drainage patterns from these stockpiles will be re-established to the appropriate Killag River and Tent Lake watersheds.

4. Water Balance

A water balance model (WBM) was developed to conduct a Mine Site water balance to support the mine water infrastructure designs and predictive water quality analysis, and an environmental water balance to support the aquatic effects assessment. This report focuses on the Mine Site water balance results. A high-level summary of the Mine impacts to the main watercourses of the tertiary basins is also provided. The Water Balance Report is provided in Appendix A.

4.1 WBM Approach

The WBM was developed in GoldSim (https://www.goldsim.com/Web/Home/, last accessed 24 March 2021). The WBM simulates monthly and annual runoff volumes for three development stages, including baseline, end-of-mine (EOM), and post-closure (PC) conditions. EOM represents the end-of-mine operations, and post-closure represents the period where the reclamation works are fully established, and the pit lake has formed. A second PC scenario was considered to represent the period where the pit will fill with water to calculate the pit filling time (i.e., 13 years) and assess the impacts to the Killag River. As a contingency, during pit filling, surface water runoff which meets water quality objectives may be diverted directly towards the Killag River during low flow months to reduce potential impacts to baseflow within the Killag River. Diverting water towards the Killag River to reduce the impact to baseflow may increase the pit filling time.

The model utilizes daily climate inputs to simulate streamflow and snowpack accumulation and depletion, and the results are aggregated to monthly and annual time intervals. Total runoff (streamflow) volumes from undisturbed areas were simulated using the Australian Water Balance

Model (AWBM). The AWBM is a standard conceptual hydrologic model that simulates saturation overland flow when excess rainfall and snowmelt exceeds the surface storage capacity of the catchment. Surface storage capacity represents the land cover and soil characteristics of the catchment.

Overflow from the surface storage occurs when the addition of rainfall and snowmelt less evapotranspiration exceeds the surface storage capacity of the catchment. The overflow is partitioned into surface runoff and baseflow according to the baseflow index (BFI). The BFI represents the fraction of the overflow that recharges the groundwater aquifer and appears as baseflow. The remaining fraction of the overflow appears as surface runoff. Surface runoff and baseflow are combined into a total runoff (streamflow) volume at the catchment outlet (assessment point).

Changes in land cover, soil conditions, and catchment area due to Mine development will impact the surface runoff volumes in receiving watercourses. Surface runoff volumes from the site features were calculated as the product of the rainfall/snowmelt and a runoff coefficient. Surface runoff volumes from the stockpiles were calculated as the sum of direct runoff and seepage. Direct runoff and seepage volumes were also calculated as the product of rainfall/snowmelt and respective runoff coefficients based on the stockpile material. A summary of the runoff coefficients is provided in the Water Balance Report in Appendix A. The groundwater flow model developed for the Mine Site was applied to predict potential changes in baseflow at EOM and PC relative to baseline conditions (Appendix E). Baseflow contributions to watercourses originating from rainfall/snowmelt occurring on the Mine Site were accounted for as percent changes from baseline conditions at each assessment point or included as groundwater inflow to the open pit. Groundwater inflow rates to the open pit are predicted to be 605 m^3/day and 385 m^3/day in EOM and PC conditions, respectively (Appendix D).

4.2 Changes to Hydrologic Conditions

This section of the report describes catchments of key assessment points in baseline, EOM, and PC conditions as well as the planned water transfers between site features.

4.2.1 Baseline Conditions

The proposed Mine development will impact three watercourse systems, including the Killag River, Cope Brook, and Tent Brook. The water balance simulates changes in streamflow volumes in these systems and their tributaries. Figure 4-1 of Appendix A shows a map of the baseline catchments and assessment points. The impacts to the Killag River at Pit and Killag River DS, Cope Brook DS #1 and Cope Brook DS #2, and Tent Brook assessment points are included in this report. The impacts to sixteen assessment points are provided in Appendix A.

4.2.2 EOM Conditions

The Mine Site layout at the EOM development stage is presented on Figure 4-3 of Appendix A. The Killag River DS catchment encompasses the Watercourse (WC)-26, WC-5, WC-27, north settling pond, and east settling pond catchment areas. The Mine Site development will increase the Killag River DS catchment area from 3,933.5 hectares (ha) to 3,974.5 ha. The WC-26, WC-27, WC-23 and Cope Brook catchment areas will decrease from baseline conditions due to the placement of mine features in their contributing drainage areas. Surface runoff from these mine features will be directed

to the north settling pond for treatment of certain metals, Nitrogen species, and total suspended solids (TSS), as determined in the predictive water quality analysis, prior to being released to the Killag River.

The north settling pond will receive surface runoff from the NAG waste rock stockpile, PAG waste rock stockpile, LGO stockpile, topsoil stockpiles, crusher pad, administrative building areas, and Mine Site roads through a proposed ditch system. Surface runoff from the till stockpiles, a portion of the organic stockpile, and site roads will be collected in ditches and directed to the east settling pond for treatment of TSS before being released to the Killag River.

The catchment area of the Tent Brook assessment point will also be reduced from baseline conditions due to the placement of the crusher pad and administrative buildings, which are partially located in its baseline catchment area. All runoff from the crusher pad and administrative buildings will be directed away from the Tent Brook system, toward the Killag River catchment as described above. Runoff from the remaining portion of the organic material stockpile and a topsoil stockpile will be collected in ditches and directed to the south settling pond for treatment of TSS before being released to WC-19 in the Tent Brook system.

The open pit is located within the Killag River catchment. During operations the pit will receive surface runoff from direct precipitation. The open pit will also draw groundwater from the aquifer, diverting some baseflow from the Killag River toward the pit. Surface runoff and groundwater will be collected in pit sumps and pumped to the north settling pond for treatment and water quality monitoring to ensure it meets discharge criteria before being released to the Killag River

4.2.3 PC Conditions

The Mine Site layout in PC conditions (applicable for both pit filling and pit filled conditions) is presented on Figure 4-4 of Appendix A. The Mine reclamation plan includes the removal, vegetation, or capping and vegetation of the stockpiles to limit the potential need for treatment as determined through the predictive water quality analysis. As a result, the east and south settling ponds will be decommissioned immediately, subject to water quality monitoring results, and the north settling pond will remain active until the open pit has been filled with water. Water in the north settling pond will be used to supplement baseflow to the Killag River during dry months of the pit filling period.

The NAG and PAG waste rock stockpiles will remain in place, and the PAG waste rock stockpile will be capped with an engineered cover (i.e., HPDE liner) and vegetated to reduce infiltration and seepage of contact water. The LGO stockpile will be removed and surface runoff from the area previously occupied by the LGO stockpile will be redirected to Mud Lake. The open pit will be filled with water from direct precipitation, surface runoff, and groundwater inflows. North settling pond discharge will be directed to the pit to reduce the pit filling time. Once the pit has filled with water (i.e., approximately 13 years), the north settling pond will be decommissioned and pit overflow will be directed to the Killag River through an engineered outfall in the east pit wall and existing outlet channel (WC-13). Water quality monitoring will be undertaken throughout active and post closure to confirm, and as necessary update impact prediction. Adaptive management measures may be required based on the outcomes of the monitoring results. Adaptive management measures will be included in successive reclamation and closure plans that are required as part of the Industrial Approval process.

Till and organic materials from stockpiles, if deemed suitable, will be used for progressive reclamation or during active closure. Materials remaining in the stockpiles will be recontoured and vegetated. Existing drainage patterns for surface runoff from these stockpiles will be re-established to the appropriate Killag River and Tent Lake watersheds.

4.3 Summary of the Results

The water balance results for the mine water infrastructure (i.e., settling ponds located upstream of site discharge points and the open pit), Killag River, Cope Brook, and Tent Brook systems are summarized below.

4.3.1 Mine Water Infrastructure

Settling pond discharge occurs when the balance between inputs, outputs, and stored water exceeds the permanent pool storage volumes. In summary, the north settling pond and east settling pond will discharge 1,699,026 m^3 and 344,905 m^3 to the Killag River system annually under average climate conditions. The south settling pond will discharge 123,873 m^3 to WC-19 in the Tent Brook system annually under average climate conditions.

Pit lake discharge occurs when the balance between inputs, outputs, and stored water exceeds the permanent pool storage volume of the lake, which is approximately 1,600,000 m^3 at a containing elevation of 127 metres above sea level (masl). The time to fill the pit immediately following closure is estimated to be 13.1 years under average climate conditions. After the pit lake is formed it is estimated to discharge 1,172,074 m^3 under average climate conditions.

4.3.2 Killag River System

The WBM predicts the Mine development will result in a 2.8% increase in annual streamflow (0.3 to 9.1% monthly variation) between baseline and EOM conditions at the Killag River at Pit assessment point, which is located approximately 1 km downstream of the north settling pond and 0.5 km downstream of the east settling pond. The increase in streamflow volume is attributed to the increase in impervious area. The largest increase in streamflow is calculated in August, when the monthly streamflow volume is low and approximately 3.1% of the annual streamflow volume.

The hydrogeologic model estimates a 1.6% reduction in baseflow contributions from the total catchment area primarily caused by the formation of the open pit, which draws water from the local groundwater system. However, the groundwater inflow to the pit will be circulated to the Killag River, as it will be pumped to the north settling pond and discharged to the Killag River. In addition, the settling ponds will be designed to provide flow attenuation to mitigate the increase in peak flows and protect against erosion of the receiving environment. The impacts to the Killag River are reduced further downstream during these development scenarios.

The impacts to the Killag River while the open pit fills with water were also assessed. The WBM simulates a 1.8% decrease in annual streamflow (-0.8% to -1.9% monthly variation) and a 2.2% decrease in annual streamflow (-1.1 to -2.4% monthly variation) between baseline and PC conditions at the Killag River at Pit and Killag River DS assessment points, respectively, during pit filling. The decrease in streamflow is caused by the reduction in drainage area, as a large portion of the Mine Site that drains to the Killag River under baseline conditions is being directed to the open pit to reduce the pit filling time. Contingency measures will be in place to mitigate baseflow reduction

in the Killag River during dry months of the pit filling period. Baseflow reduction will be augmented by stored water in the north settling pond.

Finally, the WBM simulates a 1.7% increase in annual streamflow (1.0 to 4.9% monthly variation) and 1.1% increase in annual streamflow (0.4 to 4.3% monthly variation) between baseline and PC conditions at the Killag River at Pit and Killag River DS assessment points, respectively, after the pit lake has formed.

4.3.3 Tent Brook and Cope Brook Systems

The WBM predicts a 1.2% decrease in annual streamflow with a -3.1 to 6.7% monthly variation between baseline and EOM conditions at the Tent Brook system assessment point. It also predicts a 1.2% decrease in annual streamflow between baseline and PC conditions; however, the variation in monthly impacts is reduced to -0.9 to -1.4%.

The net decrease in annual streamflow is caused by the diversion of runoff from the crusher pad and administrative building areas, (that are partially located in the Tent Brook catchment), toward the Killag River system, and a small reduction in baseflow caused by the effect of the open pit on the groundwater flow patterns. The difference in timing and monthly variation of the flows between EOM and PC conditions is attributed to the placement of the organic material stockpile in the catchment during operations.

The WBM simulates a 5.7% decrease in annual streamflow (-3.9 to -6.9% monthly variation) and 4.3% decrease in annual streamflow (-2.9 to -5.2% monthly variation) between baseline and EOM/PC conditions at the Cope Brook DS #1 and Cope Brook DS #2 assessment points, respectively. The impacts are attributed to the placement of the NAG waste rock stockpile in the WC-23 catchment within the Cope Brook system. All runoff from the NAG waste rock stockpile is directed to the north settling pond for treatment.

The Water Balance Report in Appendix A presents the WBM results for sixteen assessment points to assess the Mine impacts to smaller tributaries of the Killag River, Tent Brook, and Cope Brook systems, as well as the Crusher Lake and Mud Lake waterbodies in support of the aquatic effects assessment.

5. Water Quality

5.1 Surface Water Criteria

The Beaver Dam Mine is subject to provincial and federal water quality guidelines. Provincially, the Mine will be subjected to an Industrial Approval issued under the Nova Scotia Environment Act, S.N.S. 1994-95, c.1 (NSE 2014) and the Tier 1 Nova Scotia Environment (NSE) Environmental Quality Standards (EQS) for Surface Water. There are several federal instruments that oversee the quality of water discharged from a mine site into a natural water body. Specifically, this water quality assessment focuses on potential constituents of concern identified in the Metal and Diamond Mining Environmental Regulation (MDMER) Objectives and the Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life. It is important to note that since operations plan to commence in 2022 the MDMER objectives referenced in this report relate to “New Mines”, and therefore follow Table 1 of Schedule 4 from the MDMER. In addition, Site-Specific

Water Quality Guidelines have been established for the Mine Site. These Site-Specific Guidelines are based on background concentrations that exceed CCME and Tier 1 EQS Guidelines or a risk hazard assessment performed for the receiving water body.

Additional surface water monitoring will be required under the Environmental Effects Monitoring (EEM) Program and consists of effluent characterization, sublethal toxicity testing, and water quality monitoring.

The constituents identified in MDMER, CCME, Tier 1 EQS and Site-Specific regulations are summarized in Table 5-1. MDMER regulations are used to screen End-Of-Pipe discharge concentrations whereas CCME, Tier 1 EQS and Site-Specific guidelines are used to assess concentrations within the Killag River after mixing. In addition, an acute and chronic aquatic toxicity assessment has been undertaken by Intrinsik (2021).

Table 5-1 MDMER, CCME, Tier 1 EQS and Site-Specific Water Quality Regulations

Constituent	MDMER	CCME	Tier 1 EQS	Site-Specific[+]
	µg/L	µg/L	µg/L	µg/L
	a	b	c	d
Ag	-	0.25	0.25	-
Al	-	5.00	5.00	254
As	100	5.00	5.00	30.0
Cd	-	0.04	0.04	-
Co	-	0.78	10	-
Cu	100	2.00	2.00	-
Fe	-	300	300	509
Hg	-	0.026	0.026	-
Mn	-	190	820	-
Mo	-	73.0	73.0	-
Ni	250	25.0	25.0	-
Pb	80.0	1.00	1.00	-
Sb	-	-	20.0	-
Se	-	1.00	1.00	-
Tl	-	0.80	-	-
U	-	15.0	300	-
Zn	400	7.00	30.0	-
Nitrate	-	13,000	-	-
Nitrite	-	60[++]	-	-
Ammonia	-	27,550[+++]	-	-

[+] Site-Specific guidelines are taken from Intrinsik (2021)

[++] Nitrite guideline is listed in µg nitrite/L

[+++] Ammonia guideline is in ug ammonia-N/L based on a conservative assumption of pH of 6.0 and water temperature of 25ºC

5.2 Surface Water Background

In preparation for development of the Beaver Dam Mine, GHD undertook the monitoring of background concentration levels of surface water in the Killag River and several nearby tributaries in order to accurately determine background conditions in the surrounding watershed. The background concentrations of constituents of concern are shown in Table 5-2 and further explained in Appendix D.

Table 5-2 Background Concentrations in Killag River

Constituent	Concentration in Killag River	Detection Limit (DL)	Number of Samples at Detection Limit
	µg/L	µg/L	
Ag	0.05	0.10	14
Al	253.57	--	0
As	1.59	1.0	5
Cd	0.02	0.010	1
Co	0.29	0.40	10
Cu	0.85	2.0/0.50[+]	12
Fe	509.29	--	0
Hg	0.01	0.013	12
Mn	47.57	--	0
Mo	1.00	2.0	14
Ni	1.11	2.0	13
Pb	0.33	0.50	10
Sb	0.50	1.0	14
Se	0.46	1.0/0.50[++]	14
Tl	0.05	0.10	14
U	0.05	0.10	14
Zn	3.55	5.0	10
Nitrate	47.43	50	7
Nitrite	5.36	10/20[+++]	14
Ammonia	30.36	50	13
Hardness	3,500	--	0

[+] Copper detection limit was 2.0 µg/L for 2014/15 sampling and 0.50 µg/L for 2019 sampling
[++] Selenium detection limit was 1.0 µg/L for 2014/15 and Apr/Jun 2019 sampling and 0.50 µg/L for Sept/Dec 2019 sampling
[+++] Nitrite detection limit was 10 mg/L for 2014/15 and Apr/Jun/Sept 2019 sampling and 20 mg/L for Dec 2019 sampling

These background concentrations were used in combination with the background flow volume in the Killag River and mine effluent concentrations and volumes to perform mixing calculations for the predictive water quality analysis. Chemicals of concern (COC) mass loadings from groundwater to surface water, as predicted through the application of a groundwater flow and fate and transport model (Appendix E), are incorporated into the mixing calculations These mixing calculations were

used to determine the resulting constituent concentration within the Killag River downstream of Beaver Dam Mine during EOM and PC conditions. Cyanide was not included in the background constituents of concern for this Mine Site assessment as it is typically a by-product of the refining process of the ore, which will be occurring offsite at the Touquoy Mine. Details on water management relating to pit disposal at Touquoy is provided in the Groundwater Flow and Solute Transport Study for Touquoy, Touquoy Integrated Water and Tailings Management Plan, and Assimilative Capacity Study (Appendices F.6, F,7 and F.8 of the 2021 Updated EIS).

5.3 Predictive Surface Water Quality Assessment

As part of the MWMP, GHD has completed a predictive water quality assessment for two life cycle stages of the Mine development, including EOM and PC stages. For each life cycle stage, the potential effects of mine contact water to the water quality in the Killag River was assessed under base case (median) and upper case (90th percentile) concentration scenarios. Methodology and results for the complete assessment are in Appendix D.

As described in Section 5.1, effluent water quality must meet the requirements set out by MDMER. GHD has completed a predictive water quality assessment for two life cycle stages of the Mine development, including EOM and PC stages.

The predictive water quality assessment was calculated monthly for the average year climatic conditions. Performing the water quality assessment on a monthly basis allows for the prediction of the seasonality characteristics of water quality in the Killag River. This allows for the assessment of the wet and dry months to determine the month with the highest effect on the water quality in the Killag River and will assist with the design of water quality treatment options at the Mine Site.

5.3.1 Predictive Source Term Model

To determine the concentration of each constituent leaving the Mine Site, the geochemistry of each stockpile (till, topsoil, PAG waste rock, NAG waste rock, LGO) and the pit wall rock were assessed individually by Lorax Environmental (Lorax Environmental, 2021). This assessment included both the base case and the upper case scenarios of constituent concentrations for EOM and PC Mine life cycle conditions. The base case scenario represents the most likely concentration scenario (median) while the upper case scenario represents the likely worst-case (90th percentile) concentration scenario.

For the EOM conditions, the source term model assumed the following:

- The NAG and PAG waste rock piles have reached their maximum height but remain uncovered and unrestored.
- The LGO stockpile has an area of 86,000 m^2 and remains uncovered and unrestored.
- The pit is constantly being dewatered and discharged into the north settling pond.
- Standard best practice erosion and sediment control measures have been implemented on the topsoil and till piles.

For the PC conditions, the source term model assumed the following:

- The NAG waste rock stockpile has been covered with soil and seeded.

- The PAG waste rock stockpile has been covered with a High Density Polyethylene (HDPE) liner allowing an estimated infiltration rate of 3% of total precipitation through the liner (Power et al., 2017). The cap is covered with soil and seeded.
- The LGO stockpile has been removed from the Mine Site and processed at the Touquoy site. Surface water drainage pathways from this stockpile area re-established to Mud Lake (i.e., pre-development conditions).
- Suitable till and topsoil materials from stockpiles will be used for progressive reclamation or during active closure, recontoured and revegetated.
- The pit will be allowed to naturally fill with water to an elevation of 127 m.
- All site water will drain to the pit prior to discharge into the river.

5.3.2 Mine Site Discharge Points

The Mine Site includes three discharge points during EOM conditions and one discharge point during PC conditions. During EOM conditions site water from the PAG, NAG and LGO stockpiles, the pit, and crusher pad will be routed through the north settling pond and water treatment system (as required) prior to discharge into the Killag River. Site water from the till and part of the organics stockpiles will be routed through the east settling pond prior, where it will be monitored to ensure discharge criteria before discharge into the Killag River approximately 200 m downstream from the north settling pond discharge point. Site water from the remaining portion of the organics stockpile will be routed through the south settling pond discharge point into WC-19 of the Tent Brook system. During PC conditions, site water from the waste rock stockpiles will be routed through the pit prior to discharge into the Killag River. This discharge point will coincide with the east settling pond discharge point. The till, organics, topsoil, and LGO stockpiles will be reclaimed to self-sustaining ecosystems at PC. As a result, the east and south settling ponds are no longer required, subject to water quality monitoring, and will be decommissioned. The mine discharge and water quality assessment points are provided in Appendix D.

5.3.3 Results

The predictive water quality assessment provides insight into the potential effect of the Beaver Dam mining operation on the receiving watercourses during an average climate year. MDMER objectives are not anticipated to be exceeded at any discharge location during either EOM or PC conditions.

However, the assessment did determine potential for exceedance of the CCME regulatory limits of Nitrite within the Killag River system during EOM conditions at the Near Field – North Settling Pond, Near Field – East Settling Pond and Far Field assessment points. Additionally, the predictive water quality assessment determined potential for exceedance of the CCME regulatory limits of Cobalt and Zinc within the Killag River system during PC conditions at the Near Field – Pit and Far Field compliance points.

This water quality assessment demonstrates the need for treatment of the mine effluent water prior to discharge into the Killag River during End-of-Mine and Post-Closure conditions.

The results are predictive in nature and are expected to be refined on an annual basis using site-specific monitoring data collected during construction, operation and following closure of the Beaver Dam Mine to confirm the predicted water quality impacts to the Killag River.

5.4 Groundwater Quality Criteria

Potential groundwater quality impacts will be compared against appropriate groundwater quality guidelines. While there are no potable groundwater uses at the Beaver Dam Mine Site, a portion of the Mine Site is located on Crown land and potentially could be considered potable in the future. Therefore, simulated COC concentrations are compared against the Nova Scotia Environment (NSE) Tier 1 Environmental Quality Standards (EQS) for potable course grained soil for agricultural/residential use and maximum acceptable concentrations (MAC) specified under the Guidelines for Canadian Drinking Water Quality (GCDWQ). It is recognized that some COCs, including arsenic and manganese, are naturally present in groundwater at concentrations that exceed NSE Tier 1 EQS or MACs specified under the GCDWQ.

5.5 Predictive Groundwater Quality

An evaluation of predicted groundwater COC concentrations relative to Tier 2 Pathway Specific Standard for groundwater discharge to surface water (Tier 2 PSS) and through the surface predictive water quality assessment has been assessed to determine the potential impact to surface water quality that could result from developing the Mine Site. The evaluation of predicted groundwater COC concentrations relative to Tier 2 PSS provides an indication of areas where groundwater COC concentrations may impact surface water bodies (Appendix E). Simulated loadings of COCs from groundwater to surface water are combined with predicted surface water runoff from the Mine Site to estimate surface water COC concentrations at compliance points as discussed in the predictive water quality assessment Appendix D.

6. Design of Water Management Facilities

It is noted that the infrastructure sizing provided in this document is conceptual only and will be finalized during the next stages of design. The final design of the collection and settling ponds including the discharge points and proposed monitoring programs will be submitted as part of the IA process.

6.1 Water Management Design Basis

Water management for the Beaver Dam Mine will consist of the collection and management of mine water.

The criteria used for the design development and analyses of the water management infrastructure are based on the feasibility level design Mine Site arrangement, operational requirements, and environmental site conditions. The design basis criteria for storm events utilized for the MWMP design are summarized in Table 6-1 below.

Table 6-1 Water Management Design Basis Criteria Summary Table

Item	Design Basis
Contact Water & Non-contact Water Ditches and Culverts	• Designed to convey stormwater runoff resulting from the 1 in 100 year, 24-hour, climate change adjusted storm event (113 mm)

Table 6-1 Water Management Design Basis Criteria Summary Table

Item	Design Basis
Collection Ponds	• Designed to contain runoff resulting from the 25mm 4-hour storm event, 1 in 10-year 24-hour climate change adjusted storm event (87 mm) and 1 in 100-year 24-hour climate change adjusted storm event (113 mm) for a minimum of 24 hours to allow for TSS removal due to settling • Designed to convey runoff resulting from the 1 in 100-year 24-hour climate change adjusted storm event (113 mm) to Cameron Flowage via a concrete outlet structure • Designed to convey runoff from Hurricane Beth, modelled as a 48-hour storm event, through an emergency spillway
Pump Systems and Pipelines	• Designed to convey stormwater runoff water from low-lying areas to settling ponds for up to the 1 in 2 year 24-hour, climate adjusted storm event (66 mm). • Multiple back up pumps for larger storm events are to be located across the Mine Site to be moved to different areas across the site as needed

The Mine Site was modelled using PCSWMM (Version 7.3.3095) which is a hydrologic and hydraulic modelling software that uses the EPA SWMM (Version 5.1.015) engine. PCSWMM was used to develop the design storm hydrographs, estimate peak flow rates and runoff volumes for the design storm events. To add contingency to the design, the impacts due to climate change were considered when developing the design storm hydrographs. To account for the project duration (operation life of 5 years) and nearest climate regions (Halifax Regional Municipality and Truro), a 5% increase in the total rainfall depth was applied to each design storm. The estimated runoff volumes resulting from the 24-hour, 1 in 100-year climate change adjusted storm event were used to determine the storage capacity of the settling ponds. The 25 mm 4-hour, 10-year and 100-year climate change adjusted storm events were used to design the settling pond outlet structures such that a minimum 24-hour detention time was achieved in each settling pond to allow for settling of TSS. Hurricane Beth (as recorded by Halifax International Airport Climate Station (Climate ID: 8202251)) was used to size the emergency spillway of the settling ponds. The 100-year climate change adjusted storm event was used to size the swale, culverts and other conveyance pathways leading to the settling ponds. Additional design details for the various water management design elements are provided in the following sections.

6.1.1 Collection Ditches and Culverts

The MWMP consists of a series of surface water ditches and culverts collecting all site stormwater runoff. The surface water ditches include contact water ditches, which collect runoff from all mine infrastructure, and non-contact (clean water) ditches, which collect water from adjacent undisturbed lands and direct it away from the Mine Site. Culverts are dispersed throughout the Mine Site to convey stormwater below mine infrastructure. The contact water ditches drain to one of four settling ponds located across the Mine Site.

Each ditch will be trapezoidal in section with 3H:1V side slopes and bottom widths and depths ranging from approximately 0.5 m to 2 m. Ditch slopes range between 0.3% and 7.5% depending on the location across the Mine 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 which 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 Mine 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.

The site road crosses over top of WC-5, the watercourse leading from Crusher Lake to Mud Lake. To prevent disruption of the natural flow path, clean water ditches will collect surface water runoff on the south side of the site road and drain this runoff back towards WC-5. WC-5 will be channelized in a culvert below the site 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.

6.1.2 Settling Ponds

Settling ponds will be constructed to collect and detain stormwater runoff from disturbed site areas prior to discharging to Cameron Flowage. Collection ponds are included for runoff from the NAG, PAG, till, LGO, and organics stockpiles and crusher pad/administrative building area. The ponds were designed to maintain a 0.3 m freeboard during the 100-year climate change adjusted storm event below the emergency spillway invert.

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 m to 7 m deep 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.

To remove TSS from the stormwater runoff, each settling pond will contain a gravel filter berm for incoming stormwater runoff to flow through. 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 25 mm 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. The concrete outlet structures will be surrounded with a layer of riprap to protect the outlet structure from erosion or undercutting. 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, the only settling pond with water quality concerns, 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 Mine Site. Effluent from the north settling pond will pass through the WTS, where water quality will be monitored to ensure it meets discharge criteria prior to discharge into Cameron Flowage/Killag River.

6.1.3 Pumping 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 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. 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 from across the Mine Site will be brought to the PAG stockpile collection pond to assist with pumping.

7. Water Treatment Systems (WTS)

GHD was also retained by AMNS to identify and evaluate potential water treatment system alternatives to treat potential exceedances during the construction, operation, and PC stage.

A predictive water quality assessment (Appendix D) for the EOM and PC stages was completed and the potential effects of mine contact water on the water quality in the Killag River were assessed. The goal is to identify and evaluate potential treatment techniques to address elevated

concentrations of COCs to meet MDMER objectives and 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 the downstream mixing effect.

The development of feasible alternatives for the water treatment system at each stage, including construction, operation and post-closure was based on a three-step process:

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

The full reports including discussion and evaluations of alternatives are in Appendix F.

The WTS, located immediately downstream of the north settling pond, will act as the primary location for water treatment of mine contact water for the Mine Site. Inflows to this area will include pumped water from the historic tailings area, runoff from the waste rock piles and crusher pad area. The east and south settling ponds will collect stormwater runoff from the till and organics stockpiles. A shut off valve at the outlets of the east and south settling ponds will be put in place in case of water quality exceedances. This water will then be pumped to the north settling pond for treatment in the north settling pond and associated downstream WTS. Discharge from the WTS will meet MDMER regulations for End-Of-Pipe discharge concentrations.

7.1 Construction Water Treatment System Alternative

It is expected that metals such as aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, mercury, lead, and zinc will be among the elements that need treatment during the construction stage, based on water quality information from Touquoy. Also, most of the COCs are likely attached to suspended solids, suggesting that a significant fraction of the COCs 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.

A draft process flow diagram (PFD) can be found in Appendix F.1. A simplified block flow diagram of this alternative is shown in Figure 7-1.

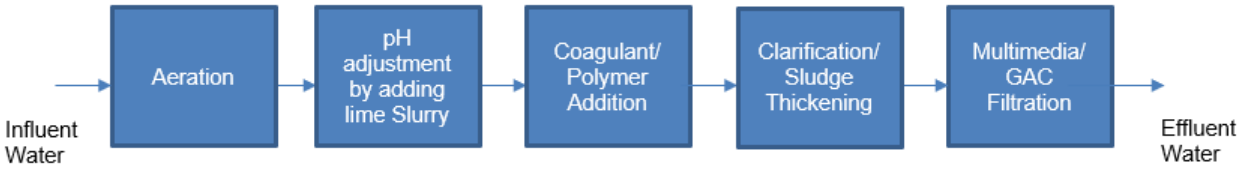


Figure 7-1 Simple Block Flow Diagram of Aeration Treatment System for Construction Stage

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.

This proposed water treatment alternative will address higher concentration of COCs. 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. Further detail can be found in Appendix F.1.

7.2 Operation Water Treatment System Assessment

The water quality assessment also indicated that nitrite level will be the only exceeded CCME guideline parameter for the EOM scenario, and zinc and cobalt are the exceedances for the PC scenario at Killag River which will require treatment during the post closure stage of the Mine.

7.2.1 Proposed Water Treatment Alternative

Reviewing the feasible alternatives, it was found that a nitrite oxidation unit such as aeration treatment pond could potentially reduce nitrite concentration and obtain the nitrite removal requirement of this project while also having the lowest capital and operation cost.

The proposed aeration treatment pond would consist of three ponds. The first 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 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 be below discharge limits during 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 schematic figure of treatment ponds is shown in Appendix F.2.

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. The process flow diagram of water treatment train is presented in Appendix F.2

The general chemistry of impacted water will determine if any nutrient or chemical addition would be required. These parameters could potentially drive the operation cost of the treatment system. It is highly recommended that the selected nitrite removal technology be tested in a bench-scale or even in a pilot-scale before designing the full-scale treatment system.

7.3 Post-Closure Water Treatment System

GHD has completed a predictive water quality assessment and developed a mass balance model which shows that zinc and cobalt are the only exceeded parameters during the PC phase. 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. 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.

7.3.1 ALDs followed by aeration cascade 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 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.

7.3.2 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 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.

7.3.3 Conclusions and Recommendations

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. A schematic of proposed alternative is shown in Appendix F.3.

8. Surface Water and Groundwater Monitoring

The objectives of the water quality monitoring programs (surface water and groundwater) are to confirm compliance with regulatory requirements, confirm impact predictions of Beaver Dam Mine on water quality, update predictive modelling, identify changes in drainage patterns and surface water flow, and to determine if additional mitigation or emergency response measures are required. Upon receipt of the IA, monitoring results and reporting will need to be submitted in a timely fashion to the specified regulatory agencies.

8.1 Surface Water Monitoring

8.1.1 Monitoring Locations

Surface water monitoring locations will be finalized during the IA process. The locations of these stations may require some adjustments in the field post-construction, where applicable. Surface water assessment locations were selected to monitor baseline/construction, operation and post-closure water quality and water quantity at the Mine Site. Site selection and nomenclature were chosen to coincide with previous surface water monitoring completed by GHD from 2014 to 2018 and McCallum Environmental Ltd. (MEL) from 2019 to present.

A total of 16 surface water assessment sites during the construction stage have been selected for continued monitoring at the Beaver Dam Mine for either quality, quantity or both. Each location has been flagged and coordinates recorded. Their locations and monitored metrics are shown on Figure 8-1 developed by MEL. SW 14 will be removed during construction.

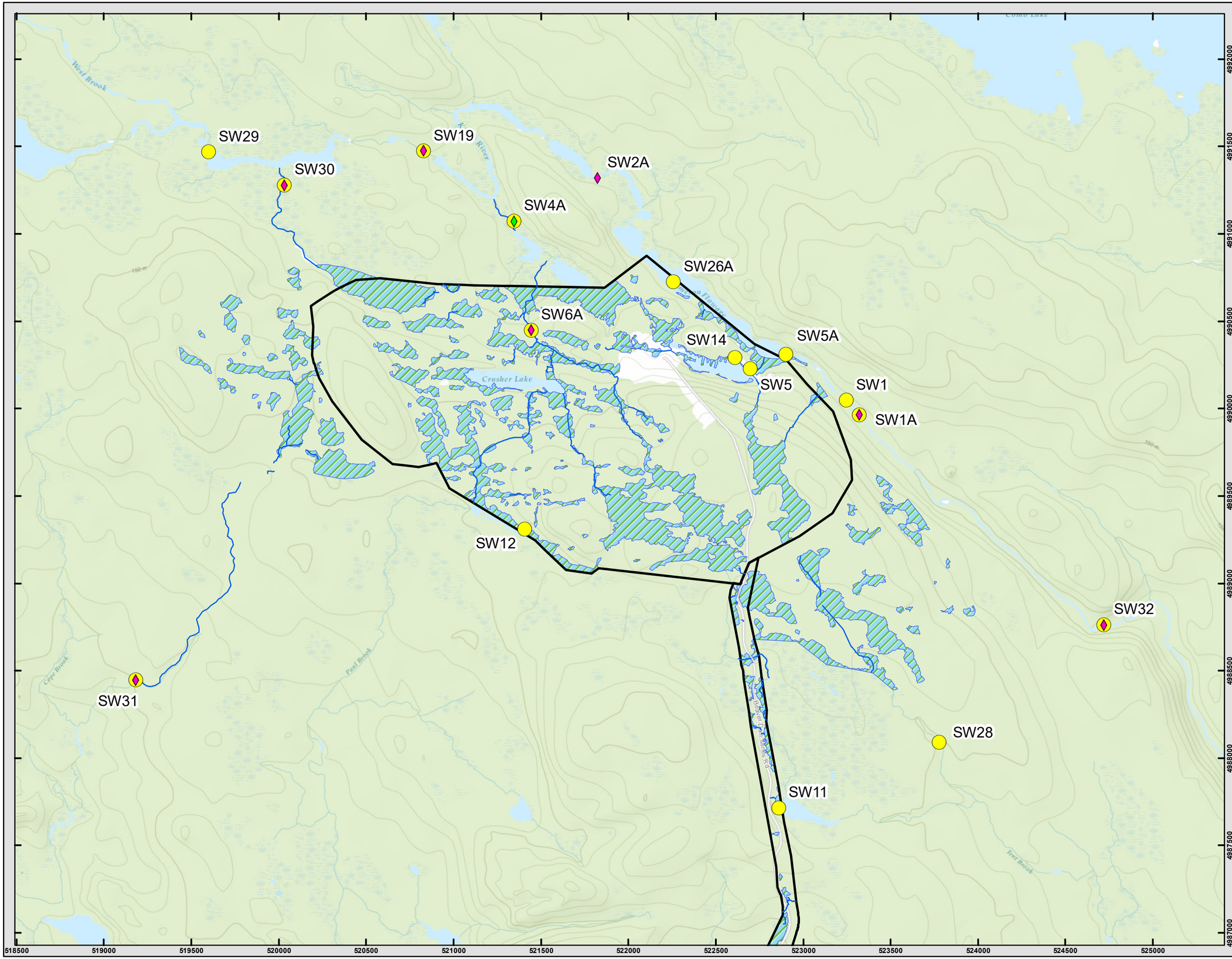
A total of 19 surface water assessment sites during the operation and 17 during PC have been proposed for continued monitoring at Beaver Dam for either quality, quantity or both. Their proposed locations and monitored metrics are shown on Figure 8-2 and Figure 8-3 respectively.

8.1.2 Surface Water Quality Monitoring

Surface water quality will be impacted by runoff in contact with the Mine. An IA has yet to be obtained; however, the parameters listed in Table 5-1 will be monitored at all of the surface water quality monitoring sites during construction, operation, and reclamation of the Mine. Additionally, pursuant to the MDMER monthly acute toxicity and bi-annual sublethal toxicity testing must be completed for effluent from the Final Discharge Points (FDP).

The surface water parameters were developed through referencing the MDMER objectives and the CCME guidelines. In addition, Site-Specific Water Quality Guidelines have been established for the Mine Site.

Additional sampling requirements may apply under the future IA or EEM program and are not fully detailed in this management plan. These requirements will be fully determined once the Mine Site becomes subject to MDMER.



Prepared For:

Atlantic Gold

FIGURE 1

Surface Water Assessment Locations

Beaver Dam, NS

- Staff Gauge and Level Logger
- Hydrometric Station and Volume Discharge Measurement
- Water Quality Location
- Field Delineated Watercourse
- Project Area
- Field delineated Wetland

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

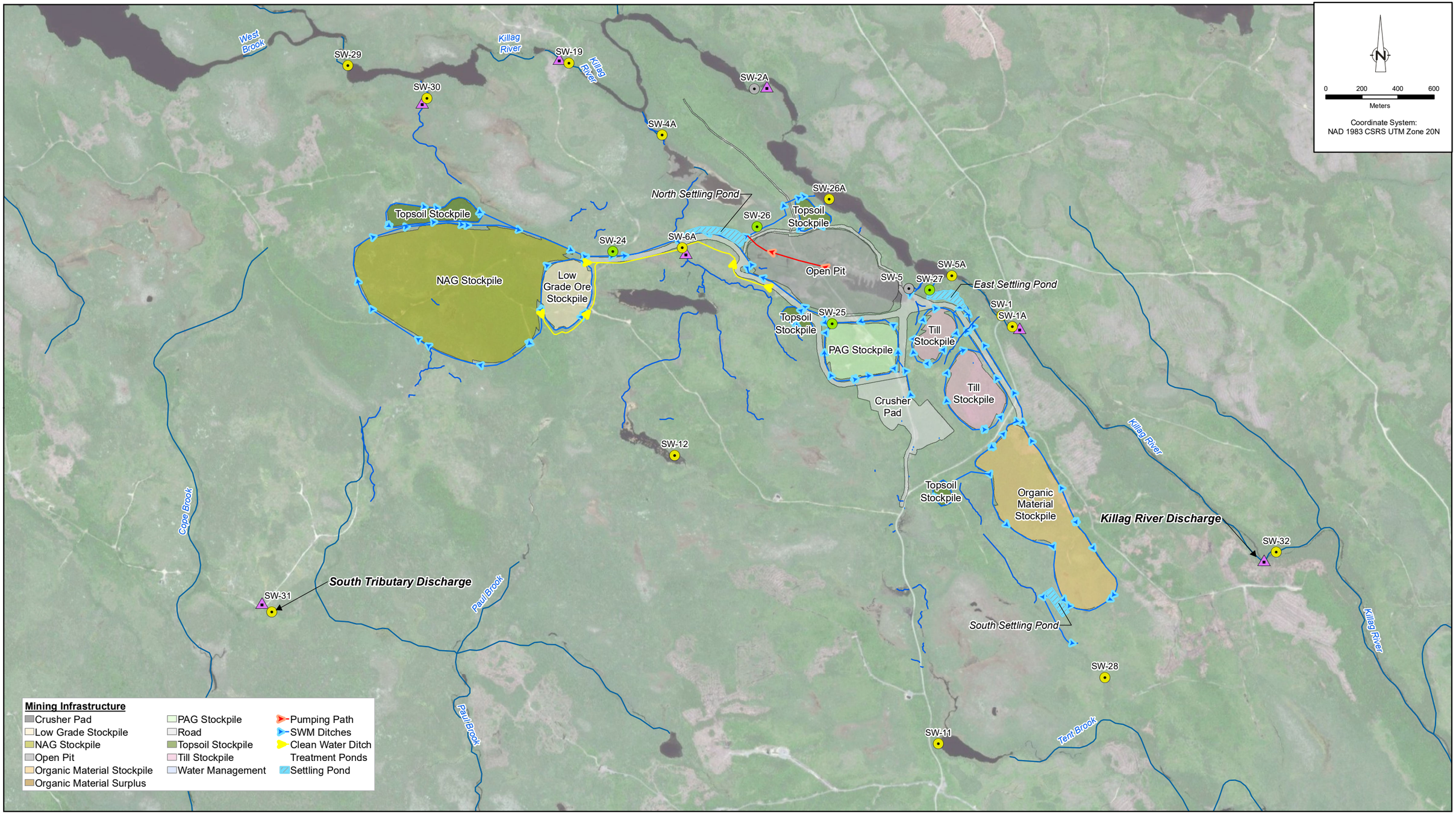
0 250 500 1,000 m

1:20,000 Scale when printed @ 11" x 17"

Drawn By: R. Gardiner Date: 2020-09-24

McCallum Environmental Ltd.

Document Name: 200517_SWAssessmentLocations



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NOTES:
1. Mud Lake and Tent Lake Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

- Water Quality Monitoring Locations
- Existing Water Quality Monitoring Locations (To Remain Active)
- Existing Water Quality Monitoring Locations (Inactive)
- Flow Monitoring Locations

GHD

ATLANTIC MINING NS CORP
BEAVER DAM MINE
SURFACE WATER MANAGEMENT PLAN

088664-27
Feb 25, 2021

OPERATIONS WATER MONITORING LOCATIONS

FIGURE 8-2

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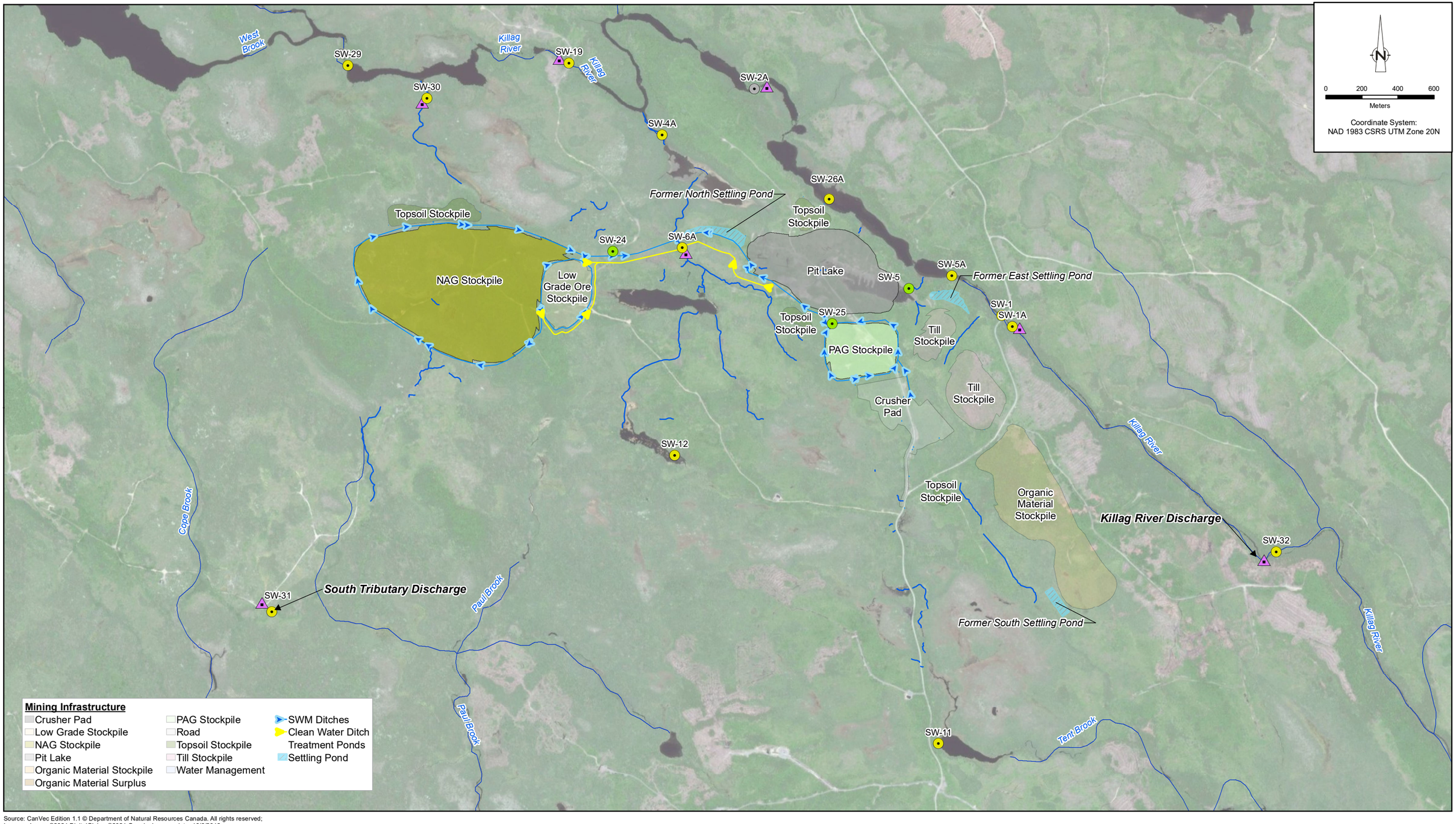

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- Water Quality Monitoring Locations
- Existing Water Quality Monitoring Locations (To Remain Active)
- Existing Water Quality Monitoring Locations (Inactive)
- Flow Monitoring Locations

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SURFACE WATER MANAGEMENT PLAN

088664-27
Feb 25, 2021

POST-CLOSURE WATER MONITORING LOCATIONS

FIGURE 8-3

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8.1.3 Surface Water Quantity Monitoring

The collection of continuous water levels (automated transducers) and manual flow data at seven locations is proposed to continue through all stages of the Mine development to support and improve the existing stage-discharge relationship/rating curves and further help validate modelling completed for the Beaver Dam Mine. This monitoring will continue until the completion of active closure.

As part of the IA process, additional water quantity monitoring requirements may be implemented for final site discharge locations.

8.2 Groundwater Monitoring

Typical mining activities such as opening a pit, storing ore material, and storing waste rock/overburden may have the potential to affect groundwater quality. The continuous dewatering associated with an open pit has the potential to lower groundwater levels near the pit. Nearby surface water bodies receiving discharge of groundwater as a component of base flow may be negatively impacted by lowered groundwater levels.

The proposed Groundwater Monitoring Plan (Appendix G) recommends using a combination of existing and proposed monitoring wells to establish a network of monitoring wells near the Mine Site to permit the collection of groundwater data adjacent to key infrastructure which has the potential to affect groundwater. Measuring the groundwater level in these wells on a periodic basis will document the impact of mine activities on groundwater elevations at the Mine and groundwater flow directions within the monitoring well network. Routine groundwater sampling and analysis will provide groundwater quality data to evaluate changes in groundwater quality, compared to baseline conditions and prior to active mining.

8.2.1 Groundwater Monitoring Locations

The existing monitoring well network was established to document baseline groundwater conditions prior to the Mine development. The monitoring network will be modified over time as the Mine enters different stages of its life cycle. The rationale for these locations are further discussed in Appendix G as well as monitoring location figures.

Termination of the groundwater monitoring program would be expected following a satisfactory review of the monitoring data collected during all project phases and as directed by and/or in consultation with Nova Scotia Environment and Climate Change (NSECC).

8.2.2 Groundwater Monitoring Frequency and Sample Requirements

Many IAs issued by NSECC prescribe a quarterly groundwater quality monitoring frequency. This conservative approach is appropriate for the groundwater monitoring frequency, especially at newly installed monitoring wells. Quarterly monitoring can be completed in each season to determine if there are cyclic changes in groundwater quality related to weather/climate. As more groundwater data is collected and evaluated it may be appropriate to reduce the monitoring frequency. More frequent monitoring may be implemented to monitor trends or mine infrastructure changes over shorter durations that may have a potential impact to groundwater.

Whenever possible the surface water and groundwater sampling should be collected in conjunction with each other.

The recommended groundwater quality monitoring parameters can be found in Table 8-1. The current program does not include hydrocarbon sampling (TPH.BTEX, etc). These parameters will be added to the analytical list prior to the commencement of Mine construction. Parameters may be adjusted from time to time to meet the needs of the project as determined from analysis of the analytical data and in consultation with regulators.

Table 8-1 Groundwater Quality Parameters

General Chemistry
Total Alkalinity (Total as CaCO3), Dissolved Chloride (Cl), Colour, Hardness (CaCO3), Nitrate + Nitrite (N), Nitrite (N), Nitrate (N), Nitrogen (Ammonia Nitrogen), Dissolved Organic Carbon (C), Total Phosphorus (P), Orthophosphate (P), Dissolved Phosphorous (P), pH, Reactive Silica (SiO2), Dissolved Sulphate (SO4), Turbidity, Conductivity, Total Suspended Solids, Total Chemical Oxygen Demand, Ion Balance (% Difference), Calculated Total Dissolved Solids, Total Organic Carbon (C), *Hydrocarbons TPH+BTEX*, Total Petroleum**
Note: ** to be added in the Construction Phase*
Metals (Dissolved)
Aluminum (Al), Antimony (Sb), Arsenic (As), Barium (Ba), Beryllium (Be), Bismuth (Bi), Boron (B), Cadmium (Cd), Calcium (Ca), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Magnesium (Mg), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Phosphorus (P), Potassium (K), Selenium (Se), Silver (Ag), Sodium (Na), Strontium (Sr), Thallium (Tl), Tin (Sn), Titanium (Ti), Uranium (U), Vanadium (V), Zinc (Zn), Mercury (Hg)
Field Parameters
Temperature, pH, Electrical Conductivity, Static Water Level

Additional parameters as specified or requested by NSECC.

8.2.3 Groundwater Level Monitoring

Each of the monitoring wells should be equipped with a pressure transducer to record water levels on an hourly frequency. In lieu of a transducer, groundwater elevations should be measured manually at all monitoring wells on a monthly frequency. If possible, these groundwater elevation monitoring events should be completed in a single day to provide a synoptic data set or “snapshot” of groundwater flow patterns beneath the Mine. Surface water elevations should also be measured at the same time to determine the hydraulic relationship between groundwater and surface water.

Pressure transducer data should be downloaded during the quarterly monitoring rounds, compensated for barometric pressure effects, and compiled.

Monitoring wells associated with the open pit will have pressure transducers installed and levels will be recorded on an hourly basis as a minimum. Telemetry systems may be added to any transducer capability to centralize collection and monitoring of data.

8.3 Water Quality Assurance and Control

Quality Assurance and Quality Control (QA/QC) are integral components of proper field and laboratory procedures. As stated in the MDMER (Schedule 5, Section 7(e)), water quality monitoring is to be conducted by implementing quality assurance and quality control measures that will ensure the accuracy of water quality monitoring data. QA/QC is essential to delivering the consistent quality service. Field duplicates will therefore be incorporated into the monitoring program as a blind

method of evaluating analytical precision, field precision and sample homogeneity. Laboratory produced trip blanks will also be taken and submitted for analysis during each site visit. Water quality samples will be submitted to accredited laboratories.

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All of Which is Respectfully Submitted,

GHD

<Original signed by>

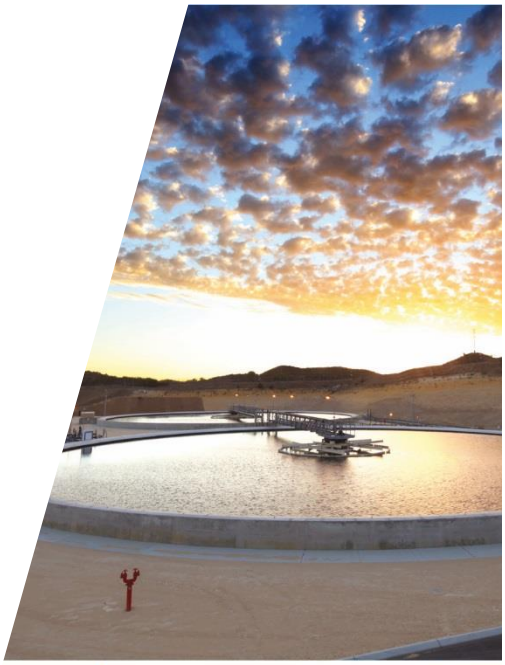
Andrew Betts

<Original signed by>

Christopher Muirhead

Appendices

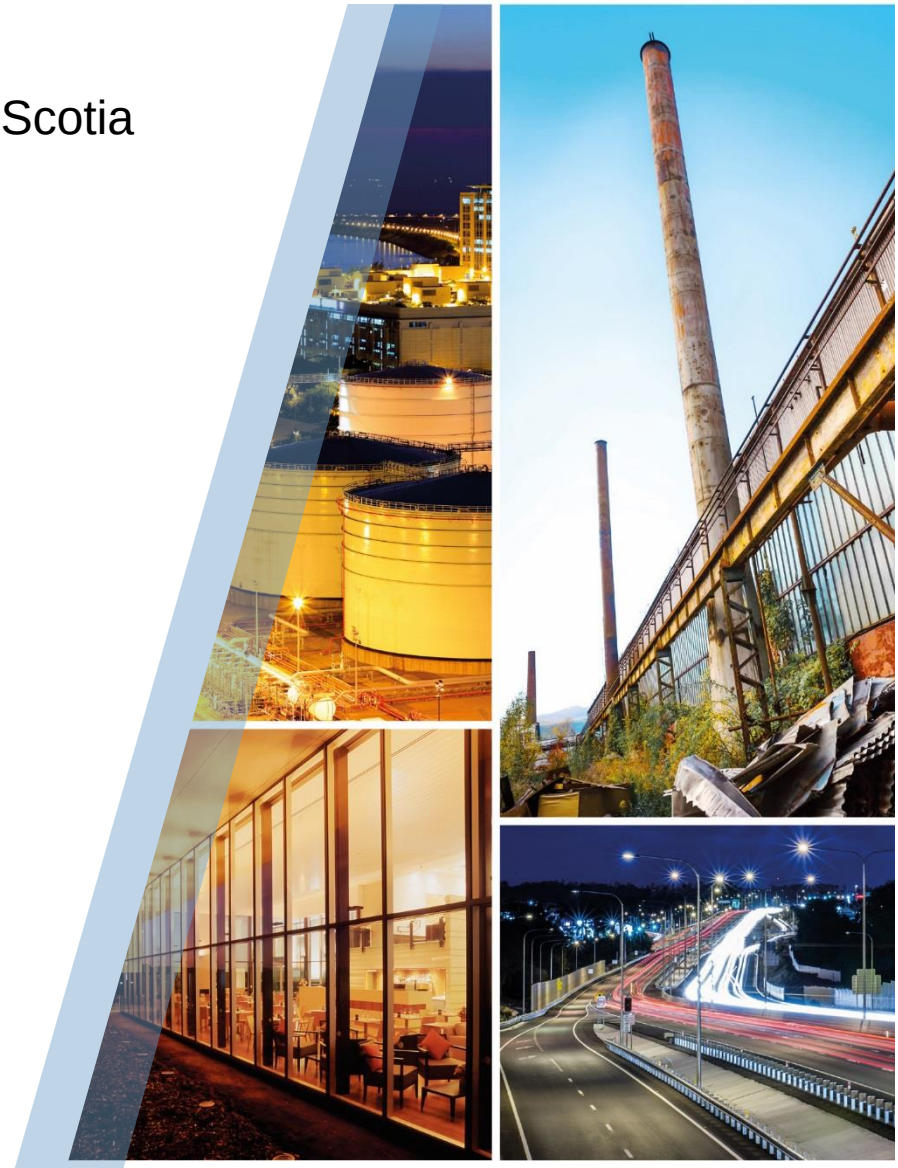
Appendix A
Water Balance Analysis



Water Balance Analysis

Beaver Dam Mine Site

Atlantic Mining Nova Scotia



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1. Introduction

GHD Limited (GHD) was retained by Atlantic Mining Nova Scotia Inc. (AMNS) to develop a Mine Water Management Plan (MWMP) for the Beaver Dam Gold Mine in Marinette, Halifax County, Nova Scotia (Site, Mine Site). The MWMP is being developed in support of the Environmental Impact Statement (EIS) for the mine. As part of the MWMP, GHD has completed a water balance analysis for three stages of mine development including baseline, End-of-Mine (EOM), and Post-Closure (PC) conditions. EOM and PC streamflow volumes were compared to baseline streamflow volumes at sixteen assessment points in the natural watercourses. This report presents the methodology and results of the water balance analysis, which are necessary to understand the impact of the proposed mine development on the receiving environment and inform potential mitigation strategies to reduce the impact of the proposed development on aquatic habitats.

2. Background

The Mine Site comprises approximately 592 hectares (ha) of lakes, rivers, and forested lands that are in varying degrees of re-growth due to historical logging. The Mine Site 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 mined ore will be processed at the existing Touquoy plant. It is anticipated that once all permits are received construction will commence and will take one year to complete. Operations will take place over five years and active closure will take two years to complete.

The MWMP aims to mitigate operational risks and environmental impacts of the mine on the receiving environment. The objectives of the water balance analysis are to assess the impacts of the mine on drainage patterns in surrounding watercourses and provide inputs to a predictive water quality analysis to determine the type and level of treatment required at the proposed site discharge locations. Monthly and annual streamflow volumes were compared between three mine development stages at sixteen assessment points where the Mine Site will discharge or impact flows in the natural environment. In addition, a water balance analysis of the open pit mine was performed to determine the time required for the pit to fill with water and form a lake as part of the proposed Mine Site reclamation plan.

2.1 Data Collection

The following sections discuss the datasets that were collected to facilitate the water balance analysis.

2.1.1 Topographic Data

Contour datasets were used to delineate the catchment areas for the Mine Site and its upstream catchment area.

A Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20 m digital elevation model (DEM) was used to generate contours for the off-site/upstream portion of the

drainage area for baseline, EOM, and PC conditions. High-resolution Light Detection and Ranging (LiDAR) data was collected for the Mine Site by Leading Edge Geomatics under contract to GHD in 2015. The LiDAR data was used to generate on-site contours for baseline conditions. In addition, proposed contours were developed to represent the topography of the proposed mine features and used to delineate on-site catchment areas for EOM and PC conditions.

2.1.2 Climate Data

The water balance analysis requires daily rainfall, snowfall, mean temperature, and evaporation records as data inputs to estimate streamflow in the receiving watercourses.

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 including 1968 – 2005, 2009, 2014 and 2016. Years with a significant amount of missing data were excluded from the analysis. The station was selected based on its proximity to the Mine Site, and relatively long, complete, and current record. Monthly lake evaporation normals were obtained from the Environment Canada Truro Climate Station (Climate ID 8205990), which is the closest climate station to the Mine Site that collects lake evaporation data.

Table 2-1 summarizes the mean monthly temperatures, precipitation totals, rainfall totals, snowfall totals, and lake evaporation rates used in the analysis.

Table 2-1 Climate Normals (Data from Middle Musquodoboit and Truro Environment Canada Climate Stations)

	January	February	March	April	May	June	July	August	September	October	November	December
Mean Temperature (°C)	-6.2	-5.3	-1.1	4.3	9.9	15.0	18.5	18.3	13.9	8.3	3.4	-2.5
Precipitation (mm)	128.8	103.3	125.6	105.1	102.6	94.8	97.8	97.7	103.0	123.9	137.1	136.0
Rainfall (mm)	82.9	62.1	94.7	94.5	101.8	94.8	97.8	97.7	103.0	122.7	129.7	103.8
Snowfall (mm)	45.9	41.2	30.9	10.6	0.8	0.0	0.0	0.0	0.0	1.2	7.4	32.2
Lake Evaporation (mm/day)	0.0	0.0	0.0	0.0	2.9	3.4	3.8	3.1	2.3	1.3	0.0	0.0

Potential evapotranspiration (PET) rates were calculated using the Hamon equation (1961). The Hamon equation requires average daylight hours and mean temperature as input. Average daylight hours were calculated for each month at Halifax, Nova Scotia using the Sunrise and Sunset Calculator (https://www.timeanddate.com/sun/, last accessed 6 November 2018).

2.1.3 Groundwater Inflows

Groundwater inflow to the open pit was obtained from the GHD groundwater model for the Mine Site (GHD, 2021a). Peak groundwater inflow rates of 605 m^3/day and 385 m^3/day were used in this analysis for EOM and PC conditions, respectively.

3. Methodology

GHD developed a predictive water balance model (WBM) to assess the impacts of the proposed mine development on the surrounding watercourses during EOM and PC conditions. The WBM was developed using the GoldSim software.

GoldSim is a highly graphical program used for carrying out dynamic, probabilistic simulations to support decision making (https://www.goldsim.com/Web/Home/, last accessed 20 November 2018). GoldSim is especially well-suited to simulating dynamic, computationally intensive, but well-defined network models such as a water balance. GoldSim can perform Monte Carlo simulations, track outputs from those simulations, and provide a graphical interface to facilitate the review and identification of interactions between system components.

The WBM was developed to utilize climate inputs at a daily time-step; allowing the results to be summarized at monthly or annual intervals. The WBM was employed to calculate runoff volumes at sixteen assessment points for three stages of mine development.

3.1 Modelling Hydrological Processes

Mine water balances generally model the interactions between climate inputs, hydrologic responses, and site processes. This section describes the hydrological processes represented in the WBM including the snowpack and rainfall-runoff models.

3.1.1 Snowpack Modelling

The snowpack was modelled using a mass balance approach. Snowfall accumulates into the snowpack, which is represented by a storage element in the WBM. Output from the snowpack storage is determined by the snowmelt rate. Snowmelt rate is calculated using the degree-day method when the daily mean temperature is greater than 0 degrees Celsius (USDA, 2004).

3.1.2 Rainfall-Runoff Modelling in Undeveloped Areas

A hydrologic modelling approach was used to calculate surface runoff and baseflow in undeveloped areas under baseline, EOM, and PC conditions. The approach follows the methodology applied in the Australian Water Balance Model (AWBM) (Boughton, 2004). The AWBM is a conceptual hydrologic model that simulates runoff when excess precipitation exceeds the surface storage capacity of the catchment. Surface storage capacity is determined by the land cover and soil characteristics of the catchment. Surface storage is represented by a storage element in the model, where the precipitation time series is the input and the PET time series is the output. In this study, precipitation was replaced with the combination of rainfall and snowmelt to provide a better representation of hydrologic processes in Nova Scotia.

The model runs on a daily time step. Rainfall and snowmelt are added, and PET is subtracted from the surface storage. Actual evapotranspiration (AET) equals PET when there is enough water within the surface storage to meet the evapotranspiration demand, otherwise, AET equals the amount of water available in the surface storage. The average annual AET is 450 millimetres (mm), which is comparable to the mean annual evapotranspiration (1979-2008) modelled for the Atlantic Maritime Canadian ecozone (Wang et al., 2013).

Surface storage overflow (surplus) is generated when the available water capacity of the surface storage is exceeded. An available water capacity of 150 mm was used based on the Water Balance Report for the Touquoy Mine Site (Stantec, 2016), and A Monthly Water-Balance Model Driven by a Graphical User Interface (USGS, 2007). Surplus is partitioned into surface runoff and baseflow recharge according to the baseflow index (BFI). The BFI represents the fraction of surplus that recharges the baseflow storage element (groundwater aquifer). The remaining portion of the surplus discharges as surface runoff. Seasonal BFIs were determined for the Mine Site using the groundwater model and are summarized in Table 3-1 (GHD, 2021a).

Table 3-1 Seasonal BFI Summary

Season	BFI
Spring (Mar, Apr, May)	0.231
Summary (Jun, Jul, Aug)	0.416
Fall (Sep, Oct, Nov)	0.116
Winter (Dec, Jan, Feb)	0.348

Baseflow recharge and discharge represent the input to and output from the baseflow storage, respectively. Baseflow discharge is calculated using a recession constant (Kb) of 0.98, also determined as part of the groundwater assessment. Baseflow discharge is equal to the product of (1-Kb) and the available water in the baseflow storage at a daily time step.

Daily streamflow volumes are calculated as the sum of surface runoff and baseflow discharge (in mm/day) multiplied by the respective catchment areas.

Figure 3-1 shows how the rainfall-runoff modelling process for non-site features is represented in the WBM.

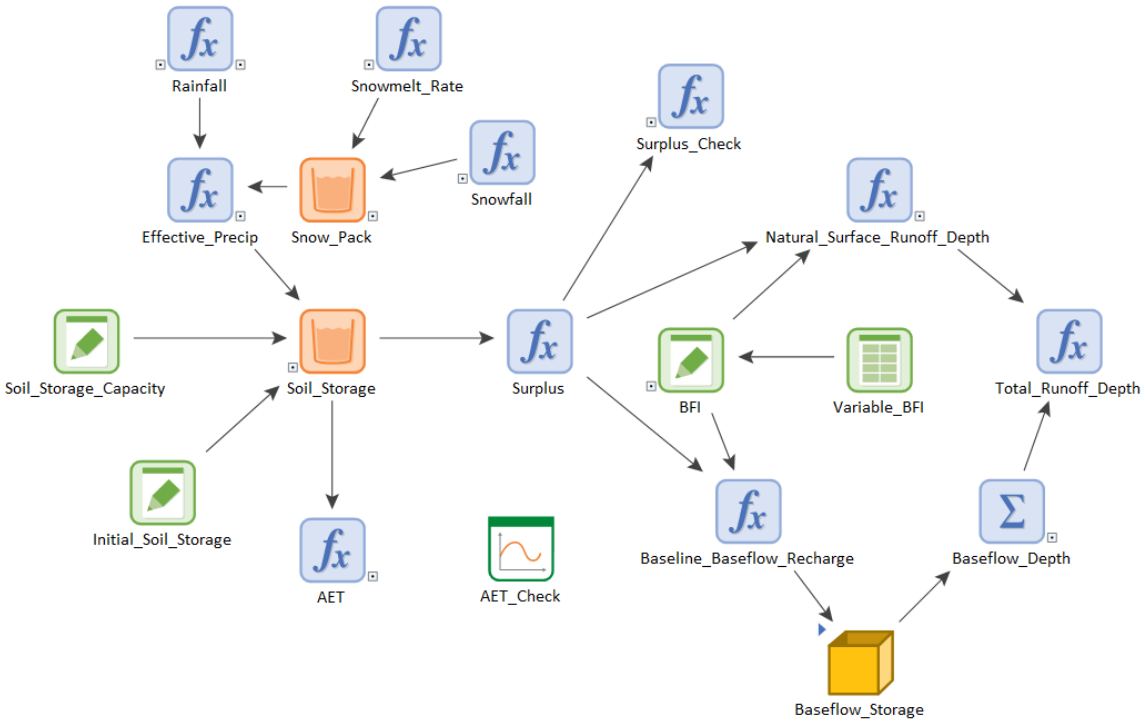


Figure 3-1 Rainfall-Runoff Model Schematic for Undeveloped Areas in the WBM

Changes in land cover, soil conditions, and catchment area due to Mine Site development will impact the surface runoff volumes between baseline and EOM/PC conditions. Section 3.1.3 provides more information on how surface runoff is modelled from the mine features. Baseflow volume variations due to the influence of mine development on groundwater flow patterns were determined using the groundwater model. Baseflow impacts were incorporated into the WBM as percent changes from baseline conditions.

3.1.3 Rainfall-Runoff Modelling of the Developed Site

The Mine Site includes stockpiles that are projected to cover approximately 130 hectares (ha) when fully developed. Hydrologic processes of the stockpile areas are complex; therefore, instead of modelling evaporation, infiltration, and direct runoff, these parameters were estimated using coefficients of the daily rainfall and snowmelt. The hydrologic coefficients were determined by Stantec for the Touquoy Mine Site for EOM and PC conditions (pers. comm., 2018). GHD assumes these coefficients can be applied to the Beaver Dam Mine Site based on its proximity, and similar geological characteristics to the Touquoy Mine Site.

Stockpile seepage also contributes to surface runoff from the stockpiles. Seepage was estimated as the difference between the infiltrated water, and the sum of groundwater recharge and absorption by the stockpile material. Groundwater recharge was assumed to be 17% of the rainfall/snowmelt for all uncapped stockpiles, and 3% of the rainfall/snowmelt for capped stockpiles based on the outcomes of the groundwater assessment (GHD, 2021a). The amount of absorbed water was determined

using an estimated 20-year time-to-saturation of the stockpiles provided by Stantec (pers. comm., 2018), and estimated field capacities of the stockpile materials.

Field capacity is the water content of the soil when its pore spaces begin to drain. The field capacity of the waste rock material was selected as 0.004, which is equivalent that of gravel (Zhan et al., 2016). The field capacity of till was selected as 0.19, which is equivalent to that of sandy loam, the predominate soil in the area (Rawls et al., 1983). Based on the assumed field capacities of 0.004 and 0.19 for waste rock/ore and till, respectively, and the 20-year time-to-saturation of the stockpiles, it was determined that approximately 0.4% of the total rainfall/snowmelt will remain in the waste rock and ore stockpiles, and 14% of total rainfall/snowmelt will remain in the till, organic and topsoil stockpiles annually. Due to the slow movement of water through the stockpiles, seepage rates were assumed to be lagged by one month. **Error! Reference source not found.** provides a summary of t he coefficients of daily rainfall/snowmelt used to calculate evaporation, direct runoff, infiltration, groundwater recharge, absorption, and seepage from the stockpile areas in the WBM. The ore, till, organic, and topsoil stockpiles will be removed post-mine closure.

Table 3-2 Coefficients of Daily Rainfall/Snowmelt Used to Calculate Evaporation, Runoff, Infiltration, Recharge, Absorption, and Seepage

Stockpile Type	Evaporation (-)	Surface Runoff (-)	Infiltration Parameters			
			Infiltration (-)	Recharge (-)	Absorption (-)	Seepage (-)
NAG Waste Rock, EOM	0.05	0.05	0.90	0.17	0.00	0.73
NAG Waste Rock, PC	0.35	0.23	0.43	0.17	0.00	0.26
PAG Waste Rock, EOM	0.05	0.05	0.90	0.17	0.00	0.73
PAG Waste Rock, PC	0.35	0.56	0.09	0.08	0.00	0.01
Ore Pile, EOM	0.05	0.05	0.90	0.17	0.00	0.73
Till Pile, EOM	0.35	0.49	0.16	0.17	0.14	0.00
Organic Pile, EOM	0.35	0.49	0.16	0.17	0.14	0.00
Topsoil Piles, EOM	0.35	0.49	0.16	0.17	0.14	0.00

A direct runoff coefficient of 1.0 was applied to impervious surfaces, including the site roads, crusher pad, and administrative building areas based on the assumption that 100% of the rainfall/snowmelt that falls on impervious surfaces will generate surface runoff.

Baseflow contributions to watercourses originating from rainfall/snowmelt falling on the developed area of the Mine Site were either accounted for in the percent change values (described in Section 3.1.2 of this report) or included as an input to the open pit. The groundwater inflow rates to the pit are provided in Section 2.1.3.

4. Mine Site Layout

This section of the report describes the proposed Mine Site catchments and assessment points as well as the proposed water transfers between site features under baseline, EOM, and PC conditions.

4.1 Baseline Conditions and Assessment Points

The Mine Site will impact three watercourse systems, including the Killag River, Cope Brook, and Tent Brook. This study simulates the change in streamflow volumes in these systems and their tributaries due to the mine development. This study also assesses the mine-related impacts to water levels in two waterbodies located in the Killag River catchment, namely Crusher Lake and Mud Lake. Crusher Lake discharges to Mud Lake through Watercourse (WC) 5. Mud Lake outlets to the Killag River through WC-27. Table 4-1 provides a summary of the selected assessment points.

Table 4-1 Summary of Assessment Points

Assessment Point	System	Description
WC-26	Killag River	The WC-26 assessment point is located on the tributary immediately upstream of its confluence with the Killag River.
WC-5 Upstream (US)	Killag River	The WC-5 US assessment point is located immediately downstream of the Crusher Lake outlet.
WC-5 Downstream (DS)	Killag River	The WC-5 DS assessment point is located immediately upstream of the inlet to Mud Lake.
WC-27 US	Killag River	The WC-27 US assessment point is located immediately downstream of the Mud Lake outlet.
WC-27 DS	Killag River	The WC-27 DS assessment point is located on the tributary immediately upstream of its confluence with the Killag River.
Killag River US	Killag River	The Killag River US assessment point is located on the Killag River upstream of the WC-26 confluence. It is outside of the influence of mine development and provides a reference for streamflow in the river system.
Killag River at WC-26	Killag River	The Killag River at WC-26 assessment point is located on the Killag River downstream of the WC-26 confluence and upstream of the WC-27 confluence. It was included to measure the impact of the mine development within the WC-26 catchment on the Killag River system.
Killag River at WC-27	Killag River	The Killag River at WC-27 assessment point is located on the Killag River immediately downstream of the WC-27 confluence. It was selected to measure the impact of the mine development within the WC-26 and WC-27 catchments on the Killag River system. It is located upstream of the proposed site discharge locations.
Killag River at Cameron Flowage	Killag River	The Killag River at Cameron Flowage assessment point is located on the Killag River immediately upstream of Cameron Flowage. It was also selected to measure the impact of mine development within the WC-26 and WC-27 catchments on the Killag River system, upstream of the proposed site discharge locations.

Table 4-1 Summary of Assessment Points

Assessment Point	System	Description
Killag River at Pit	Killag River	The Killag River at Pit assessment point is located on the Killag River approximately 1 kilometre downstream of the north settling pond discharge location. It represents the section of the river that will experience the largest impact of the open pit on baseflow contributions.
Killag River DS	Killag River	The Killag River DS assessment point is located at a point along the Killag River that fully captures the hydrologic impact of the mine development and is referred to in this study as the downstream limit of impact.
WC-23	Cope Brook	The WC-23 assessment point is located on the tributary immediately upstream of the Cope Brook confluence.
Cope Brook US	Cope Brook	The Cope Brook US assessment point is located on Cope Brook immediately upstream of the WC-23 confluence. It is outside of the influence of the mine and provides a reference for streamflow in the system.
Cope Brook DS	Cope Brook	The Cope Brook DS assessment point is located on the watercourse immediately downstream of the WC-23 confluence to fully capture the hydrologic impact of the mine on the Cope Brook system.
Cope Brook DS #2	Cope Brook	The Cope Brook DS #2 is a second assessment point located on the watercourse downstream of the WC-23 confluence that also captures the hydrologic impact of the mine on the Cope Brook system.
Tent Brook	Tent Brook	The Tent Brook assessment point located on Tent Brook immediately downstream of the WC-19 confluence to fully capture the hydrologic impact of the mine development on the Tent Brook system.

Maps of the baseline catchments and assessment points are presented on Figure 4-1 and Figure 4-2. All baseline catchments are natural with lakes, wetlands, and forested land cover.

4.2 End-of-Mine Conditions

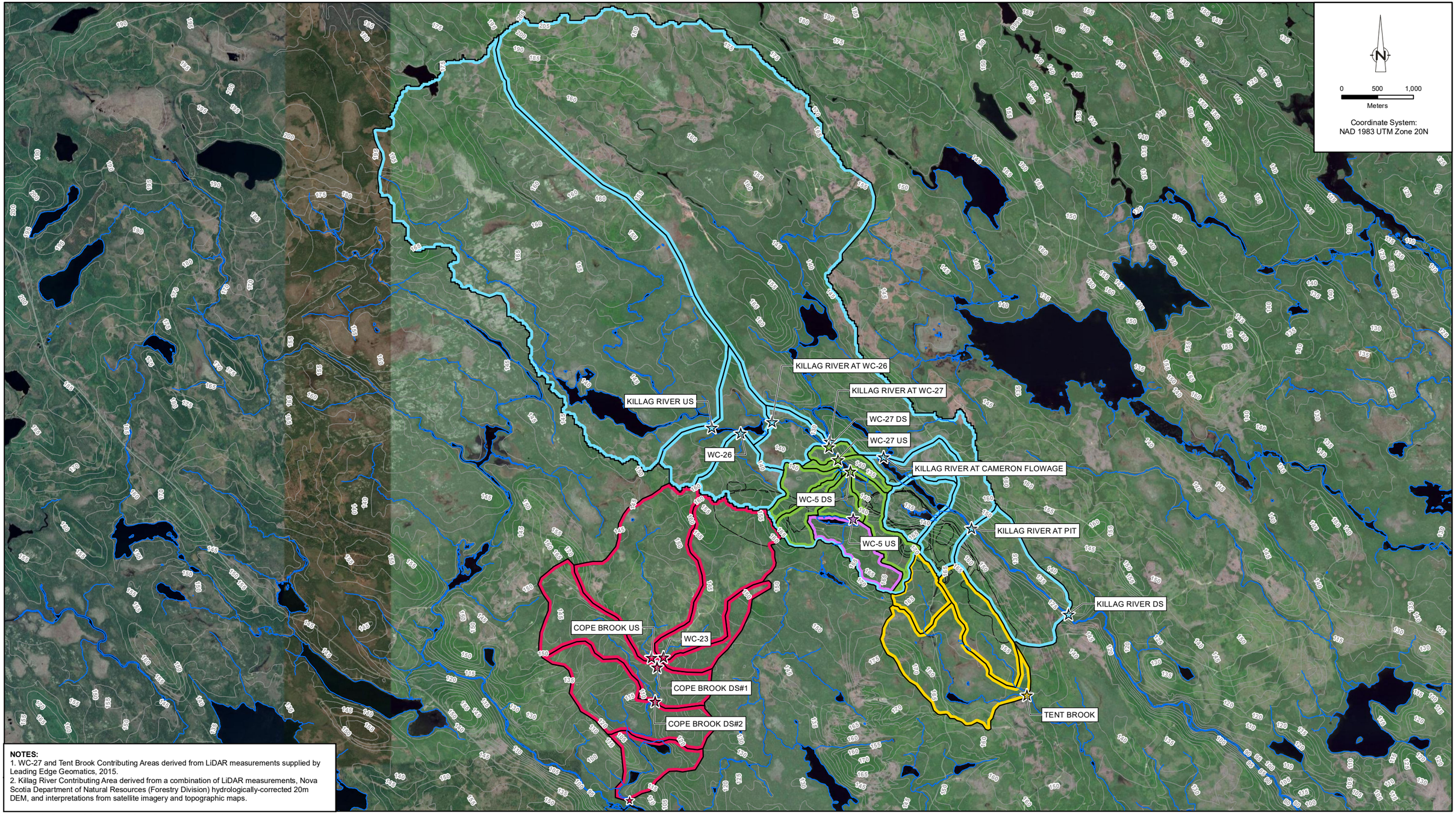
The catchments and assessment points of the study under operating conditions are presented on Figure 4-3.

The Killag River Downstream (DS) catchment encompasses the WC-26, WC-5, WC-27, north settling pond, and east settling pond catchment areas. The Mine Site development will increase the Killag River DS catchment area from 3933.5 ha to 3974.5 ha. TheWC-26, WC-27, WC-23, and Cope Brook catchment areas will decrease from baseline conditions due to the placement of mine features in their contributing drainage areas. Surface runoff from these mine features will be directed to the north settling pond for treatment of certain metals, nitrogen species, and total suspended solids (TSS) as determined in the predictive water quality analysis (GHD, 2021b) prior to being released to the Killag River.

Specifically, the north settling pond will receive surface runoff from the non-acid generating (NAG) waste rock stockpile, potentially acid generating (PAG) waste rock stockpile, low-grade ore (LGO)

stockpile, topsoil stockpiles, crusher pad, administrative building areas, and site roads through a proposed ditch system. Surface runoff from the till stockpiles, a portion of the organic stockpile, and site roads will be collected in ditches and directed to the east settling pond for treatment of TSS before being released to the Killag River.

The catchment area of the Tent Brook assessment point will also be reduced from baseline conditions due to the placement of the crusher pad and administrative buildings, which are partially located in its baseline catchment area. All runoff from the crusher pad and administrative buildings will be directed away from the Tent Brook system, toward the Killag River catchment as described above. Runoff from the remaining portion of the organic material stockpile and a topsoil stockpile will be collected in ditches and directed to the south settling pond for treatment of TSS before being released to WC-19 of the Tent Brook system.



NOTES:
1. WC-27 and Tent Brook Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

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Drainage Areas
- Killag River
- Tent Brook
- Cope Brook
- WC-27
- WC-5

Assessment Points

Future Mine Footprint
Contours (5m)
Watercourse

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
WATER BALANCE ANALYSIS

CATCHMENT AREAS - BASELINE CONDITION

088664
Apr 5, 2021

FIGURE 4-1

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\012\088664-27(012)GIS-WA001.mxd

KILLAG RIVER AT WC-26
KILLAG RIVER AT WC-27
KILLAG RIVER US
WC-26
WC-27 US
WC-27 DS
KILLAG RIVER AT CAMERON FLOWAGE
WC-5 DS
WC-5 US
KILLAG RIVER AT PIT
KILLAG RIVER DS
WC-23
COPE BROOK US
COPE BROOK DS#1
COPE BROOK DS#2
TENT BROOK

0 250 500
Meters

Coordinate System:
NAD 1983 UTM Zone 20N

NOTES:
1. WC-27 and Tent Brook Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

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Drainage Areas
- Killag River
- Mud Lake
- Crusher Lake
- Tent Brook
- Cope Brook

Assessment Points

- Future Mine Footprint
- Contours (5m)
- Contours (1m)
- Watercourse

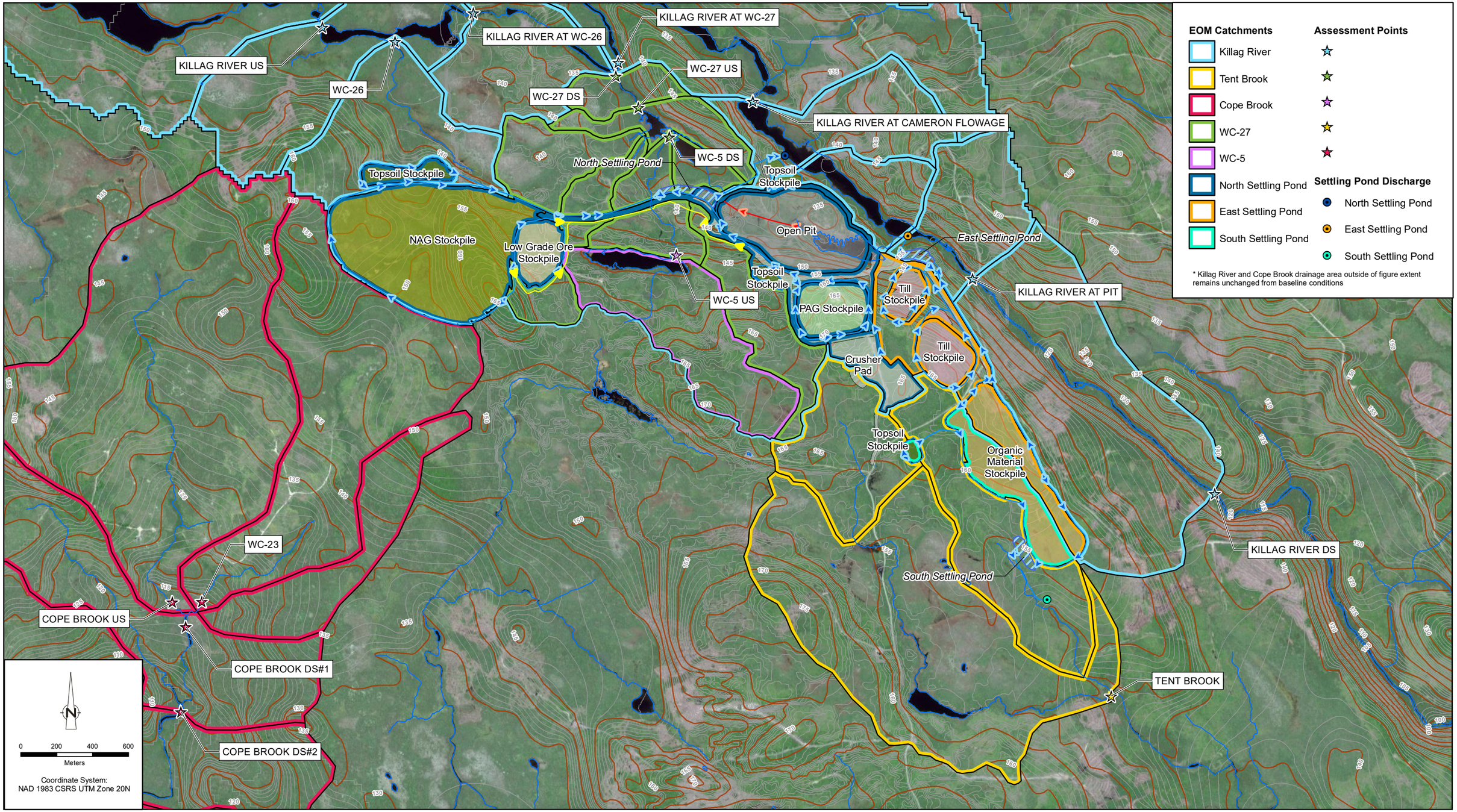
ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
WATER BALANCE ANALYSIS

CATCHMENT AREAS - BASELINE CONDITION (DETAILED VIEW)

088664
Mar 26, 2021

FIGURE 4-2

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\012\088664-27(012)GIS-WA002.mxd



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Imagery: Image ©2021 DigitalGlobe, ©2021 Google, Imagery date: 18/6/2012

NOTES:
1. WC-27 and Tent Brook Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

- Pumping Path
- SWM Ditches
- Clean Water Ditch
- Contours (5m)
- Contours (1m)
- Settling Ponds
- Crusher Pad
- Low Grade Stockpile
- NAG Stockpile
- Open Pit
- Organic Material Stockpile
- PAG Stockpile
- Road
- Topsoil Stockpile
- Till Stockpile
- Watercourse

GHD

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
WATER BALANCE ANALYSIS

CATCHMENT AREA – EOM CONDITIONS

088664
Apr 5, 2021

FIGURE 4-3

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The open pit is located within the Killag River catchment. During operations the pit will receive surface runoff from direct precipitation. The open pit will also draw groundwater from the aquifer, diverting some baseflow from the Killag River toward the pit. Surface runoff and groundwater will be collected in pit sumps and pumped to the north settling pond for treatment before being released to the Killag River.

4.3 Post-Closure Conditions

The catchments and assessment points of the Mine Site under PC conditions are presented on

Figure 4-4. As part of the Mine 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 immediately, and the north settling pond will remain active until the open pit has been filled with water. Water in the north settling pond will be used to supplement baseflow to the Killag River during dry months of the pit filling period as described in the Baseflow Mitigation Assessment Memorandum (GHD, 2021d).

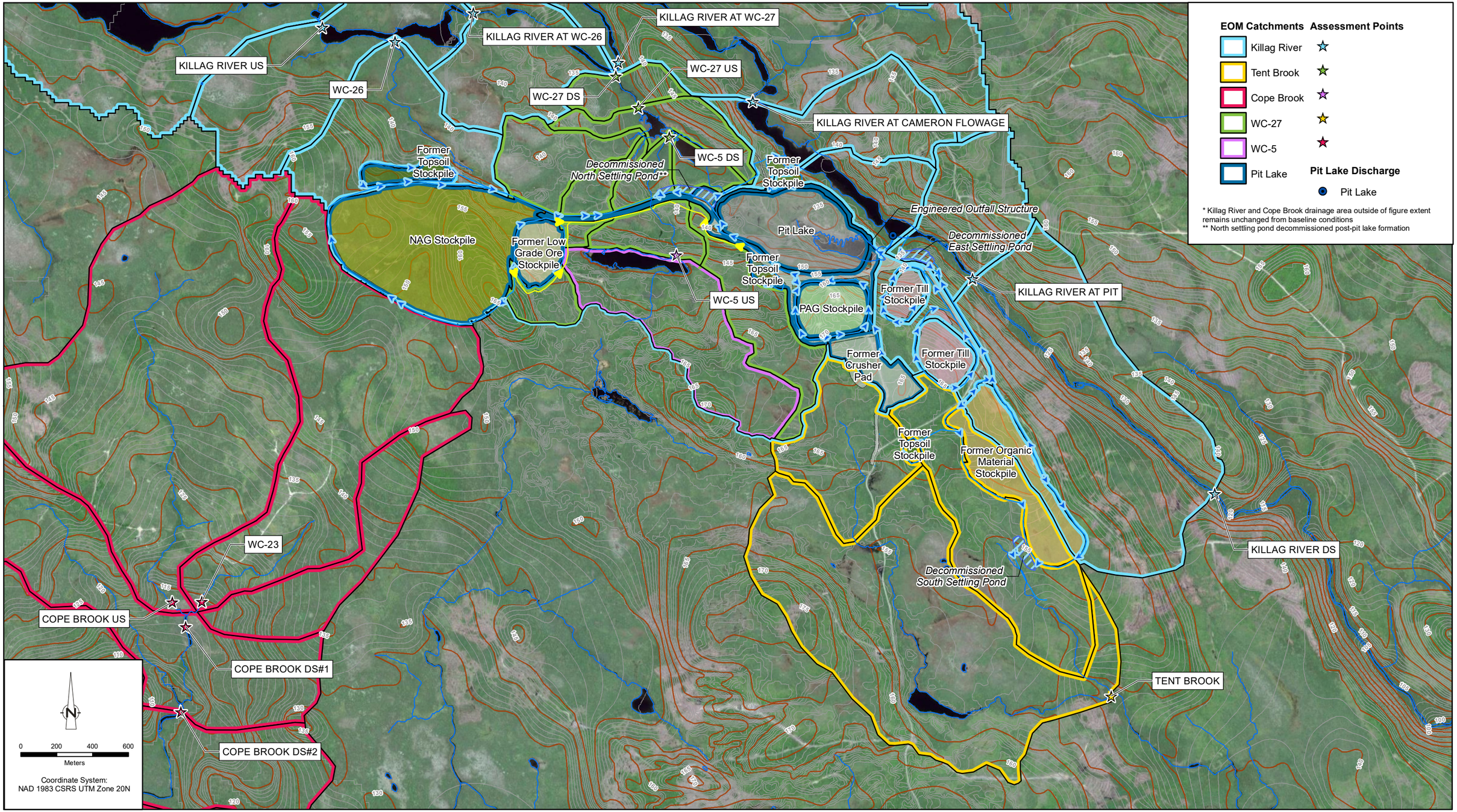
The NAG and PAG waste rock stockpiles will remain in place, and the PAG waste rock stockpile will be capped and vegetated to reduce infiltration and seepage of contact water. The LGO stockpile will be removed and surface runoff from the area previously occupied by the LGO stockpile will be redirected to Mud Lake. The open pit will be filled with water from direct precipitation, surface runoff and groundwater inflows. North settling pond discharge will be directed to the pit to reduce the pit filling time. Once the pit has filled with water, the north settling pond will be decommissioned and pit overflow will be directed to the Killag River through an engineered outfall in the east pit wall and existing outlet channel (WC-13).

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 Brook drainage systems through site ditches.

A summary of the catchment areas under baseline, EOM, and PC conditions is provided in Table 4-2.

Table 4-2 Summary of Catchment Areas under Baseline, End-of-Mine and Post-Closure Conditions

Catchment Name	Catchment Area (ha)		
	Baseline Conditions	EOM Conditions	PC Conditions
WC-26	78.6	56.5	61.4
WC-27 DS	236.4	197.2	205.8
WC-27 US (Mud Lake Outlet)	223.2	184.0	192.6
WC-5 US (Crusher Lake Outlet)	58.8	58.8	58.8
WC-5 DS	82.9	81.7	81.7
Killag River US	1,385.3	1,385.3	1,385.3
Killag River at WC-26	1,574.0	1,574.0	1,574.0
Killag River at WC-27	1,863.7	1,802.4	1,815.9
Killag River at Cameron Flowage	3,580.0	3,518.7	3,532.2
Killag River at Pit	3,763.5	3,829.2	3,829.2
Killag River DS	3,933.5	3,974.5	3,974.5
WC-23	181.8	145.6	145.6
Cope Brook US	252.3	252.3	252.3
Cope Brook DS #1	481.0	444.8	444.8
Cope Brook DS #2	640.0	603.8	603.8
Tent Brook	306.2	301.6	301.6



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NOTES:
1. WC-27 and Tent Brook Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

- SWM Ditches
- Clean Water Ditch
- Contours (5m)
- Contours (1m)
- Watercourse
- Settling Ponds
- Former Crusher Pad
- Former Low Grade Stockpile
- Former Organic Material Stockpile
- Former Topsoil Stockpile
- Former Till Stockpile
- NAG Stockpile
- Open Pit
- PAG Stockpile
- Road

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
WATER BALANCE ANALYSIS

CATCHMENT AREA – PC CONDITIONS

088664
Apr 5, 2021

FIGURE 4-4

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\012\088664-27(012)GIS-WA004.mxd

5. Water Balance Results

This section of the report presents the results of the water balance analysis. The WBM simulates stormwater runoff and streamflow volumes at sixteen assessment points under baseline, EOM and PC conditions. The average monthly and annual results are presented below. The results focus on percent change values to evaluate the hydrologic impacts on the receiving watercourses. The site runoff and Killag River streamflow volumes calculated in this study are also applied in the predictive water quality analysis to determine the level of treatment required at the site discharge locations (GHD, 2021b).

5.1 Mine Infrastructure Water Balance

Table 5-1-Table 5-3 summarize the water balances for settling ponds located upstream of the site discharge points under EOM conditions. Settling pond discharge occurs when the balance between inputs, outputs, and stored water exceeds the permanent pool storage volumes. The permanent pool storage volumes were assumed to be full at the beginning of the simulation. Details on settling pond dimensions are provided in the hydrologic modelling technical memorandum (GHD, 2021c).

Under EOM conditions, open pit inputs include pit wall runoff generated by precipitation falling directly on the pit and groundwater inflows. Outputs include evaporation and dewatering to the north settling pond. The pumping rate to the north settling pond is set equal to the difference between the inputs and evaporation from the pit, based on the assumption that the pit will be kept dry during operations.

Post-mine closure, the open pit inputs include direct precipitation, site runoff, and groundwater inflows. Output includes evaporation. Open pit water balance calculations were performed under two PC scenarios: (1) following formation of the pit lake, and (2) while the pit is being filled with water.

Under PC Scenario 1, pit lake discharge occurs when the balance between the inputs, outputs and stored water exceeds the permanent pool storage volume of the lake, which is approximately 16,000,000 m^3 at a containing elevation of 127 metres above sea level (masl). The permanent pool storage volume of the pit lake was assumed to be full at the beginning of the simulation. Table 5-4 summarizes the monthly and annual water balance results for the open pit under Scenario 1.

A simulation for PC Scenario 2 was performed to estimate the pit filling time. Table 5-5 presents detailed inputs and results of the pit filling time calculation.

Depth-varying groundwater inflow rates were obtained from the groundwater model (GHD, 2021a). Precipitation and evaporation volumes were calculated by multiplying the difference between precipitation and evaporation by the surface area of the water in the pit. The surface area of the water in the pit varies based on the stage of the water. Surface areas are provided at 10 m increments. Pit wall runoff was calculated as the product of precipitation, surface area of the pit above the water surface, and the runoff coefficient of the pit wall. A runoff coefficient of 0.85 was used based on studies completed at the Touquoy Mine Site (pers. comm., 2018). The time to fill the pit was calculated as the sum of the volume of water in the pit divided by the total inflow rate to the pit at each stage. Based on these calculations the predicted pit filling time is approximately 13.1 years.

Table 5-1 Water Balance for the North Settling Pond under Average Climate Conditions

North Settling Pond Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pond Input Summary													
Direct Precipitation	1,082	924	1,604	1,224	1,026	948	978	977	1,030	1,239	1,351	1,183	13,565
NAG Stockpile Runoff	59,649	54,343	49,049	80,088	61,414	51,764	48,155	49,561	49,686	52,901	63,183	66,917	686,710
PAG Stockpile Runoff	10,003	9,113	8,225	13,430	10,299	8,681	8,075	8,311	8,332	8,871	10,595	11,221	115,156
LGO Stockpile Runoff	7,892	7,190	6,490	10,596	8,126	6,849	6,371	6,557	6,574	6,999	8,360	8,854	90,858
Site Runoff	28,253	24,062	42,598	31,964	25,829	22,667	22,985	22,901	24,814	32,129	36,519	30,889	345,610
Pit Dewatering	46,709	40,811	60,213	49,781	23,637	20,452	20,659	22,438	26,076	39,410	53,072	49,027	452,285
Total Inflow	153,588	136,442	168,178	187,084	130,330	111,360	107,224	110,743	116,511	141,549	173,080	168,091	1,704,180
Pond Output Summary													
Pond Evaporation	-	-	-	-	899	1,020	1,178	961	690	403	-	-	5,151
Pond Discharge	153,588	136,442	168,178	187,084	129,431	110,340	106,046	109,782	115,821	141,146	173,080	168,091	1,699,029

Table 5-2 Water Balance for the East Settling Pond under Average Climate Conditions

East Settling Pond Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pond Input Summary													
Direct Precipitation	757	647	1,123	857	718	664	684	684	721	867	946	828	9,496
Till Stockpile Runoff	7,906	6,768	11,534	9,007	7,522	6,925	7,116	7,116	7,489	8,981	9,821	8,655	98,840
Organic Stockpile Runoff	7,315	6,247	10,849	8,277	6,939	6,410	6,610	6,604	6,962	8,379	9,139	8,001	91,732
Site Runoff	13,472	11,351	21,616	15,230	10,491	6,876	6,173	6,019	7,930	14,879	19,709	14,703	148,449
Total Inflow	29,450	25,011	45,122	33,371	25,670	20,874	20,584	20,422	23,101	33,107	39,616	32,188	348,516
Pond Output Summary													
Pond Evaporation	-	-	-	-	629	714	825	673	483	282	-	-	3,606
Pond Discharge	29,450	25,011	45,122	33,371	25,054	20,172	19,772	19,744	22,600	32,814	39,613	32,188	344,911

Table 5-3 Water Balance for the South Settling Pond under Average Climate Conditions

South Settling Pond Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pond Input Summary													
Direct Precipitation	757	647	1,123	857	718	664	684	684	721	867	946	828	9,496
Organic Stockpile Runoff	8,958	7,650	13,286	10,137	8,497	7,850	8,095	8,087	8,526	10,261	11,191	9,798	112,336
Site Runoff	530	453	786	600	503	465	479	479	505	607	662	580	6,647
Total Inflow	10,246	8,749	15,195	11,593	9,718	8,978	9,258	9,249	9,751	11,736	12,800	11,206	128,479
Pond Output Summary													
Pond Evaporation	-	-	-	-	629	714	825	673	483	282	-	-	3,606
Pond Discharge	10,246	8,749	15,195	11,593	9,123	8,277	8,441	8,570	9,245	11,446	12,782	11,206	124,873

Table 5-4 Water Balance for the Pit Lake under Average Climate Conditions

Pit Lake Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pit Lake Input Summary													
NAG Stockpile Runoff	35,430	31,445	38,776	44,489	35,295	30,869	30,008	30,486	31,244	35,195	40,302	39,336	422,875
PAG Stockpile Runoff	7,350	6,278	10,873	8,325	6,975	6,440	6,637	6,632	6,990	8,408	9,174	8,040	92,122
Site Runoff	22,267	18,826	35,033	25,179	18,314	13,463	12,758	12,563	15,188	24,828	31,352	24,316	254,087
Pit Wall Runoff	32,530	27,778	48,245	36,809	30,855	28,504	29,395	29,365	30,958	37,261	40,639	35,580	407,919
Groundwater	11,935	10,780	11,935	11,550	11,935	11,550	11,935	11,935	11,550	11,935	11,550	11,743	140,333
Pit Lake Inflow	109,511	95,107	144,861	126,351	103,373	90,826	90,734	90,981	95,930	117,628	133,016	119,015	1,317,333
Pit Lake Output Summary													
Lake Evaporation	-	-	-	-	25,352	28,764	33,220	27,100	19,458	11,365	-	-	145,259
Pit Lake Outflow	109,511	95,107	144,861	126,351	78,022	62,071	57,873	63,512	76,472	106,263	133,016	119,015	1,172,074

Table 5-5 Pit Filling Time Calculation

Stage Elevation	Surface Area	Volume	Ground-water Inflow	Precipitation Evaporation	Pit Wall Runoff	Surface Water Ditch Inflow	Time to Fill to Level
masl	m^2	m^3	m^3/day	m^3/day	m^3/day	m^3/day	days
127	250,679	15,922,102	393	576	0	2,107	-
120	233,141	14,234,298	531	536	55	2,107	535
110	205,312	12,047,184	574	472	143	2,107	670
100	189,323	10,065,681	582	435	193	2,107	599
90	163,450	8,309,266	584	376	275	2,107	528
80	150,309	6,740,655	587	346	316	2,107	468
70	127,595	5,351,578	588	293	388	2,107	413
60	115,159	4,137,642	590	265	427	2,107	359
50	90,705	3,104,288	591	208	504	2,107	304
40	74,025	2,284,510	592	170	557	2,107	240
30	55,930	1,638,735	593	129	614	2,107	188
20	46,784	1,124,288	594	108	643	2,107	149
10	32,266	731,422	594	74	689	2,107	114
0	24,826	449,162	594	57	712	2,107	81
-10	15,949	246,236	594	37	740	2,107	58
-20	10,808	112,633	595	25	756	2,107	38
-30	4,632	38,139	595	11	776	2,107	21
-45	0	0	595	0	792	2,107	11
Total (days)							**4,778**
Total (years)							**13.1**

5.2 Environmental Water Balance

5.2.1 WC-26

Table 5-6 presents the monthly and annual water balance results for the WC-26 assessment point for baseline, EOM, and PC conditions. Monthly streamflow volumes are highest in March and lowest in July, August and September.

The percent changes in monthly and annual surface runoff, baseflow, and streamflow volumes from baseline to EOM/PC conditions are presented in the tables. A positive value indicates an increase, and a negative value indicates a decrease in flow volume compared to baseline conditions.

The WBM predicts WC-26 will experience a decrease in surface runoff in EOM and PC conditions that is proportional to the reduction in catchment area due to the placement of stockpiles in its baseline catchment. Stockpile runoff will be directed to the north settling pond for treatment prior to discharge to the Killag River further downstream. The model shows a 28.1% decrease in surface runoff, 4.9% decrease in baseflow and 22.2% decrease in annual streamflow (-16.0 to -26.1%

monthly variation) between baseline and EOM conditions at the WC-26 assessment point. The impacts are moderately reduced between baseline and PC conditions, as the model simulates a 21.9% decrease in surface runoff, 4.9% decrease in baseflow and 17.5% decrease in annual streamflow (-13.0 to -20.4% monthly variation). This difference between EOM and PC conditions can be explained by the removal of the topsoil stockpile within the WC-26 catchment post-mine closure.

WC-26 is a tributary of the Killag River; therefore, the impacts of mine development in the WC-26 catchment on the Killag River were also assessed. Table 5-7 presents the WBM results for the Killag River at WC-26 assessment point. The model predicts a 1.1% decrease in annual streamflow (-0.8 to -1.3% monthly variation) between baseline and EOM conditions, and a 0.9% decrease in annual streamflow (-0.6 to -1.0% monthly variation) between baseline and PC conditions.

Table 5-6 Water Balance for the WC-26 Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	85,045	72,611	126,074	96,206	80,644	74,505	76,839	76,761	80,958	97,385	106,189	92,984	1,066,201
Evaporation over Catchment	5,538	6,853	12,545	22,240	40,202	59,420	74,831	61,373	35,949	19,748	9,829	6,198	354,726
Surface Runoff	51,873	43,384	86,681	58,618	35,583	16,108	11,149	10,256	20,325	56,134	81,938	56,551	528,600
Baseflow	20,917	20,863	24,055	23,426	19,503	14,839	12,114	10,640	7,444	6,586	7,691	14,326	182,404
Streamflow	72,790	64,248	110,736	82,044	55,087	30,947	23,263	20,896	27,768	62,719	89,629	70,877	711,004
EOM Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	61,133	52,195	90,626	69,156	57,969	53,556	55,234	55,178	58,195	70,004	76,332	66,840	766,417
Evaporation over Catchment	3,981	4,926	9,018	15,987	28,898	42,713	53,791	44,116	25,841	14,195	7,065	4,455	254,986
Surface Runoff	37,288	31,186	62,309	42,136	25,578	11,579	8,014	7,372	14,610	40,351	58,899	40,651	379,973
% Change from Baseline Conditions	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%	-28.1%
Baseflow	19,892	19,841	22,877	22,278	18,548	14,112	11,520	10,119	7,079	6,263	7,314	13,624	173,467
% Change from Baseline Conditions	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%
Streamflow	57,180	51,027	85,185	64,415	44,126	25,691	19,534	17,491	21,689	46,614	66,214	54,275	553,441
% Change from Baseline Conditions	-21.4%	-20.6%	-23.1%	-21.5%	-19.9%	-17.0%	-16.0%	-16.3%	-21.9%	-25.7%	-26.1%	-23.4%	-22.2%
PC Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	66,435	56,721	98,486	75,154	62,996	58,201	60,025	59,963	63,242	76,075	82,951	72,636	832,885
Evaporation over Catchment	4,326	5,354	9,800	17,373	31,404	46,417	58,456	47,942	28,082	15,426	7,678	4,841	277,099
Surface Runoff	40,522	33,891	67,712	45,790	27,797	12,583	8,709	8,012	15,877	43,850	64,008	44,176	412,927
% Change from Baseline Conditions	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%
Baseflow	19,891	19,841	22,877	22,278	18,548	14,112	11,520	10,119	7,076	6,260	7,313	13,624	173,459
% Change from Baseline Conditions	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%	-4.9%
Streamflow	60,413	53,731	90,589	68,069	46,344	26,695	20,229	18,130	22,889	50,111	71,333	57,800	586,333
% Change from Baseline Conditions	-17.0%	-16.4%	-18.2%	-17.0%	-15.9%	-13.7%	-13.0%	-13.2%	-17.6%	-20.1%	-20.4%	-18.5%	-17.5%

5.2.2 WC-5 and Crusher Lake

Table 5-8 presents the monthly and annual water balance results for the Crusher Lake outlet to WC-5 under baseline, EOM, and PC conditions.

Crusher Lake is part of the Mud Lake catchment. Its drainage area remains unchanged from baseline conditions throughout the mine development stages; however, the groundwater modelling results show a small increase in baseflow contributions to the lake in the order of 2-3% annually. The small gain in baseflow is likely attributed to the placement of the NAG waste rock and/or LGO stockpiles overtop of a watercourse in a neighbouring watershed. Under baseline conditions this watercourse would have collected baseflow prior to reaching the Crusher Lake catchment; however, under EOM and PC conditions, this portion of the baseflow emerges in the Crusher Lake catchment. In addition, during operations, water will be extracted from the lake at a rate of 3 m^3/hour to meet the domestic and truck wash water demands. The combined impact is a 4.4% decrease in annual lake discharge (-2.2 to -11.9% monthly variation) measured at the WC-5 US assessment point. In PC conditions, the Mine Site impact is reversed as water extraction from the lake is discontinued. The WBM simulates a 0.6% increase in annual lake discharge (0.2 to 1.3% monthly variation) at the WC-5 US assessment point post-closure.

Table 5-9 presents the monthly and annual water balance results for the WC-5 DS assessment point under baseline, EOM, and PC conditions. This assessment point is located immediately upstream of Mud Lake. The WBM predicts a 4.7% decrease in annual streamflow (-3.2 to -10.0% monthly variation) between baseline and EOM conditions, and a -1.2% decrease in annual streamflow (-0.8 to -1.4% monthly variation) between baseline and PC conditions at this assessment point.

Table 5-7 Water Balance for the Killag River at WC-26 Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	1,703,068	1,454,061	2,524,696	1,926,576	1,614,924	1,491,995	1,538,742	1,537,168	1,621,220	1,950,186	2,126,474	1,862,042	21,351,153
Evaporation over Catchment	110,892	137,241	251,220	445,369	805,055	1,189,910	1,498,521	1,229,012	719,898	395,453	196,822	124,110	7,103,503
Surface Runoff Volume	1,038,783	868,792	1,735,816	1,173,847	712,575	322,572	223,257	205,377	407,009	1,124,105	1,640,845	1,132,458	10,585,436
Baseflow Volume	418,865	417,794	481,722	469,122	390,562	297,159	242,585	213,069	149,066	131,878	154,016	286,885	3,652,723
Streamflow Volume	1,457,648	1,286,586	2,217,537	1,642,969	1,103,137	619,731	465,842	418,446	556,075	1,255,983	1,794,860	1,419,343	14,238,157
EOM Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	1,679,156	1,433,645	2,489,248	1,899,526	1,592,249	1,471,046	1,517,137	1,515,586	1,598,457	1,922,804	2,096,617	1,835,898	21,051,368
Evaporation over Catchment	109,363	135,349	247,756	439,229	793,956	1,173,506	1,477,861	1,212,068	709,973	390,001	194,108	122,399	7,005,569
Surface Runoff Volume	1,024,461	856,814	1,711,885	1,157,664	702,751	318,125	220,179	202,546	401,397	1,108,607	1,618,223	1,116,846	10,439,498
Percent Change from Baseline	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%
Baseflow Volume	417,840	416,772	480,543	467,974	389,607	296,432	241,991	212,548	148,701	131,556	153,639	286,183	3,643,786
Percent Change from Baseline	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Streamflow Volume	1,442,301	1,273,586	2,192,428	1,625,637	1,092,357	614,557	462,171	415,094	550,099	1,240,163	1,771,862	1,403,028	14,083,283
Percent Change from Baseline	-1.1%	-1.0%	-1.1%	-1.1%	-1.0%	-0.8%	-0.8%	-0.8%	-1.1%	-1.3%	-1.3%	-1.1%	-1.1%
PC Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	1,684,458	1,438,172	2,497,107	1,905,523	1,597,277	1,475,691	1,521,928	1,520,371	1,603,504	1,928,875	2,103,237	1,841,694	21,117,836
Evaporation over Catchment	109,708	135,776	248,538	440,615	796,462	1,177,210	1,482,526	1,215,894	712,214	391,232	194,721	122,786	7,027,682
Surface Runoff Volume	1,027,695	859,519	1,717,289	1,161,318	704,969	319,129	220,874	203,185	402,664	1,112,107	1,623,331	1,120,371	10,472,451
Percent Change from Baseline	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%	-1.1%
Baseflow Volume	417,840	416,772	480,543	467,974	389,607	296,432	241,991	212,548	148,701	131,556	153,639	286,183	3,643,786
Percent Change from Baseline	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Streamflow Volume	1,445,535	1,276,290	2,197,831	1,629,292	1,094,576	615,561	462,866	415,733	551,366	1,243,662	1,776,970	1,406,554	14,116,236
Percent Change from Baseline	-0.8%	-0.8%	-0.9%	-0.8%	-0.8%	-0.7%	-0.6%	-0.6%	-0.8%	-1.0%	-1.0%	-0.9%	-0.9%

Table 5-8 Water Balance for WC-5 Upstream Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	63,622	54,319	94,315	71,971	60,329	55,737	57,483	57,424	60,564	72,853	79,439	69,560	797,616
Evaporation over Catchment	3,826	4,735	8,667	15,364	31,818	45,640	56,997	46,723	27,940	15,456	6,790	4,282	268,238
Lake Input Summary													
Direct Precipitation	4,868	4,157	7,220	5,508	4,618	4,266	4,399	4,395	4,633	5,576	6,082	5,325	61,047
Surface Runoff	35,836	29,972	59,882	40,495	24,582	11,128	7,702	7,085	14,041	38,779	56,606	39,068	365,176
Net Baseflow	14,450	14,413	16,618	16,184	13,474	10,251	8,369	7,350	5,142	4,550	5,313	9,897	126,011
Total Inflow	55,154	48,542	83,721	62,188	42,674	25,645	20,470	18,830	23,816	48,905	68,001	54,289	552,235
Lake Output Summary													
Lake Evaporation	-	-	-	-	4,046	4,590	5,301	4,325	3,105	1,814	-	-	23,181
Lake Discharge	55,154	48,542	83,721	62,188	38,628	21,056	15,240	14,666	20,557	47,031	67,983	54,289	529,055

EOM Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	63,622	54,319	94,315	71,971	60,329	55,737	57,483	57,424	60,564	72,853	79,439	69,560	797,616
Evaporation over Catchment	3,826	4,735	8,667	15,364	31,818	45,640	56,997	46,723	27,940	15,456	6,790	4,282	268,238
Lake Input Summary													
Direct Precipitation	4,868	4,157	7,220	5,508	4,618	4,266	4,399	4,395	4,633	5,576	6,082	5,325	61,047
Surface Runoff	35,836	29,972	59,882	40,495	24,582	11,128	7,702	7,085	14,041	38,779	56,606	39,068	365,176
Net Baseflow	14,782	14,745	17,001	16,556	13,784	10,487	8,561	7,520	5,261	4,654	5,435	10,125	128,911
% Change from Baseline Conditions	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%	2.3%
Total Inflow	55,487	48,873	84,103	62,560	42,984	25,881	20,662	18,999	23,935	49,010	68,123	54,517	555,134
% Change from Baseline Conditions	0.6%	0.7%	0.5%	0.6%	0.7%	0.9%	0.9%	0.9%	0.5%	0.2%	0.2%	0.4%	0.5%
Lake Output Summary													
Lake Evaporation	-	-	-	-	4,046	4,590	5,301	4,325	3,105	1,814	-	-	23,181
Lake Discharge	53,255	46,857	81,871	60,400	36,706	19,181	13,485	12,928	18,537	44,629	65,539	52,320	505,708
% Change from Baseline Conditions	-3.4%	-3.5%	-2.2%	-2.9%	-5.0%	-8.9%	-11.5%	-11.9%	-9.8%	-5.1%	-3.6%	-3.6%	-4.4%
PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	63,622	54,319	94,315	71,971	60,329	55,737	57,483	57,424	60,564	72,853	79,439	69,560	797,616
Evaporation over Catchment	3,826	4,735	8,667	15,364	31,818	45,640	56,997	46,723	27,940	15,456	6,790	4,282	268,238
Lake Input Summary													
Direct Precipitation	4,868	4,157	7,220	5,508	4,618	4,266	4,399	4,395	4,633	5,576	6,082	5,325	61,047
Surface Runoff	35,836	29,972	59,882	40,495	24,582	11,128	7,702	7,085	14,041	38,779	56,606	39,068	365,176
Baseflow	14,797	14,759	17,017	16,572	13,797	10,497	8,570	7,527	5,266	4,659	5,441	10,135	129,037
% Change from Baseline Conditions	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%
Total Inflow	55,501	48,888	84,119	62,576	42,997	25,891	20,671	19,007	23,940	49,014	68,128	54,527	555,259
% Change from Baseline Conditions	0.6%	0.7%	0.5%	0.6%	0.8%	1.0%	1.0%	0.9%	0.5%	0.2%	0.2%	0.4%	0.5%
Lake Output Summary													
Lake Evaporation	-	-	-	-	4,046	4,590	5,301	4,325	3,105	1,814	-	-	23,181
Lake Discharge	55,501	48,888	84,119	62,576	38,952	21,302	15,436	14,839	20,686	47,142	68,111	54,527	532,079
% Change from Baseline Conditions	0.6%	0.7%	0.5%	0.6%	0.8%	1.2%	1.3%	1.2%	0.6%	0.2%	0.2%	0.4%	0.6%

Table 5-9 Water Balance for WC-5 Downstream Assessment Point under Average Climate Conditions

Baseline Streamflow Volume (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	89,698	76,583	132,972	101,470	85,055	78,581	81,043	80,960	85,387	102,713	111,998	98,071	1,124,530
Evaporation over Catchment	5,531	6,845	12,529	22,212	44,196	63,934	80,037	65,619	39,008	21,536	9,816	6,190	377,453
Crusher Lake Discharge	55,154	48,542	83,721	62,188	38,628	21,056	15,240	14,666	20,557	47,031	67,983	54,289	529,055
Surface Runoff Volume	15,971	13,358	26,688	18,048	10,956	4,959	3,433	3,158	6,258	17,283	25,228	17,411	162,751
Baseflow Volume	6,440	6,424	7,406	7,213	6,005	4,569	3,730	3,276	2,292	2,028	2,368	4,411	56,162
Streamflow Volume	77,565	68,323	117,815	87,448	55,589	30,585	22,402	21,100	29,107	66,341	95,579	76,111	747,965

EOM Streamflow Volume (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	88,399	75,474	131,047	100,001	83,824	77,443	79,870	79,788	84,151	101,226	110,377	96,651	1,108,252
Evaporation over Catchment	5,439	6,731	12,322	21,844	43,531	62,952	78,799	64,604	38,414	21,209	9,654	6,087	371,586
Crusher Lake Discharge	53,255	46,857	81,871	60,400	36,706	19,181	13,485	12,928	18,537	44,629	65,539	52,320	505,708
Percent Change from Baseline	-3.4%	-3.5%	-2.2%	-2.9%	-5.0%	-8.9%	-11.5%	-11.9%	-9.8%	-5.1%	-3.6%	-3.6%	-4.4%
Surface Runoff Volume	15,113	12,640	25,254	17,078	10,367	4,693	3,248	2,988	5,922	16,355	23,873	16,476	154,007
Percent Change from Baseline	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%
Baseflow Volume	6,060	6,045	6,969	6,787	5,651	4,299	3,510	3,083	2,157	1,908	2,228	4,151	52,848
Percent Change from Baseline	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%	-5.9%
Streamflow Volume	74,428	65,542	114,095	84,265	52,724	28,174	20,243	18,999	26,615	62,892	91,640	72,947	712,564
Percent Change from Baseline	-4.0%	-4.1%	-3.2%	-3.6%	-5.2%	-7.9%	-9.6%	-10.0%	-8.6%	-5.2%	-4.1%	-4.2%	-4.7%
PC Streamflow Volume (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	88,399	75,474	131,047	100,001	83,824	77,443	79,870	79,788	84,151	101,226	110,377	96,651	1,108,252
Evaporation over Catchment	5,439	6,731	12,322	21,844	43,531	62,952	78,799	64,604	38,414	21,209	9,654	6,087	371,586
Crusher Lake Discharge	55,501	48,888	84,119	62,576	38,952	21,302	15,436	14,839	20,686	47,142	68,111	54,527	532,079
Percent Change from Baseline	0.6%	0.7%	0.5%	0.6%	0.8%	1.2%	1.3%	1.2%	0.6%	0.2%	0.2%	0.4%	0.6%
Surface Runoff Volume	15,113	12,640	25,254	17,078	10,367	4,693	3,248	2,988	5,922	16,355	23,873	16,476	154,007
Percent Change from Baseline	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%
Baseflow Volume	6,092	6,077	7,006	6,823	5,681	4,322	3,528	3,099	2,168	1,918	2,240	4,173	53,127
Percent Change from Baseline	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%	-5.4%
Streamflow Volume	76,706	67,604	116,380	86,478	54,999	30,317	22,212	20,926	28,776	65,415	94,224	75,175	739,212
Percent Change from Baseline	-1.1%	-1.1%	-1.2%	-1.1%	-1.1%	-0.9%	-0.8%	-0.8%	-1.1%	-1.4%	-1.4%	-1.2%	-1.2%

5.2.3 WC-27 and Mud Lake

Table 5-10 presents the monthly and annual water balance results for Mud Lake outlet to WC-27 US under baseline, EOM, and PC conditions.

There is a 24.5% decrease in annual surface runoff, 21.9% decrease in baseflow, and 18.1% decrease in annual total inflow (-17.7 to -19.1% monthly variation) to Mud Lake between baseline and EOM conditions. There is a 19.1% decrease in annual surface runoff, 19.8% decrease in baseflow, and 13.6% decrease in annual total inflow (-13.2 to -13.8% monthly variation) to Mud Lake between baseline and PC conditions. In both development stages, the percent change in total inflow is less than the percent changes in surface runoff and baseflow contributions, because the Crusher Lake discharge is included in the total inflow volume, and the Crusher Lake discharge is less impacted by Mine Site development. The hydrologic impacts in the Mud Lake catchment result in a 18.3% and 13.7% decrease in annual Mud Lake discharge to the WC-27 US assessment point in EOM and PC conditions, respectively.

The changes in surface runoff volumes from baseline conditions are proportional to the reduction in drainage area due to stockpile and road development. The reduction in baseflow is caused by the change in drainage area and the formation of the open pit, which draws water from the local groundwater system. The decrease in surface runoff from baseline conditions is reduced between EOM and PC conditions, because the LGO stockpile will be removed and runoff from the restored area will be redirected to Mud Lake as per baseline conditions to reduce the environmental impact to Mud Lake as much as possible.

Although the results show there is a reduction in total inflow, and correspondingly, lake discharge under EOM and PC conditions, the lake water levels are not anticipated to drop below the invert of the outlet channel during EOM and PC conditions on a monthly basis (i.e., the outlet channel should never run dry). This is because the monthly lake inputs, including direct precipitation, Crusher Lake discharge through WC-5, surface runoff, and baseflow exceed the monthly losses by evaporation. As a result, the lake will continue to discharge to WC-27. However, water levels in the outlet channel, and therefore the lake, are anticipated to drop compared to baseline conditions as described in Section 5.2.3.1 below.

The WC-27 DS assessment point was included to evaluate the impact on WC-27 at its confluence with the Killag River. The results are presented in Table 5-11. The WBM simulates a 17.3% decrease in annual streamflow (-16.7 to -19.3% monthly variation) between baseline and EOM conditions, and a 13.0% decrease in annual streamflow (-12.8 to -13.7% monthly variation) between baseline and PC conditions. Table 5.12 presents the WBM results for the Killag River at WC-27 assessment point. The purpose of this assessment point is to simulate the hydrologic impacts of the mine development and water extractions in the WC-26 and WC-27 catchments on the Killag River. The WBM simulates a 3.1% decrease in annual streamflow (-3.0 to -3.3% monthly variation) between baseline and EOM conditions, and a 2.4% decrease in annual streamflow (-2.2 to -2.5% monthly variation) between baseline and PC conditions.

Table 5-10 Water Balance for WC-27 Upstream (Mud Lake Outlet) Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	241,502	206,192	358,013	273,197	229,003	211,571	218,200	217,977	229,896	276,545	301,543	264,046	3,027,686
Evaporation over Catchment	15,119	18,711	34,251	60,722	117,493	171,005	214,440	175,829	104,085	57,382	26,835	16,921	1,012,793
Lake Input Summary													
Direct Precipitation	4,435	3,788	6,578	5,019	4,207	3,887	4,008	4,004	4,221	5,081	5,541	4,851	55,620
Crusher Lake Discharge	55,154	48,542	83,721	62,188	38,628	21,056	15,240	14,666	20,557	47,031	67,983	54,289	529,055
Surface Runoff	105,792	88,480	176,780	119,547	72,570	32,852	22,737	20,916	41,451	114,482	167,108	115,332	1,078,047
Net Baseflow	42,658	42,549	49,060	47,777	39,776	30,263	24,705	21,700	15,181	13,431	15,685	29,217	372,002
Total Inflow	208,040	183,358	316,138	234,530	155,181	88,058	66,690	61,286	81,410	180,024	256,317	203,690	2,034,722
Lake Output Summary													
Lake Evaporation	-	-	-	-	3,686	4,182	4,830	3,940	2,829	1,652	-	-	21,119
Lake Discharge	208,040	183,358	316,138	234,530	151,496	83,876	61,860	57,347	78,583	178,371	256,314	203,690	2,013,603
EOM Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	199,088	169,979	295,136	225,216	188,784	174,414	179,878	179,694	189,520	227,976	248,584	217,672	2,495,942
Evaporation over Catchment	12,357	15,294	27,995	49,630	97,443	141,371	177,120	145,221	86,156	47,533	21,933	13,830	835,883
Lake Input Summary													
Direct Precipitation	4,435	3,788	6,578	5,019	4,207	3,887	4,008	4,004	4,221	5,081	5,541	4,851	55,620
Crusher Lake Discharge	53,255	46,857	81,871	60,400	36,706	19,181	13,485	12,928	18,537	44,629	65,539	52,320	505,708
Surface Runoff	79,922	66,843	133,550	90,313	54,824	24,818	17,177	15,801	31,314	86,486	126,243	87,129	814,420
% Change from Baseline Conditions	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%	-24.5%
Net Baseflow	33,316	33,231	38,316	37,313	31,065	23,636	19,295	16,947	11,857	10,489	12,250	22,818	290,533
% Change from Baseline Conditions	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%	-21.9%
Total Inflow	170,928	150,719	260,314	193,045	126,802	71,521	53,965	49,681	65,929	146,685	209,573	167,119	1,666,281
% Change from Baseline Conditions	-17.8%	-17.8%	-17.7%	-17.7%	-18.3%	-18.8%	-19.1%	-18.9%	-19.0%	-18.5%	-18.2%	-18.0%	-18.1%
Lake Output Summary													
Lake Evaporation	-	-	-	-	3,686	4,182	4,830	3,940	2,829	1,652	-	-	21,119
Lake Discharge	170,928	150,719	260,314	193,045	123,116	67,339	49,136	45,757	63,091	145,030	209,568	167,119	1,645,162
% Change from Baseline Conditions	-17.8%	-17.8%	-17.7%	-17.7%	-18.7%	-19.7%	-20.6%	-20.2%	-19.7%	-18.7%	-18.2%	-18.0%	-18.3%

PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	208,393	177,924	308,930	235,742	197,608	182,566	188,286	188,093	198,378	238,631	260,203	227,846	2,612,600
Evaporation over Catchment	12,963	16,043	29,367	52,063	101,842	147,872	185,307	151,936	90,090	49,694	23,008	14,508	874,693
Lake Input Summary													
Direct Precipitation	4,435	3,788	6,578	5,019	4,207	3,887	4,008	4,004	4,221	5,081	5,541	4,851	55,620
Crusher Lake Discharge	55,501	48,888	84,119	62,576	38,952	21,302	15,436	14,839	20,686	47,142	68,111	54,527	532,079
Surface Runoff	85,597	71,590	143,034	96,727	58,717	26,580	18,397	16,923	33,538	92,628	135,208	93,316	872,255
% Change from Baseline Conditions	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%	-19.1%
Net Baseflow	34,212	34,124	39,346	38,317	31,900	24,271	19,814	17,403	12,175	10,772	12,580	23,432	298,346
% Change from Baseline Conditions	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%	-19.8%
Total Inflow	179,746	158,389	273,077	202,638	133,776	76,040	57,654	53,170	70,621	155,622	221,440	176,126	1,758,299
% Change from Baseline Conditions	-13.6%	-13.6%	-13.6%	-13.6%	-13.8%	-13.6%	-13.5%	-13.2%	-13.3%	-13.6%	-13.6%	-13.5%	-13.6%
Lake Output Summary													
Lake Evaporation	-	-	-	-	3,686	4,182	4,830	3,940	2,829	1,652	-	-	21,119
Lake Discharge	179,746	158,389	273,077	202,638	130,090	71,858	52,825	49,244	67,785	153,968	221,435	176,126	1,737,181
% Change from Baseline Conditions	-13.6%	-13.6%	-13.6%	-13.6%	-14.1%	-14.3%	-14.6%	-14.1%	-13.7%	-13.7%	-13.6%	-13.5%	-13.7%

Table 5-11 Water Balance for WC-27 Downstream Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	255,785	218,386	379,186	289,354	242,546	224,084	231,105	230,868	243,492	292,900	319,376	279,661	3,206,742
Evaporation over Catchment	16,049	19,862	36,358	64,457	124,244	180,984	227,007	186,136	110,123	60,698	28,485	17,962	1,072,365
Mud Lake Discharge	208,040	183,358	316,138	234,530	151,496	83,876	61,860	57,347	78,583	178,371	256,314	203,690	2,013,603
Surface Runoff Volume	8,712	7,286	14,557	9,844	5,976	2,705	1,872	1,722	3,413	9,427	13,761	9,497	88,772
Baseflow Volume	3,513	3,504	4,040	3,934	3,275	2,492	2,034	1,787	1,250	1,106	1,292	2,406	30,633
Streamflow Volume	220,264	194,148	334,735	248,309	160,747	89,073	65,767	60,856	83,247	188,904	271,366	215,593	2,133,009
EOM Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	213,370	182,173	316,309	241,373	202,327	186,926	192,783	192,586	203,116	244,331	266,417	233,288	2,674,998
Evaporation over Catchment	13,287	16,444	30,102	53,365	104,195	151,350	189,687	155,527	92,194	50,850	23,584	14,871	895,456
Mud Lake Discharge	170,928	150,719	260,314	193,045	123,116	67,339	49,136	45,757	63,091	145,030	209,568	167,119	1,645,162
Percent Change from Baseline	-17.8%	-17.8%	-17.7%	-17.7%	-18.7%	-19.7%	-20.6%	-20.2%	-19.7%	-18.7%	-18.2%	-18.0%	-18.3%
Surface Runoff Volume	8,712	7,286	14,557	9,844	5,976	2,705	1,872	1,722	3,413	9,427	13,761	9,497	88,772
Percent Change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Baseflow Volume	3,513	3,504	4,040	3,934	3,275	2,492	2,034	1,787	1,250	1,106	1,292	2,406	30,633
Percent Change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Streamflow Volume	183,152	161,508	278,911	206,824	132,367	72,537	53,042	49,267	67,755	155,563	224,620	179,022	1,764,568
Percent Change from Baseline	-16.8%	-16.8%	-16.7%	-16.7%	-17.7%	-18.6%	-19.3%	-19.0%	-18.6%	-17.6%	-17.2%	-17.0%	-17.3%

PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	222,676	190,118	330,103	251,899	211,151	195,078	201,190	200,984	211,974	254,986	278,036	243,461	2,791,656
Evaporation over Catchment	13,893	17,194	31,474	55,798	108,593	157,851	197,874	162,243	96,127	53,011	24,659	15,549	934,266
Mud Lake Discharge	179,746	158,389	273,077	202,638	130,090	71,858	52,825	49,244	67,785	153,968	221,435	176,126	1,737,181
Percent Change from Baseline	-13.6%	-13.6%	-13.6%	-13.6%	-14.1%	-14.3%	-14.6%	-14.1%	-13.7%	-13.7%	-13.6%	-13.5%	-13.7%
Surface Runoff Volume	8,712	7,286	14,557	9,844	5,976	2,705	1,872	1,722	3,413	9,427	13,761	9,497	88,772
Percent Change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Baseflow Volume	3,513	3,504	4,040	3,934	3,275	2,492	2,034	1,787	1,250	1,106	1,292	2,406	30,633
Percent Change from Baseline	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Streamflow Volume	191,970	169,179	291,674	216,417	139,341	77,056	56,731	52,753	72,449	164,501	236,487	188,029	1,856,587
Percent Change from Baseline	-12.8%	-12.9%	-12.9%	-12.8%	-13.3%	-13.5%	-13.7%	-13.3%	-13.0%	-12.9%	-12.9%	-12.8%	-13.0%
*Note: Surface runoff and baseflow volumes are calculated from the catchment downstream of the Mud Lake outlet only.													

Table 5-12 Water Balance for the Killag River at WC-27 Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	2,016,523	1,721,686	2,989,375	2,281,169	1,912,156	1,766,601	1,821,953	1,820,089	1,919,611	2,309,124	2,517,859	2,204,757	25,280,904
Evaporation over Catchment	130,696	161,751	296,085	524,907	956,561	1,411,188	1,776,272	1,456,765	854,398	469,543	231,972	146,275	8,416,413
Surface Runoff Volume	1,290,710	1,088,856	2,125,291	1,457,971	894,176	420,076	294,550	271,401	502,787	1,349,968	1,966,483	1,383,993	13,046,262
Baseflow Volume	436,562	435,445	502,074	488,942	407,063	309,714	252,834	222,071	155,364	137,450	160,523	299,005	3,807,047
Streamflow Volume	1,727,272	1,524,301	2,627,364	1,946,913	1,301,239	729,790	547,384	493,472	658,151	1,487,418	2,127,006	1,682,998	16,853,308
EOM Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	1,950,197	1,665,057	2,891,050	2,206,138	1,849,262	1,708,495	1,762,026	1,760,224	1,856,472	2,233,174	2,435,042	2,132,239	24,449,376
Evaporation over Catchment	126,405	156,441	286,365	507,675	925,412	1,365,149	1,718,292	1,409,213	826,544	454,242	224,357	141,473	8,141,568
Surface Runoff Volume	1,239,013	1,044,017	2,045,095	1,400,005	855,791	399,011	278,690	256,928	481,581	1,300,844	1,896,698	1,331,522	12,529,195
Percent Change from Baseline	-4.0%	-4.1%	-3.8%	-4.0%	-4.3%	-5.0%	-5.4%	-5.3%	-4.2%	-3.6%	-3.5%	-3.8%	-4.0%
Baseflow Volume	435,537	434,423	500,895	487,794	406,108	308,987	252,240	221,550	154,999	137,127	160,146	298,303	3,798,109
Percent Change from Baseline	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Streamflow Volume	1,674,549	1,478,440	2,545,990	1,887,798	1,261,899	707,998	530,931	478,478	636,580	1,437,972	2,056,844	1,629,825	16,327,304
Percent Change from Baseline	-3.1%	-3.0%	-3.1%	-3.0%	-3.0%	-3.0%	-3.0%	-3.0%	-3.3%	-3.3%	-3.3%	-3.2%	-3.1%
PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	1,964,804	1,677,528	2,912,704	2,222,662	1,863,113	1,721,292	1,775,224	1,773,408	1,870,377	2,249,900	2,453,281	2,148,210	24,632,502
Evaporation over Catchment	127,357	157,618	288,519	511,495	932,317	1,375,354	1,731,145	1,419,754	832,719	457,634	226,045	142,538	8,202,495
Surface Runoff Volume	1,251,064	1,054,393	2,063,261	1,413,252	864,984	404,534	283,074	261,054	487,542	1,313,281	1,913,673	1,344,055	12,654,167
Percent Change from Baseline	-3.1%	-3.2%	-2.9%	-3.1%	-3.3%	-3.7%	-3.9%	-3.8%	-3.0%	-2.7%	-2.7%	-2.9%	-3.0%
Baseflow Volume	435,537	434,423	500,895	487,794	406,108	308,987	252,240	221,550	154,999	137,127	160,146	298,303	3,798,109
Percent Change from Baseline	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Streamflow Volume	1,686,601	1,488,816	2,564,156	1,901,046	1,271,091	713,521	535,315	482,603	642,541	1,450,408	2,073,819	1,642,358	16,452,275
Percent Change from Baseline	-2.4%	-2.3%	-2.4%	-2.4%	-2.3%	-2.2%	-2.2%	-2.2%	-2.4%	-2.5%	-2.5%	-2.4%	-2.4%

5.2.3.1 Crusher Lake and Mud Lake Water Level Assessment

The mine impacts to lake water levels were assessed by converting instantaneous (average daily) flow rates of the historical record to flow depths at the WC-5 and WC-27 US assessment points using the Manning's equation. The change in flow depths at the lake outlet assessment points were then used to estimate the change in lake water levels. Flow depths were computed for various flow statistics and compared between the mine development stages. The resulting flow depths are presented in Table 5-13 and Table 5-14 for Crusher Lake and Mud Lake, respectively.

Table 5-13 Flow Depth Comparison at the WC-5 Assessment Point

Flow Depth Statistic	Flow Depth (m)		
	Baseline Conditions	EOM Conditions	PC Conditions
Minimum	0.00	0.00	0.00
10th Percentile	0.04	0.00	0.04
25th Percentile	0.06	0.06	0.06
50th Percentile	0.10	0.09	0.10
75th Percentile	0.14	0.14	0.14
90th Percentile	0.18	0.18	0.18
Maximum	0.43	0.43	0.43
Mean	0.11	0.11	0.11

Table 5-14 Flow Depth Comparison at the WC-27 US Assessment Point

Flow Depth Statistic	Flow Depth (m)		
	Baseline Conditions	EOM Conditions	PC Conditions
Minimum	0.00	0.00	0.00
10th Percentile	0.07	0.05	0.06
25th Percentile	0.10	0.09	0.09
50th Percentile	0.16	0.15	0.15
75th Percentile	0.24	0.22	0.22
90th Percentile	0.32	0.28	0.29
Maximum	0.59	0.54	0.55
Mean	0.20	0.18	0.19

The results calculated at the WC-5 US assessment point show that the water extractions will have a small impact on flow depths and corresponding water levels in Crusher Lake. The results calculated at the WC-27 US assessment point show that water extractions and mine development cause the greatest impact to flow depth corresponding to the maximum instantaneous flow rate. It is estimated

that the maximum reductions in lake water levels will be 5 centimetres (cm) between baseline and EOM conditions and 4 cm between baseline and PC conditions.

5.2.4 Killag River

Table 5-15-Table 5-18 present monthly and annual water balance results for the remaining Killag River assessment points under baseline, EOM, and PC conditions.

Table 5-15 presents the streamflow volume components at the Killag River US assessment point, which is unimpacted by the Mine Site development and provides a reference point for the study.

Table 5.16 presents the streamflow volume components for the Killag River at Cameron Flowage assessment point. This point is located at the upstream extent of Cameron Flowage between the Killag River at WC-27 and Killag River at Pit assessment points, upstream of the proposed site discharge locations. The WBM simulates a 1.6% decrease in annual streamflow (-1.5 to -1.7% monthly variation) between baseline and EOM conditions, and a 1.2% decrease in annual streamflow (-1.1 to -1.3% monthly variation) between baseline and PC conditions.

Table 5.17 and Table 5.18 present the streamflow volume components for the Killag River at Pit and Killag River DS assessment points, which are located downstream of the site discharge locations. The WBM simulates a 2.8% increase in annual streamflow (0.8 to 9.9% monthly variation) and 2.2% increase in annual streamflow (0.3 to 9.1% monthly variation) between baseline and EOM conditions at the Killag River at Pit and Killag River DS assessment points, respectively. The increased streamflow volumes are attributed to increased surface runoff volumes due to the change in area and land cover at the Mine Site. The results show there is a reduction in baseflow caused by the formation of the open pit, which draws water from the local groundwater system. The results tables show the relative contributions of the north settling pond and east settling pond to the Killag River streamflow under average climate conditions.

The WBM simulates a 1.7% increase in annual streamflow (1.0 to 4.9% monthly variation) and 1.1% increase in annual streamflow (0.4 to 4.3% monthly variation) between baseline and PC conditions at the Killag River at Pit and Killag River DS assessment points, respectively, after the pit lake has formed. The differences between EOM and PC conditions can be explained by the proposed Mine Site modifications, including covering and removal of stockpiles and restoring areas to baseline conditions. Baseflow impacts are reduced because the open pit will be filled with water, reducing its capacity to draw water from the groundwater system compared to EOM conditions.

The impacts to the Killag River while the open pit fills with water were also assessed. The WBM simulates a 1.8% decrease in annual streamflow (-0.8 to -1.9% monthly variation) and a 2.2% decrease in annual streamflow (-1.1 to -2.4% monthly variation) between baseline and PC conditions at the Killag River at Pit and Killag River DS assessment points, respectively, during pit filling. The decrease in streamflow is caused by the reduction in drainage area, as a large portion of the Mine Site that drains to the Killag River under baseline conditions will be directed to the open pit to reduce the pit filling time. However, contingency measures will be in place to mitigate baseflow reduction in the Killag River during dry months of the pit filling period as described in the Baseflow Mitigation Assessment Memorandum (GHD, 2021d).

Table 5-15 Water Balance for the Killag River Upstream Assessment Point under Average Climate Conditions

Baseline, EOM, PC Volume (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	1,498,895	1,279,740	2,222,021	1,695,607	1,421,318	1,313,126	1,354,269	1,352,884	1,426,859	1,716,387	1,871,540	1,638,810	18,791,456
Evaporation over Catchment	97,598	120,788	221,102	391,976	708,540	1,047,257	1,318,870	1,081,671	633,592	348,044	173,226	109,231	6,251,895
Surface Runoff Volume	914,248	764,636	1,527,716	1,033,120	627,147	283,900	195,753	180,755	357,093	989,748	1,444,131	996,693	9,314,940
Baseflow Volume	368,635	367,700	423,966	412,879	343,738	261,533	213,343	187,354	131,051	115,991	135,520	252,474	3,214,184
Streamflow Volume	1,282,883	1,132,336	1,951,682	1,445,998	970,886	545,434	409,095	368,110	488,145	1,105,739	1,579,651	1,249,167	12,529,126

Table 5-16 Water Balance for the Killag River at Cameron Flowage Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	3,873,560	3,307,204	5,742,320	4,381,920	3,673,080	3,393,482	3,499,808	3,496,228	3,687,400	4,435,620	4,836,580	4,235,140	48,562,342
Evaporation over Catchment	251,613	311,399	570,016	1,010,540	1,834,398	2,708,674	3,410,269	2,796,888	1,639,379	900,748	446,588	281,606	16,162,118
Surface Runoff Volume	2,423,406	2,036,192	4,018,035	2,737,942	1,671,172	771,811	537,991	495,345	946,592	2,575,700	3,755,671	2,618,833	24,588,690
Baseflow Volume	893,295	891,011	1,027,346	1,000,475	832,935	633,738	517,350	454,403	317,906	281,251	328,463	611,826	7,789,999
Streamflow Volume	3,316,700	2,927,202	5,045,382	3,738,417	2,504,107	1,405,549	1,055,341	949,749	1,264,499	2,856,951	4,084,133	3,230,659	32,378,689
EOM Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	3,807,233	3,250,575	5,643,995	4,306,889	3,610,186	3,335,376	3,439,881	3,436,362	3,624,261	4,359,669	4,753,764	4,162,622	47,730,814
Evaporation over Catchment	247,323	306,089	560,296	993,309	1,803,249	2,662,635	3,352,289	2,749,336	1,611,525	885,447	438,973	276,804	15,887,275
Surface Runoff Volume	2,371,972	1,991,574	3,938,281	2,680,273	1,632,969	750,827	522,188	480,925	925,489	2,526,862	3,686,303	2,566,650	24,074,313
Percent Change from Baseline	-2.1%	-2.2%	-2.0%	-2.1%	-2.3%	-2.7%	-2.9%	-2.9%	-2.2%	-1.9%	-1.8%	-2.0%	-2.1%
Baseflow Volume	892,270	889,988	1,026,167	999,327	831,979	633,011	516,757	453,882	317,542	280,928	328,086	611,124	7,781,061
Percent Change from Baseline	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Streamflow Volume	3,264,242	2,881,563	4,964,448	3,679,601	2,464,948	1,383,839	1,038,945	934,807	1,243,031	2,807,790	4,014,389	3,177,773	31,855,376
Percent Change from Baseline	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.5%	-1.6%	-1.6%	-1.7%	-1.7%	-1.7%	-1.6%	-1.6%
PC Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	3,821,840	3,263,046	5,665,649	4,323,413	3,624,037	3,348,172	3,453,079	3,449,547	3,638,166	4,376,396	4,772,002	4,178,593	47,913,940
Evaporation over Catchment	248,274	307,266	562,451	997,128	1,810,154	2,672,840	3,365,142	2,759,877	1,617,700	888,839	440,661	277,868	15,948,200
Surface Runoff Volume	2,384,024	2,001,950	3,956,448	2,693,521	1,642,161	756,351	526,572	485,050	931,450	2,539,298	3,703,278	2,579,183	24,199,286
Percent Change from Baseline	-1.6%	-1.7%	-1.5%	-1.6%	-1.7%	-2.0%	-2.1%	-2.1%	-1.6%	-1.4%	-1.4%	-1.5%	-1.6%
Baseflow Volume	892,270	889,988	1,026,167	999,327	831,979	633,011	516,757	453,882	317,542	280,928	328,086	611,124	7,781,061
Percent Change from Baseline	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Streamflow Volume	3,276,293	2,891,938	4,982,615	3,692,848	2,474,140	1,389,362	1,043,329	938,932	1,248,992	2,820,227	4,031,363	3,190,307	31,980,346
Percent Change from Baseline	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.1%	-1.1%	-1.2%	-1.3%	-1.3%	-1.2%	-1.2%

Table 5-17 Water Balance for Killag River at Pit Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	4,072,215	3,476,814	6,036,814	4,606,646	3,861,454	3,567,516	3,679,295	3,675,532	3,876,508	4,663,100	5,084,624	4,452,339	51,052,858
Evaporation over Catchment	264,548	327,407	599,320	1,062,491	1,928,304	2,847,471	3,585,064	2,940,247	1,723,352	946,876	469,546	296,082	16,990,708
Surface Runoff Summary													
Mud Lake Outflow	208,040	183,358	316,138	234,530	151,496	83,876	61,860	57,347	78,583	178,371	256,314	203,690	2,013,603
North Pond Outflow	-	-	-	-	-	-	-	-	-	-	-	-	-
East Pond Outflow	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface Runoff	2,336,535	1,954,174	3,904,372	2,640,335	1,602,795	725,562	502,172	461,955	915,485	2,528,450	3,690,754	2,547,240	23,809,829
Total Surface Runoff	2,544,575	2,137,532	4,220,511	2,874,866	1,754,291	809,438	564,033	519,302	994,068	2,706,822	3,947,068	2,750,929	25,823,435
Net Baseflow	942,153	939,744	1,083,537	1,055,196	878,492	668,400	545,647	479,257	335,294	296,634	346,428	645,290	8,216,072
Streamflow	3,486,728	3,077,277	5,304,047	3,930,062	2,632,783	1,477,838	1,109,679	998,559	1,329,362	3,003,456	4,293,496	3,396,219	34,039,506
EOM Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	4,140,706	3,535,290	6,138,348	4,684,126	3,926,399	3,627,519	3,741,177	3,737,351	3,941,707	4,741,529	5,170,142	4,527,223	51,911,516
Evaporation over Catchment	274,043	332,596	607,448	1,051,285	1,914,639	2,809,576	3,530,918	2,898,458	1,709,691	950,697	477,408	306,274	16,863,033
Surface Runoff Summary													
Mud Lake Outflow	170,928	150,719	260,314	193,045	123,116	67,339	49,136	45,757	63,091	145,030	209,568	167,119	1,645,162
North Pond Outflow	153,588	136,442	168,178	187,084	129,431	110,340	106,046	109,782	115,826	141,146	173,078	168,091	1,699,032
East Pond Outflow	29,450	25,011	45,122	33,371	25,054	20,172	19,772	19,744	22,614	32,814	39,610	32,188	344,922
Surface Runoff	2,278,722	1,905,822	3,807,767	2,575,006	1,563,137	707,609	489,747	450,525	892,833	2,465,889	3,599,433	2,484,213	23,220,703
Total Surface Runoff	2,632,688	2,217,994	4,281,381	2,988,506	1,840,738	905,461	664,701	625,808	1,094,365	2,784,880	4,021,690	2,851,611	26,909,823
% Change from Baseline Conditions	3.5%	3.8%	1.4%	4.0%	4.9%	11.9%	17.8%	20.5%	10.1%	2.9%	1.9%	3.7%	4.2%
Net Baseflow	927,325	924,973	1,066,515	1,038,625	864,698	657,906	537,080	471,733	330,032	291,962	340,891	635,100	8,086,840
% Change from Baseline Conditions	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%
Streamflow	3,560,050	3,142,986	5,347,907	4,027,136	2,705,439	1,563,368	1,201,781	1,097,541	1,424,395	3,076,857	4,362,680	3,486,771	34,996,911
% Change from Baseline Conditions	2.1%	2.1%	0.8%	2.5%	2.8%	5.8%	8.3%	9.9%	7.1%	2.4%	1.6%	2.7%	2.8%

PC Volumes During Pit Filling (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	4,140,706	3,535,290	6,138,348	4,684,126	3,926,399	3,627,519	3,741,177	3,737,351	3,941,707	4,741,529	5,170,142	4,527,223	51,911,516
Evaporation over Catchment	289,362	347,091	633,051	1,079,248	1,952,425	2,859,309	3,593,005	2,949,797	1,745,100	977,164	498,483	323,123	17,247,158
Surface Runoff Summary													
Mud Lake Outflow	178,833	157,481	272,030	201,619	129,241	71,212	52,298	48,783	67,447	153,680	221,010	175,500	1,729,134
North Pond Discharge	-	-	-	-	-	-	9,393	9,393	9,090	-	-	-	27,876
Mine Pit Outflow	-	-	-	-	-	-	-	-	-	-	-	-	
East Pond Catchment Runoff	32,082	26,916	52,716	36,261	23,257	12,655	10,173	9,699	15,233	35,019	49,086	34,993	338,090
Surface Runoff	2,281,956	1,908,527	3,813,170	2,578,660	1,565,355	708,613	490,442	451,164	893,869	2,469,389	3,602,957	2,487,739	23,251,841
Total Surface Runoff	2,492,872	2,092,923	4,137,916	2,816,540	1,717,854	792,481	562,306	519,039	985,639	2,658,087	3,873,053	2,698,231	25,346,941
% Change from Baseline Conditions	-2.0%	-2.1%	-2.0%	-2.0%	-2.1%	-2.1%	-0.3%	-0.1%	-0.8%	-1.8%	-1.9%	-1.9%	-1.8%
Net Baseflow	927,325	924,973	1,066,515	1,038,625	864,698	657,906	537,080	471,733	330,032	291,962	340,891	635,100	8,086,840
% Change from Baseline Conditions	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%	-1.6%
Streamflow	3,420,197	3,017,896	5,204,431	3,855,164	2,582,552	1,450,387	1,099,386	990,772	1,315,671	2,950,049	4,213,944	3,333,331	33,433,780
% Change from Baseline Conditions	-1.9%	-1.9%	-1.9%	-1.9%	-1.9%	-1.9%	-0.9%	-0.8%	-1.0%	-1.8%	-1.9%	-1.9%	-1.8%
PC Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	4,140,706	3,535,290	6,138,348	4,684,126	3,926,399	3,627,519	3,741,177	3,737,351	3,941,707	4,741,529	5,170,142	4,527,223	51,911,516
Evaporation over Catchment	289,362	347,091	633,051	1,079,248	1,952,425	2,859,309	3,591,224	2,949,797	1,744,684	977,164	498,483	323,123	17,244,961
Surface Runoff Summary													-
Mud Lake Outflow	179,746	158,389	273,077	202,638	130,090	71,858	52,825	49,244	67,785	153,968	221,435	176,126	1,737,181
Mine Pit Outflow	109,511	95,107	144,861	126,351	78,022	62,071	57,873	63,512	76,489	106,263	133,013	119,015	1,172,088
East Pond Catchment Runoff	32,082	26,916	52,716	36,261	23,257	12,655	10,173	9,699	15,235	35,019	49,105	34,993	338,111
Surface Runoff	2,281,956	1,908,527	3,813,170	2,578,660	1,565,355	708,613	490,442	451,164	894,100	2,469,389	3,604,541	2,487,739	23,253,656
Total Surface Runoff	2,603,294	2,188,939	4,283,825	2,943,911	1,796,725	855,198	611,313	573,619	1,053,609	2,764,638	4,008,093	2,817,872	26,501,036
% Change from Baseline Conditions	2.3%	2.4%	1.5%	2.4%	2.4%	5.7%	8.4%	10.5%	6.0%	2.1%	1.5%	2.4%	2.6%
Net Baseflow	931,033	928,653	1,070,748	1,042,742	868,124	660,512	539,207	473,601	331,337	293,133	342,339	637,674	8,119,103
% Change from Baseline Conditions	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%	-1.2%
Streamflow	3,534,328	3,117,592	5,354,573	3,986,653	2,664,848	1,515,710	1,150,520	1,047,220	1,384,946	3,057,771	4,350,433	3,455,546	34,620,140
% Change from Baseline Conditions	1.4%	1.3%	1.0%	1.4%	1.2%	2.6%	3.7%	4.9%	4.2%	1.8%	1.3%	1.7%	1.7%

Table 5-18 Water Balance for Killag River Downstream Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	4,256,155	3,633,860	6,309,494	4,814,726	4,035,874	3,728,659	3,845,487	3,841,554	4,051,608	4,873,730	5,314,294	4,653,449	53,358,891
Evaporation over Catchment	276,525	342,230	626,453	1,110,593	2,015,253	2,975,988	3,746,912	3,072,986	1,801,105	989,587	490,804	309,487	17,757,923
Surface Runoff Summary													
Mud Lake Outflow	208,040	183,358	316,138	234,530	151,496	83,876	61,860	57,347	78,583	178,371	256,314	203,690	2,013,603
North Pond Outflow	-	-	-	-	-	-	-	-	-	-	-	-	-
East Pond Outflow	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface Runoff	2,448,729	2,048,008	4,091,849	2,767,117	1,679,757	760,401	526,285	484,137	959,444	2,649,860	3,867,973	2,669,551	24,953,111
Total Surface Runoff	2,656,769	2,231,366	4,407,988	3,001,647	1,831,252	844,277	588,146	541,484	1,038,027	2,828,231	4,124,287	2,873,241	26,966,715
Net Baseflow	987,393	984,868	1,135,565	1,105,864	920,675	700,495	571,847	502,270	351,394	310,878	363,062	676,275	8,610,586
Streamflow	3,644,162	3,216,235	5,543,553	4,107,511	2,751,927	1,544,772	1,159,993	1,043,753	1,389,421	3,139,108	4,487,350	3,549,515	35,577,300
EOM Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	4,300,409	3,671,643	6,375,098	4,864,788	4,077,837	3,767,429	3,885,471	3,881,497	4,093,735	4,924,406	5,369,550	4,701,834	53,913,695
Evaporation over Catchment	284,279	345,265	630,639	1,092,398	1,988,956	2,919,420	3,669,250	3,011,911	1,776,147	987,202	495,577	317,730	17,518,774
Surface Runoff Summary													
Mud Lake Outflow	170,928	150,719	260,314	193,045	123,116	67,339	49,136	45,757	63,091	145,030	209,568	167,119	1,645,162
North Pond Outflow	153,588	136,442	168,178	187,084	129,431	110,340	106,046	109,782	115,826	141,146	173,078	168,091	1,699,032
East Pond Outflow	29,450	25,011	45,122	33,371	25,054	20,172	19,772	19,744	22,614	32,814	39,610	32,188	344,922
Surface Runoff	2,374,615	1,986,022	3,968,004	2,683,366	1,628,917	737,387	510,357	469,484	930,405	2,569,658	3,750,904	2,588,754	24,197,873
Total Surface Runoff	2,728,580	2,298,195	4,441,619	3,096,867	1,906,518	935,238	685,310	644,767	1,131,937	2,888,649	4,173,161	2,956,151	27,886,992
% Change from Baseline Conditions	2.7%	3.0%	0.8%	3.2%	4.1%	10.8%	16.5%	19.1%	9.0%	2.1%	1.2%	2.9%	3.4%
Net Baseflow	970,961	968,478	1,116,667	1,087,460	905,353	688,837	562,330	493,911	345,546	305,704	357,020	665,020	8,467,287
% Change from Baseline Conditions	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%
Streamflow	3,699,541	3,266,673	5,558,285	4,184,326	2,811,871	1,624,076	1,247,640	1,138,678	1,477,483	3,194,353	4,530,181	3,621,171	36,354,278
% Change from Baseline Conditions	1.5%	1.6%	0.3%	1.9%	2.2%	5.1%	7.6%	9.1%	6.3%	1.8%	1.0%	2.0%	2.2%

PC Volumes During Pit Filling (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	4,300,409	3,671,643	6,375,098	4,864,788	4,077,837	3,767,429	3,885,471	3,881,497	4,093,735	4,924,406	5,369,550	4,701,834	53,913,695
Evaporation over Catchment	299,599	359,760	656,242	1,120,361	2,026,742	2,969,153	3,731,407	3,063,251	1,811,572	1,013,669	516,652	334,580	17,902,988
Surface Runoff Summary													
Mud Lake Outflow	178,833	157,481	272,030	201,619	129,241	71,212	52,298	48,783	67,447	153,680	221,010	175,500	1,729,134
North Pond Discharge	-	-	-	-	-	-	9,393	9,393	9,090	-	-	-	27,876
Mine Pit Outflow	-	-	-	-	-	-	-	-	-	-	-	-	
East Pond Catchment Runoff	32,082	26,916	52,716	36,261	23,257	12,655	10,173	9,699	15,233	35,019	49,086	34,993	338,090
Surface Runoff	2,377,849	1,988,727	3,973,408	2,687,021	1,631,135	738,391	511,052	470,123	931,432	2,573,158	3,754,361	2,592,279	24,228,936
Total Surface Runoff	2,588,764	2,173,124	4,298,154	2,924,900	1,783,634	822,259	582,916	537,998	1,023,201	2,761,856	4,024,457	2,802,771	26,324,034
% Change from Baseline Conditions	-2.6%	-2.6%	-2.5%	-2.6%	-2.6%	-2.6%	-0.9%	-0.6%	-1.4%	-2.3%	-2.4%	-2.5%	-2.4%
Net Baseflow	970,921	968,459	1,116,655	1,087,453	905,350	688,836	562,329	493,910	345,548	305,688	356,917	664,958	8,467,024
% Change from Baseline Conditions	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%	-1.7%
Streamflow	3,559,686	3,141,582	5,414,808	4,012,354	2,688,983	1,511,094	1,145,245	1,031,908	1,368,749	3,067,544	4,381,374	3,467,729	34,791,056
% Change from Baseline Conditions	-2.3%	-2.3%	-2.3%	-2.3%	-2.3%	-2.2%	-1.3%	-1.1%	-1.5%	-2.3%	-2.4%	-2.3%	-2.2%

PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	4,300,409	3,671,643	6,375,098	4,864,788	4,077,837	3,767,429	3,885,471	3,881,497	4,093,735	4,924,406	5,369,550	4,701,834	53,913,695
Evaporation over Catchment	299,599	359,760	656,242	1,120,361	2,026,742	2,969,153	3,729,556	3,063,251	1,811,140	1,013,669	516,652	334,580	17,900,705
Surface Runoff Summary													-
Mud Lake Outflow	179,746	158,389	273,077	202,638	130,090	71,858	52,825	49,244	67,785	153,968	221,435	176,126	1,737,181
Mine Pit Outflow	109,511	95,107	144,861	126,351	78,022	62,071	57,873	63,512	76,489	106,263	133,013	119,015	1,172,088
East Pond Catchment Runoff	32,082	26,916	52,716	36,261	23,257	12,655	10,173	9,699	15,235	35,019	49,105	34,993	338,111
Surface Runoff	2,377,849	1,988,727	3,973,408	2,687,021	1,631,135	738,391	511,052	470,123	931,672	2,573,158	3,756,012	2,592,279	24,230,827
Total Surface Runoff	2,699,187	2,269,140	4,444,062	3,052,272	1,862,504	884,976	631,923	592,578	1,091,181	2,868,406	4,159,564	2,922,412	27,478,205
% Change from Baseline Conditions	1.6%	1.7%	0.8%	1.7%	1.7%	4.8%	7.4%	9.4%	5.1%	1.4%	0.9%	1.7%	1.9%
Net Baseflow	974,812	972,320	1,121,097	1,091,774	908,945	691,570	564,561	495,870	346,917	306,917	358,437	667,658	8,500,878
% Change from Baseline Conditions	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%	-1.3%
Streamflow	3,673,999	3,241,460	5,565,159	4,144,045	2,771,449	1,576,546	1,196,484	1,088,448	1,438,098	3,175,323	4,518,001	3,590,071	35,979,083
% Change from Baseline Conditions	0.8%	0.8%	0.4%	0.9%	0.7%	2.1%	3.1%	4.3%	3.5%	1.2%	0.7%	1.1%	1.1%

5.2.5 Tent Brook

Table 5-19 presents the monthly and annual water balance results for the Tent Brook system assessment point under baseline, EOM, and PC conditions.

The WBM simulates a 1.1% decrease in annual streamflow (-3.1 to 6.7% monthly variation) at the Tent Brook system assessment point between baseline and EOM conditions. The net decrease in streamflow is caused by the diversion of runoff from the crusher pad and administrative building areas, (that are partially located in the Tent Brook catchment), toward the Killag River system. The variation in monthly flows is due to the placement of the organic material and topsoil stockpiles in the catchment of the Tent Brook assessment point. The model results also show a small reduction in baseflow caused by the reduced drainage area and effect of the open pit on the groundwater flow patterns.

The WBM simulates a 1.2% decrease in annual streamflow (-0.9 to -1.4% monthly variation) between baseline and PC conditions. The PC impacts are due to the diversion of runoff from the crusher pad and administrative building areas. The organic material and topsoil stockpiles will be removed PC.

5.2.6 WC-23 and Cope Brook

Table 5-20 presents the monthly and annual water balance results for the WC-23 assessment point for baseline, EOM, and PC conditions.

The WBM simulates a decrease in surface runoff in EOM and PC conditions, proportional to the reduction in catchment area due to the placement of the NAG waste rock stockpile. Surface runoff generated on the NAG waste rock stockpile will be directed to the north settling pond for treatment. The hydrologic impacts to WC-23 are predicted to be consistent between EOM and PC conditions. The model results show a 15.2% decrease in annual streamflow (-10.3 to -18.3% monthly variation) at the WC-23 assessment point between baseline and EOM/PC conditions.

Table 5.21 presents the streamflow volume components at the Cope Brook US assessment point, which is unimpacted by the Mine Site development and provides a reference point for the study.

Table 5.22 and Table 5.23 present the streamflow volume components for the Cope Brook DS #1 and Cope Brook DS #2 assessment points, which are both located downstream of the confluence of WC-23 with Cope Brook. The purpose of these assessment points is to evaluate the impacts of mine development in the WC-23 catchment on the Cope Brook system. The WBM simulates a 5.7% decrease in annual streamflow (-3.9 to -6.9% monthly variation) and 4.3% decrease in annual streamflow (-2.9 to -5.2% monthly variation) between baseline and EOM/PC conditions at the Cope Brook DS #1 and Cope Brook DS #2 assessment points, respectively.

Table 5-19 Water Balance for the Tent Brook System under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	331,308	282,868	491,145	374,789	314,161	290,247	299,341	299,035	315,386	379,382	413,676	362,235	4,153,572
Evaporation over Catchment	21,572	26,698	48,871	86,640	156,612	231,761	291,495	239,087	140,129	76,869	38,289	24,144	1,382,167
Surface Runoff	202,081	169,011	337,679	228,356	138,622	62,752	43,432	39,953	78,861	218,686	319,265	220,304	2,059,002
Baseflow	81,482	81,275	93,712	91,261	75,978	57,808	47,192	41,450	28,985	25,642	29,959	55,808	710,552
Streamflow	283,563	250,286	431,391	319,617	214,600	120,560	90,623	81,403	107,846	244,328	349,224	276,112	2,769,553
EOM Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation over Catchment	326,331	278,618	483,766	369,158	309,442	285,887	294,844	294,543	310,648	373,682	407,462	356,793	4,091,174
Evaporation over Catchment	26,765	30,524	55,332	87,943	151,533	220,410	276,220	227,637	136,205	79,040	43,942	29,783	1,365,334
Surface Runoff Summary													
South Pond Outflow	10,246	8,749	15,195	11,593	9,123	8,277	8,441	8,570	9,245	11,446	12,782	11,206	124,873
Surface Runoff	187,232	156,592	312,866	211,576	128,436	58,141	40,240	37,017	73,066	202,617	295,805	204,116	1,907,704
Total Surface Runoff	197,477	165,341	328,061	223,169	137,559	66,418	48,681	45,587	82,312	214,062	308,588	215,322	2,032,577
	-2.3%	-2.2%	-2.8%	-2.3%	-0.8%	5.8%	12.1%	14.1%	4.4%	-2.1%	-3.3%	-2.3%	-1.3%
Baseflow	81,156	80,950	93,337	90,896	75,674	57,577	47,003	41,284	28,869	25,540	29,839	55,585	707,710
% Change from Baseline Conditions	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
Streamflow	278,634	246,291	421,398	314,065	213,233	123,995	95,684	86,871	111,181	239,602	338,427	270,907	2,740,288
% Change from Baseline Conditions	-1.7%	-1.6%	-2.3%	-1.7%	-0.6%	2.8%	5.6%	6.7%	3.1%	-1.9%	-3.1%	-1.9%	-1.1%
PC Volumes (m3)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Precipitation	326,331	278,618	483,766	369,158	309,442	285,887	294,844	294,543	310,648	373,682	407,462	356,793	4,091,174
Evaporation	21,248	26,297	48,137	85,339	154,260	228,279	287,116	235,496	138,024	75,714	37,714	23,781	1,361,405
Surface Runoff Summary													
South Pond Catchment Runoff	-	-	-	-	-	-	-	-	-	-	-	-	-
Surface Runoff	199,045	166,472	332,606	224,925	136,539	61,809	42,779	39,353	77,676	215,401	314,469	216,995	2,028,069
Total Surface Runoff	199,045	166,472	332,606	224,925	136,539	61,809	42,779	39,353	77,676	215,401	314,469	216,995	2,028,069
% Change from Baseline Conditions	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%	-1.5%
Baseflow	81,156	80,950	93,337	90,896	75,674	57,577	47,003	41,284	28,869	25,540	29,839	55,585	707,710
% Change from Baseline Conditions	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
Streamflow	280,201	247,422	425,943	315,821	212,214	119,386	89,782	80,637	106,546	240,940	344,308	272,579	2,735,779
% Change from Baseline Conditions	-1.2%	-1.1%	-1.3%	-1.2%	-1.1%	-1.0%	-0.9%	-0.9%	-1.2%	-1.4%	-1.4%	-1.3%	-1.2%

Table 5-20 Water Balance for the WC-23 Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	196,708	167,947	291,607	222,523	186,527	172,328	177,728	177,546	187,254	225,250	245,612	215,069	2,466,099
Evaporation over Catchment	12,808	15,852	29,016	51,441	92,985	137,603	173,069	141,953	83,199	45,639	22,733	14,335	820,633
Surface Runoff	119,981	100,347	200,490	135,582	82,304	37,258	25,787	23,721	46,822	129,840	189,557	130,801	1,222,490
Baseflow	48,378	48,255	55,639	54,184	45,111	34,322	28,019	24,610	17,209	15,225	17,787	33,135	421,874
Streamflow	168,360	148,602	256,129	189,766	127,414	71,580	53,806	48,331	64,032	145,065	207,345	163,936	1,644,366

EOM Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	157,539	134,505	233,542	178,214	149,386	138,014	142,339	142,193	149,968	180,398	196,706	172,245	1,975,049
Evaporation over Catchment	10,258	12,695	23,239	41,198	74,470	110,204	138,608	113,688	66,632	36,552	18,207	11,481	657,232
Surface Runoff	96,091	80,366	160,569	108,585	65,915	29,839	20,652	18,998	37,499	103,987	151,813	104,756	979,070
% Change from Baseline Conditions	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%
Baseflow	47,701	47,580	54,860	53,426	44,479	33,842	27,627	24,265	16,968	15,011	17,538	32,671	415,968
% Change from Baseline Conditions	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%
Streamflow	143,792	127,946	215,429	162,010	110,395	63,681	48,279	43,263	54,467	118,998	169,351	137,427	1,395,038
% Change from Baseline Conditions	-14.6%	-13.9%	-15.9%	-14.6%	-13.4%	-11.0%	-10.3%	-10.5%	-14.9%	-18.0%	-18.3%	-16.2%	-15.2%
PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	157,539	134,505	233,542	178,214	149,386	138,014	142,339	142,193	149,968	180,398	196,706	172,245	1,975,049
Evaporation over Catchment	10,258	12,695	23,239	41,198	74,470	110,204	138,608	113,688	66,632	36,552	18,207	11,481	657,232
Surface Runoff	96,091	80,366	160,569	108,585	65,915	29,839	20,652	18,998	37,499	103,987	151,813	104,756	979,070
% Change from Baseline Conditions	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%	-19.9%
Baseflow	47,701	47,580	54,860	53,426	44,479	33,842	27,627	24,265	16,968	15,011	17,538	32,671	415,968
% Change from Baseline Conditions	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%	-1.4%
Streamflow	143,792	127,946	215,429	162,010	110,395	63,681	48,279	43,263	54,467	118,998	169,351	137,427	1,395,038
% Change from Baseline Conditions	-14.6%	-13.9%	-15.9%	-14.6%	-13.4%	-11.0%	-10.3%	-10.5%	-14.9%	-18.0%	-18.3%	-16.2%	-15.2%

Table 5-21 Water Balance for Cope Brook Upstream Assessment Point under Average Climate Conditions

Baseline, EOM, PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	272,989	233,075	404,689	308,815	258,860	239,155	246,648	246,396	259,869	312,600	340,857	298,471	3,422,424
Evaporation over Catchment	17,775	21,999	40,269	71,389	129,044	190,733	240,201	197,001	115,394	63,388	31,549	19,894	1,138,636
Surface Runoff Volume	166,509	139,261	278,238	188,159	114,220	51,706	35,786	32,920	65,240	180,185	263,015	181,524	1,696,763
Baseflow Volume	67,141	66,969	77,216	75,197	62,604	47,632	38,884	34,153	23,894	21,139	24,688	45,985	585,502
Streamflow Volume	233,650	206,230	355,454	263,355	176,824	99,338	74,671	67,074	89,134	201,324	287,702	227,510	2,282,266

Table 5-22 Water Balance for the Cope Brook Downstream #1 Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	520,334	444,255	771,364	588,622	493,403	455,845	470,128	469,647	495,327	595,835	649,696	568,905	6,523,360
Evaporation over Catchment	33,880	41,931	76,754	136,072	245,966	363,550	457,839	375,497	219,948	120,822	60,134	37,919	2,170,312
Surface Runoff Volume	317,377	265,440	530,339	358,642	217,711	98,555	68,211	62,748	124,352	343,445	501,323	345,997	3,234,140
Baseflow Volume	127,975	127,648	147,179	143,330	119,328	90,790	74,116	65,098	45,544	40,292	47,056	87,651	1,116,007
Streamflow Volume	445,351	393,087	677,518	501,972	337,039	189,345	142,328	127,847	169,896	383,737	548,379	433,648	4,350,147
EOM Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	481,165	410,814	713,299	544,313	456,262	421,531	434,739	434,294	458,041	550,983	600,790	526,080	6,032,311
Evaporation over Catchment	31,330	38,774	70,977	125,830	227,451	336,184	423,375	347,231	203,392	111,727	55,608	35,065	2,006,944
Surface Runoff Volume	293,486	245,459	490,418	331,645	201,323	91,136	63,077	58,025	114,992	317,592	463,586	319,952	2,990,691
Percent Change from Baseline	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%
Baseflow Volume	127,297	126,972	146,400	142,571	118,696	90,310	73,724	64,754	45,303	40,079	46,807	87,187	1,110,100
Percent Change from Baseline	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Streamflow Volume	420,783	372,430	636,818	474,216	320,019	181,446	136,801	122,779	160,294	357,671	510,393	407,139	4,100,789
Percent Change from Baseline	-5.5%	-5.3%	-6.0%	-5.5%	-5.0%	-4.2%	-3.9%	-4.0%	-5.7%	-6.8%	-6.9%	-6.1%	-5.7%

PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	481,165	410,814	713,299	544,313	456,262	421,531	434,739	434,294	458,041	550,983	600,790	526,080	6,032,311
Evaporation over Catchment	31,330	38,774	70,977	125,830	227,451	336,184	423,375	347,231	203,392	111,727	55,608	35,065	2,006,944
Surface Runoff Volume	293,486	245,459	490,418	331,645	201,323	91,136	63,077	58,025	114,992	317,592	463,586	319,952	2,990,691
Percent Change from Baseline	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%	-7.5%
Baseflow Volume	127,297	126,972	146,400	142,571	118,696	90,310	73,724	64,754	45,303	40,079	46,807	87,187	1,110,100
Percent Change from Baseline	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Streamflow Volume	420,783	372,430	636,818	474,216	320,019	181,446	136,801	122,779	160,294	357,671	510,393	407,139	4,100,789
Percent Change from Baseline	-5.5%	-5.3%	-6.0%	-5.5%	-5.0%	-4.2%	-3.9%	-4.0%	-5.7%	-6.8%	-6.9%	-6.1%	-5.7%

Table 5-23 Water Balance for the Cope Brook Downstream #2 Assessment Point under Average Climate Conditions

Baseline Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	692,372	591,140	1,026,400	783,238	656,537	606,561	625,566	624,926	659,097	792,836	864,505	757,002	8,680,180
Evaporation over Catchment	45,082	55,794	102,132	181,062	327,290	483,751	609,214	499,647	292,670	160,769	80,017	50,456	2,887,884
Surface Runoff Volume	422,311	353,202	705,685	477,220	289,693	131,140	90,764	83,495	165,467	456,998	667,075	460,394	4,303,444
Baseflow Volume	170,287	169,852	195,841	190,719	158,781	120,808	98,621	86,622	60,602	53,614	62,614	116,631	1,484,992
Streamflow Volume	592,598	523,053	901,526	667,939	448,474	251,948	189,385	170,117	226,069	510,612	729,689	577,025	5,788,435
EOM Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	653,203	557,698	968,335	738,929	619,396	572,247	590,177	589,573	621,811	747,984	815,599	714,177	8,189,130
Evaporation over Catchment	42,532	52,638	96,354	170,819	308,775	456,384	574,750	471,382	276,113	151,674	75,490	47,602	2,724,513
Surface Runoff Volume	398,420	333,221	665,764	450,223	273,305	123,721	85,629	78,771	156,106	431,145	629,338	434,349	4,059,992
Percent Change from Baseline	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%
Baseflow Volume	169,610	169,176	195,062	189,960	158,149	120,328	98,229	86,277	60,361	53,401	62,365	116,167	1,479,085
Percent Change from Baseline	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
Streamflow Volume	568,030	502,397	860,826	640,183	431,454	244,049	183,858	165,049	216,467	484,546	691,703	550,516	5,539,078
Percent Change from Baseline	-4.1%	-3.9%	-4.5%	-4.2%	-3.8%	-3.1%	-2.9%	-3.0%	-4.2%	-5.1%	-5.2%	-4.6%	-4.3%
PC Volumes (m3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation over Catchment	653,203	557,698	968,335	738,929	619,396	572,247	590,177	589,573	621,811	747,984	815,599	714,177	8,189,130
Evaporation over Catchment	42,532	52,638	96,354	170,819	308,775	456,384	574,750	471,382	276,113	151,674	75,490	47,602	2,724,513
Surface Runoff Volume	398,420	333,221	665,764	450,223	273,305	123,721	85,629	78,771	156,106	431,145	629,338	434,349	4,059,992
Percent Change from Baseline	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%	-5.7%
Baseflow Volume	169,610	169,176	195,062	189,960	158,149	120,328	98,229	86,277	60,361	53,401	62,365	116,167	1,479,085
Percent Change from Baseline	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
Streamflow Volume	568,030	502,397	860,826	640,183	431,454	244,049	183,858	165,049	216,467	484,546	691,703	550,516	5,539,078
Percent Change from Baseline	-4.1%	-3.9%	-4.5%	-4.2%	-3.8%	-3.1%	-2.9%	-3.0%	-4.2%	-5.1%	-5.2%	-4.6%	-4.3%

6. Recommendations for Mitigation

Similar to all modelling studies, the water balance modelling has inherent uncertainties. To address the uncertainties, AMNS will continuously monitor the site discharge locations during construction, operation, and post-mine closure to measure the impact of the proposed mine development on the receiving environment. The monitoring data will be used to update the models and adjust the water management system as required to mitigate impacts. The water management system will be designed with contingencies, including, but not limited to the following:

- The proposed mine development is anticipated to increase streamflow volumes in the Killag River. AMNS will ensure post-development peak discharge does not exceed baseline peak discharge in the Killag River by providing peak flow attenuation through the settling ponds.
- The WBM predicts a decrease in streamflow at the Killag River DS assessment point while the pit is being filled with water in PC conditions. AMNS will implement a circular pumping system that uses water collected in the open pit, (including groundwater that is drawn from the Killag River), to mitigate against baseflow reduction in the Killag River caused by the open pit during low flow periods as described in the Baseflow Mitigation Assessment (GHD, 2021d).
- The reclamation plan includes covering or removing mine infrastructure and restoring these areas to baselines conditions. In particular, the LGO stockpile will be removed in PC conditions, and the area that was occupied by the LGO stockpile will be restored and graded to drain to Mud Lake, as it does in baseline conditions.

7. Conclusion

The water balance analysis results presented in this document can be used to assess the impact of the proposed mine development on the receiving environment in terms of the change in surface runoff, baseflow, and streamflow at sixteen assessment points in the Killag River, Tent Brook, and Cope Brook systems. The results can be used to form the basis for development of mitigation measures to reduce the impact on aquatic habitats. Site runoff and Killag River streamflow volumes are also used as input to the predictive water quality analysis (2021b).

The WBM results predict 2.1% and 1.1% increases in annual streamflow at the Killag River DS assessment point due to mine development between baseline and EOM and PC conditions, respectively. The overall increase can be explained by the small increase in drainage area and the introduction of impervious surfaces on the Mine Site. The impacts to the Tent Brook system are expected to be small as the model results show 1.1-1.2% reductions in annual streamflow volumes at the Tent Brook assessment point between baseline and EOM and PC conditions. The model predicts a 5.7% decrease in annual streamflow at the Cope Brook DS #1 assessment point immediately downstream of the WC-23 confluence, and a 4.3% decrease in annual streamflow at the Cope Brook DS #2 assessment point.

The mine development and water extractions will also create hydrologic impacts to Crusher Lake and Mud Lake in the Killag River system. The WBM simulates a 4.4% decrease and 0.6% increase in annual streamflow at the Crusher Lake outlet (WC-5 US assessment point) between baseline and

EOM and PC conditions, respectively. Further downstream, the WBM simulates a 18.3% and 13.7% decrease in annual streamflow at the Mud Lake outlet (WC-27 US assessment point) between baseline and EOM and PC conditions, respectively. The mine impacts will have a small effect on water levels in Crusher Lake and will result in an estimated 4-5 cm decrease in water levels in Mud Lake during high flow events.

As part of the Mine Site reclamation plan, a large portion of the site runoff will be directed to the pit to create the pit lake. It is estimated to take approximately 13.1 years for the pit to fill with water. During this time, a 2.2% reduction in annual streamflow is anticipated in the Killag River at the downstream limit of impact.

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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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Appendix B
Stormwater Management Assessment Hydrological Modelling

Technical Memorandum

April 13, 2021

To:	Veronica Chisholm, Jim Mallard	Ref. No.:	088664
	<Original signed by>		
From:	Andrew Betts, P. Eng., Chris Muirhead, E.I.T./aj/8	Tel:	519-340-4408
cc:	Phillip Sheffield, Meghan Milloy, Melanie MacDonald		

Subject: **Stormwater Management Assessment – Hydrologic Modelling**
Beaver Dam Mine Water Management Plan
Marinette, Nova Scotia

1. Introduction

GHD Limited (GHD) was retained by Atlantic Mining Nova Scotia (AMNS) to develop a Mine Water Management Plan (MWMP) for the Beaver Dam Gold Mine (Mine) in Marinette, Halifax County (Site). The MWMP is being developed in support of the Environmental Impact Statement (EIS) and Feasibility Study (FS). As a part of the MWMP, GHD has completed hydrologic and hydraulic modelling of mine conditions during operations for the purpose of assisting the design of stormwater management (SWM) infrastructure for the Site for the full life cycle of the mine. This technical memorandum presents a summary of the hydrologic and hydraulic modelling performed for the Mine. The hydrologic and hydraulic modelling was completed to support the Predictive Water Quality Assessment (GHD, 2021b) and the Water Balance Analysis (GHD, 2021c) while also assessing the on-site stormwater runoff during operation of the mine site.

2. Site Background

The Mine Site comprises approximately 592 hectares (ha) of lakes, rivers and forested land that are in varying degrees of re-growth due to historical logging. The Site ultimately discharges to the Killag River, a tributary to the West River. The Killag River has an upstream contributing drainage area of approximately 3,933 ha. As such, both the on-site contributing drainage areas and the upstream contributing drainage areas were considered for this model.

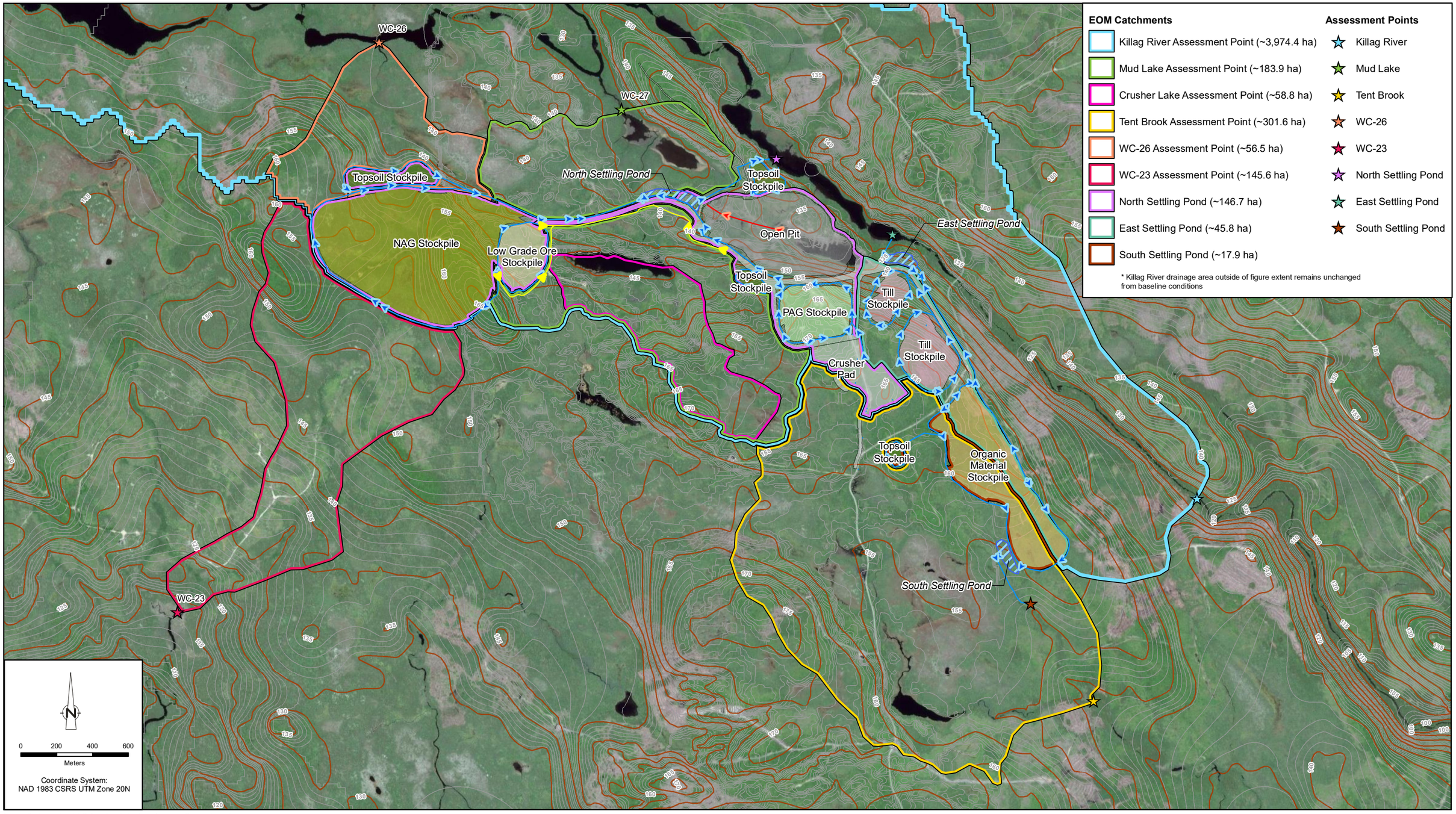
2.1 Data Collection

The following sections discuss the datasets that were collected to facilitate the hydrologic and hydraulic modelling.

2.1.1 Topographic Data

Contour datasets were used to delineate the catchment areas for the Mine Site and its upstream contributing drainage area.

A Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20 m digital elevation model (DEM) was used to generate contours for the off-site/upstream portion of the contributing drainage area. High-resolution Light Detection and Ranging (LiDAR) data was collected for the Mine Site by Leading Edge Geomatics by contract to GHD in 2015. The LiDAR data was used to generate on-site contours for areas which are not impacted by mine infrastructure. Proposed contours were developed to represent the topography of the proposed mine infrastructure in order to characterize the on-site subcatchments. The delineated subcatchments used in the hydrologic and hydraulic model are shown in Figure 2-1.



Source: CanVec Edition 1.1 © Department of Natural Resources Canada. All rights reserved;
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NOTES:
1. Mud Lake and Tent Brook Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

- Pumping Path
- SWM Ditches
- Clean Water Ditch
- Contours (5m)
- Contours (1m)
- Settling Ponds
- Crusher Pad
- Low Grade Stockpile
- NAG Stockpile
- Open Pit
- Organic Material Stockpile
- PAG Stockpile
- Road
- Topsoil Stockpile
- Till Stockpile

GHD

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
STORMWATER MANAGEMENT ASSESSMENT

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Feb 12, 2021

ON-SITE CONTRIBUTING DRAINAGE AREA - EOM CONDITIONS FIGURE 2-1

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\MEMO006\088664-27(MEMO006)GIS-WA001.mxd

2.2 Historic Soil Characteristics

The composition of the existing overburden in the delineated subcatchments were established via the Hydrogeological Modelling Report (GHD, 2021a). The existing overburden in the area around the Site consisted mostly of sandy loam with some portions of the Site consisting of shaly loam, peat, loam or sand. The drainage of the existing overburden soils ranged from poor to good, depending on the location. The historic soil characteristics were used to determine appropriate infiltration characteristics of the off-site and undisturbed on-site area of the delineated subcatchments.

2.3 Stockpile Runoff Characteristics

Several stockpiles are to be constructed as a part of mine operation. The stockpiles to be constructed include the following: potentially acid generating (PAG) waste rock stockpile, non-acid generating (NAG) waste rock stockpile, low grade ore (LGO) stockpile, organics stockpile, till stockpiles and topsoil stockpiles. Estimated average annual runoff coefficients for each stockpile were determined by Stantec (pers. comm., 2018) based on observations at the nearby Touquoy mine site. The estimated average annual runoff coefficients for each stockpile have been indicated in Table 2-1. These runoff coefficients were used to determine if the runoff and infiltration parameters selected for the stockpiles during the hydrologic modelling were reasonable.

Table 2-1 Runoff Coefficients for Stockpiles

Stockpile Type	Runoff Coefficient
NAG Waste Rock	0.05
PAG Waste Rock	0.05
Low Grade Ore	0.05
Till/Topsoil Stockpiles	0.49
Organics Stockpile	0.49

3. Hydrologic and Hydraulic Modelling Methodology

The Site was modelled using PCSWMM (Version 7.3.3095) which is a hydrologic and hydraulic modelling software that uses the EPA SWMM (Version 5.1.015) engine. PCSWMM allows for dynamic assessment of a stormwater network using the dynamic routing method. Dynamic routing allows for backflow conditions and accounts for different timing of outflows from each contributing drainage area. Additional modelling considerations include:

- Modelling of mine infrastructure components (stockpiles, Haul Road, crusher pad etc.) individually
- Estimated overland flow characteristics (slope, flow length etc.)

The purpose of the hydrologic and hydraulic modeling was to design the SWM infrastructure that is to be constructed on the Site during operation of the mine. The hydrologic and hydraulic modelling occurred in two phases (conceptual modelling and infrastructure design modelling) with both modelling phases occurring in

PCSWMM. The conceptual PCSWMM model was used initially for development of conceptual mine water infrastructure for the Site and incorporated the upstream contributing drainage area leading to the Killag River. This upstream contributing drainage area was used to determine the expected flows within the Killag River to support the Predictive Water Quality Assessment (GHD, 2021b) and the Water Balance Analysis (GHD, 2021c). The conceptual SWM layout included determining the approximate layout of the swale network across the site, determining settling pond locations and finalizing the discharge points from the Site.

Upon completion of the conceptual mine water infrastructure layout and the water quality and water balance studies, the model was transitioned to the second phase of development; infrastructure design modelling. The infrastructure design modelling was completed in support of a FS for the Beaver Dam Mine Site. The infrastructure design model incorporated updated mine infrastructure layouts (provided by Ausenco Limited) while increasing the detail of modelling with regards to the SWM swale network and the settling pond design. The groundwater seepage rates from the stockpiles and into the open pit based on the Site Hydrogeologic Study (GHD, 2021a) and the stockpile runoff characteristics discussed in Section 2.3 were also incorporated. The SWM infrastructure discussed in the following sections of this memo references the updated SWM infrastructure design and layout included in the infrastructure design modelling.

The SWM infrastructure proposed on the Site consists of a network of SWM swales and culverts leading to four settling ponds: north settling pond, east settling pond, south settling pond and west settling pond. The west settling pond will receive runoff water from the NAG stockpile, which will be treated for TSS and then be directed to the north pond for further treatment. The north settling pond is to receive all mine contact water from the PAG, NAG, LGO, crusher pad, pit and several topsoil piles. The north settling pond will treat the stormwater runoff for Total Suspended Solids (TSS) prior to discharge to an adjacent aeration lagoon (east of the north settling pond) for treatment of constituents of concern identified in the Predictive Water Quality Assessment (GHD, 2021b). The north settling pond emergency overflow spillway will discharge into the open pit so that if a large storm event were to occur, stormwater runoff would be contained within the Site. The east and south settling ponds are to treat the stormwater runoff for TSS prior to discharge.

To further mitigate impacts to fish and fish habitat downstream of the settling ponds during more frequent events, all pond outlet structures (including the aeration lagoon) will be equipped with emergency shut-off valves that will be closed if any water quality parameter exceedances are triggered. The ponds will be designed with freeboard to accommodate the inflow while the shut-off valves are closed. Any overflow from the north settling pond/aeration lagoon system will be directed to the pit until capacity for treatment becomes available. If the nitrite or metal concentration objectives are exceeded in the east or south settling ponds, the impacted water will be pumped, or collected in a vacuum truck, and transported to the north settling pond for further treatment. The Ontario Stormwater Management Planning and Design Manual (MOE, 2003) and British Columbia Technical Guidance 7 for the Design, Size, and Operation of Sediment Ponds Used in Mining (2015) were used to inform the settling pond design.

3.1 Design Storm Development and Application

The Environment Canada Intensity-Duration-Frequency (IDF) curve for Upper Stewiacke Climate Station (Climate ID: 8204193) was used to size the mine water infrastructure to convey up to the 100-year storm event. It was selected due to its proximity to the site of approximately 33 km. Specifically, 3 design storm

events, based off the Chicago Storm distribution and the Upper Stewiacke IDF curve, were used to size the mine water infrastructure for the site:

- 4-hour 25mm Chicago Storm – Water Quality
- 10-year 24-hour Chicago Storm – Water Quality
- 100-year 24-hour Chicago Storm – Water Quality & Water Quantity

To add contingency to the SWM design, the impacts due to climate change were considered when developing design storms. Nova Scotia Environment (NSE) provides climate change projections across the province for 30 year time periods termed the 2020s, 2050s and 2080s. Considering the mine will be in operation short-term (i.e. less than 15 years), the climate change projection for the 2020s was chosen. This 30-year period covers 2011-2040. The two climate regions nearest the Site (Halifax Regional Municipality and Truro) Mine a 5% increase in short period rainfall intensity for the 2020s according to NSE (2020). As such, a 5% increase to the historic IDF curve for the Upper Stewiacke Climate Station was incorporated to account for potential impacts due to climate change. Table 3-1 provides a summary of the design storms.

Table 3-1 Design Storm Events

	25mm 4-hour	10-year + 5% CC	100-year + 5% CC	Hurricane Beth
Precipitation (mm)	25.0	87.3	113.8	296.4
Duration (hr)	4	24	24	48
Distribution	Chicago	Chicago	Chicago	SCS-Type II

The 25mm 4-hour, 10-year and 100-year storm events were used to size the settling ponds in order to achieve a minimum 24-hour detention time to allow for settling of TSS within the settling ponds. The 100-year storm event was also used to size the SWM swales and culverts leading to the settling ponds. Hurricane Beth (as recorded by Halifax International Airport Climate Station (Climate ID: 8202251)) was modelled as a SCS Type II 48-hour storm event. Hurricane Beth was used to size the emergency spillway of the three settling ponds. The 10-year and 100-year storm events included a 5% increase in total precipitation to account for potential impacts due to climate change.

3.2 Modelling Parameters

The mine subcatchments delineated in PCSWMM consisted of 6 main land use types: waste rock stockpiles (including low grade ore), till stockpiles, topsoil stockpiles, organics material stockpile, the Haul Road and the crusher pad, and the open pit. Each land use type required different parameters in order to properly determine the estimated runoff from each catchment. The parameters used to model each land use type are shown in Table 3-2.

Table 3-2 Subcatchment Parameters

Land Use Type	% Impervious	N Imperv	N Perv	Depression Storage – Imperv	Depression Storage - Perv	Minimum Infiltration Rate (mm/hr)	Maximum Infiltration Rate (mm/hr)
Waste Rock	6	0.02	0.024	2.5	20.0	7.62	127.0
Till	15	0.02	0.050	2.5	5.0	3.30	25.4
Topsoil	4	0.02	0.050	2.5	5.0	3.30	25.4

Table 3-2 Subcatchment Parameters

Land Use Type	% Impervious	N Imperv	N Perv	Depression Storage – Imperv	Depression Storage - Perv	Minimum Infiltration Rate (mm/hr)	Maximum Infiltration Rate (mm/hr)
Organics	40	0.02	0.800	2.5	5.0	3.30	50.8
Haul Road + Crusher Pad	80	0.02	0.240	2.5	7.5	0.50	4.0
Open Pit	80	0.80	0.800	2.5	5.0	3.30	25.4

The parameters indicated in Table 3-2 were selected based on available references for modelling stockpiles and mine infrastructure. These parameters were adjusted based on professional judgement and the average annual runoff coefficients expected for each land use type, as indicated in Section 2.3. The expected average annual runoff coefficient for the individual stockpiles were compared to the modelled runoff coefficient for the 25mm 4-hour Chicago storm, a design storm which can be expected to occur yearly. The slopes and flow path lengths of the subcatchments were calculated based on proposed infrastructure contours for each subcatchment provided by Ausenco Limited.

The SWM swales, which are to convey the stormwater from the stockpiles to the respective settling ponds, are proposed to be open channel ditches. The ditches are to be lined with an HDPE liner to prevent infiltration, a sand layer and a surficial layer of riprap or gravel to prevent erosion. A Manning's roughness (n) of 0.035 was assumed for the ditches. There are a total of 10 culverts proposed on Site. The culverts are to be Corrugated Steel Pipe (CSP) with a Manning's n of 0.024.

The four settling ponds were added to the model as storage. Multiple orifices and/or weirs were added as required to achieve a minimum 24-hour detention time for the three water quality events (25mm 4-hour event, 10-year 24-hour event, and 100-year 24-hour event). An emergency spillway, designed to pass the Hurricane Beth design storm, was included for each settling pond. The north settling pond emergency spillway was directed to the pit as previously described.

Groundwater inflow into the open pit during operating conditions is assumed to be 605 m^3/day (GHD, 2021a). It was assumed that in addition to the daily groundwater inflow, the pit would provide some initial storage of rainfall during a storm event. Therefore, water which is continually pumped out of the pit during normal operations due to groundwater inflow was modelled as storage during a storm event. This was done to reflect assumed field operations and reduce the required north settling pond storage volume during the 100-year event. The ability to pump water from the north settling pond to the pit before and during a large storm event provides contingency against uncontrolled discharge to the environment. As storage becomes available, the water in the pit will be pumped back into the north settling pond for treatment before discharge. The settling ponds were sized iteratively, starting with the smallest water quality event, adjusting the orifices as required to achieve the design criteria. The model was also run simulating de-watering in the pit to evaluate pond performance during a rain fall event with ongoing pit de-watering activities.

4. Results

This section includes further information on the settling ponds that were incorporated into the infrastructure design PCSWMM model. Section 4.1 includes the settling pond dimensions while Section 4.2 discusses the

performance of the settling ponds for each design storm event. The output files from PCSWMM for the 100-year storm event can be found in Attachment A.

4.1 Settling Pond Infrastructure

Table 4-1 presents a summary of the dimensions for each settling pond. The settling ponds will consist of a forebay separated from the main settling basin by a rock filter berm. The rock filter berm will include a filter gravel core with a riprap layer covering the filter gravel. Non-woven geotextile will be placed between the gravel core and riprap layer. The berms are sized to extend above the permanent pool. The settling ponds will have side slopes of 3H:1V. The length to width ratio for each settling pond was maximized to the extent possible within the site constraints. The invert elevations are listed as metres above datum (mAD)

Table 4-1 Settling Pond Details and Dimensions

	North Settling Pond	East Settling Pond	South Settling Pond	West Settling Pond
Contributing Area (ha)	86.9	44.1	24.0	34.1
Surface Area (ha)	1.52	1.02	0.87	0.76
Volume (m^3)	48,438	36,834	22,880	19,980
Depth (m)	4.8	5.5	3.5	3.6
Permanent Pool Depth (m)	1.50	1.25	1.00	1.50
Active Storage Depth[1] (m)	2.60	3.25	2.00	1.60
Invert Elevation (mAD)	130	128	152	146

[1] Depth from top of permanent pool to emergency spillway invert; includes minimum 0.3 m freeboard

Each settling pond will be controlled by a multi-orifice outlet structure. Table 4-2 provides the outlet configurations and dimensions. Each settling pond will maintain a permanent pool to the level of the first low flow orifice and will control the three design storms with a minimum detention time of 24 hours. There will be a minimum of 0.3 m of freeboard between the 100-year design event and the emergency spillway invert. Above the 100-year event, the emergency spillway is designed to pass Hurricane Beth as described above, with side slopes of 3H:1V.

Table 4-2 Settling Pond Outlets

Outlet	Details	North Settling Pond	East Settling Pond	South Settling Pond	West Settling Pond
Rectangular multi-stage riser	Perimeter of top, horizontal, orifice (m)	5	5	8	5
Low flow orifice	Invert elevation (mAD)	131.50	129.25	153.00	147.75
	Diameter (m)	0.300	0.156	0.105	0.150

Table 4-2 Settling Pond Outlets

Outlet	Details	North Settling Pond	East Settling Pond	South Settling Pond	West Settling Pond
Slot orifice	Invert elevation (mAD)	131.65	n/a	153.05	n/a
	Area (m^2)	1.080	n/a	0.094	n/a
Orifice #2	Invert elevation (mAD)	n/a	129.35	n/a	147.90
	Diameter (m)	n/a	0.5	n/a	0.165
Orifice #3	Invert elevation (mAD)	n/a	129.50	n/a	n/a
	Diameter (m)	n/a	0.3	n/a	n/a
Emergency Spillway	Invert Elevation (mAD)	135.1	132.5	155.0	149.4
	Bottom width (m)	10	7	7	7
	Height (m)	0.7	1.0	0.5	0.5

4.2 Settling Pond Performance

The detention times, peak outflows, and modelled depths in the settling ponds for each design event are shown in Table 4-3.

Table 4-3 Settling Pond Performance

	25mm 4-hour	10-year 24-hour + 5% Climate Change (CC)	100-year 24-hour + 5% CC	Hurricane Beth 48-hour
North Settling Pond				
Detention Time (hr)	26	34	34	N/A
Peak Inflow (m^3/s)	1.3	4.4	12.6	20.0
Peak Outflow (m^3/s)	0.5	2.6	4.1	4.8 + 6.2[1]
Maximum Depth in Pond (m)	1.9	2.6	3.7	4.6
East Settling Pond				
Detention Time (hr)	24	32	32	N/A
Peak Inflow (m^3/s)	1.2	4.7	7.4	10.1
Peak Outflow (m^3/s)	0.3	1.0	1.4	6.3
Maximum Depth in Pond (m)	1.8	2.9	3.7	5.0
South Settling Pond				
Detention Time (hr)	26	34	36	N/A
Peak Inflow (m^3/s)	0.6	2.2	3.6	5.3
Peak Outflow (m^3/s)	0.1	0.4	0.6	3.8
Maximum Depth in Pond (m)	1.3	2.1	2.6	3.4
West Settling Pond				
Detention Time (hr)	25	32	37	N/A
Peak Inflow (m^3/s)	0.1	1.0	3.7	7.0

Table 4-3 Settling Pond Performance

	25mm 4-hour	10-year 24-hour + 5% Climate Change (CC)	100-year 24-hour + 5% CC	Hurricane Beth 48-hour
Peak Outflow (m^3/s)	0.004	0.1	0.34	3.8
Maximum Depth in Pond (m)	1.6	2.0	2.8	3.5
[1] Outflow is divided between the outlet (4.8 m^3/s) and the pit (6.2 m^3/s)				

The settling pond outlet structures will be fitted with gate valves to allow for complete control of outflow in the event of water quality issues in the pond discharge. Table 4-4 shows the storm event which can be contained by each settling pond with a fully closed outlet, and the associated freeboard. The east, south and west settling ponds can contain the 10-year 24-hour rain event with no outflow, while the north settling pond can contain up to the 5-year 24-hour event with no outflow. As noted earlier, discharge from the north settling pond/aeration lagoon system can also be re-directed to the pit through the emergency spillway and 2-way pump. Thus, the north settling pond and aeration lagoon can be completely controlled so that no untreated discharge from the north settling pond leaves the site.

Table 4-4 Settling Pond Performance with no Outflow

	North Settling Pond	East Settling Pond	South Settling Pond	West Settling Pond
Storm Event	5-year 24-hour	10-year 24-hour	10-year 24-hour	10-year 24-hour
Precipitation (mm)	75	83	83	83
Water Depth in Pond (m)	4.0	4.2	2.9	2.2
Freeboard[1] (m)	0.1	0.3	0.1	0.9
[1] to emergency spillway invert				

5. Conclusions

GHD developed a hydrologic and hydraulic model to determine the SWM requirements for the Beaver Dam Mine Site. The hydrologic and hydraulic model was initially used to perform conceptual design of the SWM infrastructure while supporting the Predictive Water Quality Assessment and Water Balance Analysis completed in 2020. Upon completion of the conceptual SWM infrastructure design and the water quality and water balance studies, the hydrologic and hydraulic model was used to perform design of the SWM infrastructure on Site in support of the Feasibility Study.

6. References

British Columbia Ministry of the Environment (2015). Technical Guidance 7 Environmental Management Act: Assessing the Design, Size, and Operation of Sediment Ponds Used in Mining. Version 1.0, December 2015.

GHD (2021a). Hydrogeologic Model Report, Beaver Dam Mine Site, Marinette, Nova Scotia

GHD (2021b). Predictive Water Quality Assessment, Beaver Dam Mine Site, Marinette, Nova Scotia

GHD (2021c). Water Balance Analysis, Beaver Dam Mine Site, Marinette, Nova Scotia

Nova Scotia Environment (NSE). 2020. Climate Data for Nova Scotia. Accessed October 19, 2020. https://climatechange.novascotia.ca/climate-data.

Ontario Ministry of the Environment (2003). Stormwater Management Planning and Design Manual, March 2003.

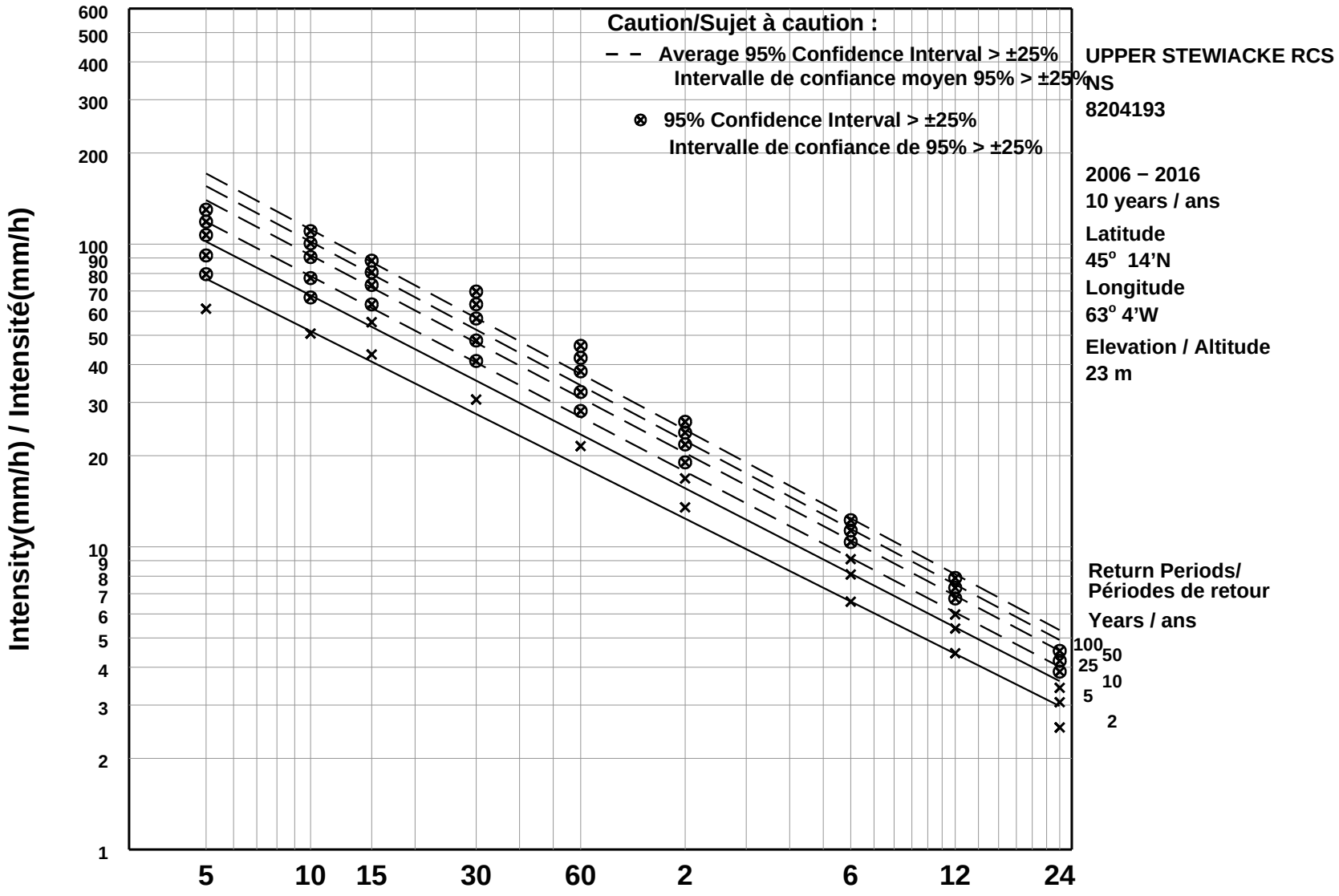
Stantec (2018). E-mail communication with Jonathan Keizer on October 16, 2018

Attachment A

Short Duration Rainfall Intensity−Duration−Frequency Data

2020/03/27

Données sur l’intensité, la durée et la fréquence des chutes de pluie de courte durée



Environment Canada Environnement Canada

Canada

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.015)

Beaver Dam Mine SWM Infrastructure

****
Element Count
****
Number of rain gages 27
Number of subcatchments ... 123
Number of nodes 150
Number of links 164
Number of pollutants 0
Number of land uses 0

****
Raingage Summary
****

Name	Data Source	Data Type	Recording Interval
Aug01-Oct12	Aug01-Oct12	INTENSITY	60 min.
Beth_SCS_Type_II_296.4mm_48h	Beth_SCS_Type_II_296.4mm_48h	INTENSITY	30 min.
Combined_Flows	Combined_Flows	INTENSITY	60 min.
Precip_High	Precip_High	INTENSITY	60 min.
Precip_Low	Precip_Low	INTENSITY	60 min.
SCS_Type_III_108.5mm_25YR	SCS_Type_III_108.5mm_25YR	INTENSITY	15 min.
SCS_Type_III_113.8mm_100yrCC	SCS_Type_III_113.8mm_100yrCC	INTENSITY	6 min.
SCS_Type_III_117.5mm_50YR	SCS_Type_III_117.5mm_50YR	INTENSITY	15 min.
SCS_Type_III_126.5mm_100YR	SCS_Type_III_126.5mm_100YR	INTENSITY	15 min.
SCS_Type_III_72.1mm_2YR	SCS_Type_III_72.1mm_2YR	INTENSITY	15 min.
SCS_Type_III_86.6mm_5YR	SCS_Type_III_86.6mm_5YR	INTENSITY	15 min.
SCS_Type_III_87.25mm_10yrCC	SCS_Type_III_87.25mm_10yrCC	INTENSITY	6 min.
SCS_Type_III_96.3mm_10YR	SCS_Type_III_96.3mm_10YR	INTENSITY	15 min.
UpperStew_100yr_24h_5percentCC	UpperStew_100yr_24h_5percentCC	INTENSITY	5 min.
UpperStew_100yr_24h_noCC	UpperStew_100yr_24h_noCC	INTENSITY	5 min.
UpperStew_100yr_6h_noCC	UpperStew_100yr_6h_5percentCC	INTENSITY	5 min.
UpperStew_10yr_24h_5percentCC	UpperStew_10yr_24h_5percentCC	INTENSITY	5 min.
UpperStew_10yr_24h_noCC	UpperStew_10yr_24h_noCC	INTENSITY	5 min.
UpperStew_25yr_24h_5percentCC	UpperStew_25yr_24h_5percentCC	INTENSITY	5 min.
UpperStew_25yr_24h_noCC	UpperStew_25yr_24h_noCC	INTENSITY	5 min.
UpperStew_2yr_24h_5percentCC	UpperStew_2yr_24h_5percentCC	INTENSITY	5 min.
UpperStew_2yr_24h_noCC	UpperStew_2yr_24h_noCC	INTENSITY	5 min.

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UpperStew_4h_25mm    UpperStew_4h_25mm              INTENSITY    5 min.
UpperStew_50yr_24h_5percentCC UpperStew_50yr_24h_5percentCC  INTENSITY    5 min.
UpperStew_50yr_24h_noCC UpperStew_50yr_24h_noCC        INTENSITY    5 min.
UpperStew_5yr_24h_5percentCC UpperStew_5yr_24h_5percentCC   INTENSITY    5 min.
UpperStew_5yr_24h_noCC UpperStew_5yr_24h_noCC         INTENSITY    5 min.


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Subcatchment Summary
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Name	Area	Width	%Imperv	%Slope	Rain Gage	Outlet
BD100_1	19.51	343.72	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD400
BD100_2	14.63	455.89	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD401
BD101_1	7.40	160.18	6.00	20.0000	UpperStew_100yr_24h_5percentCC	J18
BD101_2	5.33	160.17	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD401_2
BD102_1	4.50	161.20	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD402
BD102_2	7.31	232.74	6.00	20.0000	UpperStew_100yr_24h_5percentCC	J5
BD103	1.89	233.30	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD403
BD104	11.79	228.39	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD404
BD105	1.79	101.80	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD405
BD106	2.62	192.69	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD406
BD108	3.00	167.80	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD408
BD109	2.30	127.27	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD409
BD111	0.74	130.57	95.00	2.0000	UpperStew_100yr_24h_5percentCC	BD412
BD115	10.25	652.55	31.00	3.0000	UpperStew_100yr_24h_5percentCC	BD415
BD120	0.71	82.76	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD420
BD121	0.58	67.86	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD421
BD123_2	0.64	132.90	95.00	2.0000	UpperStew_100yr_24h_5percentCC	BD423_2
BD123_3	1.63	144.47	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD423
BD123_4	0.56	111.36	20.00	2.3000	UpperStew_100yr_24h_5percentCC	BD423_2
BD123_5	0.53	122.88	95.00	2.0000	UpperStew_100yr_24h_5percentCC	BD423_3
BD123_6	0.27	91.03	20.00	2.3000	UpperStew_100yr_24h_5percentCC	BD423_3
BD123_7	1.38	86.37	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD423_3
BD124_2	0.59	97.55	95.00	2.0000	UpperStew_100yr_24h_5percentCC	BD424
BD124_3	1.96	111.98	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD424
BD124_4	0.40	133.27	20.00	3.5000	UpperStew_100yr_24h_5percentCC	BD424
BD126_1	1.89	125.81	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD426
BD126_2	0.91	126.89	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD426
BD127_1	0.82	144.61	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD427
BD127_2	1.42	88.93	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD427_2
BD127_4	0.25	98.64	20.00	1.0000	UpperStew_100yr_24h_5percentCC	BD427
BD127_5	0.49	147.49	20.00	2.0000	UpperStew_100yr_24h_5percentCC	BD427_2
BD127_6	1.16	192.80	95.00	2.0000	UpperStew_100yr_24h_5percentCC	BD427_2
BD127_7	1.50	115.14	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD427
BD128_1	0.35	84.45	95.00	1.5000	UpperStew_100yr_24h_5percentCC	BD428_2

BD128_2	0.27	113.04	20.00	2.2000	UpperStew_100yr_24h_5percentCC	BD428
BD128_4	1.60	122.98	6.00	20.0000	UpperStew_100yr_24h_5percentCC	BD428
BD128_5	0.23	75.67	20.00	1.0000	UpperStew_100yr_24h_5percentCC	BD428
BD130_1	2.17	197.70	95.00	3.0000	UpperStew_100yr_24h_5percentCC	BD430
BD130_2	1.01	144.49	95.00	2.6000	UpperStew_100yr_24h_5percentCC	BD490
BD132	1.11	201.38	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD432
BD133_1	1.42	117.64	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD435_1
BD133_2	0.19	55.38	95.00	1.0000	UpperStew_100yr_24h_5percentCC	J10
BD133_4	0.26	70.08	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD435
BD133_5	0.21	55.81	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD433
BD138_1	1.41	176.80	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD439
BD138_2	0.96	159.80	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD143
BD139_2	0.64	103.50	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD439
BD139_3	1.46	107.66	5.00	1.0000	UpperStew_100yr_24h_5percentCC	BD435
BD139_4	1.15	134.98	5.00	1.0000	UpperStew_100yr_24h_5percentCC	BD439
BD142_1	1.64	149.06	25.00	2.0000	UpperStew_100yr_24h_5percentCC	BD448
BD142_2	0.50	33.11	25.00	5.0000	UpperStew_100yr_24h_5percentCC	BD445
BD143	2.64	306.65	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD423
BD146_1	1.18	267.70	30.00	6.0000	UpperStew_100yr_24h_5percentCC	BD446
BD146_2	1.66	166.00	95.00	2.0000	UpperStew_100yr_24h_5percentCC	BD446_2
BD146_3	1.06	91.49	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD446
BD146_4	0.84	66.79	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD446_3
BD148_2	1.21	90.81	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD448
BD149_2	0.57	157.78	25.00	4.0000	UpperStew_100yr_24h_5percentCC	BD449
BD149_3	0.75	67.28	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD450
BD149_4	0.33	111.13	25.00	5.0000	UpperStew_100yr_24h_5percentCC	BD450
BD149_5	1.01	90.03	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD449
BD151_1	0.52	65.19	20.00	4.0000	UpperStew_100yr_24h_5percentCC	BD451
BD151_3	0.89	70.56	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD451
BD151_4	0.43	82.14	95.00	2.0000	UpperStew_100yr_24h_5percentCC	J12
BD151_5	0.38	93.82	95.00	3.0000	UpperStew_100yr_24h_5percentCC	BD446_3
BD152_1	1.36	194.87	95.00	2.0000	UpperStew_100yr_24h_5percentCC	J11
BD152_3	2.29	246.22	30.00	5.0000	UpperStew_100yr_24h_5percentCC	BD452
BD152_4	1.03	87.94	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD453
BD154_1	1.67	112.23	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD455
BD154_3	1.01	68.07	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD454
BD154_4	1.25	131.77	30.00	4.0000	UpperStew_100yr_24h_5percentCC	BD454
BD156_1	2.34	144.69	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD456
BD156_2	3.57	256.99	40.00	1.0000	UpperStew_100yr_24h_5percentCC	BD456
BD157_1	2.27	157.40	30.00	1.0000	UpperStew_100yr_24h_5percentCC	BD457
BD157_3	1.42	100.18	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD457
BD157_4	1.94	136.50	15.00	20.0000	UpperStew_100yr_24h_5percentCC	BD458
BD157_5	0.60	40.19	30.00	4.0000	UpperStew_100yr_24h_5percentCC	BD458
BD159_2	4.49	295.31	40.00	20.0000	UpperStew_100yr_24h_5percentCC	BD459
BD161_1	0.31	60.10	30.00	2.0000	UpperStew_100yr_24h_5percentCC	BD461
BD161_2	0.67	142.34	95.00	1.0000	UpperStew_100yr_24h_5percentCC	BD483

BD162	2.48	253.07	40.00	20.0000	UpperStew_100yr_24h_5percentCC	BD462
BD163	4.74	329.04	40.00	20.0000	UpperStew_100yr_24h_5percentCC	BD463
BD166_1	0.54	175.23	30.00	4.0000	UpperStew_100yr_24h_5percentCC	BD466
BD166_2	4.35	129.99	40.00	20.0000	UpperStew_100yr_24h_5percentCC	BD466
BD168_1	10.33	421.76	40.00	20.0000	UpperStew_100yr_24h_5percentCC	BD468
BD168_2	0.26	87.03	30.00	0.6000	UpperStew_100yr_24h_5percentCC	BD468
BD169	5.12	320.22	40.00	20.0000	UpperStew_100yr_24h_5percentCC	BD469
BD171	0.40	46.28	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD471
BD173	0.72	83.17	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD473
BD175	0.60	100.77	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD475
BD176	0.44	73.88	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD476
BD177	0.74	59.95	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD477
BD179	0.49	57.99	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD479
BD180	1.61	112.41	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD480
BD181	1.58	211.23	4.00	20.0000	UpperStew_100yr_24h_5percentCC	BD481
BD181_1	1.53	203.71	4.00	20.0000	UpperStew_100yr_24h_5percentCC	J6
BD181_2	1.51	209.46	4.00	20.0000	UpperStew_100yr_24h_5percentCC	J7
BD1EastPond	1.01	60.00	100.00	0.0500	UpperStew_100yr_24h_5percentCC	EastPond
BD1NorthPond	1.33	63.50	100.00	0.0500	UpperStew_100yr_24h_5percentCC	NorthPond
BD1SouthPond	0.87	51.00	100.00	0.0500	UpperStew_100yr_24h_5percentCC	SouthPond
BDPit	28.97	1053.52	80.00	30.0000	UpperStew_100yr_24h_5percentCC	Pit_Storage
CL101	100.59	1596.89	35.00	3.0000	UpperStew_100yr_24h_5percentCC	Crusher_Lake
CL102	10.70	427.80	31.00	0.5000	UpperStew_100yr_24h_5percentCC	CL400
KR100	209.04	910.00	6.00	1.8200	UpperStew_100yr_24h_5percentCC	KR400
KR101	113.05	714.95	12.00	0.8300	UpperStew_100yr_24h_5percentCC	KR401
KR102	185.33	830.00	56.00	0.1700	UpperStew_100yr_24h_5percentCC	WestLake
KR103	389.95	1581.07	4.00	1.3600	UpperStew_100yr_24h_5percentCC	KR402
KR104	469.63	1253.13	14.00	0.4300	UpperStew_100yr_24h_5percentCC	KR405
KR105	147.63	1153.32	21.00	0.5900	UpperStew_100yr_24h_5percentCC	UpperCameronFlowage
KR107	9.06	213.35	31.00	3.5900	UpperStew_100yr_24h_5percentCC	CL404
KR108	19.08	537.34	59.00	4.7000	UpperStew_100yr_24h_5percentCC	CL404
KR109	171.73	1391.62	38.00	1.8700	UpperStew_100yr_24h_5percentCC	SU3
KR110	70.64	470.93	7.00	0.9800	UpperStew_100yr_24h_5percentCC	KR411
KR111	461.56	1179.99	1.00	1.9300	UpperStew_100yr_24h_5percentCC	McNeilDam
KR112	309.74	1088.00	7.00	0.7400	UpperStew_100yr_24h_5percentCC	TaiteLake
KR113	71.20	426.12	0.00	1.8000	UpperStew_100yr_24h_5percentCC	KR409
KR114	182.97	571.00	0.00	0.8000	UpperStew_100yr_24h_5percentCC	KR410
KR115	340.99	1363.05	4.00	0.9300	UpperStew_100yr_24h_5percentCC	TaiteLake
KR116	190.59	676.98	22.00	4.5800	UpperStew_100yr_24h_5percentCC	TaiteLake
KR117	162.77	1043.42	14.00	2.5000	UpperStew_100yr_24h_5percentCC	KR412
KR118	96.80	436.49	18.00	6.5800	UpperStew_100yr_24h_5percentCC	KR415
KR119	1.83	285.80	3.00	25.0000	UpperStew_100yr_24h_5percentCC	KROF1
KR120	5.91	150.81	1.00	7.7200	UpperStew_100yr_24h_5percentCC	KROF1

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Node Summary
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Name	Type	Invert Elev.	Max. Depth	Ponded Area	External Inflow
BD400	JUNCTION	164.05	0.75	0.0	
BD401	JUNCTION	154.55	1.00	0.0	
BD401_2	JUNCTION	145.36	1.00	0.0	
BD402	JUNCTION	143.90	1.00	0.0	
BD403	JUNCTION	139.85	1.50	0.0	Yes
BD404	JUNCTION	163.88	0.75	0.0	
BD405	JUNCTION	152.97	0.75	0.0	
BD406	JUNCTION	147.99	1.00	0.0	
BD407	JUNCTION	143.00	1.20	0.0	Yes
BD408	JUNCTION	152.97	0.50	0.0	
BD409	JUNCTION	147.80	1.00	0.0	
BD412	JUNCTION	132.60	2.00	0.0	
BD413	JUNCTION	131.00	1.50	12896.0	
BD414	JUNCTION	128.79	1.00	0.0	
BD415	JUNCTION	144.15	0.50	0.0	
BD420	JUNCTION	154.07	0.50	0.0	
BD421	JUNCTION	154.88	0.50	0.0	
BD422	JUNCTION	150.94	0.80	0.0	
BD423	JUNCTION	169.08	0.50	0.0	
BD423_2	JUNCTION	168.24	0.50	0.0	
BD423_3	JUNCTION	164.63	0.75	0.0	
BD424	JUNCTION	161.24	0.75	0.0	
BD424_2	JUNCTION	158.42	0.75	0.0	
BD425	JUNCTION	157.44	0.75	0.0	Yes
BD426	JUNCTION	160.12	0.75	0.0	
BD427	JUNCTION	165.19	0.80	0.0	
BD427_2	JUNCTION	162.95	0.75	0.0	
BD428	JUNCTION	169.08	0.50	0.0	
BD428_2	JUNCTION	166.58	0.50	0.0	
BD429	JUNCTION	155.98	1.20	0.0	
BD430	JUNCTION	152.67	1.20	0.0	
BD431	JUNCTION	136.91	1.60	0.0	
BD432	JUNCTION	135.92	1.60	0.0	
BD433	JUNCTION	172.00	0.50	0.0	
BD434	JUNCTION	169.50	0.60	0.0	
BD435	JUNCTION	169.00	0.60	0.0	
BD435_1	JUNCTION	171.00	0.50	0.0	
BD439	JUNCTION	167.00	1.00	0.0	
BD440	JUNCTION	166.60	1.40	0.0	
BD441	JUNCTION	166.50	1.40	0.0	
BD442	JUNCTION	166.32	0.80	0.0	

BD445	JUNCTION	157.62	0.50	0.0
BD446	JUNCTION	154.28	1.00	0.0
BD446_2	JUNCTION	149.51	1.25	0.0
BD446_3	JUNCTION	145.04	1.25	0.0
BD447	JUNCTION	140.62	1.60	0.0
BD448	JUNCTION	162.19	0.50	0.0
BD449	JUNCTION	162.19	0.75	0.0
BD450	JUNCTION	153.61	0.75	0.0
BD451	JUNCTION	147.38	1.25	0.0
BD452	JUNCTION	150.01	1.00	0.0
BD453	JUNCTION	151.45	0.75	0.0
BD454	JUNCTION	164.62	0.50	0.0
BD455	JUNCTION	161.06	0.75	0.0
BD456	JUNCTION	164.62	0.50	0.0
BD457	JUNCTION	157.92	0.50	0.0
BD458	JUNCTION	155.28	0.75	0.0
BD459	JUNCTION	158.51	0.50	0.0
BD460	JUNCTION	157.11	0.50	0.0
BD461	JUNCTION	155.47	1.00	0.0
BD462	JUNCTION	158.51	0.75	0.0
BD463	JUNCTION	157.62	0.75	0.0
BD464	JUNCTION	155.89	0.75	0.0
BD465	JUNCTION	155.30	1.00	0.0
BD466	JUNCTION	162.53	0.50	0.0
BD467	JUNCTION	159.35	0.50	0.0
BD468	JUNCTION	162.53	0.75	0.0
BD469	JUNCTION	156.98	1.00	0.0
BD470	JUNCTION	153.00	1.35	7488.0
BD471	JUNCTION	165.16	0.50	0.0
BD472	JUNCTION	163.42	0.75	0.0
BD473	JUNCTION	165.62	0.50	0.0
BD474	JUNCTION	129.25	1.00	9074.3
BD474_2	JUNCTION	128.79	1.00	0.0
BD474_3	JUNCTION	130.00	1.00	0.0
BD475	JUNCTION	135.51	0.50	0.0
BD476	JUNCTION	133.52	0.50	0.0
BD477	JUNCTION	132.31	0.50	0.0
BD478	JUNCTION	131.26	0.75	0.0
BD479	JUNCTION	135.51	0.50	0.0
BD480	JUNCTION	153.34	0.50	0.0
BD481	JUNCTION	153.34	0.50	0.0
BD482	JUNCTION	144.66	1.00	0.0
BD483	JUNCTION	153.98	1.00	0.0
BD484	JUNCTION	137.40	1.60	0.0
BD484_2	JUNCTION	135.00	1.00	0.0
BD489	JUNCTION	138.12	0.50	0.0

BD490	JUNCTION	143.90	1.00	0.0	
BD495	JUNCTION	137.84	1.75	0.0	
BD497	JUNCTION	137.41	0.75	0.0	
BD499	JUNCTION	131.00	2.00	0.0	
CL400	JUNCTION	141.14	2.00	0.0	
CL401	JUNCTION	139.01	2.00	0.0	
CL402	JUNCTION	136.09	2.00	0.0	
CL403	JUNCTION	133.40	2.00	0.0	
CL404	JUNCTION	129.60	2.50	0.0	
J1	JUNCTION	148.84	1.00	0.0	
J10	JUNCTION	170.50	0.50	0.0	
J11	JUNCTION	148.50	0.75	0.0	
J12	JUNCTION	135.40	1.00	0.0	
J13	JUNCTION	130.92	1.50	0.0	
J14	JUNCTION	129.08	1.00	0.0	
J15	JUNCTION	152.78	1.35	0.0	
J16	JUNCTION	148.80	2.20	0.0	
J17	JUNCTION	147.75	0.60	10000.0	
J18	JUNCTION	154.55	1.00	0.0	
J19	JUNCTION	147.36	0.60	0.0	
J2	JUNCTION	160.93	0.75	0.0	
J3	JUNCTION	138.19	1.25	0.0	
J4	JUNCTION	127.29	2.50	0.0	
J5	JUNCTION	140.71	1.50	0.0	
J6	JUNCTION	148.46	1.00	0.0	
J7	JUNCTION	149.50	1.00	0.0	
J8	JUNCTION	136.15	4.50	0.0	
J9	JUNCTION	144.87	1.25	0.0	
KR400	JUNCTION	151.70	1.00	0.0	
KR401	JUNCTION	142.50	1.00	0.0	
KR402	JUNCTION	148.70	1.00	0.0	
KR403	JUNCTION	138.75	1.00	0.0	
KR404	JUNCTION	138.58	1.00	0.0	
KR405	JUNCTION	138.00	2.00	0.0	
KR406	JUNCTION	137.56	2.00	0.0	
KR407	JUNCTION	137.47	2.00	0.0	
KR408	JUNCTION	129.40	4.00	0.0	Yes
KR409	JUNCTION	175.00	2.00	0.0	
KR410	JUNCTION	152.50	2.20	0.0	
KR411	JUNCTION	129.10	9.00	0.0	
KR412	JUNCTION	129.00	3.50	0.0	
KR413	JUNCTION	128.27	3.50	0.0	
KR414	JUNCTION	128.33	1.60	0.0	
KR415	JUNCTION	127.50	2.50	0.0	
KR416	JUNCTION	127.00	2.50	0.0	
BDOF3	OUTFALL	151.90	1.00	0.0	

KROF1	OUTFALL	124.00	2.50	0.0	
OF1	OUTFALL	145.02	0.60	0.0	
CameronFlowage	STORAGE	129.05	5.00	0.0	
Crusher_Lake	STORAGE	145.00	1.50	0.0	
EastPond	STORAGE	128.00	5.50	0.0	
LittleTaite	STORAGE	131.85	1.50	0.0	
LowerCameronFlowage	STORAGE	128.33	1.50	0.0	
McNeilDam	STORAGE	147.00	5.00	0.0	
NorthPond	STORAGE	130.00	4.80	0.0	
Pit_Storage	STORAGE	0.00	100.00	0.0	Yes
SouthPond	STORAGE	152.00	3.50	0.0	
SU3	STORAGE	129.50	1.50	0.0	
TaiteLake	STORAGE	132.80	1.50	0.0	
UpperCameronFlowage	STORAGE	130.00	1.50	0.0	
UpperPond	STORAGE	135.20	1.50	0.0	
WestLake	STORAGE	137.70	1.50	0.0	
WestPond	STORAGE	146.25	5.00	0.0	

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Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
BD700_1	BD400	J16	CONDUIT	598.6	2.5487	0.0350
BD700_2	BD401	J16	CONDUIT	657.1	0.8752	0.0350
BD701_1	J18	BD401_2	CONDUIT	382.5	2.4048	0.0350
BD701_2	BD401_2	BD402	CONDUIT	130.5	1.1126	0.0350
BD702_1	BD402	J5	CONDUIT	287.8	1.1096	0.0350
BD702_2	J5	BD403	CONDUIT	396.6	0.2179	0.0350
BD703_2	BD495	BD412	CONDUIT	468.6	1.1180	0.0350
BD703_3	BD403	J3	CONDUIT	147.8	1.1181	0.0350
BD703_4	J3	BD495	CONDUIT	31.9	1.1176	0.0350
BD704	BD404	BD405	CONDUIT	220.8	4.9436	0.0350
BD705	BD405	BD406	CONDUIT	208.5	2.3909	0.0350
BD706	BD406	BD407	CONDUIT	208.7	2.3910	0.0350
BD707_Culv	BD407	BD403	CONDUIT	42.9	7.3641	0.0240
BD708	BD408	BD409	CONDUIT	336.9	1.5349	0.0350
BD709	BD409	BD407	CONDUIT	312.9	1.5351	0.0350
BD712	BD412	NorthPond	CONDUIT	23.8	1.4701	0.0350
BD713_1	BD413	J13	CONDUIT	20.0	0.4200	0.0240
BD713_2	J13	BD414	CONDUIT	428.9	0.4964	0.0350
BD714	BD414	KR413	CONDUIT	65.7	0.7885	0.0350
BD715	BD415	J8	CONDUIT	540.7	0.7400	0.0350
BD720	BD420	BD422	CONDUIT	241.8	1.2931	0.0350
BD720_Culv	BD422	J1	CONDUIT	31.1	6.7706	0.0240

BD721	BD421	BD422	CONDUIT	226.5	1.7399	0.0350
BD723_1	BD423	BD423_2	CONDUIT	33.3	2.5291	0.0350
BD723_3	BD423_2	BD423_3	CONDUIT	142.8	2.5306	0.0350
BD723_4	BD423_3	BD424	CONDUIT	133.9	2.5310	0.0350
BD724_1	BD424	BD424_2	CONDUIT	111.5	2.5297	0.0350
BD724_2	BD424_2	BD425	CONDUIT	38.8	2.5316	0.0350
BD725	BD425	BD429	CONDUIT	12.2	11.9978	0.0350
BD726	BD426	BD425	CONDUIT	182.5	1.4672	0.0350
BD727_1	BD427	BD427_2	CONDUIT	153.1	1.4671	0.0350
BD727_2	BD427_2	BD426	CONDUIT	192.7	1.4669	0.0350
BD728_1	BD428	BD428_2	CONDUIT	170.5	1.4673	0.0350
BD728_2	BD428_2	BD427	CONDUIT	94.8	1.4669	0.0350
BD729_Culv	BD429	BD430	CONDUIT	35.4	9.3879	0.0240
BD730_2	BD490	BD431	CONDUIT	112.5	6.2315	0.0350
BD730_3	BD430	J1	CONDUIT	85.0	4.5077	0.0350
BD730_4	J1	BD490	CONDUIT	283.4	1.7443	0.0350
BD731_Culv	BD431	BD432	CONDUIT	106.0	0.9285	0.0240
BD732	BD432	BD412	CONDUIT	245.4	1.3540	0.0350
BD733_1	BD433	J10	CONDUIT	180.2	0.8323	0.0350
BD733_2	J10	BD434	CONDUIT	149.9	0.6672	0.0350
BD734_Culv	BD434	BD435	CONDUIT	30.2	1.6558	0.0240
BD735	BD435	BD439	CONDUIT	244.3	0.8185	0.0350
BD737_1	BD435_1	BD435	CONDUIT	155.4	1.2867	0.0350
BD739	BD439	BD440	CONDUIT	217.7	0.1838	0.0350
BD740_Culv	BD440	BD441	CONDUIT	44.2	0.2263	0.0240
BD741	BD441	BD442	CONDUIT	234.3	0.0768	0.0350
BD744_Culv	BD442	BD427	CONDUIT	112.5	1.0031	0.0240
BD745	BD445	BD446	CONDUIT	80.2	4.1663	0.0350
BD746_1	BD446	BD446_2	CONDUIT	114.7	4.1662	0.0350
BD746_3	BD446_2	BD446_3	CONDUIT	107.4	4.1653	0.0350
BD746_4	BD446_3	BD447	CONDUIT	106.0	4.1665	0.0350
BD747_1	BD484	BD484_2	CONDUIT	48.7	4.9361	0.0350
BD747_1_Culv	BD447	BD484	CONDUIT	35.5	9.1088	0.0240
BD747_3	BD484_2	EastPond	CONDUIT	72.3	2.0756	0.0350
BD748	BD448	BD445	CONDUIT	109.9	4.1665	0.0350
BD749	BD449	BD450	CONDUIT	154.0	5.5809	0.0350
BD750	BD450	BD451	CONDUIT	111.9	5.5802	0.0350
BD751	BD451	BD447	CONDUIT	121.2	5.5811	0.0350
BD752	BD453	BD452	CONDUIT	62.8	2.2998	0.0350
BD754	BD454	BD455	CONDUIT	68.7	5.1997	0.0350
BD755	BD455	BD452	CONDUIT	290.0	3.8135	0.0350
BD755_2	BD452	J9	CONDUIT	130.4	3.9425	0.0350
BD755_3	J9	BD447	CONDUIT	125.2	3.3940	0.0350
BD756	BD456	BD457	CONDUIT	291.6	2.2993	0.0350
BD757	BD457	BD458	CONDUIT	114.9	2.2996	0.0350
BD758	BD458	BD453	CONDUIT	166.6	2.2993	0.0350

BD759	BD459	BD460	CONDUIT	190.0	0.7374	0.0350
BD760_1	BD460	BD483	CONDUIT	423.4	0.7378	0.0350
BD760_2	J11	J12	CONDUIT	431.9	3.0342	0.0350
BD760_3	BD483	J11	CONDUIT	171.4	3.2005	0.0350
BD760_5	J12	BD484_2	CONDUIT	78.9	0.5067	0.0350
BD762	BD462	BD463	CONDUIT	173.1	0.5113	0.0350
BD763	BD463	BD464	CONDUIT	338.9	0.5114	0.0350
BD764	BD464	BD465	CONDUIT	246.8	0.2386	0.0350
BD765	BD465	SouthPond	CONDUIT	25.4	1.1803	0.0350
BD766	BD466	BD467	CONDUIT	90.2	3.5273	0.0350
BD767	BD467	BD461	CONDUIT	110.2	3.5271	0.0350
BD767_Culv	BD461	BD483	CONDUIT	46.7	3.1929	0.0240
BD768_1	BD468	J2	CONDUIT	151.1	1.0613	0.0350
BD768_2	J2	BD469	CONDUIT	596.7	0.6623	0.0350
BD769	BD469	BD465	CONDUIT	355.0	0.4727	0.0350
BD770_1	BD470	J15	CONDUIT	15.0	1.5002	0.0240
BD770_2	J15	BDOF3	CONDUIT	41.2	2.1231	0.0350
BD771	BD471	BD472	CONDUIT	172.0	1.0129	0.0350
BD772	BD472	J2	CONDUIT	248.7	0.9997	0.0350
BD773	BD473	BD472	CONDUIT	216.0	1.0205	0.0350
BD774_2	BD474_2	J4	CONDUIT	41.5	3.6236	0.0350
BD774_3	BD474	J14	CONDUIT	20.0	0.8600	0.0240
BD774_4	J14	BD474_2	CONDUIT	12.8	2.2259	0.0350
BD775	BD475	BD476	CONDUIT	161.3	1.2396	0.0350
BD776	BD476	BD477	CONDUIT	138.2	0.8748	0.0350
BD777	BD477	BD478	CONDUIT	183.7	0.5712	0.0350
BD778	BD478	BD414	CONDUIT	29.3	8.4764	0.0350
BD779	BD479	BD478	CONDUIT	140.6	3.0290	0.0350
BD780_1	BD480	J6	CONDUIT	376.7	1.2964	0.0350
BD780_2	J6	BD482	CONDUIT	293.5	1.2966	0.0350
BD781_1	BD481	J7	CONDUIT	251.9	1.5285	0.0350
BD781_2	J7	BD482	CONDUIT	316.5	1.5288	0.0350
BD782	BD482	J5	CONDUIT	235.6	1.6749	0.0350
BD795	BD497	J8	CONDUIT	365.7	0.3432	0.0350
BD796_2	BD489	BD497	CONDUIT	199.6	0.3592	0.0350
BDCL701_3_Culv	CL402	CL403	CONDUIT	49.6	5.4307	0.0240
BD-EP-SpillwayChannel	BD474_3	J14	CONDUIT	37.3	2.4741	0.0350
BDNorthPondSpillway	BD499	Pit_Storage	CONDUIT	549.9	20.6079	0.0130
C1	J16	WestPond	CONDUIT	34.6	1.5906	0.0100
C2	J17	J19	CONDUIT	22.5	1.7410	0.0150
C3	J19	OF1	CONDUIT	69.7	3.3577	0.0150
CL700	Crusher_Lake	CL400	CONDUIT	112.3	3.4409	0.0400
CL701	CL400	CL401	CONDUIT	39.5	5.3893	0.0400
CL701_2	CL401	J8	CONDUIT	254.9	1.1221	0.0400
CL701_3	J8	CL402	CONDUIT	6.8	0.8688	0.0400
CL701_4	CL403	CL404	CONDUIT	455.2	0.8346	0.0400

CL702	CL404	SU3	CONDUIT	155.0	0.0645	0.0550
CL703	SU3	KR408	CONDUIT	330.8	0.0302	0.0550
KR700	KR400	KR401	CONDUIT	2210.2	0.4163	0.0350
KR701	KR401	WestLake	CONDUIT	1980.0	0.2424	0.0350
KR702	WestLake	UpperPond	CONDUIT	1827.1	0.1368	0.0350
KR703	KR402	KR403	CONDUIT	4347.6	0.2288	0.0350
KR704	KR403	KR404	CONDUIT	73.9	0.2285	0.0400
KR705	KR404	KR405	CONDUIT	254.4	0.2291	0.0350
KR706	KR405	KR406	CONDUIT	275.1	0.1607	0.0350
KR707	KR406	KR407	CONDUIT	55.7	0.1597	0.0400
KR708	KR407	UpperPond	CONDUIT	1413.5	0.1605	0.0350
KR709	UpperPond	UpperCameronFlowage	CONDUIT	745.8	0.6972	0.0350
KR710	UpperCameronFlowage	KR408	CONDUIT	412.2	0.1456	0.0350
KR711	KR408	KR411	CONDUIT	696.4	0.0431	0.0350
KR712	McNeilDam	TaiteLake	CONDUIT	3035.9	0.4677	0.0350
KR713	KR409	KR410	CONDUIT	2440.7	0.9219	0.0350
KR714	KR410	TaiteLake	CONDUIT	4035.1	0.4882	0.0350
KR715	TaiteLake	LittleTaite	CONDUIT	660.7	0.1438	0.0350
KR716	LittleTaite	KR411	CONDUIT	757.5	0.3630	0.0350
KR717	KR411	CameronFlowage	CONDUIT	529.8	0.0094	0.0350
KR718	CameronFlowage	KR412	CONDUIT	739.8	0.0068	0.0350
KR719	KR412	KR413	CONDUIT	631.2	0.1158	0.0350
KR720_1	KR413	KR414	CONDUIT	70.3	-0.0910	0.0350
KR720_2	KR414	LowerCameronFlowage	CONDUIT	56.2	0.0036	0.0350
KR721	LowerCameronFlowage	KR415	CONDUIT	732.0	0.1135	0.0350
KR722_1	KR415	J4	CONDUIT	81.7	0.2571	0.0350
KR722_2	J4	KR416	CONDUIT	112.4	0.2581	0.0350
KR723	KR416	KROF1	CONDUIT	429.9	0.6979	0.0350
BD722_Pump	Pit_Storage	BD412	TYPE2 PUMP			
OR1	WestPond	J17	ORIFICE			
OR2	WestPond	J17	ORIFICE			
OR-EP-1	EastPond	BD474	ORIFICE			
OR-EP-2	EastPond	BD474	ORIFICE			
OR-EP-3	EastPond	BD474	ORIFICE			
OR-NP-1	NorthPond	BD413	ORIFICE			
OR-NP-2	NorthPond	BD413	ORIFICE			
OR-NP-3	NorthPond	BD413	ORIFICE			
OR-NP-4	NorthPond	BD413	ORIFICE			
OR-SP-1	SouthPond	BD470	ORIFICE			
OR-SP-2	SouthPond	BD470	ORIFICE			
OR-SP-3	SouthPond	BD470	ORIFICE			
OR-SP-4	SouthPond	BD470	ORIFICE			
BD-EP-10yr100yr	EastPond	BD474	WEIR			
BD-EP-Spillway	EastPond	BD474_3	WEIR			
BD-NP_HurricaneSpillway	NorthPond	BD499	WEIR			
BD-SP-100yr	SouthPond	BD470	WEIR			

NP-100yr	NorthPond	BD413	WEIR
SouthPond_Spillway	SouthPond	BD470	WEIR
W1	WestPond	J17	WEIR
W2	WestPond	J17	WEIR

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
BD700_1	TRAPEZOIDAL	0.75	2.44	0.42	5.50	1	6.28
BD700_2	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	7.14
BD701_1	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	11.84
BD701_2	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	8.06
BD702_1	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	8.04
BD702_2	TRAPEZOIDAL	1.50	8.25	0.79	10.00	1	9.38
BD703_2	TRAPEZOIDAL	1.75	10.94	0.91	11.50	1	30.95
BD703_3	TRAPEZOIDAL	1.25	5.63	0.65	8.25	1	12.75
BD703_4	TRAPEZOIDAL	1.25	5.94	0.67	8.50	1	13.69
BD704	TRAPEZOIDAL	0.75	2.44	0.42	5.50	1	8.75
BD705	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	4.89
BD706	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	9.91
BD707_Culv	CIRCULAR	1.20	1.13	0.30	1.20	1	5.73
BD708	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.49
BD709	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	7.94
BD712	TRAPEZOIDAL	2.00	13.50	1.01	12.75	1	47.01
BD713_1	CIRCULAR	1.50	1.77	0.38	1.50	1	2.48
BD713_2	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	5.38
BD714	TRAPEZOIDAL	1.00	5.00	0.60	8.00	1	9.03
BD715	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.03
BD720	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.37
BD720_Culv	CIRCULAR	0.80	0.50	0.20	0.80	1	1.86
BD721	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.59
BD723_1	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.91
BD723_3	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.91
BD723_4	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	5.03
BD724_1	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	5.03
BD724_2	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	5.03
BD725	TRAPEZOIDAL	0.75	2.25	0.41	5.25	1	12.28
BD726	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	3.83
BD727_1	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	3.83
BD727_2	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	3.83
BD728_1	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.46
BD728_2	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.46

BD729_Culv	CIRCULAR	1.20	1.13	0.30	1.20	1	6.47
BD730_2	TRAPEZOIDAL	1.00	4.25	0.56	7.25	1	20.62
BD730_3	TRAPEZOIDAL	1.00	3.75	0.53	6.75	1	14.90
BD730_4	TRAPEZOIDAL	1.00	3.75	0.53	6.75	1	9.27
BD731_Culv	CIRCULAR	1.60	2.01	0.40	1.60	1	4.38
BD732	TRAPEZOIDAL	1.50	9.75	0.85	11.00	1	29.06
BD733_1	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.10
BD733_2	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	0.98
BD734_Culv	CIRCULAR	0.60	0.28	0.15	0.60	1	0.43
BD735	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.09
BD737_1	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.36
BD739	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	3.27
BD740_Culv	CIRCULAR	1.40	1.54	0.35	1.40	1	1.52
BD741	TRAPEZOIDAL	0.50	1.25	0.30	4.00	1	0.44
BD744_Culv	CIRCULAR	0.80	0.50	0.20	0.80	1	0.72
BD745	TRAPEZOIDAL	0.50	1.25	0.30	4.00	1	3.27
BD746_1	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	15.59
BD746_3	TRAPEZOIDAL	1.25	5.94	0.67	8.50	1	26.43
BD746_4	TRAPEZOIDAL	1.25	5.94	0.67	8.50	1	26.43
BD747_1	TRAPEZOIDAL	1.00	3.75	0.53	6.75	1	15.59
BD747_1_Culv	CIRCULAR	1.60	2.01	0.40	1.60	1	13.73
BD747_3	TRAPEZOIDAL	1.00	3.75	0.53	6.75	1	10.11
BD748	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	2.46
BD749	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	7.47
BD750	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	7.47
BD751	TRAPEZOIDAL	1.25	5.31	0.63	8.00	1	26.41
BD752	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	4.80
BD754	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	2.74
BD755	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	6.18
BD755_2	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	12.72
BD755_3	TRAPEZOIDAL	1.25	5.31	0.63	8.00	1	20.60
BD756	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.82
BD757	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.82
BD758	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	4.80
BD759	TRAPEZOIDAL	0.50	1.25	0.30	4.00	1	1.38
BD760_1	TRAPEZOIDAL	0.50	1.25	0.30	4.00	1	1.38
BD760_2	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	5.51
BD760_3	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	5.66
BD760_5	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	4.56
BD762	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	2.26
BD763	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	2.26
BD764	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	1.55
BD765	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	6.96
BD766	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	2.26
BD767	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	2.26
BD767_Culv	CIRCULAR	1.00	0.79	0.25	1.00	1	2.32

BD768_1	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	3.26
BD768_2	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	2.58
BD769	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	4.41
BD770_1	CIRCULAR	1.35	1.43	0.34	1.35	1	3.54
BD770_2	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	11.13
BD771	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.21
BD772	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	3.16
BD773	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.21
BD774_2	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	14.54
BD774_3	CIRCULAR	1.00	0.79	0.25	1.00	1	1.20
BD774_4	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	11.39
BD775	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.34
BD776	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.12
BD777	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	0.91
BD778	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	9.21
BD779	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	2.09
BD780_1	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.37
BD780_2	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	7.30
BD781_1	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	1.49
BD781_2	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	7.92
BD782	TRAPEZOIDAL	1.00	3.50	0.51	6.50	1	8.29
BD795	TRAPEZOIDAL	0.75	2.06	0.39	5.00	1	1.85
BD796_2	TRAPEZOIDAL	0.50	1.00	0.27	3.50	1	0.72
BDCL701_3_Culv	CIRCULAR	1.40	1.54	0.35	1.40	1	7.42
BD-EP-SpillwayChannel	TRAPEZOIDAL	1.00	4.00	0.55	7.00	1	12.01
BDNorthPondSpillway	CIRCULAR	2.00	3.14	0.50	2.00	1	69.12
C1	CIRCULAR	1.00	0.79	0.25	1.00	1	3.93
C2	CIRCULAR	0.60	0.28	0.15	0.60	1	0.70
C3	CIRCULAR	0.60	0.28	0.15	0.60	1	0.98
CL700	11	2.00	160.50	0.38	157.00	1	393.24
CL701	11	2.00	160.50	0.38	157.00	1	492.14
CL701_2	11	2.00	160.50	0.38	157.00	1	224.57
CL701_3	11	2.00	160.50	0.38	157.00	1	197.60
CL701_4	11	2.00	160.50	0.38	157.00	1	193.67
CL702	10	2.50	354.50	0.87	284.00	1	149.03
CL703	10	2.50	354.50	0.87	284.00	1	102.02
KR700	C11/C17/C18	1.00	24.60	0.17	42.50	1	13.72
KR701	C11/C17/C18	1.00	24.60	0.17	42.50	1	10.47
KR702	1	2.20	51.64	0.61	45.00	1	39.34
KR703	C11/C17/C18	1.00	24.60	0.17	42.50	1	10.17
KR704	C18_3	1.00	21.60	0.25	42.50	1	10.15
KR705	C11/C17/C18	1.00	24.60	0.17	42.50	1	10.18
KR706	C27	2.00	59.20	0.76	50.00	1	56.31
KR707	C18_3	1.00	21.60	0.25	42.50	1	8.48
KR708	C27	2.00	59.20	0.76	50.00	1	56.28
KR709	4	4.00	281.09	1.00	100.00	1	671.26

KR710	4	4.00	281.09	1.00	100.00	1	306.71
KR711	9	1.50	167.87	0.47	160.00	1	60.44
KR712	C19	2.00	86.20	0.29	123.50	1	74.28
KR713	C26	2.00	42.20	0.38	41.50	1	61.04
KR714	C25	2.20	80.40	0.40	88.00	1	87.44
KR715	5	2.20	226.70	0.28	300.00	1	105.05
KR716	7	9.00	1792.12	1.99	292.00	1	4884.82
KR717	8	5.60	1165.35	1.71	284.00	1	463.28
KR718	12	3.50	553.38	1.69	189.00	1	184.50
KR719	12	3.50	553.38	1.69	189.00	1	763.76
KR720_1	13	1.60	198.37	1.04	162.00	1	175.98
KR720_2	13	1.60	198.37	1.04	162.00	1	34.81
KR721	13	1.60	198.37	1.04	162.00	1	196.54
KR722_1	14	2.50	93.75	1.31	64.00	1	162.57
KR722_2	14	2.50	93.75	1.31	64.00	1	162.90
KR723	14	2.50	93.75	1.31	64.00	1	267.88

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Transect Summary
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Transect 1
Area:

0.0043	0.0088	0.0136	0.0189	0.0248
0.0314	0.0385	0.0463	0.0546	0.0635
0.0731	0.0832	0.0939	0.1053	0.1172
0.1297	0.1430	0.1569	0.1717	0.1871
0.2034	0.2203	0.2381	0.2565	0.2758
0.2957	0.3164	0.3379	0.3601	0.3831
0.4068	0.4313	0.4565	0.4825	0.5092
0.5367	0.5649	0.5939	0.6236	0.6541
0.6853	0.7173	0.7500	0.7834	0.8177
0.8526	0.8883	0.9248	0.9620	1.0000

Hrad:

0.0701	0.1375	0.2038	0.2617	0.3115
0.3552	0.3939	0.4286	0.4600	0.4888
0.5153	0.5398	0.5628	0.5845	0.6049
0.6242	0.6407	0.6561	0.6705	0.6842
0.6973	0.7099	0.7220	0.7337	0.7451
0.7563	0.7673	0.7781	0.7888	0.7993
0.8097	0.8200	0.8303	0.8405	0.8506
0.8607	0.8707	0.8808	0.8908	0.9007
0.9107	0.9206	0.9306	0.9405	0.9504
0.9603	0.9703	0.9802	0.9901	1.0000

Width:

0.1150	0.1189	0.1314	0.1470	0.1627
0.1783	0.1940	0.2096	0.2252	0.2409
0.2565	0.2722	0.2878	0.3035	0.3191
0.3351	0.3547	0.3742	0.3938	0.4133
0.4329	0.4524	0.4720	0.4916	0.5111
0.5307	0.5502	0.5698	0.5893	0.6089
0.6284	0.6480	0.6676	0.6871	0.7067
0.7262	0.7458	0.7653	0.7849	0.8044
0.8240	0.8436	0.8631	0.8827	0.9022
0.9218	0.9413	0.9609	0.9804	1.0000

Transect 10
Area:

0.0013	0.0026	0.0045	0.0077	0.0121
0.0178	0.0247	0.0328	0.0422	0.0528
0.0643	0.0763	0.0888	0.1019	0.1155
0.1296	0.1442	0.1594	0.1751	0.1913
0.2080	0.2253	0.2430	0.2614	0.2802
0.2995	0.3194	0.3398	0.3608	0.3822
0.4044	0.4275	0.4515	0.4764	0.5023
0.5291	0.5567	0.5853	0.6148	0.6453
0.6766	0.7089	0.7421	0.7762	0.8112
0.8471	0.8840	0.9217	0.9604	1.0000

Hrad:

0.0566	0.1117	0.1423	0.1519	0.1600
0.1696	0.1808	0.1932	0.2064	0.2203
0.2433	0.2669	0.2906	0.3142	0.3376
0.3607	0.3835	0.4061	0.4284	0.4503
0.4720	0.4935	0.5147	0.5357	0.5564
0.5770	0.5973	0.6175	0.6375	0.6573
0.6729	0.6895	0.7066	0.7240	0.7416
0.7593	0.7770	0.7947	0.8123	0.8298
0.8473	0.8646	0.8818	0.8990	0.9160
0.9330	0.9498	0.9666	0.9833	1.0000

Width:

0.0324	0.0331	0.0640	0.0949	0.1258
0.1566	0.1875	0.2184	0.2493	0.2802
0.2933	0.3064	0.3195	0.3326	0.3457
0.3588	0.3719	0.3850	0.3981	0.4112
0.4243	0.4374	0.4505	0.4636	0.4767
0.4898	0.5029	0.5160	0.5291	0.5423
0.5651	0.5880	0.6109	0.6338	0.6567
0.6796	0.7025	0.7254	0.7482	0.7711
0.7940	0.8169	0.8398	0.8627	0.8856
0.9085	0.9313	0.9542	0.9771	1.0000

Transect 11
Area:

0.0003	0.0006	0.0009	0.0013	0.0017
0.0027	0.0048	0.0080	0.0123	0.0177
0.0242	0.0318	0.0405	0.0503	0.0612
0.0732	0.0863	0.1004	0.1157	0.1321
0.1496	0.1682	0.1879	0.2086	0.2305
0.2533	0.2767	0.3008	0.3256	0.3510
0.3771	0.4039	0.4313	0.4594	0.4882
0.5177	0.5478	0.5786	0.6100	0.6421
0.6749	0.7084	0.7425	0.7773	0.8127
0.8488	0.8856	0.9231	0.9612	1.0000

Hrad:

0.0951	0.1773	0.2512	0.3194	0.3834
0.3594	0.2820	0.2400	0.2229	0.2193
0.2229	0.2309	0.2416	0.2541	0.2678
0.2824	0.2977	0.3135	0.3296	0.3461
0.3628	0.3797	0.3968	0.4140	0.4314
0.4559	0.4804	0.5047	0.5289	0.5529
0.5767	0.6003	0.6238	0.6471	0.6702
0.6931	0.7159	0.7385	0.7610	0.7834
0.8056	0.8276	0.8496	0.8714	0.8931
0.9147	0.9362	0.9575	0.9788	1.0000

Width:

0.0074	0.0084	0.0094	0.0104	0.0115
0.0396	0.0676	0.0957	0.1238	0.1519
0.1800	0.2081	0.2362	0.2643	0.2924
0.3204	0.3485	0.3766	0.4047	0.4328
0.4609	0.4890	0.5171	0.5452	0.5732
0.5903	0.6074	0.6245	0.6415	0.6586
0.6757	0.6927	0.7098	0.7269	0.7439
0.7610	0.7781	0.7952	0.8122	0.8293
0.8464	0.8634	0.8805	0.8976	0.9146
0.9317	0.9488	0.9659	0.9829	1.0000

Transect 12
Area:

0.0010	0.0021	0.0032	0.0047	0.0096
0.0186	0.0317	0.0477	0.0646	0.0824
0.1012	0.1208	0.1414	0.1629	0.1851
0.2075	0.2299	0.2525	0.2751	0.2979
0.3207	0.3436	0.3665	0.3895	0.4125
0.4356	0.4587	0.4818	0.5050	0.5282
0.5514	0.5747	0.5981	0.6215	0.6449
0.6683	0.6918	0.7153	0.7389	0.7625

0.7861 0.8097 0.8334 0.8571 0.8808
0.9046 0.9284 0.9522 0.9761 1.0000
Hrad:
0.0404 0.0792 0.1165 0.1081 0.0666
0.0564 0.0569 0.0664 0.0795 0.0938
0.1090 0.1246 0.1407 0.1570 0.1783
0.2023 0.2263 0.2503 0.2742 0.2981
0.3219 0.3457 0.3694 0.3932 0.4170
0.4407 0.4644 0.4880 0.5116 0.5352
0.5588 0.5823 0.6057 0.6292 0.6526
0.6760 0.6993 0.7227 0.7460 0.7693
0.7925 0.8157 0.8389 0.8620 0.8851
0.9082 0.9312 0.9542 0.9771 1.0000
Width:
0.0438 0.0453 0.0468 0.1206 0.2910
0.4614 0.6317 0.6888 0.7269 0.7651
0.8032 0.8414 0.8795 0.9177 0.9339
0.9376 0.9413 0.9450 0.9487 0.9524
0.9561 0.9586 0.9603 0.9620 0.9636
0.9653 0.9670 0.9686 0.9703 0.9720
0.9736 0.9753 0.9770 0.9786 0.9803
0.9819 0.9831 0.9844 0.9857 0.9870
0.9883 0.9896 0.9909 0.9922 0.9935
0.9948 0.9961 0.9974 0.9987 1.0000

Transect 13
Area:
0.0129 0.0259 0.0388 0.0518 0.0648
0.0778 0.0908 0.1039 0.1170 0.1301
0.1432 0.1563 0.1695 0.1827 0.1959
0.2091 0.2224 0.2356 0.2490 0.2640
0.2813 0.3009 0.3229 0.3467 0.3709
0.3951 0.4194 0.4438 0.4683 0.4928
0.5175 0.5422 0.5669 0.5918 0.6167
0.6417 0.6668 0.6920 0.7172 0.7425
0.7679 0.7934 0.8190 0.8446 0.8703
0.8961 0.9220 0.9479 0.9739 1.0000
Hrad:
0.0305 0.0609 0.0913 0.1217 0.1519
0.1821 0.2123 0.2424 0.2724 0.3024
0.3323 0.3621 0.3919 0.4217 0.4514
0.4810 0.5106 0.5401 0.5694 0.5932
0.6103 0.6216 0.6281 0.6326 0.6397
0.6484 0.6585 0.6696 0.6815 0.6941
0.7073 0.7210 0.7350 0.7494 0.7641
0.7791 0.7942 0.8095 0.8249 0.8405

0.8562 0.8720 0.8878 0.9037 0.9197
0.9357 0.9517 0.9678 0.9839 1.0000

Width:

0.4946 0.4954 0.4962 0.4970 0.4978
0.4986 0.4994 0.5001 0.5009 0.5017
0.5025 0.5033 0.5041 0.5049 0.5057
0.5065 0.5073 0.5080 0.5307 0.6187
0.7067 0.7947 0.8828 0.9230 0.9259
0.9289 0.9319 0.9348 0.9378 0.9407
0.9437 0.9467 0.9496 0.9526 0.9556
0.9585 0.9615 0.9644 0.9674 0.9704
0.9733 0.9763 0.9793 0.9822 0.9852
0.9881 0.9911 0.9941 0.9970 1.0000

Transect 14

Area:

0.0107 0.0214 0.0322 0.0431 0.0540
0.0650 0.0760 0.0870 0.0982 0.1093
0.1208 0.1328 0.1453 0.1584 0.1720
0.1861 0.2008 0.2160 0.2317 0.2480
0.2648 0.2821 0.3000 0.3184 0.3373
0.3568 0.3768 0.3973 0.4184 0.4400
0.4622 0.4850 0.5084 0.5324 0.5570
0.5822 0.6081 0.6346 0.6616 0.6893
0.7176 0.7466 0.7761 0.8062 0.8370
0.8684 0.9004 0.9330 0.9662 1.0000

Hrad:

0.0379 0.0754 0.1126 0.1494 0.1860
0.2222 0.2581 0.2937 0.3290 0.3641
0.4001 0.4338 0.4654 0.4951 0.5231
0.5494 0.5743 0.5978 0.6201 0.6413
0.6615 0.6807 0.6990 0.7166 0.7334
0.7495 0.7650 0.7799 0.7943 0.8081
0.8211 0.8335 0.8455 0.8570 0.8681
0.8788 0.8891 0.8991 0.9088 0.9182
0.9273 0.9362 0.9448 0.9532 0.9614
0.9695 0.9773 0.9850 0.9926 1.0000

Width:

0.3141 0.3156 0.3172 0.3188 0.3203
0.3219 0.3234 0.3250 0.3266 0.3281
0.3438 0.3594 0.3750 0.3906 0.4063
0.4219 0.4375 0.4531 0.4688 0.4844
0.5000 0.5156 0.5313 0.5469 0.5625
0.5781 0.5938 0.6094 0.6250 0.6406
0.6586 0.6766 0.6945 0.7125 0.7305
0.7484 0.7664 0.7844 0.8023 0.8203

0.8383	0.8563	0.8742	0.8922	0.9102
0.9281	0.9461	0.9641	0.9820	1.0000

Transect 15

Area:

0.0003	0.0007	0.0011	0.0015	0.0020
0.0024	0.0033	0.0054	0.0087	0.0133
0.0191	0.0262	0.0345	0.0441	0.0549
0.0670	0.0803	0.0949	0.1107	0.1278
0.1461	0.1656	0.1865	0.2085	0.2319
0.2561	0.2808	0.3061	0.3320	0.3584
0.3853	0.4128	0.4408	0.4693	0.4984
0.5281	0.5582	0.5890	0.6202	0.6520
0.6844	0.7173	0.7507	0.7847	0.8192
0.8543	0.8899	0.9261	0.9628	1.0000

Hrad:

0.1114	0.2115	0.3033	0.3889	0.4695
0.5464	0.5562	0.4330	0.3424	0.2939
0.2705	0.2610	0.2598	0.2636	0.2707
0.2800	0.2909	0.3029	0.3158	0.3294
0.3435	0.3580	0.3728	0.3879	0.4033
0.4286	0.4540	0.4793	0.5045	0.5297
0.5546	0.5794	0.6041	0.6286	0.6530
0.6771	0.7012	0.7250	0.7487	0.7723
0.7957	0.8189	0.8420	0.8650	0.8878
0.9105	0.9331	0.9555	0.9778	1.0000

Width:

0.0091	0.0100	0.0108	0.0117	0.0126
0.0135	0.0387	0.0720	0.1053	0.1386
0.1719	0.2053	0.2386	0.2719	0.3052
0.3385	0.3718	0.4052	0.4385	0.4718
0.5051	0.5384	0.5717	0.6050	0.6384
0.6528	0.6673	0.6818	0.6962	0.7107
0.7252	0.7396	0.7541	0.7685	0.7830
0.7975	0.8119	0.8264	0.8409	0.8553
0.8698	0.8843	0.8987	0.9132	0.9277
0.9421	0.9566	0.9711	0.9855	1.0000

Transect 2

Area:

0.0135	0.0270	0.0406	0.0543	0.0681
0.0820	0.0960	0.1101	0.1242	0.1384
0.1528	0.1672	0.1817	0.1963	0.2110
0.2261	0.2417	0.2577	0.2741	0.2910
0.3083	0.3261	0.3443	0.3629	0.3820
0.4014	0.4214	0.4417	0.4625	0.4838

	0.5054	0.5276	0.5501	0.5731	0.5965
	0.6203	0.6446	0.6693	0.6945	0.7201
	0.7461	0.7726	0.7995	0.8268	0.8546
	0.8828	0.9115	0.9405	0.9700	1.0000
Hrad:					
	0.0293	0.0583	0.0871	0.1157	0.1441
	0.1722	0.2002	0.2279	0.2555	0.2828
	0.3100	0.3369	0.3637	0.3903	0.4181
	0.4459	0.4726	0.4982	0.5228	0.5465
	0.5694	0.5914	0.6126	0.6331	0.6529
	0.6720	0.6905	0.7084	0.7257	0.7425
	0.7588	0.7747	0.7901	0.8050	0.8196
	0.8337	0.8475	0.8609	0.8740	0.8868
	0.8993	0.9115	0.9234	0.9350	0.9464
	0.9576	0.9685	0.9792	0.9897	1.0000
Width:					
	0.4473	0.4502	0.4531	0.4560	0.4589
	0.4618	0.4647	0.4676	0.4704	0.4733
	0.4762	0.4791	0.4820	0.4849	0.4944
	0.5089	0.5233	0.5378	0.5522	0.5667
	0.5811	0.5956	0.6100	0.6244	0.6389
	0.6533	0.6678	0.6822	0.6967	0.7111
	0.7256	0.7400	0.7544	0.7689	0.7833
	0.7978	0.8122	0.8267	0.8411	0.8556
	0.8700	0.8844	0.8989	0.9133	0.9278
	0.9422	0.9567	0.9711	0.9856	1.0000
Transect 3					
Area:					
	0.0161	0.0323	0.0485	0.0648	0.0812
	0.0975	0.1140	0.1305	0.1470	0.1636
	0.1802	0.1969	0.2137	0.2305	0.2474
	0.2645	0.2819	0.2995	0.3174	0.3356
	0.3540	0.3727	0.3916	0.4108	0.4302
	0.4499	0.4699	0.4901	0.5106	0.5313
	0.5523	0.5735	0.5950	0.6168	0.6388
	0.6611	0.6836	0.7064	0.7295	0.7528
	0.7763	0.8001	0.8242	0.8486	0.8732
	0.8980	0.9231	0.9485	0.9741	1.0000
Hrad:					
	0.0248	0.0494	0.0740	0.0985	0.1228
	0.1471	0.1713	0.1954	0.2194	0.2433
	0.2672	0.2909	0.3146	0.3382	0.3623
	0.3864	0.4100	0.4331	0.4558	0.4781
	0.5000	0.5214	0.5425	0.5632	0.5835
	0.6035	0.6231	0.6425	0.6614	0.6801

	0.6985	0.7166	0.7344	0.7519	0.7692
	0.7862	0.8029	0.8194	0.8356	0.8517
	0.8674	0.8830	0.8983	0.9134	0.9284
	0.9431	0.9576	0.9719	0.9860	1.0000
Width:					
	0.6210	0.6230	0.6250	0.6270	0.6290
	0.6309	0.6329	0.6349	0.6369	0.6389
	0.6408	0.6428	0.6448	0.6468	0.6533
	0.6632	0.6731	0.6830	0.6930	0.7029
	0.7128	0.7227	0.7326	0.7425	0.7524
	0.7623	0.7722	0.7821	0.7920	0.8019
	0.8118	0.8217	0.8316	0.8415	0.8514
	0.8613	0.8712	0.8811	0.8910	0.9010
	0.9109	0.9208	0.9307	0.9406	0.9505
	0.9604	0.9703	0.9802	0.9901	1.0000
Transect 4					
Area:					
	0.0019	0.0043	0.0081	0.0134	0.0202
	0.0284	0.0381	0.0494	0.0620	0.0763
	0.0920	0.1092	0.1279	0.1470	0.1663
	0.1860	0.2060	0.2262	0.2468	0.2676
	0.2888	0.3102	0.3320	0.3540	0.3764
	0.3990	0.4220	0.4452	0.4686	0.4921
	0.5156	0.5393	0.5630	0.5868	0.6107
	0.6347	0.6588	0.6831	0.7076	0.7325
	0.7577	0.7832	0.8091	0.8354	0.8620
	0.8889	0.9162	0.9438	0.9717	1.0000
Hrad:					
	0.0773	0.1362	0.1596	0.1728	0.1833
	0.1933	0.2033	0.2134	0.2235	0.2336
	0.2438	0.2541	0.2695	0.2905	0.3122
	0.3342	0.3564	0.3787	0.4009	0.4231
	0.4453	0.4673	0.4892	0.5109	0.5325
	0.5535	0.5743	0.5961	0.6190	0.6418
	0.6647	0.6875	0.7103	0.7331	0.7557
	0.7784	0.8010	0.8198	0.8350	0.8502
	0.8654	0.8805	0.8956	0.9106	0.9257
	0.9406	0.9555	0.9704	0.9852	1.0000
Width:					
	0.0682	0.1080	0.1600	0.2120	0.2640
	0.3160	0.3680	0.4200	0.4724	0.5260
	0.5796	0.6332	0.6652	0.6756	0.6860
	0.6964	0.7068	0.7172	0.7276	0.7380
	0.7484	0.7588	0.7692	0.7796	0.7900
	0.8012	0.8124	0.8196	0.8228	0.8260

0.8292	0.8324	0.8356	0.8388	0.8420
0.8452	0.8484	0.8560	0.8680	0.8800
0.8920	0.9040	0.9160	0.9280	0.9400
0.9520	0.9640	0.9760	0.9880	1.0000

Transect 5

Area:

0.0008	0.0016	0.0025	0.0034	0.0043
0.0053	0.0063	0.0073	0.0084	0.0095
0.0106	0.0118	0.0130	0.0142	0.0155
0.0168	0.0181	0.0203	0.0241	0.0297
0.0371	0.0461	0.0569	0.0694	0.0836
0.0995	0.1172	0.1366	0.1577	0.1806
0.2052	0.2315	0.2595	0.2893	0.3207
0.3539	0.3889	0.4255	0.4639	0.5040
0.5458	0.5894	0.6347	0.6817	0.7304
0.7809	0.8331	0.8870	0.9426	1.0000

Hrad:

0.1526	0.2979	0.4367	0.5698	0.6980
0.8217	0.9416	1.0579	1.1710	1.2814
1.3891	1.4945	1.5978	1.6992	1.7988
1.8967	1.9932	2.0224	1.8683	1.6469
1.4337	1.2569	1.1196	1.0163	0.9396
0.8833	0.8425	0.8135	0.7936	0.7807
0.7733	0.7704	0.7710	0.7744	0.7803
0.7882	0.7977	0.8086	0.8207	0.8339
0.8479	0.8627	0.8782	0.8943	0.9109
0.9280	0.9455	0.9633	0.9815	1.0000

Width:

0.0139	0.0145	0.0151	0.0157	0.0163
0.0169	0.0174	0.0180	0.0186	0.0192
0.0198	0.0204	0.0210	0.0215	0.0221
0.0227	0.0233	0.0516	0.0813	0.1109
0.1405	0.1702	0.1998	0.2294	0.2591
0.2887	0.3184	0.3480	0.3776	0.4073
0.4369	0.4665	0.4962	0.5258	0.5554
0.5851	0.6147	0.6444	0.6740	0.7036
0.7333	0.7629	0.7925	0.8222	0.8518
0.8815	0.9111	0.9407	0.9704	1.0000

Transect 6

Area:

0.0052	0.0104	0.0156	0.0209	0.0262
0.0326	0.0402	0.0490	0.0590	0.0703
0.0827	0.0965	0.1114	0.1276	0.1450
0.1636	0.1834	0.2045	0.2268	0.2499

0.2732 0.2966 0.3201 0.3437 0.3674
0.3913 0.4152 0.4393 0.4635 0.4879
0.5123 0.5369 0.5616 0.5864 0.6114
0.6364 0.6616 0.6869 0.7124 0.7379
0.7636 0.7894 0.8153 0.8413 0.8674
0.8937 0.9201 0.9466 0.9732 1.0000

Hrad:

0.0547 0.1089 0.1624 0.2153 0.2672
0.3075 0.3357 0.3558 0.3706 0.3820
0.3912 0.3991 0.4061 0.4126 0.4188
0.4248 0.4307 0.4367 0.4426 0.4547
0.4691 0.4846 0.5009 0.5178 0.5353
0.5531 0.5712 0.5895 0.6079 0.6265
0.6452 0.6640 0.6828 0.7017 0.7205
0.7394 0.7583 0.7771 0.7959 0.8147
0.8334 0.8522 0.8708 0.8894 0.9080
0.9265 0.9450 0.9634 0.9817 1.0000

Width:

0.1939 0.1947 0.1956 0.1964 0.2139
0.2596 0.3054 0.3512 0.3970 0.4428
0.4885 0.5343 0.5801 0.6259 0.6717
0.7174 0.7632 0.8090 0.8548 0.8649
0.8694 0.8739 0.8784 0.8829 0.8874
0.8919 0.8964 0.9009 0.9054 0.9099
0.9144 0.9189 0.9234 0.9279 0.9324
0.9370 0.9415 0.9460 0.9505 0.9550
0.9595 0.9640 0.9685 0.9730 0.9775
0.9820 0.9865 0.9910 0.9955 1.0000

Transect 7

Area:

0.0007 0.0016 0.0024 0.0034 0.0049
0.0077 0.0118 0.0173 0.0241 0.0323
0.0419 0.0527 0.0649 0.0785 0.0934
0.1097 0.1273 0.1463 0.1666 0.1882
0.2112 0.2355 0.2609 0.2863 0.3120
0.3378 0.3637 0.3898 0.4160 0.4424
0.4689 0.4955 0.5223 0.5493 0.5763
0.6036 0.6310 0.6585 0.6861 0.7139
0.7419 0.7700 0.7982 0.8266 0.8552
0.8838 0.9127 0.9416 0.9707 1.0000

Hrad:

0.0849 0.1614 0.2317 0.2973 0.3317
0.3006 0.2689 0.2491 0.2390 0.2354
0.2361 0.2398 0.2455 0.2527 0.2609
0.2699 0.2796 0.2897 0.3003 0.3111

0.3222 0.3336 0.3543 0.3780 0.4020
0.4262 0.4505 0.4748 0.4992 0.5236
0.5480 0.5724 0.5968 0.6210 0.6453
0.6695 0.6936 0.7176 0.7416 0.7655
0.7893 0.8131 0.8367 0.8603 0.8838
0.9072 0.9305 0.9538 0.9769 1.0000

Width:

0.0264 0.0289 0.0314 0.0338 0.0725
0.1184 0.1643 0.2102 0.2561 0.3020
0.3479 0.3938 0.4397 0.4856 0.5315
0.5774 0.6233 0.6692 0.7151 0.7610
0.8069 0.8528 0.8668 0.8718 0.8767
0.8816 0.8866 0.8915 0.8964 0.9014
0.9063 0.9112 0.9162 0.9211 0.9260
0.9310 0.9359 0.9408 0.9458 0.9507
0.9556 0.9605 0.9655 0.9704 0.9753
0.9803 0.9852 0.9901 0.9951 1.0000

Transect 8

Area:

0.0033 0.0066 0.0100 0.0134 0.0190
0.0345 0.0512 0.0682 0.0854 0.1028
0.1205 0.1384 0.1566 0.1750 0.1937
0.2126 0.2317 0.2511 0.2708 0.2906
0.3107 0.3311 0.3517 0.3726 0.3937
0.4150 0.4366 0.4584 0.4805 0.5028
0.5253 0.5481 0.5711 0.5944 0.6179
0.6417 0.6657 0.6900 0.7145 0.7392
0.7642 0.7894 0.8149 0.8406 0.8666
0.8928 0.9192 0.9459 0.9728 1.0000

Hrad:

0.0646 0.1281 0.1907 0.2524 0.2679
0.1980 0.1911 0.2013 0.2174 0.2363
0.2565 0.2774 0.2986 0.3200 0.3415
0.3629 0.3842 0.4053 0.4264 0.4472
0.4679 0.4885 0.5089 0.5290 0.5491
0.5689 0.5886 0.6080 0.6274 0.6465
0.6655 0.6844 0.7031 0.7216 0.7400
0.7582 0.7763 0.7943 0.8121 0.8298
0.8474 0.8648 0.8821 0.8993 0.9164
0.9333 0.9501 0.9669 0.9835 1.0000

Width:

0.1213 0.1229 0.1245 0.1260 0.4120
0.6078 0.6168 0.6257 0.6346 0.6435
0.6524 0.6613 0.6702 0.6791 0.6881
0.6970 0.7059 0.7148 0.7237 0.7326

0.7415 0.7504 0.7594 0.7683 0.7772
0.7861 0.7950 0.8039 0.8128 0.8217
0.8307 0.8396 0.8485 0.8574 0.8663
0.8752 0.8841 0.8930 0.9020 0.9109
0.9198 0.9287 0.9376 0.9465 0.9554
0.9643 0.9733 0.9822 0.9911 1.0000

Transect 9
Area:
0.0039 0.0079 0.0119 0.0159 0.0199
0.0240 0.0280 0.0321 0.0367 0.0435
0.0524 0.0636 0.0770 0.0926 0.1105
0.1306 0.1528 0.1756 0.1986 0.2218
0.2452 0.2688 0.2925 0.3164 0.3405
0.3647 0.3892 0.4138 0.4386 0.4635
0.4887 0.5140 0.5395 0.5652 0.5910
0.6170 0.6432 0.6696 0.6962 0.7229
0.7498 0.7769 0.8042 0.8316 0.8592
0.8870 0.9150 0.9432 0.9715 1.0000
Hrad:
0.0630 0.1255 0.1877 0.2494 0.3108
0.3717 0.4323 0.4925 0.5438 0.5578
0.5473 0.5257 0.5016 0.4789 0.4594
0.4434 0.4337 0.4360 0.4433 0.4540
0.4671 0.4817 0.4975 0.5142 0.5316
0.5494 0.5676 0.5860 0.6047 0.6235
0.6425 0.6615 0.6805 0.6996 0.7187
0.7378 0.7568 0.7759 0.7949 0.8138
0.8327 0.8516 0.8704 0.8891 0.9077
0.9263 0.9449 0.9633 0.9817 1.0000
Width:
0.1383 0.1390 0.1398 0.1405 0.1413
0.1420 0.1428 0.1435 0.1957 0.2737
0.3517 0.4297 0.5077 0.5857 0.6637
0.7417 0.7958 0.8020 0.8082 0.8144
0.8206 0.8268 0.8329 0.8391 0.8453
0.8515 0.8577 0.8639 0.8701 0.8763
0.8824 0.8886 0.8948 0.9010 0.9072
0.9134 0.9196 0.9258 0.9319 0.9381
0.9443 0.9505 0.9567 0.9629 0.9691
0.9753 0.9814 0.9876 0.9938 1.0000

Transect C11/C17/C18
Area:
0.0102 0.0205 0.0308 0.0412 0.0516
0.0623 0.0734 0.0848 0.0967 0.1089

0.1216 0.1346 0.1480 0.1618 0.1760
0.1906 0.2056 0.2209 0.2367 0.2528
0.2694 0.2863 0.3036 0.3213 0.3394
0.3580 0.3773 0.3972 0.4178 0.4390
0.4609 0.4834 0.5066 0.5304 0.5549
0.5800 0.6058 0.6322 0.6593 0.6870
0.7154 0.7444 0.7741 0.8044 0.8354
0.8670 0.8993 0.9322 0.9658 1.0000
Hrad:
0.0345 0.0687 0.1027 0.1364 0.1699
0.1977 0.2248 0.2512 0.2770 0.3023
0.3271 0.3514 0.3754 0.3989 0.4222
0.4451 0.4677 0.4901 0.5122 0.5340
0.5557 0.5771 0.5984 0.6195 0.6404
0.6524 0.6648 0.6774 0.6904 0.7036
0.7170 0.7307 0.7445 0.7586 0.7728
0.7872 0.8017 0.8164 0.8312 0.8461
0.8611 0.8762 0.8914 0.9067 0.9220
0.9375 0.9530 0.9686 0.9843 1.0000
Width:
0.2960 0.2979 0.2998 0.3016 0.3035
0.3148 0.3261 0.3374 0.3487 0.3600
0.3713 0.3826 0.3939 0.4052 0.4165
0.4278 0.4391 0.4504 0.4616 0.4729
0.4842 0.4955 0.5068 0.5181 0.5294
0.5482 0.5671 0.5859 0.6047 0.6235
0.6424 0.6612 0.6800 0.6988 0.7176
0.7365 0.7553 0.7741 0.7929 0.8118
0.8306 0.8494 0.8682 0.8871 0.9059
0.9247 0.9435 0.9624 0.9812 1.0000

Transect C18_3
Area:
0.0024 0.0048 0.0073 0.0099 0.0125
0.0156 0.0197 0.0246 0.0305 0.0373
0.0449 0.0535 0.0630 0.0734 0.0847
0.0969 0.1101 0.1241 0.1390 0.1549
0.1716 0.1893 0.2078 0.2273 0.2477
0.2689 0.2908 0.3135 0.3369 0.3611
0.3860 0.4117 0.4381 0.4652 0.4931
0.5217 0.5510 0.5811 0.6119 0.6435
0.6758 0.7089 0.7427 0.7772 0.8125
0.8485 0.8853 0.9228 0.9610 1.0000
Hrad:
0.0793 0.1557 0.2295 0.3010 0.3703
0.4324 0.4679 0.4878 0.4994 0.5070

0.5129 0.5185 0.5242 0.5304 0.5372
0.5446 0.5525 0.5610 0.5701 0.5795
0.5894 0.5996 0.6102 0.6210 0.6321
0.6460 0.6601 0.6744 0.6889 0.7035
0.7181 0.7328 0.7476 0.7624 0.7772
0.7920 0.8069 0.8218 0.8367 0.8515
0.8664 0.8813 0.8962 0.9110 0.9259
0.9407 0.9555 0.9704 0.9852 1.0000

Width:

0.0607 0.0626 0.0645 0.0664 0.0682
0.0913 0.1144 0.1374 0.1605 0.1835
0.2066 0.2296 0.2527 0.2758 0.2988
0.3219 0.3449 0.3680 0.3911 0.4141
0.4372 0.4602 0.4833 0.5064 0.5294
0.5482 0.5671 0.5859 0.6047 0.6235
0.6424 0.6612 0.6800 0.6988 0.7176
0.7365 0.7553 0.7741 0.7929 0.8118
0.8306 0.8494 0.8682 0.8871 0.9059
0.9247 0.9435 0.9624 0.9812 1.0000

Transect C19

Area:

0.0017 0.0034 0.0052 0.0075 0.0101
0.0131 0.0165 0.0204 0.0246 0.0292
0.0343 0.0397 0.0456 0.0518 0.0585
0.0656 0.0730 0.0809 0.0892 0.0979
0.1069 0.1164 0.1263 0.1366 0.1473
0.1592 0.1729 0.1884 0.2058 0.2251
0.2462 0.2691 0.2940 0.3206 0.3492
0.3796 0.4118 0.4459 0.4819 0.5197
0.5594 0.6009 0.6443 0.6896 0.7367
0.7856 0.8364 0.8891 0.9436 1.0000

Hrad:

0.1324 0.2582 0.3810 0.4805 0.5564
0.6166 0.6662 0.7084 0.7454 0.7787
0.8091 0.8374 0.8640 0.8894 0.9138
0.9374 0.9604 0.9828 1.0048 1.0264
1.0478 1.0689 1.0898 1.1105 1.1311
1.0915 1.0605 1.0346 1.0124 0.9931
0.9765 0.9626 0.9510 0.9418 0.9347
0.9297 0.9265 0.9251 0.9253 0.9269
0.9299 0.9340 0.9393 0.9456 0.9528
0.9608 0.9696 0.9791 0.9893 1.0000

Width:

0.0296 0.0309 0.0351 0.0422 0.0492
0.0563 0.0633 0.0704 0.0774 0.0845

0.0915 0.0986 0.1056 0.1127 0.1197
0.1268 0.1339 0.1409 0.1480 0.1550
0.1621 0.1691 0.1762 0.1832 0.1903
0.2227 0.2551 0.2874 0.3198 0.3522
0.3846 0.4170 0.4494 0.4818 0.5142
0.5466 0.5789 0.6113 0.6437 0.6761
0.7085 0.7409 0.7733 0.8057 0.8381
0.8704 0.9028 0.9352 0.9676 1.0000

Transect C25
Area:
0.0022 0.0046 0.0071 0.0102 0.0137
0.0178 0.0225 0.0276 0.0333 0.0395
0.0462 0.0535 0.0612 0.0695 0.0783
0.0877 0.0976 0.1079 0.1189 0.1303
0.1423 0.1548 0.1678 0.1819 0.1973
0.2140 0.2320 0.2513 0.2718 0.2937
0.3168 0.3412 0.3669 0.3938 0.4221
0.4516 0.4824 0.5146 0.5479 0.5826
0.6186 0.6558 0.6943 0.7342 0.7753
0.8176 0.8613 0.9063 0.9525 1.0000
Hrad:
0.1062 0.2072 0.3043 0.3803 0.4395
0.4874 0.5276 0.5623 0.5929 0.6206
0.6460 0.6697 0.6920 0.7133 0.7337
0.7534 0.7725 0.7912 0.8095 0.8274
0.8451 0.8625 0.8741 0.8712 0.8691
0.8676 0.8667 0.8663 0.8666 0.8674
0.8689 0.8711 0.8739 0.8773 0.8814
0.8861 0.8913 0.8971 0.9035 0.9103
0.9176 0.9253 0.9335 0.9420 0.9509
0.9601 0.9697 0.9795 0.9896 1.0000
Width:
0.0475 0.0495 0.0579 0.0688 0.0797
0.0906 0.1015 0.1124 0.1233 0.1341
0.1450 0.1559 0.1668 0.1777 0.1886
0.1995 0.2104 0.2213 0.2321 0.2430
0.2539 0.2648 0.2800 0.3067 0.3333
0.3600 0.3867 0.4133 0.4400 0.4667
0.4933 0.5200 0.5467 0.5733 0.6000
0.6267 0.6533 0.6800 0.7067 0.7333
0.7600 0.7867 0.8133 0.8400 0.8667
0.8933 0.9200 0.9467 0.9733 1.0000

Transect C26
Area:

0.0015 0.0031 0.0050 0.0077 0.0111
0.0154 0.0205 0.0264 0.0332 0.0408
0.0492 0.0584 0.0685 0.0793 0.0910
0.1036 0.1169 0.1311 0.1461 0.1620
0.1786 0.1961 0.2144 0.2336 0.2536
0.2743 0.2958 0.3181 0.3411 0.3649
0.3895 0.4148 0.4409 0.4677 0.4953
0.5236 0.5527 0.5826 0.6132 0.6445
0.6767 0.7096 0.7432 0.7776 0.8128
0.8487 0.8854 0.9228 0.9610 1.0000
Hrad:
0.0980 0.1860 0.2702 0.3225 0.3508
0.3690 0.3830 0.3953 0.4071 0.4189
0.4308 0.4429 0.4552 0.4678 0.4805
0.4935 0.5067 0.5200 0.5334 0.5470
0.5607 0.5745 0.5884 0.6023 0.6164
0.6317 0.6470 0.6624 0.6778 0.6932
0.7086 0.7240 0.7394 0.7548 0.7702
0.7855 0.8009 0.8163 0.8316 0.8470
0.8623 0.8777 0.8930 0.9083 0.9236
0.9389 0.9542 0.9695 0.9847 1.0000
Width:
0.0400 0.0439 0.0563 0.0773 0.0983
0.1193 0.1402 0.1612 0.1822 0.2032
0.2242 0.2452 0.2662 0.2872 0.3082
0.3292 0.3501 0.3711 0.3921 0.4131
0.4341 0.4551 0.4761 0.4971 0.5181
0.5373 0.5566 0.5759 0.5952 0.6145
0.6337 0.6530 0.6723 0.6916 0.7108
0.7301 0.7494 0.7687 0.7880 0.8072
0.8265 0.8458 0.8651 0.8843 0.9036
0.9229 0.9422 0.9614 0.9807 1.0000

Transect C27
Area:
0.0068 0.0137 0.0208 0.0284 0.0366
0.0454 0.0548 0.0648 0.0753 0.0865
0.0982 0.1105 0.1235 0.1370 0.1511
0.1657 0.1810 0.1969 0.2133 0.2303
0.2480 0.2662 0.2850 0.3043 0.3243
0.3449 0.3659 0.3876 0.4097 0.4324
0.4557 0.4795 0.5038 0.5286 0.5541
0.5800 0.6065 0.6335 0.6611 0.6892
0.7178 0.7470 0.7768 0.8070 0.8378
0.8692 0.9011 0.9335 0.9665 1.0000
Hrad:

```
             0.0521     0.1033     0.1540     0.2010     0.2436
             0.2825     0.3182     0.3513     0.3819     0.4104
             0.4372     0.4623     0.4859     0.5083     0.5296
             0.5498     0.5691     0.5876     0.6053     0.6224
             0.6388     0.6547     0.6701     0.6849     0.6994
             0.7139     0.7281     0.7421     0.7557     0.7691
             0.7823     0.7952     0.8080     0.8205     0.8328
             0.8449     0.8569     0.8687     0.8803     0.8918
             0.9032     0.9144     0.9255     0.9364     0.9473
             0.9580     0.9687     0.9792     0.9896     1.0000
Width:
             0.2032     0.2064     0.2167     0.2341     0.2516
             0.2690     0.2864     0.3038     0.3212     0.3387
             0.3561     0.3735     0.3909     0.4084     0.4258
             0.4432     0.4606     0.4780     0.4955     0.5129
             0.5303     0.5477     0.5652     0.5826     0.6000
             0.6160     0.6320     0.6480     0.6640     0.6800
             0.6960     0.7120     0.7280     0.7440     0.7600
             0.7760     0.7920     0.8080     0.8240     0.8400
             0.8560     0.8720     0.8880     0.9040     0.9200
             0.9360     0.9520     0.9680     0.9840     1.0000


**********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
**********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ YES
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/30/2020 00:00:00
Ending Date .............. 10/03/2020 00:00:00
```

```
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 8
Number of Threads ........ 2
Head Tolerance ........... 0.001500 m
```

Runoff Quantity Continuity	Volume hectare-m	Depth mm
Total Precipitation	450.448	113.824
Evaporation Loss	0.000	0.000
Infiltration Loss	373.231	94.312
Surface Runoff	67.107	16.957
Final Storage	10.143	2.563
Continuity Error (%)	-0.007	

Flow Routing Continuity	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	67.104	671.045
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	1.407	14.071
External Outflow	45.704	457.043
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	2.852	28.517
Final Stored Volume	25.801	258.014
Continuity Error (%)	-0.200	

```
Highest Continuity Errors
Node KR403 (8.46%)
Node KR410 (-4.91%)
Node TaiteLake (3.48%)
Node WestLake (3.29%)
```

Node KR411 (2.72%)

****
Time-Step Critical Elements
****
Link CL701_3 (57.99%)
Link BD725 (6.41%)
Link BD770_1 (6.31%)
Link BD713_1 (2.62%)
Link BD774_3 (1.01%)

****
Highest Flow Instability Indexes
****
Link OR-EP-2 (8)
Link BD774_3 (8)
Link BD774_4 (8)
Link OR-EP-3 (8)
Link BD774_2 (8)

****
Routing Time Step Summary
****
Minimum Time Step   :   0.63 sec
Average Time Step   :   3.82 sec
Maximum Time Step   :   5.00 sec
Percent in Steady State   :   -0.00
Average Iterations per Step :   2.24
Percent Not Converging   :   0.41
Time Step Frequencies   :
    5.000 - 3.155 sec   :   68.90 %
    3.155 - 1.991 sec   :   30.89 %
    1.991 - 1.256 sec   :   0.20 %
    1.256 - 0.792 sec   :   0.00 %
    0.792 - 0.500 sec   :   0.00 %

****
Subcatchment Runoff Summary
****

	Total	Total	Total	Total	Imperv	Perv	Total	Total	Peak	Runoff

Subcatchment	Precip mm	Runon mm	Evap mm	Infil mm	Runoff mm	Runoff mm	Runoff mm	Runoff 10^6 ltr	Runoff CMS	Coeff
BD100_1	113.82	0.00	0.00	85.75	6.68	21.72	28.40	5.54	2.54	0.250
BD100_2	113.82	0.00	0.00	85.40	6.68	22.34	29.02	4.25	2.42	0.255
BD101_1	113.82	0.00	0.00	85.60	6.68	21.95	28.63	2.12	1.03	0.252
BD101_2	113.82	0.00	0.00	85.41	6.68	22.30	28.98	1.55	0.87	0.255
BD102_1	113.82	0.00	0.00	85.33	6.68	22.48	29.16	1.31	0.79	0.256
BD102_2	113.82	0.00	0.00	85.39	6.68	22.36	29.04	2.12	1.22	0.255
BD103	113.82	0.00	0.00	1.02	105.98	4.68	110.66	2.09	0.61	0.972
BD104	113.82	0.00	0.00	85.67	6.68	21.83	28.51	3.36	1.58	0.250
BD105	113.82	0.00	0.00	85.18	6.68	23.01	29.69	0.53	0.36	0.261
BD106	113.82	0.00	0.00	85.12	6.68	23.36	30.04	0.79	0.55	0.264
BD108	113.82	0.00	0.00	85.18	6.68	22.99	29.67	0.89	0.60	0.261
BD109	113.82	0.00	0.00	85.19	6.68	22.97	29.65	0.68	0.46	0.261
BD111	113.82	0.00	0.00	1.01	105.97	4.69	110.66	0.82	0.26	0.972
BD115	113.82	0.00	0.00	66.60	40.22	11.98	43.82	4.49	0.57	0.385
BD120	113.82	0.00	0.00	56.39	4.46	53.16	57.61	0.41	0.24	0.506
BD121	113.82	0.00	0.00	56.39	4.46	53.16	57.61	0.34	0.20	0.506
BD123_2	113.82	0.00	0.00	1.01	105.96	4.69	110.65	0.71	0.23	0.972
BD123_3	113.82	0.00	0.00	85.08	6.69	23.64	30.33	0.50	0.35	0.266
BD123_4	113.82	0.00	0.00	73.36	19.79	17.79	37.58	0.21	0.05	0.330
BD123_5	113.82	0.00	0.00	1.01	105.95	4.69	110.64	0.58	0.19	0.972
BD123_6	113.82	0.00	0.00	71.64	19.80	19.56	39.37	0.11	0.03	0.346
BD123_7	113.82	0.00	0.00	85.15	6.68	23.13	29.81	0.41	0.28	0.262
BD124_2	113.82	0.00	0.00	1.01	105.98	4.69	110.66	0.65	0.21	0.972
BD124_3	113.82	0.00	0.00	85.18	6.68	23.02	29.70	0.58	0.39	0.261
BD124_4	113.82	0.00	0.00	71.06	19.81	20.17	39.98	0.16	0.05	0.351
BD126_1	113.82	0.00	0.00	85.14	6.68	23.22	29.90	0.56	0.39	0.263
BD126_2	113.82	0.00	0.00	1.02	105.98	4.68	110.67	1.01	0.30	0.972
BD127_1	113.82	0.00	0.00	1.02	105.98	4.69	110.67	0.91	0.28	0.972
BD127_2	113.82	0.00	0.00	85.15	6.68	23.13	29.81	0.42	0.29	0.262
BD127_4	113.82	0.00	0.00	72.37	20.58	18.80	39.38	0.10	0.03	0.346
BD127_5	113.82	0.00	0.00	72.15	20.58	19.04	39.62	0.19	0.05	0.348
BD127_6	113.82	0.00	0.00	1.01	105.98	4.69	110.66	1.28	0.41	0.972
BD127_7	113.82	0.00	0.00	85.11	6.69	23.42	30.11	0.45	0.32	0.265
BD128_1	113.82	0.00	0.00	1.01	105.96	4.69	110.65	0.39	0.13	0.972
BD128_2	113.82	0.00	0.00	71.08	20.59	20.15	40.73	0.11	0.04	0.358
BD128_4	113.82	0.00	0.00	85.11	6.69	23.42	30.11	0.48	0.34	0.265
BD128_5	113.82	0.00	0.00	73.01	20.58	18.15	38.72	0.09	0.02	0.340
BD130_1	113.82	0.00	0.00	1.02	105.98	4.69	110.67	2.41	0.73	0.972
BD130_2	113.82	0.00	0.00	1.02	105.98	4.69	110.66	1.12	0.36	0.972
BD132	113.82	0.00	0.00	1.02	105.98	4.69	110.67	1.23	0.38	0.972
BD133_1	113.82	0.00	0.00	1.02	105.96	4.68	110.64	1.57	0.42	0.972
BD133_2	113.82	0.00	0.00	1.01	105.96	4.69	110.65	0.21	0.07	0.972
BD133_4	113.82	0.00	0.00	1.01	105.97	4.69	110.65	0.28	0.09	0.972

BD133_5	113.82	0.00	0.00	1.01	105.97	4.69	110.65	0.23	0.07	0.972
BD138_1	113.82	0.00	0.00	1.02	105.98	4.68	110.66	1.57	0.45	0.972
BD138_2	113.82	0.00	0.00	1.02	105.98	4.69	110.67	1.06	0.32	0.972
BD139_2	113.82	0.00	0.00	1.02	105.98	4.69	110.67	0.71	0.22	0.972
BD139_3	113.82	0.00	0.00	96.14	4.95	12.02	16.97	0.25	0.04	0.149
BD139_4	113.82	0.00	0.00	93.24	4.95	14.94	19.89	0.23	0.04	0.175
BD142_1	113.82	0.00	0.00	72.06	28.09	13.34	41.43	0.68	0.11	0.364
BD142_2	113.82	0.00	0.00	71.39	28.09	14.02	42.12	0.21	0.04	0.370
BD143	113.82	40.24	0.00	1.03	144.21	6.69	150.90	3.98	0.98	0.979
BD146_1	113.82	0.00	0.00	62.13	30.82	17.70	48.52	0.57	0.17	0.426
BD146_2	113.82	0.00	0.00	1.02	105.98	4.69	110.67	1.84	0.55	0.972
BD146_3	113.82	0.00	0.00	49.95	16.70	47.05	63.75	0.68	0.36	0.560
BD146_4	113.82	0.00	0.00	49.96	16.70	47.03	63.74	0.54	0.28	0.560
BD148_2	113.82	0.00	0.00	49.96	16.70	47.03	63.73	0.77	0.40	0.560
BD149_2	113.82	0.00	0.00	66.74	25.73	18.78	44.50	0.25	0.08	0.391
BD149_3	113.82	0.00	0.00	49.94	16.70	47.05	63.75	0.48	0.25	0.560
BD149_4	113.82	0.00	0.00	66.07	25.73	19.49	45.22	0.15	0.05	0.397
BD149_5	113.82	0.00	0.00	49.94	16.70	47.05	63.75	0.64	0.34	0.560
BD151_1	113.82	0.00	0.00	74.13	20.57	17.01	37.58	0.20	0.04	0.330
BD151_3	113.82	0.00	0.00	49.96	16.70	47.03	63.74	0.57	0.30	0.560
BD151_4	113.82	0.00	0.00	1.01	105.97	4.69	110.65	0.47	0.15	0.972
BD151_5	113.82	0.00	0.00	1.01	105.93	4.69	110.61	0.42	0.14	0.972
BD152_1	113.82	0.00	0.00	1.02	105.98	4.69	110.67	1.51	0.48	0.972
BD152_3	113.82	0.00	0.00	64.53	29.67	15.22	44.89	1.03	0.23	0.394
BD152_4	113.82	0.00	0.00	49.95	16.70	47.04	63.75	0.66	0.35	0.560
BD154_1	113.82	0.00	0.00	49.98	16.70	47.01	63.71	1.07	0.54	0.560
BD154_3	113.82	0.00	0.00	49.98	16.70	47.01	63.71	0.65	0.33	0.560
BD154_4	113.82	0.00	0.00	65.00	29.67	14.74	44.41	0.56	0.12	0.390
BD156_1	113.82	0.00	0.00	49.99	16.70	46.99	63.69	1.49	0.75	0.560
BD156_2	113.82	0.00	0.00	59.01	44.26	9.31	53.57	1.91	0.21	0.471
BD157_1	113.82	0.00	0.00	69.71	33.67	9.99	43.66	0.99	0.12	0.384
BD157_3	113.82	0.00	0.00	49.97	16.72	47.01	63.74	0.91	0.46	0.560
BD157_4	113.82	0.00	0.00	49.97	16.72	47.01	63.74	1.24	0.63	0.560
BD157_5	113.82	0.00	0.00	66.78	33.70	12.94	46.64	0.28	0.04	0.410
BD159_2	113.82	0.00	0.00	36.31	44.57	32.04	76.62	3.44	0.97	0.673
BD161_1	113.82	0.00	0.00	64.05	29.68	15.71	45.39	0.14	0.03	0.399
BD161_2	113.82	0.00	0.00	1.02	105.98	4.69	110.67	0.74	0.23	0.972
BD162	113.82	0.00	0.00	35.92	44.55	32.45	77.00	1.91	0.59	0.677
BD163	113.82	0.00	0.00	36.25	44.57	32.10	76.67	3.63	1.03	0.674
BD166_1	113.82	0.00	0.00	61.82	29.70	18.03	47.73	0.26	0.08	0.419
BD166_2	113.82	0.00	0.00	37.54	44.61	30.79	75.40	3.28	0.79	0.662
BD168_1	113.82	0.00	0.00	36.95	44.60	31.38	75.98	7.85	2.00	0.668
BD168_2	113.82	0.00	0.00	64.28	29.67	15.47	45.15	0.12	0.03	0.397
BD169	113.82	0.00	0.00	36.37	44.68	31.98	76.66	3.93	1.09	0.673
BD171	113.82	0.00	0.00	56.39	4.46	53.16	57.61	0.23	0.14	0.506
BD173	113.82	0.00	0.00	56.39	4.46	53.16	57.61	0.41	0.24	0.506

BD175	113.82	0.00	0.00	56.35	4.46	53.18	57.64	0.35	0.21	0.506
BD176	113.82	0.00	0.00	56.35	4.46	53.18	57.64	0.26	0.16	0.506
BD177	113.82	0.00	0.00	56.44	4.46	53.10	57.56	0.42	0.24	0.506
BD179	113.82	0.00	0.00	56.38	4.46	53.16	57.62	0.28	0.17	0.506
BD180	113.82	0.00	0.00	56.46	4.46	53.07	57.53	0.92	0.50	0.505
BD181	113.82	0.00	0.00	56.37	4.45	53.17	57.62	0.91	0.55	0.506
BD181_1	113.82	0.00	0.00	56.37	4.45	53.17	57.62	0.88	0.53	0.506
BD181_2	113.82	0.00	0.00	56.37	4.46	53.17	57.63	0.87	0.52	0.506
BD1EastPond	113.82	0.00	0.00	0.00	113.93	0.00	113.93	1.15	0.22	1.001
BD1NorthPond	113.82	0.00	0.00	0.00	113.91	0.00	113.91	1.52	0.27	1.001
BD1SouthPond	113.82	0.00	0.00	0.00	113.93	0.00	113.93	0.99	0.19	1.001
BDPit	113.82	0.00	0.00	11.92	88.99	10.88	99.87	28.93	3.92	0.877
CL101	113.82	0.00	0.00	68.19	40.96	5.80	41.54	41.78	2.53	0.365
CL102	113.82	0.00	0.00	72.51	37.17	6.04	37.77	4.04	0.26	0.332
KR100	113.82	0.00	0.00	104.59	8.22	2.41	8.46	17.68	1.05	0.074
KR101	113.82	0.00	0.00	93.38	17.99	6.79	18.67	21.10	0.74	0.164
KR102	113.82	0.00	0.00	49.40	41.51	0.68	41.58	77.07	0.67	0.365
KR103	113.82	0.00	0.00	107.65	5.45	1.62	5.62	21.90	1.46	0.049
KR104	113.82	0.00	0.00	96.99	13.73	0.90	13.82	64.92	1.21	0.121
KR105	113.82	0.00	0.00	87.86	22.70	2.07	22.91	33.82	1.10	0.201
KR107	113.82	0.00	0.00	70.26	39.28	8.29	40.11	3.63	0.29	0.352
KR108	113.82	0.00	0.00	38.98	66.95	7.71	67.72	12.92	0.95	0.595
KR109	113.82	0.00	0.00	67.31	39.65	3.27	39.98	68.66	2.27	0.351
KR110	113.82	0.00	0.00	99.42	12.68	6.44	13.33	9.41	0.63	0.117
KR111	113.82	0.00	0.00	111.52	2.06	1.16	2.18	10.05	0.81	0.019
KR112	113.82	0.00	0.00	104.86	7.76	1.00	7.86	24.35	1.02	0.069
KR113	113.82	0.00	0.00	111.40	0.00	2.42	2.42	1.73	0.19	0.021
KR114	113.82	0.00	0.00	112.92	0.00	0.91	0.91	1.66	0.17	0.008
KR115	113.82	0.00	0.00	108.04	5.12	1.23	5.24	17.87	1.12	0.046
KR116	113.82	0.00	0.00	86.25	25.37	2.54	25.62	48.84	1.79	0.225
KR117	113.82	0.00	0.00	94.67	17.02	3.23	17.34	28.23	1.56	0.152
KR118	113.82	0.00	0.00	90.10	22.01	3.24	22.33	21.62	1.13	0.196
KR119	113.82	0.00	0.00	86.06	2.97	24.56	27.53	0.50	0.20	0.242
KR120	113.82	0.00	0.00	98.18	1.14	14.53	2.59	0.15	0.02	0.023

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Node Depth Summary
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Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
BD400	JUNCTION	0.02	0.49	164.55	0 12:10	0.49

BD401	JUNCTION	0.02	0.61	155.16	0	12:08	0.60
BD401_2	JUNCTION	0.02	0.51	145.86	0	12:11	0.50
BD402	JUNCTION	0.02	0.58	144.48	0	12:12	0.57
BD403	JUNCTION	0.10	0.98	140.83	0	12:16	0.98
BD404	JUNCTION	0.01	0.34	164.22	0	12:10	0.34
BD405	JUNCTION	0.02	0.50	153.47	0	12:10	0.50
BD406	JUNCTION	0.02	0.54	148.53	0	12:09	0.54
BD407	JUNCTION	0.04	0.61	143.61	0	12:12	0.60
BD408	JUNCTION	0.01	0.32	153.29	0	12:07	0.31
BD409	JUNCTION	0.01	0.39	148.19	0	12:10	0.39
BD412	JUNCTION	0.13	1.14	133.74	0	12:18	1.14
BD413	JUNCTION	0.22	1.15	132.15	0	12:53	1.15
BD414	JUNCTION	0.11	0.65	129.44	0	12:53	0.65
BD415	JUNCTION	0.05	0.43	144.58	0	12:26	0.43
BD420	JUNCTION	0.01	0.22	154.29	0	12:01	0.21
BD421	JUNCTION	0.01	0.19	155.07	0	12:01	0.18
BD422	JUNCTION	0.01	0.24	151.18	0	12:05	0.24
BD423	JUNCTION	0.03	0.43	169.51	0	12:05	0.43
BD423_2	JUNCTION	0.03	0.46	168.70	0	12:05	0.45
BD423_3	JUNCTION	0.03	0.51	165.14	0	12:05	0.50
BD424	JUNCTION	0.04	0.56	161.81	0	12:05	0.56
BD424_2	JUNCTION	0.04	0.57	158.99	0	12:06	0.56
BD425	JUNCTION	0.04	0.50	157.94	0	12:07	0.49
BD426	JUNCTION	0.06	0.63	160.75	0	12:08	0.63
BD427	JUNCTION	0.04	0.48	165.67	0	12:08	0.48
BD427_2	JUNCTION	0.05	0.55	163.50	0	12:07	0.55
BD428	JUNCTION	0.01	0.28	169.36	0	12:05	0.27
BD428_2	JUNCTION	0.01	0.30	166.88	0	12:07	0.29
BD429	JUNCTION	0.07	0.80	156.78	0	12:07	0.77
BD430	JUNCTION	0.06	0.65	153.32	0	12:07	0.63
BD431	JUNCTION	0.12	1.58	138.49	0	12:12	1.55
BD432	JUNCTION	0.05	0.71	136.63	0	12:10	0.71
BD433	JUNCTION	0.01	0.14	172.14	0	12:02	0.13
BD434	JUNCTION	0.02	0.20	169.70	0	12:07	0.20
BD435	JUNCTION	0.03	0.37	169.37	0	12:06	0.37
BD435_1	JUNCTION	0.02	0.29	171.29	0	12:01	0.28
BD439	JUNCTION	0.05	0.60	167.60	0	12:08	0.60
BD440	JUNCTION	0.07	0.80	167.40	0	12:19	0.80
BD441	JUNCTION	0.07	0.86	167.36	0	12:21	0.86
BD442	JUNCTION	0.06	0.63	166.95	0	12:26	0.63
BD445	JUNCTION	0.01	0.20	157.81	0	12:01	0.19
BD446	JUNCTION	0.01	0.28	154.56	0	12:02	0.27
BD446_2	JUNCTION	0.02	0.34	149.85	0	12:02	0.33
BD446_3	JUNCTION	0.02	0.38	145.42	0	12:02	0.37
BD447	JUNCTION	0.05	0.73	141.35	0	12:05	0.73
BD448	JUNCTION	0.01	0.25	162.44	0	12:00	0.25

BD449	JUNCTION	0.01	0.20	162.40	0	12:00	0.20
BD450	JUNCTION	0.01	0.26	153.87	0	12:01	0.25
BD451	JUNCTION	0.01	0.31	147.69	0	12:02	0.30
BD452	JUNCTION	0.04	0.56	150.57	0	12:05	0.56
BD453	JUNCTION	0.04	0.53	151.98	0	12:04	0.53
BD454	JUNCTION	0.01	0.21	164.84	0	12:00	0.21
BD455	JUNCTION	0.02	0.33	161.38	0	12:02	0.32
BD456	JUNCTION	0.03	0.36	164.98	0	12:02	0.35
BD457	JUNCTION	0.03	0.43	158.35	0	12:03	0.43
BD458	JUNCTION	0.04	0.50	155.78	0	12:04	0.50
BD459	JUNCTION	0.02	0.46	158.97	0	12:01	0.44
BD460	JUNCTION	0.02	0.39	157.49	0	12:07	0.38
BD461	JUNCTION	0.03	0.42	155.89	0	12:02	0.41
BD462	JUNCTION	0.03	0.41	158.92	0	12:02	0.40
BD463	JUNCTION	0.04	0.63	158.26	0	12:04	0.63
BD464	JUNCTION	0.05	0.68	156.57	0	12:11	0.68
BD465	JUNCTION	0.07	0.75	156.05	0	12:15	0.75
BD466	JUNCTION	0.02	0.33	162.86	0	12:00	0.32
BD467	JUNCTION	0.02	0.32	159.68	0	12:01	0.31
BD468	JUNCTION	0.05	0.63	163.16	0	12:00	0.62
BD469	JUNCTION	0.07	0.82	157.79	0	12:11	0.81
BD470	JUNCTION	0.10	0.36	153.36	0	13:51	0.36
BD471	JUNCTION	0.01	0.18	165.33	0	12:02	0.17
BD472	JUNCTION	0.01	0.26	163.67	0	12:07	0.25
BD473	JUNCTION	0.01	0.24	165.86	0	12:01	0.23
BD474	JUNCTION	0.15	0.73	129.98	0	13:37	0.72
BD474_2	JUNCTION	0.07	0.34	129.13	0	13:01	0.34
BD474_3	JUNCTION	0.00	0.00	130.00	0	00:00	0.00
BD475	JUNCTION	0.01	0.21	135.73	0	12:01	0.20
BD476	JUNCTION	0.01	0.28	133.80	0	12:03	0.28
BD477	JUNCTION	0.02	0.46	132.77	0	12:05	0.46
BD478	JUNCTION	0.01	0.23	131.48	0	12:06	0.22
BD479	JUNCTION	0.00	0.15	135.67	0	12:01	0.15
BD480	JUNCTION	0.01	0.30	153.65	0	12:03	0.30
BD481	JUNCTION	0.01	0.31	153.65	0	12:01	0.29
BD482	JUNCTION	0.02	0.49	145.15	0	12:08	0.49
BD483	JUNCTION	0.03	0.45	154.43	0	12:07	0.45
BD484	JUNCTION	0.04	0.65	138.05	0	12:05	0.65
BD484_2	JUNCTION	0.07	0.88	135.88	0	12:07	0.87
BD489	JUNCTION	0.00	0.00	138.12	0	00:00	0.00
BD490	JUNCTION	0.04	0.56	144.47	0	12:08	0.56
BD495	JUNCTION	0.08	0.93	138.77	0	12:18	0.93
BD497	JUNCTION	0.00	0.00	137.41	0	00:00	0.00
BD499	JUNCTION	0.00	0.00	131.00	0	00:00	0.00
CL400	JUNCTION	0.10	0.32	141.46	0	14:27	0.32
CL401	JUNCTION	0.14	0.41	139.42	0	14:32	0.41

CL402	JUNCTION	0.13	0.45	136.54	0	14:32	0.45
CL403	JUNCTION	0.15	0.43	133.83	0	14:42	0.43
CL404	JUNCTION	0.18	0.53	130.13	0	15:11	0.53
J1	JUNCTION	0.08	0.86	149.71	0	12:08	0.85
J10	JUNCTION	0.01	0.19	170.69	0	12:04	0.19
J11	JUNCTION	0.04	0.49	148.99	0	12:08	0.48
J12	JUNCTION	0.06	0.71	136.11	0	12:11	0.70
J13	JUNCTION	0.20	0.97	131.88	0	12:54	0.97
J14	JUNCTION	0.07	0.37	129.44	0	13:14	0.37
J15	JUNCTION	0.07	0.25	153.02	0	13:52	0.25
J16	JUNCTION	0.03	0.77	149.57	0	12:17	0.76
J17	JUNCTION	0.08	0.30	148.05	0	13:19	0.30
J18	JUNCTION	0.01	0.33	154.88	0	12:10	0.33
J19	JUNCTION	0.06	0.25	147.60	0	13:19	0.25
J2	JUNCTION	0.05	0.64	161.57	0	12:09	0.64
J3	JUNCTION	0.09	0.94	139.13	0	12:17	0.93
J4	JUNCTION	0.19	0.28	127.57	1	05:11	0.28
J5	JUNCTION	0.05	1.07	141.78	0	12:16	1.07
J6	JUNCTION	0.01	0.39	148.86	0	12:05	0.39
J7	JUNCTION	0.01	0.40	149.89	0	12:04	0.39
J8	JUNCTION	0.15	0.44	136.59	0	14:32	0.44
J9	JUNCTION	0.04	0.58	145.45	0	12:06	0.58
KR400	JUNCTION	0.04	0.24	151.94	0	13:27	0.24
KR401	JUNCTION	0.11	0.46	142.96	0	17:10	0.46
KR402	JUNCTION	0.06	0.34	149.04	0	15:15	0.34
KR403	JUNCTION	0.11	0.30	139.05	0	19:20	0.30
KR404	JUNCTION	0.06	0.19	138.77	0	19:35	0.19
KR405	JUNCTION	0.11	0.27	138.27	0	18:39	0.27
KR406	JUNCTION	0.24	0.46	138.01	0	12:43	0.46
KR407	JUNCTION	0.13	0.42	137.89	0	14:26	0.42
KR408	JUNCTION	0.24	0.48	129.88	0	16:34	0.48
KR409	JUNCTION	0.01	0.16	175.16	0	13:22	0.16
KR410	JUNCTION	0.01	0.12	152.62	0	14:32	0.12
KR411	JUNCTION	0.43	0.64	129.74	0	23:40	0.64
KR412	JUNCTION	0.41	0.63	129.63	1	00:33	0.63
KR413	JUNCTION	0.20	0.33	128.60	0	13:02	0.33
KR414	JUNCTION	0.13	0.24	128.58	0	13:00	0.24
KR415	JUNCTION	0.17	0.27	127.77	1	05:19	0.27
KR416	JUNCTION	0.17	0.24	127.24	1	05:16	0.24
BDOF3	OUTFALL	0.06	0.25	152.15	0	13:52	0.25
KROF1	OUTFALL	0.09	0.14	124.14	1	05:16	0.14
OF1	OUTFALL	0.06	0.25	145.26	0	13:19	0.25
CameronFlowage	STORAGE	0.44	0.67	129.72	1	00:12	0.67
Crusher_Lake	STORAGE	0.10	0.34	145.34	0	14:33	0.34
EastPond	STORAGE	1.59	3.68	131.68	0	13:14	3.68
LittleTaite	STORAGE	0.09	0.15	132.00	1	03:46	0.15

LowerCameronFlowage	STORAGE	0.09	0.15	128.48	1	05:02	0.15
McNeilDam	STORAGE	0.04	0.27	147.27	0	13:57	0.27
NorthPond	STORAGE	1.76	3.40	133.40	0	12:53	3.40
Pit_Storage	STORAGE	3.74	4.48	4.48	3	00:00	4.48
SouthPond	STORAGE	1.28	2.63	154.63	0	13:51	2.63
SU3	STORAGE	0.23	0.60	130.10	0	15:19	0.60
TaiteLake	STORAGE	0.24	0.36	133.16	1	00:29	0.36
UpperCameronFlowage	STORAGE	0.21	0.36	130.36	0	21:15	0.36
UpperPond	STORAGE	0.12	0.22	135.42	0	21:37	0.22
WestLake	STORAGE	0.14	0.21	137.91	1	23:57	0.21
WestPond	STORAGE	1.74	2.80	149.05	0	13:19	2.79

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Node Inflow Summary
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Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
BD400	JUNCTION	2.541	2.541	0	12:10	5.54	5.54	-0.844
BD401	JUNCTION	2.419	2.419	0	12:05	4.25	4.25	-1.634
BD401_2	JUNCTION	0.868	1.809	0	12:08	1.55	3.67	0.073
BD402	JUNCTION	0.786	2.391	0	12:10	1.31	4.98	-0.301
BD403	JUNCTION	0.626	7.093	0	12:14	7.38	25	0.062
BD404	JUNCTION	1.577	1.577	0	12:10	3.36	3.36	-0.077
BD405	JUNCTION	0.360	1.880	0	12:06	0.532	3.89	0.050
BD406	JUNCTION	0.555	2.265	0	12:08	0.787	4.68	-0.116
BD407	JUNCTION	0.003	3.078	0	12:10	0.697	6.96	0.232
BD408	JUNCTION	0.601	0.601	0	12:05	0.891	0.891	-0.616
BD409	JUNCTION	0.460	0.967	0	12:06	0.683	1.58	-0.105
BD412	JUNCTION	0.264	12.083	0	12:16	0.816	51.1	0.184
BD413	JUNCTION	0.000	3.708	0	12:50	0	51.3	-0.005
BD414	JUNCTION	0.000	3.779	0	12:51	0	52.5	0.011
BD415	JUNCTION	0.572	0.572	0	12:15	4.49	4.49	0.011
BD420	JUNCTION	0.242	0.242	0	12:00	0.41	0.41	-0.292
BD421	JUNCTION	0.198	0.198	0	12:00	0.336	0.336	-0.285
BD422	JUNCTION	0.000	0.402	0	12:02	0	0.748	0.286
BD423	JUNCTION	1.331	1.331	0	12:05	4.47	4.47	-0.004
BD423_2	JUNCTION	0.270	1.543	0	12:05	0.915	5.39	-0.018
BD423_3	JUNCTION	0.451	1.985	0	12:05	1.1	6.49	0.001
BD424	JUNCTION	0.598	2.554	0	12:05	1.39	7.88	0.011
BD424_2	JUNCTION	0.000	2.535	0	12:05	0	7.88	-0.007

BD425	JUNCTION	0.003	4.865	0	12:07	0.881	19.8	-0.008
BD426	JUNCTION	0.633	2.411	0	12:06	1.58	11.1	0.029
BD427	JUNCTION	0.561	1.331	0	12:06	1.46	7.58	0.025
BD427_2	JUNCTION	0.645	1.887	0	12:06	1.9	9.48	-0.014
BD428	JUNCTION	0.398	0.398	0	12:05	0.68	0.68	-0.018
BD428_2	JUNCTION	0.129	0.465	0	12:05	0.392	1.07	-0.102
BD429	JUNCTION	0.000	4.860	0	12:07	0	19.8	0.001
BD430	JUNCTION	0.729	5.350	0	12:07	2.41	22.2	-0.003
BD431	JUNCTION	0.000	5.834	0	12:08	0	24.1	0.032
BD432	JUNCTION	0.380	5.753	0	12:09	1.23	25.3	-0.113
BD433	JUNCTION	0.074	0.074	0	12:00	0.228	0.228	-0.135
BD434	JUNCTION	0.000	0.111	0	12:04	0	0.437	0.090
BD435	JUNCTION	0.117	0.585	0	12:03	0.531	2.54	0.022
BD435_1	JUNCTION	0.416	0.416	0	12:00	1.57	1.57	-0.107
BD439	JUNCTION	0.697	1.123	0	12:03	2.5	5.05	-0.229
BD440	JUNCTION	0.000	1.020	0	12:08	0	5.06	0.253
BD441	JUNCTION	0.000	0.868	0	12:10	0	5.05	-0.152
BD442	JUNCTION	0.000	0.690	0	12:16	0	5.05	0.101
BD445	JUNCTION	0.036	0.493	0	12:00	0.209	1.66	0.017
BD446	JUNCTION	0.491	0.960	0	12:01	1.25	2.91	0.004
BD446_2	JUNCTION	0.546	1.459	0	12:01	1.84	4.74	-0.005
BD446_3	JUNCTION	0.422	1.822	0	12:01	0.957	5.7	-0.042
BD447	JUNCTION	0.000	5.728	0	12:04	0	18.8	0.021
BD448	JUNCTION	0.473	0.473	0	12:00	1.45	1.45	-0.019
BD449	JUNCTION	0.401	0.401	0	12:00	0.895	0.895	-0.022
BD450	JUNCTION	0.296	0.678	0	12:00	0.631	1.53	-0.001
BD451	JUNCTION	0.328	0.970	0	12:01	0.762	2.29	-0.104
BD452	JUNCTION	0.226	3.190	0	12:04	1.03	10.8	0.041
BD453	JUNCTION	0.346	2.141	0	12:03	0.656	7.47	-0.000
BD454	JUNCTION	0.410	0.410	0	12:00	1.2	1.2	-0.004
BD455	JUNCTION	0.541	0.941	0	12:00	1.07	2.27	-0.201
BD456	JUNCTION	0.882	0.882	0	12:00	3.41	3.41	-0.030
BD457	JUNCTION	0.540	1.346	0	12:01	1.9	5.3	0.026
BD458	JUNCTION	0.663	1.878	0	12:02	1.51	6.82	-0.005
BD459	JUNCTION	0.967	0.967	0	12:00	3.44	3.44	-0.136
BD460	JUNCTION	0.000	0.939	0	12:02	0	3.44	0.124
BD461	JUNCTION	0.032	0.852	0	12:01	0.139	3.68	0.010
BD462	JUNCTION	0.590	0.590	0	12:00	1.91	1.91	-0.135
BD463	JUNCTION	1.033	1.530	0	12:00	3.63	5.54	-0.251
BD464	JUNCTION	0.000	1.480	0	12:06	0	5.56	0.146
BD465	JUNCTION	0.000	3.663	0	12:13	0	18.1	0.121
BD466	JUNCTION	0.853	0.853	0	12:00	3.54	3.54	-0.007
BD467	JUNCTION	0.000	0.846	0	12:00	0	3.54	-0.007
BD468	JUNCTION	2.021	2.021	0	12:00	7.97	7.97	-0.085
BD469	JUNCTION	1.092	2.582	0	12:06	3.93	12.5	-0.021
BD470	JUNCTION	0.000	0.554	0	13:51	0	18.9	0.000

BD471	JUNCTION	0.135	0.135	0	12:00	0.229	0.229	-0.572	
BD472	JUNCTION	0.000	0.347	0	12:02	0	0.645	0.089	
BD473	JUNCTION	0.243	0.243	0	12:00	0.412	0.412	-0.569	
BD474	JUNCTION	0.000	1.225	0	13:14	0	29.6	0.039	
BD474_2	JUNCTION	0.000	1.249	0	13:15	0	29.6	-0.040	
BD474_3	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
BD475	JUNCTION	0.214	0.214	0	12:00	0.348	0.348	-0.195	
BD476	JUNCTION	0.157	0.343	0	12:00	0.255	0.605	-0.111	
BD477	JUNCTION	0.236	0.513	0	12:02	0.424	1.03	0.113	
BD478	JUNCTION	0.000	0.597	0	12:05	0	1.31	-0.027	
BD479	JUNCTION	0.166	0.166	0	12:00	0.281	0.281	-0.270	
BD480	JUNCTION	0.500	0.500	0	12:00	0.925	0.925	-0.253	
BD481	JUNCTION	0.548	0.548	0	12:00	0.913	0.913	-0.230	
BD482	JUNCTION	0.000	1.649	0	12:04	0	3.6	-0.364	
BD483	JUNCTION	0.235	1.752	0	12:04	0.74	7.86	0.004	
BD484	JUNCTION	0.000	5.680	0	12:05	0	18.8	-0.008	
BD484_2	JUNCTION	0.000	7.373	0	12:07	0	28.6	-0.004	
BD489	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
BD490	JUNCTION	0.358	5.859	0	12:08	1.12	24.1	0.006	
BD495	JUNCTION	0.000	6.980	0	12:17	0	25	0.097	
BD497	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
BD499	JUNCTION	0.000	0.000	0	00:00	0	0	0.000	ltr
CL400	JUNCTION	0.262	1.543	0	14:26	4.04	44.8	-0.012	
CL401	JUNCTION	0.000	1.543	0	14:27	0	44.8	0.091	
CL402	JUNCTION	0.000	1.660	0	14:32	0	49.3	0.001	
CL403	JUNCTION	0.000	1.660	0	14:33	0	49.3	0.041	
CL404	JUNCTION	1.247	2.168	0	14:18	16.6	65.8	-0.432	
J1	JUNCTION	0.000	5.692	0	12:07	0	23	0.014	
J10	JUNCTION	0.068	0.126	0	12:01	0.208	0.437	-0.020	
J11	JUNCTION	0.475	2.012	0	12:06	1.51	9.37	-0.068	
J12	JUNCTION	0.154	2.050	0	12:08	0.473	9.85	0.097	
J13	JUNCTION	0.000	3.708	0	12:50	0	51.3	0.068	
J14	JUNCTION	0.000	1.349	0	13:14	0	29.6	-0.020	
J15	JUNCTION	0.000	0.554	0	13:51	0	18.9	0.001	
J16	JUNCTION	0.000	4.723	0	12:10	0	10	1.267	
J17	JUNCTION	0.000	0.342	0	13:19	0	9.59	0.001	
J18	JUNCTION	1.033	1.033	0	12:05	2.12	2.12	-0.202	
J19	JUNCTION	0.000	0.342	0	13:19	0	9.59	0.001	
J2	JUNCTION	0.000	2.166	0	12:01	0	8.62	0.005	
J3	JUNCTION	0.000	7.001	0	12:16	0	25	0.028	
J4	JUNCTION	0.000	3.202	1	05:10	0	429	0.054	
J5	JUNCTION	1.219	4.791	0	12:10	2.12	10.7	0.436	
J6	JUNCTION	0.528	0.903	0	12:01	0.88	1.81	-0.137	
J7	JUNCTION	0.524	0.986	0	12:00	0.869	1.78	-0.344	
J8	JUNCTION	0.000	1.666	0	14:24	0	49.2	-0.051	
J9	JUNCTION	0.000	3.155	0	12:05	0	10.8	0.018	

KR400	JUNCTION	1.053	1.053	0	12:30	17.7	17.7	-1.899
KR401	JUNCTION	0.739	1.661	0	13:34	21.1	39.1	1.053
KR402	JUNCTION	1.456	1.456	0	12:25	21.9	21.9	-2.634
KR403	JUNCTION	0.000	0.812	0	17:14	0	22.5	9.240
KR404	JUNCTION	0.000	0.455	0	19:25	0	20.6	0.210
KR405	JUNCTION	1.212	1.314	0	18:30	64.9	85.5	0.097
KR406	JUNCTION	0.000	1.313	0	18:39	0	85.4	0.182
KR407	JUNCTION	0.000	1.311	0	18:46	0	85.2	0.073
KR408	JUNCTION	0.020	4.841	0	15:34	5.18	297	-0.220
KR409	JUNCTION	0.189	0.189	0	12:45	1.73	1.73	-1.615
KR410	JUNCTION	0.173	0.329	0	13:18	1.66	3.41	-4.680
KR411	JUNCTION	0.626	4.856	0	16:28	9.41	370	2.796
KR412	JUNCTION	1.556	3.410	0	23:30	28.2	361	0.491
KR413	JUNCTION	0.000	4.862	0	12:57	0	409	0.160
KR414	JUNCTION	0.000	4.880	0	13:09	0	409	0.107
KR415	JUNCTION	1.129	3.179	1	04:53	21.6	403	0.879
KR416	JUNCTION	0.000	3.202	1	05:12	0	429	0.148
BDOF3	OUTFALL	0.000	0.554	0	13:52	0	18.9	0.000
KROF1	OUTFALL	0.222	3.202	1	05:16	0.657	429	0.000
OF1	OUTFALL	0.000	0.342	0	13:19	0	9.59	0.000
CameronFlowage	STORAGE	0.000	4.040	0	16:16	0	362	2.211
Crusher_Lake	STORAGE	2.528	2.528	0	12:30	41.8	41.8	0.019
EastPond	STORAGE	0.217	7.565	0	12:07	1.15	35.1	0.015
LittleTaite	STORAGE	0.000	0.495	1	01:35	0	65.3	0.527
LowerCameronFlowage	STORAGE	0.000	4.903	0	13:11	0	408	0.497
McNeilDam	STORAGE	0.809	0.809	0	12:20	10.1	10.1	-3.831
NorthPond	STORAGE	0.267	11.989	0	12:18	1.52	64	-0.050
Pit_Storage	STORAGE	3.925	3.925	0	12:10	31	31	0.013
SouthPond	STORAGE	0.186	3.729	0	12:15	0.994	24.1	0.002
SU3	STORAGE	2.274	4.388	0	12:59	68.7	135	-0.164
TaiteLake	STORAGE	3.902	4.242	0	13:05	91.1	105	3.608
UpperCameronFlowage	STORAGE	1.099	1.666	0	20:32	33.8	162	0.343
UpperPond	STORAGE	0.000	1.435	0	19:34	0	134	1.156
WestLake	STORAGE	0.668	1.532	0	17:55	77	116	3.402
WestPond	STORAGE	0.000	3.688	0	12:17	0	16.5	-0.046

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Node Surcharge Summary
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No nodes were surcharged.

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Node Flooding Summary

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No nodes were flooded.

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Storage Volume Summary
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Storage Unit	Average Volume 1000 m3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 m3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow CMS
CameronFlowage	23.144	7	0	0	35.296	11	1 00:12	3.283
Crusher_Lake	4.465	7	0	0	14.701	22	0 14:33	1.402
EastPond	7.250	20	0	0	20.594	56	0 13:14	1.225
LittleTaite	2.610	6	0	0	4.256	9	1 03:46	0.487
LowerCameronFlowage	35.632	5	0	0	58.328	9	1 05:02	3.145
McNeilDam	0.219	0	0	0	1.681	3	0 13:57	0.634
NorthPond	13.897	29	0	0	30.710	63	0 12:53	3.708
Pit_Storage	24.706	0	0	0	30.955	0	3 00:00	0.000
SouthPond	6.794	30	0	0	15.790	69	0 13:51	0.554
SU3	7.985	15	0	0	20.988	38	0 15:19	3.643
TaiteLake	46.726	16	0	0	71.022	24	1 00:29	0.495
UpperCameronFlowage	2.312	13	0	0	3.942	23	0 21:15	1.657
UpperPond	6.512	7	0	0	11.996	14	0 21:37	1.338
WestLake	45.943	9	0	0	66.926	13	1 23:57	0.322
WestPond	7.929	25	0	0	14.249	45	0 13:19	0.535

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Outfall Loading Summary
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Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
BDOF3	96.76	0.095	0.554	18.878
KROF1	99.83	1.842	3.202	428.571
OF1	95.92	0.049	0.342	9.592
System	97.50	1.986	3.740	457.041

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Link Flow Summary
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Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days	hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
BD700_1	CONDUIT	2.485	0	12:10	1.97	0.40	0.82
BD700_2	CONDUIT	2.278	0	12:09	1.33	0.32	0.66
BD701_1	CONDUIT	1.013	0	12:10	1.13	0.09	0.42
BD701_2	CONDUIT	1.739	0	12:11	1.23	0.22	0.54
BD702_1	CONDUIT	2.316	0	12:12	0.89	0.29	0.79
BD702_2	CONDUIT	3.972	0	12:16	0.94	0.42	0.69
BD703_2	CONDUIT	6.871	0	12:18	1.61	0.22	0.59
BD703_3	CONDUIT	7.001	0	12:16	2.01	0.55	0.77
BD703_4	CONDUIT	6.980	0	12:17	2.02	0.51	0.75
BD704	CONDUIT	1.574	0	12:10	1.74	0.18	0.56
BD705	CONDUIT	1.842	0	12:10	1.72	0.38	0.69
BD706	CONDUIT	2.236	0	12:09	1.93	0.23	0.57
BD707_Culv	CONDUIT	2.971	0	12:12	3.86	0.52	0.66
BD708	CONDUIT	0.541	0	12:07	1.05	0.36	0.70
BD709	CONDUIT	0.839	0	12:10	0.95	0.11	0.50
BD712	CONDUIT	11.799	0	12:18	2.47	0.25	0.57
BD713_1	CONDUIT	3.708	0	12:50	2.79	1.49	0.71
BD713_2	CONDUIT	3.705	0	12:54	1.34	0.69	0.81
BD714	CONDUIT	3.778	0	12:53	2.23	0.42	0.49
BD715	CONDUIT	0.530	0	12:26	0.93	0.51	0.72
BD720	CONDUIT	0.223	0	12:02	0.86	0.16	0.45
BD720_Culv	CONDUIT	0.360	0	12:05	1.04	0.19	0.65
BD721	CONDUIT	0.179	0	12:01	0.83	0.11	0.42
BD723_1	CONDUIT	1.329	0	12:05	1.65	0.69	0.88
BD723_3	CONDUIT	1.536	0	12:05	1.69	0.80	0.96
BD723_4	CONDUIT	1.966	0	12:05	1.75	0.39	0.71
BD724_1	CONDUIT	2.535	0	12:05	2.04	0.50	0.75
BD724_2	CONDUIT	2.532	0	12:06	2.27	0.50	0.71
BD725	CONDUIT	4.860	0	12:07	2.96	0.40	0.83
BD726	CONDUIT	2.370	0	12:08	1.91	0.62	0.76
BD727_1	CONDUIT	1.319	0	12:08	1.25	0.34	0.69
BD727_2	CONDUIT	1.859	0	12:08	1.37	0.49	0.79
BD728_1	CONDUIT	0.379	0	12:05	0.98	0.26	0.57
BD728_2	CONDUIT	0.446	0	12:07	0.69	0.31	0.78
BD729_Culv	CONDUIT	4.860	0	12:07	6.84	0.75	0.60
BD730_2	CONDUIT	5.834	0	12:08	2.07	0.28	0.78

BD730_3	CONDUIT	5.348	0	12:07	2.37	0.36	0.75
BD730_4	CONDUIT	5.652	0	12:08	2.75	0.61	0.71
BD731_Culv	CONDUIT	5.552	0	12:13	3.76	1.27	0.72
BD732	CONDUIT	5.724	0	12:10	1.58	0.20	0.61
BD733_1	CONDUIT	0.064	0	12:02	0.43	0.06	0.32
BD733_2	CONDUIT	0.111	0	12:04	0.56	0.11	0.39
BD734_Culv	CONDUIT	0.105	0	12:07	0.78	0.24	0.48
BD735	CONDUIT	0.553	0	12:06	0.70	0.51	0.87
BD737_1	CONDUIT	0.400	0	12:01	0.91	0.29	0.65
BD739	CONDUIT	1.020	0	12:08	0.56	0.31	0.67
BD740_Culv	CONDUIT	0.868	0	12:10	1.17	0.57	0.59
BD741	CONDUIT	0.690	0	12:16	0.55	1.55	1.00
BD744_Culv	CONDUIT	0.656	0	12:27	1.92	0.91	0.66
BD745	CONDUIT	0.485	0	12:01	1.21	0.15	0.47
BD746_1	CONDUIT	0.952	0	12:02	1.61	0.06	0.31
BD746_3	CONDUIT	1.447	0	12:02	1.94	0.05	0.29
BD746_4	CONDUIT	1.810	0	12:02	1.41	0.07	0.44
BD747_1	CONDUIT	5.679	0	12:05	2.50	0.36	0.76
BD747_1_Culv	CONDUIT	5.680	0	12:05	6.85	0.41	0.43
BD747_3	CONDUIT	7.360	0	12:07	2.49	0.73	0.88
BD748	CONDUIT	0.467	0	12:00	1.83	0.19	0.44
BD749	CONDUIT	0.389	0	12:00	1.41	0.05	0.31
BD750	CONDUIT	0.660	0	12:01	1.71	0.09	0.38
BD751	CONDUIT	0.957	0	12:02	1.08	0.04	0.41
BD752	CONDUIT	2.129	0	12:04	1.82	0.44	0.73
BD754	CONDUIT	0.406	0	12:00	1.20	0.15	0.54
BD755	CONDUIT	0.885	0	12:02	1.20	0.14	0.59
BD755_2	CONDUIT	3.155	0	12:05	2.51	0.25	0.57
BD755_3	CONDUIT	3.143	0	12:06	1.96	0.15	0.52
BD756	CONDUIT	0.835	0	12:02	1.29	0.46	0.79
BD757	CONDUIT	1.302	0	12:03	1.47	0.71	0.93
BD758	CONDUIT	1.860	0	12:04	1.74	0.39	0.69
BD759	CONDUIT	0.939	0	12:02	1.08	0.68	0.81
BD760_1	CONDUIT	0.806	0	12:07	0.85	0.59	0.84
BD760_2	CONDUIT	1.965	0	12:08	1.52	0.36	0.79
BD760_3	CONDUIT	1.701	0	12:07	1.91	0.30	0.63
BD760_5	CONDUIT	1.957	0	12:11	0.91	0.43	0.79
BD762	CONDUIT	0.546	0	12:02	0.54	0.24	0.69
BD763	CONDUIT	1.480	0	12:06	0.99	0.65	0.85
BD764	CONDUIT	1.224	0	12:11	0.68	0.79	0.95
BD765	CONDUIT	3.592	0	12:15	1.83	0.52	0.73
BD766	CONDUIT	0.846	0	12:00	1.80	0.37	0.65
BD767	CONDUIT	0.826	0	12:01	1.44	0.37	0.74
BD767_Culv	CONDUIT	0.845	0	12:02	2.75	0.36	0.43
BD768_1	CONDUIT	1.986	0	12:01	1.51	0.61	0.80
BD768_2	CONDUIT	1.756	0	12:09	0.98	0.68	0.93

BD769	CONDUIT	2.448	0	12:13	1.10	0.56	0.78
BD770_1	CONDUIT	0.554	0	13:51	2.28	0.16	0.23
BD770_2	CONDUIT	0.554	0	13:52	1.28	0.05	0.25
BD771	CONDUIT	0.121	0	12:02	0.58	0.10	0.42
BD772	CONDUIT	0.268	0	12:07	0.33	0.08	0.60
BD773	CONDUIT	0.228	0	12:03	0.80	0.19	0.48
BD774_2	CONDUIT	1.223	0	13:15	2.45	0.08	0.29
BD774_3	CONDUIT	1.349	0	13:14	3.26	1.12	0.55
BD774_4	CONDUIT	1.249	0	13:15	1.72	0.11	0.35
BD775	CONDUIT	0.196	0	12:01	0.68	0.15	0.49
BD776	CONDUIT	0.306	0	12:03	0.53	0.27	0.74
BD777	CONDUIT	0.471	0	12:05	0.90	0.52	0.69
BD778	CONDUIT	0.591	0	12:06	1.33	0.06	0.49
BD779	CONDUIT	0.157	0	12:01	0.91	0.08	0.37
BD780_1	CONDUIT	0.437	0	12:03	0.84	0.32	0.69
BD780_2	CONDUIT	0.790	0	12:05	1.06	0.11	0.44
BD781_1	CONDUIT	0.496	0	12:01	0.95	0.33	0.70
BD781_2	CONDUIT	0.869	0	12:04	1.21	0.11	0.44
BD782	CONDUIT	1.494	0	12:08	1.07	0.18	0.74
BD795	CONDUIT	0.000	0	00:00	0.00	0.00	0.29
BD796_2	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
BDCL701_3_Culv	CONDUIT	1.660	0	14:33	3.97	0.22	0.32
BD-EP-SpillwayChannel	CONDUIT	0.000	0	00:00	0.00	0.00	0.18
BDNorthPondSpillway	CONDUIT	0.000	0	00:00	0.00	0.00	0.00
C1	CONDUIT	3.688	0	12:17	5.69	0.94	0.77
C2	CONDUIT	0.342	0	13:19	2.77	0.49	0.45
C3	CONDUIT	0.342	0	13:19	3.14	0.35	0.41
CL700	CHANNEL	1.402	0	14:32	1.38	0.00	0.16
CL701	CHANNEL	1.543	0	14:27	1.20	0.00	0.18
CL701_2	CHANNEL	1.541	0	14:32	0.70	0.01	0.21
CL701_3	CHANNEL	1.660	0	14:32	0.90	0.01	0.22
CL701_4	CHANNEL	1.650	0	14:42	0.55	0.01	0.24
CL702	CHANNEL	2.115	0	12:59	0.22	0.01	0.23
CL703	CHANNEL	3.643	0	15:25	0.18	0.04	0.21
KR700	CHANNEL	0.946	0	13:34	0.28	0.07	0.31
KR701	CHANNEL	0.866	0	18:00	0.23	0.08	0.27
KR702	CHANNEL	0.322	1	04:56	0.32	0.01	0.08
KR703	CHANNEL	0.812	0	17:14	0.22	0.08	0.27
KR704	CHANNEL	0.455	0	19:25	0.38	0.04	0.24
KR705	CHANNEL	0.454	0	19:35	0.15	0.04	0.23
KR706	CHANNEL	1.313	0	18:39	0.29	0.02	0.18
KR707	CHANNEL	1.311	0	18:46	0.50	0.15	0.43
KR708	CHANNEL	1.334	0	19:08	0.45	0.02	0.13
KR709	CHANNEL	1.338	0	21:37	0.42	0.00	0.07
KR710	CHANNEL	1.657	0	21:15	0.34	0.01	0.10
KR711	CHANNEL	4.634	0	16:34	0.25	0.08	0.35

KR712	CHANNEL	0.634	0	14:54	0.61	0.01	0.11
KR713	CHANNEL	0.173	0	13:36	0.76	0.00	0.07
KR714	CHANNEL	0.235	0	14:32	0.37	0.00	0.09
KR715	CHANNEL	0.495	1	01:35	0.44	0.00	0.11
KR716	CHANNEL	0.487	1	03:46	0.16	0.00	0.04
KR717	CHANNEL	4.040	0	16:16	0.29	0.01	0.12
KR718	CHANNEL	3.283	0	23:53	0.16	0.02	0.19
KR719	CHANNEL	3.384	1	00:51	0.35	0.00	0.13
KR720_1	CHANNEL	4.880	0	13:09	0.21	0.03	0.18
KR720_2	CHANNEL	4.903	0	13:11	0.43	0.14	0.11
KR721	CHANNEL	3.145	1	05:02	0.19	0.02	0.13
KR722_1	CHANNEL	3.176	1	05:19	0.58	0.02	0.11
KR722_2	CHANNEL	3.202	1	05:12	0.61	0.02	0.10
KR723	CHANNEL	3.202	1	05:16	0.84	0.01	0.08
BD722_Pump	PUMP	0.000	0	00:00		0.00	
OR1	ORIFICE	0.197	0	13:19			1.00
OR2	ORIFICE	0.049	0	13:19			1.00
OR-EP-1	ORIFICE	0.071	0	13:14			1.00
OR-EP-2	ORIFICE	0.725	0	13:14			1.00
OR-EP-3	ORIFICE	0.261	0	13:14			1.00
OR-NP-1	ORIFICE	0.221	0	12:50			1.00
OR-NP-2	ORIFICE	1.379	0	12:50			1.00
OR-NP-3	ORIFICE	1.379	0	12:50			1.00
OR-NP-4	ORIFICE	0.613	0	12:50			1.00
OR-SP-1	ORIFICE	0.027	0	13:51			1.00
OR-SP-2	ORIFICE	0.099	0	13:51			1.00
OR-SP-3	ORIFICE	0.099	0	13:51			1.00
OR-SP-4	ORIFICE	0.099	0	13:51			1.00
BD-EP-10yr100yr	WEIR	0.168	0	13:14			1.00
BD-EP-Spillway	WEIR	0.000	0	00:00			0.00
BD-NP_HurricaneSpillway	WEIR	0.000	0	00:00			0.00
BD-SP-100yr	WEIR	0.230	0	13:51			1.00
NP-100yr	WEIR	0.116	0	12:53			1.00
SouthPond_Spillway	WEIR	0.000	0	00:00			0.00
W1	WEIR	0.000	0	00:00			0.00
W2	WEIR	0.096	0	13:19			1.00

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Flow Classification Summary
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	Adjusted	Fraction of Time in Flow Class							
	/Actual		Up	Down	Sub	Sup	Up	Down	Norm	Inlet
Conduit	Length	Dry	Dry	Dry	Crit	Crit	Crit	Crit	Ltd	Ctrl

BD700_1	1.00	0.02	0.15	0.00	0.82	0.01	0.00	0.00	0.96	0.00
BD700_2	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.95	0.00
BD701_1	1.00	0.04	0.27	0.00	0.69	0.00	0.00	0.00	0.87	0.00
BD701_2	1.00	0.02	0.02	0.00	0.96	0.00	0.00	0.00	0.97	0.00
BD702_1	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.96	0.00
BD702_2	1.00	0.00	0.02	0.00	0.98	0.00	0.00	0.00	0.95	0.00
BD703_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.98	0.00
BD703_3	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
BD703_4	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.28	0.00
BD704	1.00	0.04	0.33	0.00	0.62	0.01	0.00	0.00	0.79	0.00
BD705	1.00	0.02	0.02	0.00	0.95	0.00	0.00	0.00	0.96	0.00
BD706	1.00	0.00	0.02	0.00	0.97	0.01	0.00	0.00	0.96	0.00
BD707_Culv	1.00	0.00	0.00	0.00	0.98	0.02	0.00	0.00	1.00	0.00
BD708	1.00	0.06	0.25	0.00	0.68	0.00	0.00	0.00	0.89	0.00
BD709	1.00	0.00	0.07	0.00	0.93	0.00	0.00	0.00	0.97	0.00
BD712	1.00	0.00	0.00	0.00	0.04	0.00	0.00	0.96	0.01	0.00
BD713_1	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
BD713_2	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
BD714	1.00	0.02	0.00	0.00	0.93	0.06	0.00	0.00	0.76	0.00
BD715	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
BD720	1.00	0.38	0.01	0.00	0.61	0.00	0.00	0.00	0.44	0.00
BD720_Culv	1.00	0.00	0.42	0.00	0.58	0.00	0.00	0.00	0.97	0.00
BD721	1.00	0.42	0.03	0.00	0.56	0.00	0.00	0.00	0.46	0.00
BD723_1	1.00	0.02	0.00	0.00	0.97	0.01	0.00	0.00	0.97	0.00
BD723_3	1.00	0.02	0.00	0.00	0.97	0.01	0.00	0.00	0.97	0.00
BD723_4	1.00	0.02	0.00	0.00	0.97	0.01	0.00	0.00	0.97	0.00
BD724_1	1.00	0.02	0.00	0.00	0.95	0.03	0.00	0.00	0.96	0.00
BD724_2	1.00	0.00	0.02	0.00	0.91	0.07	0.00	0.00	0.69	0.00
BD725	1.00	0.00	0.00	0.00	0.66	0.34	0.00	0.00	1.00	0.00
BD726	1.00	0.00	0.01	0.00	0.93	0.06	0.00	0.00	0.62	0.00
BD727_1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00
BD727_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.97	0.00
BD728_1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.97	0.00
BD728_2	1.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.99	0.00
BD729_Culv	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.03	0.00
BD730_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.99	0.00
BD730_3	1.00	0.00	0.00	0.00	0.96	0.04	0.00	0.00	1.00	0.00
BD730_4	1.00	0.00	0.00	0.00	0.66	0.34	0.00	0.00	0.00	0.00
BD731_Culv	1.00	0.00	0.00	0.00	0.01	0.99	0.00	0.00	0.00	0.00
BD732	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.99	0.00
BD733_1	1.00	0.02	0.08	0.00	0.90	0.00	0.00	0.00	0.97	0.00
BD733_2	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.70	0.00
BD734_Culv	1.00	0.02	0.01	0.00	0.96	0.00	0.00	0.00	0.97	0.00
BD735	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
BD737_1	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.96	0.00

BD739	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.91	0.00
BD740_Culv	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.37	0.00
BD741	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.66	0.00
BD744_Culv	1.00	0.00	0.03	0.00	0.94	0.03	0.00	0.00	0.01	0.00
BD745	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00
BD746_1	1.00	0.00	0.00	0.00	0.96	0.04	0.00	0.00	0.97	0.00
BD746_3	1.00	0.00	0.00	0.00	0.90	0.10	0.00	0.00	0.97	0.00
BD746_4	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.98	0.00
BD747_1	1.00	0.01	0.00	0.00	0.97	0.03	0.00	0.00	0.97	0.00
BD747_1_Culv	1.00	0.00	0.00	0.00	0.06	0.94	0.00	0.00	0.23	0.00
BD747_3	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00
BD748	1.00	0.00	0.00	0.00	0.67	0.33	0.00	0.00	0.00	0.00
BD749	1.00	0.00	0.02	0.00	0.95	0.03	0.00	0.00	0.99	0.00
BD750	1.00	0.00	0.00	0.00	0.95	0.05	0.00	0.00	0.98	0.00
BD751	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.98	0.00
BD752	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.22	0.00
BD754	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
BD755	1.00	0.00	0.02	0.00	0.98	0.00	0.00	0.00	0.97	0.00
BD755_2	1.00	0.00	0.00	0.00	0.73	0.27	0.00	0.00	0.96	0.00
BD755_3	1.00	0.00	0.01	0.00	0.90	0.08	0.00	0.00	0.59	0.00
BD756	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.98	0.00
BD757	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.98	0.00
BD758	1.00	0.00	0.00	0.00	0.99	0.01	0.00	0.00	0.98	0.00
BD759	1.00	0.02	0.07	0.00	0.91	0.00	0.00	0.00	0.83	0.00
BD760_1	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
BD760_2	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.96	0.00
BD760_3	1.00	0.02	0.00	0.00	0.92	0.06	0.00	0.00	0.97	0.00
BD760_5	1.00	0.01	0.01	0.00	0.98	0.00	0.00	0.00	0.71	0.00
BD762	1.00	0.02	0.09	0.00	0.89	0.00	0.00	0.00	0.97	0.00
BD763	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.95	0.00
BD764	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.95	0.00
BD765	1.00	0.02	0.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00
BD766	1.00	0.02	0.00	0.00	0.86	0.12	0.00	0.00	0.83	0.00
BD767	1.00	0.02	0.00	0.00	0.97	0.00	0.00	0.00	0.59	0.00
BD767_Culv	1.00	0.02	0.00	0.00	0.65	0.33	0.00	0.00	0.96	0.00
BD768_1	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.95	0.00
BD768_2	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
BD769	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.88	0.00
BD770_1	1.00	0.01	0.00	0.00	0.04	0.96	0.00	0.00	0.14	0.00
BD770_2	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
BD771	1.00	0.02	0.42	0.00	0.56	0.00	0.00	0.00	0.95	0.00
BD772	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
BD773	1.00	0.02	0.37	0.00	0.61	0.00	0.00	0.00	0.93	0.00
BD774_2	1.00	0.00	0.01	0.00	0.75	0.24	0.00	0.00	0.76	0.00
BD774_3	1.00	0.01	0.00	0.00	0.03	0.96	0.00	0.00	0.02	0.00
BD774_4	1.00	0.01	0.00	0.00	0.82	0.17	0.00	0.00	0.06	0.00

BD775	1.00	0.27	0.20	0.00	0.53	0.00	0.00	0.00	0.64	0.00
BD776	1.00	0.02	0.25	0.00	0.73	0.00	0.00	0.00	0.97	0.00
BD777	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
BD778	1.00	0.02	0.07	0.00	0.92	0.00	0.00	0.00	0.97	0.00
BD779	1.00	0.08	0.48	0.00	0.44	0.00	0.00	0.00	0.80	0.00
BD780_1	1.00	0.03	0.25	0.00	0.72	0.00	0.00	0.00	0.95	0.00
BD780_2	1.00	0.02	0.01	0.00	0.97	0.00	0.00	0.00	0.94	0.00
BD781_1	1.00	0.15	0.25	0.00	0.60	0.00	0.00	0.00	0.79	0.00
BD781_2	1.00	0.02	0.13	0.00	0.85	0.00	0.00	0.00	0.94	0.00
BD782	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.97	0.00
BD795	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BD796_2	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BDCL701_3_Culv	1.00	0.00	0.00	0.00	0.01	0.98	0.00	0.00	0.84	0.00
BD-EP-SpillwayChannel	1.00	0.01	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BDNorthPondSpillway	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C1	1.00	0.02	0.00	0.00	0.12	0.01	0.00	0.85	0.09	0.00
C2	1.00	0.03	0.00	0.00	0.02	0.95	0.00	0.00	0.02	0.00
C3	1.00	0.03	0.00	0.00	0.00	0.97	0.00	0.00	0.45	0.00
CL700	1.00	0.00	0.01	0.00	0.56	0.43	0.00	0.00	0.17	0.00
CL701	1.00	0.00	0.00	0.00	0.88	0.12	0.00	0.00	0.98	0.00
CL701_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.97	0.00
CL701_3	1.00	0.00	0.00	0.00	0.96	0.03	0.00	0.00	0.21	0.00
CL701_4	1.00	0.00	0.02	0.00	0.98	0.00	0.00	0.00	0.58	0.00
CL702	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.29	0.00
CL703	1.00	0.00	0.02	0.00	0.98	0.00	0.00	0.00	0.43	0.00
KR700	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.81	0.00
KR701	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.63	0.00
KR702	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.22	0.00
KR703	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.76	0.00
KR704	1.00	0.09	0.00	0.00	0.91	0.00	0.00	0.00	0.00	0.00
KR705	1.00	0.00	0.15	0.00	0.85	0.00	0.00	0.00	0.83	0.00
KR706	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.90	0.00
KR707	1.00	0.03	0.00	0.00	0.97	0.00	0.00	0.00	0.00	0.00
KR708	1.00	0.05	0.00	0.00	0.95	0.00	0.00	0.00	0.65	0.00
KR709	1.00	0.01	0.11	0.00	0.88	0.00	0.00	0.00	0.85	0.00
KR710	1.00	0.00	0.01	0.00	0.99	0.00	0.00	0.00	0.67	0.00
KR711	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.22	0.00
KR712	1.00	0.01	0.00	0.00	0.99	0.00	0.00	0.00	0.79	0.00
KR713	1.00	0.14	0.00	0.00	0.86	0.00	0.00	0.00	0.80	0.00
KR714	1.00	0.02	0.12	0.00	0.86	0.00	0.00	0.00	0.83	0.00
KR715	1.00	0.02	0.00	0.00	0.98	0.00	0.00	0.00	0.00	0.00
KR716	1.00	0.00	0.09	0.00	0.90	0.00	0.00	0.00	0.87	0.00
KR717	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
KR718	1.00	0.00	0.05	0.00	0.94	0.00	0.00	0.00	0.08	0.00
KR719	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.11	0.00
KR720_1	1.00	0.02	0.06	0.00	0.92	0.00	0.00	0.00	0.00	0.00

KR720_2	1.00	0.08	0.00	0.00	0.92	0.00	0.00	0.00	0.00	0.00
KR721	1.00	0.00	0.08	0.00	0.92	0.00	0.00	0.00	0.89	0.00
KR722_1	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.95	0.00
KR722_2	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
KR723	1.00	0.04	0.00	0.00	0.96	0.00	0.00	0.00	0.01	0.00

****
Conduit Surcharge Summary
****

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
BD700_1	0.01	0.01	0.11	0.01	0.01
BD702_1	0.01	0.01	0.22	0.01	0.01
BD713_1	0.01	0.01	0.01	2.03	0.01
BD720_Culv	0.01	0.01	0.17	0.01	0.01
BD723_3	0.01	0.01	0.05	0.01	0.01
BD725	0.01	0.01	0.11	0.01	0.01
BD730_2	0.01	0.01	0.37	0.01	0.01
BD731_Culv	0.01	0.01	0.01	0.23	0.01
BD735	0.01	0.01	0.35	0.01	0.01
BD741	0.71	0.84	0.72	0.82	0.70
BD757	0.01	0.01	0.05	0.01	0.01
BD764	0.01	0.01	0.07	0.01	0.01
BD768_2	0.01	0.01	0.29	0.01	0.01
BD774_3	0.01	0.01	0.01	1.21	0.01
BD782	0.01	0.01	0.22	0.01	0.01

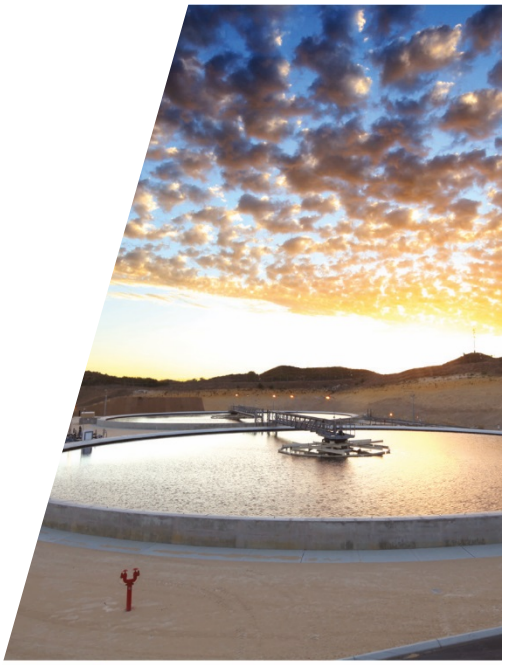
****
Pumping Summary
****

Pump	Percent Utilized	Number of Start-Ups	Min Flow CMS	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr	Power Usage Kw-hr	% Time Off Pump Curve Low	% Time Off Pump Curve High
BD722_Pump	0.00	0	0.00	0.00	0.00	0.000	0.00	0.0	0.0

Analysis begun on: Mon Apr 12 17:31:49 2021

Analysis ended on: Mon Apr 12 17:32:01 2021
Total elapsed time: 00:00:12

Appendix C
Erosion and Sediment Control Plan



Erosion and Sediment Control Plan

Beaver Dam Mine Site

Atlantic Mining NS Inc

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.

Revision History

Version	Date	Notes/Revisions
Version 1	April 2021	Submitted with the Beaver Dam Mine Project 2021 Environmental Impact Statement Update application to the Canadian Environmental Assessment Agency and Nova Scotia Environment. Describes the management practices that will be followed for the control of sedimentation and erosion on land and in water for the mine water infrastructure.

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Draft Document – For Discussion Only – Final Version May Differ From Draft

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CI-01 Erosion & Sediment Control Plan

CI-02 Erosion & Sediment Details

1. Introduction

GHD Limited (GHD) was retained by Atlantic Mining Nova Scotia (AMNS) to develop a Mine Water Management Plan (MWMP) for the Beaver Dam Gold Mine in Marinette, Halifax County, Nova Scotia (Site, Mine Site). The MWMP is being developed in support of the Environmental Impact Statement (EIS) for the mine. As part of the MWMP, GHD has developed an Erosion and Sediment Control Plan (ESCP) for the mine water infrastructure for construction of the Mine Site and during operations. This report presents the ESCP for the Beaver Dam Mine Site mine water infrastructure.

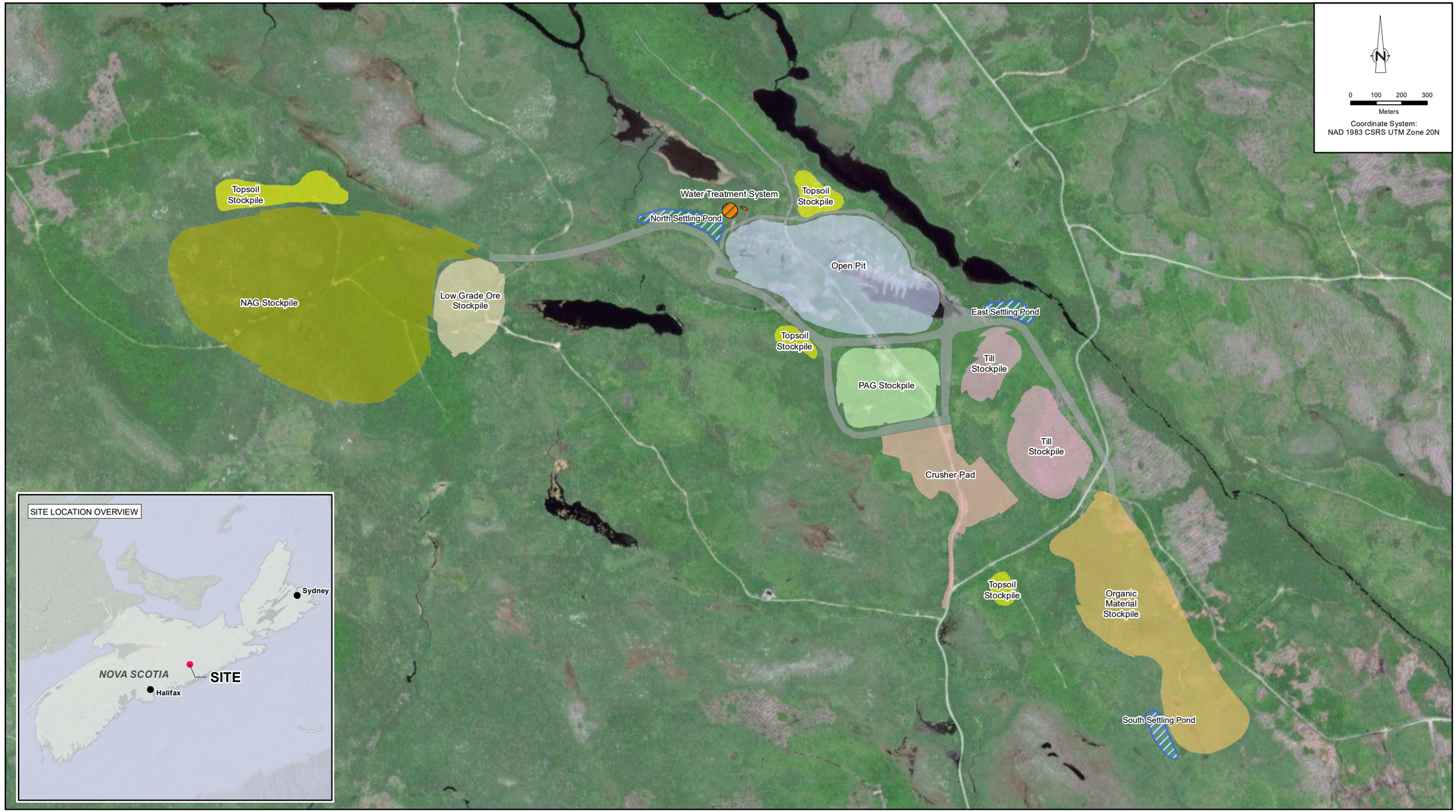
The Site comprises approximately 592 hectares (ha) of lakes, rivers, and forested lands that are in varying degrees of re-growth due to historical logging. The Site will operate as a satellite surface mine to the existing and fully permitted Touquoy Gold Mine, located nearby in Moose River Gold Mines, Nova Scotia. The ore that is mined from the Site will be processed at the existing Touquoy plant. It is anticipated that once all permits are received construction will commence and will take one year to complete. Operations will take place over five years and active closure will take two years to complete. Post closure monitoring is expected to be 10+ years with each successive reclamation plan informing the next. Refer to Figure 1-1 for the location of the Site.

1.1 Key Project Components

An open pit mine site requires many components to function and operate. Refer to Figure 1-1 for a plan of the proposed Site layout. The key components of this Site are as follows:

- Open pit
- Potentially Acid Generating (PAG) Waste Rock stockpile
- Non-Acid Generating (NAG) Waste Rock stockpile
- Low Grade Ore (LGO) stockpiles
- Organics, Topsoil and Till stockpiles
- Crusher Pad and Administrative Building area
- Site roads, parking areas and haul roads
- Settling ponds, stormwater (SWM) ditches (contact water and non-contact water), culverts and watercourse crossings
- Water Treatment System (WTS)

The scope of this report is to provide details on the potential sources of erosion, risk assessment on erosion susceptibility and best management practices (BMPs) for the mine water infrastructure on Site during construction and operation of the Mine. The mine water infrastructure includes the contact and non-contact SWM ditches, settling ponds, culverts, watercourse crossings and associated areas to be graded.



Source: CanVec Edition 1.1 © Department of Natural Resources Canada. All rights reserved;
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- Settling Pond
- Water Treatment System
- Road
- Bypass Road
- Crusher Pad
- Low Grade Ore Stockpile
- NAG Stockpile
- Open Pit
- Organic Material Stockpile
- PAG Stockpile
- Till Stockpile
- Topsoil Stockpile
- Water Pump Intake

GHD

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
EROSION AND SEDIMENT CONTROL PLAN

088664
Mar 24, 2021

SITE PLAN

FIGURE 1-1

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\20210324_ErosionandSedimentControlPlan\088664_20210324_ErosionandSedimentControlPlan_GIS001.mxd

2. Erosion and Sediment Management Plan

2.1 Objective

Erosion is defined as the detachment and transport of sediment by water, wind, ice, or gravity. Sedimentation is the deposition of those transported materials. Construction activities can adversely affect the aquatic environment due to sediment-laden water being released to natural receiving waters. The prevention and management of erosion and sediment movement on an active mine site involves many critical paths, including planning, material source selection, soil composition, equipment handling, and risk management.

The ESCP provides direction to mitigate erosion and sedimentation associated with the construction and operations of the Mine. Adherence to this document will be a specified requirement under all construction contracts related to the Mine. It will also provide guidance to the construction contractor(s) in the development of more detailed, site specific erosion and sediment standard operating procedures (SOP). This plan includes:

- Reference documents and summary of Best Management Practices (BMPs) used to control erosion and sedimentation
- Identification of potential erosion and sediment sources at the mine site and strategies to control erosion and sedimentation at these sites
- Incident Management
- Record Keeping
- Reporting to Responsible Authorities

For this ESCP, erosion management will focus on preventing erosion within the mine water infrastructure. Sediment management will focus on supplementing erosion control methods and controlling sediment supplied by other Site infrastructure such as stockpiles or roads while preventing sediment from travelling off-site.

2.2 Erosion Risk Assessment Methodology

2.2.1 Activity Erosion Potential

The various factors that affect erosion potential over extended periods of time include:

- Soil Characteristics
  - Particle size and texture, organic matter, water content, and permeability of the soils will all influence soil erodibility. Soil texture refers to the sizes and proportions of the materials making up the soil. In general, soil with high silt content tends to be most susceptible to erosion and soil with high sand content or high organic content has a low erosion potential.
- Topography
  - Topographic features can have a significant impact on the erosion potential of a site. Slope length and steepness are two major factors which affect erosion potential. For example, long, steep slopes have a higher erosion potential than short and/or flat slopes.

- Climate
  - Climate, particularly rainfall frequency, duration, intensity, and type, affects the rate of erosion. Climate also effects growth rates and density of plants and development of vegetation cover, which influences erosion potential.

2.2.2 On Land Soil Erosion Risk Assessment Methods

A risk assessment is essential to determining the appropriate level of effort to be applied to erosion and sediment control (ESC) on a site-specific basis (TAC 2005). Risk is commonly defined as the product of the likelihood of an event occurring and its consequences. The general approach to perform the erosion risk assessment is by applying the modified universal soil loss equation as described by Tajek et al. (1985). The basic universal soil loss equation is:

$$A = R \times K \times LS \times C \times P$$

Where: A = average annual soil loss; R = rainfall-runoff density; K = soil erodibility; L = slope length; S = slope steepness; C = cover management; and P = erosion control practices.

The universal soil loss equation method was developed for agricultural soils and it is commonly calculated based on bare soil using the R, K, and LS factors only. This approach is applicable to other disturbed soil situations where the greatest risk of erosion occurs on bare soils resulting from recent disturbance and on stockpiled soils.

To estimate the maximum potential soil loss that may occur at the Mine site, the cover management factor (C) and the conservation practices factor (P) were not used in calculating the erosion risk. The R, K, and LS factors cannot be changed and represent the erosion risk for a given soil or map unit when it is left unprotected.

Soil texture and related characteristics affecting erodibility include grain size, permeability, and chemistry (K factor). Table 2-1 presents the classification of erodibility by soil type used in the risk assessment.

Table 2-1 Classification of Erodibility by Soil Type

Erodibility Classification	Soil Type	Soil Erodibility Rating
Most	Silt	High
	Silty Loam	High
	Loam	High
	Silty Sand	High
	Sandy Loam	Medium
	Silty Clay Loam	Medium
	Sandy Clay Loam	Medium
	Silty Clay	Medium
	Sandy Clay	Low
	Clay	Low
	Heavy Clay	Low
	Loamy Sand	Low
	Sand	Low
	Poor Graded Gravel	Low
Least	Well Graded Gravel	Low

Source: Adapted from Alberta Transportation (2003).

Slope length and gradient (LS factor) are site specific factors, which are governed by the site topography. Table 2-2 provides a matrix for assessing erosion risk based on the soil loss class (Table 2-1), slope gradient, and slope length.

Table 2-2 Erosion Potential Associated with Slope Length, Slope Gradient, and Soil Erodibility Rating

Slope Gradient	Soil Erodibility	Slope Length	
		<70m	>70m
0-10%	Low	Low	Low
	Medium	Low	Moderate
	High	Moderate	High
10-20%	Low	Low	Moderate
	Medium	Moderate	High
	High	High	High
>20%	Low	Moderate	Moderate
	Medium	High	High
	High	High	High

The erosion risk classes, and their potential soil losses, are listed in Table 3-4. The system's six categories were simplified to three (Low, Moderate, and High) for the Project area to facilitate rating of soils for which there is relatively little data. Erosion risk (Tajek et al. 1985) determined based on R, K, and LS factors, was applied in determining the susceptibility to erosion for soils in the LAA.

Table 2-3 Erosion Risk Classes and Potential Soil Losses

Erosion Risk Classes	System Category	Potential Soil Loss (t/ha/y)
Low	Negligible	<6
Low	Slight	6 to 11
Moderate	Moderate	11 to 22
High	Severe	22 to 33
High	Very Severe	33 to 55
High	Extreme	>55
Notes: t/ha/y = tones per hectare per year, <= less than, >= greater than		

2.2.3 Consequence of Erosion Risk Assessment

The risk assessment should consider potential ecological, legal, and mine schedule and budget consequences.

- **Ecological Consequence**: related to the introduction of sediment to the aquatic environment and low-lying areas, notably wetlands, floodplains, and meadows
- **Project Consequence**: related to the need to response to and repair erosion damage and the implications for the project schedule and finances
- **Legal consequence**: associated with the deposition of sediment in receiving waterbodies and ecological significant area, which could potentially result in charges laid under the *Fisheries Act*

For a project to have low consequence of erosion and sedimentation there should be:

- No environmentally sensitive area that could be disturbed by discharge of water and sediment from the construction site
- No project schedules that would be significantly affected by erosion or sedimentation
- No risk of legal consequence due to regulatory violations, including sediment deposition or violations of provincial or municipal regulations

If the level of any of the three listed consequence is significant, then the consequence will be rated as high.

Higher levels of effort for ESC are appropriate for higher levels of risk, which are based on the site erosion potential and the consequences of erosion and sedimentation. A framework for assessing mine risk and the appropriate level of effort for ESC is shown Table 2-4 and is discussed in detail in TAC (2005).

Table 2-4 Risk Assessment Framework for Erosion and Sediment Control

Erosion Potential	Consequences of Erosion and Sedimentation	Level of Erosion and Sediment Control			Level of Erosion and Sediment Control		
		Procedural BMPs	ESC Plan and Structural BMPs	Water Management BMPs	Staged construction and Progressive Rehabilitation	More Intensive Sediment Control BMPs	Monitor Water Quality (TSS and Turbidity)
Low	Low	recommended	-	-	-	-	-
	High	required	required	-	-	-	-
Moderate	Low	required	-	-	-	-	-
	High	required	required	recommended	recommended	recommended	recommended
High	Low	required	required	required	required	required	recommended
	High	required	required	required	required	required	required

Notes:
Source: TAC, 2005
BMP = Best Management Practices, TSS = Total Suspended Solids

2.3 Best Management Practices

Mine infrastructure will be designed to minimize erosion during construction and operations, so as to preserve the stability of the ground surface surrounding mine infrastructure, SWM ditches, settling ponds and conveyance pathways, dykes, berms and any other Mine installations. The potential for scouring downstream of structures and the potential impacts of sudden changes in flow volume will also be considered.

Short courses on erosion and sediment control design and inspection will be given to all managers and supervisors prior to mining or construction activities that may cause erosion or sediment movement and deposition. Environmental monitors will participate in a short course or seminar on inspection activities associated with erosion and sediment control. An 'Erosion Awareness and Identification' module will be a component of Mine specific training provided to all workers associated with earthwork mining activities.

The BMPs presented in Nova Scotia Environment Erosion and Sedimentation Control Handbook for Construction Sites (Nova Scotia Environment, 1988), Alberta Transportation Erosion and Sediment Control Manual (Alberta Transportation, 2011) and in British Columbia's Dyke Design and Construction Guide Best Management Practices for British Columbia (British Columbia Ministry of Water Land & Air Protection, 2003) will act as general reference. These BMPs are comprehensive in their coverage of erosion and sediment control practices on land and in and around water.

The principles by which the ESCP has been developed are base on those presented in the Nova Scotia Environment Erosion and Sediment Control Handbook for Construction Sites (Nova Scotia Environment, 1988). Principles for the ESCP for the Site include:

1. Fit the activity to the existing topography, soils, waterways, and natural vegetation of the site
2. Expose the smallest practical area of land for the shortest possible time
3. Apply erosion control practices as the primary method to prevent on-site damage
4. Apply sediment control practices as perimeter protection to prevent off-site damage
5. Implement a thorough maintenance plan during construction and operations

Each of these principles will be discussed in greater detail in Section 3.1.

3. Beaver Dam Mine Site Erosion & Sediment Control Plan

The purpose of the Project ESCP is to provide measures and best management practices for the mine water infrastructure to minimize site erosion and protect nearby waterbodies from sedimentation for the protection of the environment. Objectives and targets are established to drive continuous improvement in environmental performance and are consistent with the overall strategic goals of the Project.

In support of AMNS environmental objectives, the ESCP's key objectives include:

- Prevent the uncontrolled release of sediment to natural watercourses
- Compliance with the environmental monitoring criteria established as a part of the environmental approvals process

The ESCP should effectively minimize the potential impact of earthwork and other Site activities on the surrounding environment by:

- Managing surface water runoff across the Site
- Designing mine water infrastructure to include erosion and sediment control measures where necessary
- Identifying potential impacts of erosion and sedimentation
- Identifying mitigation measures for erosion and sedimentation
- Sequence mitigation measures with required site work to prevent erosion and sedimentation issues

The ESCP identifies a series of erosion and sediment control measures related to the mine water infrastructure that should be put in place including location, design, and construction sequencing for each measure. The ESCP should be considered a 'living' document to be updated and adjusted throughout the life of the Project to be effective.

Changes or updates to the ESCP may occur if:

1. Erosion and sediment control issues are present on the Site
2. Project scheduling changes the sequence of earthwork activities (e.g., hydroseeding can not be completed due to a missed growing season)
3. The contractor, AMNS or other project personnel identify or present an alternative procedure for erosion and sediment control for a specific area of the Site which meets the original intent of the ESCP and conforms to Site Approvals and Permits

3.1 Principles of Erosion and Sediment Control

The approach taken for the ESCP for mine water infrastructure is to emphasize erosion control techniques in an effort to eliminate and/or minimize the amount of sediment mobilized due to earthwork activities. Sediment control BMP will be included in case of erosion of the mine water infrastructure or of other Site infrastructure such as stockpiles or haul roads. The main principles of erosion and sediment control included in the ESCP are as follows:

1. Keep Clean Water Clean

All attempts should be made to prevent sediment from entering clean water runoff. This can be accomplished by diverting water away from exposed soils while isolating runoff from actively disturbed areas from the Site.

2. Minimize Exposed Soil

The chance of erosion occurring drastically increases with exposed soil. Soil should be left undisturbed until disruption is absolutely necessary. The more soil that is exposed at any given time,

the greater change for erosion. Cover management and erosion control practices are the most practical and cost-effective measures to control erosion.

3. Minimize Time of Exposure

The chance of erosion occurring also increases significantly the longer exposed soil is left exposed. Construction sequencing should occur in such a manner as to cover exposed/disturbed soils as soon as possible. Cover management is integral to preventing erosion at the Site.

4. Keep Sediment on Site

When erosion does inevitably occur sediment will be prevented from leaving the Site. This will occur through a series of sediment control practices such as settling ponds, check dams and other BMPs to be discussed in this ESCP

3.2 Erosion and Sediment Sources and Receptors

During construction, operations, and post-closure phases there will be several sources of sediment across the Site. These sources include:

- Exposed stockpiles;
- Disturbed areas such as cleared/grubbed areas and recently graded ditches;
- The on-site Haul Road; and
- The Haul Road.

The ESCP will focus on the design of erosion and sediment control measures within and around the mine water infrastructure. All efforts should be made to reduce the erosion of other on-site infrastructure such as stockpiles and the haul road.

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

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

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

3.3 Selection of Best Management Practices

The BMPs presented in the ESCP focus on the Mine water infrastructure. BMPs for sequencing of construction or other components of the Mine Site are not included. The main two components of the Mine water infrastructure include SWM ditches (including culverts) and settling ponds. The methodology for selecting BMPs for each component of the Mine water infrastructure are discussed below.

3.3.1 Stormwater Management Ditch BMPs

SWM ditch BMPs apply to both contact water and non-contact water ditches, culverts and any grading that is required around the ditches or culverts. This includes disturbed soils which need to be sloped to existing grade. The erosion control BMPs for the SWM ditches and culverts focus on preventing erosion within the ditches, around the culverts and on any associated disturbed slopes. Preventing erosion from occurring within and around the ditches and culverts reduces the amount of sediment that needs to be managed downstream.

In addition to preventing erosion, the BMPs for the SWM ditches and culvert include sediment control BMPs to prevent further downstream travel of sediment generated from the stockpiles, haul road or other mine infrastructure.

3.3.2 Settling Pond BMPs

The settling ponds are the ultimate perimeter control point for sediment for the Site. The settling ponds have been designed to prevent off-site travel of sediment through BMPs such as filter berms and retention time for larger storm events. The goal of the settling ponds is to prevent reportable sediment releases from occurring in the downstream natural watercourses.

4. Construction Erosion & Sediment Control

4.1 Construction Sequencing of Mine Water Infrastructure

Construction is when the majority of the Site development outside of the open pit is to occur including clearing, grubbing, and stockpiling of overburden soils. This is also the case for Haul Road upgrades. At Site, during construction not all mine water infrastructure will have been constructed. To prevent discharge of sediment laden water from the Site during construction the first piece of site infrastructure to be constructed is to 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 via 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 for 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 haul road. 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 haul road development, starting at the downstream end and working upstream.

4.2 Construction Erosion & Sediment Control Measures

The first step in erosion and sediment control is to source appropriate road and site infrastructure construction materials. Construction materials may be sourced from the following locations:

- Touquoy Mine Site,

- Beaver Dam Mine Site,
- Off- Site Commercial Quarries, and/or
- small local quarries (< 4 ha) adjacent to the Haul Road .

Materials will be mechanically (i.e., strength) tested as well as chemically tested to determine its suitability for Beaver Dam Mine mining and hauling operations. Figure 4-1 provides a typical cross-section of road.

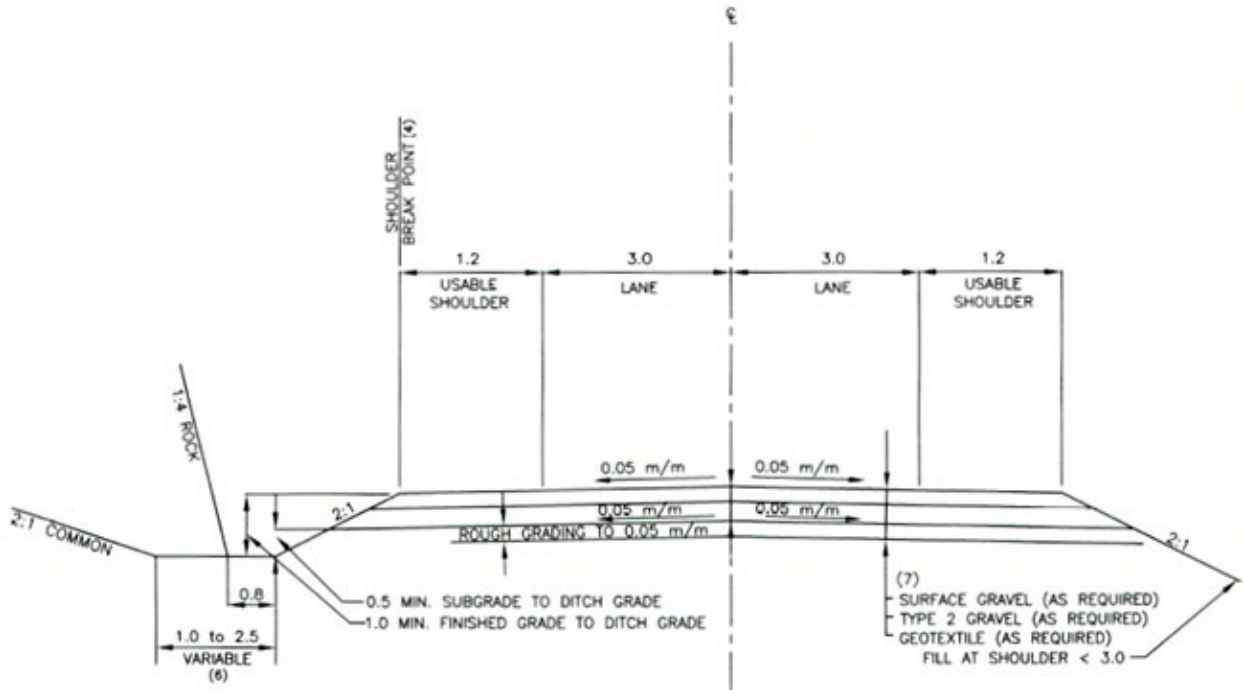

Figure 4-1 Typical Road Profile Cross-section

The road will be constructed of a rough grade, followed by a layer of type 2 gravel and surface gravel. Where necessary a geotextile material will be used to provide additional impermeability where organics are present. Culvert installation will follow the guidelines (DFO 2015). Additional details on site infrastructure and construction is provided in the Project Description of the 2021 Updated EIS (AMNS 2021)

At Site, the north settling pond is the first piece of site infrastructure to be developed specific erosion and sediment controls will need to be implemented during construction as there is no downstream infrastructure to prevent off-site travel of sediment. During construction of the north settling pond, silt fence and straw waddle will be placed on the downstream side of the construction extents to prevent off-site runoff containing significant amount of TSS. Silt fence and straw waddle prevent runoff from directly exiting the site and allow time for suspended sediment to settle out of the runoff.

Exposed soils around the north settling pond with slope of greater than 4:1 (H:V) slope are to be covered with erosion control blanket to reduce the potential for erosion once they have reached final grade. All disturbed areas are to be seeded once they have reached final grade elevations.

Similar methodology for the east and south settling ponds will be followed as these controls are the furthest downstream sediment control point in the respective catchments.

During construction of SWM ditches check dams (straw or rock) should be put in place downstream of the active construction area. Check dams will reduce the flow of runoff within the active construction portion of the SWM ditches, preventing excess sediment from travelling to the downstream settling ponds (contact water ditches) or natural watercourse (non-contact water ditches). Once a section of the ditch has been completed the check dams will be removed and any accumulated sediment will be excavated from the ditch.

The purpose of all culverts, except for the non-mine contact water (i.e., clean water) culvert for Watercourse 5 (WC-5), is to convey water for on-site water management. As such, as long as the upstream SWM ditch network has not been constructed, these culverts will experience minimal flow during construction. The clean water culvert for WC-5 will experience flow while construction is occurring and as such will require specific erosion and sediment control measures. In order to prevent sediment from entering WC-5, the watercourse will be isolated from the culvert construction. The upstream and downstream ends of the culvert construction will be isolated with silt fence and straw waddle and WC-5 will be pumped from the upstream side of the construction to the downstream side of the construction. This will prevent sediment created during construction from entering WC-5. Once the culvert has been installed, following DFO (2015) guidelines, the existing silt fence and straw waddle will be connected to the entrance and exit of the culvert to prevent any sediment from entering the watercourse and culvert while the embankment and road construction is completed.

5. Operations Erosion & Sediment Control Measures

Once all mine water infrastructure has been constructed on site erosion and sediment control will function as a treatment train approach. Beginning in the SWM ditches, once runoff reaches the ditches, each ditch will be lined with an appropriately sized granular channel lining (riprap or gravel). The channel lining will be sized based on the detailed design flows and shear stress calculations. This channel lining will prevent erosion while also increasing roughness of the channel bed, leading to reduced channel velocities, encouraging settling of sediment. Within the ditches, rock check dams will be constructed in ditches with slopes of greater than 3%. Rock check dams decrease the overall slope of the ditch, decreasing velocities and allowing time for suspended sediment to settle out.

Surface water runoff will then discharge from the SWM ditches into one of three settling ponds. Each settling pond consists of a forebay, filter berm, main pond, and outlet structure. The settling ponds have been designed specifically to remove suspended sediment. The forebay design allows for stormwater which enters the pond with high entrance velocities to dissipate energy, reducing the sediment carrying capacity of the flow. The stormwater runoff will then travel through filter berm consisting of a layer of riprap and a gravel core as per the Alberta Transportation Erosion and Sediment Control Manual (Alberta Transportation, 2011) resulting in additional sediment removal. Finally, the pond has been designed such at all storm events up to and including the 100-year design storm event will be retained within each settling pond for a minimum of 24 hours. A retention time of 24 hours allows for any remaining suspended sediment to settle out of the water column prior to discharge into the downstream receiving environment.

Haul Road culverts will be inspected regularly to ensure they allowing for water conveyance and that there are no obstructions to fish passage. Inspection logs will be maintained, and water quality will be routinely sampled as described in Section 6.7. When necessary, the site will be adaptively managed to include additional site-specific mitigations such as water pumping, silt fencing, coir logs, and straw bales.

6. Monitoring and Maintenance

It is necessary throughout the implementation of this ESCP that communication between all parties be maintained. The following are key lines of communication to be understood by Site personnel.

- Prior to installation of environmental structures an on-site Environmental Inspector must communicate the intention and details of the ESCP to the Contractor. The Contractor will provide feedback if a measure appears to be ineffective when constructed.
- During monitoring, the on-site Environmental Inspector must inform the Contractor of the surface water monitoring as soon as possible when maintenance and repair to erosion and sediment control measures are necessary.
- In the event that an erosion and/or sediment control measure fails, AMNS and other relevant regulatory agencies are to be notified immediately along with any potential impacts. The Contractor is to be instructed to make repairs within 12 hours.

Field records of all erosion and sediment control related activities are to be kept. These records may be shared with relevant regulatory agencies at any time. Field records are to be kept on standard forms for ease of comparison and identification of deficiencies.

6.1 Review of Erosion and Sediment Control Measures

All erosion and sediment control measures must be installed as per the manufacturer's recommendations and specifications. Improper installations may not be effective in controlling erosion or sediment on-site, resulting in the potential for transport of sediment off-site.

Environmental control measures will be reviewed and inspected by an on-site Environmental Inspector during construction for deficiencies. Any noted deficiencies must be corrected as soon as possible. The Environmental Inspector can be a trained Environmental Department team member or an independent professional engineer.

Weather forecasts are to be consulted on a daily basis during site preparation activities. In the event of a forecasted precipitation event in excess of 15 millimetres (mm) in 24 hours or 5-10 mm in three hours, environmental controls will be inspected in the field by the on-site Environmental Inspector and preventative maintenance will be performed by the Contractor in advance of the storm event.

If deficiencies are noted during regular inspections which cannot be solved by routine maintenance a professional engineer should be retained to advise on how to resolve the deficiency.

6.2 Construction Monitoring and Maintenance

Effective monitoring of erosion and sediment control measures is vital to the success of the ESCP. Early detection of deficiencies can prevent the need for drastic repair measures and overall improve the outcomes of the ESCP.

Monitoring of the erosion and sediment control measures will take place daily during each day of active construction. A detailed examination of erosion and sediment control measures will be carried out prior to and immediately after a rainfall event; a snowmelt event; or a combination of the two (where the combined total is greater than 15 mm). Areas to be routinely monitored include:

- Areas of exposed soils
- Erosion and sediment control measures such as silt fence, straw waddles etc.
- Areas adjacent to the sensitive receptors identified in Section 3.2

Maintenance activities should be carried out in accordance with this ESCP.

Check dams and settling ponds require sediment removal when the sediment reaches the lesser of a height of 0.3 m or one third of the effective height of the control measure.

Monitoring of TSS in the downstream environment may suggest existing Site erosion and sediment controls are ineffective or additional controls need to be implemented. A professional engineer will be consulted to develop remedial erosion and sediment control measures as necessary.

6.3 Operations Monitoring and Maintenance

Regular monitoring of established erosion and sediment control measures is essential to prevent failure and minimize the chance of significant erosion or sediment transport off-site. If problem areas are identified through repeated inspections a remediation plan will be prepared to address the deficiencies. On-site monitoring and inspections are the responsibility of the Environmental Inspector.

6.4 Contingency and Deficiency Identification

In the case the erosion and sediment control measures are found to be ineffective or overwhelmed by significant/unexpected flow events a contingency plan will be in place including back up erosion and sediment control measure supplies. Contingency planning should include:

- Location and quantity of back up erosion and sediment control mitigation materials
- Details on appropriate construction equipment to be used for repair and location of applicable construction resources
- Plan to prevent discharge of sediment-laden water off-site
- An emergency action plan including sequence events and site-wide protocols

AMNS will maintain a list of Emergency Preparedness supplies and location on-site, including supplies that could be required to remediate or maintain ESC measures, such as pumps, silt fencing, coir logs, and straw bales. Mine equipment (e.g., excavator, bobcat) can also be mobilized in case of need.

6.5 Incident Reporting

In the event that a release of TSS in site discharge exceeds provincial guidelines, relevant regulatory agencies will be alerted. Failures which do not result in the release of sediment from the Site should be recorded by the Environmental Department as these failures could lead to a reportable incident in the future.

Reportable incidents include:

- For Clear Flows (Normal background conditions)
  - Maximum increase of 25 mg/L from background levels (24 hours or less); and
  - Maximum average increase of 5 mg/L from background levels (inputs lasting between 24 hours and 30 days)
- For High Flow (Spring freshet and storm events)
  - Maximum increase of 25 mg/L from background levels when background levels are between 25 mg/LO and 250 mg/L; and
  - Shall not increase more than 10% over background levels when background is greater than 250 mg/L

6.6 Decommissioning of Environmental Controls

Temporary sediment controls are to be removed at the appropriate time in order to ensure the success of the mine water infrastructure. These measures are to be removed once the Site Inspector as identified that construction work in this area has been completed, the area is sufficiently stabilized, and the downstream control is no longer required. A control will no longer be necessary when:

- No further activities resulting in disturbance of soil and earthwork is expected in this area
- The upstream area has been sufficiently stabilized and there are not signs of active erosion
- Compliance with provincial guidelines for TSS in runoff can be met.

6.7 Documentation

Documentation of all activities related to erosion and sediment control is vital to demonstrate that all reasonable efforts have been made to prevent the release of sediment-laden surface water from the Site. All erosion and sediment control activities are to be documented to indicate that this ESCP is being followed. The documentation should include:

- The ESCP
- Revisions to the ESCP
- Erosion and Sediment Control Inspection Reports
- Surface water sampling results
- Maintenance Reports
- Erosion and Sediment Control Incident Reports

- Erosion and Sediment Control Decommissioning Reports for temporary structures

These documents may be provided to relevant regulatory agencies at any time to demonstrate due diligence regarding erosion and sediment control at the Site.

7. Conclusion

This Erosion and Sediment Control Plan includes general principles to govern erosion and sediment control measures implemented at the Beaver Dam Mine Site and Haul Road along with specific erosion and sediment control measures to be implemented for the mine water infrastructure during construction and operations. Best management practices and principles outlined in this ESCP should be followed when constructing erosion and sediment control measures.

8. References

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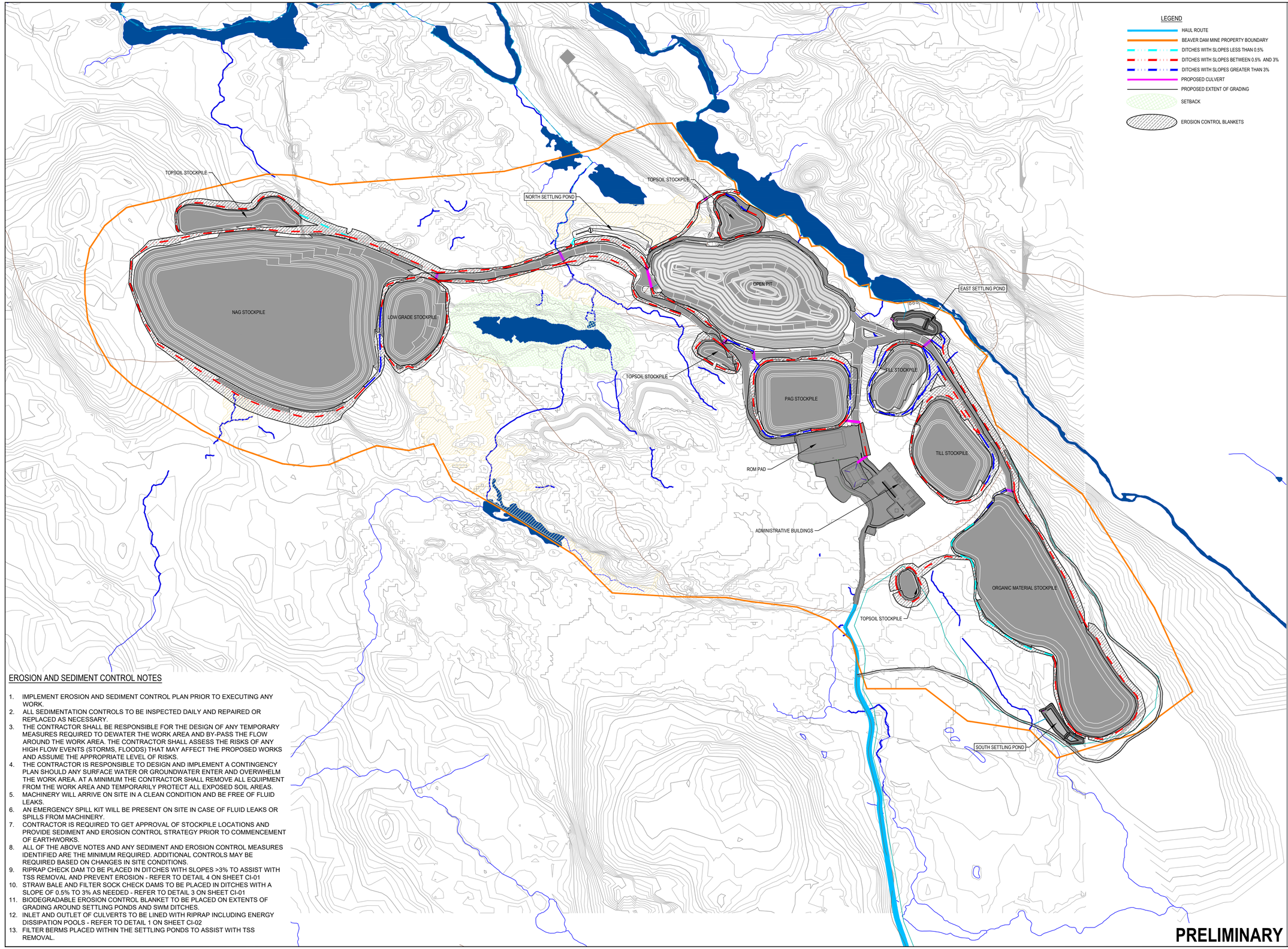

EROSION AND SEDIMENT CONTROL NOTES

1. IMPLEMENT EROSION AND SEDIMENT CONTROL PLAN PRIOR TO EXECUTING ANY WORK.
2. ALL SEDIMENTATION CONTROLS TO BE INSPECTED DAILY AND REPAIRED OR REPLACED AS NECESSARY.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DESIGN OF ANY TEMPORARY MEASURES REQUIRED TO DEWATER THE WORK AREA AND BY-PASS THE FLOW AROUND THE WORK AREA. THE CONTRACTOR SHALL ASSESS THE RISKS OF ANY HIGH FLOW EVENTS (STORMS, FLOODS) THAT MAY AFFECT THE PROPOSED WORKS AND ASSUME THE APPROPRIATE LEVEL OF RISKS.
4. THE CONTRACTOR IS RESPONSIBLE TO DESIGN AND IMPLEMENT A CONTINGENCY PLAN SHOULD ANY SURFACE WATER OR GROUNDWATER ENTER AND OVERWHELM THE WORK AREA. AT A MINIMUM THE CONTRACTOR SHALL REMOVE ALL EQUIPMENT FROM THE WORK AREA AND TEMPORARILY PROTECT ALL EXPOSED SOIL AREAS.
5. MACHINERY WILL ARRIVE ON SITE IN A CLEAN CONDITION AND BE FREE OF FLUID LEAKS.
6. AN EMERGENCY SPILL KIT WILL BE PRESENT ON SITE IN CASE OF FLUID LEAKS OR SPILLS FROM MACHINERY.
7. CONTRACTOR IS REQUIRED TO GET APPROVAL OF STOCKPILE LOCATIONS AND PROVIDE SEDIMENT AND EROSION CONTROL STRATEGY PRIOR TO COMMENCEMENT OF EARTHWORKS.
8. ALL OF THE ABOVE NOTES AND ANY SEDIMENT AND EROSION CONTROL MEASURES IDENTIFIED ARE THE MINIMUM REQUIRED. ADDITIONAL CONTROLS MAY BE REQUIRED BASED ON CHANGES IN SITE CONDITIONS.
9. RIPRAP CHECK DAM TO BE PLACED IN DITCHES WITH SLOPES >3% TO ASSIST WITH TSS REMOVAL AND PREVENT EROSION - REFER TO DETAIL 4 ON SHEET CI-01
10. STRAW BALE AND FILTER SOCK CHECK DAMS TO BE PLACED IN DITCHES WITH A SLOPE OF 0.5% TO 3% AS NEEDED - REFER TO DETAIL 3 ON SHEET CI-01
11. BIODEGRADABLE EROSION CONTROL BLANKET TO BE PLACED ON EXTENTS OF GRADING AROUND SETTLING PONDS AND SWM DITCHES.
12. INLET AND OUTLET OF CULVERTS TO BE LINED WITH RIPRAP INCLUDING ENERGY DISSIPATION POOLS - REFER TO DETAIL 1 ON SHEET CI-02
13. FILTER BERMS PLACED WITHIN THE SETTLING PONDS TO ASSIST WITH TSS REMOVAL.

PRELIMINARY

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Client
ATLANTIC MINING NS INC.
BEAVER DAM, NOVA SCOTIA

Project
BEAVER DAM MINE PROJECT
EROSION & SEDIMENT CONTROL PLAN

No.	Issue	Drawn	Approved	Date

Drawn	**J. SPENLER**	Designer	**C. MUIRHEAD**
Drafting Check	**N. QUEHL**	Design Check	**A. BETTS**
Project Manager	**A. BETTS**	Date	**Apr 14, 2021**
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Title
EROSION & SEDIMENT CONTROLS PLAN

Sheet No.
CI-01
Sheet **1** of **2**

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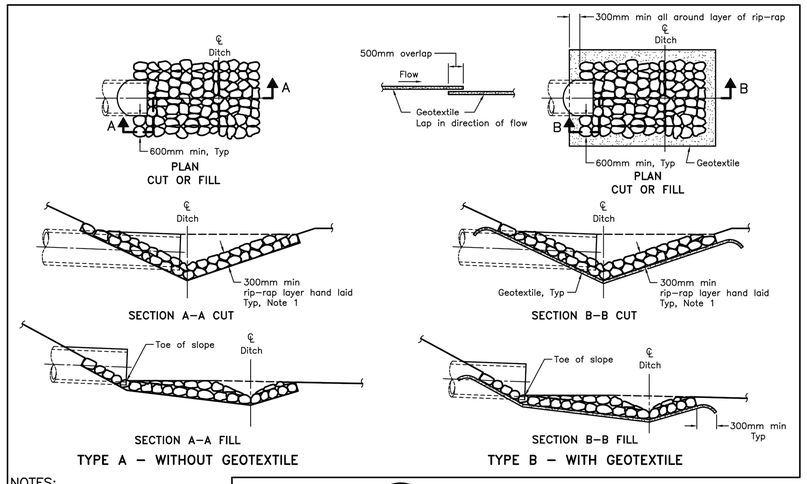
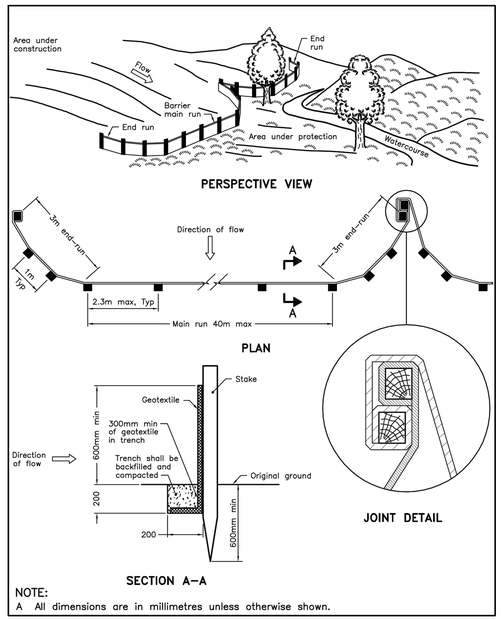


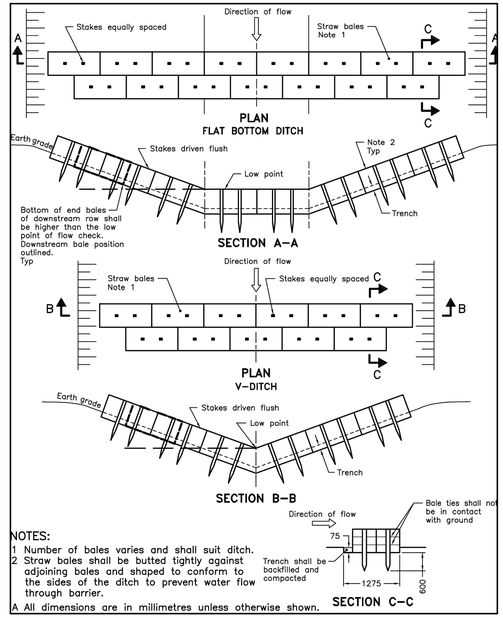
NOTES:
1 The thickness of the rip–rap layer shall be at least 1.5 times the rip–rap mean diameter.
A All dimensions are in millimetres unless otherwise shown.

DETAIL 1 CI-01 — NTS — GENERAL RIP-RAP LAYOUT FOR CULVERT OUTLETS



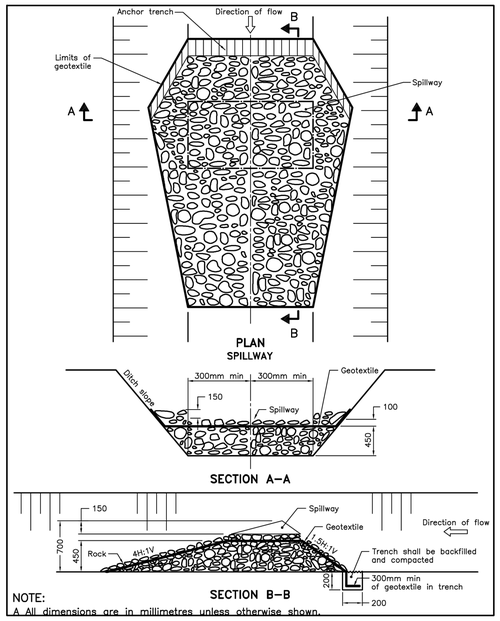
NOTE:
A All dimensions are in millimetres unless otherwise shown.

DETAIL 2 CI-01 — NTS — LIGHT-DUTY SILT FENCE BARRIER



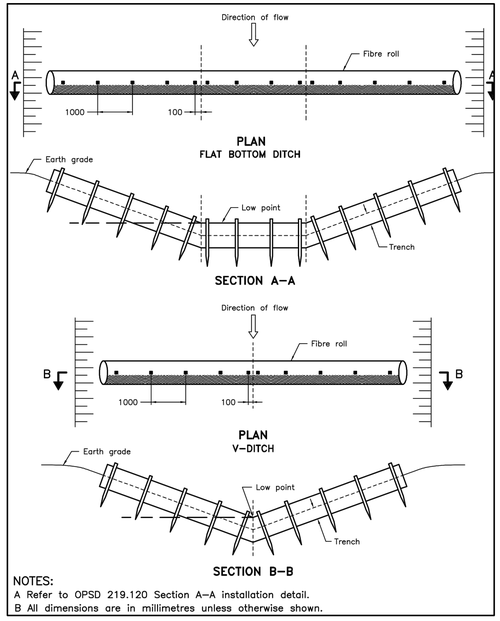
NOTES:
1 Number of bales varies and shall suit ditch.
2 Straw bales shall be butted tightly against adjoining bales and shaped to conform to the sides of the ditch to prevent water flow through barrier.
A All dimensions are in millimetres unless otherwise shown.

DETAIL 3 CI-01 — NTS — STRAW BALE FLOW CHECK DAM



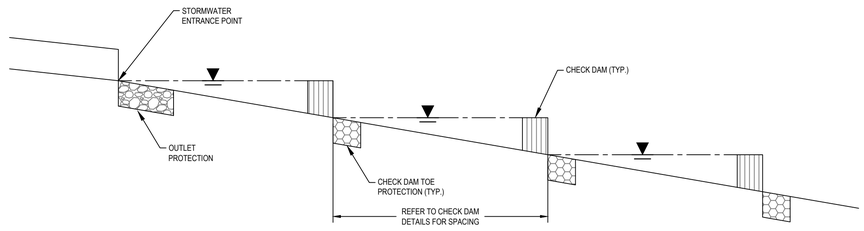
NOTE:
A All dimensions are in millimetres unless otherwise shown.

DETAIL 4 CI-01 — NTS — TEMPORARY ROCK FLOW CHECK DAM



NOTES:
A Refer to OPSD 219.120 Section A–A installation detail.
B All dimensions are in millimetres unless otherwise shown.

DETAIL 5 CI-01 — NTS — FILTER SOCK CHECK DAM



DETAIL 6 CI-01 — NTS — CHECK DAM SPACING

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BEAVER DAM, NOVA SCOTIA

Project
BEAVER NAM MINE PROJECT
EROSION & SEDIMENT CONTROL PLAN

No.	Issue	Drawn	Approved	Date

Drawn	J. SPENLER	Designer	C. MUIRHEAD
Drafting Check	N. QUEHL	Design Check	A. BETTS
Project Manager	A. BETTS	Date	Apr 14, 2021
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Project No. **88664**

Title
EROSION & SEDIMENT DETAILS

Sheet No.
CI-02

Sheet 2 of 2

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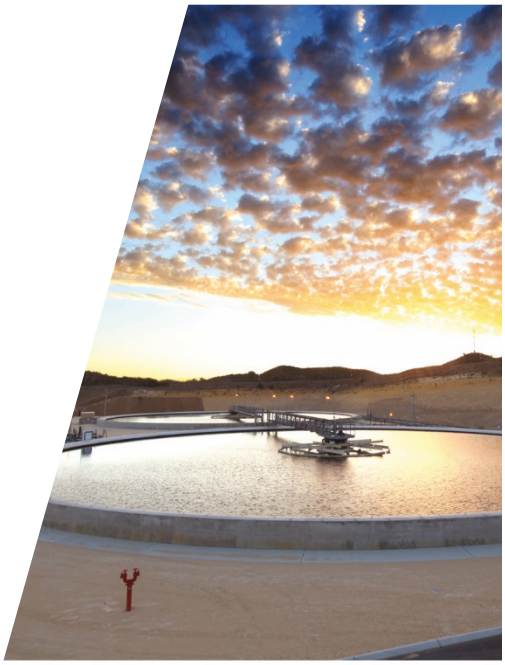
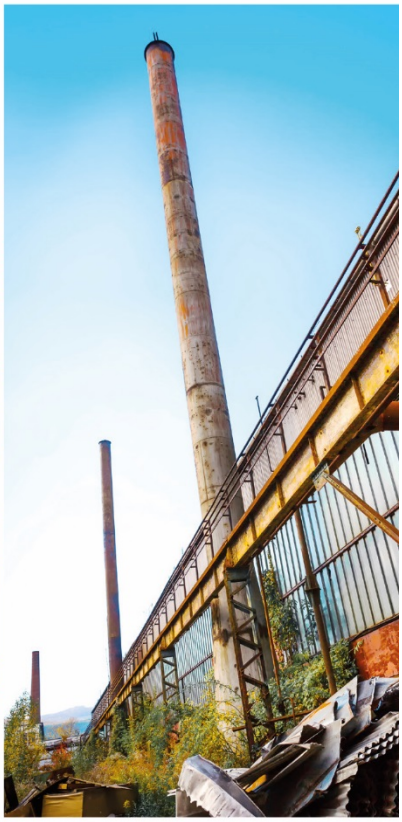
Appendix D
Predictive Water Quality Assessment



Predictive Water Quality Assessment

Beaver Dam Mine Site

Atlantic Mining NS Inc.



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1. Introduction

GHD Limited (GHD) was retained by Atlantic Mining NS Inc. (AMNS) to develop a Mine Water Management Plan (MWMP) for the Beaver Dam Gold Mine (Mine) in Marinette, Halifax County (Site), Nova Scotia. The MWMP is 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 Post-Closure (PC) stages. For each life cycle stage the potential effects of mine contact water to the water quality in the Killag River was assessed under base case (median) and upper case (90th percentile) concentration scenarios. This report presents the methodology and results for the predictive water quality assessment, which are used to determine whether the Mine has the potential to impact water quality in the Killag River, and whether water treatment will be required at the Site during EOM and PC conditions before discharging to the receiving watercourses.

2. Background Information

The Site comprises approximately 592 hectares (ha) of lakes, rivers, and forested lands that are in varying degrees of re-growth due to historical logging. The Mine 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. Construction of the Mine is anticipated to take 1 year. The Mine will be in operation for 5 years followed by 2 years of active closure/reclamation and greater than 10 years of monitoring.

The objective of the MWMP is to mitigate the operational risks and environmental impacts of the Mine on the surrounding environment including the receiving watercourse and ultimately, the Killag River. As part of the MWMP, GHD completed a water quality assessment to predict the concentration of constituents of concern in the mine discharge water at the Site discharge point, near field mixing zone, and far field mixing zone in the Killag River.

The total contributing drainage area to the far field mixing zone assessment point in the Killag River (downstream of the Site) is approximately 3,930 ha, which includes the Mine Site and Mud Lake. The contributing drainage areas and mine footprint can be seen on Figure 2-1 and Figure 2-2.

0 500 1,000
Meters

Coordinate System:
NAD 1983 UTM Zone 20N

NOTES:
1. Mud Lake and Tent Brook Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

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Drainage Areas
- Killag River Assessment Point (~3,933.5 ha)
- Mud Lake Assessment Point (~223.1 ha)
- Crusher Lake Assessment Point (~58.8 ha)
- Tent Brook Assessment Point (~306.2 ha)
- WC-26 Assessment Point (~78.6 ha)
- WC-23 Assessment Point (~181.8 ha)

Assessment Points
- Killag River
- Mud Lake
- WC-23
- Tent Brook
- WC-26

- Future Mine Footprint
- Contours (5m)

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
PREDICTIVE WATER QUALITY ASSESSMENT

CATCHMENT AREAS - BASELINE CONDITION

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FIGURE 2-1

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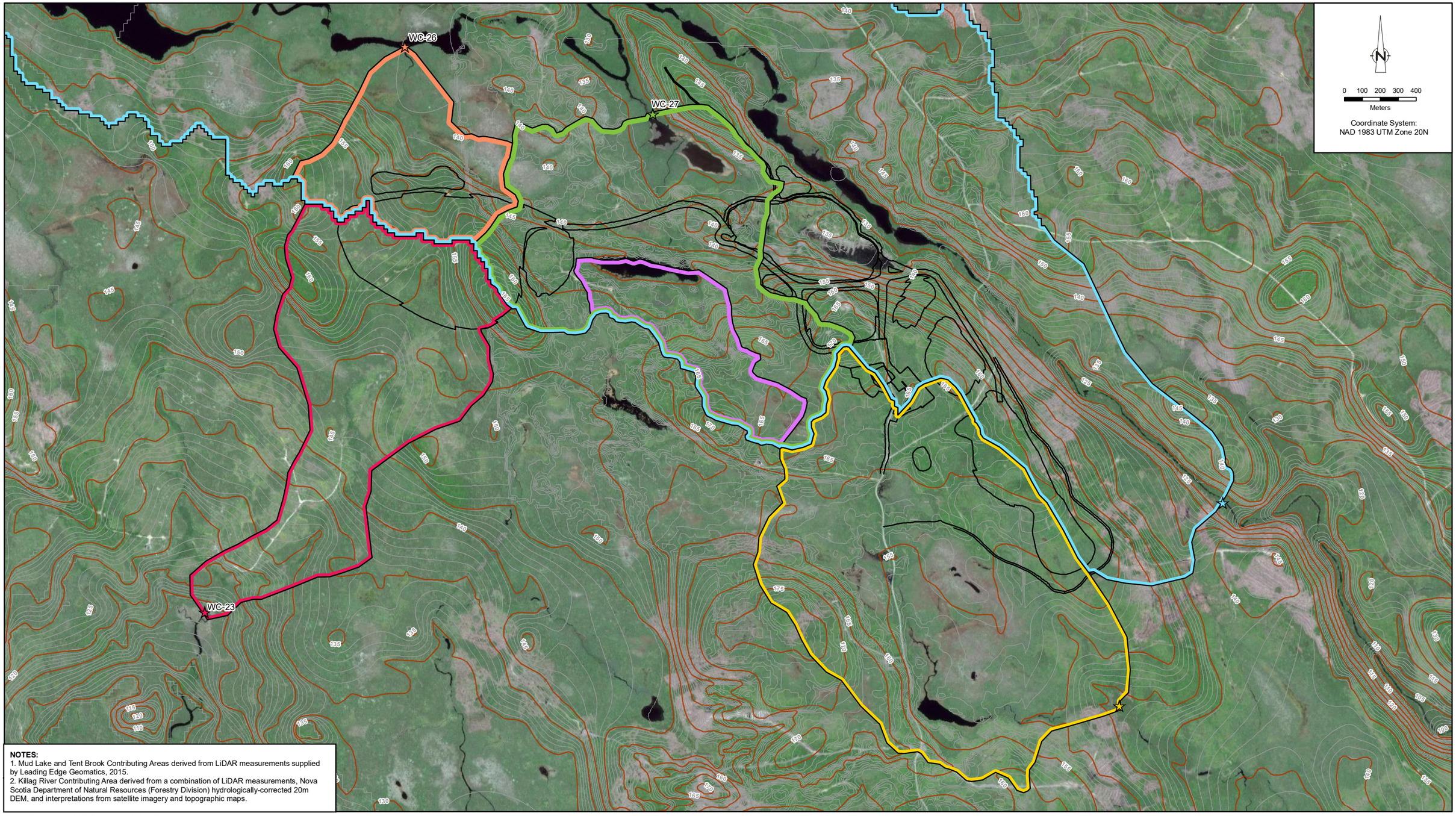

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Assessment Points
- Killag River
- Mud Lake
- WC-23
- Tent Brook
- WC-26

- Future Mine Footprint
- Contours (5m)
- Contours (1m)

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
PREDICTIVE WATER QUALITY ASSESSMENT

CATCHMENT AREAS - BASELINE CONDITION (DETAILED VIEW)

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FIGURE 2-2

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2.1 Surface Water Sampling Results

In preparation for development of the Beaver Dam mine, GHD undertook the monitoring of background concentration levels of surface water in the Killag River and several nearby tributaries in order to accurately determine background conditions in the surrounding watershed. Two periods of sampling was undertaken: between October 2014 to August 2015, and April 2019 to December 2019. 10 surface water samples were taken at seven (7) locations from 2014 to 2015. 14 samples were collected at nine (9) locations in 2019. In total 24 samples were taken across the two sampling periods. The sampling locations in relation to the mine footprint are shown on Figure 2-3. The location of the mine water discharge during EOM and PC will occur upstream of the surface water monitoring station SW-1. As such, the background conditions of the Killag River were taken as the average concentration of samples at SW-1.

The background concentrations of constituents of concern are shown in Table 2-1. When constituent concentrations were recorded as a non-detect value the concentration was conservatively assumed to be equal to half the detection limit. The detection limits for these samples are shown in Table 2-1 along with the number of samples found at the detection limit.

Table 2-1 Background Concentrations in Killag River

Constituent	Concentration in Killag River	Detection Limit (DL)	Number of Samples at Detection Limit
	µg/L	µg/L	
Ag	0.05	0.10	14
Al	253.57	--	0
As	1.59	1.0	5
Cd	0.02	0.010	1
Co	0.29	0.40	10
Cu	0.85	2.0/0.50[+]	12
Fe	509.29	--	0
Hg	0.01	0.013	12
Mn	47.57	--	0
Mo	1.00	2.0	14
Ni	1.11	2.0	13
Pb	0.33	0.50	10
Sb	0.50	1.0	14
Se	0.46	1.0/0.50[++]	14
Tl	0.05	0.10	14
U	0.05	0.10	14
Zn	3.55	5.0	10

Table 2-1 Background Concentrations in Killag River

Constituent	Concentration in Killag River	Detection Limit (DL)	Number of Samples at Detection Limit
	µg/L	µg/L	
Nitrate	47.43	50	7
Nitrite	5.36	10/20[+++]	14
Ammonia	30.36	50	13
Hardness	3,500	--	0

[+] Copper detection limit was 2.0 µg/L for 2014/15 sampling and 0.50 µg/L for 2019 sampling
[++] Selenium detection limit was 1.0 µg/L for 2014/15 and Apr/Jun 2019 sampling and 0.50 µg/L for Sept/Dec 2019 sampling
[+++] Nitrite detection limit was 10 mg/L for 2014/15 and Apr/Jun/Sept 2019 sampling and 20 mg/L for Dec 2019 sampling

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- Surface Water Sample Location
- Contours (5m)

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
PREDICTIVE WATER QUALITY ASSESSMENT

BASELINE SURFACE WATER MONITORING LOCATIONS

088664-27
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FIGURE 2-3

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These background concentrations will be used in combination with the background flow volume in the Killag River and mine effluent concentrations and volumes to perform mixing calculations. These mixing calculations will be used to determine the resulting constituent concentration within the Killag River downstream of Beaver Dam mine during EOM and PC conditions. Cyanide has not been included in the background constituents of concern because it is typically a by-product of the refining process of the ore. The refining process is to take place off-site at the Touquoy mine and therefore Cyanide will not be a concern regarding water quality entering the Killag River from the Beaver Dam mine.

2.2 Water Quality Effluent Regulations

There are several federal instruments that oversee the quality of water discharged from a mine site into a natural water body. Specifically, this water quality assessment focuses on potential constituents of concern identified in the Metal and Diamond Mining Environmental Regulation (MDMER) Objectives, Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life and Tier 1 Nova Scotia Environment (NSE) Environmental Quality Standards (EQS) for Surface Water. It is important to note that since operations plan to commence in 2022 the MDMER objectives referenced in this report relate to “New Mines”, and therefore follow Table 1 of Schedule 4 from the MDMER. In addition, Site-Specific Water Quality Guidelines have been established for the Mine Site. These Site-Specific Guidelines are based on background concentrations that exceed CCME and Tier 1 EQS Guidelines or a risk hazard assessment performed for the receiving water body.

The constituents identified in MDMER, CCME, Tier 1 EQS and Site-Specific regulations are summarized in Table 2-2. MDMER regulations are used to assess End-Of-Pipe discharge concentrations whereas CCME, Tier 1 EQS and Site-Specific guidelines are used to assess concentrations within the Killag River after mixing. Hardness was not included in Table 2-2 as hardness of the water was not assessed relative to regulatory guidelines but rather for determining CCME guidelines of other constituents of concern. Refer to Appendix A for additional information regarding hardness calculations for the purpose of determining appropriate regulatory limits.

Table 2-2 MDMER, CCME, Tier 1 EQS and Site-Specific Water Quality Regulations

Constituent	MDMER	CCME	Tier 1 EQS	Site-Specific[+]
	µg/L	µg/L	µg/L	µg/L
	a	b	c	d
Ag	-	0.25	0.25	-
Al	-	5.00	5.00	254
As	100	5.00	5.00	30.0
Cd	-	0.04	0.04	-
Co	-	0.78	10	-
Cu	100	2.00	2.00	-

Table 2-2 MDMER, CCME, Tier 1 EQS and Site-Specific Water Quality Regulations

Constituent	MDMER	CCME	Tier 1 EQS	Site-Specific[+]
	µg/L	µg/L	µg/L	µg/L
	a	b	c	d
Fe	-	300	300	509
Hg	-	0.026	0.026	-
Mn	-	190	820	-
Mo	-	73.0	73.0	-
Ni	250	25.0	25.0	-
Pb	80.0	1.00	1.00	-
Sb	-	-	20.0	-
Se	-	1.00	1.00	-
Tl	-	0.80	-	-
U	-	15.0	300	-
Zn	400	7.00	30.0	-
Nitrate	-	13,000	-	-
Nitrite	-	60[++]	-	-
Ammonia	-	27,550[+++]	-	-

[+] Site-Specific guidelines are taken from Intrinsik (2021)
[++] Nitrite guideline is listed in µg nitrite/L
[+++] Ammonia guideline is in ug ammonia-N/L based on a conservative assumption of pH of 6.0 and water temperature of 25ºC

3. Predictive Water Quality Assessment

The predictive water quality assessment was calculated monthly for the average year climatic conditions. Performing the water quality assessment on a monthly basis allows for the prediction of the seasonality characteristics of water quality in the Killag River. This allows for the assessment of the wet and dry months to determine the month with the highest effect on the water quality in the Killag River and will assist with the design of water quality treatment options at the Mine Site.

The following section presents the environmental data inputs and predictive water quality results.

3.1 Environmental Data

3.1.1 Climatic Data

Historical rainfall data was obtained from the Environment Canada climate station Middle Musquodoboit (ID: 8203535) with continuous historical daily precipitation data from 1968 to 2005.

Monthly precipitation totals were calculated from the Middle Musquodoboit Climate Station daily precipitation record for 41 years including 1968 – 2005, 2009, 2014 and 2016. Years that have a significant amount of missing data were excluded from the analysis. The station was selected based on its proximity to the Mine Site, and relatively long, complete, and current record.

3.1.2 Predictive Source Term Model

To determine the concentration of each constituent leaving the Site, the geochemistry of each stockpile (till, topsoil, potentially acid generating (PAG) waste rock, non-acid generating (NAG) waste rock, low grade ore (LGO)) and the pit wall rock were assessed individually by Lorax Environmental (Lorax Environmental, 2019). This assessment included both the base case and the upper case scenarios of constituent concentrations for EOM and PC mine life cycle conditions. The base case scenario represents the most likely concentration scenario (median) while the upper case scenario represents the likely worst-case (90^{th} percentile) concentration scenario.

For the EOM conditions, the source term model assumed the following:

- The NAG and PAG waste rock piles have reached their maximum height but remain uncovered and unrestored.
- The LGO stockpile has an area of 86,000 m^2 and remains uncovered and unrestored.
- The pit is constantly being dewatered and discharged into the north settling pond.
- Standard best practice erosion and sediment control measures have been implemented on the topsoil and till piles.

For the PC conditions, the source term model assumed the following:

- The NAG waste rock stockpile has been covered with soil and seeded.
- The PAG waste rock stockpile has been covered with a High Density Polyethylene (HDPE) liner allowing an estimated infiltration rate of 3% of total precipitation through the liner. The cap is covered with soil and seeded.
- The LGO stockpile has been removed from the Mine Site and processed at the Touquoy site. Surface water from this stockpile area is to be restored back to Mud Lake.
- The till and topsoil stockpiles have been removed and restored.
- The pit has been allowed to naturally fill with water to an elevation of 127 m.
- All Site water will drain to the pit prior to discharge into the river.
- Other than what is mentioned above no other reclamation activities have been implemented at the Mine Site

3.1.3 Mine Site Water Balance

Stockpiles Water Balance

Runoff, infiltration and evaporation from each stockpile material were determined as a percentage of total rainfall based on estimated runoff-infiltration values from Touquoy mine for EOM and PC conditions and were provided by Stantec (pers., comm., 2018). Waste rock and LGO stockpiles will have high infiltration rates (90%) and low runoff rates (5%) during EOM conditions due to the high porosity of the stockpile. The LGO stockpile will be removed in PC conditions. The NAG waste rock infiltration rate will decrease during PC conditions (42.5%) while runoff rates will increase (22.5%) due to covering of the stockpile with soil and seed. The PAG waste rock pile will have a HDPE liner reducing infiltration into the waste rock pile (estimated 3%) resulting in greater runoff during PC conditions (62%). Till and topsoil are less permeable and are only expected to infiltrate approximately 16% of rainfall with 49% leaving as runoff during EOM conditions. Till and topsoil stockpiles will be removed during PC conditions.

Runoff volumes for the stockpiles were calculated based on the runoff coefficient provided by Stantec and the area of each stockpile while runoff volumes from catchments with no stockpiles were determined through GHD's water balance model (WBM) (GHD, 2021a). The WBM considered field capacity of the soil, saturation points and calculated both infiltration and runoff as a result. Infiltration volumes for the stockpile catchments were calculated based on the stockpile area. Infiltration into each stockpile was then split into absorbed infiltration (water remaining within the stockpile or recharging groundwater baseflow) and seepage (water leaching out of the stockpile).

The volume of water absorbed by the stockpile was determined based on estimated recharge into the groundwater, an estimated 20-year time-to-saturation of the stockpiles, and the respective field capacity of each stockpile, provided by Stantec (pers., comm., 2018). The area surrounding the Beaver Dam Site experiences approximately 17% infiltration of the total precipitation into the ground on an annual basis (GHD, 2021b). Field capacity is defined as the point at which water in the pore spaces of a soil will begin to drain. A field capacity of 0.004 is equivalent to the field capacity of gravel and is the assumed field capacity for the waste rock piles (Zhan et al., 2016). A field capacity of 0.19 is equivalent to the field capacity of sandy loam, the predominate soil in the area and is the assumed field capacity for the till stockpiles (Rawls et al., 1983).

Based on assumed field capacities of 0.004 and 0.19 for waste rock/ore and till/topsoil, respectively, it was determined approximately 0.4% of total rainfall will be absorbed and 17% of total rainfall will recharge into the groundwater system under the waste rock and LGO stockpiles in EOM conditions. In PC conditions approximately 17% of water will recharge into the groundwater system under the NAG stockpile, while it is assumed all water entering the PAG waste rock pile through the clay liner will either infiltrate to groundwater or seep out the base of the stockpile. Water that is unable to be absorbed will leave the stockpile as seepage. Due to the slow movement of water through the stockpile, the seepage is estimated to take approximately one month to leave the stockpile. Thus, the seepage is equal to the previous month's infiltration minus absorption.

For each stockpile, direct runoff was assumed to be clean with no constituents of concern while seepage was assumed to contain the constituents of concern identified in the Lorax Environmental source term model (Lorax Environmental, 2019). All infiltration into the till and topsoil stockpiles is expected to be absorbed based on the assumed field capacities above. As a conservative assumption it was assumed 10% of infiltrated water in the till and topsoil stockpiles will be discharged as seepage.

The predictive water quality assessment incorporated groundwater discharge into the surface water ditches and the Killag River, including potential additional loading from mining related activities. Concentrations of constituents of concern and discharge volumes were taken from GHD's groundwater model for the Beaver Dam Site (GHD, 2021b).

Pit Water Balance

During the operational phase of the open pit, dewatering will have to occur since the natural groundwater table is above the mining elevation. In addition, runoff from direct precipitation and snow melt will also contribute to the water within the open pit. The water collected within the pit will be pumped to the north settling pond. During PC conditions, the dewatering operations will cease and the pit will naturally fill with groundwater and Site runoff. As outlined in Beaver Dam Mine Site - Water Balance Analysis (GHD, 2021a), the filling of the pit will take approximately 13 years. Once the pit has filled with water to an elevation of 127 m, additional water will overflow the pit walls through an engineered outfall structure directly into the Killag River. During both the EOM and PC phases water in the pit will also evaporate into the atmosphere.

The pit area is expected to produce runoff equal to 85% of total rainfall as per discussions with Stantec (pers., comm., 2018).

The additional inflow to the pit from groundwater seepage was determined using GHD's groundwater model and was estimated to be approximately 605 m^3/day during EOM conditions and 393 m^3/day during PC conditions (GHD, 2021b).

During EOM conditions, the precipitation that fell into the pit was assumed to contact the freshly exposed pit walls causing the release of the weathering products, particularly those related to sulphide oxidation (Lorax Environmental, 2019). Groundwater inflows are expected to contain constituents of concern equal to the background groundwater monitoring concentration levels. Average measured groundwater concentrations were used for the base case scenario while maximum measured groundwater concentrations were used for the upper case scenario.

During PC conditions the direct precipitation into the pit is assumed to be clean as it will fall directly onto the lake which has formed in the pit. Groundwater inputs are assumed to remain at background concentrations during PC. While pH was not explicitly analyzed in the water quality assessment, it was considered in the generation of the source terms during PC conditions in the pit lake. The water within the pit lake will likely be at or near a neutral pH after complete mixing of Site runoff and groundwater. This has a significant effect on metals such as Aluminum and Iron resulting in precipitation of these metals out of the water. To account for the effect of pH on Aluminum and Iron the concentrations of these two metals were set to have upper bounds associated with the expected pH in the pit during PC

conditions. These upper bounds are shown in Table 3-1 and were received from Lorax (pers., comm., 2018).

Table 3-1 Upper Objectives for Aluminum and Iron Concentration in Pit, PC Conditions

	Aluminum (µg/L)	Iron (µg/L)
Base Case	13	52
Upper Case	50	1,050

It should be noted that Nitrite and Ammonia are modelled as µg Nitrite-N/L and µg ammonia-N/L respectively. This is consistent with the regulatory guidelines shown in Table 2-2.

3.2 Mine Site Discharge Points

The Mine Site includes three discharge points during EOM conditions and one discharge point during PC conditions. During EOM conditions Site water from the PAG and LGO stockpiles, the pit, and crusher pad will be routed through the north settling pond prior to discharge into the Killag River. Site water from the NAG stockpile will be routed through the west settling pond before travelling to the north settling pond for discharge to the Killag River. Site water from the till and part of the organics stockpiles will be routed through the east settling pond prior to discharge into the Killag River approximately 200 m downstream from the north settling pond discharge point. Site water from the remaining portion of the organics stockpile will be routed through the south settling pond discharge point into WC-19. During PC conditions, Site water from the waste rock stockpiles will be routed through the pit prior to discharge into the Killag River. This discharge point will coincide with the east settling pond discharge point. Natural drainage pathways will be re-established where stockpiles have been removed including the till, organics, topsoil and LGO stockpile locations. The north, east and south settling ponds will be decommissioned for the PC scenario.

Constituent concentrations in the Killag River were calculated at near field mixing zones (100 m downstream of the north settling pond and east settling pond discharge points) and far field mixing zone (approximately 1 km downstream of east settling pond/pit discharge point in the Killag River) locations for EOM conditions. Constituent concentrations in the Killag River were calculated at the near field mixing zone (100 m downstream of the pit discharge point) and far field mixing zone location for PC conditions. The Near Field – North Settling Pond assessment point includes constituent loading from background and the north settling pond discharge. The Near Field – East Pond/Pit and the Far Field assessment points includes the constituent loading from background, the north settling pond and the east settling pond/pit.

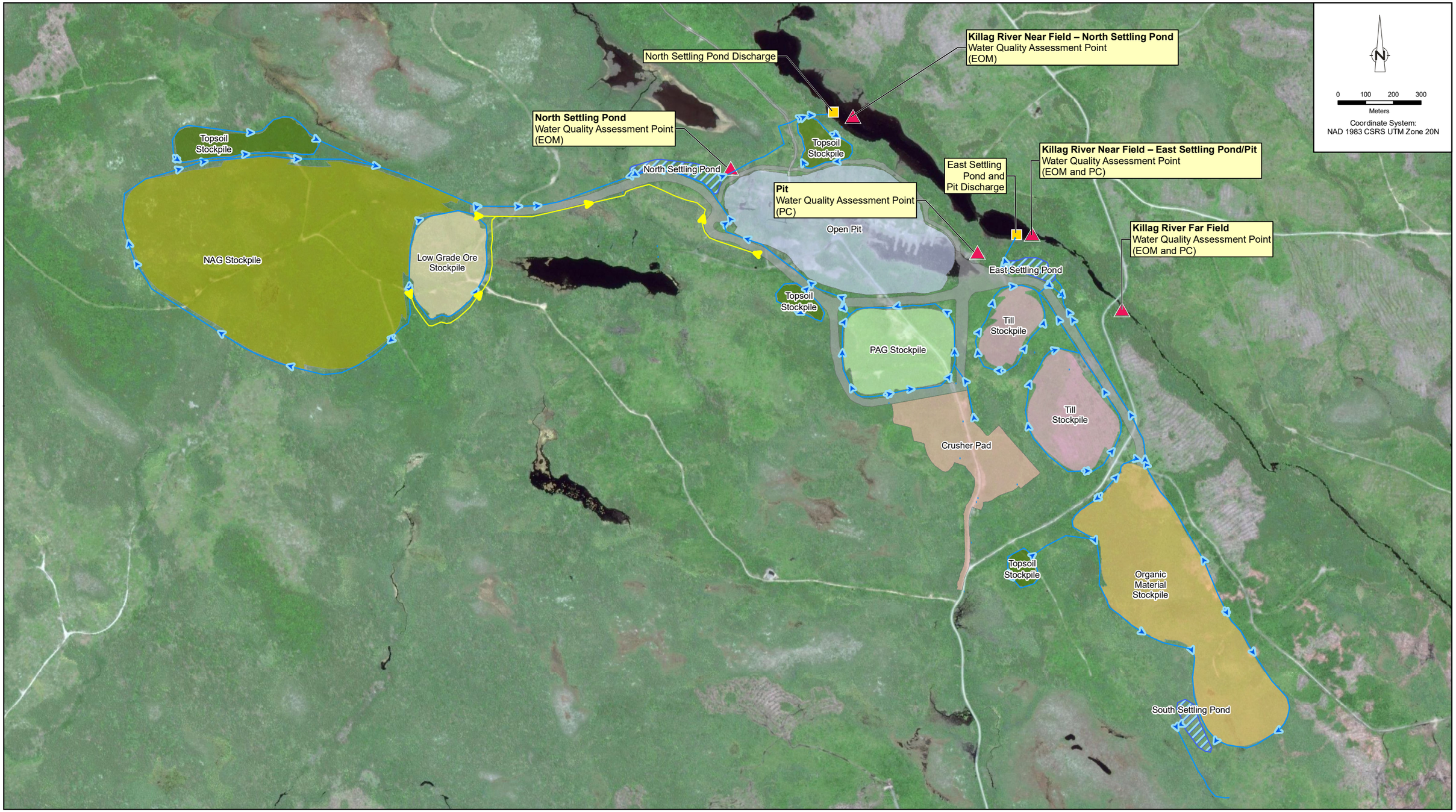
The discharge and water quality assessment points can be seen on Figure 3-1. Based on previous experience with mixing models in rivers of similar size to the Killag River, it was assumed that full mixing would occur at the near field location. Field observations of the flow in the Killag River at the near field location indicate slightly turbulent flow. Furthermore, immediately downstream of the near field location there is a pinch point in the river, which will further force the full mixing in the water column. In addition, based on the requirements set out in MDMER Part 2, 9 (1) (b) in order to assess

the effect on the benthic invertebrate community, the concentrations of constituents of concern must be determined at a location that is 100 m from the point at which the effluent enters that watercourse from the final discharge point.

Half of the organics stockpile discharges south, away from the Killag River, towards WC-19. The constituent concentrations in the organics stockpile were determined to be at or below background concentrations. As such WC-19 is not anticipated to have water quality concerns during EOM or PC conditions.

The contributing drainage areas to each discharge point during EOM conditions is presented on Figure 3-2. Figure 3-3 depicts the PC drainage conditions with the settling ponds being decommissioned, and the pit being filled and discharging into Killag River.

The volume produced by Killag River – Far Field is based on the average monthly volumes calculated in the Beaver Dam Mine Site - Water Balance Analysis (GHD, 2021a). The volumes produced by Killag River – Near Field were calculated using a drainage area ratio method.



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- Contact Water Ditch
- Clean Water Ditch
- Settling Pond
- Road
- Bypass Road
- Crusher Pad
- Low Grade Ore Stockpile
- NAG Stockpile
- Open Pit
- Organic Material Stockpile
- PAG Stockpile
- Till Stockpile
- Topsoil Stockpile
- Water Pump Intake
- Discharge Point
- Water Quality Assessment Point

EOM = End of Mine
PC = Post Closure

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
PREDICTIVE WATER QUALITY ASSESSMENT

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MINE DISCHARGE AND WATER QUALITY ASSESSMENT POINTS FIGURE 3-1

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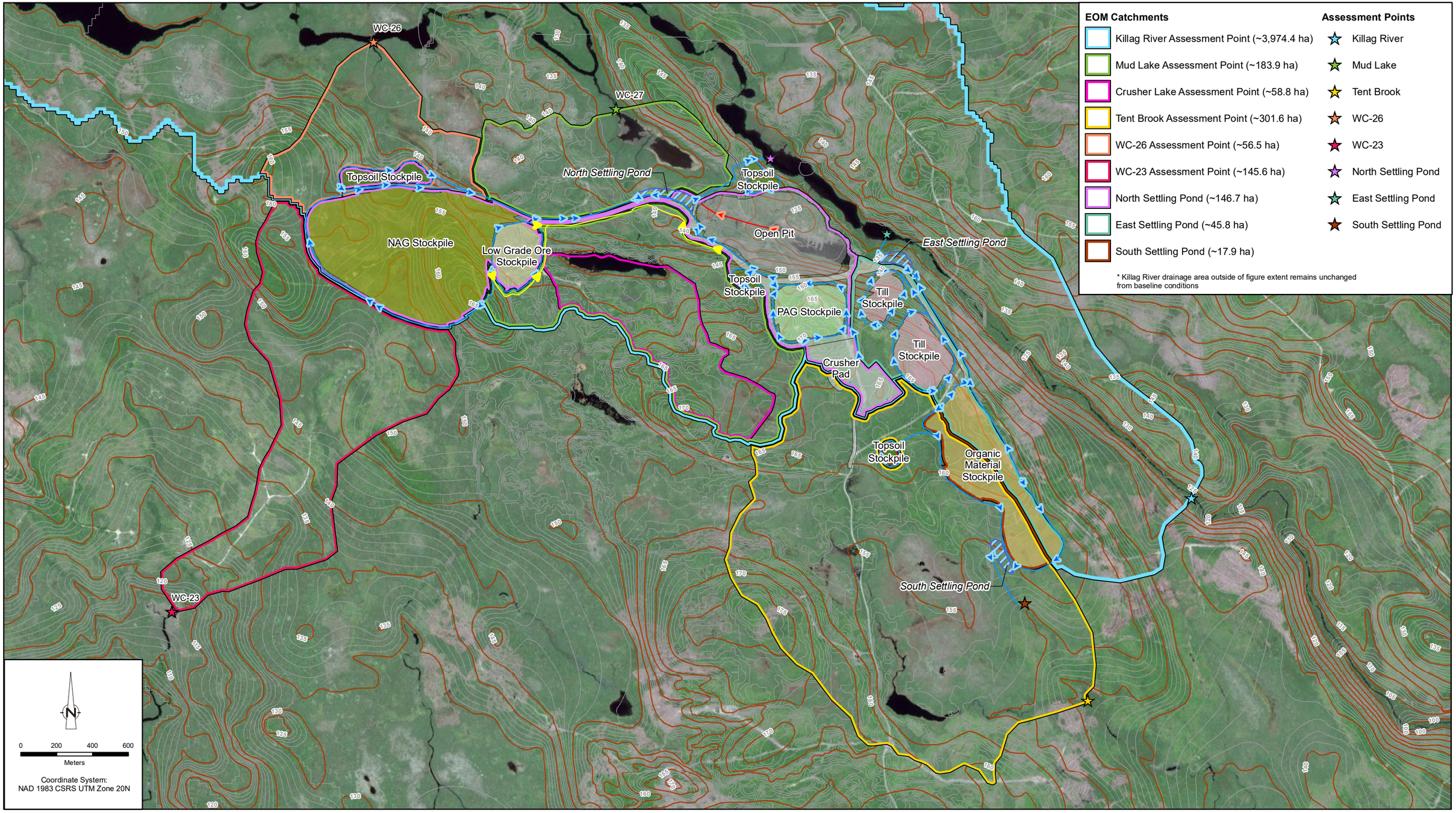

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NOTES:
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2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

- Pumping Path
- SWM Ditches
- Clean Water Ditch
- Contours (5m)
- Contours (1m)
- Settling Ponds
- Crusher Pad
- Low Grade Stockpile
- NAG Stockpile
- Open Pit
- Organic Material Stockpile
- PAG Stockpile
- Road
- Topsoil Stockpile
- Till Stockpile

GHD

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BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
PREDICTIVE WATER QUALITY ASSESSMENT

CATCHMENT AREA – EOM CONDITIONS

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FIGURE 3-2

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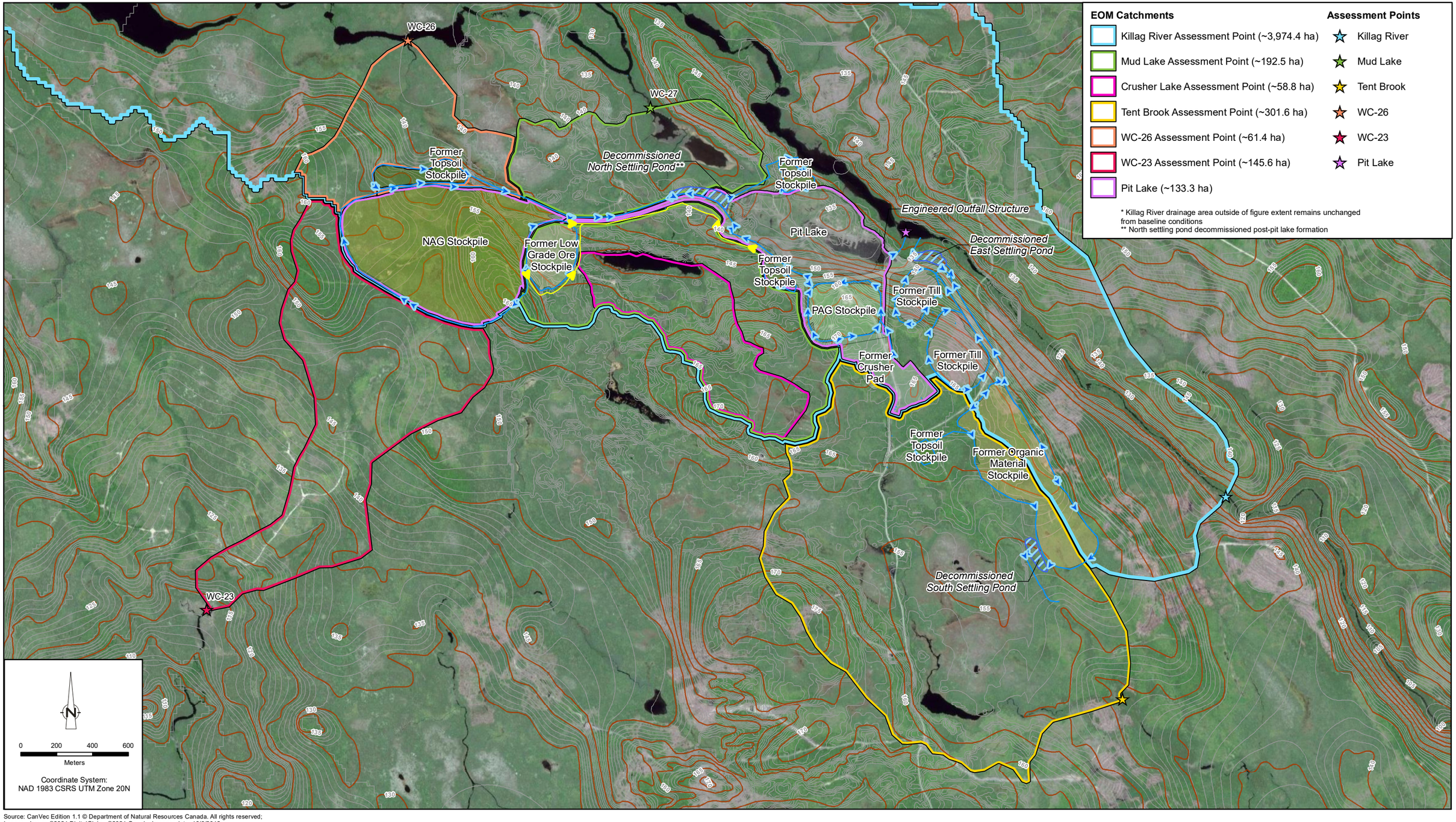

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NOTES:
1. Mud Lake and Tent Brook Contributing Areas derived from LiDAR measurements supplied by Leading Edge Geomatics, 2015.
2. Killag River Contributing Area derived from a combination of LiDAR measurements, Nova Scotia Department of Natural Resources (Forestry Division) hydrologically-corrected 20m DEM, and interpretations from satellite imagery and topographic maps.

- SWM Ditches
- Clean Water Ditch
- Contours (5m)
- Contours (1m)
- Settling Ponds
- Former Crusher Pad
- Former Low Grade Ore Stockpile
- Former Organic Material Stockpile
- Former Topsoil Stockpile
- Former Till Stockpile
- NAG Stockpile
- Open Pit
- PAG Stockpile
- Road

GHD

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
PREDICTIVE WATER QUALITY ASSESSMENT

CATCHMENT AREA – PC CONDITIONS

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FIGURE 3-3

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3.3 Predictive Water Quality Assessment Results

3.3.1 North Settling Pond Water Quality

The constituent concentrations entering the north settling pond during EOM conditions for base case and upper case scenarios are presented in Table 3-2 and Table 3-3, respectively. The north settling pond during EOM conditions includes the water pumped from the pit during mining operations. The pond will be decommissioned for PC conditions after the pit lake has formed.

As demonstrated in Table 3-2 and Table 3-3, MDMER objectives are not exceeded in the north settling pond during either base case or upper case scenarios.

3.3.2 East Settling Pond Water Quality

The constituent concentrations entering the east settling pond during EOM conditions for base case and upper case scenarios are presented in Table 3-4 and Table 3-5, respectively. The east settling pond will be decommissioned for PC conditions.

As demonstrated in Table 3-4 and Table 3-5, MDMER objectives are not exceeded in the east settling pond during either base case or upper case scenarios.

3.3.3 Pit Water Quality

Under PC conditions, all Site contact water will be routed through the pit prior to discharge into the Killag River. The constituent concentrations within the pit during PC conditions for base case and upper case scenarios are presented in Table 3-6 and Table 3-7, respectively.

As demonstrated in Table 3-6 and Table 3-7, MDMER objectives are not exceeded in the pit during either base case or upper case scenarios.

3.3.4 Killag River – Near Field – North Settling Pond – EOM Conditions Water Quality

The north settling pond is one of two Mine Site discharge points with potential for elevated constituent concentrations into the Killag River during EOM conditions. To assess the anticipated level of water quality treatment needed to meet the regulatory guidelines (CCME, Tier 1 EQS or Site-Specific Criteria) a water quality assessment was completed at the end of the mixing zone, approximately 100 m downstream of the discharge point. The analysis assumed no treatment of mine contact water in the north settling pond and only analyzed the results from a mass balance (dilution) calculation at the extent of the predicted mixing zone. The results for EOM base case and upper case are presented in Table 3-8 and Table 3-9, respectively.

As demonstrated in Table 3-8 no constituents are expected to exceed regulatory guidelines during EOM base case conditions. Table 3-9 demonstrates Nitrite concentrations are expected to exceed CCME guidelines for 3 months (July, August, and September) during EOM upper case conditions. No other constituents are expected to exceed regulatory guidelines during EOM upper case conditions.

3.3.5 Killag River – Near Field – East Settling Pond – EOM Conditions Water Quality

The east settling pond is one of two Mine Site discharge points with potential for elevated constituent concentrations into the Killag River during EOM conditions. To assess the anticipated level of water quality treatment needed to meet the regulatory guidelines (CCME, Tier 1 EQS or Site-Specific Criteria) a water quality assessment was completed at the end of the mixing zone, approximately 100 m downstream of the discharge point. The analysis assumed no treatment of mine contact water in the east settling pond and only analyzed the results from a mass balance (dilution) calculation at the extent of the predicted mixing zone. The background concentration in the Killag River in the analysis for the east settling pond discharge near field location includes the inputs from the north settling pond discharge. The results for EOM base case and upper case are presented in Table 3-10 and Table 3-11, respectively.

As demonstrated in Table 3-10 no constituents are expected to exceed regulatory guidelines during EOM base case conditions. Table 3-11 demonstrates Nitrite concentrations are expected to exceed CCME guidelines for 3 months (July, August and September) during EOM upper case conditions. No other constituents are expected to exceed regulatory guidelines during EOM upper case conditions.

3.3.6 Killag River – Near Field – PC Conditions Water Quality

During PC conditions the pit lake discharges into the Killag River directly. To assess the anticipated level of water quality treatment needed to meet the regulatory guidelines (CCME, Tier 1 EQS or Site Specific Criteria) a water quality assessment was completed at the end of the mixing zone. The analysis assumed no treatment of mine contact water in the pit lake and only analyzed the results from a mass balance (dilution) calculation at the extent of the predicted mixing zone. The results from the dilution calculation at the extent of the predicted mixing zone for base case and upper case are presented in Table 3-12 and Table 3-13, respectively.

As demonstrated in Table 3-12 no constituents are expected to exceed regulatory guidelines during PC base case conditions. Table 3-13 demonstrates Cobalt and Zinc concentrations are expected to exceed CCME guidelines in 2 months (July, August) with no other constituents exceeding regulatory guidelines.

3.3.7 Far Field – Killag River

The north settling pond, east settling pond and pit ultimately discharge into the Killag River during both EOM and PC conditions. Flow in the Killag River was determined using the WBM (GHD, 2021a) as discussed in Section 3.2. Table 3-14, Table 3-15, Table 3-16 and Table 3-17 display the concentrations in the Killag River after 100% mixing and approximately one kilometer downstream of the pit discharge point for EOM and PC conditions during base case and upper case scenarios, respectively. The concentrations in the Killag River were set equal to background concentrations when mixing with flow from the north settling pond, east settling pond and pit.

As demonstrated in Table 3-14 no constituents are expected to exceed regulatory guidelines during EOM base case conditions. Table 3-15 shows EOM upper case conditions are expected to result in exceedance of CCME guidelines for Nitrite in 3 months (July, August, and September). Table 3-16 indicates that no constituents are expected to exceed regulatory guidelines during PC base case conditions. Table 3-17 demonstrates PC upper case conditions results have the potential for exceedances of CCME regulatory guidelines in Cobalt and Zinc in the months of July and August. It is anticipated that all other constituents will not exceed water quality regulatory limits at any point in the year for any scenario.

These predicted water quality values presented in the tables do not include treatment within the north settling pond or east settling pond during EOM conditions, or the pit lake during PC conditions, and only account for the dilution from the mine Site and the Killag River upstream of the far field point.

3.3.8 Predicted Hardness

The Killag River consists of extremely soft water with hardness values of approximately 3.5 milligrams per litre as calcium carbonate (mg $CaCO_3$/L). Runoff from the mine Site is expected to consist of water with hardness higher than background hardness. Table 3-18 states the predicted hardness of the water in the north settling pond, east settling pond and pit along with the near field and far field predicted hardness values.

Table 3-2 Constituent Concentrations in the North Settling Pond – EOM Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Al	4.07	4.11	3.66	4.28	4.16	4.10	4.02	4.04	4.02	3.90	3.99	4.14
As	11.97	12.09	10.75	12.69	12.24	12.02	11.74	11.82	11.78	11.47	11.80	12.22
Cd	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Co	1.69	1.71	1.50	1.80	1.73	1.70	1.66	1.67	1.66	1.61	1.66	1.73
Cu	0.68	0.69	0.61	0.72	0.70	0.68	0.67	0.67	0.67	0.65	0.67	0.70
Fe	3.21	3.24	2.88	3.29	3.28	3.27	3.23	3.24	3.21	3.09	3.11	3.23
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	49.82	50.84	40.14	54.09	51.51	49.97	48.02	48.59	48.05	45.69	47.87	51.17
Mo	16.10	15.93	17.49	16.21	16.08	16.20	16.34	16.31	16.50	16.77	16.67	16.22
Ni	24.40	24.62	22.25	25.78	24.91	24.50	23.98	24.14	24.09	23.52	24.14	24.89
Pb	0.21	0.21	0.20	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Sb	0.16	0.16	0.15	0.17	0.16	0.16	0.16	0.16	0.16	0.15	0.16	0.16
Se	0.94	0.95	0.79	1.01	0.96	0.94	0.91	0.92	0.91	0.87	0.91	0.96
Tl	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
U	20.95	20.91	21.10	21.56	21.13	21.05	20.95	20.99	21.11	21.08	21.25	21.22
Zn	4.55	4.62	3.80	4.90	4.68	4.56	4.41	4.45	4.41	4.23	4.41	4.66
Nitrate	11,466	11,739	8,886	12,566	11,899	11,489	10,974	11,124	10,975	10,357	10,933	11,808
Nitrite	126	127	113	133	128	126	123	124	124	121	124	128
Ammonia	624	611	743	610	615	629	646	641	654	679	663	624

Notes:

[a] denotes an exceedance of the MDMER Water Quality Regulatory Objectives

Table 3-3 Constituent Concentrations in the North Settling Pond – EOM Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.06	0.06	0.06	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.07
Al	5.42	5.48	4.88	5.39	5.53	5.58	5.57	5.58	5.49	5.25	5.16	5.37
As	16.11	16.28	14.43	17.01	16.47	16.20	15.85	15.95	15.88	15.43	15.83	16.41
Cd	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Co	2.43	2.45	2.16	2.58	2.48	2.44	2.38	2.40	2.39	2.32	2.39	2.48
Cu	1.37	1.39	1.23	1.45	1.40	1.38	1.35	1.36	1.35	1.31	1.35	1.40
Fe	3.71	3.76	3.32	3.74	3.79	3.80	3.78	3.79	3.73	3.58	3.55	3.70
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	59.82	61.04	48.18	64.94	61.84	60.00	57.65	58.34	57.69	54.85	57.47	61.43
Mo	36.59	36.21	39.69	36.84	36.55	36.80	37.13	37.06	37.48	38.07	37.86	36.87
Ni	31.61	31.89	28.82	33.38	32.27	31.74	31.08	31.28	31.21	30.47	31.26	32.24
Pb	0.46	0.46	0.47	0.47	0.46	0.46	0.46	0.46	0.46	0.46	0.47	0.46
Sb	0.35	0.35	0.32	0.37	0.36	0.35	0.34	0.35	0.35	0.34	0.35	0.36
Se	1.61	1.64	1.36	1.74	1.66	1.62	1.57	1.58	1.57	1.51	1.57	1.65
Tl	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
U	26.58	26.53	26.77	27.35	26.80	26.70	26.59	26.63	26.78	26.74	26.96	26.93
Zn	5.43	5.52	4.53	5.84	5.59	5.45	5.27	5.32	5.28	5.05	5.26	5.56
Nitrate	21,657	22,101	17,423	23,550	22,394	21,708	20,846	21,098	20,869	19,845	20,818	22,258
Nitrite	468	460	532	464	464	471	479	477	485	498	491	470
Ammonia	1,958	1,899	2,474	1,871	1,912	1,973	2,051	2,031	2,081	2,193	2,118	1,948

Notes:

[a] denotes an exceedance of the MDMER Water Quality Regulatory Objectives

Table 3-4 Constituent Concentrations in the East Settling Pond – EOM Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	0.14	0.15	0.08	0.14	0.17	0.18	0.18	0.19	0.17	0.12	0.11	0.14
As	0.04	0.04	0.02	0.04	0.05	0.05	0.05	0.05	0.05	0.03	0.03	0.04
Cd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Co	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Cu	0.04	0.04	0.02	0.04	0.04	0.05	0.05	0.05	0.04	0.03	0.03	0.03
Fe	0.41	0.44	0.24	0.43	0.49	0.55	0.54	0.55	0.49	0.35	0.32	0.40
Hg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	2.01	2.16	1.17	2.12	2.43	2.70	2.68	2.71	2.44	1.73	1.56	1.99
Mo	0.05	0.05	0.03	0.05	0.06	0.07	0.07	0.07	0.06	0.04	0.04	0.05
Ni	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Pb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Se	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Tl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
Zn	0.09	0.09	0.05	0.09	0.11	0.12	0.12	0.12	0.11	0.08	0.07	0.09
Nitrate	1.57	1.67	1.02	1.36	1.87	2.23	2.34	2.34	2.06	1.45	1.15	1.44
Nitrite	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Ammonia	0.02	0.03	0.02	0.02	0.03	0.03	0.04	0.04	0.03	0.02	0.02	0.02

Notes:
[a] denotes an exceedance of the MDMER Water Quality Regulatory Objectives

Table 3-5 Constituent Concentrations in the East Settling Pond – EOM Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Al	1.98	2.12	1.15	2.09	2.39	2.66	2.63	2.67	2.40	1.70	1.53	1.95
As	0.14	0.15	0.08	0.14	0.16	0.18	0.18	0.18	0.16	0.12	0.10	0.13
Cd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Co	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02
Cu	0.06	0.06	0.03	0.06	0.07	0.08	0.08	0.08	0.07	0.05	0.05	0.06
Fe	2.85	3.06	1.65	3.01	3.45	3.83	3.80	3.85	3.45	2.45	2.21	2.82
Hg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	5.22	5.60	3.02	5.51	6.30	7.01	6.95	7.04	6.32	4.49	4.05	5.16
Mo	0.21	0.23	0.12	0.23	0.26	0.29	0.29	0.29	0.26	0.19	0.17	0.21
Ni	0.03	0.04	0.02	0.03	0.04	0.05	0.05	0.05	0.04	0.03	0.03	0.03
Pb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sb	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Se	0.02	0.03	0.01	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
Tl	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U	0.02	0.02	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
Zn	0.09	0.09	0.05	0.09	0.11	0.12	0.12	0.12	0.11	0.08	0.07	0.09
Nitrate	2.81	2.99	1.83	2.44	3.34	3.99	4.18	4.18	3.68	2.60	2.06	2.57
Nitrite	0.02	0.03	0.02	0.02	0.03	0.03	0.04	0.04	0.03	0.02	0.02	0.02
Ammonia	0.05	0.05	0.03	0.04	0.05	0.06	0.07	0.07	0.06	0.04	0.03	0.04

Notes:
[a] denotes an exceedance of the MDMER Water Quality Regulatory Objectives

Table 3-6 Constituent Concentrations in the Pit – PC Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Al	1.43	1.50	0.91	1.55	1.56	1.55	1.48	1.50	1.43	1.21	1.22	1.44
As	1.39	1.46	0.84	1.60	1.52	1.47	1.37	1.41	1.34	1.15	1.21	1.44
Cd	0.04	0.04	0.03	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.04
Co	2.88	3.01	2.10	2.61	3.09	3.31	3.36	3.35	3.13	2.64	2.35	2.71
Cu	0.28	0.29	0.18	0.29	0.30	0.30	0.29	0.30	0.28	0.24	0.24	0.28
Fe	0.94	0.99	0.59	1.04	1.03	1.02	0.97	0.99	0.94	0.80	0.81	0.96
Hg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	23.19	24.43	14.29	26.24	25.41	24.85	23.37	23.84	22.74	19.38	20.12	23.86
Mo	10.59	11.17	6.27	12.48	11.65	11.17	10.32	10.58	10.15	8.67	9.30	11.09
Ni	28.05	29.28	20.55	25.13	30.03	32.30	32.88	32.81	30.60	25.76	22.85	26.28
Pb	0.45	0.47	0.33	0.39	0.48	0.52	0.53	0.53	0.49	0.41	0.36	0.42
Sb	0.02	0.03	0.01	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.03
Se	0.15	0.15	0.09	0.17	0.16	0.15	0.15	0.15	0.14	0.12	0.13	0.15
Tl	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
U	1.37	1.44	0.83	1.57	1.50	1.46	1.37	1.40	1.33	1.14	1.19	1.42
Zn	19.10	19.91	14.26	16.57	20.39	22.17	22.76	22.67	21.09	17.73	15.44	17.68
Nitrate	168	177	108	182	184	183	176	178	169	144	144	170
Nitrite	3.87	4.07	2.48	4.18	4.22	4.21	4.03	4.09	3.88	3.30	3.31	3.90
Ammonia	21.1	22.2	13.5	22.9	23.1	23.0	22.0	22.4	21.2	18.0	18.1	21.3

Notes:
[a] denotes an exceedance of the MDMER Water Quality Regulatory Objectives

Table 3-7 Constituent Concentrations in the Pit – PC Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Al	1.47	1.55	0.94	1.59	1.60	1.60	1.53	1.55	1.48	1.25	1.26	1.48
As	1.62	1.71	0.98	1.87	1.78	1.73	1.61	1.65	1.57	1.34	1.42	1.68
Cd	0.06	0.06	0.04	0.05	0.06	0.07	0.07	0.07	0.06	0.05	0.05	0.05
Co	3.65	3.82	2.66	3.31	3.92	4.19	4.25	4.25	3.97	3.34	2.99	3.44
Cu	0.59	0.62	0.39	0.62	0.64	0.65	0.63	0.63	0.60	0.51	0.50	0.59
Fe	0.73	0.77	0.43	0.86	0.80	0.77	0.71	0.73	0.70	0.60	0.64	0.76
Hg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mn	24.71	26.03	15.22	27.97	27.08	26.47	24.90	25.39	24.23	20.64	21.44	25.43
Mo	11.53	12.16	6.83	13.59	12.69	12.16	11.23	11.52	11.05	9.44	10.12	12.07
Ni	41.60	43.43	30.34	37.54	44.57	47.80	48.56	48.49	45.25	38.11	33.95	39.08
Pb	1.00	1.05	0.75	0.88	1.07	1.16	1.19	1.19	1.11	0.93	0.81	0.93
Sb	0.05	0.05	0.03	0.06	0.05	0.05	0.05	0.05	0.05	0.04	0.04	0.05
Se	0.41	0.43	0.25	0.47	0.45	0.44	0.41	0.42	0.40	0.34	0.36	0.43
Tl	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
U	1.52	1.60	0.93	1.74	1.67	1.62	1.52	1.55	1.48	1.26	1.32	1.57
Zn	26.86	28.00	19.99	23.43	28.69	31.13	31.91	31.79	29.59	24.89	21.74	24.92
Nitrate	212	223	141	219	230	234	229	231	218	185	179	210
Nitrite	4.89	5.13	3.25	5.04	5.30	5.40	5.27	5.32	5.02	4.26	4.13	4.84
Ammonia	27	28	18.0	27.8	29.3	29.8	29.1	29.4	27.7	23.5	22.8	26.7

Notes:
[a] denotes an exceedance of the MDMER Water Quality Regulatory Objectives

Table 3-8 Constituent Concentrations – Near Field – North Pond – EOM Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	241.06	241.02	244.11	239.77	236.10	225.42	214.71	211.06	215.84	237.00	241.03	239.37
As	2.09	2.10	1.91	2.18	2.33	2.78	3.20	3.36	3.14	2.22	2.07	2.17
Cd	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Co	0.36	0.36	0.34	0.37	0.39	0.45	0.51	0.53	0.50	0.38	0.36	0.37
Cu	0.84	0.84	0.84	0.84	0.84	0.83	0.82	0.82	0.82	0.83	0.84	0.84
Fe	483.95	483.85	490.14	481.31	473.89	452.25	430.57	423.18	432.86	475.74	483.89	480.52
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	47.65	47.71	47.23	47.87	47.88	48.02	47.97	48.09	47.87	47.42	47.50	47.72
Mo	1.71	1.71	1.57	1.80	2.02	2.69	3.37	3.59	3.30	1.99	1.72	1.82
Ni	2.23	2.25	1.85	2.42	2.75	3.76	4.71	5.07	4.59	2.54	2.20	2.41
Pb	0.33	0.33	0.33	0.33	0.33	0.32	0.31	0.31	0.32	0.33	0.33	0.33
Sb	0.48	0.48	0.49	0.48	0.48	0.46	0.45	0.44	0.45	0.48	0.48	0.48
Se	0.49	0.49	0.47	0.49	0.50	0.52	0.54	0.55	0.53	0.49	0.48	0.49
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	1.05	1.06	0.78	1.19	1.49	2.40	3.30	3.62	3.20	1.38	1.04	1.20
Zn	3.59	3.60	3.55	3.62	3.63	3.67	3.70	3.72	3.69	3.59	3.58	3.61
Nitrate	603	621	363	716	870	1356	1789	1977	1721	714	566	694
Nitrite	11.14	11.25	9.14	12.12	13.81	19.01	23.90	25.78	23.25	12.70	10.93	12.04
Ammonia	58.2	57.8	54.6	60.5	69.6	96.2	124.2	132.3	121.9	70.5	59.4	62.0

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-9 Constituent Concentrations – Near Field – North Pond – EOM Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	241.34	241.30	244.29	240.02	236.50	226.13	215.75	212.18	216.78	237.37	241.27	239.66
As	2.34	2.36	2.08	2.46	2.69	3.38	4.04	4.28	3.94	2.54	2.30	2.45
Cd	0.020	0.020	0.019	0.020	0.020	0.020	0.021	0.021	0.021	0.020	0.020	0.020
Co	0.40	0.40	0.36	0.42	0.45	0.54	0.63	0.66	0.62	0.42	0.39	0.41
Cu	0.87	0.87	0.86	0.88	0.89	0.91	0.94	0.95	0.93	0.88	0.87	0.88
Fe	484.04	483.95	490.21	481.40	474.03	452.50	430.93	423.56	433.19	475.87	483.98	480.62
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	48.17	48.25	47.54	48.48	48.64	49.25	49.61	49.90	49.44	48.05	47.98	48.32
Mo	2.69	2.69	2.33	2.88	3.41	4.99	6.58	7.10	6.42	3.32	2.71	2.93
Ni	2.59	2.61	2.09	2.83	3.26	4.59	5.85	6.32	5.68	2.99	2.54	2.81
Pb	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.36	0.35	0.34	0.34	0.34
Sb	0.49	0.49	0.49	0.49	0.49	0.48	0.48	0.47	0.48	0.49	0.49	0.49
Se	0.52	0.52	0.50	0.53	0.55	0.60	0.64	0.66	0.63	0.53	0.52	0.53
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	1.32	1.33	0.98	1.49	1.88	3.04	4.18	4.57	4.05	1.74	1.31	1.50
Zn	3.64	3.65	3.58	3.67	3.70	3.80	3.87	3.91	3.85	3.65	3.63	3.66
Nitrate	1096	1127	666	1301	1595	2519	3353	3703	3226	1324	1034	1266
Nitrite	27.19	27.01	23.41	29.35	36.30	56.86	76.53[b]	84.58[b]	76.14[b]	36.06	27.80	30.21
Ammonia	120.4	118.3	113.3	125.8	155.9	242.8	336.7	362.2	329.8	163.7	126.0	132.0

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-10 Constituent Concentrations – Near Field – East Pond – EOM Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	240.58	240.55	243.61	239.28	235.46	224.36	213.22	209.49	214.37	236.27	240.50	238.84
As	2.08	2.09	1.90	2.17	2.31	2.75	3.16	3.32	3.11	2.21	2.06	2.16
Cd	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Co	0.36	0.36	0.33	0.37	0.39	0.45	0.50	0.53	0.50	0.38	0.36	0.37
Cu	0.84	0.84	0.84	0.84	0.83	0.83	0.82	0.81	0.82	0.83	0.84	0.84
Fe	482.98	482.93	489.14	480.33	472.60	450.13	427.59	420.03	429.91	474.27	482.83	479.45
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	47.53	47.59	47.12	47.74	47.70	47.72	47.53	47.61	47.44	47.24	47.36	47.58
Mo	1.71	1.70	1.56	1.79	2.01	2.66	3.33	3.54	3.26	1.97	1.72	1.81
Ni	2.22	2.24	1.84	2.41	2.73	3.72	4.65	5.01	4.53	2.52	2.18	2.39
Pb	0.33	0.33	0.33	0.33	0.32	0.32	0.31	0.31	0.31	0.32	0.33	0.33
Sb	0.48	0.48	0.49	0.48	0.47	0.46	0.44	0.44	0.45	0.48	0.48	0.48
Se	0.49	0.49	0.47	0.49	0.50	0.52	0.53	0.54	0.53	0.49	0.48	0.49
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	1.04	1.05	0.77	1.17	1.47	2.38	3.26	3.56	3.16	1.36	1.03	1.19
Zn	3.58	3.59	3.54	3.61	3.61	3.65	3.67	3.69	3.66	3.58	3.57	3.59
Nitrate	598	616	361	710	862	1341	1765	1949	1697	707	561	688
Nitrite	11.08	11.18	9.09	12.05	13.71	18.82	23.60	25.44	22.96	12.60	10.87	11.96
Ammonia	57.9	57.5	54.3	60.2	69.1	95.3	122.7	130.6	120.4	70.0	59.1	61.6

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-11 Constituent Concentrations – Near Field – East Pond – EOM Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	240.84	240.82	243.78	239.51	235.83	225.03	214.20	210.54	215.25	236.61	240.72	239.11
As	2.33	2.35	2.07	2.44	2.67	3.35	3.99	4.23	3.89	2.53	2.29	2.44
Cd	0.020	0.020	0.019	0.020	0.020	0.020	0.021	0.021	0.021	0.020	0.019	0.020
Co	0.40	0.40	0.36	0.41	0.44	0.54	0.62	0.65	0.61	0.42	0.39	0.41
Cu	0.87	0.87	0.86	0.88	0.88	0.91	0.93	0.93	0.92	0.87	0.87	0.88
Fe	483.06	483.00	489.19	480.40	472.71	450.32	427.88	420.33	430.17	474.37	482.90	479.53
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	48.01	48.09	47.40	48.31	48.41	48.86	49.05	49.30	48.91	47.83	47.82	48.14
Mo	2.67	2.67	2.32	2.86	3.38	4.93	6.49	6.99	6.33	3.29	2.69	2.91
Ni	2.57	2.60	2.08	2.81	3.24	4.54	5.77	6.24	5.61	2.97	2.52	2.79
Pb	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.34	0.34	0.34
Sb	0.49	0.49	0.49	0.49	0.49	0.48	0.47	0.47	0.47	0.49	0.49	0.49
Se	0.52	0.52	0.49	0.53	0.54	0.59	0.63	0.65	0.63	0.53	0.51	0.53
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	1.31	1.31	0.97	1.48	1.86	3.00	4.12	4.51	3.99	1.72	1.30	1.49
Zn	3.64	3.64	3.57	3.66	3.69	3.77	3.83	3.87	3.82	3.64	3.62	3.65
Nitrate	1087	1117	660	1290	1580	2490	3307	3650	3182	1311	1025	1254
Nitrite	26.98	26.81	23.24	29.12	35.99	56.23	75.51[b]	83.40[b]	75.13[b]	35.73	27.58	29.97
Ammonia	119.5	117.5	112.5	124.9	154.6	240.2	332.3	357.2	325.5	162.3	125.1	131.0

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-12 Constituent Concentrations – Near Field – Pit – PC Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	242.76	243.01	243.62	242.34	239.81	232.25	223.68	220.94	223.69	238.55	241.77	241.44
As	1.59	1.59	1.57	1.59	1.60	1.62	1.62	1.63	1.61	1.58	1.58	1.59
Cd	0.020	0.020	0.019	0.020	0.020	0.022	0.023	0.024	0.023	0.020	0.020	0.020
Co	0.39	0.40	0.35	0.39	0.44	0.56	0.69	0.72	0.65	0.42	0.38	0.40
Cu	0.82	0.82	0.82	0.82	0.82	0.81	0.79	0.78	0.79	0.81	0.82	0.82
Fe	487.62	488.12	489.33	486.75	481.72	466.60	449.47	443.98	449.47	479.18	485.61	484.96
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	46.59	46.67	46.30	46.62	46.54	46.17	45.57	45.43	45.33	46.03	46.29	46.47
Mo	1.45	1.47	1.24	1.52	1.69	2.14	2.57	2.74	2.46	1.54	1.40	1.51
Ni	2.15	2.18	1.77	2.08	2.64	3.86	5.14	5.49	4.74	2.46	1.98	2.20
Pb	0.34	0.34	0.33	0.34	0.34	0.35	0.36	0.36	0.35	0.34	0.33	0.34
Sb	0.48	0.48	0.48	0.48	0.47	0.46	0.44	0.44	0.44	0.47	0.48	0.48
Se	0.45	0.45	0.45	0.45	0.45	0.44	0.43	0.43	0.43	0.44	0.45	0.45
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	0.11	0.11	0.08	0.12	0.14	0.20	0.26	0.28	0.25	0.12	0.10	0.12
Zn	4.12	4.14	3.88	4.05	4.41	5.15	5.94	6.14	5.66	4.29	3.99	4.13
Nitrate	104	106	84	99	131	199	272	291	249	122	95	106
Nitrite	6.48	6.53	6.03	6.35	7.04	8.48	10.00	10.40	9.48	6.82	6.25	6.51
Ammonia	36.5	36.7	34.0	35.8	39.6	47.4	55.7	57.9	52.9	38.3	35.2	36.6

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-13 Constituent Concentrations – Near Field – Pit – PC Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	242.76	243.01	243.62	242.34	239.82	232.25	223.68	220.94	223.70	238.55	241.77	241.44
As	1.60	1.60	1.57	1.61	1.62	1.64	1.66	1.67	1.64	1.59	1.59	1.60
Cd	0.020	0.021	0.020	0.020	0.021	0.023	0.025	0.026	0.025	0.021	0.020	0.021
Co	0.42	0.43	0.37	0.41	0.49	0.64	0.80[b]	0.85[b]	0.75	0.46	0.40	0.43
Cu	0.84	0.84	0.83	0.84	0.84	0.84	0.84	0.84	0.83	0.83	0.83	0.83
Fe	487.96	488.46	489.55	487.05	482.21	467.50	450.80	445.42	450.66	479.62	485.90	485.30
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	46.66	46.74	46.34	46.70	46.65	46.35	45.81	45.70	45.56	46.11	46.35	46.54
Mo	1.50	1.52	1.26	1.57	1.75	2.25	2.72	2.90	2.60	1.59	1.44	1.56
Ni	2.68	2.73	2.11	2.58	3.42	5.25	7.16	7.70	6.58	3.15	2.44	2.76
Pb	0.36	0.36	0.35	0.35	0.37	0.41	0.44	0.45	0.43	0.36	0.35	0.36
Sb	0.48	0.48	0.48	0.48	0.48	0.46	0.45	0.44	0.45	0.47	0.48	0.48
Se	0.46	0.46	0.46	0.46	0.47	0.47	0.47	0.48	0.47	0.46	0.46	0.46
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	0.12	0.12	0.09	0.13	0.15	0.22	0.28	0.31	0.27	0.13	0.11	0.13
Zn	4.42	4.45	4.07	4.32	4.84	5.94	7.09[b]	7.39[b]	6.70	4.68	4.25	4.44
Nitrate	149	152	114	139	197	319	449	483	408	182	133	153
Nitrite	7.53	7.60	6.72	7.28	8.56	11.26	14.12	14.86	13.18	8.21	7.13	7.58
Ammonia	42.2	42.6	37.8	40.9	47.9	62.7	78.3	82.4	73.2	46.0	40.0	42.5

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-14 Constituent Concentrations – Far Field – EOM Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	240.73	240.71	243.73	239.45	235.67	224.68	213.64	209.94	214.78	236.47	240.66	239.01
As	2.08	2.09	1.90	2.16	2.31	2.74	3.15	3.31	3.09	2.20	2.06	2.15
Cd	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019
Co	0.36	0.36	0.33	0.37	0.39	0.45	0.50	0.52	0.49	0.37	0.36	0.37
Cu	0.84	0.84	0.84	0.84	0.84	0.83	0.82	0.82	0.82	0.83	0.84	0.84
Fe	483.29	483.23	489.37	480.67	473.02	450.77	428.44	420.94	430.75	474.67	483.14	479.80
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	47.56	47.62	47.14	47.76	47.74	47.79	47.63	47.73	47.54	47.28	47.39	47.61
Mo	1.70	1.70	1.55	1.78	2.00	2.65	3.31	3.52	3.24	1.96	1.71	1.80
Ni	2.21	2.23	1.84	2.39	2.71	3.69	4.62	4.97	4.49	2.51	2.17	2.38
Pb	0.33	0.33	0.33	0.33	0.32	0.32	0.31	0.31	0.31	0.32	0.33	0.33
Sb	0.48	0.48	0.49	0.48	0.48	0.46	0.44	0.44	0.45	0.48	0.48	0.48
Se	0.49	0.49	0.47	0.49	0.50	0.52	0.53	0.54	0.53	0.49	0.48	0.49
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	1.03	1.03	0.77	1.16	1.46	2.35	3.23	3.53	3.13	1.35	1.02	1.17
Zn	3.59	3.59	3.54	3.61	3.62	3.65	3.67	3.69	3.66	3.58	3.57	3.60
Nitrate	592	609	357	702	853	1327	1748	1930	1680	700	555	681
Nitrite	11.01	11.12	9.05	11.97	13.61	18.68	23.42	25.24	22.78	12.52	10.81	11.89
Ammonia	57.6	57.2	54.0	59.8	68.7	94.6	121.8	129.6	119.5	69.6	58.8	61.2

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-15 Constituent Concentrations – Far Field – EOM Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	241.02	241.00	243.91	239.70	236.08	225.41	214.71	211.09	215.74	236.84	240.90	239.30
As	2.33	2.34	2.06	2.44	2.67	3.34	3.97	4.21	3.87	2.52	2.29	2.43
Cd	0.020	0.020	0.019	0.020	0.020	0.020	0.021	0.021	0.021	0.020	0.019	0.020
Co	0.39	0.40	0.36	0.41	0.44	0.53	0.62	0.65	0.61	0.42	0.39	0.41
Cu	0.87	0.87	0.86	0.88	0.89	0.91	0.93	0.94	0.92	0.88	0.87	0.88
Fe	483.40	483.35	489.45	480.77	473.19	451.06	428.85	421.38	431.12	474.82	483.24	479.91
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	48.08	48.16	47.45	48.38	48.51	49.04	49.31	49.58	49.14	47.92	47.88	48.22
Mo	2.65	2.65	2.30	2.84	3.36	4.90	6.45	6.94	6.29	3.27	2.67	2.89
Ni	2.55	2.58	2.06	2.79	3.21	4.51	5.72	6.19	5.56	2.95	2.50	2.78
Pb	0.34	0.34	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.34	0.34	0.34
Sb	0.49	0.49	0.49	0.49	0.49	0.48	0.47	0.47	0.47	0.49	0.49	0.49
Se	0.52	0.52	0.49	0.53	0.54	0.59	0.63	0.65	0.63	0.53	0.51	0.53
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	1.29	1.30	0.96	1.46	1.84	2.97	4.08	4.47	3.96	1.70	1.28	1.47
Zn	3.64	3.64	3.57	3.66	3.69	3.77	3.84	3.87	3.82	3.64	3.62	3.65
Nitrate	1075	1105	653	1276	1563	2464	3274	3614	3150	1296	1014	1241
Nitrite	26.73	26.56	23.03	28.85	35.64	55.69	76.32[b]	82.62[b]	74.42[b]	35.39	27.33	29.69
Ammonia	118.5	116.5	111.5	123.8	153.2	237.9	329.2	353.9	322.5	160.8	124.0	129.9

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-16 Constituent Concentrations – Far Field – PC Conditions Base Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	243.43	243.66	244.27	243.03	240.72	233.75	225.80	223.21	225.77	239.54	242.49	242.18
As	1.59	1.60	1.57	1.60	1.61	1.63	1.64	1.64	1.62	1.58	1.58	1.59
Cd	0.020	0.020	0.019	0.020	0.021	0.022	0.023	0.024	0.023	0.020	0.020	0.020
Co	0.39	0.40	0.35	0.39	0.44	0.56	0.69	0.72	0.65	0.42	0.38	0.40
Cu	0.83	0.83	0.82	0.83	0.82	0.81	0.80	0.79	0.79	0.82	0.82	0.82
Fe	488.96	489.42	490.63	488.13	483.53	469.60	453.73	448.55	453.64	481.17	487.06	486.45
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	46.70	46.78	46.42	46.74	46.70	46.44	45.96	45.85	45.71	46.20	46.41	46.60
Mo	1.45	1.47	1.24	1.52	1.68	2.14	2.57	2.74	2.47	1.54	1.40	1.51
Ni	2.14	2.17	1.76	2.07	2.63	3.85	5.14	5.50	4.74	2.45	1.98	2.19
Pb	0.34	0.34	0.33	0.34	0.34	0.35	0.36	0.37	0.36	0.34	0.33	0.34
Sb	0.48	0.48	0.48	0.48	0.48	0.46	0.45	0.44	0.45	0.47	0.48	0.48
Se	0.45	0.45	0.45	0.45	0.45	0.44	0.44	0.43	0.43	0.45	0.45	0.45
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	0.11	0.11	0.08	0.12	0.14	0.20	0.26	0.28	0.25	0.12	0.10	0.12
Zn	4.12	4.14	3.89	4.05	4.41	5.16	5.96	6.17	5.68	4.30	4.00	4.13
Nitrate	104	106	84	99	130	199	271	291	249	122	95	106
Nitrite	6.48	6.53	6.04	6.36	7.05	8.50	10.03	10.43	9.51	6.83	6.26	6.51
Ammonia	36.5	36.7	34.1	35.8	39.6	47.5	55.9	58.1	53.0	38.4	35.3	36.6

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-17 Constituent Concentrations – Far Field – PC Conditions Upper Case

Constituent	Average Monthly Concentration (µg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Al	242.89	243.13	243.73	242.47	239.97	232.49	224.00	221.29	224.02	238.72	241.90	241.58
As	1.60	1.60	1.57	1.61	1.62	1.64	1.66	1.67	1.64	1.59	1.59	1.60
Cd	0.020	0.021	0.020	0.020	0.021	0.023	0.025	0.026	0.025	0.021	0.020	0.020
Co	0.42	0.43	0.37	0.41	0.48	0.64	0.80[b]	0.84[b]	0.75	0.46	0.40	0.43
Cu	0.84	0.84	0.83	0.84	0.84	0.84	0.84	0.84	0.83	0.83	0.83	0.84
Fe	488.20	488.71	489.78	487.30	482.52	467.96	451.42	446.09	451.29	479.96	486.17	485.58
Hg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mn	46.67	46.75	46.35	46.71	46.66	46.36	45.83	45.72	45.58	46.13	46.36	46.56
Mo	1.49	1.51	1.26	1.57	1.74	2.24	2.70	2.88	2.59	1.59	1.43	1.56
Ni	2.66	2.71	2.09	2.57	3.39	5.20	7.10	7.63	6.52	3.13	2.42	2.74
Pb	0.36	0.36	0.35	0.35	0.37	0.41	0.44	0.45	0.43	0.36	0.35	0.36
Sb	0.48	0.48	0.48	0.48	0.48	0.46	0.45	0.44	0.45	0.47	0.48	0.48
Se	0.46	0.46	0.46	0.46	0.47	0.47	0.47	0.48	0.47	0.46	0.46	0.46
Tl	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
U	0.12	0.12	0.09	0.12	0.15	0.22	0.28	0.31	0.27	0.13	0.11	0.13
Zn	4.41	4.44	4.07	4.31	4.83	5.91	7.05[b]	7.35[b]	6.66	4.67	4.24	4.43
Nitrate	148	151	113	138	195	316	445	479	404	181	132	152
Nitrite	7.50	7.57	6.71	7.26	8.53	11.19	14.03	14.76	13.10	8.18	7.11	7.56
Ammonia	42.1	42.5	37.7	40.7	47.7	62.3	77.8	81.8	72.7	45.8	39.9	42.4

Notes:
[b] denotes an exceedance of the CCME Freshwater Aquatic Life Guidelines
[c] denotes an exceedance of the NSE Tier 1 EQS Surface Water Guidelines
[d] denotes an exceedance of the Site Specific Guidelines

Table 3-18 Estimated Hardness at Mine Site Discharge Points

Location	EOM - Base Case	EOM - Upper Case	PC – Base Case	PC – Upper Case
North Pond	303.2	264.9	--	--
East Pond	14.8	9.3	--	--
Pit	--	--	244.6	223.4
Killag River - Near Field	15.5	14.0	12.2	11.4
Killag River - Far Field	15.3	13.8	12.2	11.4

4. Methodological Conservatism

The predictive water quality assessment presented in this report is to be used to determine whether the Mine has the potential to result in water quality impacts to the Killag River and if treatment is required at the Site during EOM and PC conditions. The results are predictive in nature and are expected to be refined using site-specific monitoring data collected during construction, operation and following closure of the Beaver Dam Mine.

Conservatism has been included throughout the assessment including the use of the upper case source terms for the constituents of concern in the analysis and the assumption that 10% of the water which infiltrates into the stockpiles will infiltrate into the surficial groundwater.

5. Conclusions & Future Works

The predictive water quality assessment provides insight into the potential effect of the Beaver Dam mining operation on the Killag River during an average climate year. MDMER objectives are not anticipated to be exceeded during either EOM or PC conditions.

The predictive water quality assessment determined potential for exceedance of the CCME regulatory limits of Nitrite within the Killag River system during EOM conditions at the Near Field – North Settling Pond, Near Field – East Settling Pond and Far Field assessment points.

The predictive water quality assessment determined potential for exceedance of the CCME regulatory limits of Cobalt and Zinc within the Killag River system during PC conditions at the Near Field – Pit and Far Field assessment points.

This water quality assessment demonstrates the need for treatment of the mine effluent water prior to discharge into the Killag River during End-of-Mine and Post-Closure conditions.

Additionally, GHD recognizes the predictive nature of the results presented in this memo. As such, GHD recommends the source terms be re-evaluated on an annual basis in order to confirm the predicted water quality impacts of the proposed Mine to the Killag River.

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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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Appendix E
Hydrogeological Modelling Report

Hydrogeologic Modelling Report

Beaver Dam Mine Project
Marinette, Nova Scotia Additional Text

Atlantic Mining NS Inc.

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1. Introduction

1.1 Background

Atlantic Mining NS Inc. (AMNS), formerly Atlantic Gold Corporation (AGC) is proposing the construction, operation, decommissioning, and reclamation of an open pit gold mine in Marinette, Nova Scotia (Beaver Dam Mine Site). The Beaver Dam Mine Project (Project) would have a maximum ore production rate of approximately 5,500 tonnes per day, over a five-year period. Ore from the Project would be crushed and transported approximately 31 km by road to the Moose River (Touquoy) mine for processing. Components of the Project include an open pit, a materials storage facilities (i.e., waste rock, topsoil and organic materials), mine haul roads, mine infrastructure for crushing, water management, hauling, truck maintenance, administration, and road upgrades.

GHD Limited (GHD) was retained by AMNS to develop a three-dimensional (3D) groundwater flow model for the Beaver Dam Mine Site. This Hydrogeologic Modelling Report (Report) presents the development, calibration, and application of the model to evaluate potential impacts of mining operations on the surrounding groundwater and surface water flow regimes. The Beaver Dam Mine Site is located approximately 7 kilometres (km) northeast of Highway 224. Figure 1.1 illustrates the Beaver Dam Mine Site location. The Beaver Dam Mine Site is remote, and the closest residences are located approximately 5 km away. The nearest regional centres are the small rural communities of Sheet Harbour, Mooseland, and Middle Musquodoboit located approximately 23 km, 32 km and 40 km away from the Beaver Dam Mine Site, respectively.

Following the discovery of gold at the Beaver Dam Mine Site in 1868, there have been several attempts to develop and mine the area. Initial development was focused on the Austen Shaft, followed by the Mill Shaft area located 1.2 km west of the Austen Shaft. The small Papke Pit approximately 400 metres (m) west of the Austen Shaft was excavated in 1926. Most of the development focused on a belt of quartz veins in greywacke and slates that are approximately 23 m wide and are intersected by the Austen Shaft. A total of 967 ounces of gold production is recorded for the Beaver Dam gold district between 1889 and 1941.

The next major period of work began in 1975 when MEX Explorations acquired claims to the Beaver Dam Mine Site. From 1978 until 1988 a number of different companies drilled a combined total of 251 diamond holes for geologic exploration as well as undertaking geophysical and geochemical surveys.

Between 1986 and 1989, Seabright Resources Ltd. (Seabright) explored from underground via a decline that reached a maximum depth of 100 m below ground surface (bgs). A total of 34 drillholes were drilled from underground by Seabright. In 1986, Seabright also excavated a small open pit in the Papke and Austen zones, removing 10,822 tonnes of material. In total, 2,445 ounces of gold were recovered from bulk samples during this period.

In 2002, Tempus Corporation, a predecessor company to Acadian Gold Corporation and now known as Acadian Mining Corporation (Acadian), acquired the Beaver Dam Mine Site. Acadian retained Mercator Geological Services (Mercator) to manage its exploration activities until 2008, and from that date until 2013, Acadian managed all exploration activities within the Beaver Dam Mine Site.

Between 2005 and 2009, Mercator and then Acadian managed several diamond drill programs with a total of 153 holes drilled.

AGC secured the Beaver Dam Mine Site in 2014 through the acquisition of Acadian. AGC undertook a drilling program from October 2014 to January 2015 and drilled 41 diamond holes and an additional 8 geotechnical holes. The October 2014 to January 2015 drillhole results were incorporated into the gold resource estimate for the Beaver Dam Mine Site (FSSI, 2015), which facilitated completing a feasibility study for developing an open pit gold mine at the Beaver Dam Mine Site (Ausenco Engineering Canada Inc., 2015). To obtain regulatory approval for an open pit mine development at the Beaver Dam Mine Site, an Environmental Impact Statement (EIS) was prepared (AGC, 2017) and submitted to the Canadian Environmental Assessment Agency (CEAA) and Nova Scotia Environment (NSE). CEAA and NSE Information Requests (IRs) stemming from their review of the EIS called for a groundwater flow modelling analysis to evaluate potential impacts to the groundwater and surface water flow regimes caused by mining operations. A Revised EIS incorporating groundwater flow modelling analyses was submitted to CEAA and NES by AGC (2019). CEAA and NSE provided a second round of IRs (Round 2 IRs) pertaining to the Revised 2019 EIS. This Report presents the 3D groundwater flow modelling conducted to support development of the Updated 2021 EIS and to address the Round 2 IRs (CEAA-2-14, CEAA-2-35, CEAA-2-41, CEA-2-42, NSE 2-35, NSE-2-145, NSE-2-149, NSE-2-150, NSE-2-159, NSE-2-160, NSE-2-161, NSE-2-162, NSE-2-163, NSE-2-164, NSE-2-166, NSE-2-167, and NSE-2-190) pertaining to the 3D groundwater flow modelling presented in the Updated 2021 EIS (AMNS 2021).

This Report describes the details of developing and applying a numerical 3D groundwater flow model for the Beaver Dam Mine Site. GHD applied the model as a predictive tool to evaluate impacts to groundwater quality and quantity with respect to groundwater flow and groundwater interactions with surface water at the Beaver Dam Mine Site. Groundwater quality and quantity are examined at end of mine life (EOM[1]) and post-closure (PC[2]). Specifically, the 3D groundwater flow model was developed to assess:

1. Groundwater inflow rates to the open pit mine at EOM
2. Groundwater drawdown at EOM and PC
3. Pit infilling rates following EOM
4. Change in groundwater discharge to/from surface water features (baseflow) at EOM and PC
5. Transport of constituents of concern (COCs) from mine features into the surrounding environment at EOM and PC

1.2 Purpose

This Report documents GHD's development of the numerical 3D groundwater flow model to represent the complex hydrogeologic conditions observed at the Beaver Dam Mine Site and surrounding area. The groundwater flow model was developed to provide a reasonable representation of hydrologic, geologic, and hydrogeologic conditions observed at the Beaver Dam

[1] EOM is defined as the condition immediately following the cessation of mining, with the pit excavated to the maximum proposed depth and completely dewatered.

[2] PC is defined as the long-term post-reclamation condition, once the pit has filled forming the pit lake.

Mine Site. The groundwater flow model was calibrated to match measured groundwater elevations and groundwater flow directions as well as estimated baseflow. GHD used the calibrated model to evaluate potential impacts of mine development on groundwater quality and quantity as well as groundwater interactions with surface water.

The objectives for developing the groundwater flow model include:

- To enhance the understanding of groundwater flow conditions at and surrounding the Beaver Dam Mine Site to facilitate developing a Hydrogeologic Conceptual Site Model (CSM) to use as the basis for developing the numerical groundwater flow model
- To construct and calibrate the numerical groundwater flow model consistent with the CSM to represent observed Beaver Dam Mine Site conditions
- To apply the calibrated groundwater flow model to evaluate potential changes in groundwater quality and quantity with respect to groundwater flow and groundwater interactions with surface water at the Beaver Dam Mine Site under EOM and PC conditions

1.3 Scope of Work

GHD developed the groundwater flow model based on site-specific and available regional data including surface water features, topography, water well records, and geologic information.

The scope of work completed by GHD to develop the groundwater flow model and apply the model to evaluate potential impacts to groundwater and surface water flow regimes included the following:

- Compiled, reviewed, and interpreted the geologic, groundwater flow, and surface water flow data available for the Beaver Dam Mine Site and surrounding area
- Developed a 3D geologic model of the Beaver Dam Mine Site and surrounding area
- Developed a CSM for the Beaver Dam Mine Site and surrounding area based on available regional and site-specific data
- Developed a 3D groundwater flow model based on the CSM to represent the existing conditions that incorporates the 3D geologic model
- Calibrated the groundwater flow model under steady-state conditions to match measured groundwater elevations and groundwater flow directions, as well as estimated baseflow
- Evaluated the sensitivity of the model calibration to model input parameters
- Applied the calibrated groundwater flow model to evaluate potential changes in groundwater quality and quantity with respect to groundwater flow and groundwater interactions with surface water at the Beaver Dam Mine Site under EOM and PC conditions
- Evaluated the sensitivity of selected model predictions to model input parameters
- Evaluated the effectiveness of potential mitigation measures
- Documented the groundwater flow model development and its application in this Report

1.4 Report Organization

This Report is organized as follows:

- **Section 1 – Introduction:** Presents the introduction, purpose, and scope of work of the hydrogeologic modelling conducted for the Beaver Dam Mine Site
- **Section 2 – Summary of Hydrologic, Geologic, and Hydrogeologic Conditions:** Presents a summary of observed regional and site-specific hydrologic, geologic, and hydrogeologic conditions at the Beaver Dam Mine Site
- **Section 3 –Hydrogeologic Conceptual Site Model:** Presents the CSM developed for the Beaver Dam Mine Site that forms the basis for the construction of the numerical groundwater flow model
- **Section 4 – Simulation Program Selection:** Presents a description of the simulation programs selected to conduct the hydrogeologic modelling
- **Section 5 – Base-Case Groundwater Flow Model Construction:** Presents details regarding construction of the numerical groundwater flow model to represent the key components of the CSM
- **Section 6 – Base-Case Groundwater Flow Model Calibration:** Presents the calibration of the numerical groundwater flow model to observed groundwater flow conditions at the Beaver Dam Mine Site and the sensitivity analysis of model calibration to variations in model input parameters
- **Section 7 – Groundwater Flow Model Application:** Presents the application of the calibrated groundwater flow model to evaluate potential impacts to the groundwater and surface water flow regimes at the Beaver Dam Mine Site at EOM and PC, and the accompanying sensitivity analysis, as well as the evaluation of potential mitigation measures
- **Section 8 – Summary and Conclusions:** Presents a summary of the hydrogeologic modelling conducted for the Beaver Dam Mine Site and the conclusions obtained
- **Section 9 – References:** Lists the references cited in this Report

2. Summary of Hydrologic, Geologic, and Hydrogeologic Conditions

A review of the regional and site-specific hydrologic, geologic, and hydrogeologic conditions at the Beaver Dam Mine Site was conducted to develop the CSM, followed by developing the 3D groundwater flow model. The details of the regional and site-specific hydrologic, geologic, hydrogeologic conditions are summarized below.

2.1 Hydrologic Conditions

The hydrologic conditions at the Beaver Dam Mine Site are affected by regional physiography, topography, and surface water features. The following sections provide brief overviews of the regional physiography, topography, and surface water features.

2.1.1 Physiography

The Beaver Dam Mine Site is located in the Atlantic Uplands division of the Appalachian physiographic province of Canada (Williams et al., 1972). The Atlantic Upland spans approximately 450 km from Cape Canso, past Halifax to Cape Sable and then continue northward approximately 100 km from Port Yarmouth to St. Mary Bay (Goldthwait, 1924). The Atlantic Upland appears in low islands and capes along the Atlantic coast, rising inland at a rate of approximately 3 m per kilometer reaching an altitude of approximately 180 to 220 m above mean sea level (AMSL) in the centre of the Nova Scotia peninsula. The Atlantic Upland is characterized by rolling hills, drumlin fields, and smooth ridges with intervening lakes, streams and muskegs.

Physiographic sections often can be subdivided into hydrologic units (basins) of common drainage areas. The Beaver Dam Mine Site is located within East/West Sheet Harbour basin, which occupies approximately 865 square kilometers in central Nova Scotia. The East/West Sheet Harbour basin is drained by the East Branch Sheet Harbour River and the West Branch Sheet Harbour River, both of which converge on Sheet Harbour and discharge to the Atlantic Ocean. The Beaver Dam Mine Site is located in a low-lying area, adjacent to Cameron Flowage. Cameron Flowage is a stillwater area on the Killag River (Jacques, Whitford & Associates Ltd. [JWA], 1986a), and is the dominant physiographic feature in the vicinity of the Beaver Dam Mine Site.

2.1.2 Topography

Regionally, the topography surrounding the Beaver Dam Mine Site slopes gently from a maximum level of approximately 210 m AMSL in the central Nova Scotia peninsula northwest of the Beaver Dam Mine Site towards sea level near Sheet Harbor to the southwest of the Beaver Dam Mine Site. Locally, the Beaver Dam Mine Site is situated in an area of low topographic relief at approximately 140 m AMSL with scattered drumlins reaching 165 to 175 m AMSL and Cameron Flowage channeling through a topographic low of approximately 130 m AMSL. Figure 2.1 presents the Beaver Dam Mine Site topography under current conditions (i.e., pre-mining).

Throughout mining operations, the local topography will be altered by the construction of major mine features including the open pit, till stockpiles, and waste stockpile. The Beaver Dam Mine Site is expected to be operated for approximately 4 years. In the final year of operation, the open pit is expected to be mined to an elevation of approximately -45 m AMSL while the waste stockpile is expected to reach an elevation of approximately 210 m AMSL.

2.1.3 Surface Water Features

Figure 2.2 presents the surface water features surrounding the Beaver Dam Mine Site, including mapped surface water features and predicted flow accumulation channels[3]. Regional surface water drainage is predominantly to the southeast along several poorly drained stream channels and shallow lakes, and there are several low-lying boggy areas across the Beaver Dam Mine Site (Peter Clifton & Associates [PCA], 2015). Most major streams in the region, including the Killag and West Branch Sheet Harbour River, follow the northwest-southeast strike of the major fault lineaments (JWA, 1986a). The most significant surface water body in the Beaver Dam Mine Site area is

[3] Flow accumulation channels correspond to the location of potential unmapped streams or below ground flow. All predicted flow accumulation channels connect to a mapped surface water body (Nova Scotia Department of Natural Resources [NSDNR], 2012).

Cameron Flowage, which is located approximately 70 m northwest of the proposed open pit mine. Cameron Flowage receives the majority of surface water drainage from the Beaver Dam Mine Site with the exception of a small portion of the Beaver Dam Mine Site that drains towards Tent Lake. Cameron Flowage likely is a location of groundwater discharge.

In addition to Cameron Flowage, the other significant surface water features near the Beaver Dam Mine Site include Mud Lake, Crusher Lake, Tait Lake, and West Lake. These lakes are interconnected by a series of streams that drain into Cameron Flowage, which in turn drains into the Killag River.

2.2 Geologic Conditions

The geology at the Beaver Dam Mine Site generally consists of a silty sand glacial till (overburden), overlaying argillite and greywacke bedrock of the Moose River Member. The Moose River member is part of the larger greywacke dominated Goldenville Formation. The overburden deposits range in grain size from clays to boulders up to 1 m in diameter. Sections 2.2.1 and 2.2.2 provide descriptions of the overburden and bedrock geology, respectively.

The information presented below focuses on geologic conditions pertinent to the development of a 3D geologic model for the Beaver Dam Mine Site. The 3D geologic model formed the basis for the site-specific geology (i.e., hydraulic conductivity distribution) represented in the 3D groundwater flow model. Regional geologic conditions were inferred from monitoring well installation borehole records, exploratory geologic drillhole records, regional well records, and regional geology reports.

2.2.1 Overburden Geology

The overburden at the Beaver Dam Mine Site consists of glacial till deposits of varying thickness and occasional shallow peat bogs. Stea and Fowler (1979) describe the overburden as a blue-greenish-grey, loose, cobbly silt-sand till that will grade into a sandier, coarser till, sometimes with red clay inclusions. A typical composition of the glacial till matrix is 80 percent sand, 15 percent silt and 5 percent clay. Site-specific grain size analysis indicates that the till averages approximately 60 percent gravel, 25 percent sand, 15 percent silt, and 1 percent clay. In the upland regions, such as at the Beaver Dam Mine Site, the glacial till material is generally a coarse sandy matrix with numerous quartz cobbles and boulders, exhibiting relatively good permeability and internal drainage (JWA, 1986a). Compact silt-clay till drumlins located in the vicinity of the Beaver Dam Mine Site are expected to be less permeable due to their soil type and composition. Drumlins located in the vicinity of the Beaver Dam Mine Site are shown on Figure 2.3.

Regionally, the till deposit has an average thickness of approximately 3 m and can be up to 20 m thick in some locations such as drumlin deposits (PCA, 2015). At the Beaver Dam Mine Site, the glacial till deposits are on average approximately 3.5 to 4.5 m thick and range from 0.5 to over 22 m thick in a bedrock depression associated with the Mud Lake Fault (JWA, 1986b). Figure 2.4 shows the location of the Mud Lake Fault interpreted based on the findings of JWA (1986a) combined with the overburden thickness interpolated based on observations in exploratory drillhole records, monitoring well installation records, and regional well records.

2.2.2 Bedrock Geology

Regional Geology

Nova Scotia is divided into two distinct geologic parts: the Avalon Terrane to the north; and the Meguma Terrane to the south. The two terranes are separated by the Minus Geofracture (commonly referred to as the Cobequid-Chedabucto Fault System) (Sangster and Smith, 2007). The oldest known rocks of the Meguma Terrane are the greywackes and argillites of the Cambrian to Ordovician aged Meguma Group, which were intruded by granitic plutons during the Devonian Acadian Orogeny (Duncan, 1987; and FSS International Consultants (Australia) Pty Ltd. [FSSI], 2015).

The Paleozoic turbiditic metasedimentary sequence of the Meguma Group consists of two major stratigraphic units: the basal greywacke dominated Goldenville Formation; and the overlying, finer grained, argillite dominated Halifax Formation. The Goldenville Formation is at least 5,600 m thick, while the overlaying Halifax Formation averages approximately 4,400 m in thickness (FSSI, 2015).

The sediments of the Goldenville and Halifax Formations were deformed, uplifted, metamorphosed and intruded by granitic plutons during the Acadian Orogeny, approximately 50 to 375 million years ago. The main feature of the deformation is a series of tightly folded subparallel northeast trending upright to slightly reclined asymmetric folds (Duncan, 1987; and PCA, 2015). A group of northwest trending sinistral faults have truncated and offset the asymmetric folds by up to 6 km. Regional geologic conditions depicting the approximate locations of the Goldenville Formation, Halifax Formation, and granite intrusions are presented on Figure 2.5.

Local Geology

The Beaver Dam Mine Site is located within the Goldenville Formation of the Meguma Group. The series of tightly folded subparallel northeast trending anticlines and synclines have exposed the different stratigraphic members of the Goldenville Formation. After the classification proposed by Horne and Pelley (2007), the Meguma Group can be broken down into three members, consisting of the lowermost Moose River Member that is overlain by the Tangier Member, which in turn is overlain by the Taylors Head Member. Both the Beaver Dam Mine Site and the Touquoy Mine Site (located 19 km to the southwest of the Beaver Dam Mine Site) are located within the Moose River Member (FSSI, 2015).

The Moose River Member is at its widest in the Beaver Dam Mine Site vicinity and is folded into three sub-parallel anticlines. The Beaver Dam Mine Site is located on the southern limb of the overturned central anticline (commonly referred to as the Moose River-Beaver Dam Anticline), with both limbs dipping to the north.

The Beaver Dam Mine Site is centered on Moose River-Beaver Dam Anticline with gold mineralization occurring within the overturned southern limb of the anticline, which dips north at between 75 and 90 degrees. The Moose River-Beaver Dam Anticline is sinisterly offset into segments by two northwest trending faults: the Mud Lake Fault; and the Cameron Flowage Fault (shown on Figure 2.4). The Mud Lake Fault has been described as a 2 to 3 m wide zone of gouge within a 10 to 20 m wide brecciated zone (PCA, 2015). Duncan (1987) stated an average thickness of 12 m, ranging from 5 to 26 m, for the Mud Lake Fault and that the Mud Lake Fault usually can be sub-divided into three zones consisting of:

1. Hanging Wall Breccia (2 to 10 m) consisting of greywacke and minor argillite orthobreccia and minor parabreccia
2. Gouge Zone (2 to 10 m) consisting of graphitic argillite gouge and minor greywacke
3. Footwall Breccia (1 to 5 m) consisting of greywacke and argillite ortho-and parabreccia

The stratigraphy of the southern limb of the Moose River-Beaver Dam Anticline largely has been defined through exploratory drilling and consists of alternating interbedded argillite and greywacke units. Early efforts placed emphasis on determining the nature and extent of gold mineralization that occurs in argillite dominated units surrounded by greywacke dominated units (Duncan, 1987). The initial distinction between units was made in the late 1800s and early 1900s based on the gold bearing properties of the units, rather than their hydraulic properties. Gold bearing units at the Beaver Dam Mine Site typically are argillite dominated units surrounded by greywacke dominate units, including the Crusher Lake Greywacke as shown on Figure 2.6 (Sangster and Smith, 2007) and the Mud Lake Greywacke defined by Duncan (1987). Three argillite dominated units have been defined relative to the Beaver Dam Mine Site, consisting of the Austen, Crouse, and Papke units. The argillite and greywacke dominated units defined for the Beaver Dam Mine Site consist of:

- Austen Argillite – approximately 45 to 70 m thick, composed of dark grey argillite and 20 to 30 percent greywacke.
- Crouse Argillite – approximately 7 to 22 m thick, marking the transition from overlying greywacke dominated units to lower units dominated by argillite. Composed of dark grey, moderately graphitic argillite with greywacke intercalations forming up to 40 percent of the unit.
- Papke Argillite – approximately 15 to 30 m thick, comprised of black, graphitic argillite with less than 20 percent greywacke.
- Hanging Wall Greywacke – approximately 6 to 18 m thick, composed of light grey, fine grained greywacke and up to 40 to 50 percent dark grey to black argillite.
- Millet Seed Greywacke – approximately 8 to 25 m thick, composed of light grey fine to medium grain greywacke and 20 to 30 percent argillite.

Boreholes advanced throughout the Beaver Dam Mine Site during gold exploration identified geologic units consistent with those shown on Figure 2.6. Further boreholes advanced by GHD during monitoring well installation at the Beaver Dam Mine Site largely encountered greywacke, consistent with the Beaver Dam Mine Site being surrounding by greywacke dominated bedrock (Crusher Lake Greywacke and Mud Lake Greywacke). One GHD monitoring well borehole location, MW-02B, contacted granite bedrock, which is consistent with surficial geologic maps showing a large body of granitoids southwest of the Beaver Dam Mine Site, as presented on Figure 2.5. The borehole logs for the recent monitoring wells installed by GHD are included in GHD (2018).

The lithological dataset based on previous drillhole observations provided by AMNS was combined with the lithological data from the GHD monitoring well borehole logs to develop a 3D geologic model that was used to define geologic conditions at the Beaver Dam Mine Site. The development of the 3D geologic model is described in Section 2.3.2.

2.3 Hydrogeologic Conditions

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).

At the Beaver Dam Mine Site, the groundwater table is close to ground surface (typically within 2 to 5 m 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 m, which is consistent with seasonal groundwater level variations of approximately 1 to 2 m observed at monitoring wells throughout the Beaver Dam Mine Site. Surface water monitoring locations show a lesser average seasonal variation of approximately 30 centimetres (cm) in shallow streams and lakes. Hydrographs showing observed groundwater and surface water elevations relative to precipitation at the Beaver Dam Mine Site are presented in Appendices A and B, respectively.

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

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 contours corresponding to overburden/shallow bedrock groundwater elevations from the July 18, 2018 monitoring event conducted at the Beaver Dam Mine Site are presented on Figure 2.7. The interpreted groundwater elevation contours support 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 Beaver Dam Mine Site.

Regional groundwater flow in the fractured crystalline bedrock is controlled by secondary permeability and fracturing. 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 (JWA, 1986a). 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 AMSL in central Nova Scotia to sea level at the southeast shore of Nova Scotia.

2.3.1 Aquifers and Hydraulic Properties

For the purposes of the hydrogeologic modelling, three major aquifer units are defined at the Beaver Dam Mine Site consisting of the overburden, shallow weathered fractured bedrock (shallow bedrock), and deeper competent less fractured bedrock (deep bedrock). The shallow and deep bedrock units are further divided into five subunits each based on rock type/structure, consisting greywacke, argillite, granite, the Cameron Flowage Fault Zone, and the Mud Lake Fault Zone. The hydraulic properties (i.e., hydraulic conductivity) of each of the three major aquifer units are summarized below. The hydraulic conductivity values are based on a pumping test conducted by JWA (1986b), packer tests conducted by JWA and Stantec and summarized in PCA (2015), packer

tests conducted by GHD in three deep boreholes surrounding the proposed open pit location (MW-05C, MW-07C, and MW-09C), and slug tests conducted by GHD in newly installed monitoring wells.

Overburden

The glacial till overburden deposits consist of silty sand and gravel containing cobbles and boulders up to 1 m in diameter. The median thickness of the overburden unit identified by AGC exploratory drillholes in the proposed pit area is 5.5 m, and the median thickness identified in GHD boreholes, which cover an area in and surrounding the Beaver Dam Mine Site, is 2.1 m. The hydraulic conductivity of the overburden was estimated as 2×10^{-7} metres per second (m/s) from a pumping test conducted by JWA (1986b).

GHD conducted slug testing in monitoring wells installed in the till overburden. The overburden slug test results are summarized in Table 2.1. Hydraulic conductivity values calculated from the slug tests range from 6.1×10^{-7} m/s to 3.8×10^{-4} m/s, with a geometric mean of 1.0×10^{-5} m/s. Lower conductivity values were observed in areas of increased overburden thickness (>10 m), such as in the vicinity of MW-12A and MW-14A. MW-12A is installed in a silt-clay drumlin and is expected to have a lower hydraulic conductivity value than that observed in the surrounding overburden.

Shallow Bedrock

In general, bedrock hydraulic conductivity at the Beaver Dam Mine Site has been observed to decrease with depth consistent with weathered and fractured bedrock at shallow depths grading into less fractured and more competent bedrock at depth. Consistent with JWA (1986b), shallow bedrock is defined as bedrock located from the top of bedrock to 22 m below the top of bedrock (and deep bedrock lies below this).

Table 2.2 summarizes the hydraulic conductivity results obtained for shallow bedrock from the GHD slug tests and packer tests, as well as the packer tests summarized by PCA (2015). The shallow bedrock hydraulic conductivity values range from 1.7×10^{-9} m/s to 1.6×10^{-4} m/s, with a geometric mean of 5.6×10^{-7} m/s.

Deep Bedrock

Consistent with JWA (1986b), deep bedrock is defined as bedrock located 22 m or more below the top of bedrock. Table 2.3 summarizes the hydraulic conductivity results obtained for deep bedrock from the GHD slug tests and packer tests, as well as the packer tests summarized by PCA (2015). The deep bedrock hydraulic conductivity values range from 1.0×10^{-10} m/s to 5.4×10^{-6} m/s, with a geometric mean of 2.9×10^{-8} m/s. The geometric mean hydraulic conductivity for the deep bedrock is approximately 20 times lower than that of the shallow bedrock, which is consistent with the less fractured and more competent nature of the deep bedrock.

2.3.1.1 Major Aquifer Rock Types

The most abundant rock types located at the Beaver Dam Mine Site are the greywacke and argillite of the Goldenville Formation. As shown on Figure 2.5, granitoids are located to the west and southwest of the Beaver Dam Mine Site, and on a regional scale, bands of the Halifax Formation are located to the north and south of the Beaver Dam Mine Site. Table 2.4 presents the hydraulic

conductivity values determined from the GHD and PCA (2015) packer tests sorted by lithology and structure. The geometric mean hydraulic conductivity values from packer tests completed in argillite and greywacke are 2.7×10^{-8} m/s and 3.4×10^{-8} m/s, respectively. The similar geometric mean hydraulic conductivity values for both argillite and greywacke indicate that these two bedrock types have similar hydraulic properties at the Beaver Dam Mine Site.

2.3.1.2 Fault Zones

Two major faults are located in the vicinity of the proposed Beaver Dam Mine Site. The Cameron Flowage Fault runs below Cameron Flowage and the Mud Lake Fault location passes through the proposed pit (see Figure 2.4). Hydraulic conductivity values determined from packer tests summarized by PCA (2015) for drillhole sections that intersected the Mud Lake Fault range from 1.2×10^{-9} m/s to 1.9×10^{-6} m/s, with a geometric mean of 1.4×10^{-8} m/s (see Table 2.4). The packer test results indicate that the Mud Lake Fault has a hydraulic conductivity value similar to the surrounding bedrock. Observations by JWA (1986b) that the Mud Lake Fault is filled with a clay-like gouge support the low hydraulic conductivity results obtained for the Mud Lake Fault.

2.3.2 3D Geologic Model Development

The near vertical orientation of the interbedded greywacke and argillite units, coupled with faulting, at the Beaver Dam Mine Site does not easily lend itself to developing regionally continuous layered lithological units. To overcome this, GHD developed a 3D geologic model for the Beaver Dam Mine Site to facilitate a rigorous representation of the spatial variability and orientation observed in the lithology. GHD converted the 3D geologic model into a hydraulic conductivity zone distribution to apply in the 3D groundwater flow model.

GHD developed a 3D geologic model for the Beaver Dam Mine Site using the geologic indicator kriging (GIK) approach implemented in the software package Mining Visualization System (MVS) developed C Tech Development Corporation (C Tech) (C Tech, 2015). GIK is particularly well suited to interpolating systems that have complex heterogeneous geology, which do not readily lend themselves to a layered representation. GHD conducted a detailed review of the stratigraphic logs for all drillholes/monitoring well locations provided by AGC and those locations installed by GHD. Geologic units were categorized based on common lithological types. The 3D spatial distribution for each lithological unit then was interpolated throughout the Beaver Dam Mine Site using GIK.

Based on the observations documented in the Beaver Dam Mine Site stratigraphic logs, GHD categorized the main lithological units as follows:

- Overburden
- Argillite
- Greywacke

An interpolation domain was established for the 3D geologic model that consisted of rectangular grid blocks over the horizontal and vertical extent of the available geologic data at the Beaver Dam Mine Site. GHD applied a horizontal grid block size of 10 m by 10 m and a vertical grid block size of 10 m. GIK was used to compute the probably for each lithological type to occur in every grid block based on the observed geology at each boring. The lithological type having the highest probability (for an

individual grid block) is assigned to the grid block. GIK applies an anisotropy ratio that represents the degree to which a lithological type will be interpolated horizontally in favour of vertically. For example, an anisotropy ratio of 1 represents interpolation with no direction favour, and an anisotropy ratio of 10 represents interpolation in the horizontal direction 10 times more in favour than interpolation in the vertical direction. GIK also can apply a heading (i.e., the planar direction of the formation) and a dip angle. Since the lithology at the Beaver Dam Mine Site is primarily vertical, GHD applied an anisotropy ratio of 3, a dip angle of 73 degrees, consistent with the observed 70 to 90 degree dip of the interbedded argillite and greywacke units, and a heading of 105 degrees consistent with the horizontal east/west orientation of the interbedded argillite and greywacke units.

A visualization of the 3D geologic model is included electronically in Appendix C along with the visualization viewer installation, viewing, and interaction instructions.

Screen captures from the 3D geologic model are presented on Figures 2.8 and 2.9, which show the following key features:

- Lithological types identified in drillhole/borehole records;
- Proposed open pit shell;
- Historical Mine Features; and
- Approximate Mud Lake Fault Location (on Figure 2.9) based on AGC's interpretation of geologic drillholes.

The conversion of the 3D geologic model into the hydraulic conductivity distribution specified in the 3D groundwater flow model is described in Section 5.3.

2.3.3 Groundwater Sinks

A groundwater sink is any feature that that removes groundwater from the groundwater flow system. Within the Beaver Dam Mine Site area, the primary groundwater sinks correspond to groundwater discharge to surface water features. Groundwater discharge to surface water features is discussed in more detail in the following section.

2.3.3.1 Discharge to Surface Water Features

Locally, groundwater flow typically follows the topographic relief, moving towards surface water features in low lying areas. The proposed open pit at the Beaver Dam Mine Site is located adjacent to Cameron Flowage, a stillwater area on the Killag River. Cameron Flowage is approximately 1.2 km long and up to 120 m wide. All surface water generated within the drainage catchment that includes the proposed open pit area flows into Cameron Flowage. Cameron Flowage also is a likely area of groundwater discharge (PCA, 2015).

Prior to the collection of site-specific data, the average annual groundwater discharge (baseflow) to Cameron Flowage was estimated using the four nearest hydrometric stations and scaling the watersheds that contain those stations to the size of the Cameron Flowage watershed. The nearest four hydrometric stations are Pembroke River at Glenbervie, Musquodoboit River Near Upper Musquodoboit, Musquodoboit River Near Middle Musquodoboit, and Musquodoboit River at Crawford Falls, which have drainage areas of 7,330 hectares (ha), 14,100 ha, 33,400 ha, and

65,000 ha, respectively. A baseflow value was estimated for each drainage area by applying a recursive digital filter (Eckhardt, 2005) as implemented in WHAT: Web-based Hydrograph Analysis Tool (Lim et al., 2005) to daily discharge data recorded at each of the four hydrometric stations. The estimated baseflow for each drainage area was scaled to the total drainage area of approximately 3,871 ha for Cameron Flowage, providing an estimated total average annual baseflow of approximately 23,426 meters per day (m^3/d) for Cameron Flowage with a total annual flow of 103,881 m^3/d. Based on these estimates, baseflow to Cameron Flowage would represent approximately 23 percent of the total flow. The estimated average annual baseflow for Cameron Flowage provides a calibration target against which simulated baseflow can be compared as discussed in Section 6.

Following model calibration, preliminary stage-discharge relationships were developed for six gauging locations using available flow monitoring measurement events and corresponding surface water elevations measured at the gauging locations. The preliminary stage-discharge relationships will be further refined as additional flow monitoring measurement events are conducted. The preliminary stage-discharge relationships were applied to estimate stream discharge (flow) at each of the six gauging locations. Two gauging locations, SW2A and SW1A, are located immediately upstream and downstream of Cameron Flowage, respectively, and were selected to verify the total flow and baseflow estimates calculated using the nearest four hydrometric stations. Consistent with the method applied for the nearest four hydrometric stations, a recursive digital filter (Eckhardt, 2005) as implemented in WHAT: Web-based Hydrograph Analysis Tool (Lim et al., 2005) was applied to the average daily discharge data for SW2A and SW1A to estimate baseflow at those gauge locations. The average annual baseflow estimated for SW2A and SW1A is 24,686 cubic m^3/d, with an average annual total flow of 112,420 m^3/d. Based on these values, the average annual baseflow to at SW2A and SW1A represents approximately 22 percent of the total average annual flow at those gauge locations. The estimated average annual baseflow at SW2A and SW1A is within approximately 5 percent of the estimated average annual baseflow estimated from the nearest four hydrometric station for Cameron Flowage. This comparison verifies that the estimated average annual baseflow from the nearest four hydrometric stations is reasonable and provides an appropriate model calibration target.

GHD also evaluated available streamflow data collected at SW2A and SW1A to identify seasonal lows in streamflow and baseflow as surface water features are typically most vulnerable to changes in baseflow under low-flow conditions. This occurs because under periods of low flow, baseflow is typically the dominant physical process contributing to total stream flow, whereas under periods of high flow surface water runoff is typically the dominant physical process contributing to total stream flow. The lowest two-week average flow in Cameron Flowage recorded at SW-1A and SW2A corresponds to August 16 through August 29, 2019, and is selected being representative of low-flow conditions in Cameron Flowage. From August 16 through August 29, 2019, the average total flow estimated at SW-2A and SW-1A is 3,009 m^3/d and 3,364 m^3/d, respectively. The estimated baseflow contribution to Cameron Flowage between SW-2A and SW-1A is 335 m^3/d which provides a basis for comparison for predicted baseflow changes at EOM and PC.

2.3.4 Groundwater Sources

A groundwater source is any feature that contributes water to the groundwater flow system. At the Beaver Dam Mine Site, the primary groundwater source is from groundwater recharge through precipitation infiltration. In some areas it is expected that groundwater will receive recharge from surface water features; however, surface water features overall are expected to receive net discharge from the groundwater flow system.

2.3.4.1 Recharge Through Precipitation Infiltration

Groundwater at and surrounding the Beaver Dam Mine Site receives precipitation at a reported average annual rate of approximately 1,357.7 millimetres per year (mm/yr) (climate normal for the 30-year period [1981 to 2010] at Middle Musquodoboit Climate Station). The amount of precipitation reaching the groundwater table is typically considered to range from approximately 10 to 40 percent of the average annual precipitation (Arnold et al., 2000; and Rushton and Ward, 1979).

Baseflow often is used to estimate recharge rates, with the caveats that: 1) baseflow probably represents some amount less than that which recharges the aquifer; and 2) baseflow is best applied to provide a reasonable estimate of recharge occurring over long time periods (1 year or more) (Risser et al., 2005). To estimate recharge from baseflow, the total baseflow is divided by the area of the watershed. For the Cameron Flowage watershed, the average annual estimated baseflow of 23,426 m^3/d divided by the area of the Cameron Flowage watershed of 3,871 ha gives an estimated average annual recharge rate of 221 mm/yr (approximately 16 percent of the average annual precipitation). Applying the same method to an average dry month (typically September) and an average wet month (typically April) provides an estimated range in recharge from 77 to 377 mm/yr (approximately 6 to 28 percent of the average annual precipitation). Although applying baseflow to estimate recharge has some limitations, it is suitable for the purpose of establishing a potential range of average recharge conditions at the Beaver Dam Mine Site.

The recharge estimates developed through baseflow analysis correspond well to those developed by the Nova Scotia Department of Natural Resources (NSDNR). Using a similar method, the NSDNR estimated recharge for primary watersheds across Nova Scotia (Kennedy et al., 2010). The average annual recharge rate calculated for the primary watershed within which the Beaver Dam Mine Site is located ranged from 220 to 260 mm/yr. The average annual recharge rate of 221 mm/yr estimated for the Beaver Dam Mine Site through the baseflow analysis is consistent with the range of 220 to 260 mm/yr estimated by Kennedy et al. (2010).

2.3.4.2 Recharge from Surface Water Features

While surface water features are expected to be a net groundwater sink, there will be losing reaches (i.e., sections where surface water recharges groundwater) along some surface water features. Surface water features will recharge groundwater in areas where groundwater levels fall below adjacent surface water elevations.

3. Hydrogeologic Conceptual Site Model (CSM)

The CSM forms the working basis for understanding the hydrogeologic conditions at the Beaver Dam Mine Site, including the extent, geometry, and composition of the hydrostratigraphic units, groundwater flow characters of each hydrostratigraphic unit, groundwater flow interactions between the units, and groundwater/surface water interaction. The CSM facilitates selecting model domain limits for the numerical groundwater flow model, as well as hydrostratigraphic unit representation and boundary conditions taking into consideration the observed site-specific and regional hydrogeologic conditions. The CSM then forms the basis for constructing the numerical groundwater flow model.

3.1 General Hydrogeologic Characteristics

Understanding the general hydrogeologic characteristics of the groundwater flow system for the Beaver Dam Mine Site is fundamental to developing a representative CSM and guides the development of the numerical groundwater flow model. Based on the available regional and site-specific information, the hydrogeologic characteristics are summarized as follows:

- The available monitoring well installation logs, regional well records, and exploratory drillhole records, and the 3D geologic model developed from these logs/records, the geologic conditions at the Beaver Dam Mine Site consist of steeply dipping interbedded argillite and greywacke overlain by a thin till overburden layer. The overburden consists of a silty sand and gravel containing cobbles and boulders up to 1 m in diameter. The interbedded argillite and greywacke bedrock sequence at the Beaver Dam Mine Site is truncated by the Mud Lake Fault towards the east end of the proposed open pit location.
- Groundwater flow at the Beaver Dam Mine Site occurs primarily in the till overburden layer and the shallow weathered fractured bedrock zone. Bedrock permeability decreases with depth indicating that groundwater flow rates also are expected to decrease with depth.
- Groundwater flow directions in the till overburden typically follow topographic relief, and the groundwater table is expected to mimic ground surface, with recharge occurring in upland areas, and discharge occurring to surface water features in low lying areas within the Killag River watershed.
- Groundwater flow in the bedrock is controlled by secondary permeability and fracturing, and more so in the weathered shallow bedrock than in the more competent deep bedrock. Locally, bedrock groundwater flow largely is expected to occur predominantly towards the southeast along dominant fault trends, with smaller flow components to the northeast and east. It is assumed that the secondary permeability and fracturing is well enough connected at the scale of interest that the fractured bedrock system can be treated as an equivalent porous media.
- The surface water features surrounding the Beaver Dam Mine Site receive net groundwater discharge; however, there may be some localized areas where surface water bodies recharge groundwater when the surface water elevations lie above the immediately surrounding groundwater elevations.
- At depth within the deep bedrock, the permeability becomes sufficiently low such that vertical groundwater flow is negligible.

3.2 Groundwater Flow Model Domain Limits

A groundwater flow model domain should extend to where reasonably defensible boundary conditions can be established. Model domain limits, and the associated boundary conditions, should be based on regional-scale natural hydrogeologic features where possible. The model domain limits and the associated boundary conditions should also be selected to minimize the potential to cause an incorrect bias[4] in model predictions over the area of interest within the interior of the model domain.

GHD selected a model domain and associated boundary conditions that are representative of observed conditions at the Beaver Dam Mine Site and reasonably expected conditions regionally. The selected model domain and boundary conditions assigned at the model domain limits are illustrated on Figure 3.1, and are described in general terms as follows:

- Northeast: The northeastern model domain limit is aligned with expected groundwater flow divide located between topographic highs and the surface water elevations along the centre of Como Lake and Seven Mile Stream. The northeastern boundary condition was extended beyond the secondary watershed divide shown on Figure 3.1, to provide additional physical separation between the Beaver Dam Mine Site and northeastern boundary condition such that the northeastern boundary condition would not provide a potentially incorrect bias within the area of interest at the Beaver Dam Mine Site. A river boundary condition is specified along the location of Como Lake and Seven Mile Stream in the upper-most model layers where these surface water features are present, and a no-flow boundary condition is specified to depth beneath the surface water features. A no-flow boundary condition is specified to depth between topographic highs where a lake or stream/river is not present.
- Southeast: The southeastern model domain boundary was selected as corresponding to anticipated flow divides between topographic highs southeast of Cameron Flowage. Regional groundwater flow from northwest to southeast is expected to exit the model domain along the southeastern boundary to the south of Cameron Flowage, following the general topographic relief towards the southeast. Shallow groundwater discharge is expected to the surface water features located in the southeast portion of the model and abutting the southeastern model domain boundary (which are represented in the groundwater flow model, as shown on Figure 3.1 and described in Section 5.2). A general head boundary was tested along the southeastern boundary south of Cameron flowage; however, due to the low permeability of the bedrock, flow at depth was found to be negligible with respect to groundwater flow conditions at the Beaver Dam Mine Site. Therefore, a no-flow boundary was assigned to depth (except where shallow surface water bodies are present) along the entire southeastern model domain limit.
- Southwest: The southwestern model domain limit corresponds to the tertiary water shed boundary along the centre of River Lake and the West Sheet Harbour River, as shown on Figure 3.1. A river boundary condition is specified along the southwestern model domain limit consistent the location of River Lake and the West Sheet Harbour River in the upper-most model

[4] For example, unless there is a regional-scale natural hydrologic feature to warrant doing so (i.e., a substantial lake), a constant head boundary condition should not be assigned in close proximity to the area of interest since this may artificially maintain groundwater elevations should a future groundwater sink condition (i.e., a pumping well or an open pit mine) be represented within the area of interest.

layers where these surface water features are present, and a no-flow boundary condition is specified to depth beneath the surface water features.

- Northwest: The northwestern boundary condition corresponds to surface water features along West Sheet Harbour River, Kent Lake, Cope Flowage, West Lake, and West Brook. Between West Brook to north of McNeil Brook, the northwestern boundary corresponds to an inferred flow divide between topographic highs. River boundary conditions are specified in the upper-most model layers where the surface water features are present, and a no-flow boundary condition is specified to depth beneath the surface water features. A no-flow boundary condition is specified to depth where a flow divide is inferred between topographic highs.

As presented on Figure 3.1, the model domain extends approximately 8.5 km in the north-south direction and 9 km in the east-west direction. Details on implementing the boundary conditions described above at the model domain limits are provided in Section 5.2. Additional river and drain boundary conditions on the interior of the model domain corresponding to surface water features are shown on Figure 3.1. Section 5.2 describes the basis for these interior boundary conditions.

Vertically, the model domain extends from ground surface, where a recharge boundary condition is applied, to approximately 250 m bgs where a vertical no-flow boundary is inferred. At depth, the permeability the deep bedrock becomes sufficiently low such that active groundwater flow, and vertical groundwater flow in particular, is considered negligible. Ground surface is at approximately 130 m AMSL on average in the vicinity of the Beaver Dam Mine Site making the bottom of the model domain correspond to -120 m AMSL. The bottom of the proposed open pit is to extend to an elevation of -45 m AMSL, 75 m above the bottom of the model domain.

3.3 Hydrostratigraphic Unit Representation

The steeply dipping and interbedded nature of the argillite and greywacke units at the Beaver Dam Mine Site, combined with the truncation of these units caused by the Mud Lake Fault, precludes using horizontal model layers specific to each hydrostratigraphic unit. The 3D geologic model that GHD developed for the Beaver Dam Mine Site using MVS accounted for the dip angle and heading of the steeply dipping interbedded argillite and greywacke units, as well as the Mud Lake Fault. GHD imported the 3D geologic model into the numerical groundwater flow model as a 3D hydraulic conductivity distribution that specifically honoured the location of argillite and greywacke.

The Cameron Flowage Fault is located beyond the area investigated by the exploratory drillholes, and thus its location and orientation are not represented in the 3D geologic model. The Cameron Flowage Fault is assumed to have a vertical orientation, and its location is assigned based on the interpreted regional orientation presented in JWA (1986a).

Within the model domain, the Halifax Formation and location of granitoids are incorporated based on the regional extents presented on Figure 2.5.

For each bedrock and fault zone, it is assumed there is a shallow more permeable zone, caused by weathering and fracturing, and a deeper less permeable zone where weathered and fracturing are diminished.

The specific hydrostratigraphic units considered in the CSM for the Beaver Dam Mine Site are as follows:

- Overburden
- Shallow Greywacke
- Deep Greywacke
- Shallow Granite
- Deep Granite
- Shallow Argillite
- Deep Argillite
- Shallow Mud Lake Fault Zone
- Deep Mud Lake Fault Zone
- Shallow Cameron Flowage Fault Zone
- Deep Cameron Flowage Fault Zone

The shallow units listed are considered more permeable due to weathering and fracturing, while the deep units are considered less permeable due to reduced weathering and fracturing. As described in Section 2.3.1, the shallow bedrock units are defined as extending to 22 m below the top of bedrock, and the deep units lie below this.

4. Simulation Program Selection

The simulation program selection to develop the numerical groundwater flow model for the Beaver Dam Mine Site was based on the following considerations:

- The ability of the program to represent the key components of the CSM
- The demonstrated verification that the program correctly represents the hydrogeologic processes being considered
- The proven acceptance of the program by regulatory agencies and the scientific/engineering community
- The ability of the program to represent the proposed mine design
- The ability of the program to provide a reasonable numerical solution in consideration of the complexity of the hydrogeologic conditions at the Beaver Dam Mine Site

4.1 Groundwater Flow Model

MODFLOW-NWT (Niswonger et al., 2011), developed by the United States Geological Survey (USGS), is capable of simulating steady-state or transient groundwater flow in two or three dimensions. MODFLOW-NWT uses the finite-difference method to numerically approximate a solution to complex groundwater flow problems. A rectangular grid is superimposed over the study area to horizontally subdivide the region of interest into a number of rectangular cells, and then the

study area is subdivided vertically using layers. Hydraulic properties are assigned to the resulting model cells per layer consistent with the hydrogeologic unit that falls within each cell. Groundwater flow is formulated as a differential water balance for every model cell and hydraulic head is solved at the center of every model cell. MODFLOW-NWT allows for the specification of flows associated with wells, areal groundwater recharge, rivers, drains, streams, and other groundwater sources/sinks.

MODFLOW-NWT was selected to simulated groundwater flow for this modelling study due to its ability to efficiently solve complex groundwater flow simulations characterized by drying and rewetting of model cells such as that encountered in the simulation of dewatering scenarios. MODFLOW-NWT is a standalone version of MODFLOW-2005 (Harbaugh, 2005), which is an update to the original MODFLOW (McDonald and Harbaugh, 1988) and MODFLOW-2000 (Harbaugh et al., 2000). MODFLOW has been extensively verified and is readily accepted by many regulatory agencies throughout North America and Europe. MODFLOW-NWT can represent the hydrogeologic components of the CSM for the Beaver Dam Mine Site. The Newton Solver (NWT) and the Upstream Weighting (UPW) package included in MODFLOW-NWT was employed to solve the groundwater flow equation. For convergence, the solution technique required the satisfaction of both hydraulic head and flow residual criteria providing a rigorous and reliable simulated water balance throughout the model domain.

4.2 Parameter Estimation

The calibration of the groundwater flow model was aided through the use of the parameter estimation program PEST, which is an acronym for Parameter Estimation (Watermark Numerical Computing, 2016). PEST is a model-independent parameter estimator that has become a groundwater industry standard for groundwater flow model calibration. It has a powerful inversion engine, which provides the ability to set bounds on model input parameters such as hydraulic conductivity and groundwater recharge. PEST was used in conjunction with pilot points (Doherty et al., 2010). Pilot points are a spatial parameterization device that can be used to estimate an initial hydraulic conductivity distribution. PEST conveys to MODFLOW-NWT input parameter values that vary within their specified bounds with the objective of establishing optimal input parameter values that minimize the error between observed and simulated calibration targets. For each run of input parameters, PEST calculates objective function values (OFVs) at each model calibration target location. OFVs represent the error between calculated versus measured values at each calibration target location. PEST automatically makes changes to the input parameter values (within their specified bounds) to reduce OFVs, selecting the run that exhibits the lowest overall OFVs as the optimal solution.

4.3 Contaminant Transport Model

Contaminant (metals) transport was simulated using MT3D-USGS (Bedekar et al., 2016). MT3D-USGS, an update to MT3DMS (Zheng and Wang, 1999), includes new transport modelling capabilities to accommodate flow terms calculated by MODFLOW packages that previously were unsupported by MT3DMS and to provide greater flexibility in the simulation of solute transport and reactive solute transport. MT3D-USGS also includes the capability to route a solute through dry model cells that may be simulated in MODFLOW-NWT. MT3D-USGS is a reactive transport model that, when integrated with MODFLOW-NWT, can simulate multispecies transport in one, two, or three dimensions, and is able to simulate transport processes that are applicable to the Beaver Dam

Mine Site, including advection, biodegradation (or decay), adsorption, and dispersion in groundwater flow systems. MT3D-USGS is commonly used by the industry and accepted by regulatory agencies throughout North America and Internationally.

4.4 Particle Tracking

Particle tracking provides a means to evaluate advective groundwater flow pathways within a simulated groundwater flow field. The program MODPATH Version 7 (Pollock, 2016), also developed by the USGS, is a 3D particle tracking program that is integrated with MODFLOW-NWT and was selected to evaluate the degree of hydraulic containment that could potentially be achieved by mitigation measures. MODPATH is commonly used by the industry and accepted by regulatory agencies throughout North America and Europe.

4.5 Graphical User Interface

The graphical user interface (GUI) Groundwater Vistas (Rumbaugh, 2017) was used as the interface between the assembled hydrogeologic data and the required MODFLOW-NWT and MT3D-USGS input files. The GUI facilitates pre- and post-processing of MODFLOW-NWT and MT3D-USGS input/output files.

5. Base-Case Groundwater Flow Model Construction

Groundwater flow model construction is the process of developing the horizontal and vertical discretization of the selected model domain, specifying hydraulic properties consistent with the hydrostratigraphic units, and implementing boundary conditions consistent with the CSM. The groundwater flow model construction relative to these aspects is presented in the following sections.

5.1 Groundwater Flow Model Spatial Domain and Discretization

Horizontally, the model domain is discretized into rows and columns using a rectangular finite-difference grid. The finite-difference grid is extended over the model domain described in Section 3.2. The finite-difference grid is presented on Figure 5.1. A minimum finite-difference grid spacing of 10 m was applied over the area of interest as defined by the preliminary mine layout. Beyond the area of interest, the grid spacing progressively increases to a maximum of 100 m at the edge of the model domain. The model domain is discretized horizontally into 272 rows and 290 columns.

Vertically, the model domain extends from ground surface to approximately 250 m bgs where a vertical no-flow boundary is inferred, as described in Section 3.2. The vertical discretization of the model domain consists of 13 model layers to capture major changes in lithology as represented by the 3D geologic model. With the exception of model layer 1, the model layers have a uniform thickness. For model layer 1, a variable layer thickness is assigned, consistent with the estimated overburden thickness presented on Figure 2.4. Ground surface elevations over the model domain were generated using a combination of Digital Elevation Model (DEM) data for the Beaver Dam Mine Site, LiDAR imagery data for the Beaver Dam Mine Site, and surveyed ground surface elevations at

monitoring well, drillhole, and surface water gauge locations. Model layer 2 has a uniform thickness of 22 m, corresponding the depth of the shallow bedrock zone. Model layers 3 through 13 have a uniform thickness of 20 m.

5.2 Flow Model Boundary Conditions

As described in Section 3.2 and shown on Figure 3.1, the boundary conditions for the groundwater flow model consist of:

- River boundary conditions to represent surface water features that potentially could receive groundwater discharge or potentially could recharge groundwater (e.g., Cameron Flowage, Como Lake, Crusher Lake, Mud Lake, etc.)
- Drain boundary conditions to represent flow accumulation channels, which primarily receive groundwater discharge
- No-flow boundary conditions to represented anticipated flow divides located between topographic highs along the model domain limits
- Recharge over the top of the model domain due to precipitation infiltration
- Vertical no-flow boundary condition at depth corresponding to the inferred base of the active groundwater flow system within deep bedrock

With respect to applying the calibrated model for predictive simulations of the open pit mine, pit filling, and proposed surface water management ditches, the following additional boundary condition types are used:

- A drain boundary condition is specified to represent surface water features that are considered to represent a point of groundwater discharge only. This includes surface water management ditches, which are assumed to rapidly convey groundwater discharge to Cameron Flowage, and the seepage face of the open pit mine above the specified pike lake elevation.
- A general head boundary condition is applied to represent groundwater in-flow/out-flow. A general head boundary is specified to simulate pit lake elevations at PC, and to estimate groundwater inflow into the open pit at specific pit lake stage elevations occurring as the pit fills.

The implementation of these boundary conditions in the model is described in further detail below.

5.2.1 River Boundary Condition

A river boundary can simulate the interaction between surface water and groundwater. It can represent both groundwater discharge to surface water (i.e., a gaining stream) and groundwater recharge from surface water (i.e., a losing stream). If a specified river stage elevation is lower than the simulated groundwater elevation, the river boundary receives discharge from groundwater. If the specified river stage elevation is higher than the simulated groundwater elevation, the river boundary serves as a recharge to groundwater. The quantity of surface and groundwater exchange is equal to the difference between the simulated groundwater elevation within the river cell and the specified head within the river cell multiplied by a conductance term. The conductance term reflects the relative ease of groundwater flow through sediments or bedding material that form the base of the surface water body.

As shown on Figure 3.1, river boundary conditions were assigned to represent natural surface water features located within the active model domain. The river cell stage elevations were assigned based on ground surface elevations minus the depth to water interpolated between surface water gauge locations. The conductance term for the river cells was estimated using:

$$C_{River} = \frac{KA}{M}$$

Where:

C_{River} = river cell conductance (square metres per day [m^2/d])

K = hydraulic conductivity of streambed sediments (m/d)

A = area of the river cell (square metres [m^2])

M = thickness of the river bed material (m)

For larger surface water features (i.e., lakes and wider water features like Cameron Flowage) that encompass multiple model cells, the river cell area was calculated as the model cell area or the portion of the surface water body contained by the river cell. For narrow surface water features (i.e., streams), the river cell area was calculated as the length of the stream within the river cell multiplied by stream width estimated from satellite imagery. The streambed sediment thickness was assumed to be 0.1 m. The hydraulic conductivity of the streambed sediments was adjusted during model calibration.

5.2.2 No-Flow Boundary Condition

No-flow boundary conditions were applied where negligible groundwater flow across a model boundary reasonably can be expected. No-flow boundary conditions are specified between adjacent topographic highs where groundwater is expected to flow downslope creating a groundwater flow divide with negligible groundwater flow across the divide (the divide is assumed to correspond to a line drawn between the two adjacent topographic highs). At the bottom of the model domain (at approximately 250 m bgs), it is assumed that the permeability of the deep bedrock becomes sufficiently low such that active groundwater flow, and vertical groundwater flow in particular, is considered negligible. As a result, a no-flow boundary condition is specified across the bottom of the model domain. A no-flow boundary condition also is applied along the southeastern model domain boundary where, due to the low permeability of the bedrock, flow across this boundary is negligible with respect to groundwater flow conditions at the Beaver Dam Mine Site.

5.2.3 Recharge

Recharge from precipitation infiltration was applied as the top model domain boundary condition. Based on the 30-year annual average normal precipitation values from 1981 to 2010 for Middle Musquodoboit, Nova Scotia (Stantec, 2018), the average annual precipitation is 1,357.7 mm/yr. The total precipitation in June 2018 (one month prior to the July 18, 2018 monitoring event selected as the base case calibration target dataset, as described in Section 6.1) was 178.1 mm, which is the equivalent of a total annualized precipitation of 2,137.2 mm (about 1.6 times high than the 30-year average annual precipitation). The average monthly precipitation for June (from 1981 to 2010 for

Middle Musquodoboit) is 99.8 mm, and the total precipitation for June 2018 is approximately 1.8 times this average.

The amount of precipitation reaching the groundwater table as recharge depends on topography, shallow soil types, ground cover and land use (vegetation or building/pavement coverage), season, weather conditions, etc. Through the baseflow analysis described in Section 2.3.4.1, recharge for the Beaver Dam Mine Site was estimated to range from 77 to 377 mm/yr. Recharge was adjusted within this range during model calibration as described in Section 6.

The ground cover and land use is consistent throughout the Beaver Dam Mine Site; therefore, a single uniform recharge rate was applied over the entire model domain.

5.2.4 Drain Boundary Condition

A drain boundary condition simulates groundwater/surface water interaction in terms of groundwater discharge only. Unlike a river boundary condition, a drain boundary condition cannot represent a losing stream condition where surface water recharges groundwater. The drain boundary condition is active if the specified drain stage elevation is lower than the simulated groundwater elevation, and inactive when the specified drain stage elevation is higher than the simulation groundwater elevation. Similar to river cells, the quantity of groundwater discharge to the drain boundary is equal to the difference between the simulated groundwater elevation within the drain cell and the specified drain stage elevation multiplied by a conductance term.

A drain boundary condition was applied along flow accumulation channels. Flow accumulation channels connect to and potentially convey water to mapped surface water features. Therefore, flow accumulation channels are expected to function as groundwater discharge locations. The hydraulic conductivity value assigned to the to drain cells representing flow accumulation channels is the same as that used for the river cell streambed sediments as determined through model calibration.

A drain boundary condition was applied along the open pit wall to simulate the open pit above specified pit lake stage elevations. The drain stage elevation above the specified pit lake stage was set based on the elevation of the proposed pit walls. The drain conductance was set to a high value of 1,000 m^2/d to ensure that any groundwater entering a drain cell along the open pit wall would discharge to the open pit without resistance (when the groundwater elevation is above the drain stage elevation).

A drain boundary condition was also applied to simulate the surface water management ditches planned throughout the Beaver Dam Mine Site and interceptor trenches considered as potential mitigation measures. The ditches and trenches are designed to efficiently convey collected water to discharge locations and are expected to function as a groundwater discharge location as well. The conductance term for drain cells assigned to represent the surface water management ditches and potential interceptor trenches were calculated using the same approach as applied for the river cells. The area of the drain cell was calculated based on the length of the surface water management ditch, or interceptor trench, specified within the drain cell multiplied by the designed width of the surface water management ditch, or interceptor trench. The hydraulic conductivity used to calculate the conductance term is the same as that used for the river cell streambed sediments since the surface water management ditches, or potential interceptor trenches, are designed to be naturally lined.

5.2.5 General Head Boundary Condition

A general head boundary (GHB) condition was assigned to represent the open pit below the simulated pit lake stage elevation. The GHB condition requires specifying a hydraulic head value and a conductance term for each model cell where the boundary is applied. The hydraulic head values were set equal to the simulated pit lake stage elevation, and the conductance term was set to a high value of 1,000 m^2/d to ensure that any groundwater entering a GHB cell along the open pit wall would discharge to the open pit without resistance (when the groundwater elevation is above the hydraulic head value).

5.3 Hydraulic Conductivity Distribution

The hydraulic conductivity zones were assigned in the model to represent each of the major hydrogeologic units identified in the CSM and represented in the 3D geologic model. A single hydraulic conductivity zone was assigned in model layer 1 to represent the overburden. Within the overburden hydraulic conductivity zone, a continuously variable hydraulic conductivity distribution was assigned to represent the multiple soil types which make up the overburden unit ranging from less permeable silty-clay to more permeable cobbled silty-sand. A single hydraulic conductivity zone was assigned to each of the shallow and deep bedrock and fault units which consist of the shallow and deep greywacke, shallow and deep granite, shallow and deep argillite, shallow and deep Mud Lake Fault Zone, and shallow and deep Cameron Flowage Fault Zone. A uniform hydraulic conductivity value is assigned within each of the shallow and deep bedrock and fault zones. The hydraulic conductivity zones specified in model layers 1 to 13 are presented on Figures 5.2 through 5.14. Specifying hydraulic zones per hydrogeologic unit permits parameter estimation for each unit implemented through PEST using pilot points. The hydraulic conductivity value for each unit was adjusted during model calibration within reasonable bounds based on the results of the hydraulic conductivity testing conducted within each hydrogeologic unit (see Tables 2.1, 2.2, and 2.3), as well as values available in published literature consistent with the geological materials that make up each unit.

6. Base-Case Groundwater Flow Model Calibration

Groundwater flow model calibration is the process of adjusting model input parameter and boundary conditions such that simulated results provide a reasonable representation of observed groundwater flow conditions at the Beaver Dam Mine Site. The object is to determine a unique combination of input parameters to produce a numerical solution that best matches the observed groundwater elevations, observed groundwater flow directions, and estimated baseflow at the Beaver Dam Mine Site.

6.1 Calibration Targets

Selection of steady-state model calibration target datasets normally considers whether the available groundwater elevation monitoring captures the following:

- Represents the range in groundwater flow conditions (i.e., seasonal variations) observed at the Beaver Dam Mine Site, typically consisting of a base case (i.e., average) condition, and wet and dry conditions
- Groundwater stresses/boundary conditions represent the range of conditions affecting groundwater elevations and flow directions
- Provides spatial coverage of the model domain with measurements at the majority of the available monitoring well locations
- Includes the key area of interest within the model domain

The Site monitoring network includes monitoring well/surface water gauge locations both within and surrounding the area of interest where mining operations are proposed. Groundwater/surface water elevations have been measured at the monitoring well/surface water gauge network at the Beaver Dam Mine Site since the network was installed in May 2018. Groundwater/surface water monitoring consists of both manual water elevation measurements and automated water elevation measurements. To automatically record water elevations, transducers were installed in groundwater monitoring wells and at staff gauge locations. Manual water elevation measurements were taken periodically to verify the transducer readings. Transducer readings and manual measurements at groundwater and surface water monitoring locations are included in Appendices A and B, respectively. Gaps in manual water elevation measurements occur in winter when Site conditions precluded the collection of manual water elevations. Gaps in transducer elevation readings occur when the transducer was dry or had been removed from the well for maintenance or well sampling. Transducers were removed from surface water monitoring locations during the winter to avoid damage to the instruments due to the formation of ice on surface water features.

Dry conditions at Beaver Dam Mine Site are observed in August through September and wetter conditions are observed from November through April. The highest groundwater elevations were observed in November, corresponding to the onset of fall/winter precipitation events, and again in April corresponding to the spring freshet. The observed groundwater elevations show that seasonal variations in groundwater elevations observed at the Beaver Dam Mine Site are consistent with the seasonal variations in groundwater elevations observed at the Touquoy Mine Site, where dry conditions are also typically observed in August through September and the highest groundwater elevations are observed in November/December and in April. Similar seasonal variations in groundwater elevations are expected at the Beaver Dam and Touquoy Mine Sites since the two Site are located within 19 km of each other, within the same geologic formation, and in very similar hydrogeologic settings.

To represent the range in seasonal variations observed at the Beaver Dam Mine Site, three groundwater elevation target datasets were developed for model calibration, corresponding to average annual (base case) conditions, and then dry and wet conditions. Transducer elevation data were applied to develop the calibration target datasets. Where there was a gap in transducer elevation readings, manual measurements were applied to supplement the transducer data where

available. The base case calibration target dataset corresponds to the average observed groundwater elevations from June 12, 2018 through June 12, 2019, representing a complete year of groundwater elevation data collection. The dry condition calibration target dataset corresponds to the average of the groundwater elevations observed during the two week period from September 13, 2018 through September 26, 2018 when the lowest groundwater elevations occurred (i.e., dry conditions). Two periods of consistently high groundwater elevations (i.e., wet conditions) were observed: one period in early November; and another in late April. The wet condition calibration target dataset was selected as the average of the groundwater elevations observed during the two week period in early November (from November 1, 2018 through November 14, 2018), since average observed groundwater elevations were similar for both early November and late April, and corresponding surface water elevations were available for November but not for April.

In addition to the base case, dry, and wet condition average groundwater elevation calibration target datasets, the model calibration also was evaluated against estimated baseflow throughout the model domain. Estimated baseflow rates for Cameron Flowage described in Section 2.3.3.1 were scaled up to the model domain size of 7,816 ha. The total estimated baseflow for the entire model domain is 47,299 m^3/d.

The model calibration to the base case, dry, and wet condition average groundwater elevation calibration target datasets, as well as estimated baseflow, is presented in Section 6.3. The model calibration methodology is described in Section 6.2.

6.2 Calibration Methodology

The groundwater flow field throughout the model domain was simulated under steady-state conditions for each calibration target dataset. The solution to the groundwater flow equation was obtained using a numerical solver with specified convergence criteria. As described in Section 4.1, the NWT solver and the UPW package implemented in MODFLOW-NWT was used. The convergence criteria between successive solver iterations was specified as 0.001 m for the maximum hydraulic head change, and 100 m^3/d for the maximum flow residual throughout the model domain.

Model calibration was performed in an iterative manner by adjusting the hydraulic conductivity values per geologic unit, recharge rate, and the hydraulic conductivity of the streambed sediments for river cell boundary conditions. PEST was applied to aid the model calibration process as an automated means to optimize model input parameter values within reasonable or expected ranges.

Hydraulic conductivity values were held consistent between the model calibration to each of the base case, dry, and wet conditions. Recharge was independently reduced from the base case condition for the calibration to dry conditions and was independently increased from the base case condition the calibration to wet conditions. The river and drain boundary conditions within the model domain were varied to correspond with observed average surface water elevations during the base case, dry, and wet conditions. The recharge rate was decreased for the model calibration to dry conditions to reflect the lower volume of groundwater recharge occurring during dry conditions relative to the average annual base case condition. The recharge rate was increased for the model calibration to wet conditions to reflect the increase in groundwater recharge occurring during wet conditions relative to the average annual base case condition. Dry condition groundwater elevations

were approximately 0.95 m lower than the base case groundwater elevations, which supports reduced recharge for the dry condition relative to the base case condition. Wet condition groundwater elevations were 0.49 m higher than the base case groundwater elevations, which supports increased recharge for the wet condition relative to the base case condition.

The model calibration was evaluated both qualitatively and quantitatively. Qualitative evaluations included visually comparing the simulated versus observed groundwater elevations and groundwater flow directions, as well as the spatial distribution of calibration residuals, or error in matching the calibration targets. Calibration residuals are calculated as the observed groundwater elevation minus the simulated groundwater elevation at each calibration target location. A negative residual value indicates that the observed groundwater elevation is over-predicted, and a positive residual value indicates that the observed groundwater elevation is under-predicted. Focused areas of largely over- or under-predicted groundwater elevations would indicate spatial bias in the calibration results, and adjustments to model input parameters are made to minimize this bias.

The quantitative assessment of the calibration was conducted by examining the calibration residual statistics. Statistics such as the mean residual, absolute mean residual, sum of the residual values squared (referred to as the 'residual sum of squares'), and residual standard deviation, were calculated to quantify an overall measure of the discrepancy between observed and simulated groundwater elevations provided by the calibrated model. The objective of the model calibration is to minimize these residual statistics.

Another quantitative assessment of the calibration was conducted by comparing the difference between observed and simulated total baseflow for the model domain, with the goal of minimizing this difference.

A further quantitative measure of the calibration was provided by the simulated volumetric water budget reported by MODFLOW-NWT, indicating the quantities of flow into and out of the model domain via the groundwater flow components specified in the model. The volumetric budget was reviewed to ensure that the total inflows and outflows were consistent with the CSM, and to ensure that the discrepancy between simulated inflows and outflows is less than 1 percent, indicating that a satisfactory numerical convergence was obtained for the solution of the groundwater flow equation.

6.3 Groundwater Flow Model Calibration Results

The locations of all calibration targets are presented on Figure 2.4. The base case, dry, and wet condition calibration targets are listed in Tables 6.1, 6.2, and 6.3, respectively. Figures 6.1, 6.2, and 6.3 present simulated versus observed groundwater elevation contours in the overburden/shallow bedrock for the base case, dry, and wet conditions, respectively. Figures 6.1, 6.2, and 6.3 provide a qualitative evaluation of the model calibration and demonstrate that there is reasonably good agreement between the simulated and observed groundwater elevations and groundwater flow directions in the overburden.

Tables 6.1, 6.2, and 6.3 present the calibration residual at each target location for the base case, dry, and wet conditions, respectively. Scatter plots of observed versus simulated groundwater elevations are presented on Figures 6.4, 6.5, and 6.6 for the base case, dry, and wet conditions, respectively. Figures 6.4, 6.5, and 6.6 all show there is a reasonable distribution of plotted points above and below the line of exact match. This indicates that there is limited spatial bias in areas of

over- and under-predicted groundwater elevations throughout the monitoring well network for all three calibration cases. The residual values at each target location are presented on Figures 6.1, 6.2, and 6.3 and demonstrate that the over- and under-predictions of observed groundwater elevations have a reasonably random distribution throughout the Beaver Dam Mine Site and surrounding area. This further supports that there is limited spatial bias in areas of over- or under-predicted groundwater elevations, and particularly so when considering that the range in observed groundwater elevations varies between 33.99 m to 35.16 m across all three calibration conditions.

The residual statistics for the base case calibrated model are summarized on Figure 6.4. The calibrated model provides a residual mean of -0.13 m, an absolute residual mean of 0.78 m, a residual sum of squares of 83.42 m^2, and residual standard deviation of 1.30 m. These residual statistics were minimized during the model calibration process while maintaining a reasonable representation of observed groundwater flow directions. The residual statistics for the base case calibrated model are considered reasonably small. There are a limited number of target locations that are distant from the primary area of interest surrounding the proposed open pit mine that have relatively larger residual values (i.e., MW-21B and MW-21C). MW-21B and MW-21C are far removed from the area of interest, are located in an area of more coarse model cell discretization, and exhibit significant downward gradients relative to other monitoring locations likely because they are located in an area of steep topographic relief. Improving the match to MW-21B and MW-21C is not possible without deteriorating the overall match to observed groundwater elevations. Since these locations are distant from the primary area of interest (i.e., the proposed open pit mine), improving the match to observed groundwater elevations at these locations is not warranted.

The residual standard deviation for the base case calibrated model is only 3.7 percent of the range in the base case condition calibration target dataset, as indicated on Figure 6.4. Spitz and Moreno (1996) suggest that the residual standard deviation should be less than about 10 percent of the range in measured groundwater elevations used as calibration targets. The residual standard deviation for the calibrated model lies well below this metric. This result, combined with the residual mean and the absolute mean being less than 1.0 m, indicates that the base case calibrated model provides a reasonably good match to the measured groundwater elevations.

The residual statistics for the model calibration to dry and wet conditions are summarized on Figures 6.5 and 6.6, respectively. In general, the dry and wet condition residual statistics are similar to the base case calibration, which demonstrates that a good calibration was obtained to both the dry and wet condition calibration datasets.

The simulated baseflow for the base case condition is 49,226 m^3/d which is within approximately 4 percent of the estimated baseflow of 47,299 m^3/d for the model domain. This indicates that a good match was obtained to the estimated baseflow, which further supports that a reasonable model calibration was obtained.

The volumetric water budget for the calibrated model was examined for the model calibration to the base case, dry and wet conditions. A discrepancy of close to zero occurs in the water budget between the simulated inflow and outflows for all three cases, which demonstrates that good numerical convergence was achieved throughout the model domain for all three calibration datasets.

Table 6.4 presents the calibrated parameter values and the corresponding bounds applied during model calibration. In general, the bounds for hydraulic conductivity values were determined from the hydraulic conductivity values obtained from the slug tests and packer tests conducted at the Beaver Dam Mine Site (see Tables 2.1, 2.2, and 2.3). The recharge bounds were set based on the baseflow analysis presented in Section 2.3.4.1.

The overburden hydraulic conductivity assigned to the calibrated model in the vicinity of MW-12A is approximately one order of magnitude below the minimum observed overburden hydraulic conductivity of 6.1×10^{-7} m/s. The measured overburden hydraulic conductivity at MW-12A of 8.8×10^{-7} m/s is near the minimum measured overburden hydraulic conductivity, and is located in a silt-clay drumlin that is expected to have a lower hydraulic conductivity value relative to the surrounding quartzite till overburden. The reduced overburden hydraulic conductivity in the vicinity of MW-12A better reflects the groundwater mounding in the overburden observed at MW-12A. As shown in Table 6.4, the calibrated variable hydraulic conductivity distribution assigned to the overburden has an average value of 1.4×10^{-4} m/s, which is within the range of measured overburden hydraulic conductivity values.

As shown in Table 6.4, the calibrated hydraulic conductivity for the shallow bedrock ranges from 3.7×10^{-7} to 4.3×10^{-7} m/s across the different shallow bedrock hydraulic conductivity zones (i.e., argillite, greywacke, granite, Cameron Flowage Fault, and Mud Lake Fault). The calibrated hydraulic conductivity for all zones in the deep bedrock is 3.3×10^{-9} m/s (i.e., deep argillite, greywacke, granite, Cameron Flowage Fault, and Mud Lake Fault).

A horizontal to vertical hydraulic conductivity anisotropy ratio of 5:1 was applied in the overburden to represent horizontal stratification of the different soil types (clay, silty, sand and gravel/cobbles) that make up the overburden. A horizontal to vertical hydraulic conductivity anisotropy ratio of 1:1 was applied in bedrock to represent the relatively uniform vertical to horizontal hydraulic characteristics of the folded and fractured bedrock.

The calibrated hydraulic conductivity values are generally consistent with the measured hydraulic conductivity values obtained from slug tests and packer tests conducted at the Beaver Dam Mine Site. The calibrated hydraulic conductivity for the shallow bedrock tended towards a higher value (3.7×10^{-7} to 4.3×10^{-7} m/s), while the calibrated hydraulic conductivity for the deep bedrock tended towards a lower value (3.3×10^{-9} m/s), which is consistent with the CSM of reduced permeability with depth in the bedrock, as presented in Section 3. The calibrated hydraulic conductivity values in the shallow and deep bedrock do not vary significantly with rock type, which is consistent with packer test results that showed similar hydraulic conductivity values in argillite and greywacke, as well as within the Mud Lake Fault Zone.

For the base case, dry, and wet conditions, the calibrated recharge rates are 197, 230, and 255 mm/yr, respectively. The range in calibrated recharge rates for the base case, dry, and wet conditions is within the range of 77 to 377 mm/yr identified through the baseflow analysis presented in Section 2.3.4.1. The range in calibrated recharge rates also is consistent with regional recharge estimates of 220 to 260 mm/yr for the primary watershed containing the Beaver Dam Mine Site (Kennedy et al., 2010).

6.4 Calibrated Model Sensitivity Analysis

GHD conducted a sensitivity analysis of the calibrated model to evaluate the potential impact of parameter changes on the calibrated model results and to address uncertainties associated with the model input parameters. A total of 15 model input parameters were considered in the sensitivity analysis, including all of the model input parameters (i.e., boundary conditions and hydraulic properties) that were adjusted during model calibration.

A series of sensitivity simulations for base case, dry, and wet condition model calibration target sets were conducted for each model input parameter. Each input parameter value was adjusted while holding all other input parameter values the same as those specified in the calibrated model. The value of each parameter was adjusted by three gradations above and below the value specified in the calibrated model. In general, the input parameter values were adjusted based upon the range of parameter values specified for the PEST calibration simulations. For the overburden, the variable hydraulic conductivity distribution was adjusted uniformly by a specified hydraulic conductivity value such that the average overburden hydraulic conductivity value varied within the specified range in observed overburden hydraulic conductivity values.

A total of 90 sensitivity simulations were conducted; six for each of the 15 model input parameters. For each sensitivity simulation, the residual sum of squares (RSS) between the observed and simulated groundwater elevations was determined for the base case, dry, and wet conditions. The percent difference between the residual sum of squares for each sensitivity simulation and that of the calibrated model was calculated. Table 6.5 presents the adjustments that were made to each input parameter value in the sensitivity simulations. The resulting change in the residual sum of squares also is shown in Table 6.5. Of the 90 sensitivity simulations, only five provided an improvement in the residual sum of squares of greater than 1 percent across the base case, dry, and wet condition calibration target datasets. Two of these corresponded to a decrease in hydraulic conductivity for the deep greywacke unit, two corresponded to an increase in the deep granite hydraulic conductivity, and one corresponded to a decrease in the deep Mud Lake Fault hydraulic conductivity.

The sensitivity analysis changes to the deep greywacke and deep Mud Lake Fault hydraulic conductivity values were not incorporated into the calibrated model since a decrease in the hydraulic conductivity for those units would approach the lower bound of the observed range for those parameter values and doing so would not be conservative with respect to conducting predictive simulations for the development of the Beaver Dam Mine Site (i.e., reducing the hydraulic conductivity of the deep greywacke unit would reduce the lateral extent of groundwater drawdown, reduce changes in baseflow, and reduce COC mobility under mine development conditions).

The sensitivity analysis changes to the hydraulic conductivity of the deep granite unit also were not incorporated into the model since the net improvement in the RSS achieved by these changes would only result in improving the match to observed groundwater elevations at MW-21C, which as discussed in Section 6.3, is far removed from the area of interest. When MW-21C is excluded from the calibration target datasets, increasing the hydraulic conductivity of the deep granite unit increases the RSS for the each of base case, dry, and wet conditions by more than 5 percent. This result represents a less optimal calibration to the remaining calibration targets that more closely correspond to the area of interest for the Beaver Dam Mine Site.

The sensitivity analysis results demonstrate that the input parameter values applied in the calibrated model are at or near optimal to match all three calibration target datasets and/or provide a conservative bias with respect to conducting the predictive simulations for the development of the Beaver Dam Mine Site.

To further examine parameter sensitivity, GHD also applied PEST to calculate the composite sensitivity of each model input parameter with respect to all calibration targets. A higher sensitivity value indicates that a parameter is well defined by the model calibration targets while a lower sensitivity value indicates that a parameter is less well defined by the model calibration targets. Those parameters that are less well defined by model calibration targets require further evaluation were they have the potential to significantly impact predictive simulations for the development of the Beaver Dam Mine Site. Figure 6.7 presents the calculated composite sensitivity values for each input parameter adjusted during model calibration. Figure 6.7 illustrates that the recharge rates, the overburden hydraulic conductivity and the shallow greywacke hydraulic conductivity have the highest composite sensitivity values and are most well defined by model calibration targets. This is expected as the recharge rates control the amount of water available throughout the model domain and the majority of calibration targets are located within the overburden and shallow greywacke units. The input parameters with lower composite sensitivity values, most specifically the hydraulic conductivity values for the Mud Lake and Cameron Flowage Fault Zones, may have some potential to impact predictive simulations for the development of the Beaver Dam Mine Site. This is evaluated through conducting additional sensitivity analysis of the predictive simulations that incorporate variations in these parameter values from that applied in the calibrated model, as discussed in Section 7.5.

7. Groundwater Flow Model Application

As described in Section 1.1, the primary objectives of this modelling effort include simulating the predictive scenarios to estimate the following:

1. Groundwater inflow rates into the open pit mine at EOM
2. Groundwater drawdown at EOM and PC
3. Pit infilling rates following EOM
4. Change in groundwater discharge to/from surface water features at EOM and PC
5. Transport of COCs from mine features into the surrounding environment at EOM and PC

GHD implemented the EOM and PC scenarios in the calibrated model to simulate potential impacts of the Beaver Dam Mine Site development. Where appropriate, predictive simulation results are compared against spatial boundaries and regulatory guidelines to assess the extent and significance of potential impacts. The implementation of the EOM and PC scenarios in the calibrated groundwater flow model is described in Section 7.1. Sections 7.2 and 7.3 present the definition of spatial boundaries and applied regulatory criteria, respectively, to assess the potential impacts of the EOM and PC scenarios. The predictive simulation results are summarized in Section 7.4.

7.1 Scenario Implementation

7.1.1 Estimation of Groundwater Inflow Rates at EOM

EOM was simulated through the incorporation of the proposed open pit mine and surface water management ditches into the calibrated models for the base case, dry, and wet conditions. The surface water management ditches were incorporated by specifying drain boundary conditions corresponding to the proposed ditch locations and dimensions, as discussed in Section 5.2.4. The open pit mine was represented by specifying drain cells along the perimeter of the proposed open pit mine. Internal model cells within the proposed open pit mine are set to no-flow boundaries. The stage elevation of the drain cells was set based on the proposed pit floor elevations provided by AMNS. As discussed in Section 5.2.4, a high conductance value of 1,000 m^2/d was assigned to the drain cells such that water entering a drain cell would discharge to the open pit without resistance (when the groundwater elevation is above the drain stage elevation). The simulated volumetric flow of water entering the pit drain cells was summed over the entire pit to estimate the total groundwater inflow rate into the pit at EOM under the base case, dry, and wet conditions.

7.1.2 Estimation of Drawdown at EOM and PC

Simulated drawdown was estimated through comparing simulated groundwater elevation contours under the calibrated base case, dry, and wet conditions against those simulated under each condition at EOM and PC. To estimate drawdown for each condition, simulated groundwater elevation contours at EOM or PC were subtracted from simulated groundwater elevation contours for the calibrated model (i.e., to estimate drawdown under dry conditions, EOM groundwater elevation contours under dry conditions were subtracted from groundwater elevation contours for the dry condition calibrated model). The extent of drawdown was compared against the project area (PA), local assessment area (LAA), and regional assessment area (RAA) boundaries shown on Figure 1.1, and also against the Property Boundary shown on Figure 7.1a.

7.1.3 Pit Infilling Rate

The pit infilling rate was developed by calculating the groundwater inflow rate at specific stage elevations as the proposed open pit mine fills with water following EOM and fills towards the PC pit lake level. The groundwater inflow rate was calculated in a 10 m increment from an initial stage elevation of -30 m AMSL (approximately 15 m above the proposed open pit mine floor) to a final pit lake elevation of 127 m AMSL (GHD, 2021a). As pit infilling progressed, drain cells with stage elevations below the specified pit lake stage elevation were converted to GHB cells to allow either groundwater discharge to the pit or groundwater recharge from the pit. Drain cells located above the specified pit lake stage elevation remained unchanged from the EOM condition so that simulation of only groundwater discharge to the pit would continue at these drain cells. The stage elevation of the GHB cells was set to the specified pit lake stage elevation. As discussed in Section 5.2.5, the conductance of the GHB cells was set to a high value of 1,000 m^2/d to ensure that any groundwater entering the GHB cells would interact freely (i.e., without resistance) with the pit lake.

Calculated groundwater inflow rates were incorporated into the Beaver Dam Mine Site water balance analysis (GHD, 2021b) to predict the pit infilling time.

7.1.4 Simulated Change in Baseflow

GHD applied the numerical groundwater flow model to evaluate potential changes in baseflow that may occur at the Beaver Dam Mine Site under EOM and PC conditions. The simulated baseflow was calculated through a mass balance of river and drain boundary conditions within the model domain (i.e., baseflow is equal to the simulated groundwater recharge from surface water features minus groundwater discharge to surface water features). The simulated baseflow at EOM is subtracted from the simulated baseflow for the calibrated model to estimate the potential change in baseflow. The potential change in baseflow is also estimated at PC. The change in baseflow is calculated under base case, dry, and wet conditions to estimate a potential range in baseflow changes moving from the current conditions (i.e., the calibrated model), to EOM conditions, and then to PC conditions. The potential change in baseflow is compared to the estimated total flow and estimated baseflow in Cameron Flowage.

7.1.5 COC Transport

The development of the Beaver Dam Mine Site has the potential to degrade groundwater and surface water quality within and surrounding the PA. Water that may have associated COC concentrations and could migrate into the surrounding environment includes:

- Water released from the open pit lake
- Water that migrates through the topsoil stockpiles, till stockpiles, and low-grade ore (LGO) stockpile
- Water that migrates through the non-acid generating (NAG) and potentially acid generating (PAG) waste rock stockpiles

Figure 7.1a shows the location of the open pit lake and the stockpiles. GHD developed a contaminant transport model to simulate the potential migration of COCs from these locations at EOM and PC.

A geosynthetic cover is proposed for the PAG waste rock stockpile to reduce precipitation infiltration into the PAG waste rock stockpile during PC. The geosynthetic cover will reduce the volume of seepage from the PAG waste rock stockpile that could recharge groundwater thereby reducing the potential COC mass loading to groundwater. The geosynthetic cover will be designed to reduce infiltration into the stockpile to under 3% of average annual precipitation. Therefore, the PAG waste rock stockpile cover is represented in the PC scenarios through specifying a recharge rate over the stockpile equal to 3% of average annual precipitation.

Three naturally occurring transport mechanism zones were specified, including the overburden, shallow bedrock, and deep bedrock. The transport mechanism zones reflect the difference in transport processes that occur within each zone, such as different effective porosities within each zone. Effective porosity values of 0.15, 0.1, and 0.02 were assigned to the overburden, shallow bedrock, and deep bedrock, respectively.

The COCs are treated as a conservative tracer using a constant unit concentration specified within each source zone. Sorption/retardation and reactions along the groundwater flow path, which may reduce COC concentrations, are assumed to be negligible and therefore were not simulated. This is conservative with respect to simulating potential COC migration. The COC transport mechanisms

implemented in each zone include advection and dispersion only, which are discussed in Sections 7.1.5.1 and 7.1.5.2, respectively.

COC migration was simulated using MT3DMS-USGS. For each potential source zone that may have a unique source concentration (i.e., full pit lake, topsoil stockpiles, till stockpiles, LGO stockpile, and NAG and PAG waste rock stockpiles), an independent transport simulation was conducted. The source concentrations for each source zone were obtained from Lorax Environmental (2021) for EOM and PC conditions and are presented in Table 7.1. The total simulation duration for each scenario was selected based on the duration that potential source will be present, and to provide a conservative bias with respect to the simulated concentration at receptor locations. The duration for which each potential source is simulated to be active is described below:

- The LGO stockpile, and the till and topsoil stockpile source terms are simulated to be active for 10 years. The LGO stockpile will be removed from the Site after approximately 4 years, once the mining operation is complete. The topsoil and till stockpiles will be used in reclamation and also will be removed after approximately 4 years, once the mining operation is complete. Assuming a 10-year source duration provides a conservative bias with respect to simulating potential COC migration from the LGO stockpile, and the topsoil and till stockpiles.
- The transition from EOM to the onset of slightly acidic drainage and corresponding PC source terms will take at least 20 years (Lorax Environmental, 2018). Therefore, sources that are not removed at the end of the mine operation (i.e., the NAG and PAG stockpiles) are simulated for 50 years to provide a conservative bias with respect to the extent of the simulated COC concentration distribution and COC concentrations simulated at potential receptors (i.e., the nearby surface water features).
- The PC sources are simulated for 500-years to approximate steady-state conditions and provide a conservative estimate of potential long-term impacts relative to the maximum extent of the simulated COC concentration distributions and maximum COC concentrations simulated at potential receptors.

The concentration at each model cell simulated to migrate from the unit concentration specified at the source locations was multiplied by the source concentration associated with each potential source. Then, using the principle of superposition[5], the concentrations were summed across the transport simulations for all sources (i.e., full pit lake, topsoil stockpiles, till stockpiles, LGO stockpile, and NAG and PAG waste rock stockpiles) to estimate the total predicted COC concentrations throughout the model domain. The COC mass loading to each surface water feature was determined by multiplying the predicted COC concentrations in each model cell representing the surface water features by the groundwater discharge simulated to those model cells.

[5] The principle of superposition states that for a linear problem (i.e., the 3D contaminant transport equation), the net response cause by two or more stimuli (e.g., contaminant sources) is the sum of the responses that are caused by each stimuli individually. Therefore, each source zone can be simulated independently and summed together to estimate the total combined impact of all sources at a given receptor.

7.1.5.1 Advection

Advection, the bulk movement of a fluid through a geologic medium, is the primary transport mechanism at the Beaver Dam Mine Site. The advection mechanism is governed by Darcy's Law, which determines the groundwater flow velocity, accounting for the hydrogeologic characteristics (hydraulic gradients, hydraulic conductivity, and porosity), of the aquifer. Groundwater flow conditions simulated by MODFLOW-NWT represent advection throughout the entire model domain. MT3DMS-USGS uses the groundwater flow field simulated by MODFLOW-NWT as input for solving the advection-dispersion transport equation.

7.1.5.2 Dispersion

Dispersion is a transport mechanism by which a solute spreads along the groundwater flow path. Dispersion results from two basic processes: molecular diffusion; and mechanical mixing. Molecular diffusion is a process where solutes move from zones of higher concentrations to zones of lower concentrations. The driving force of this movement is kinetic activity at the molecular level. Mechanical dispersion occurs due to the variability (i.e., heterogeneity) in pore-space groundwater velocities that act to spread or mix a solute in an aquifer. The primary aquifer characteristics that cause this mixing are variable frictional forces in pore channels, variations in pore channel geometry, and pore channel branching.

Dispersion/spreading of solutes during groundwater flow results in dilution of solute pulses and attenuation of concentration peaks. This dilution/attention affect is accounted for in the transport equation by applying longitudinal, transverse, and vertical dispersivity coefficients in a 3D domain.

Obtaining field measurements of the dispersivity is impracticable. However, simple estimate techniques, based on the length of plume or distance to the measured point ("scale"), are available by compiling field data. It is noted that researchers indicate dispersivity values can range over two to three orders of magnitude for a given value of plume length or distance to a measurement point (Gelhar et al., 1992). Empirical relationships of dispersivity versus plume length (L_P) are provided by Al-Suwaiyan (1996) and Xu and Eckstein (1995), as follows:

$$\alpha_L = 0.82(\log_{10}(L_P))^{2.446}$$

Where:

α_L = is the longitudinal dispersivity in m

L_P = is the estimated plume length (m)

The plume length or scale is assumed to be 900 m, roughly corresponding to the maximum distance from a potential source zone (i.e., the waste rock piles) to a potential groundwater receptor (i.e., Mud Lake). Using an assumed plume length of 900 m, an estimated longitudinal dispersivity value of 11.6 m was calculated. The horizontal transverse dispersivity was specified to be 1/10 of the longitudinal dispersivity and the vertical transverse dispersivity was assumed to be 1/100 of the longitudinal dispersivity, as suggested by Gelhar et al. (1992) and Spitz and Moreno (1996).

7.1.6 Particle Tracking

GHD applied particle tracking methods as a means to evaluate the effectiveness of potential mitigation measures at providing hydraulic containment of COCs. Particle tracking is a conservative means to delineate hydraulic containment and potential migration in groundwater because it reflects only advective migration processes. Particle tracking does not account for attenuation mechanisms, such as degradation, adsorption/precipitation, and dispersion that serve to slow and reduce COC concentrations as migration occurs in groundwater. Particle tracking using MODPATH is significantly more computationally efficient than contaminant transport using MT3D-USGS for the specific purpose of evaluating hydraulic containment and was therefore selected to evaluate potential mitigation measures.

7.2 Spatial Boundaries

The spatial boundaries considered in the evaluation of potential groundwater impacts resulting from the Beaver Dam Mine Site development are the PA, LAA, RAA, and Property Boundary. The Property Boundary is the compliance point with respect to potential groundwater impacts. The PA, LAA, and RAA boundaries are presented on Figure 1.1, and the Property Boundary is presented on Figure 7.1a. The PA encompasses the proposed Beaver Dam Mine Site features including the open pit, LGO stockpile, NAG/PAG waste rock stockpiles, and Haul Road. The LAA encompasses an 800 m buffer from the PA, as required by the Province of Nova Scotia with respect to blasting for mining and construction projects. The RAA aims to account for the maximum extent of potential groundwater quality and quantity impacts and roughly corresponds to the extent of the groundwater flow model domain.

7.3 Regulatory Guidelines

Potential groundwater quality impacts should be compared against appropriate groundwater quality guidelines. While there are no potable groundwater uses at the Beaver Dam Mine Site, a portion of the Beaver Dam Mine Site is located on Crown land and potentially could be considered potable in the future. Therefore, simulated COC concentrations are compared against the Nova Scotia Environment (NSE) Tier 1 Environmental Quality Standards (EQS) for potable course grained soil for agricultural/residential use and maximum acceptable concentrations (MAC) specified under the Guidelines for Canadian Drinking Water Quality (GCDWQ). It is recognized that some COCs, including arsenic and manganese, are naturally present in groundwater at concentrations that exceed NSE Tier 1 EQS or MACs specified under the GCDWQ.

The impact to surface water quality that potentially could result from developing the open pit mine is assessed through the an evaluation of predicted groundwater COC concentrations relative to Tier 2 Pathway Specific Standard for groundwater discharge to surface water (Tier 2 PSS) and through the Predictive Water Quality Assessment for the Beaver Dam Mine Site (GHD, 2021a). The evaluation of predicted groundwater COC concentrations relative to Tier 2 PSS provides an indication of areas where groundwater COC concentrations may impact surface water bodies while the Predicted Water Quality Assessment (GHD, 2021a) evaluates the potential significance of that impact at compliance points. Simulated loadings of COCs from groundwater to surface water are combined with predicted surface water runoff from the Site to estimate surface water COC concentrations at compliance points as discussed in GHD (2021a). Predicted surface water quality is compared against Metal and

Diamond Mining Effluent Regulations (MDMER), Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Aquatic Life, and Site-Specific Water Quality Guidelines.

7.4 Scenario Simulation Results

7.4.1 Simulated Groundwater Inflow Rates at EOM

Steady-state groundwater inflow rates into the open pit were simulated under base case, dry, and wet conditions at EOM. The simulated volumetric flow from the pit drain cells was summed over the entire open pit to estimate the range of potential groundwater inflow rates into the open pit (presented in Table 7.2). The steady-state simulated pit groundwater inflow rates range from 531 m^3/d under dry conditions to 655 m^3/d under wet conditions. The simulated pit groundwater inflow range is consistent with the range of estimated groundwater inflow rates from 550 to 1,450 m^3/d presented in PCA (2015).

7.4.2 Simulated Drawdown

Figures 7.1a/b, 7.2a/b, and 7.3a/b show plan view simulated drawdown for EOM/PC under base case, dry, and wet conditions, respectively. Figures 7.4a/b, 7.5a/b, and 7.6a/b show simulated drawdown through a cross-section of the proposed open pit for EOM/PC under base case, dry, and wet conditions, respectively. As shown on Figure 7.3a, the greatest extent of drawdown is simulated under wet conditions at EOM. A maximum drawdown of approximately 0.5 m is simulated adjacent to Cameron Flowage within the PA, as shown on Figure 7.2a. Maximum simulated drawdown at EOM is generally less than 10 cm outside of the PA, with the exception of the area between the till stockpiles and Cameron Flowage where the maximum drawdown reaches approximately 1 m. Simulated drawdown is negligible beyond the LAA. Figures 7.1b, 7.2b, 7.3b, 7.4b, 7.5b, and 7.6b show that simulated drawdown decreases at PC relative to EOM for all conditions.

7.4.3 Estimated Pit Infilling Rate

Based on the simulation results, the estimated groundwater inflow rate into the open pit at each stage is presented in Table 7.3. GHD (2021b) combines the estimated groundwater inflow rates into the open pit with precipitation/evaporation, pit wall runoff, and surface water ditch inflow to estimate the pit infilling time based on all inflows to the pit. The estimated pit infilling time considering all inflows is 13 years, as presented in GHD (2021b).

7.4.4 Simulated Change in Baseflow

GHD applied the calibrated groundwater flow model to simulate potential changes in baseflow that may occur at the Beaver Dam Mine Site under EOM and PC conditions. The simulated within the overall groundwater flow model domain and to simulated watercourses is presented in Table 7.4. The simulated baseflow reduction over the entire groundwater flow model domain ranges from 677 to 754 m^3/d at EOM and from 446 to 620 m^3/d at PC, representing 2 to 3 percent of the total baseflow contribution to the Cameron Flowage watershed, and less than 1 percent of the total estimated average annual flow in Cameron Flowage as presented in Section 2.3.3.1.

The calibrated groundwater flow model was also used to simulate changes in baseflow within the field delineated watercourses under EOM and PC conditions. For average conditions, baseflow

contribution to Cameron Flowage, adjacent to the proposed open pit, is simulated to decrease by an average of 41 percent relative to baseline conditions at EOM and 22 percent at PC. Baseflow within the Killag River downstream of Cameron Flowage is simulated to decrease by an average of 2 percent relative to baseline conditions at both EOM and PC. Baseflow within the Crusher Lake area is simulated to increase slightly by 1 and 2 percent relative to baseline conditions at EOM and PC, respectively. Baseflow in Mud Lake is simulated to decrease by 45 percent relative to baseline at EOM and by 39 percent at PC. Base contribution to WC2 is predicted to decrease by 8 and 28 percent under EOM and PC, respectively. Baseflow in WC3 is simulated to decrease by 16 percent relative to baseline conditions at EOM and by 19 percent at PC. Baseflow contribution to WC5 is simulated to decrease by 5 percent relative to baseline conditions at EOM and by 2 percent at PC. Baseflow in WC19 and WC27 are simulated to change by less than 2 percent relative to baseline conditions at both EOM and PC.

Under low-flow conditions, corresponding to August 16 through 29, 2019, the estimated baseflow contribution to Cameron Flowage is 335 m^3/d. Through applying the simulated reduction in baseflow of 42 percent and 24 percent, corresponding to EOM and PC, respectively, the potential change in total flow can be estimated. By reducing the baseflow contribution to Cameron Flowage by 42 percent and 24 percent, it is estimated that the total flow within Cameron Flowage during low-flow conditions will decrease by approximately 4 percent and 2 percent under EOM and PC conditions, respectively.

To mitigate potential impacts to flow within Cameron Flowage, during mine operations, all groundwater discharge to the open pit mine and to the surface water management ditches will be managed and ultimately discharged to back into Cameron Flowage. Once the pit lake has reached 127 m AMSL the pit will naturally discharge to Cameron Flowage. Therefore, no reduction in total flow is expected during mine operation or once the pit has filled.

Of the total simulated baseflow reduction, approximately 50 to 60 percent of the total baseflow reduction is simulated to occur within the Property Boundary and the remaining 40 to 50 percent of total baseflow reduction is simulated to occur between the Property Boundary and the LAA indicating that mine operations will not impact the baseflow beyond LAA. Within the LAA approximately 40 to 75 percent of the baseflow reduction is simulated to occur within Cameron Flowage.

7.4.5 Simulated COC Transport

GHD conducted COC transport simulations to estimate the extent and significance of potential COC impacts to groundwater and surface water. The potential COC impacts to groundwater are assessed through comparing predicted COC concentrations in groundwater against the lower of the Tier 1 EQS for potable groundwater or GCDWQ, hereafter referred to as the ′Potable Criteria′. Predicted COC concentration distributions are presented for COCs that are simulated to exceed the Potable Criteria. For these COCs, the extent of the simulated exceedance is compared to the spatial boundaries described in Section 7.2.

The potential COC impacts to surface water are assessed through comparing predicted COC concentrations in groundwater against Tier 2 PSS and through developing simulated groundwater COC mass loadings to surface water for all COCs. The simulated groundwater COC mass loadings to surface water are provided as inputs into the Predictive Water Quality Assessment (GHD, 2021a).

Within GHD (2021a), the groundwater COC mass loadings are combined with COC mass loadings from surface water runoff to assess the combined potential impact of surface water and groundwater discharge from the Beaver Dan Mine Site on Killag River surface water quality.

Figures 7.7 through 7.13 present the simulated COC exceedances of the Potable Criteria for the base case and upper case source terms under base case conditions for EOM, as follows:

- Arsenic (Figures 7.7 and 7.8) is predicted to exceed its Potable Criteria in the vicinity of the NAG and PAG waste rock stockpiles for both the base case and upper case source terms, and in the vicinity of the topsoil stockpiles for the upper case source term. The simulated arsenic Potable Criteria exceedances occur within the Property Boundary, except small isolated areas north of the NAG waste rock stockpile and the topsoil stockpile south of Mud Lake. As discussed in Lorax Environmental (2021), the simulated arsenic exceedance is expected to be temporary since arsenic concentrations will decrease as EOM source terms transition to the PC source terms. It should be noted that arsenic is naturally occurring in groundwater at the Beaver Dam Mine Site and is found at concentrations above the Potable Criteria under baseline conditions. Therefore, the potential release of arsenic at concentrations above its Potable Criteria does not represent a significant reduction in the beneficial use of groundwater at the Beaver Dam Mine Site, since groundwater requires treatment for arsenic to meet its Potable Criteria under baseline conditions.
- Manganese (Figure 7.9) is predicted to exceed its Potable Criteria at the till stockpiles for the upper case source term. The simulated manganese Potable Criteria exceedance is located within the Property Boundary and the exceedance is expected to be temporary since the till stockpiles are to be removed during reclamation of the Beaver Dam Mine Site.
- Nitrate (Figures 7.10 and 7.11) is predicted to exceed its Potable Criteria in the vicinity of the NAG waste rock stockpile for both the base case and upper case source terms. The simulated nitrate Potable Criteria exceedance is located within the Property Boundary. Furthermore, nitrate concentrations will decrease as nitrate is leeched from and depleted within NAG waste rock stockpile. Nitrate concentrations are predicted to decrease from the maximum simulated concentrations shown on Figures 7.10 and 7.11 to below the Potable Criteria within approximately 10 years and 25 years for base case and upper case source terms, respectively.
- Uranium (Figures 7.12 and 7.13) is predicted to exceed its Potable Criteria in the vicinity of the NAG waste rock stockpile for both the base case and upper case source terms, and in vicinity of the PAG waste rock stockpile for the upper case source term. The simulated uranium Potable Criteria exceedance is located within the Property Boundary. As discussed in Lorax Environmental (2021), the simulated uranium exceedance is expected to be temporary since uranium concentrations will decrease as EOM source terms transition to the PC source terms.

Figures 7.14 through 7.28 present the simulated COC exceedances of the Potable Criteria for base case and upper case source terms under base case conditions for PC, as follows:

- Arsenic (Figure 7.14), cadmium (Figure 7.16), cobalt (Figure 7.18), manganese (Figure 7.20), nickel (Figure 7.22), lead (Figure 7.24), and uranium (Figure 7.26) are predicted to exceed the Potable Criteria in the vicinity of the PAG waste rock stockpile for the base case source term. The predicted exceedances of the Potable Criteria all occur within the Property Boundary.

- Arsenic (Figure 7.15), cadmium (Figure 7.17), cobalt (Figure 7.19), manganese (Figure 7.21), nickel (Figure 7.23), lead (Figure 7.25), uranium (Figure 7.27), and zinc (Figure 7.28) are predicted to exceed the Potable Criteria in the vicinity of the PAG waste rock stockpile for the upper case source term. In all cases the pit lake contains the majority of COCs migrating from the PAG waste rock stockpile, and no predicted exceedances of the Potable Criteria occur beyond the Property Boundary.

Simulated COC exceedances of the Potable Criteria for the base case and upper case source terms for EOM and PC under dry conditions are presented on Figures D.1 to D.22 of Appendix D. Simulated COC exceedances of the Potable Criteria for the base case and upper case source terms for EOM and PC under wet conditions are presented on Figures E.1 to E.22 of Appendix E. The Appendix D and E figures show that simulated COC exceedances of the Potable Criteria in groundwater do not change significantly from that predicted under base case conditions.

Figures 7.29 through 7.32 present the simulated COC exceedances of the Tier 2 PSS for the base case and upper case source terms under base case conditions for EOM, as follows:

- Aluminum (Figure 7.29 and Figure 7.30) is predicted to exceed its Tier 2 PSS in the vicinity of the topsoil stockpiles for both the base case and upper case source terms. The predicted exceedance is within the Property Boundary for the base case source terms (Figure 7.29) and extends slightly beyond the Property Boundary for the upper case source terms (Figure 7.30).
- Arsenic (Figure 7.31) and Cadmium (Figure 7.32) are predicted to exceed the Tier 2 PSS in the vicinity of the topsoil stockpiles for the upper case source term. The predicted exceedance is within the Property Boundary for both Arsenic and Cadmium.

Figures 7.33 through 7.47 present simulated COC exceedances of the Tier 2 PSS for base case and upper case source terms under base case conditions for PC, as follows:

- Aluminum (Figure 7.33), cobalt (Figure 7.37), iron (Figure 7.40), nickel (Figure 7.42), lead (Figure 7.44), and zinc (Figure 7.46) are predicted to exceed the Tier 2 PSS in the vicinity of the PAG waste rock stockpile for the base case source terms. The predicted exceedances do not reach nearby surface water features and are within the Property Boundary.
- Cadmium (Figure 7.35) is predicted to exceed the Tier 2 PSS in the vicinity of the PAG waste rock stockpile for the base case source terms. The simulated exceedances encroach on the Property Boundary and/or reach surface water features (either Cameron Flowage to the northwest of the PAG waste rock stockpile or mapped streams to the west of the PAG waste rock stockpile).
- Aluminum (Figure 7.34), cobalt (Figure 7.38), copper (Figure 7.39), iron (Figure 7.41), and zinc (Figure 7.47) are predicted to exceed the Tier 2 PSS in the vicinity of the PAG waste rock stockpile for the upper case source terms. The predicted exceedances do not reach the nearby surface water features and are within the Property Boundary.
- Cadmium (Figure 7.36), nickel (Figure 7.43), and lead (Figure 7.45) are predicted to exceed the Tier 2 PSS in the vicinity of the PAG waste rock stockpile for the upper case source terms. The simulated exceedances encroach on the Property Boundary and/or reach surface water features (either Cameron Flowage to the northwest of the PAG waste rock stockpile or mapped streams to the west of the PAG waste rock stockpile).

Simulated COC exceedances of Tier 2 PSS for the base case and upper case source terms for EOM and PC under dry conditions are presented on Figures F.1 to F.19 of Appendix F. Simulated COC exceedances of Tier 2 PSS for the base case and upper case source terms for EOM and PC under wet conditions are presented on Figures G.1 to G.19 of Appendix G. The Appendix F and G figures show that simulated COC exceedances of the Tier 2 PSS in groundwater do not change significantly from that predicted under base case conditions.

To further evaluate the potential risk to surface water features as a result of predicted Tier 2 PSS exceedances, GHD incorporated the simulated COC mass loading to surface water features into the Predictive Water Quality Assessment (GHD, 2021a) to predict COC concentrations in surface water features. The total simulated mass loading for each COC from groundwater discharge to surface water within the Killag River watershed is presented in Table 7.5 for EOM and PC for both the base case and upper case source terms. The predicted COC concentrations in surface water are compared to CCME Guidelines for the Protection of Aquatic Life at the near-field and far-field locations within the Killag River/Cameron Flowage. The Predictive Water Quality Assessment (GHD, 2021a) addresses any potential need for treatment of the effluent water prior to discharge into the Killag River such that the combined groundwater and surface water discharge into the Killag River will meet CCME Guidelines for the Protection of Aquatic Life. However, potential localized impacts to surface water features located to the west of the PAG waste rock stockpile may not be addressed. Therefore, GHD evaluated the effectiveness of potential mitigation measures that could be applied to address the potential migration of COCs to the west of the PAG waste rock stockpile should groundwater quality monitoring indicate that there may be potential exceedances of Tier 2 PSS. The evaluation of potential mitigation measures for groundwater migration west of the PAG waste rock stockpile is presented in Section 7.6.

It is also recognized that potential uncertainty in the quality or quantity of PAG waste rock deposited in the PAG waste rock stockpile could impact potential COC concentrations. Therefore, monitoring of the PAG waste rock material deposited in the PAG waste rock pile will be addressed through the Geochemical Characterization Management Plan. A contingency of in-pit disposal will be maintained throughout operation should the Geochemical Characterization Management Plan identify that the quality or quantity of PAG may exceed prediction.

7.5 Scenario Simulation Sensitivity Analysis

7.5.1 Pit Inflow Rate Sensitivity Analysis

GHD conducted a sensitivity analysis on simulated pit inflow rates under wet conditions to assess the sensitivity of the simulated pit inflow rates from changes to the input parameter values applied in the calibrated groundwater flow model. The sensitivity analysis included changes to the following parameters:

- Pit Conductance
- Mud Lake Fault Hydraulic Conductivity
- Cameron Flowage Fault Hydraulic Conductivity
- Deep Argillite Hydraulic Conductivity
- Deep Greywacke Hydraulic Conductivity

- Shallow Argillite Hydraulic Conductivity
- Shallow Greywacke Hydraulic Conductivity

The predicted pit inflow for sensitivity analysis simulation is presented in Table 7.6. As shown in Table 7.6, the simulated pit inflow rates for the sensitivity analysis range from 655 to 1,835 m^3/d. However, the maximum inflow rate of 1,835 m^3/d corresponds to a 661 percent increase in the RSS for the calibrated groundwater flow model under wet conditions, and therefore, is not supported by observed groundwater elevations. Thus, excluding the inflow rate of 1,835 m^3/d, the expected range in simulated pit inflow rates obtained through the sensitivity analysis is from 655 to 829 m^3/d, which compares well with the estimated range in pit inflow rates of 550 to 1,450 m^3/d presented in PCA (2015).

7.5.2 COC Transport Sensitivity Analysis

A sensitivity analysis of the simulated COC concentrations was conducted in accordance with British Columbia Ministry of the Environment Guidelines (Wels et al., 2012). As described by Wels et al. (2012), there are four types of uncertainty/sensitivity:

- Type 1: Modification of this parameter within a reasonable bound has an insignificant impact on both model calibration residuals and predictive simulation results
- Type 2: Modification of this parameter within a reasonable bound has a significant impact on model calibration residuals, but has an insignificant impact on predictive simulations results
- Type 3: Modification of this parameter within a reasonable bound has a significant impact on model calibration residuals and predictive simulation results
- Type 4: Modification of this parameter within a reasonable bound has an insignificant impact on model calibration residuals, but a significant impact on predictive simulations results

Type 1 and 2 sensitivities are not of concern for predictive simulations as their impact on the predictive simulation results are insignificant. Type 3 is only of concern for an uncalibrated model and while important has been addressed through model calibration and model calibration sensitivity analysis. Type 4 is of potential cause for concern because a non-uniqueness in a model input might allow a range of valid calibrations which could have significant impact on model predictions. A non-unique model calibration can occur when model calibration residuals are insensitive to changes in a given parameter value. Therefore, in addition to testing an increase in hydraulic conductivity values for the Mud Lake Fault Zone and Cameron Flowage Fault Zone, where the model calibration sensitivity analysis identified parameters which did not significantly impact model calibration residuals, changes to those parameters were further evaluated through COC transport sensitivity analysis.

The parameter changes considered in the COC transport sensitivity analysis of COC loadings to the Killag watershed are:

- Sens 1 – Shallow Cameron Flowage Fault Zone conductivity increase by 1 order of magnitude
- Sens 2 – Shallow Cameron Flowage Fault Zone conductivity increase by 2 orders of magnitude
- Sens 3 – Deep Cameron Flowage Fault Zone conductivity increase by 1 order of magnitude

- Sens 4 – Deep Cameron Flowage Fault Zone conductivity increase by 2 orders of magnitude
- Sens 5 – Shallow Mud Lake Fault Zone conductivity increase by 1 order of magnitude
- Sens 6 – Shallow Mud Lake Fault Zone conductivity increase by 2 orders of magnitude
- Sens 7 – Deep Mud Lake Fault Zone conductivity increase by 1 order of magnitude
- Sens 8 – Deep Mud Lake Fault Zone conductivity increase by 2 orders of magnitude
- Sens 9 – Deep greywacke unit conductivity set to 0.0001016 m/d
- Sens 10 – Deep greywacke unit conductivity set to 0.0000086 m/d
- Sens 11 – Deep granite unit conductivity set to 0.1095 m/d
- Sens 12 – Deep granite unit conductivity set to 0.0549 m/d
- Sens 13 – Deep Mud Lake Fault Zone conductivity set to 0.0000086 m/d

Tables 7.7 and 7.8 present the percent change in simulated COC loadings to surface water from groundwater for EOM and PC, respectively. As shown in Tables 7.7 and 7.8, the change in simulated COC mass loading identified through the sensitivity analysis ranged from a 1% increase to a 32% decrease for EOM, and from an 11% increase to a 17% decrease for PC. To determine the impact of the potential change in loading on predicted concentrations within the Killag River, the scenarios that resulted in the maximum increase in loading were carried through to the Predictive Water Quality Assessment (GHD, 2021a). The Predictive Water Quality Assessment showed that the potential changes in COC loading identified through the transport sensitivity analysis would result in a 0 to 2% change in the predicted COC concentrations within the Killag River and no additional exceedances of CCME surface water quality guidelines beyond that already identified for PC upper case source terms (GHD, 2021a). Therefore, the sensitivity analysis of the simulated COC loadings to surface water does not identify any additional significant impacts to the Killag River.

Since the sensitivity analysis was complete, minor modifications were proposed to the topsoil stockpile layout, and the extent of the till stockpiles. While these modifications were incorporated into the predictive simulation results as they can impact the potential extent of simulated COC impacts it is not necessary to revise the sensitivity analysis since the sensitivity analysis is not significantly impacted by minor modifications to the proposed infrastructure layout. Rather, the results of the sensitivity analysis are drive by the parameter changes considered, which are independent of the infrastructure layout considered.

7.6 Simulation of Potential Mitigation Measures

GHD conducted a particle tracking analysis to evaluate the effectiveness of potential mitigation measures to provide hydraulic containment of COCs predicted to migrate west from the PAG waste rock pile towards surface water features. Figures 7.48, 7.49 and 7.50 present simulated particle pathways for COC migration from the PAG waste rock stockpile under base case, dry, and wet conditions, respectively. Figures 7.51 through 7.53 show that COCs are predicted to migrate towards surface water features west of the PAG waste rock stockpile. Therefore, a potential mitigation measure is evaluated to mitigate simulated COC migration west of the PAG waste rock stockpile.

Due to the low permeability overburden and bedrock at the Beaver Dam Mine Site, groundwater extraction wells are not feasible for providing hydraulic containment of COC migration westward from PAG waste rock stockpile. Therefore, an interceptor trench was selected as a potential mitigation measure to intercept COCs that are predicted to migrate west from the PAG waste rock stockpile towards surface water features. Figures 7.51, 7.52, and 7.53 present the potential interceptor trench location west of the PAG waste rock stockpile and the simulated particle pathways for the base case, dry, and wet conditions, respectively, with the interceptor trench in place. The depth of the interceptor trench was adjusted to achieve hydraulic containment of the COCs predicted to migrate west from the PAG waste rock stockpile. The average depth of the interceptor trench is approximately 3 m below the interpolated top of weather bedrock, as necessary to maintain simulated hydraulic containment and also to achieve gravity drainage towards the pit. Figure 7.51 through 7.53 demonstrate that hydraulic containment of COC migration west from the PAG waste rock stockpile can be achieved through implementing an interceptor trench in this area should groundwater monitoring indicate that COC concentrations are approaching Tier 2 PSS guidelines. Should monitoring indicate that an interceptor trench is necessary, additional data collected throughout development of the Beaver Dam Mine Site can be applied to refine the design of this potential mitigation measure.

8. Summary and Conclusions

GHD developed a 3D numerical groundwater flow model to represent the geologic and hydrogeologic conditions within the overburden and bedrock observed at the Beaver Dam Mine Site and surrounding area. The 3D groundwater flow model is based on a 3D geologic model that GHD developed for the Beaver Dam Mine Site to facilitate a rigorous representation of the observed geology. GHD directly converted the 3D geologic model into a hydraulic conductivity zone distribution to apply in the 3D groundwater flow model. The groundwater flow model was developed using the USGS's MODFLOW-NWT groundwater flow computer program. GHD calibrated the groundwater flow model to provide a reasonable representation of the groundwater elevations and groundwater flow directions demonstrated in the base case (average annual), dry (September 13, 2018 through September 26, 2018) and wet (November 1, 2018 through November 14, 2018) calibration target datasets. Model calibration was compared against and provides a reasonable match to estimated baseflow conditions within the model domain. The model input parameters (e.g., hydraulic conductivity and recharge) applied in the calibrated model are consistent with observed Beaver Dam Mine Site conditions.

GHD conducted a sensitivity analysis of the calibrated model which demonstrated that model parameter input values were at or near their optimal values or were selected to provide a conservative bias with respect to predictive simulations. As a result, the calibrated model input parameters are considered reasonable and appropriate for providing a calibrated groundwater flow model suitable for use as a predictive tool to evaluate potential impacts of the Beaver Dam Mine Site development.

Using the calibrated model, GHD estimated that pit inflow rates could range from 531 to 829 m^3/d. It is further estimated that it will take approximately 13 years for the open pit to naturally fill to a pit lake elevation of 127 m AMSL following EOM.

GHD applied the calibrated model to estimate potential groundwater quantity impacts at EOM and PC. A maximum drawdown of 0.5 m was simulated adjacent to Cameron Flowage and simulated drawdown was generally less than 0.1 m outside of the PA, and negligible beyond the LAA. The simulated reduction in baseflow for the Cameron Flowage watershed represents approximately 4 to 5 percent of the total baseflow, and under 1 percent of the total estimated average annual flow in Cameron Flowage. Approximately 90 percent of the simulated baseflow reduction occurs within the PA, with the remaining 10 percent occurring within the LAA, supporting that Beaver Dam Mine Site development will not impact groundwater quantity beyond the LAA. Furthermore, all groundwater discharge to mine features will be managed and discharged to Cameron Flowage following treatment. Therefore, the total flow average annual flow in Cameron Flowage should not be impacted by the Beaver Dam Mine Site development during operation and once the pit lake has been filled and discharges naturally to Cameron Flowage.

GHD also applied the calibrated groundwater model to simulate potential COC impacts to groundwater and surface water at and surrounding the Beaver Dam Mine Site. The simulation of potential COC impacts incorporates a geosynthetic cover installed over the PAG waste rock stockpile as a baseline mitigation measure to reduce the potential COC mass loading to the receiving environment. It was identified that there is potential for arsenic and uranium to exceed the Potable Criteria in the vicinity of the NAG waste rock stockpile; however, the impact is expected to be temporary as arsenic and uranium concentrations within the NAG waste rock stockpile are predicted to decrease as the source terms transition from EOM to PC conditions. Furthermore, the predicted exceedance of Potable Criteria for uranium does not extend beyond the Property Boundary, and arsenic is naturally occurring in groundwater at the Beaver Dam Mine Site at concentrations above Potable Criteria. Therefore, at EOM, no significant impact to the reasonable use of groundwater is predicted beyond the Property Boundary. At PC, using the Base Case (i.e., median) source terms, predicted exceedances of the Potable Criteria for arsenic, cadmium, cobalt, manganese, nickel, lead, and uranium occur in the vicinity of the PAG waste rock stockpile. Using the Upper Case (i.e., 90th percentile) source concentrations, zinc is also predicted to exceed the Potable Criteria in the vicinity of the PAG waste rock stockpile. All predicted long-term PC impacts are contained within the PA boundary.

Potential impacts of COC mass loadings to surface water from groundwater were assessed through a comparison of predicted COC concentrations in groundwater to Tier 2 PSS and the calculation of COC mass loadings from groundwater to surface water for incorporation into the Predictive Water Quality Assessment GHD (2021a). For EOM, the comparison against Tier 2 PSS indicated that COC concentrations are predicted to exceed Tier 2 PSS for aluminum for both the base case and upper case source terms and for arsenic and cadmium for the upper case source terms. The predicted exceedances at EOM are related to the topsoil stockpiles. For PC, exceedances of Tier 2 PSS were predicted in association with the PAG waste rock stockpile for aluminum, cadmium, cobalt, copper, iron, nickel, lead, and zinc. The predicted exceedances occur either towards Cameron Flowage or towards surface water features west of the PAG waste rock stockpile. To address predicted exceedances of Tier 2 PSS in the vicinity of Cameron Flowage, simulated COC mass loadings to the Killag River watershed were provided as inputs to the Predictive Water Quality Assessment that combined impacts from groundwater discharge and surface water runoff to assess the cumulative impact on the Killag River watershed, as presented in GHD (2020a). To address predicted exceedances of the Tier 2 PSS west of the PAG waste rock stockpile, an interceptor trench was

evaluated as a potential mitigation measure. Implementing an interceptor trench is effective for achieving hydraulic containment of potential COC migration west from the PAG waste rock stockpile in the event that groundwater quality monitoring indicates COC concentrations are approaching the Tier 2 PSS in this area.

Model development and predictive scenario analysis is based on data available at the time of model development. As additional data is collected during the development of the Beaver Dam Mine Site, it is recommended that the calibrated model and predictive scenario results be updated, as warranted.

All of Which is Respectfully Submitted,

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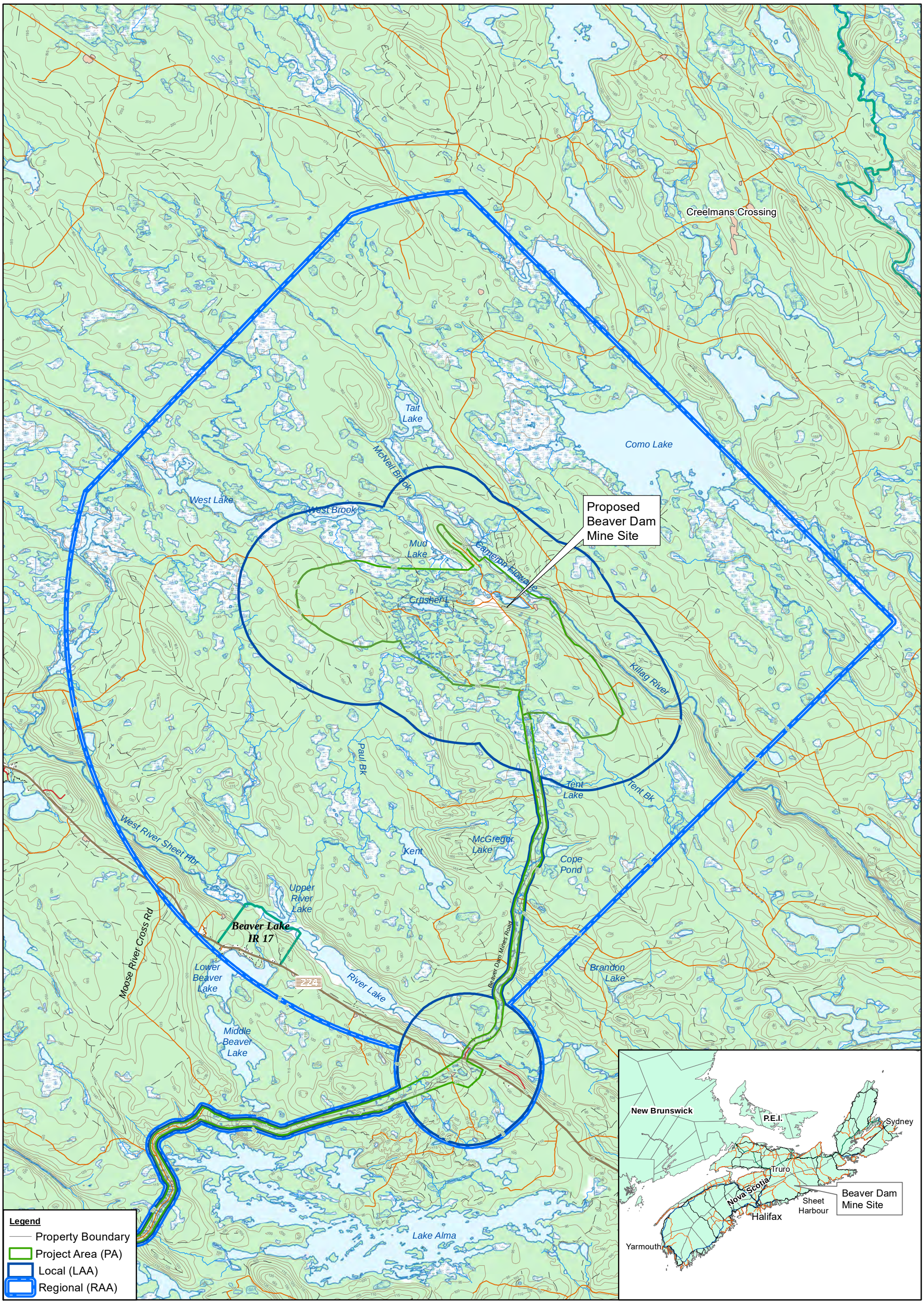


Source: Service Nova Scotia, Atlantic Mining NS, GHD, McCallum Environmental

0 500 1,000 1,500
Meters

Coordinate System:
NAD 1983 CSRS UTM Zone 20N

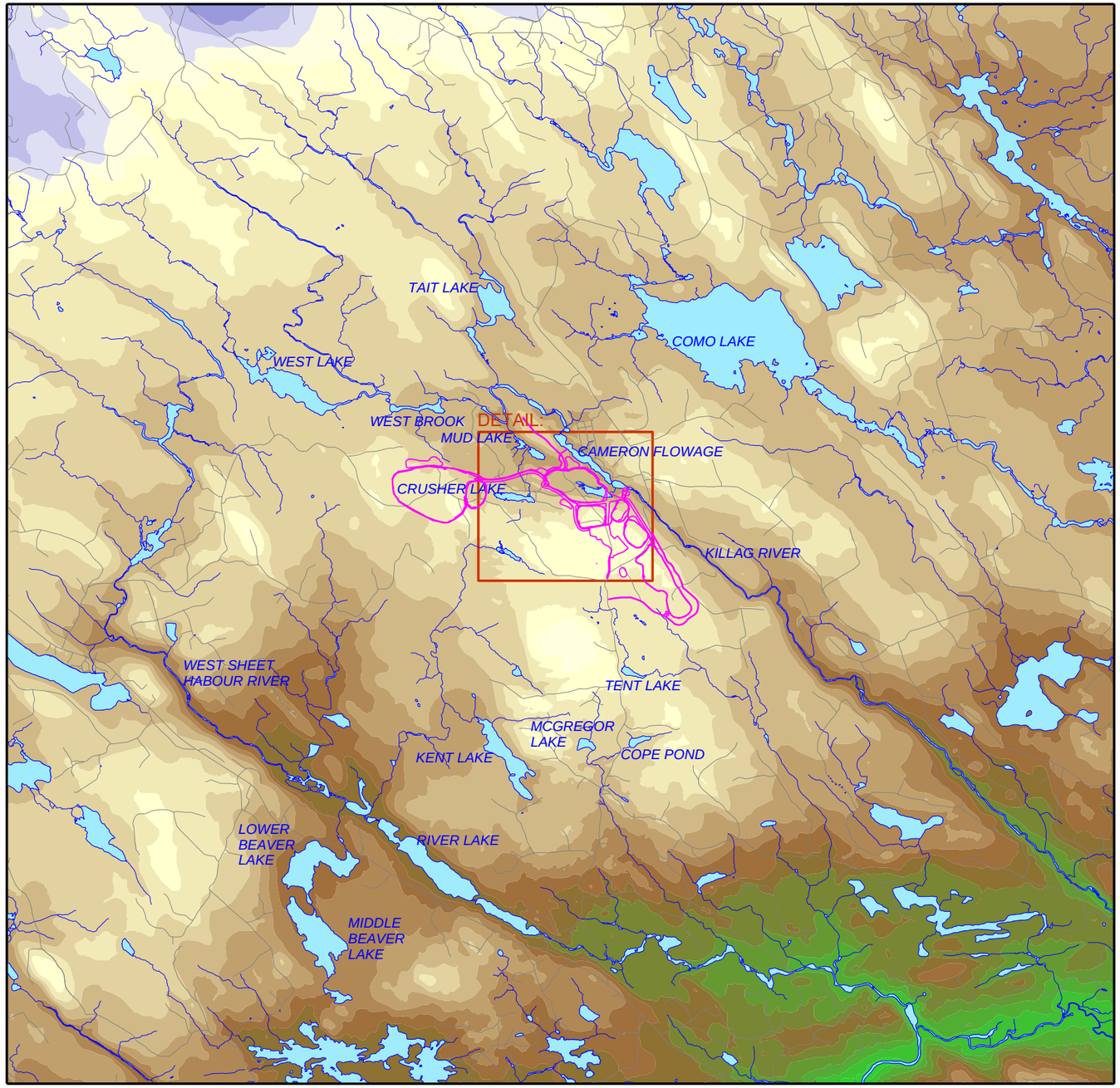
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

088664 (013)
Mar 10, 2021

BEAVER DAM MINE SITE LOCATION

FIGURE 1.1

GIS File: I:\GIS_DATA\Projects\6-chars\08----\088---\088664 Atlantic BD\088664(013)\088664(013)_GIS-HX001.mxd



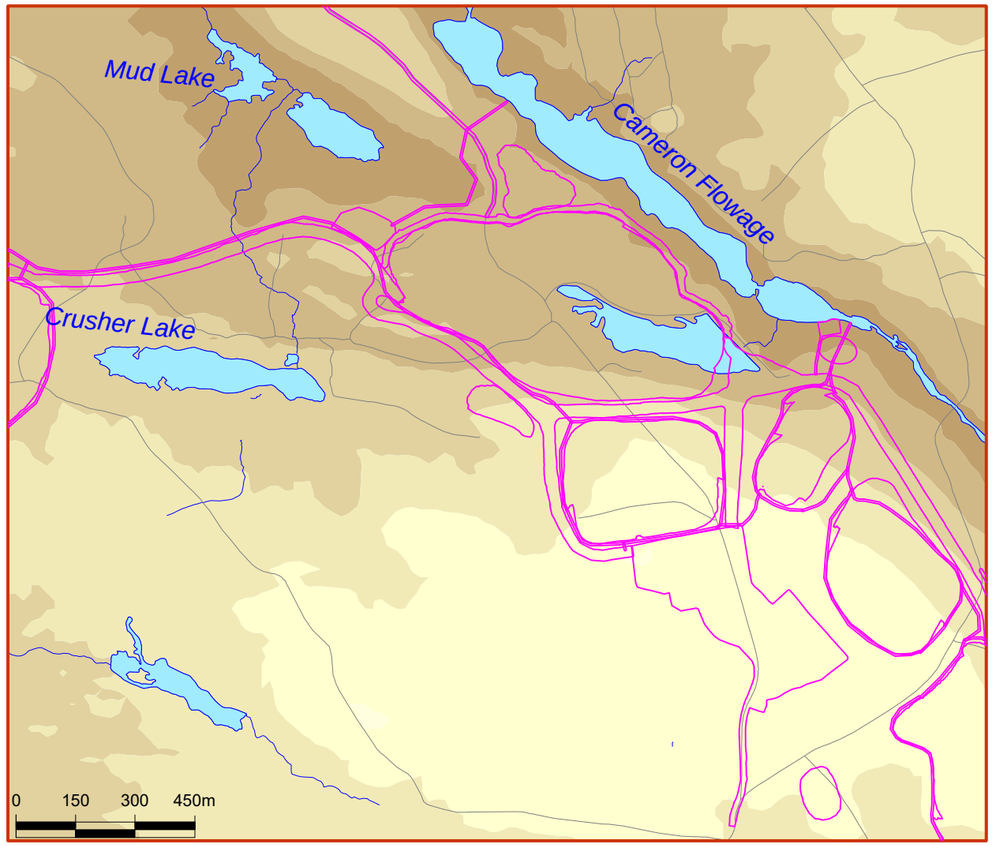
LEGEND

- SURFACE WATER BODY
- MINE FEATURES
- ROAD

GROUND SURFACE ELEVATION (m AMSL)

0 20 40 60 80 100 120 140 160 180 200

DETAIL:



0 700 1,400 2,100m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

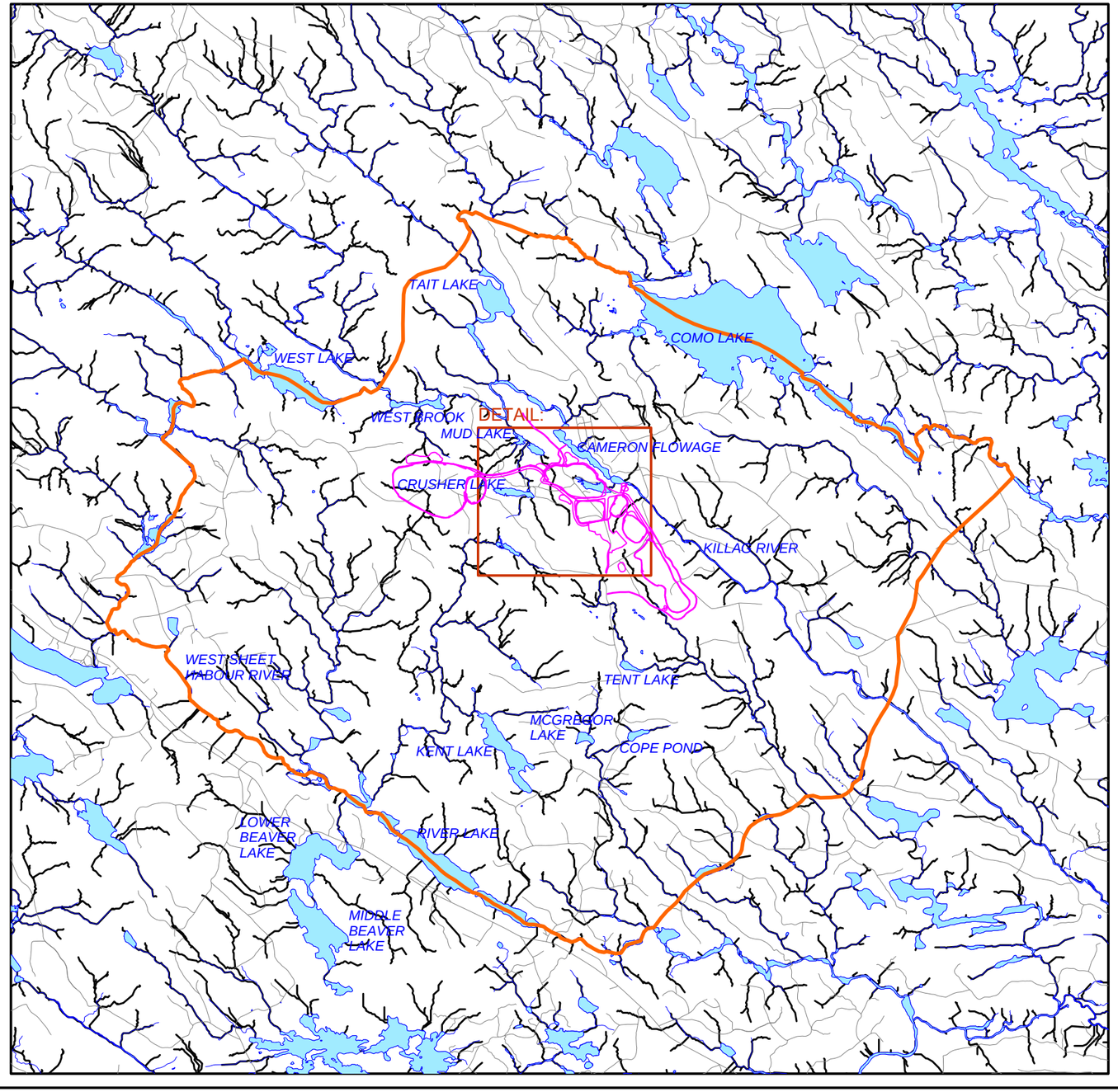
088664-031

January 19, 2021

PRE-MINING TOPOGRAPHY

FIGURE 2.1

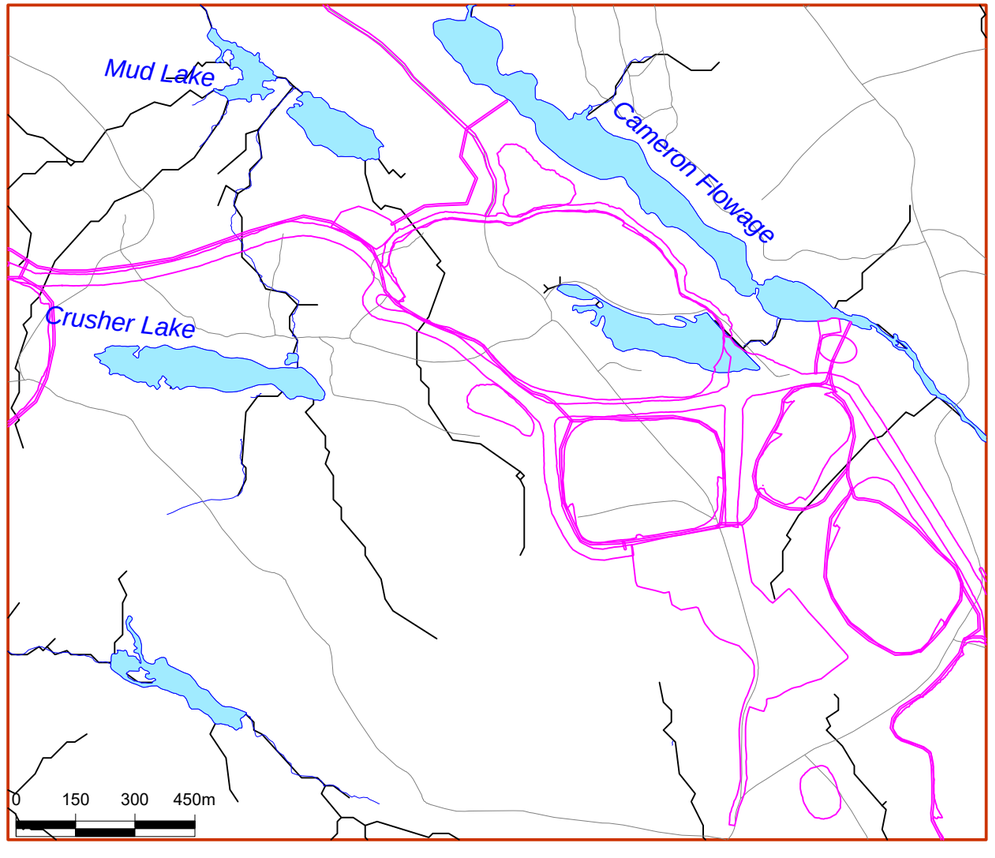
HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 2.1 - Pre-Mining Topography.srf



LEGEND

- SURFACE WATER BODY
- MINE FEATURES
- ROAD
- FLOW ACCUMULATION CHANNEL
- ACTIVE MODEL DOMAIN

DETAIL:



0 700 1,400 2,100m

N

GHD

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

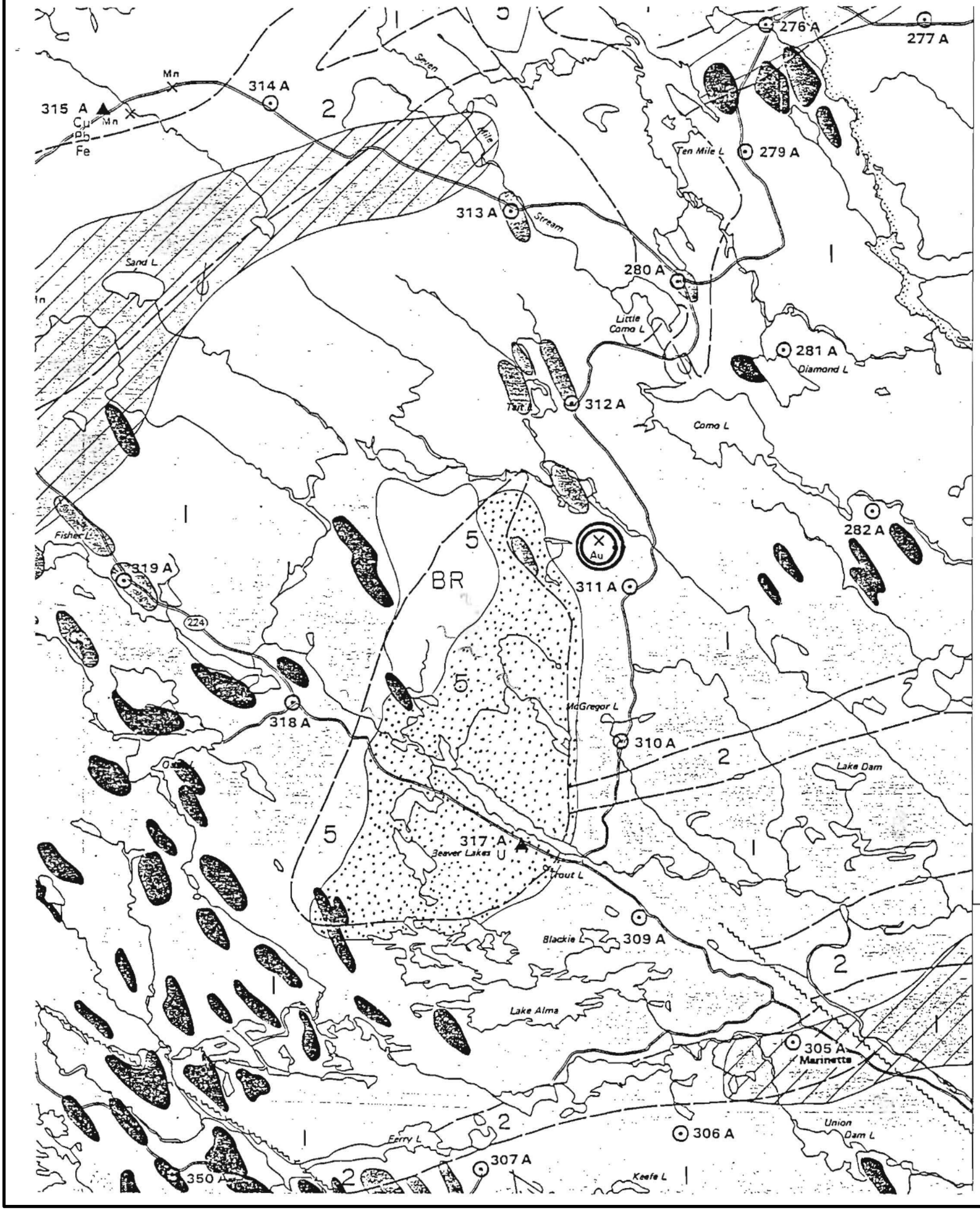
088664-031

January 19, 2021

SURFACE WATER FEATURES

FIGURE 2.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 2.2- Surface Water Features.srf



SOURCE:
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LEGEND

- SLATE TILL
- QUARTZITE TILL
- GRANITE TILL
- SILT-CLAY TILL DRUMLIN
- LOCATION OF BEAVERDAM MINE

Bedrock Geology

12	Basalt, sandstone, shale	6	Mixed sedimentary and volcanic rocks
11	Sedimentary rocks	5	Granite: mainly granite
10	Marginal basin sedimentary rocks	4	Torbrook formation
9	Marginal basin sedimentary rocks	3	White rock
8	Continential and marginal basin sedimentary rocks	2	Halifax formation
7	Undifferentiated sedimentary and volcanic rocks	1	Goldenville formation

0 70 140 210km

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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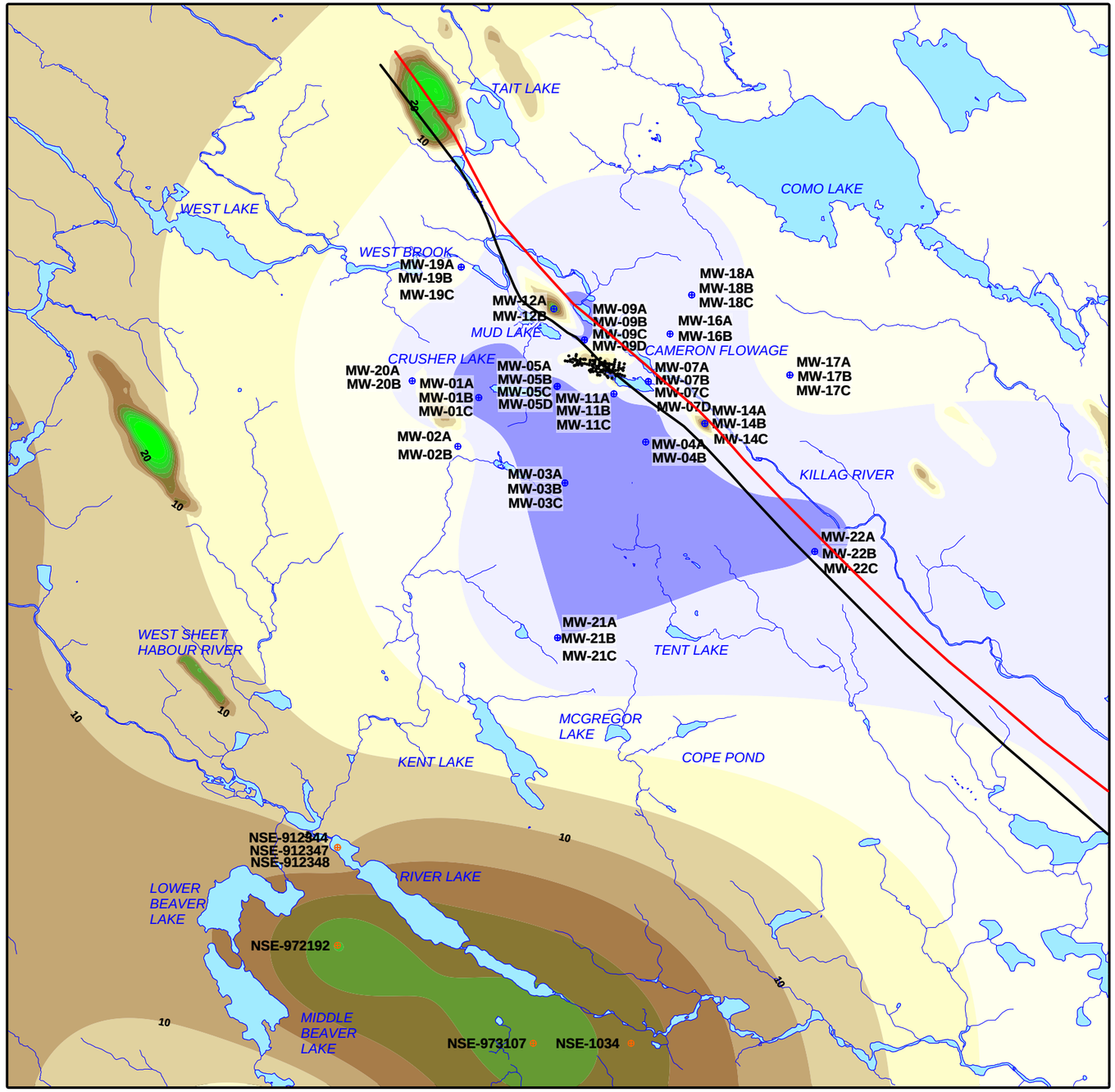
LOCATION OF DRUMLINS

FIGURE 2.3

Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 2.3 - Location of Drumlins.srf



LEGEND

- SURFACE WATER BODY
- MUD LAKE FAULT
- CAMERON FLOWAGE FAULT
- MW-17A ⊕ GROUNDWATER MONITORING LOCATIONS
- • EXPLORATORY DRILLHOLE LOCATIONS
- NSE-1034 ⊕ REGIONAL WELL RECORD LOCATIONS

OVERBURDEN THICKNESS (m)

0 2 4 6 8 10 12 14 16 18 20 22 24

0 700 1,400 2,100m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

088664-031

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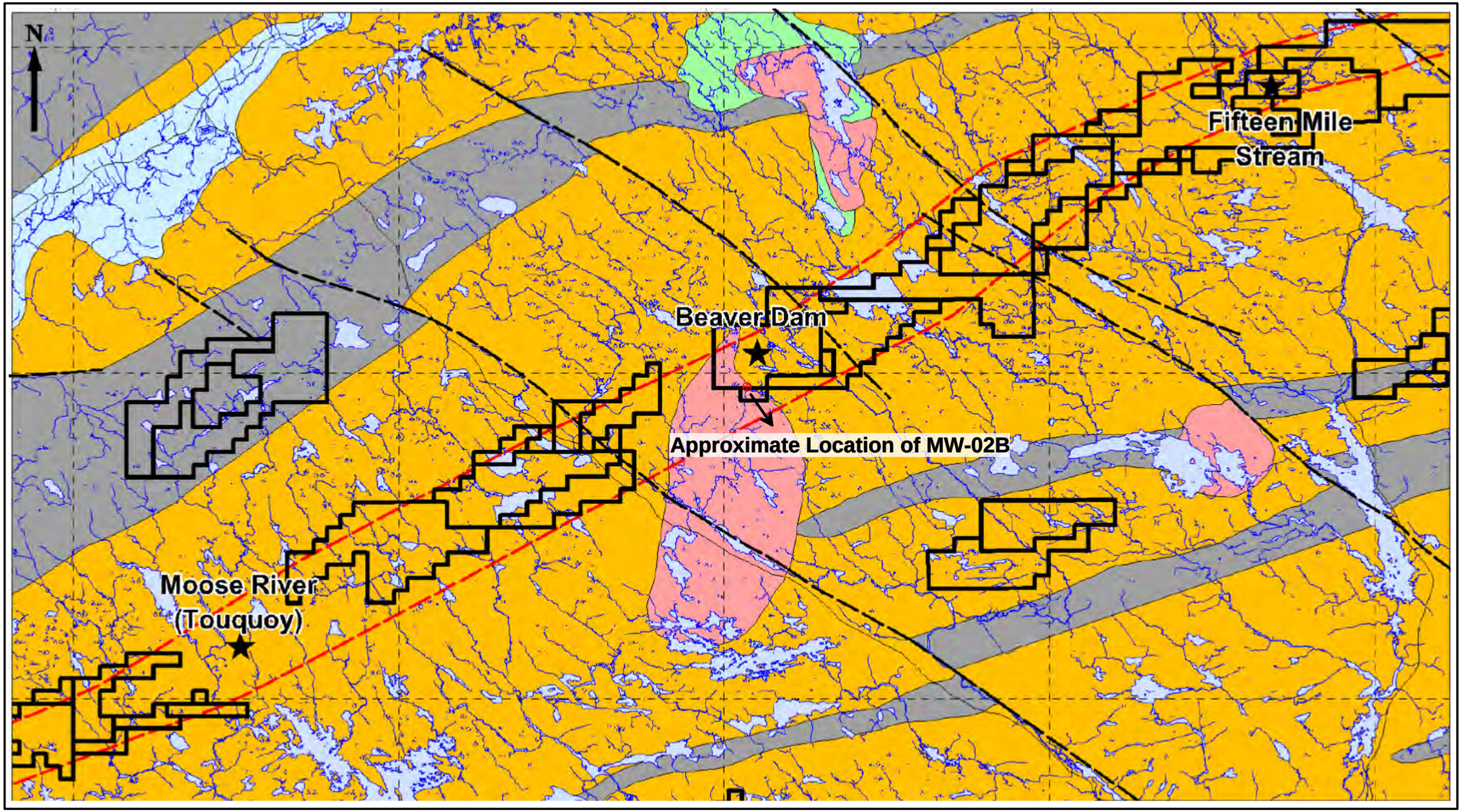
ESTIMATED OVERBURDEN THICKNESS

FIGURE 2.4

Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 2.4 - Estimated Overburden Thickness.srf



SOURCE:
ANNUAL QUALIFIED PERSONS REPORT FOR BEAVER DAM GOLD PROJECT, HALIFAX, NOVA SCOTIA - YEAR ENDED 31 MARCH 2014 - LIONGOLD CORPORATION LIMITED, SINGAPORE PREPARED IN ACCORDANCE WITH THE REQUIREMENTS OF SINGAPORE EXCHANGE PRACTICE NOTE 6.3. PRODUCED BY DR SIMON DOMINY AND MR RICHARD HORNE

0 1,300 2,600 3,900m

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BEAVER DAM MINE

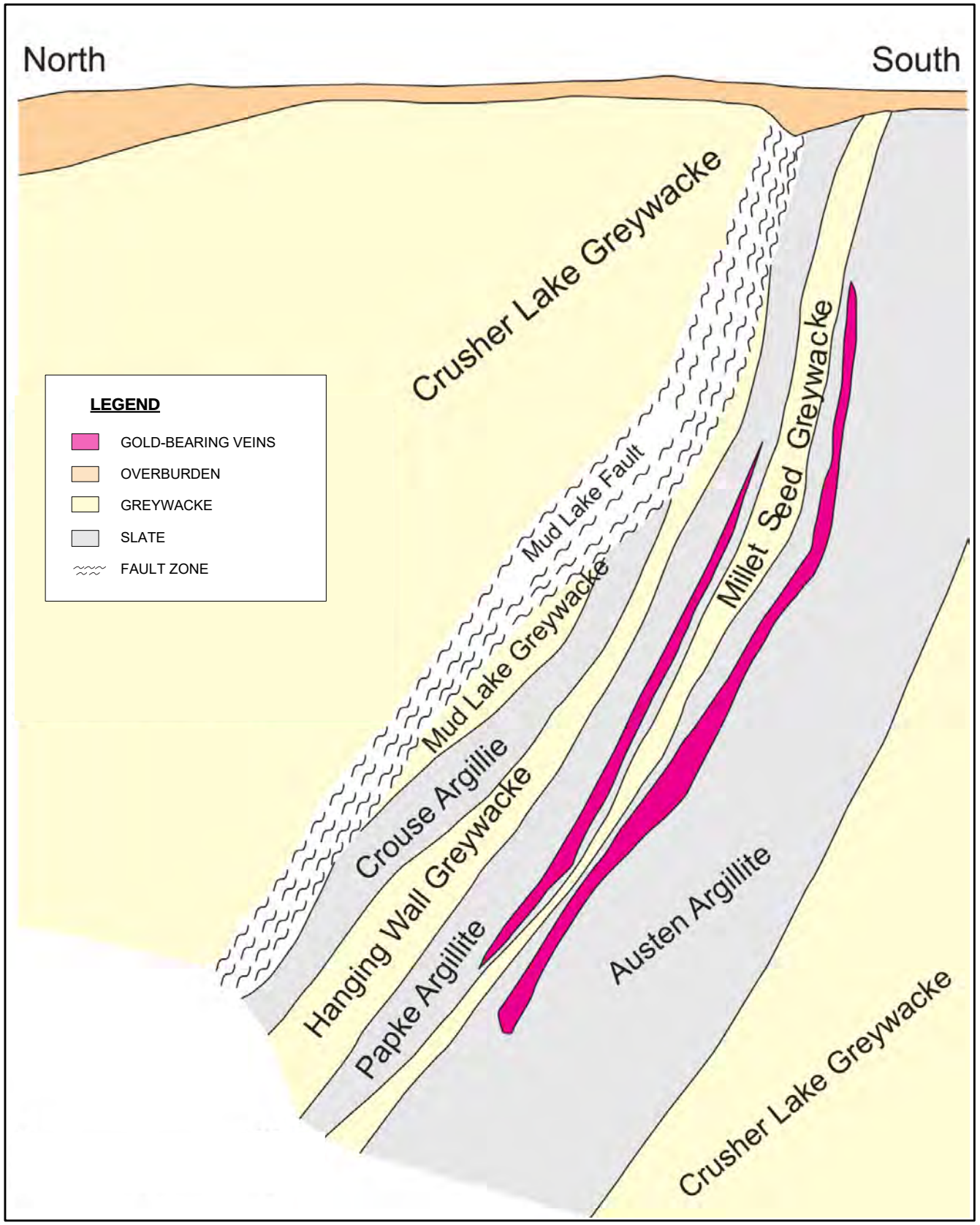
REGIONAL GEOLOGY

088664-031

October 22, 2019

FIGURE 2.5

Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 2.5 - Regional Geology.srf



SOURCE: SANGSTER, A.L.,AND SMITH, P.K., 2007, METALLOGENIC SUMMARY OF THE MEGUMA GOLD DEPOSITS, NOVA SCOTIA, IN GOODFELLOW, W.D., ED., MINERAL DEPOSITS OF CANADA: A SYNTHESIS OF MAJOR DEPOSIT-TYPES, DISTRICT METALLOGENY, THE EVOLUTION OF GEOLOGICAL PROVINCES

0 23 46 69m

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

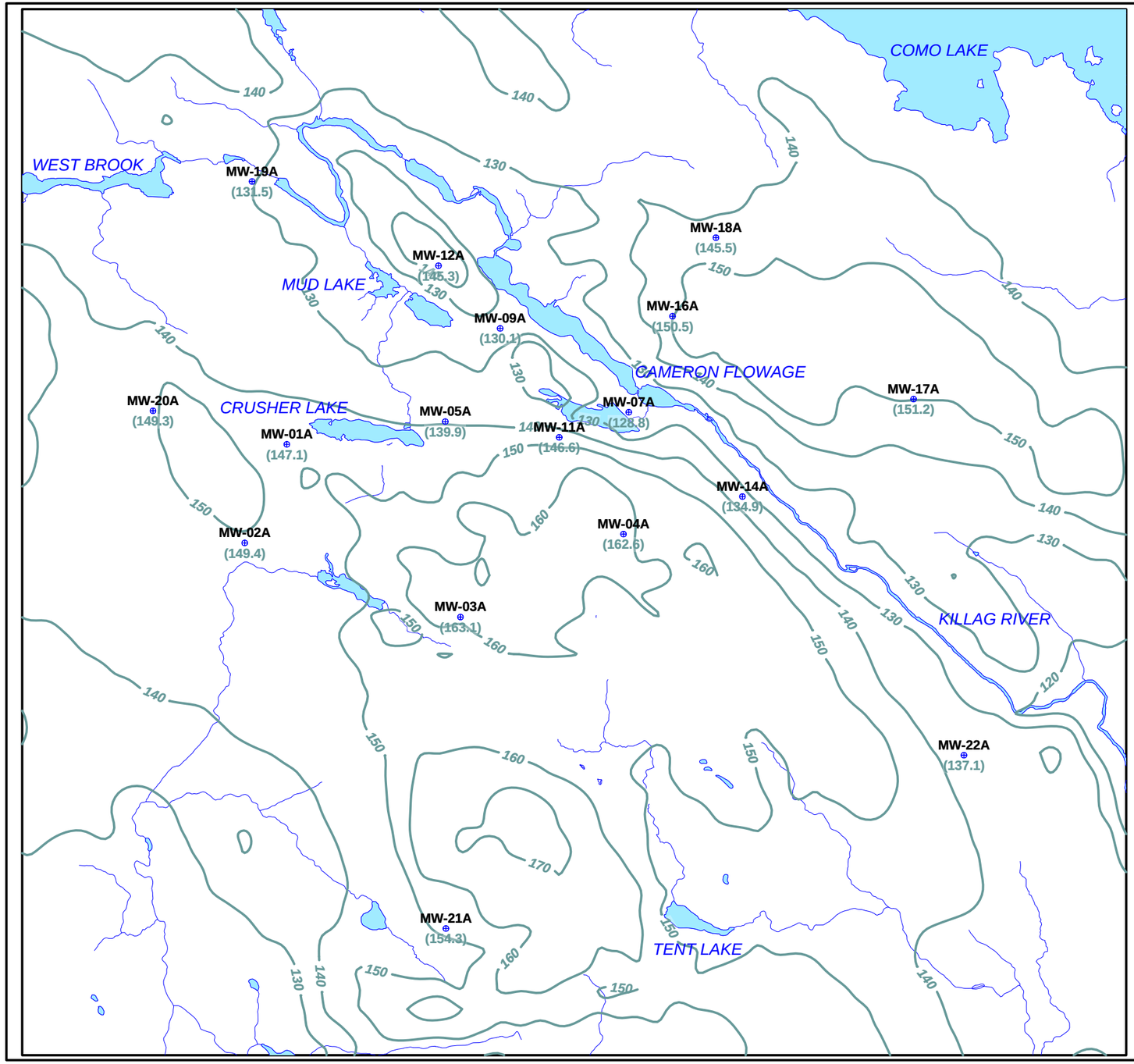
088664-031

October 22, 2019

SECTION THROUGH BEAVER DAM DEPOSIT

FIGURE 2.6

Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 2.6 - Section through Beaver Dam Deposit.srf



LEGEND

- SURFACE WATER BODY
- MW-17A ⊕ — WATER LEVEL MONITORING LOCATION
- (154.5) — OVERBURDEN GROUNDWATER ELEVATION MEASURED ON JULY 18, 2018 (m AMSL)
- — 140 — OBSERVED OVERBURDEN GROUNDWATER ELEVATION CONTOURS - JULY 18, 2018 (m AMSL)

0 200 400 600m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

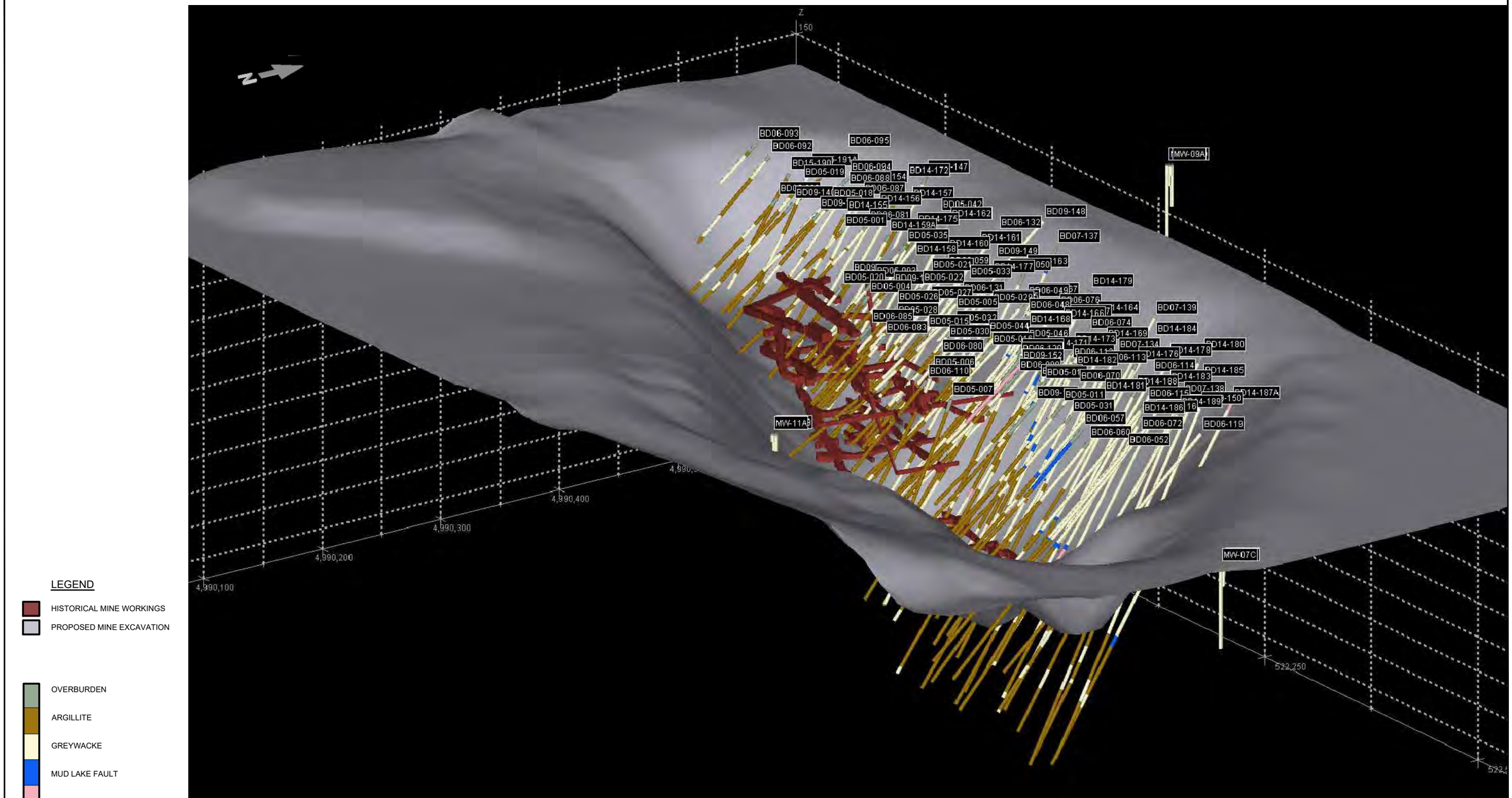
OBSERVED OVERBURDEN GROUNDWATER ELEVATION CONTOURS - JULY 18, 2018

088664-031

March 18, 2021

FIGURE 2.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\RPTFigures\Figure 2.7 - Observed Overburden Groundwater Elevation Contours - July 18, 2018.srf



LEGEND

- HISTORICAL MINE WORKINGS
- PROPOSED MINE EXCAVATION

- OVERBURDEN
- ARGILLITE
- GREYWACKE
- MUD LAKE FAULT
- UNDEFINED

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BEAVER DAM MINE

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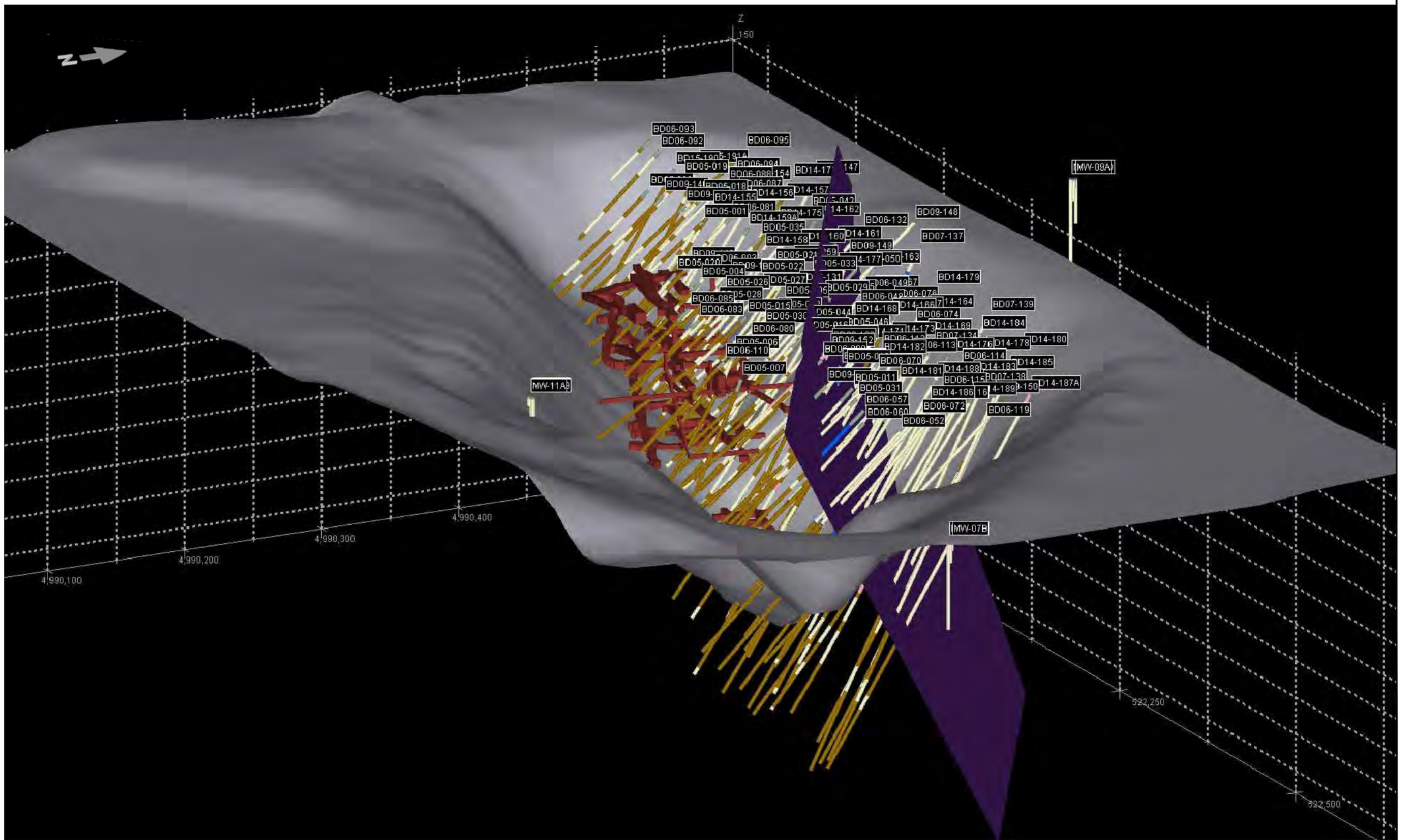
HISTORIC MINE WORKINGS

FIGURE 2.8

CAD File: P:\drawings\88000s\88664\88664-reports\88664-00(009)\88664-00(009)GN\88664-00(009)GN-WA001.dwg



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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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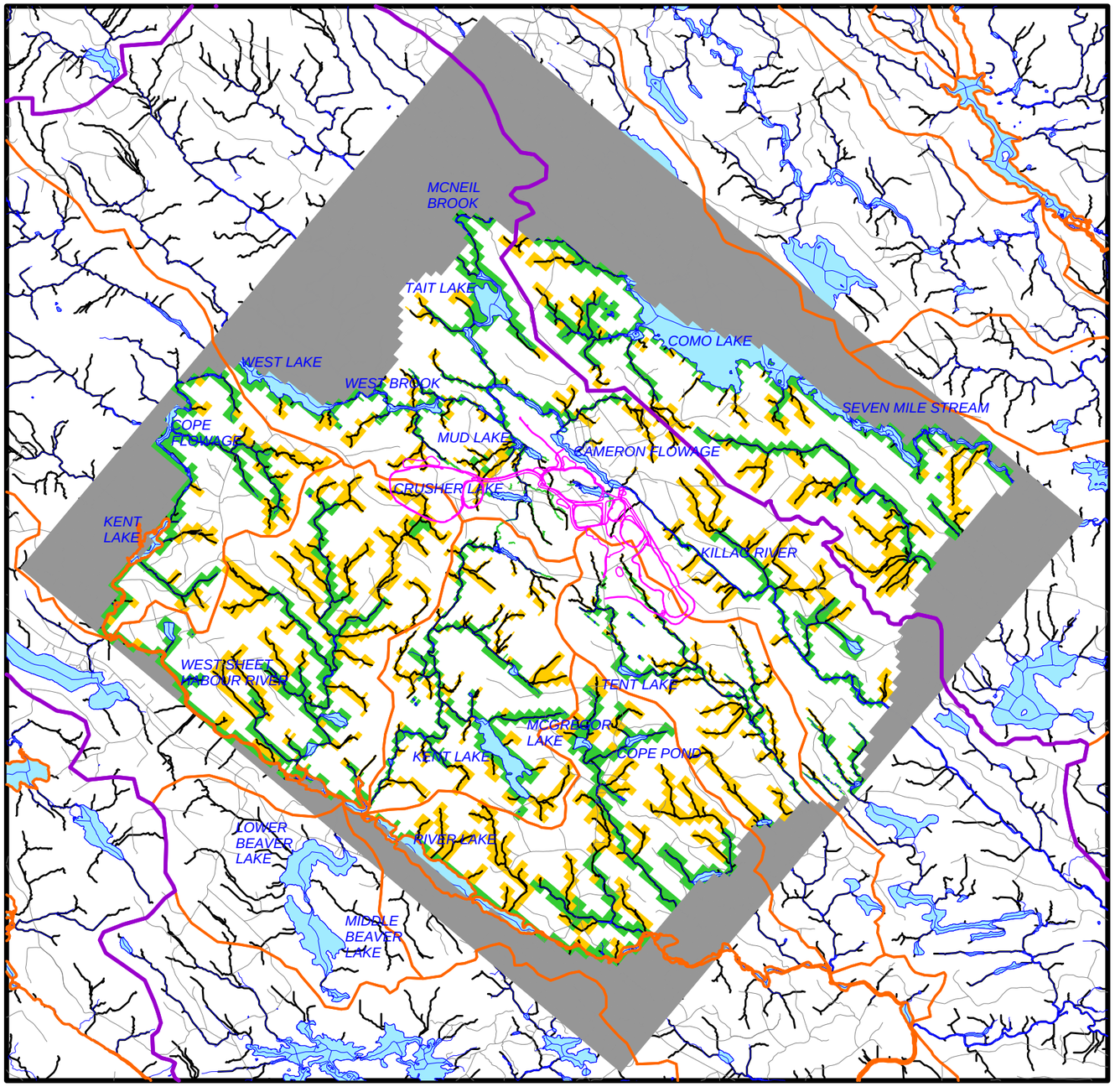
Oct 22, 2019

APPROXIMATE MUD LAKE FAULT LOCATION

FIGURE 2.9

CAD File: P:\drawings\88000s\88664\88664-reports\88664-00(009)\88664-00(009)GN\88664-00(009)GN-WA001.dwg



LEGEND

- SURFACE WATER BODY
- MINE FEATURES
- ROAD
- FLOW ACCUMULATION CHANNEL
- SECONDARY WATERSHED DIVIDE
- TERTIARY WATERSHED DIVIDE
- RIVER BOUNDARY CONDITION
- NO-FLOW BOUNDARY CONDITION
- DRAIN BOUNDARY CONDITION

0 700 1,400 2,100m

N

GHD

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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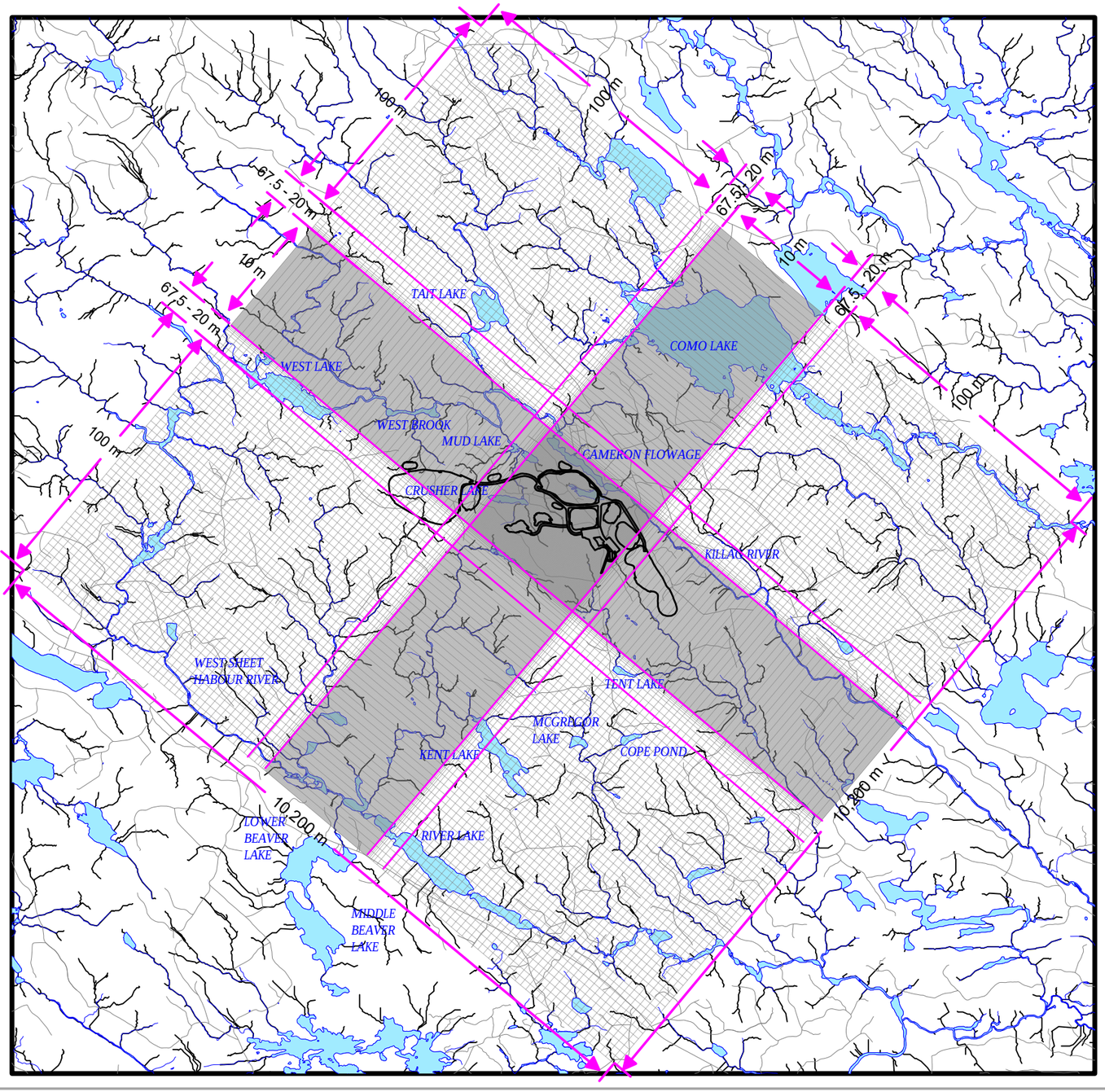
January 19, 2021

GROUNDWATER FLOW MODEL DOMAIN

FIGURE 3.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 3.1 - Groundwater Flow Model Domain.srf



LEGEND

- SURFACE WATER BODY
- MINE FEATURES
- ROAD
- FLOW ACCUMULATION LINE
- FINITE-DIFFERENCE GRID
- 10 m — HORIZONTAL FINITE-DIFFERENCE GRID SPACING
- BEGINNING OF MODEL CELL SIZE TRANSITION

0 700 1,400 2,100m

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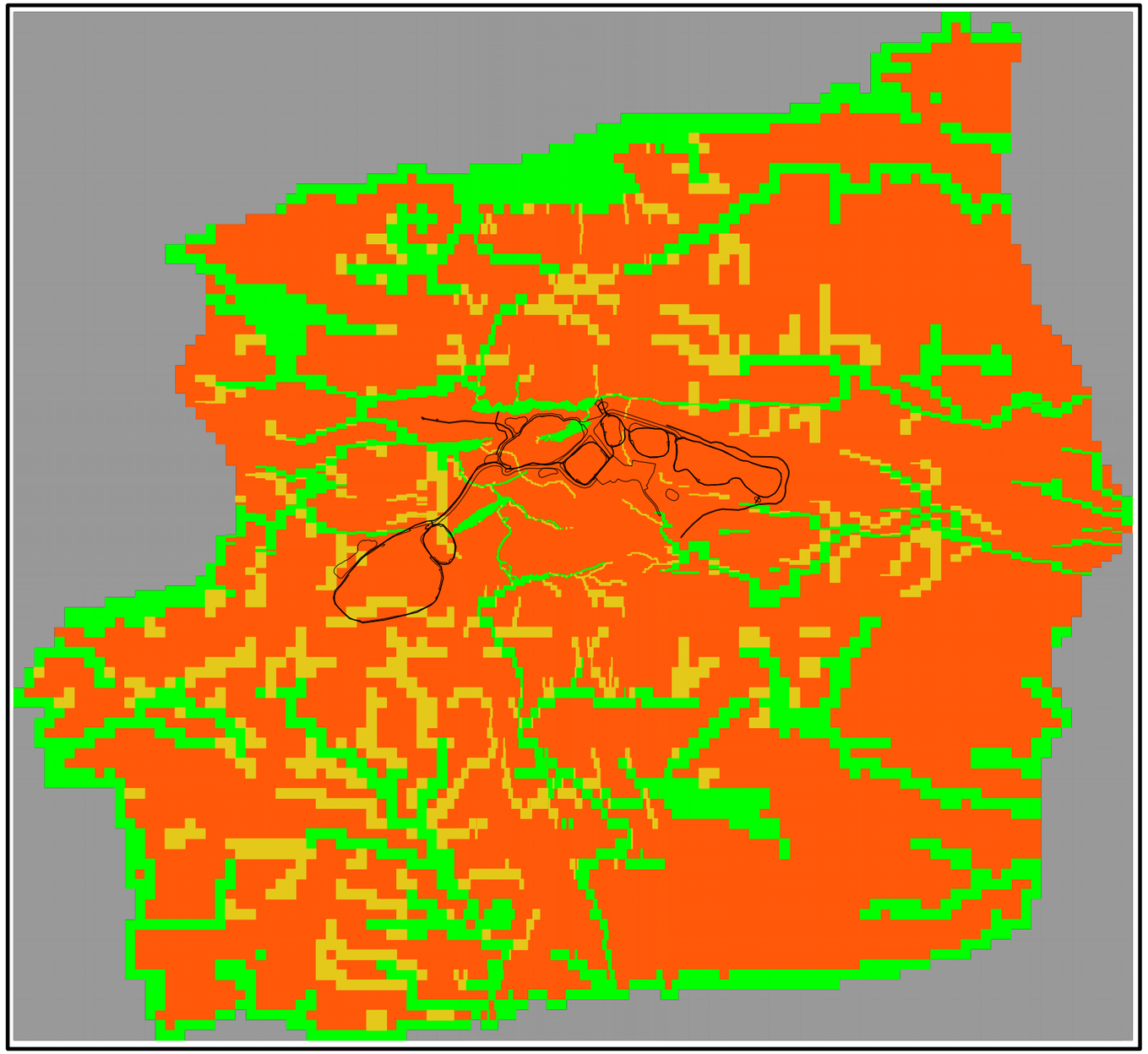
BEAVER DAM MINE

088664-031
October 24, 2019

FINITE-DIFFERENCE GRID

FIGURE 5.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.1 - Finite-Difference Grid.srf



LEGEND

- MINE FEATURES
- RIVER BOUNDARY CONDITION
- NO-FLOW BOUNDARY CONDITION
- DRAIN BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

- OVERBURDEN

0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

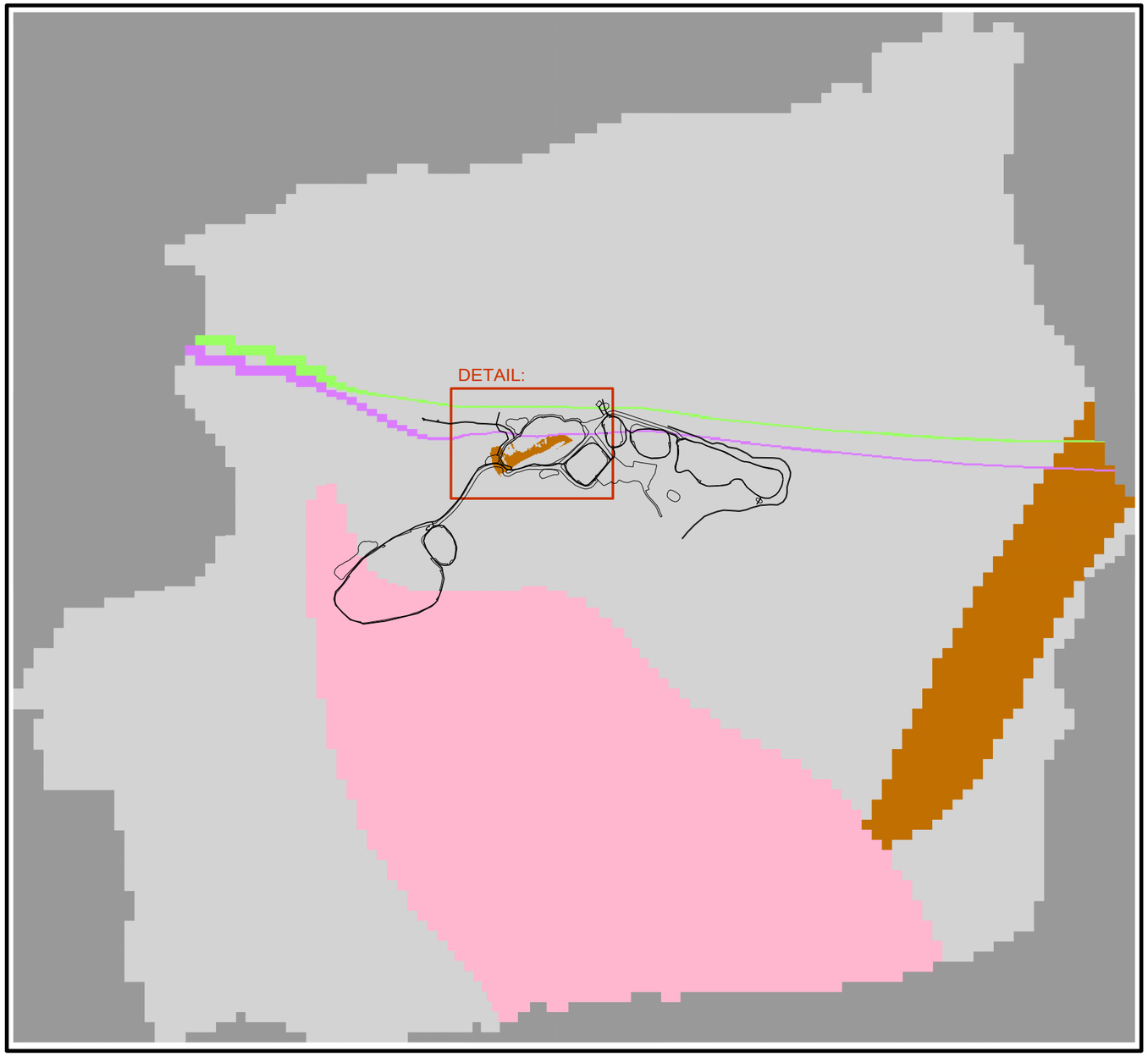
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN OVERBURDEN (LAYER 1)

088664-031

January 19, 2021

FIGURE 5.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.2 - Hydraulic Conductivity Distribution in Overburden (Layer 1).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

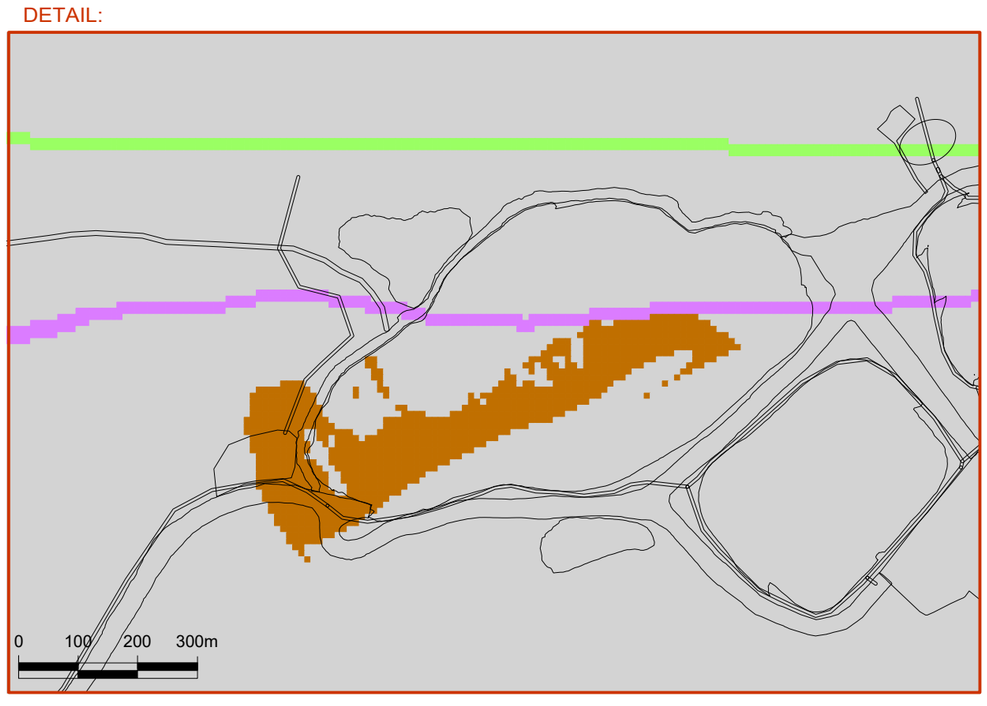
SHALLOW BEDROCK GREYWACKE FORMATION

SHALLOW BEDROCK GRANITE FORMATION

SHALLOW BEDROCK ARGILLITE FORMATION

SHALLOW MUD LAKE FAULT

SHALLOW CAMERON FLOWAGE FAULT



0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

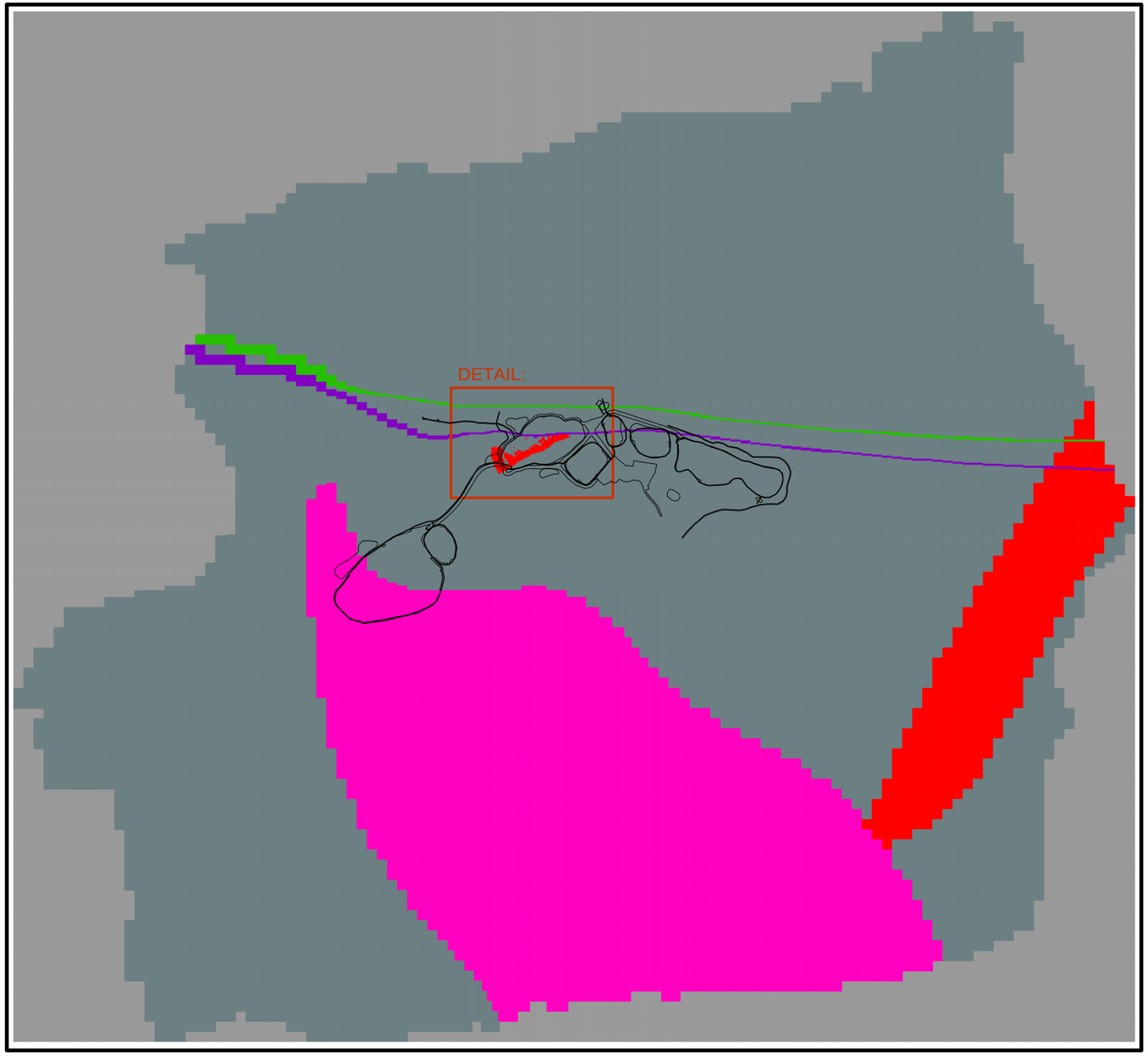
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN SHALLOW BEDROCK (LAYER 2)

088664-031

January 19, 2021

FIGURE 5.3

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.3 - Hydraulic Conductivity Distribution in Shallow Bedrock (Layer 2).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

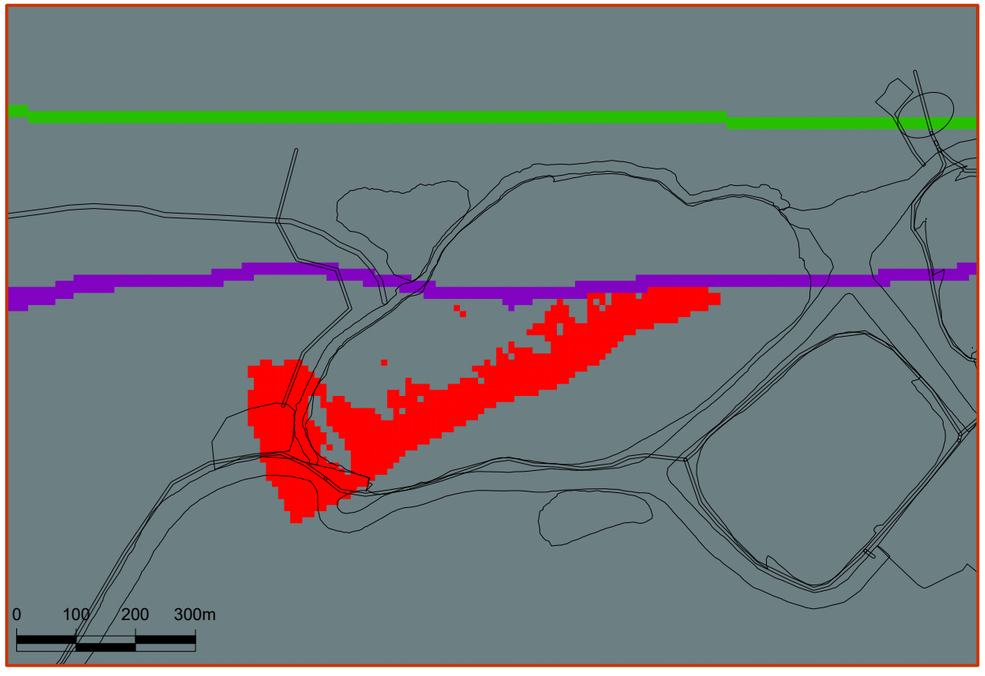
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

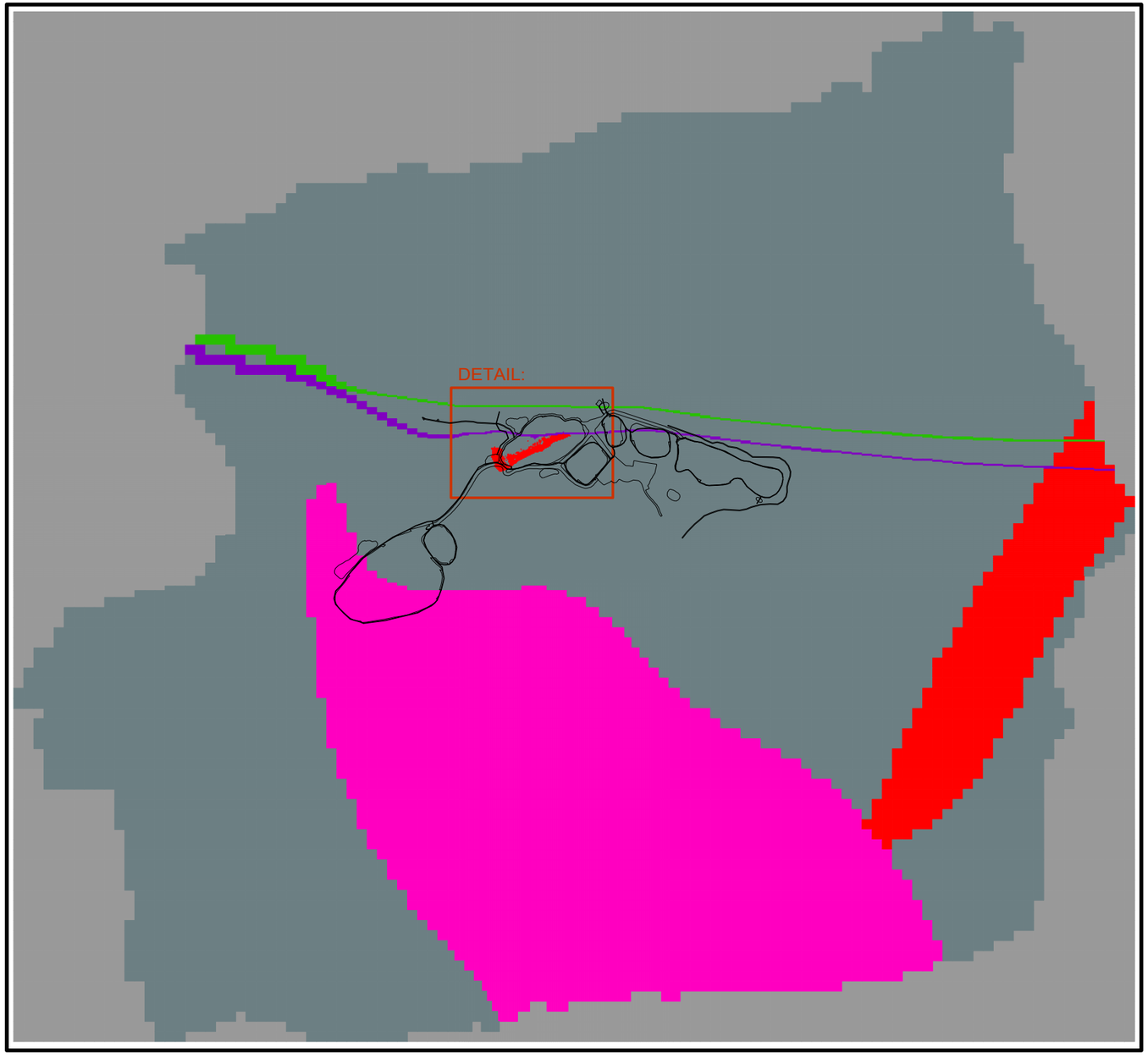
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 3)

088664-031

January 19, 2021

FIGURE 5.4

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.4 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 3).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

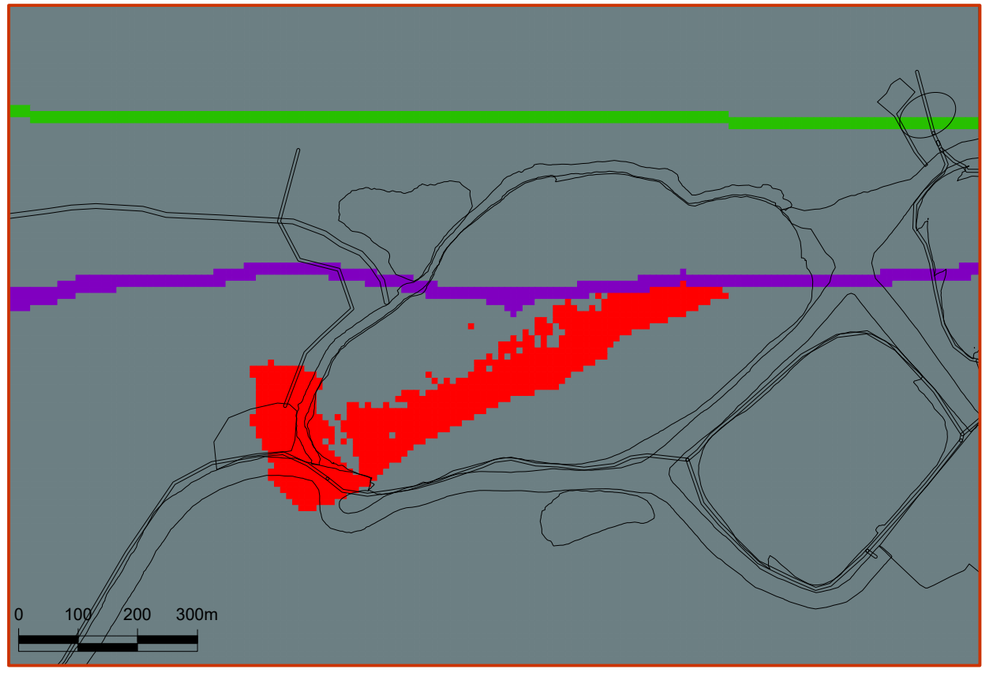
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

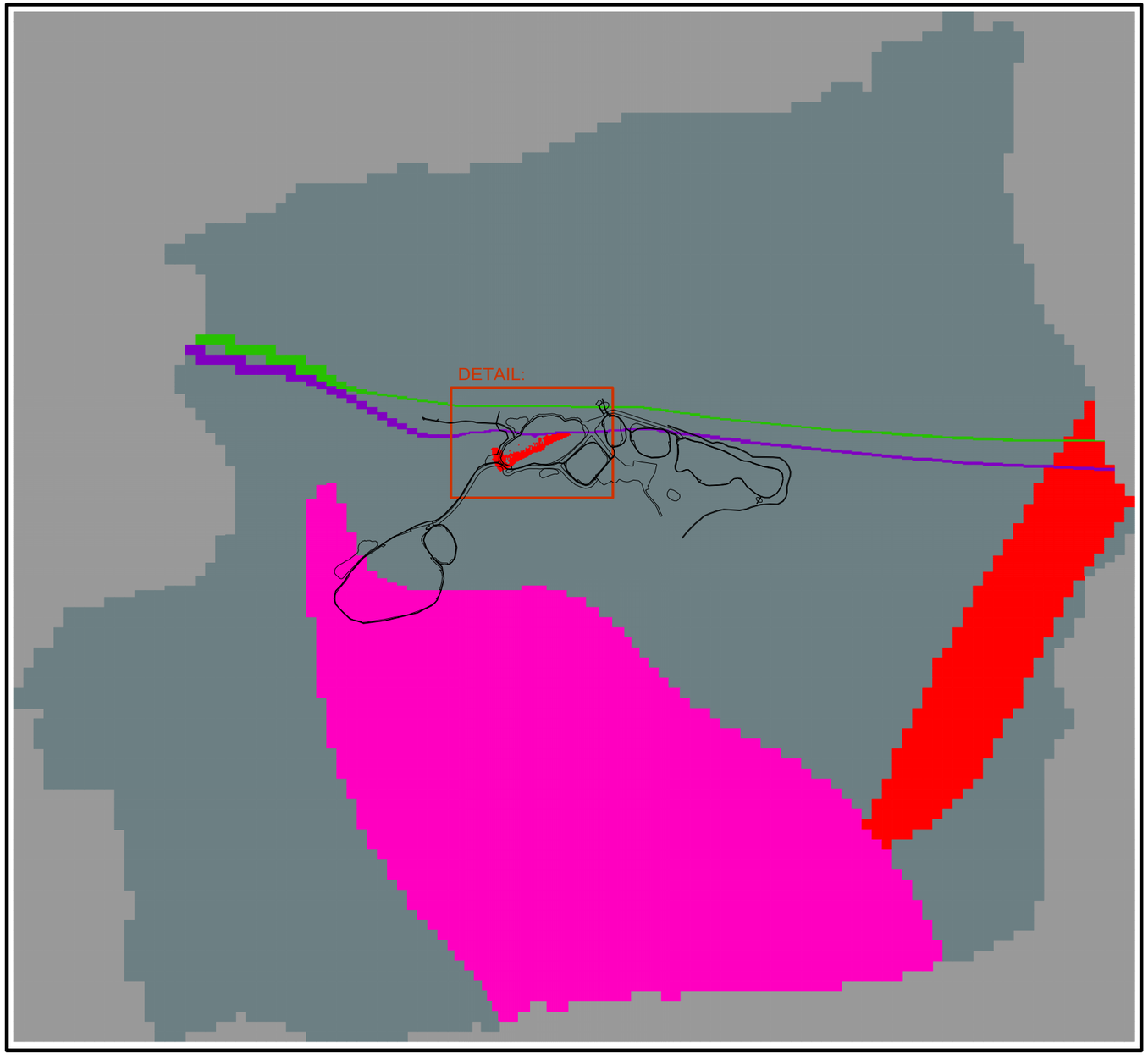
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 4)

088664-031

January 19, 2021

FIGURE 5.5

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.5 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 4).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

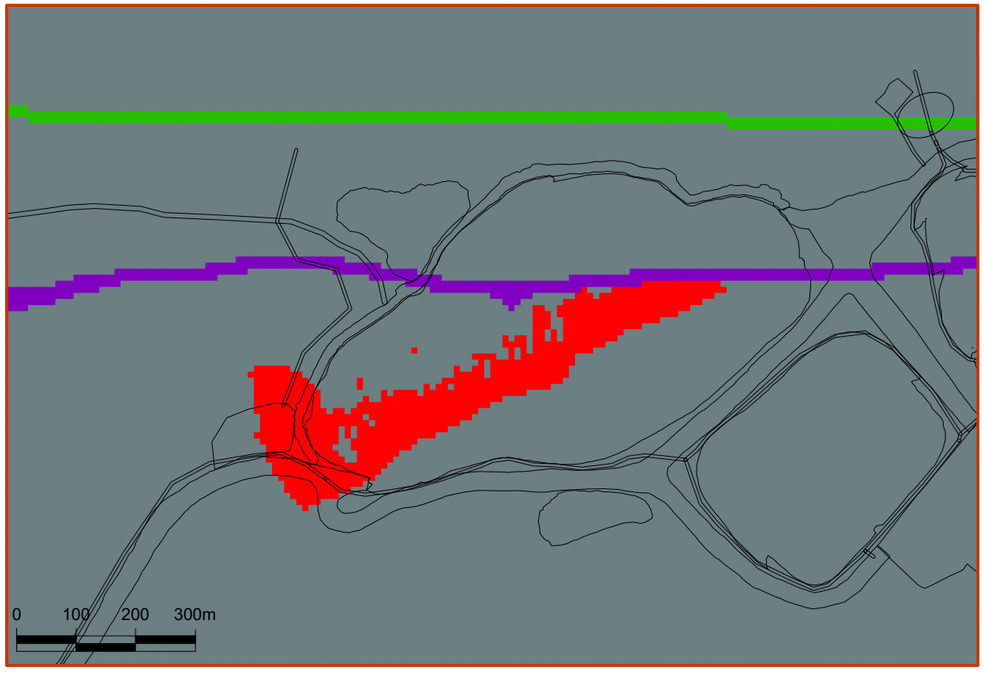
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

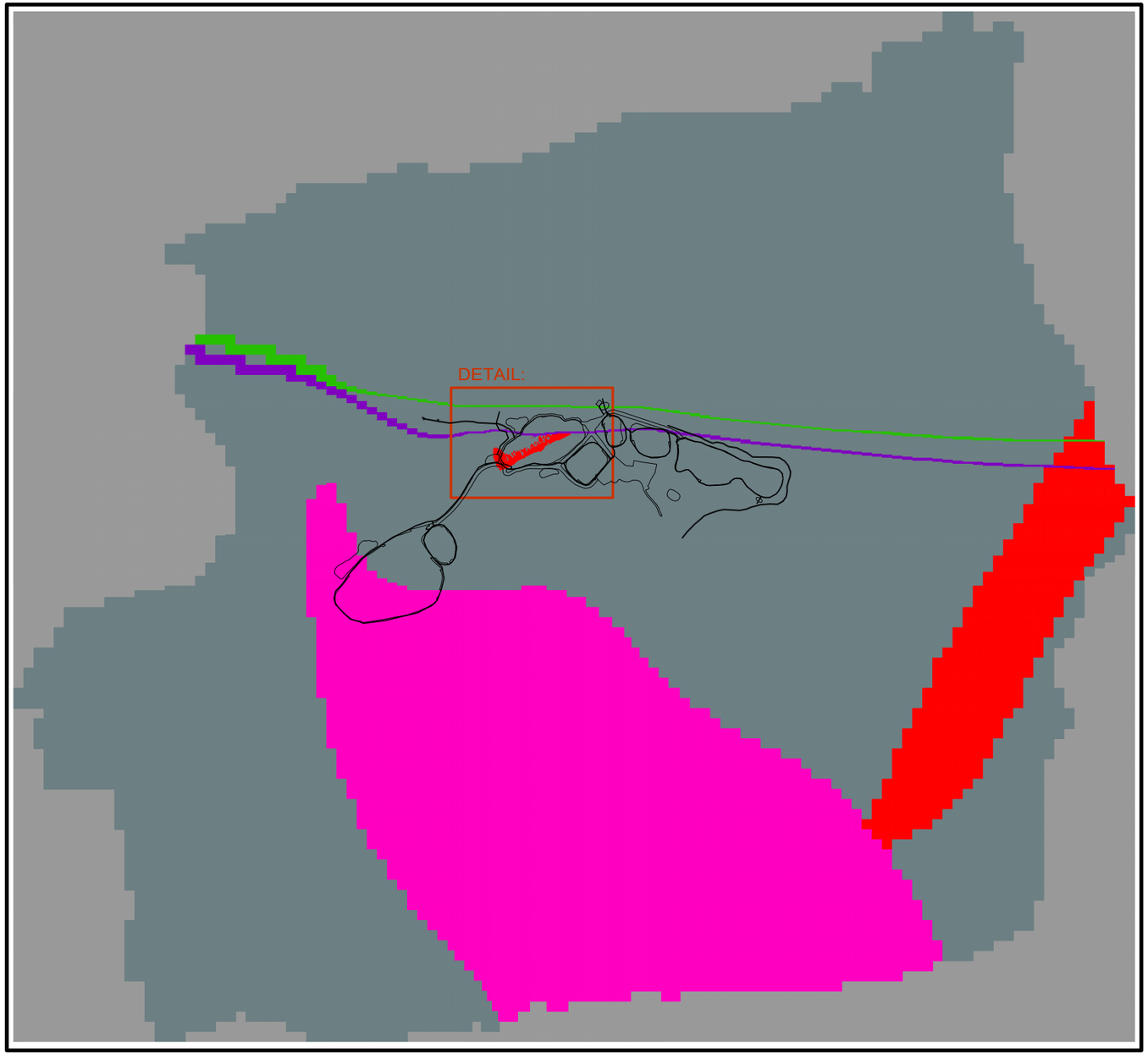
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 5)

088664-031

January 19, 2021

FIGURE 5.6

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.6 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 5).srf



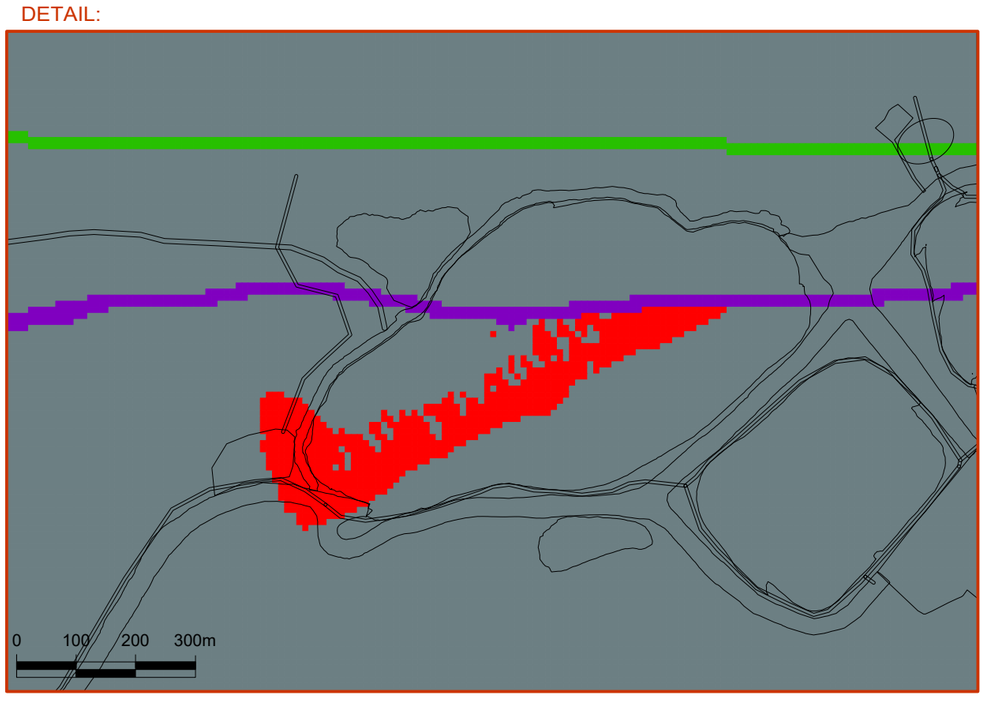
LEGEND

- MINE FEATURES
- NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

- DEEP BEDROCK GREYWACKE FORMATION
- DEEP BEDROCK GRANITE FORMATION
- DEEP BEDROCK ARGILLITE FORMATION
- DEEP MUD LAKE FAULT
- DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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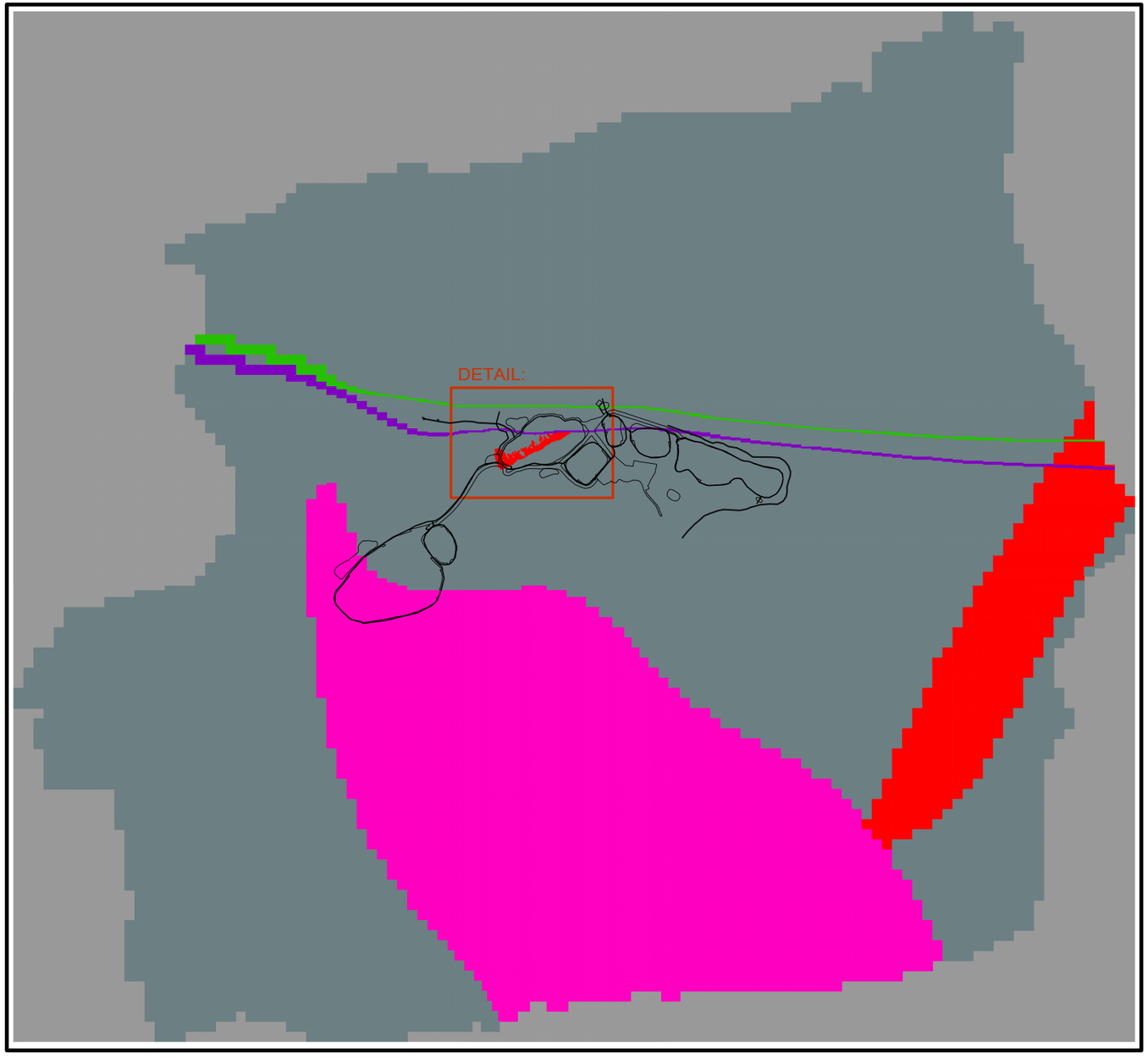
January 19, 2021

HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 6)

FIGURE 5.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.7 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 6).srf



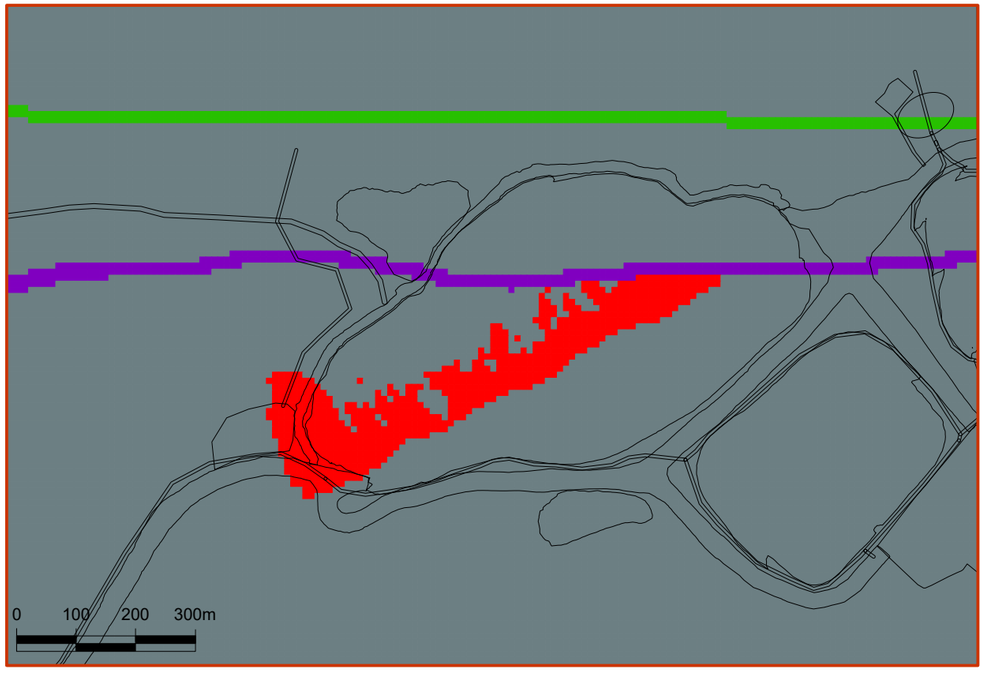
LEGEND

- MINE FEATURES
- NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

- DEEP BEDROCK GREYWACKE FORMATION
- DEEP BEDROCK GRANITE FORMATION
- DEEP BEDROCK ARGILLITE FORMATION
- DEEP MUD LAKE FAULT
- DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 7)

088664-031
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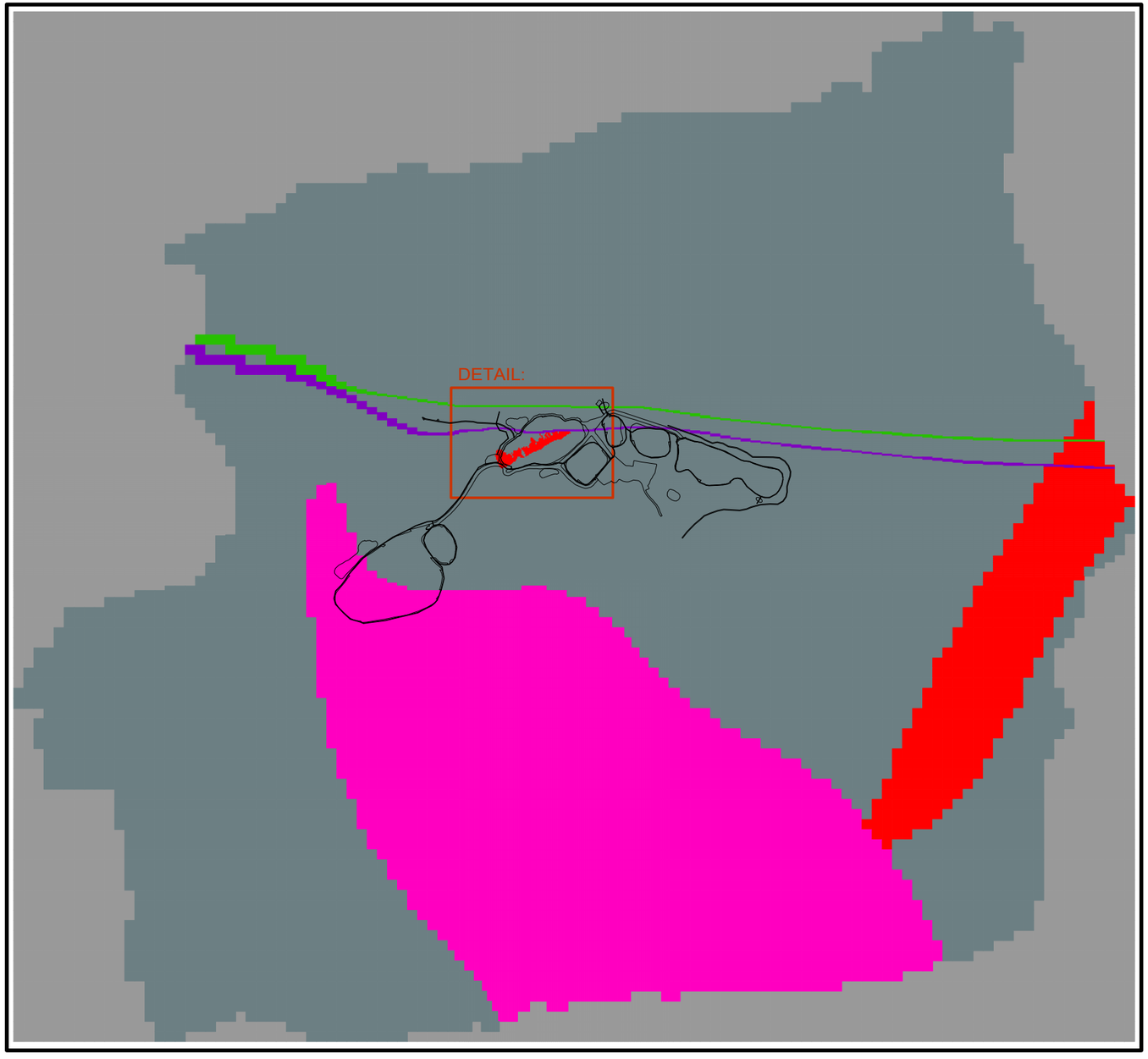
FIGURE 5.8

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.8 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 7).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

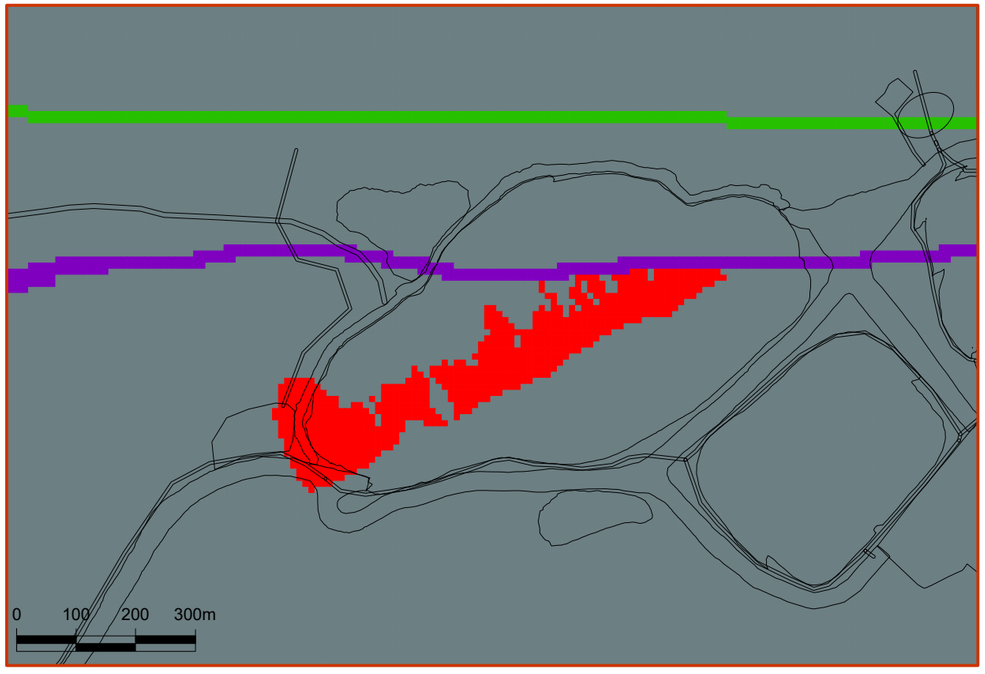
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 8)

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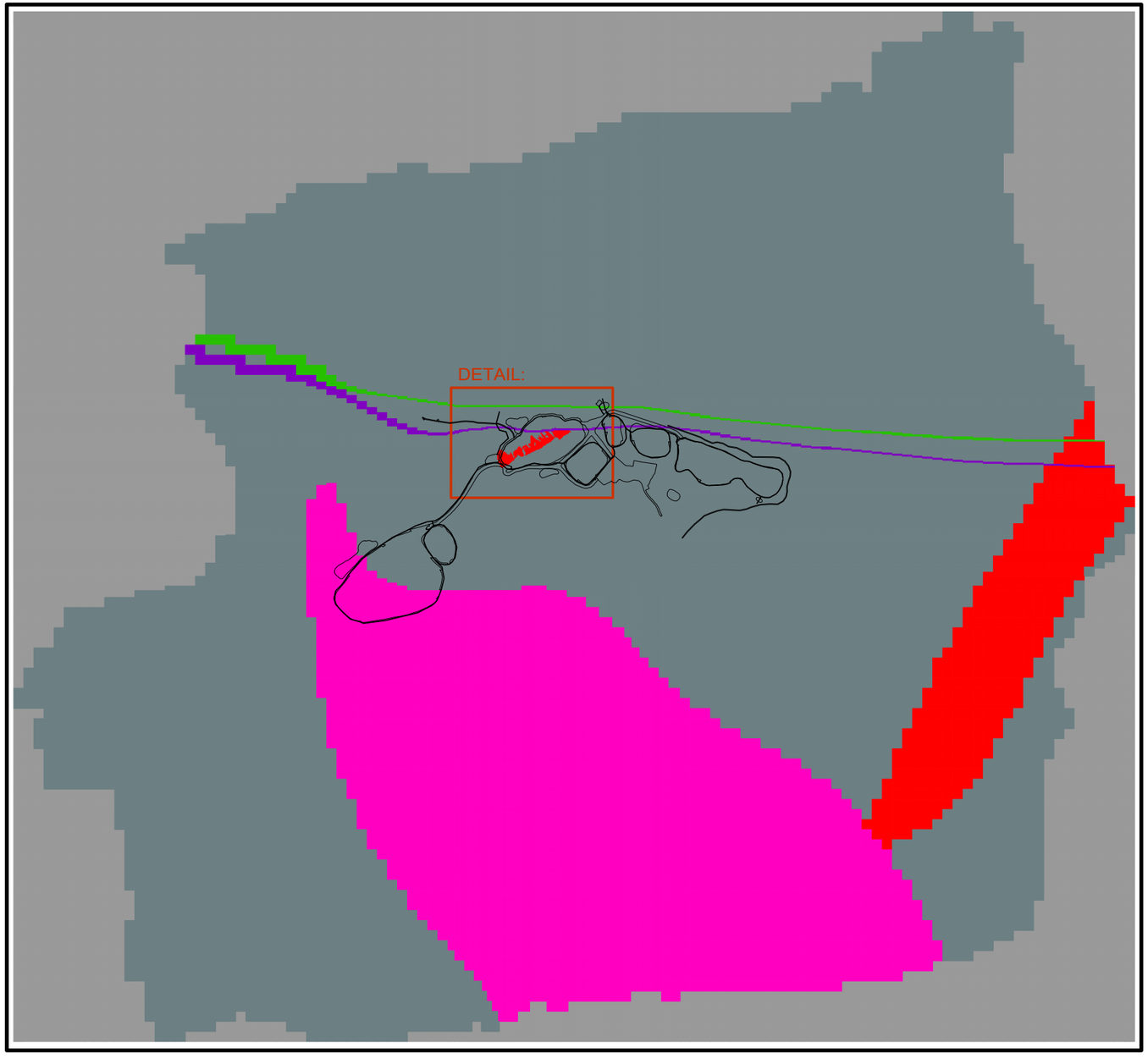
January 19, 2021

FIGURE 5.9

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.9 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 8).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

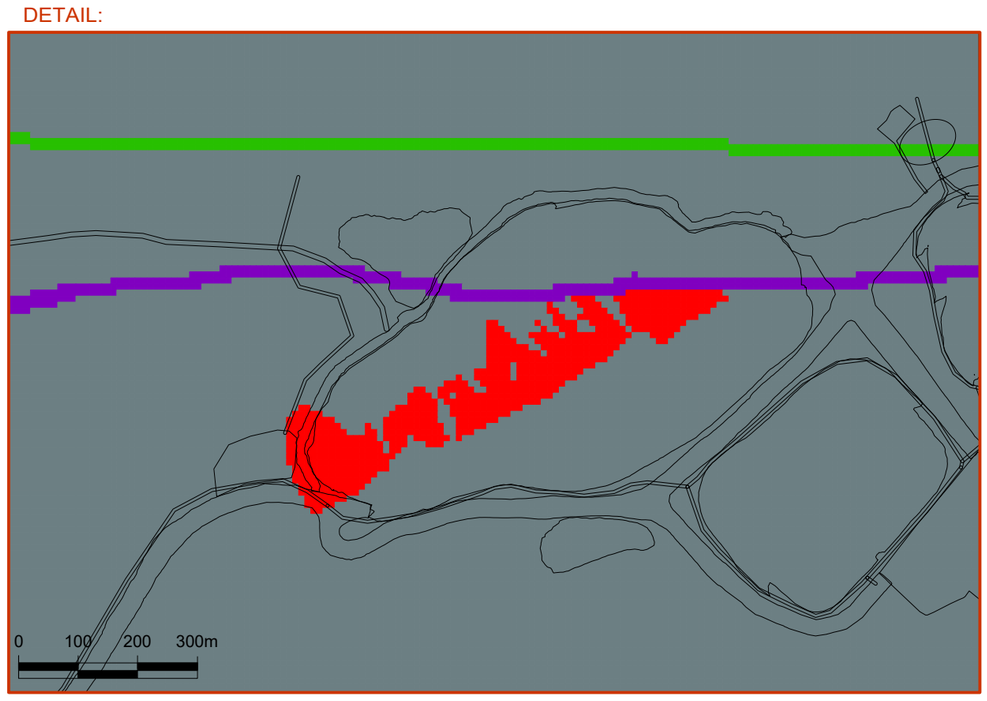
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 9)

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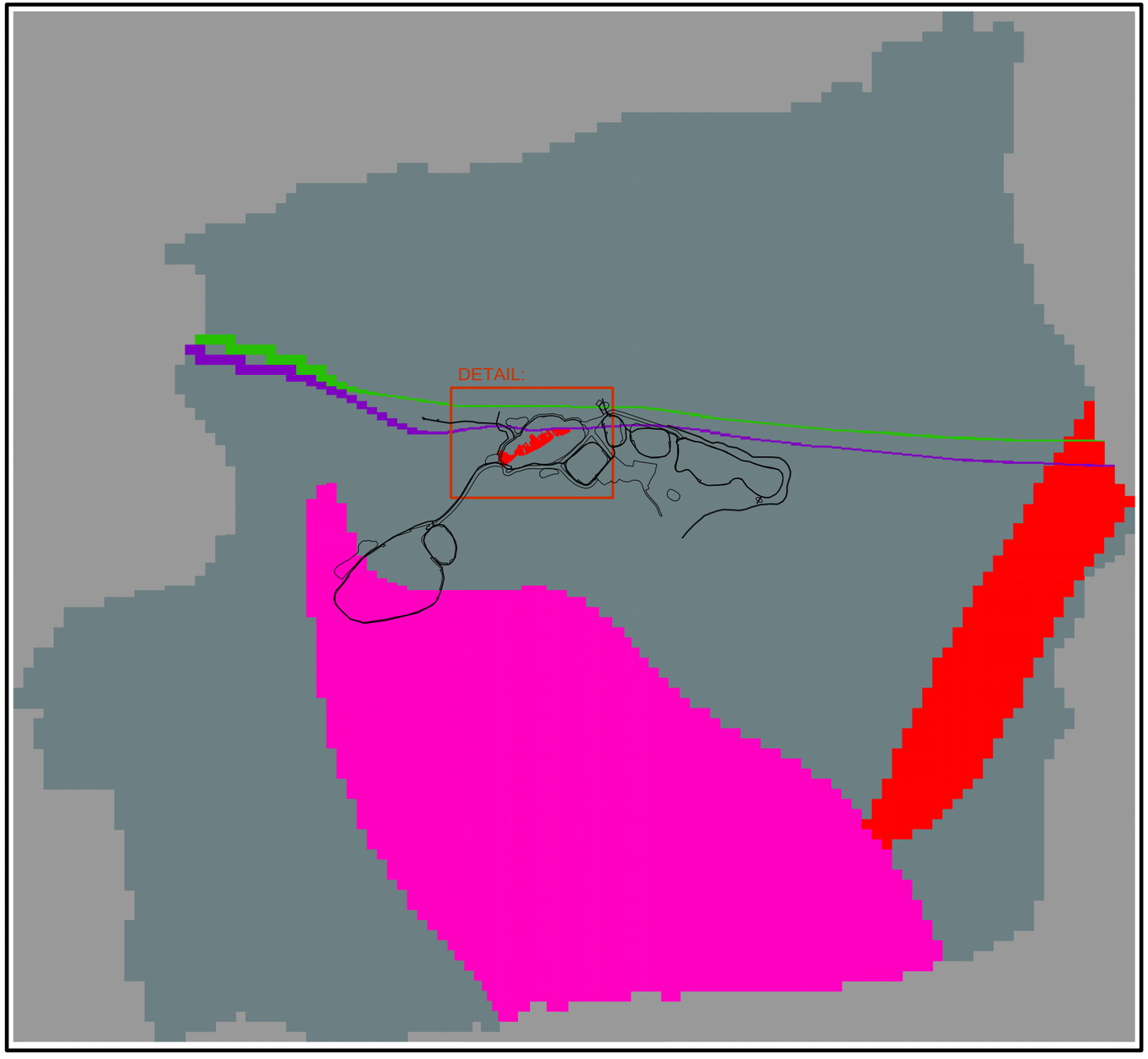
FIGURE 5.10

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.10 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 9).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

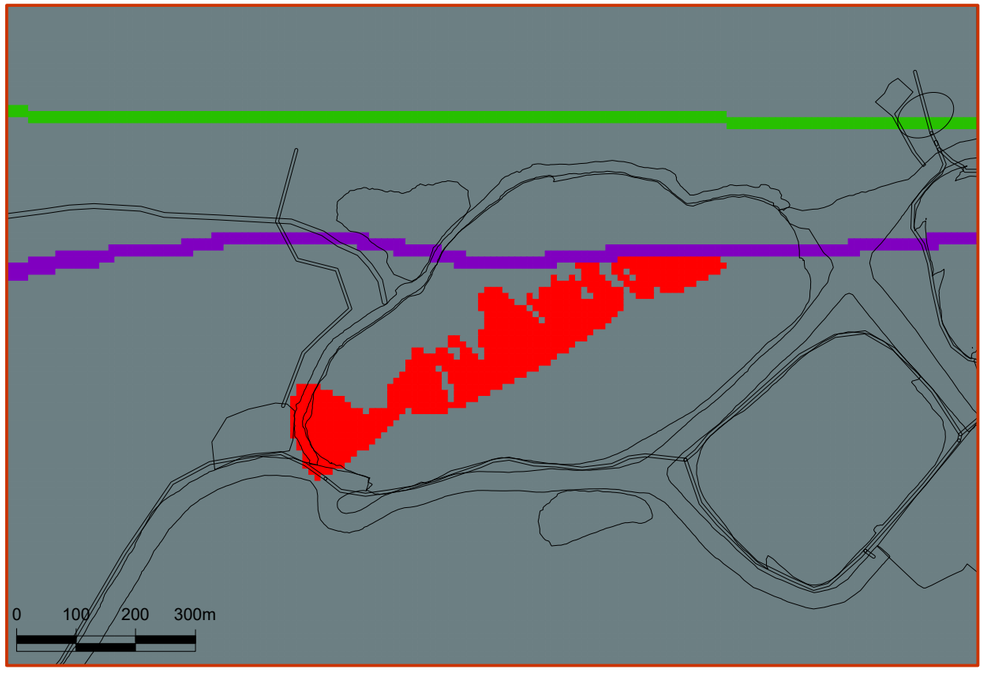
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

GHD

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

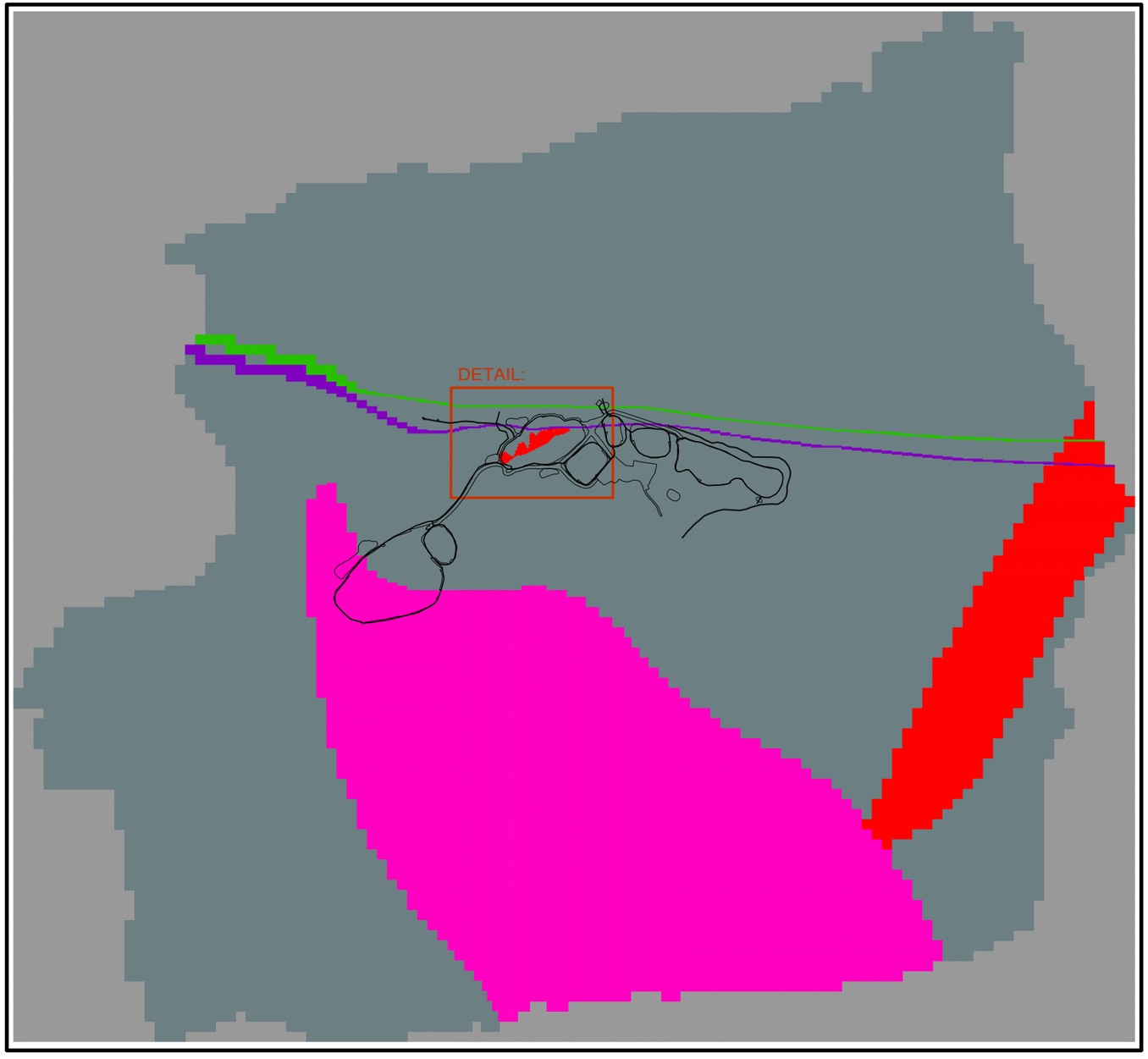
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 10)

088664-031

January 19, 2021

FIGURE 5.11

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.11 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 10).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

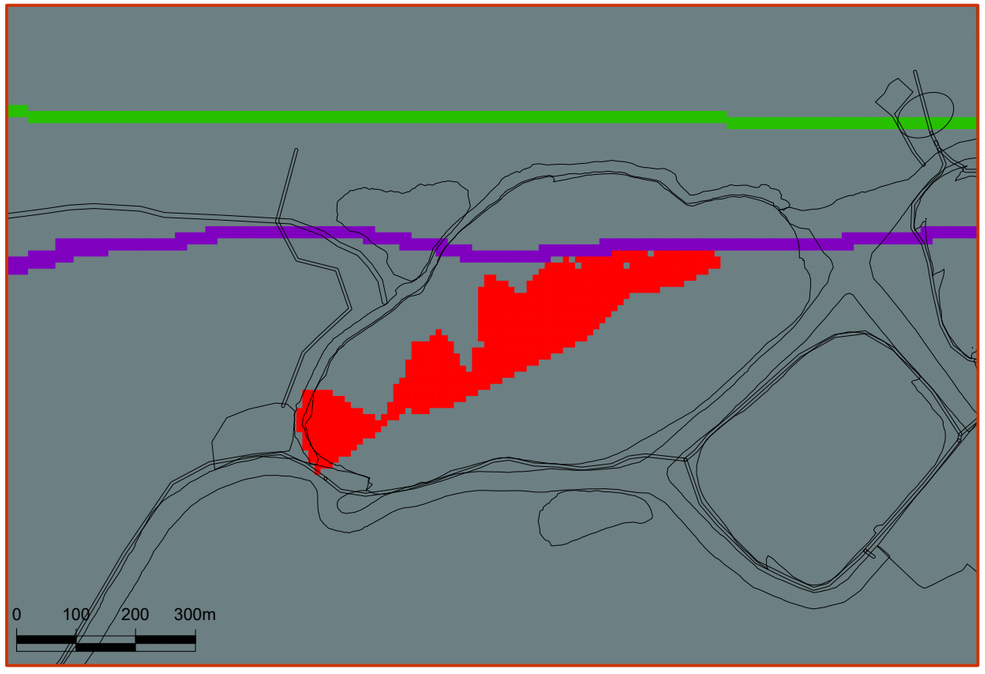
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

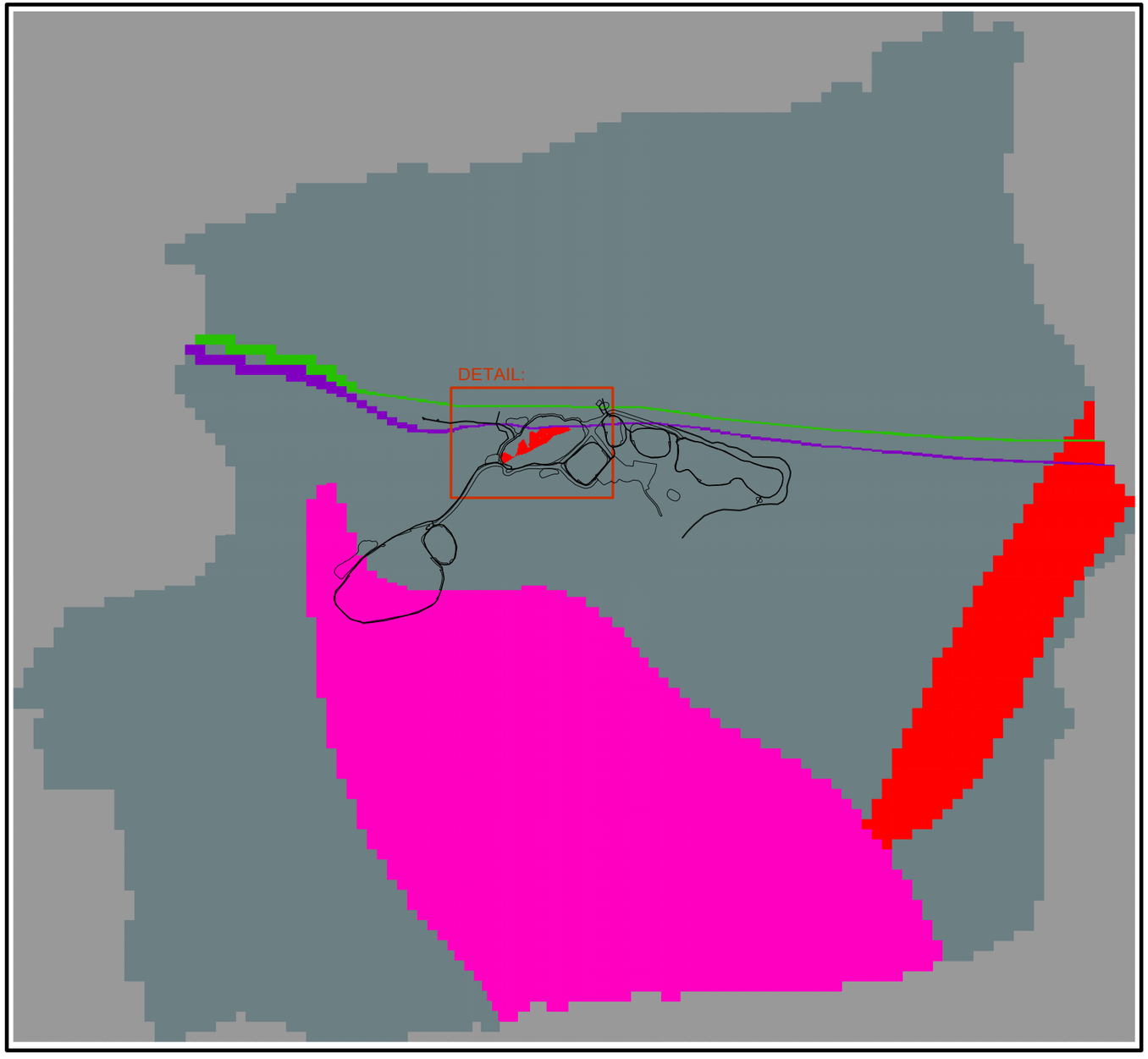
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 11)

088664-031

January 19, 2021

FIGURE 5.12

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.12 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 11).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

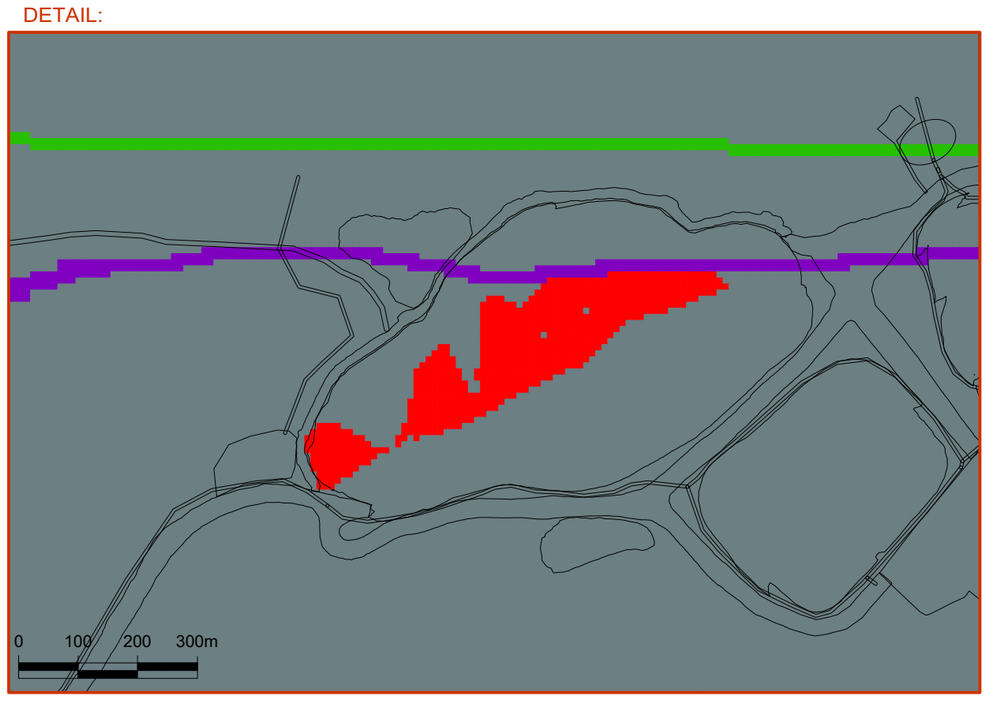
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

GHD

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

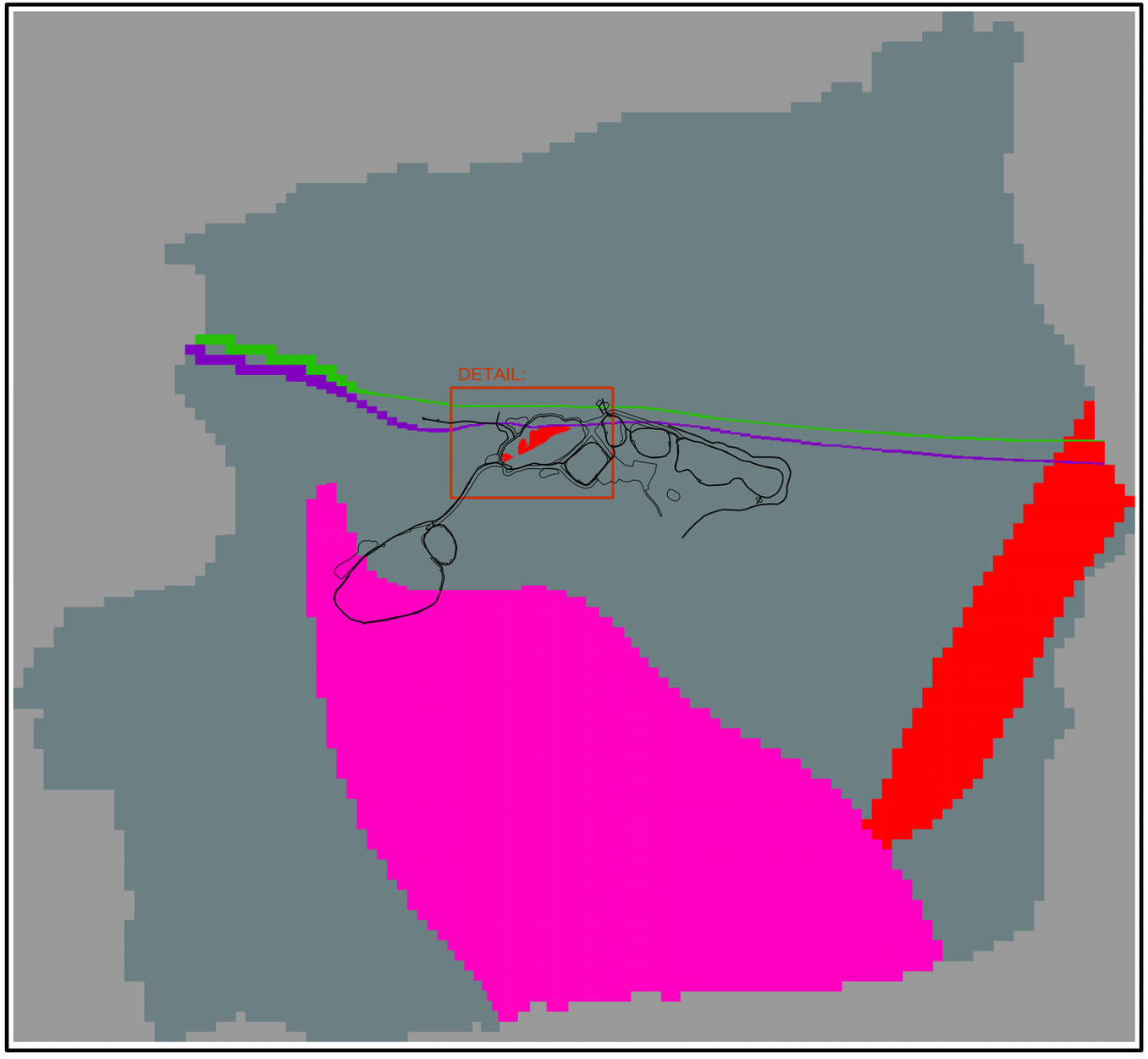
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 12)

088664-031

January 19, 2021

FIGURE 5.13

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.13 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 12).srf



LEGEND

MINE FEATURES

NO-FLOW BOUNDARY CONDITION

HYDRAULIC CONDUCTIVITY ZONES

DEEP BEDROCK GREYWACKE FORMATION

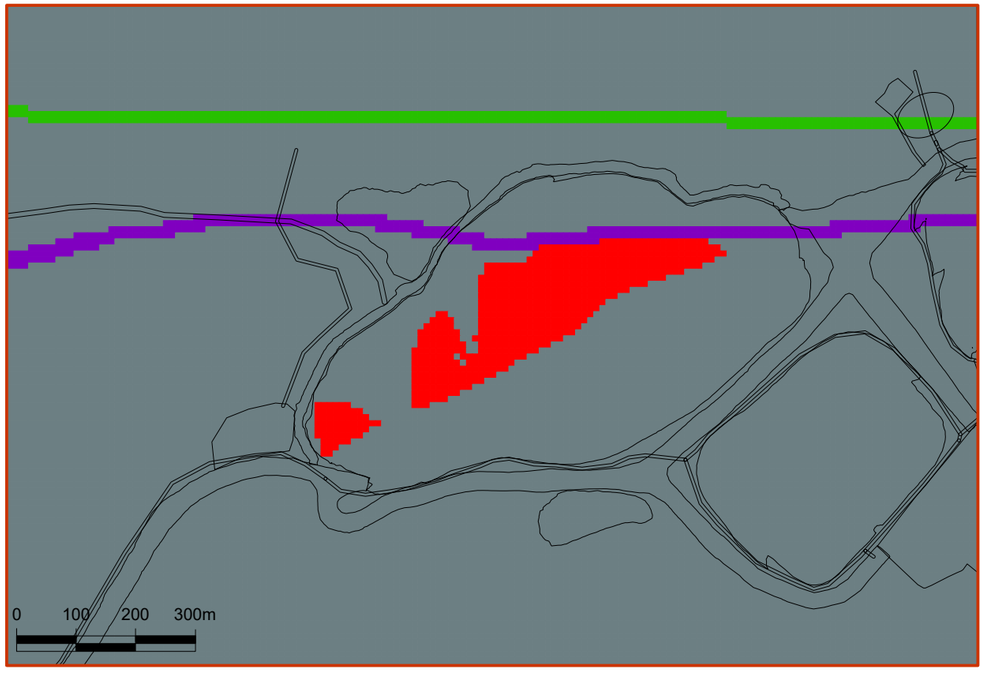
DEEP BEDROCK GRANITE FORMATION

DEEP BEDROCK ARGILLITE FORMATION

DEEP MUD LAKE FAULT

DEEP CAMERON FLOWAGE FAULT

DETAIL:



0 500 1,000 1,500m

GHD

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

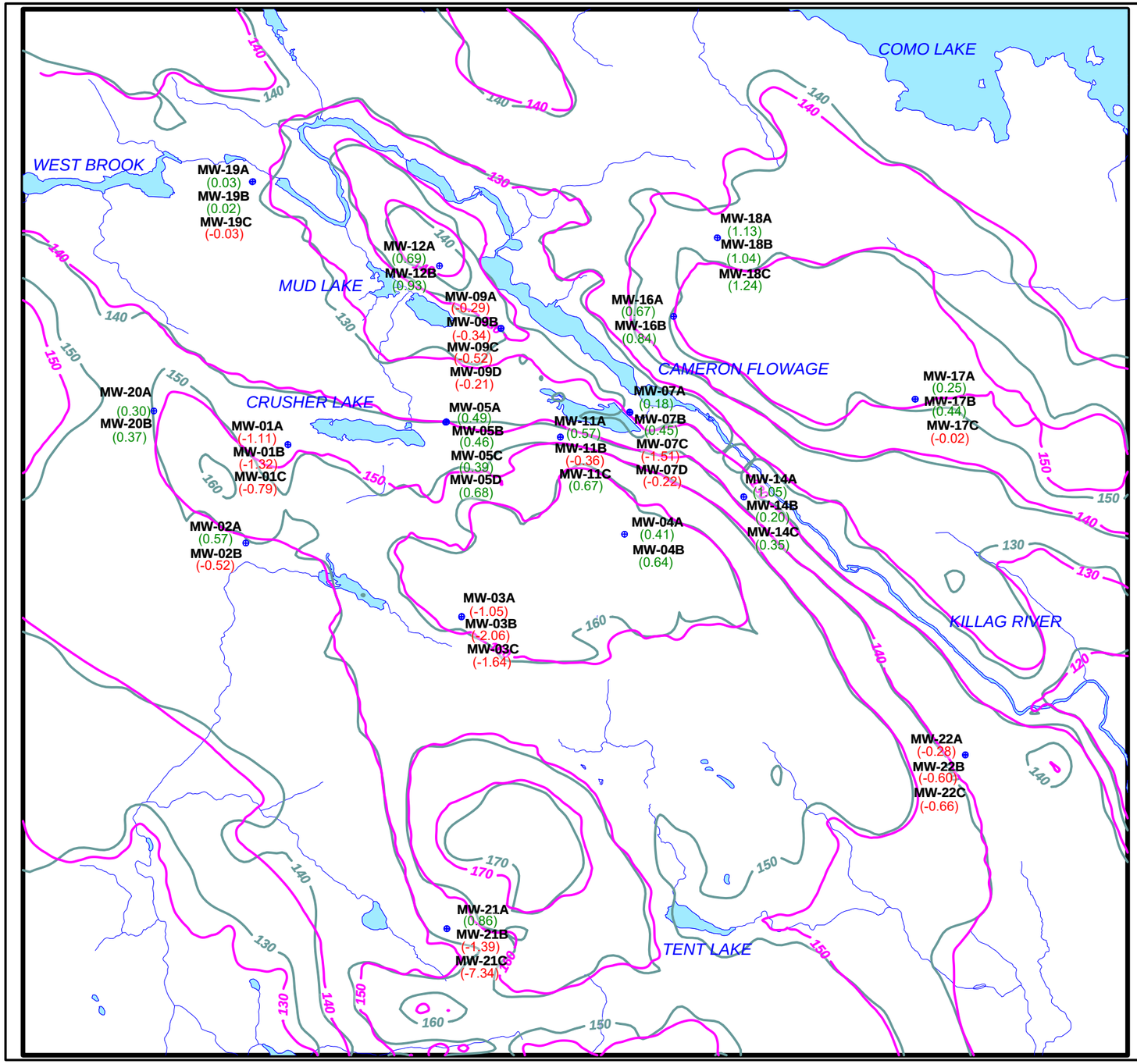
HYDRAULIC CONDUCTIVITY DISTRIBUTION IN DEEP BEDROCK (LAYER 13)

088664-031

January 19, 2021

FIGURE 5.14

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 5.14 - Hydraulic Conductivity Distribution in Deep Bedrock (Layer 13).srf



LEGEND

- SURFACE WATER BODY
- MW-17A ⊕ — WATER LEVEL MONITORING LOCATION
- (0.03) — UNDER-PREDICTION OF OBSERVED GROUNDWATER ELEVATION (m)
- (-0.21) — OVER-PREDICTION OF OBSERVED GROUNDWATER ELEVATION (m)
- 140 — OBSERVED GROUNDWATER ELEVATION CONTOURS - JULY 18, 2018 (m AMSL)
- 140 — SIMULATED GROUNDWATER ELEVATION CONTOURS - JULY 18, 2018 (m AMSL)

0 600 1,200 1,800m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

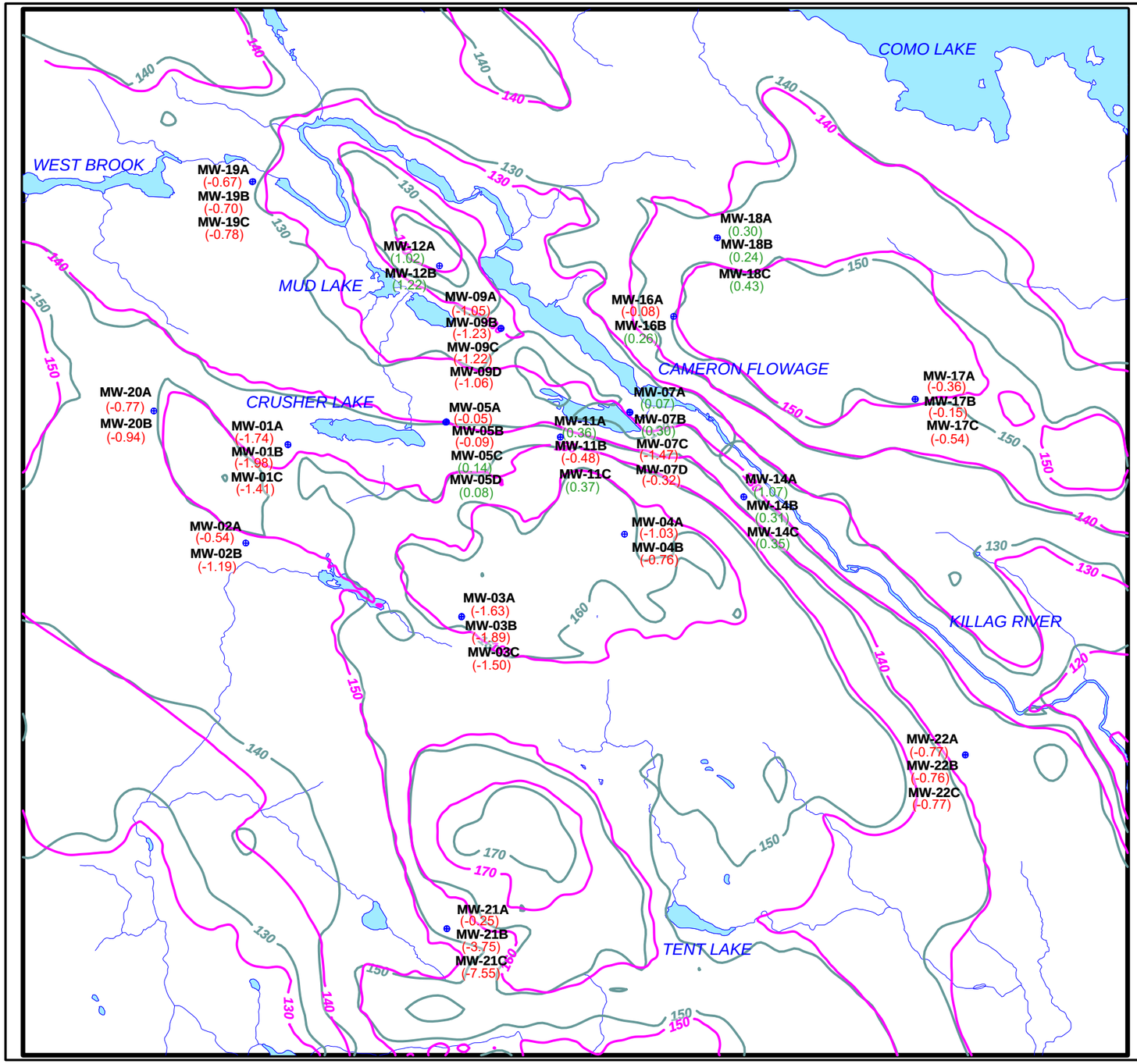
SIMULATE VERSUS OBSERVED GROUNDWATER ELEVATION CONTOURS - BASE CASE CONDITION

088664-031

November 13, 2019

FIGURE 6.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 6.1 - Simulate versus Observed Groundwater Elevation Contours - Base Case Condition.srf



LEGEND

- SURFACE WATER BODY
- MW-17A ⊕ — WATER LEVEL MONITORING LOCATION
- (0.11) — UNDER-PREDICTION OF OBSERVED GROUNDWATER ELEVATION (m)
- (-0.54) — OVER-PREDICTION OF OBSERVED GROUNDWATER ELEVATION (m)
- 140 — OBSERVED GROUNDWATER ELEVATION CONTOURS - SEPTEMBER 5, 2018 (m AMSL)
- 140 — SIMULATED GROUNDWATER ELEVATION CONTOURS - SEPTEMBER 5, 2018 (m AMSL)

0 600 1,200 1,800m

N

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

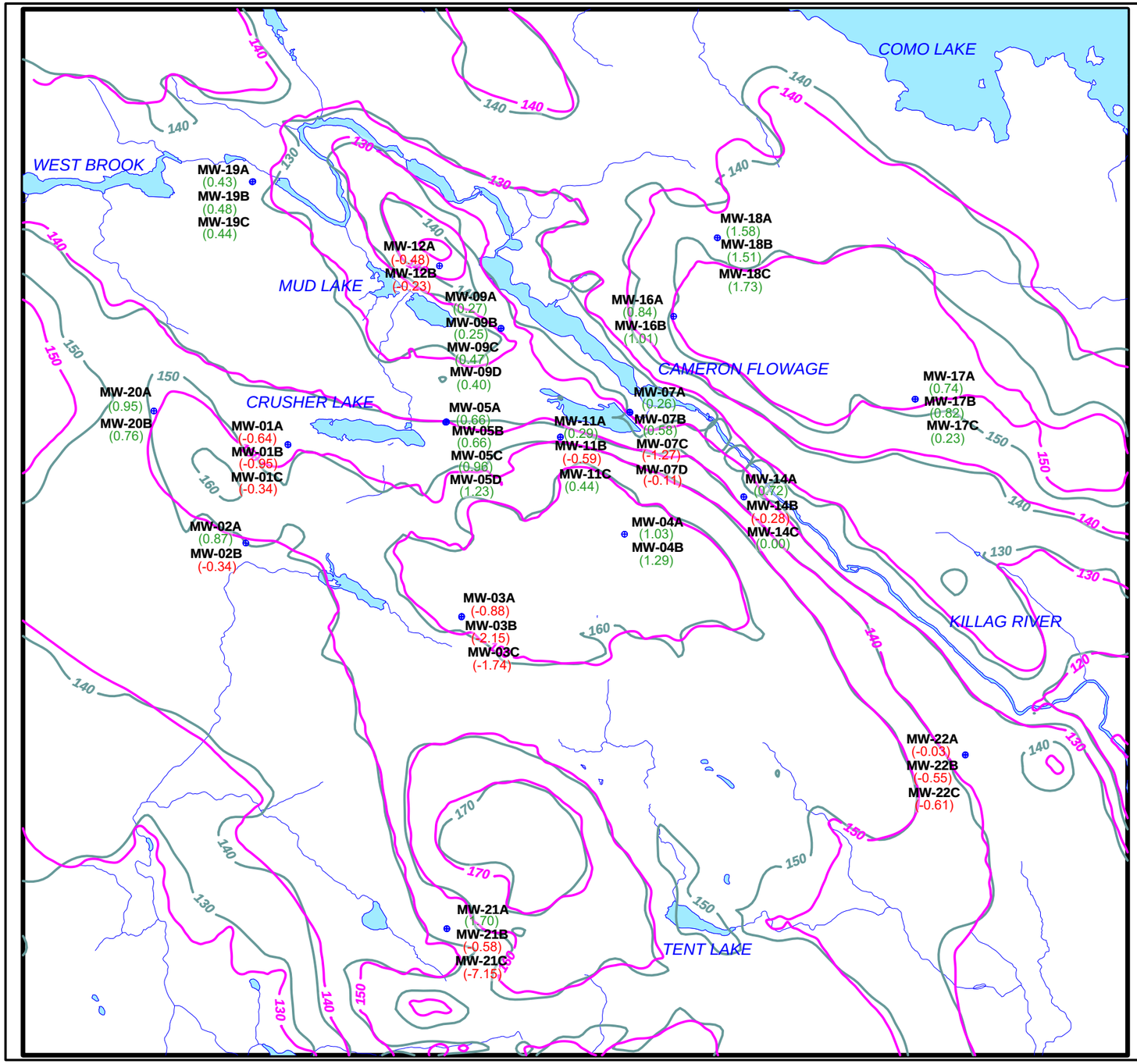
SIMULATE VERSUS OBSERVED GROUNDWATER ELEVATION CONTOURS - DRY CONDITION

088664-031

November 13, 2019

FIGURE 6.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 6.2 - Simulate versus Observed Groundwater Elevation Contours - Dry Condition.srf



LEGEND

- SURFACE WATER BODY
- MW-17A ⊕ — WATER LEVEL MONITORING LOCATION
- (0.74) — UNDER-PREDICTION OF OBSERVED GROUNDWATER ELEVATION (m)
- (-0.33) — OVER-PREDICTION OF OBSERVED GROUNDWATER ELEVATION (m)
- 140 — OBSERVED GROUNDWATER ELEVATION CONTOURS - JULY 18, 2018 (m AMSL)
- 140 — SIMULATED GROUNDWATER ELEVATION CONTOURS - JULY 18, 2018 (m AMSL)

0 600 1,200 1,800m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

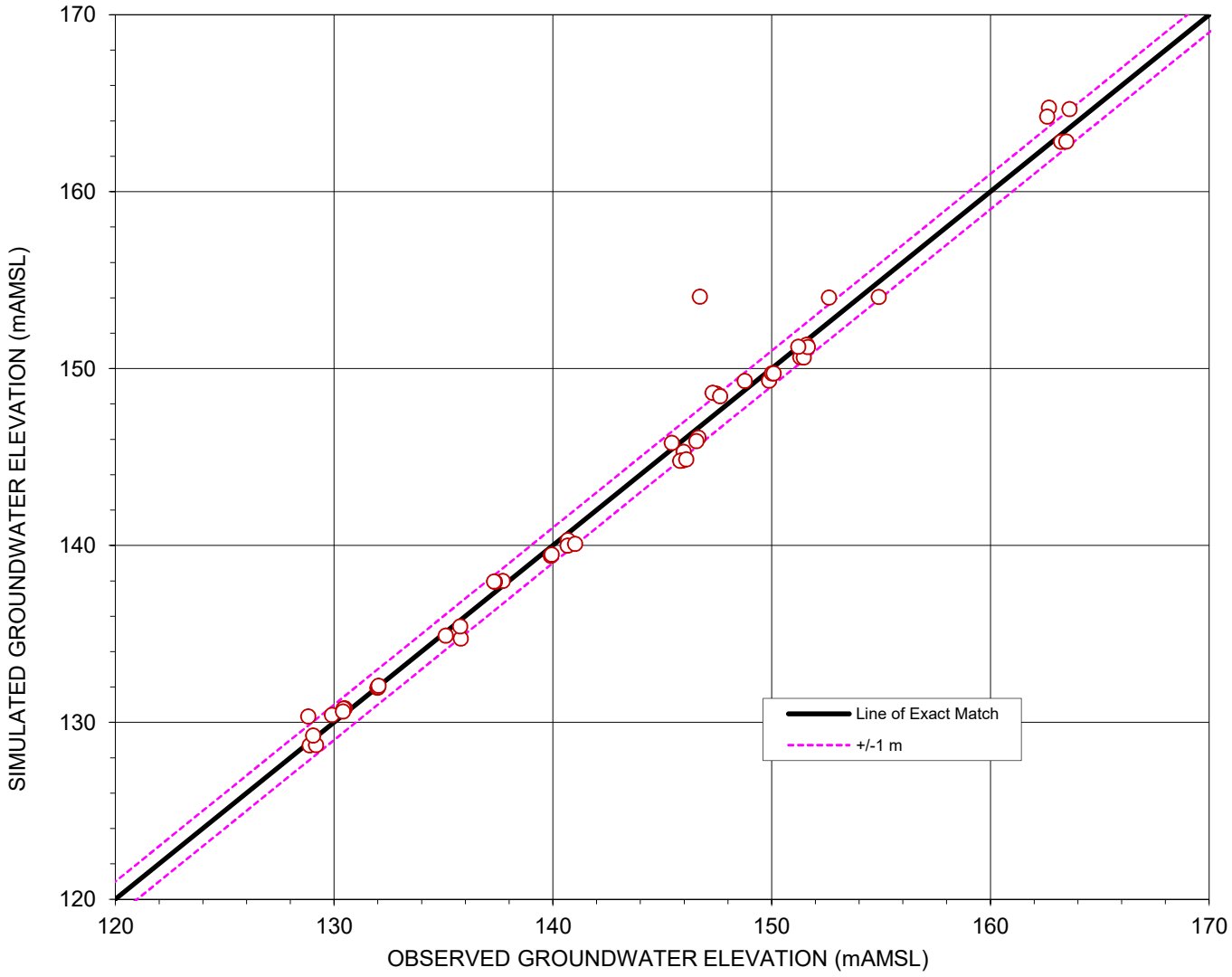
SIMULATE VERSUS OBSERVED GROUNDWATER ELEVATION CONTOURS - WET CONDITION

088664-031

November 13, 2019

FIGURE 6.3

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 6.3 - Simulate versus Observed Groundwater Elevation Contours - Wet Condition.srf

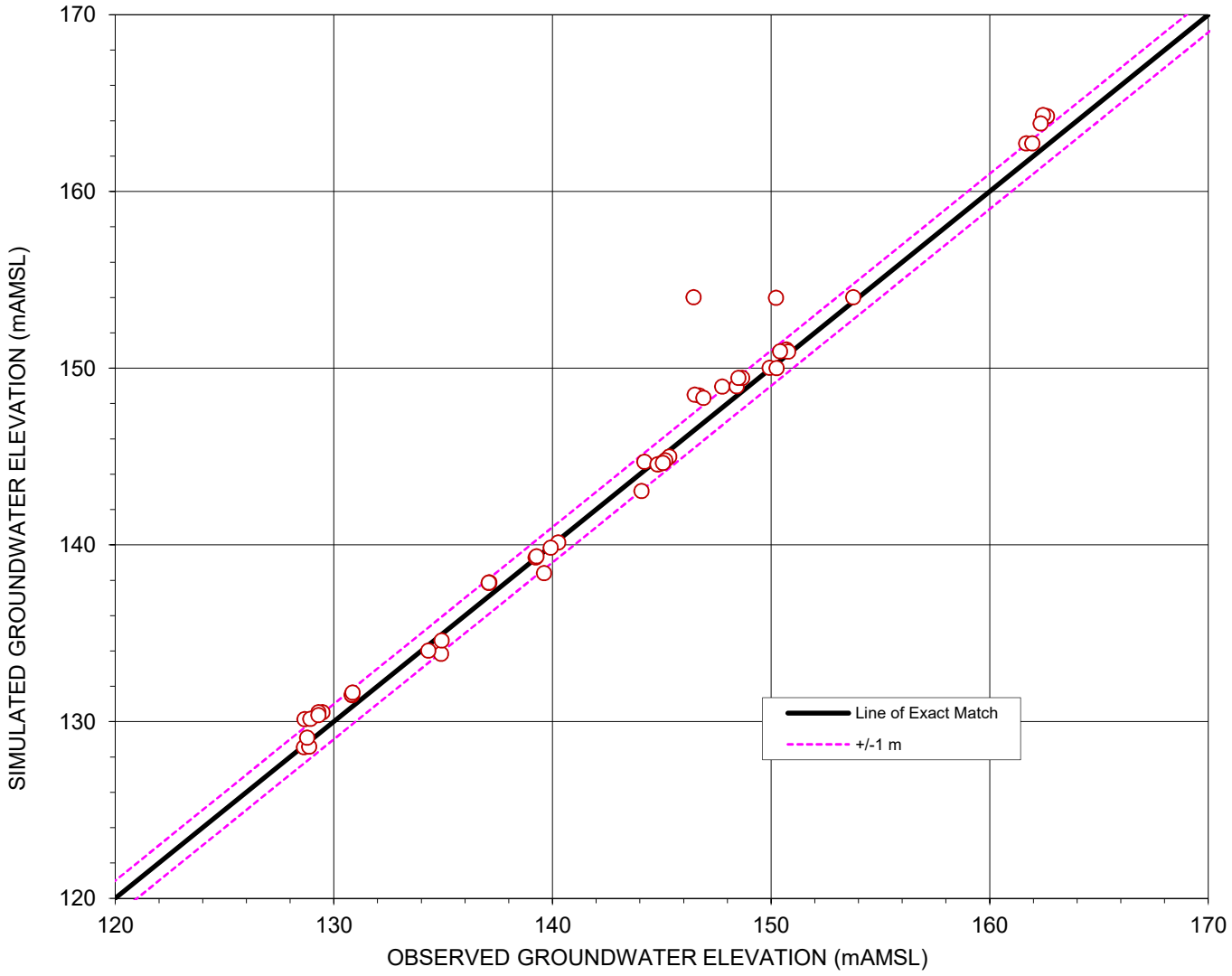


CALIBRATION STATISTICS

NUMBER OF OBSERVATIONS =	49
RESIDUAL MEAN (m) =	-0.13
ABSOLUTE RESIDUAL MEAN (m) =	0.78
RESIDUAL STANDARD DEVIATION (m) =	1.30
RESIDUAL SUM OF SQUARES (m^2) =	83.42
MINIMUM RESIDUAL (m) =	-7.34
MAXIMUM RESIDUAL (m) =	1.24
OBSERVED HEAD RANGE (m) =	34.80
STANDARD DEVIATION/HEAD RANGE =	0.037
SCALED RMSE (%) =	3.7%

figure 6.4

SCATTER PLOT OF SIMULATED VS. OBSERVED
GROUNDWATER ELEVATIONS - BASE CASE CONDITION
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
Beaver Dam Mine

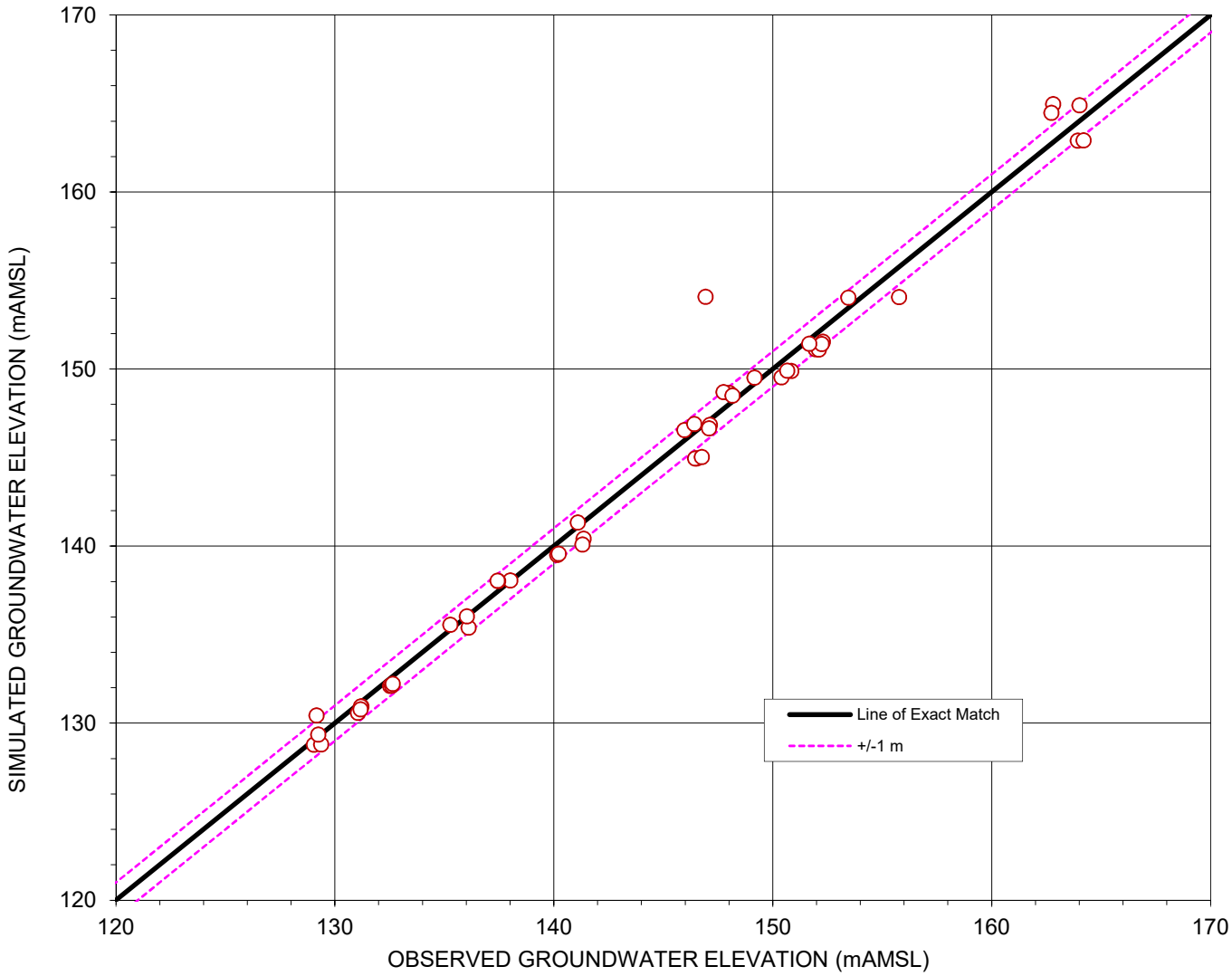


CALIBRATION STATISTICS

NUMBER OF OBSERVATIONS =	49
RESIDUAL MEAN (m) =	-0.67
ABSOLUTE RESIDUAL MEAN (m) =	0.94
RESIDUAL STANDARD DEVIATION (m) =	1.34
RESIDUAL SUM OF SQUARES (m^2) =	109.57
MINIMUM RESIDUAL (m) =	-7.55
MAXIMUM RESIDUAL (m) =	1.22
OBSERVED HEAD RANGE (m) =	33.99
STANDARD DEVIATION/HEAD RANGE =	0.039
SCALED RMSE (%) =	4.4%

figure 6.5

SCATTER PLOT OF SIMULATED VS. OBSERVED
GROUNDWATER ELEVATIONS - DRY CONDITION
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
Beaver Dam Mine

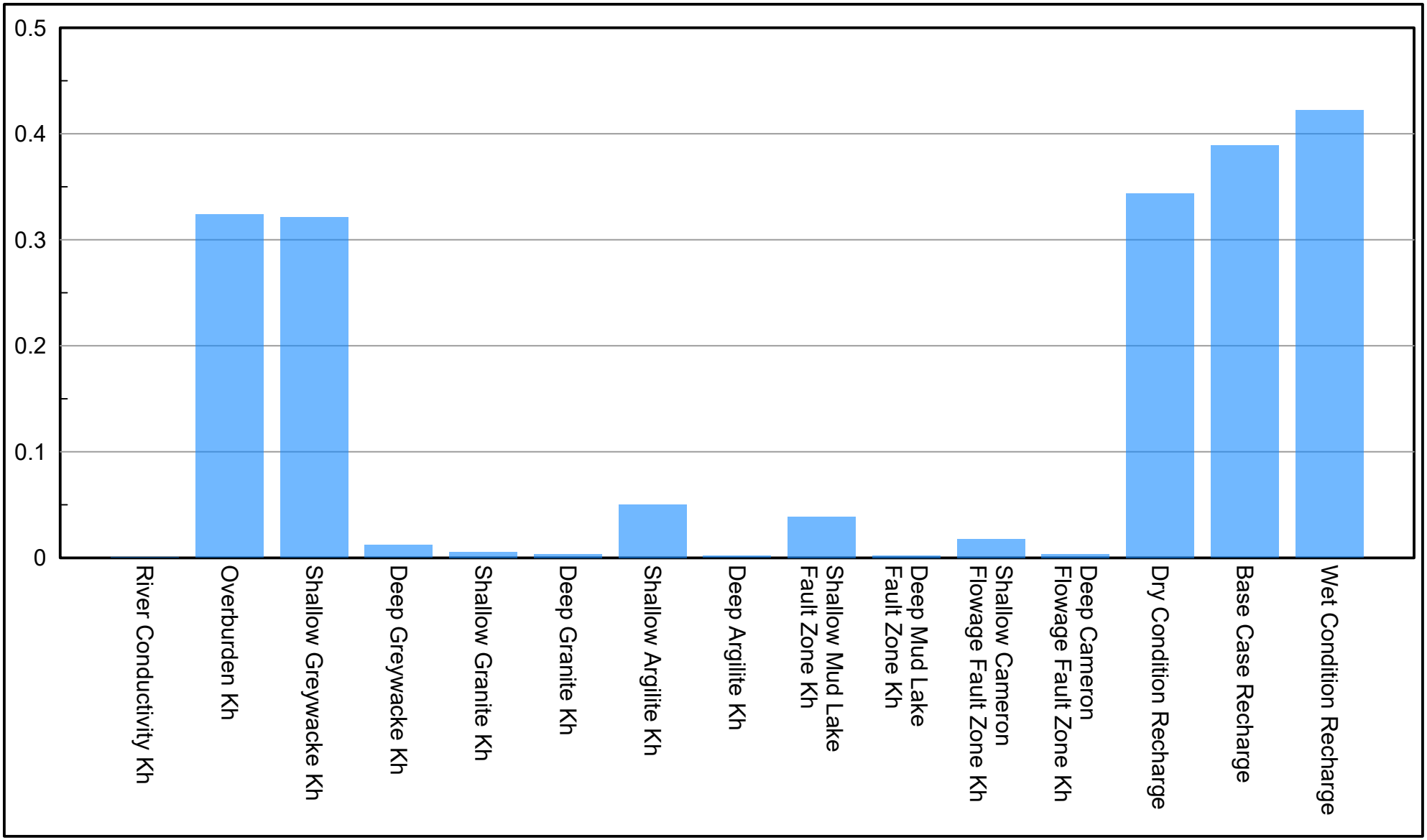


CALIBRATION STATISTICS

NUMBER OF OBSERVATIONS =	49
RESIDUAL MEAN (m) =	0.10
ABSOLUTE RESIDUAL MEAN (m) =	0.87
RESIDUAL STANDARD DEVIATION (m) =	1.34
RESIDUAL SUM OF SQUARES (m^2) =	88.66
MINIMUM RESIDUAL (m) =	-7.15
MAXIMUM RESIDUAL (m) =	1.73
OBSERVED HEAD RANGE (m) =	35.16
STANDARD DEVIATION/HEAD RANGE =	0.038
SCALED RMSE (%) =	3.8%

figure 6.6

SCATTER PLOT OF SIMULATED VS. OBSERVED
GROUNDWATER ELEVATIONS - WET CONDITION
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
Beaver Dam Mine



ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

CALIBRATED MODEL PARAMETER COMPOSITE SENSITIVITIES

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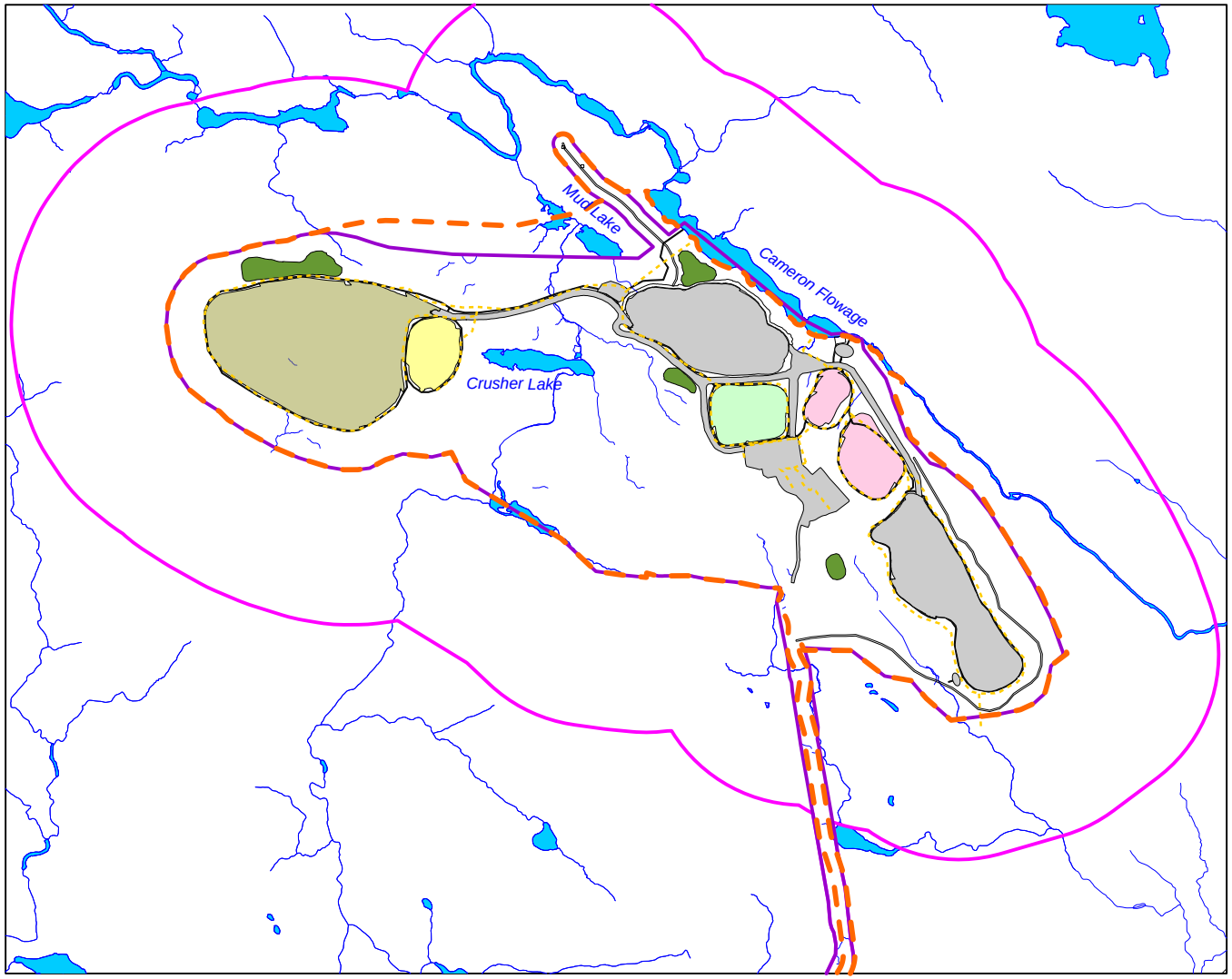
FIGURE 6.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 6.7 - Composite Sensitivities.grf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 300 600 900m

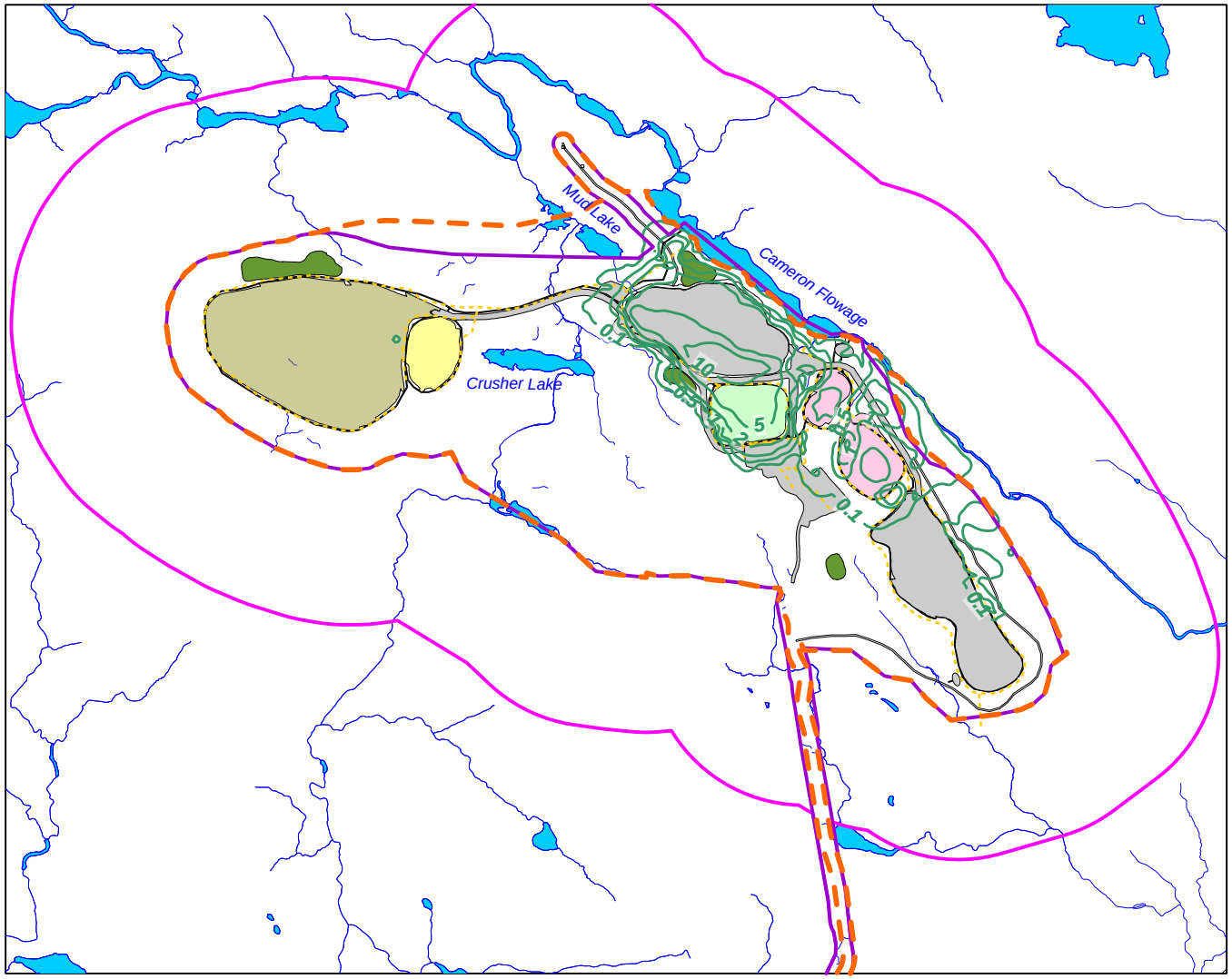
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

088664-031
March 11, 2021

SIMULATED DRAWDOWN EOM - BASE CASE CONDITION

FIGURE 7.1a

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.1a - Simulated Drawdown Base Case Condition - EOM.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 300 600 900m

N

GHD

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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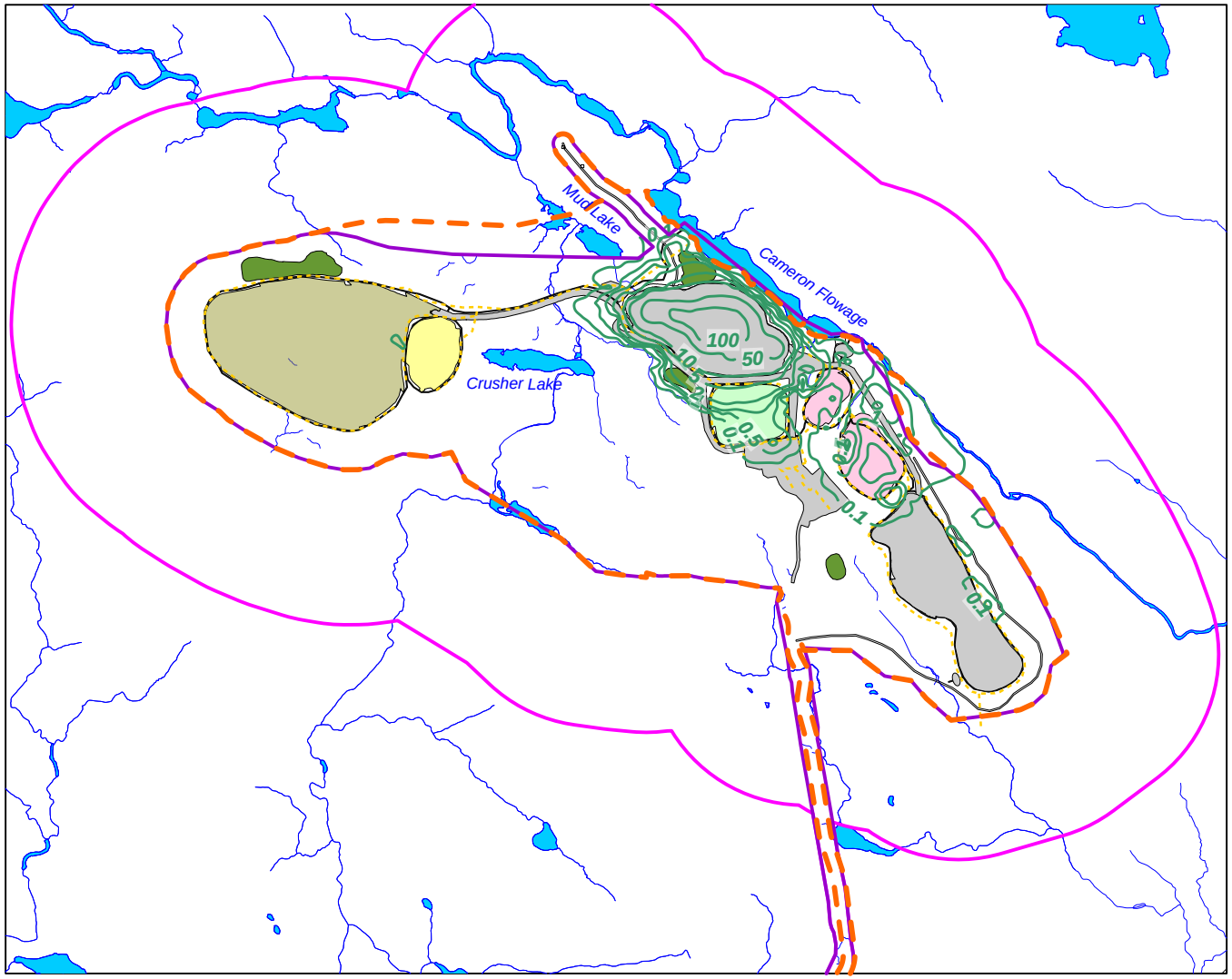
March 11, 2021

SIMULATED DRAWDOWN PC - BASE CASE CONDITION

FIGURE 7.1b

HEG file: Z:\\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.1b - Simulated Drawdown Base Case Condition - PC.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 300 600 900m

N

GHD

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

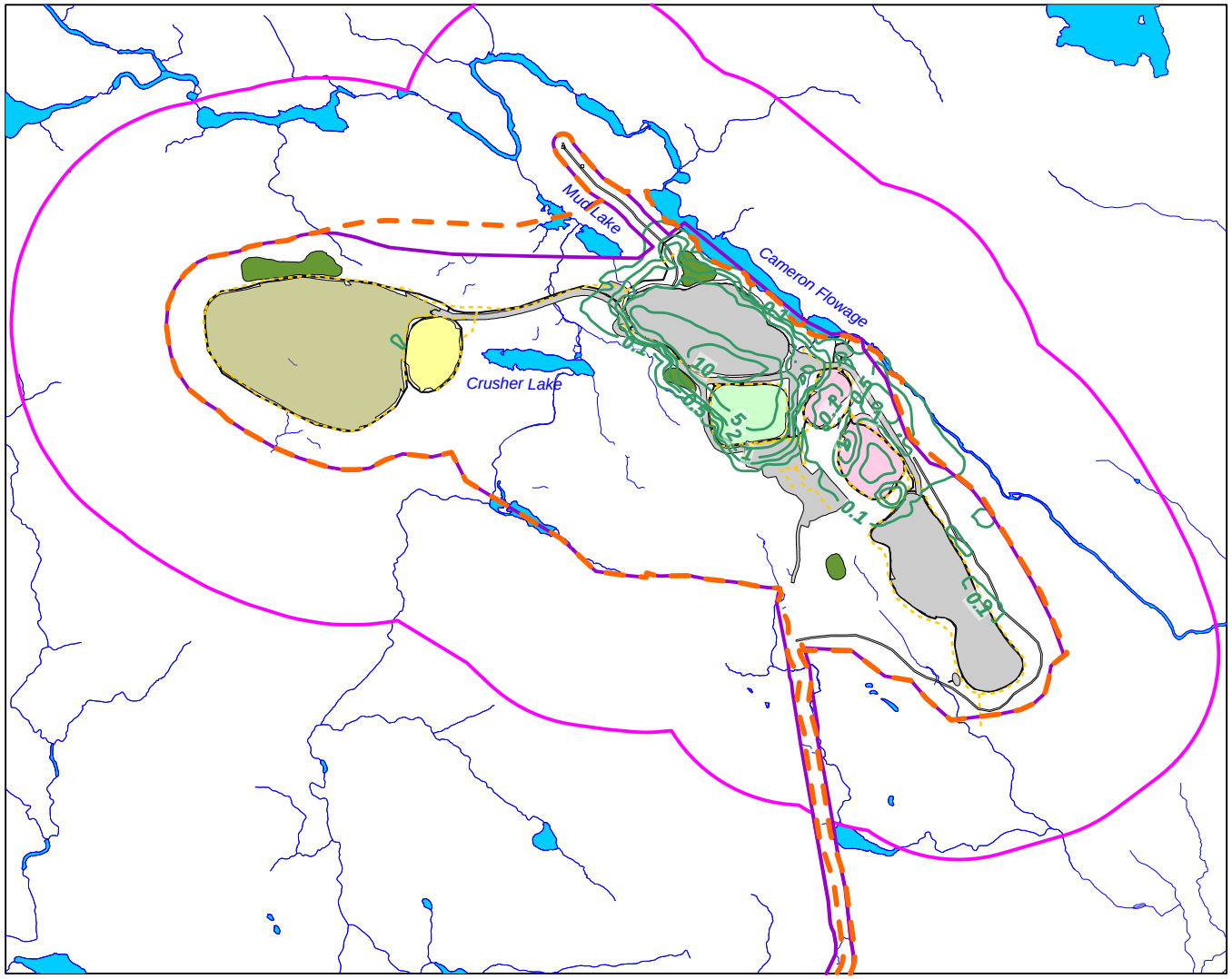
SIMULATED DRAWDOWN EOM - DRY CONDITION

088664-031

March 11, 2021

FIGURE 7.2a

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.2a - Simulated Drawdown Dry Condition - EOM.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 300 600 900m

N

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED DRAWDOWN PC - DRY CONDITION

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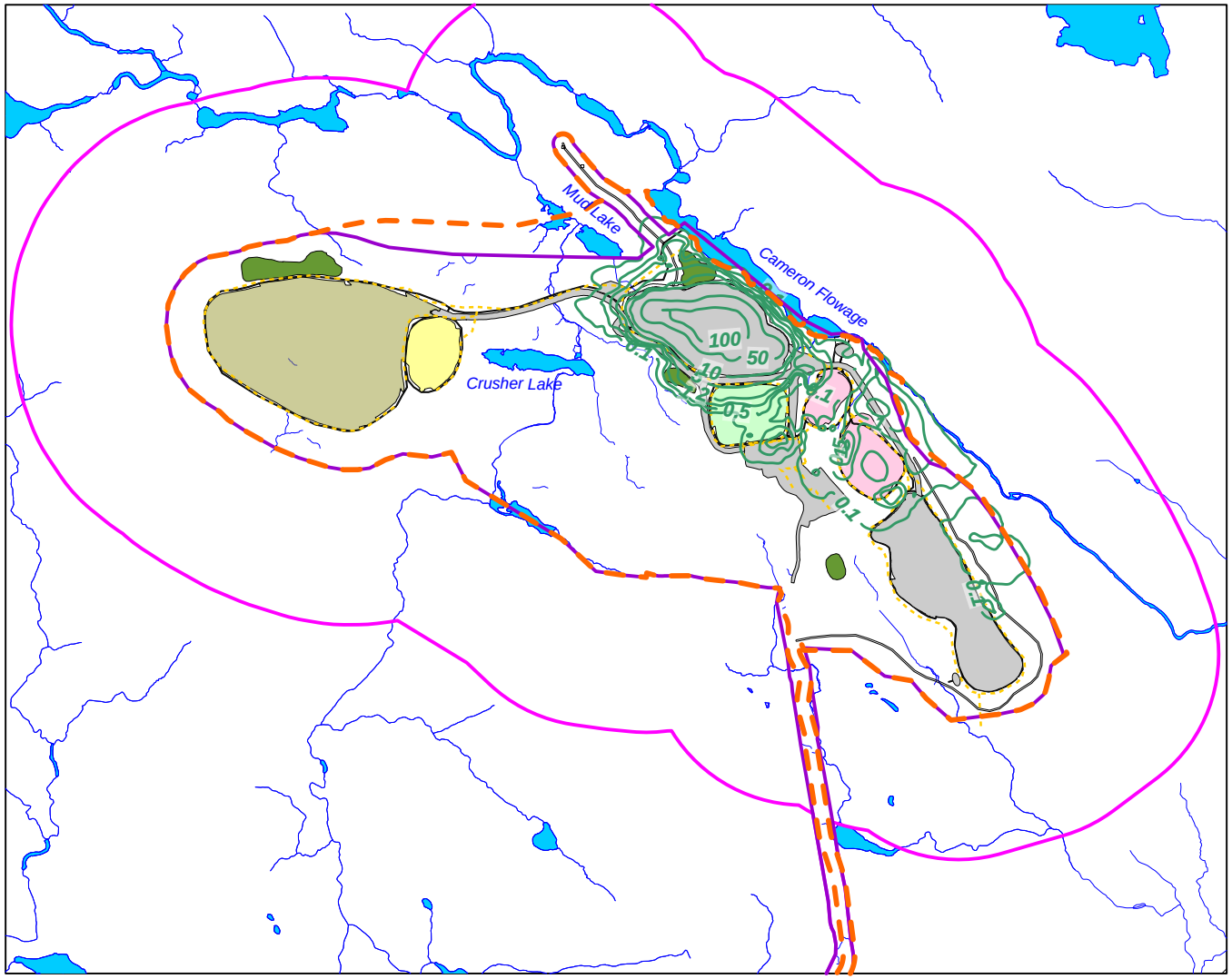
FIGURE 7.2b

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.2b - Simulated Drawdown Dry Condition - PC.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED DRAWDOWN EOM - WET CONDITION

088664-031

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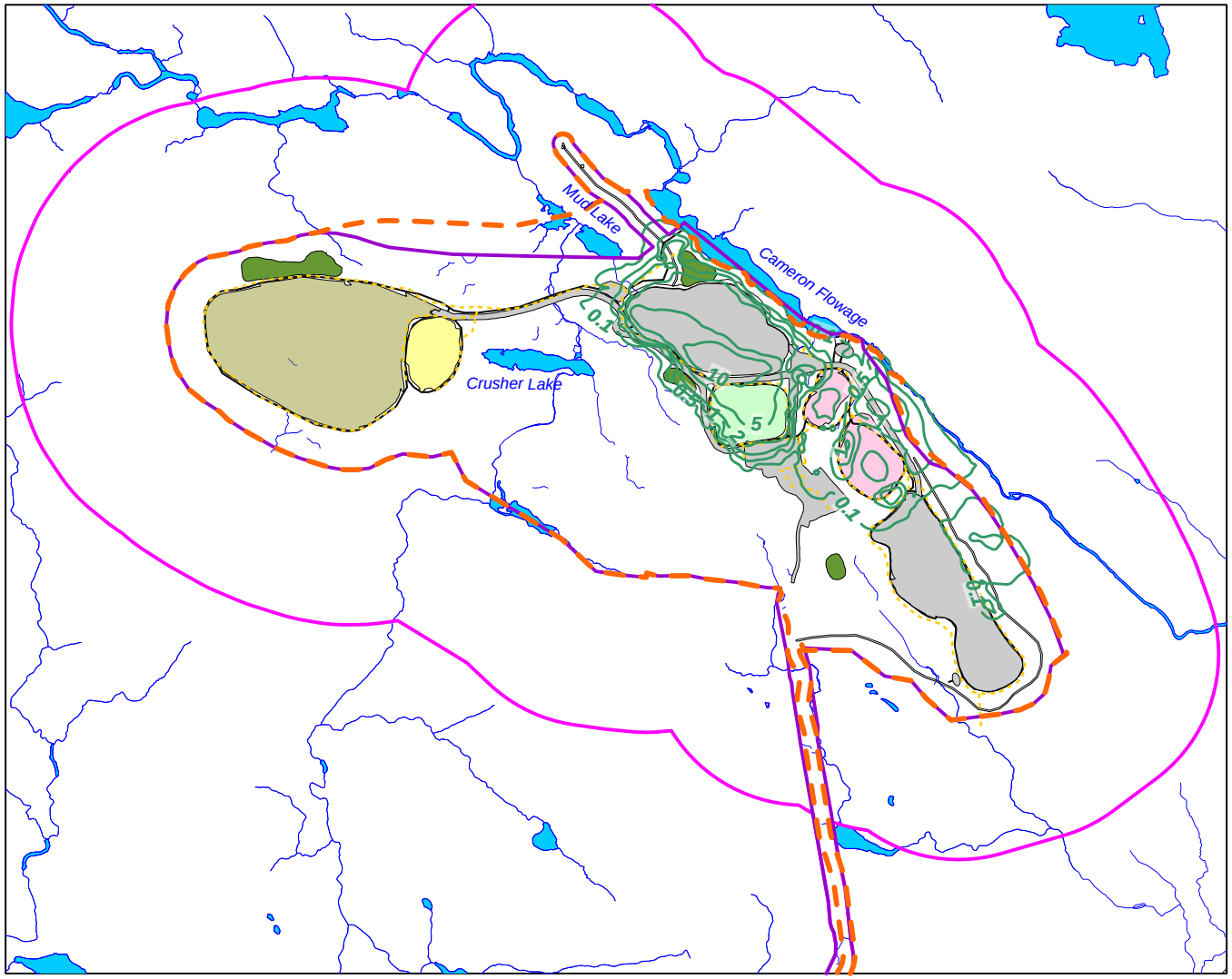
FIGURE 7.3a

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.3a - Simulated Drawdown Wet Condition - EOM.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 300 600 900m

N

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SIMULATED DRAWDOWN PC - WET CONDITION

088664-031

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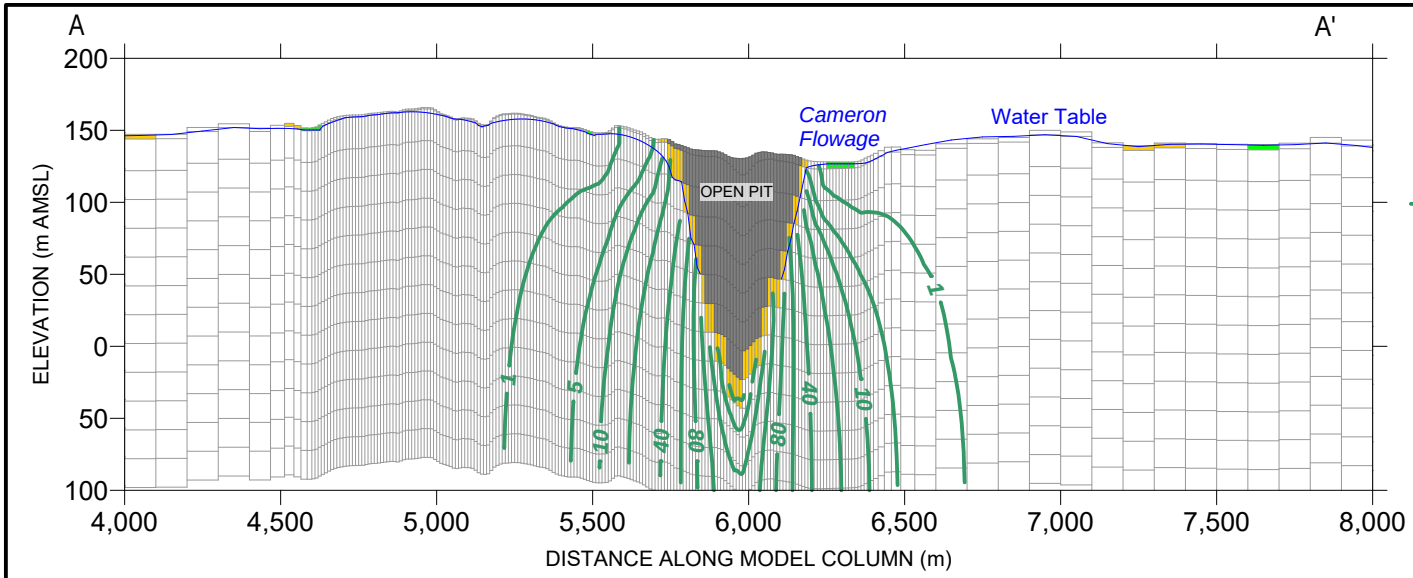
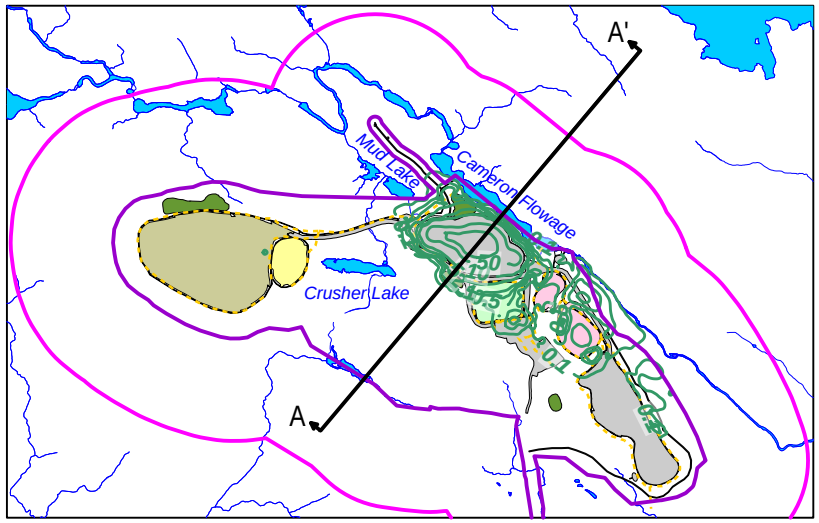
FIGURE 7.3b

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.3b - Simulated Drawdown Wet Condition - PC.srf





LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- FINITE-DIFFERENCE GRID
- NO-FLOW BOUNDARY CONDITION
- DRAIN BOUNDARY CONDITION

0 500 1000 1500m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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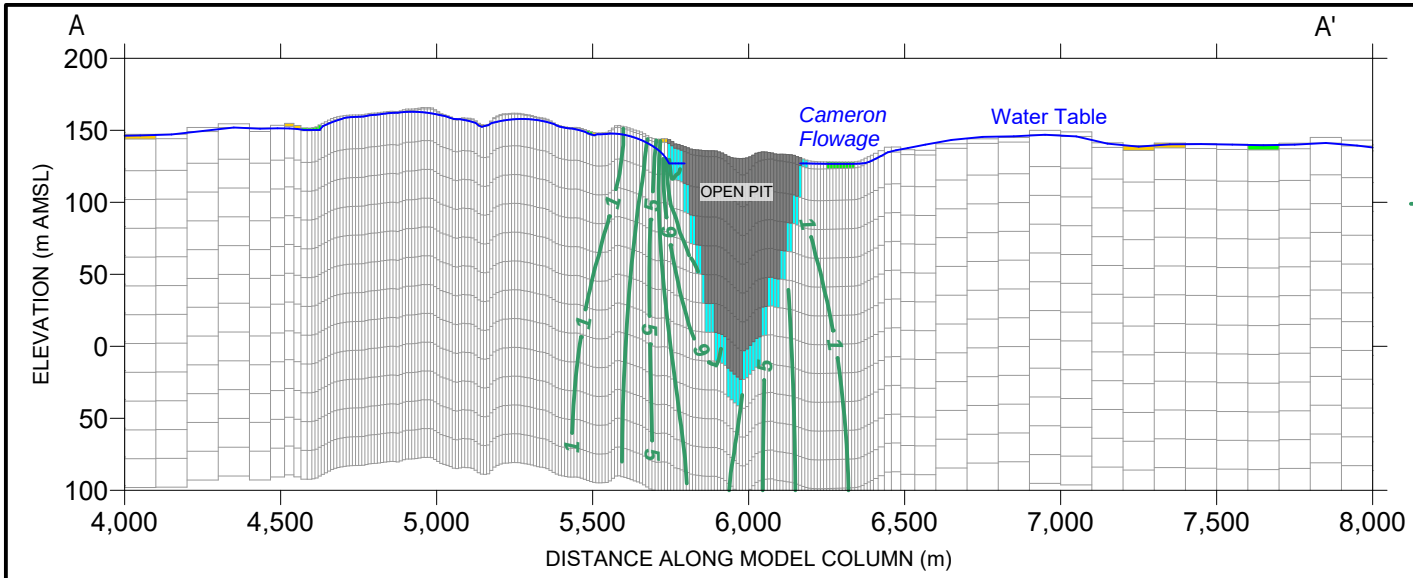
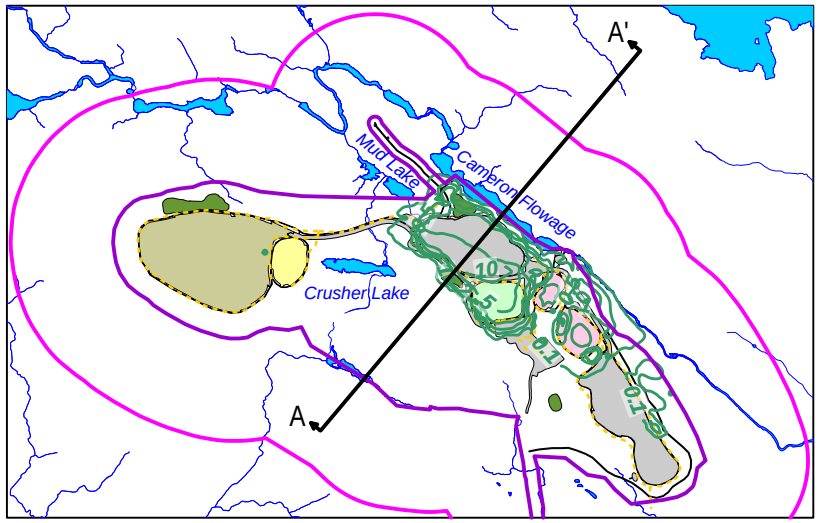
SIMULATED DRAWDOWN THROUGH OPEN PIT (EOM - BASE CASE CONDITION)

FIGURE 7.4a

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.4a - Simulated Drawdown Base Case Condition - EOM.srf





LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- FINITE-DIFFERENCE GRID
- NO-FLOW BOUNDARY CONDITION
- DRAIN BOUNDARY CONDITION
- GENERAL HEAD BOUNDARY CONDITION

0 500 1000 1500m

N

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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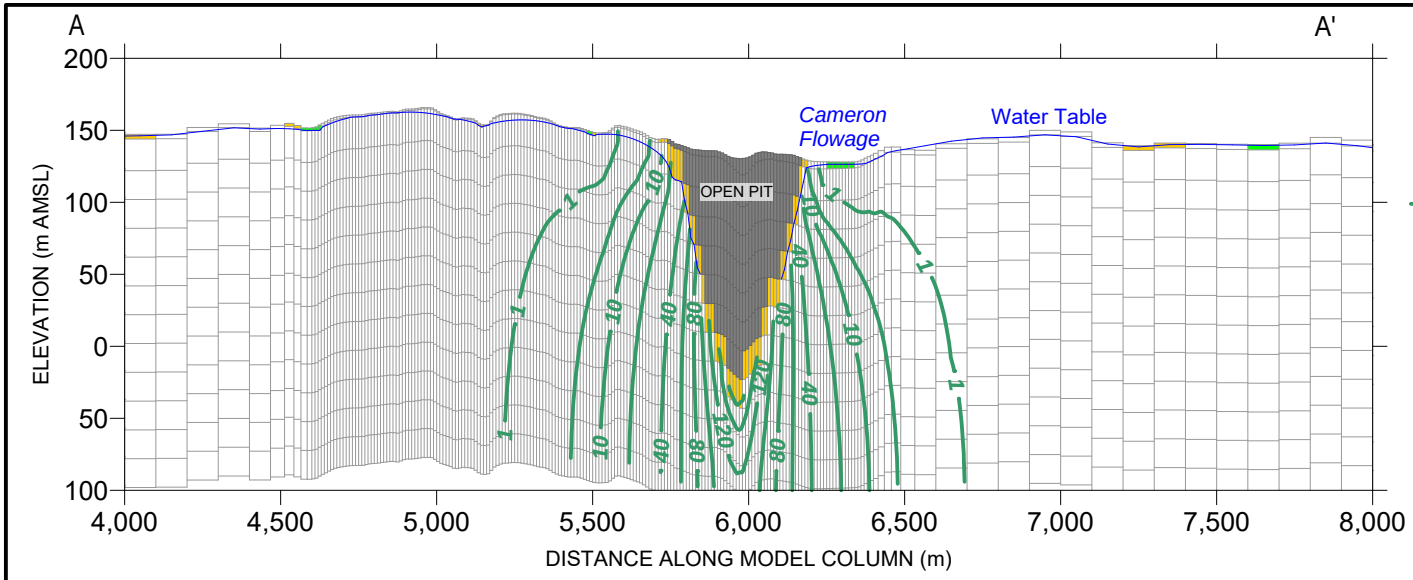
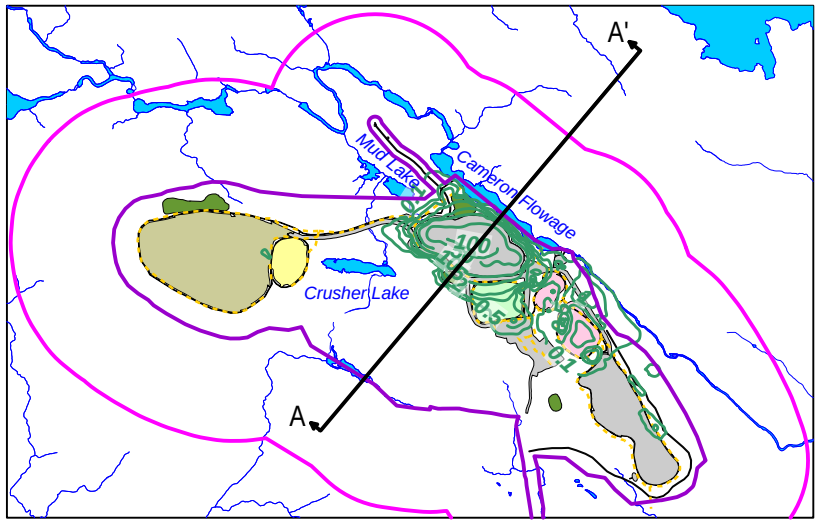
SIMULATED DRAWDOWN THROUGH OPEN PIT (PC - BASE CASE CONDITION)

FIGURE 7.4b

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.4b - Simulated Drawdown Base Case Condition - PC.srf





LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- FINITE-DIFFERENCE GRID
- NO-FLOW BOUNDARY CONDITION
- DRAIN BOUNDARY CONDITION

0 500 1000 1500m

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

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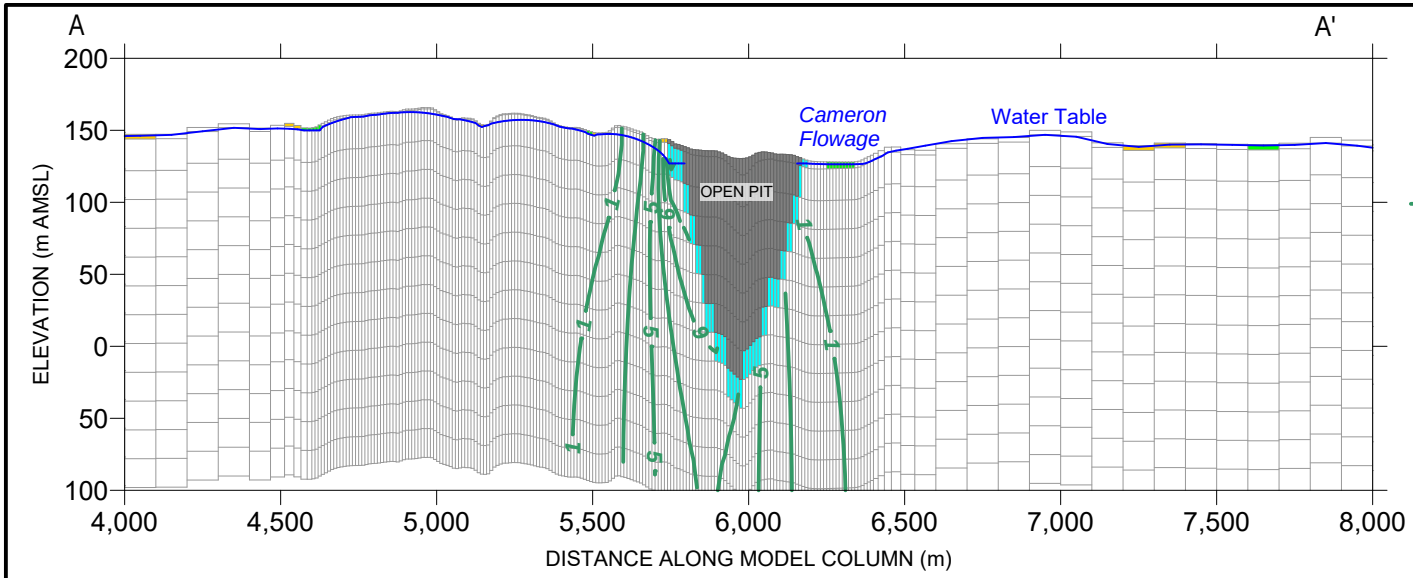
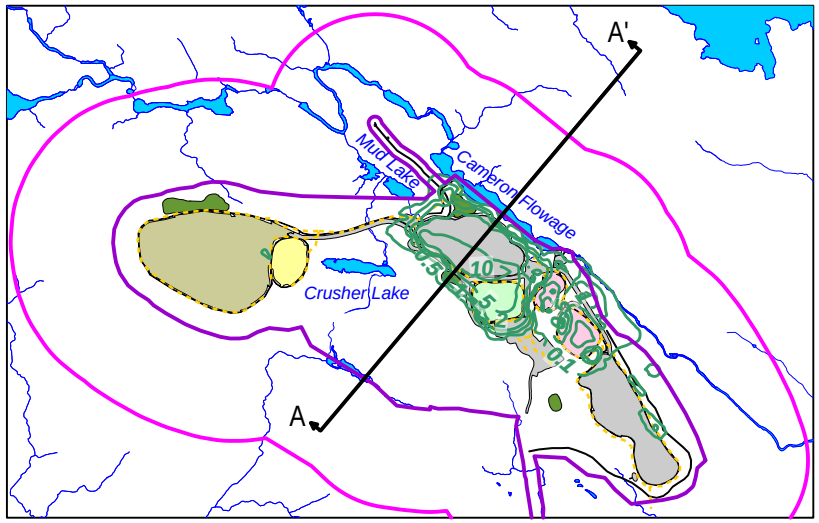
SIMULATED DRAWDOWN THROUGH OPEN PIT (EOM - DRY CONDITION)

FIGURE 7.5a

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.5a - Simulated Drawdown Dry Condition - EOM.srf





LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- FINITE-DIFFERENCE GRID
- NO-FLOW BOUNDARY CONDITION
- DRAIN BOUNDARY CONDITION
- GENERAL HEAD BOUNDARY CONDITION

0 500 1000 1500m

N

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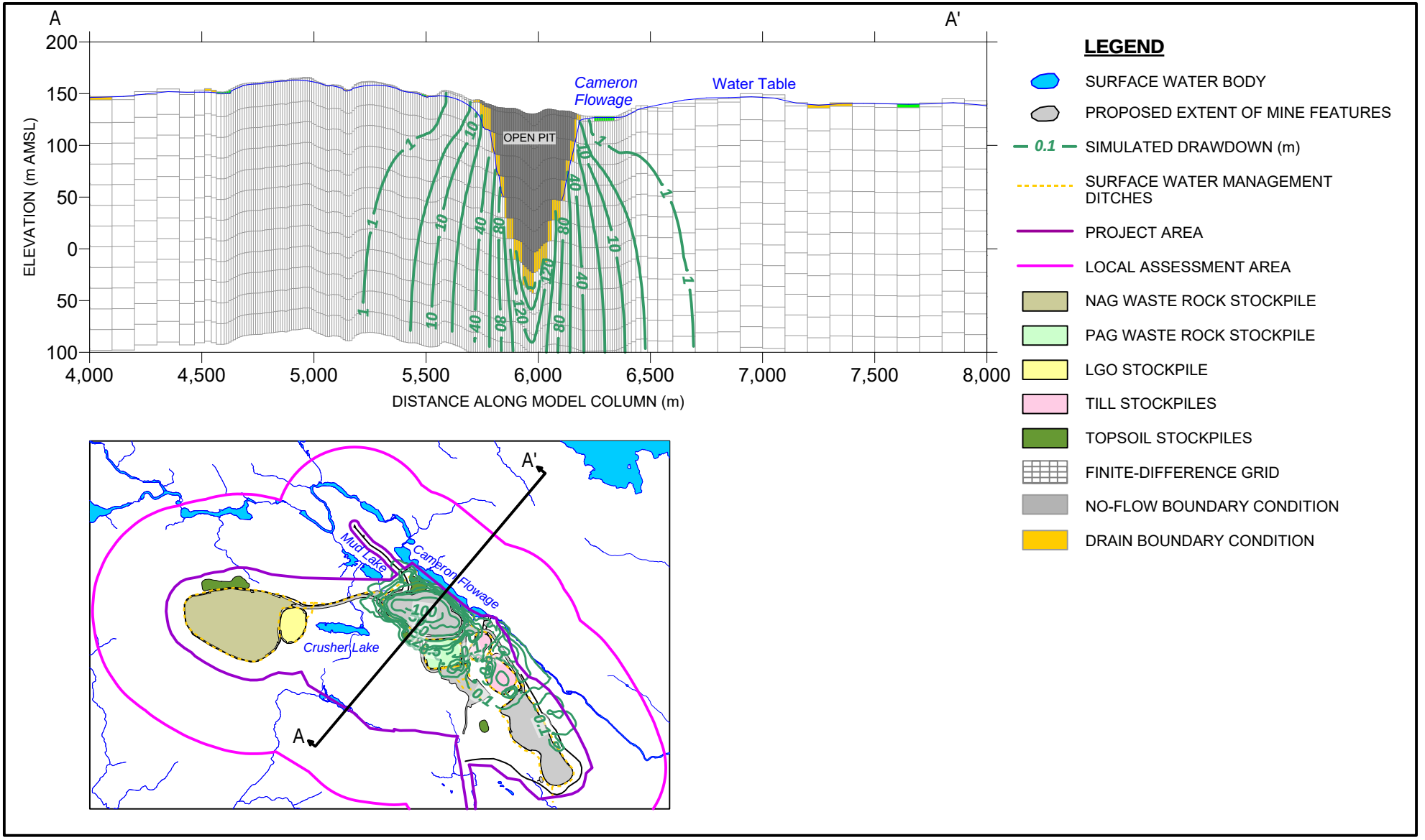
SIMULATED DRAWDOWN THROUGH OPEN PIT (PC - DRY CONDITION)

FIGURE 7.5b

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.5b - Simulated Drawdown Dry Condition - PC.srf



0 500 1000 1500m

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BEAVER DAM MINE

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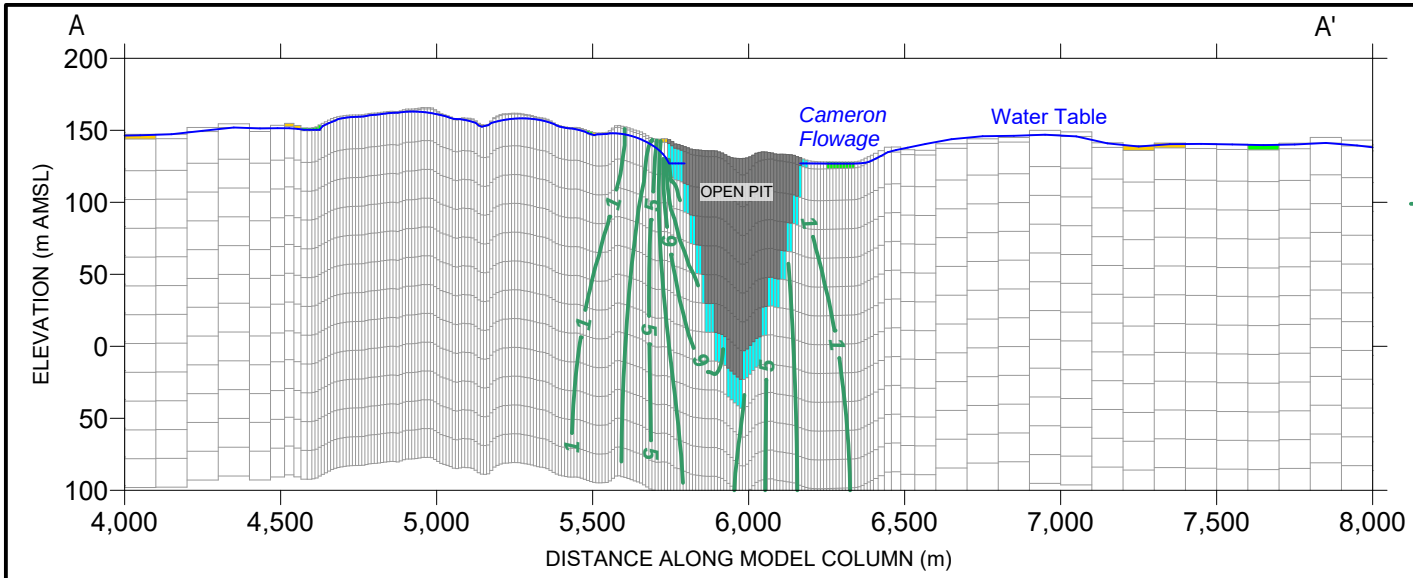
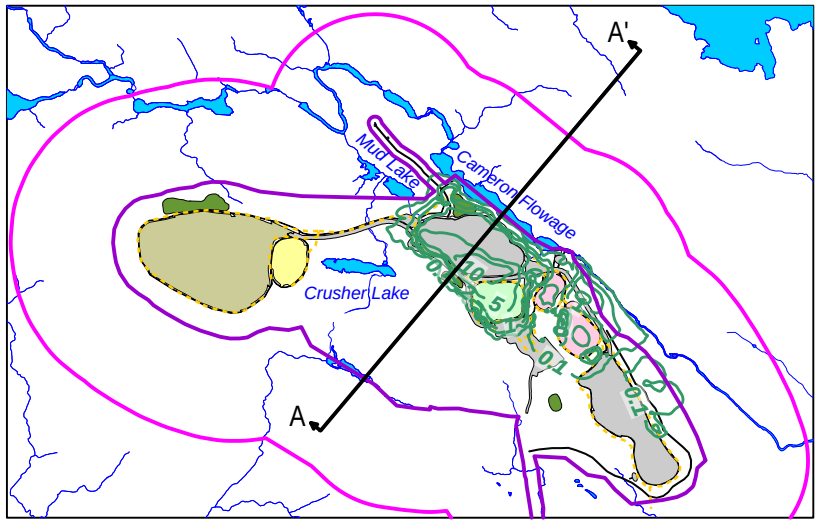
SIMULATED DRAWDOWN THROUGH OPEN PIT (EOM - WET CONDITION)

FIGURE 7.6a

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.6a - Simulated Drawdown Wet Condition - EOM.srf





LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED DRAWDOWN (m)
- SURFACE WATER MANAGEMENT DITCHES
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- FINITE-DIFFERENCE GRID
- NO-FLOW BOUNDARY CONDITION
- DRAIN BOUNDARY CONDITION
- GENERAL HEAD BOUNDARY CONDITION

0 500 1000 1500m

N

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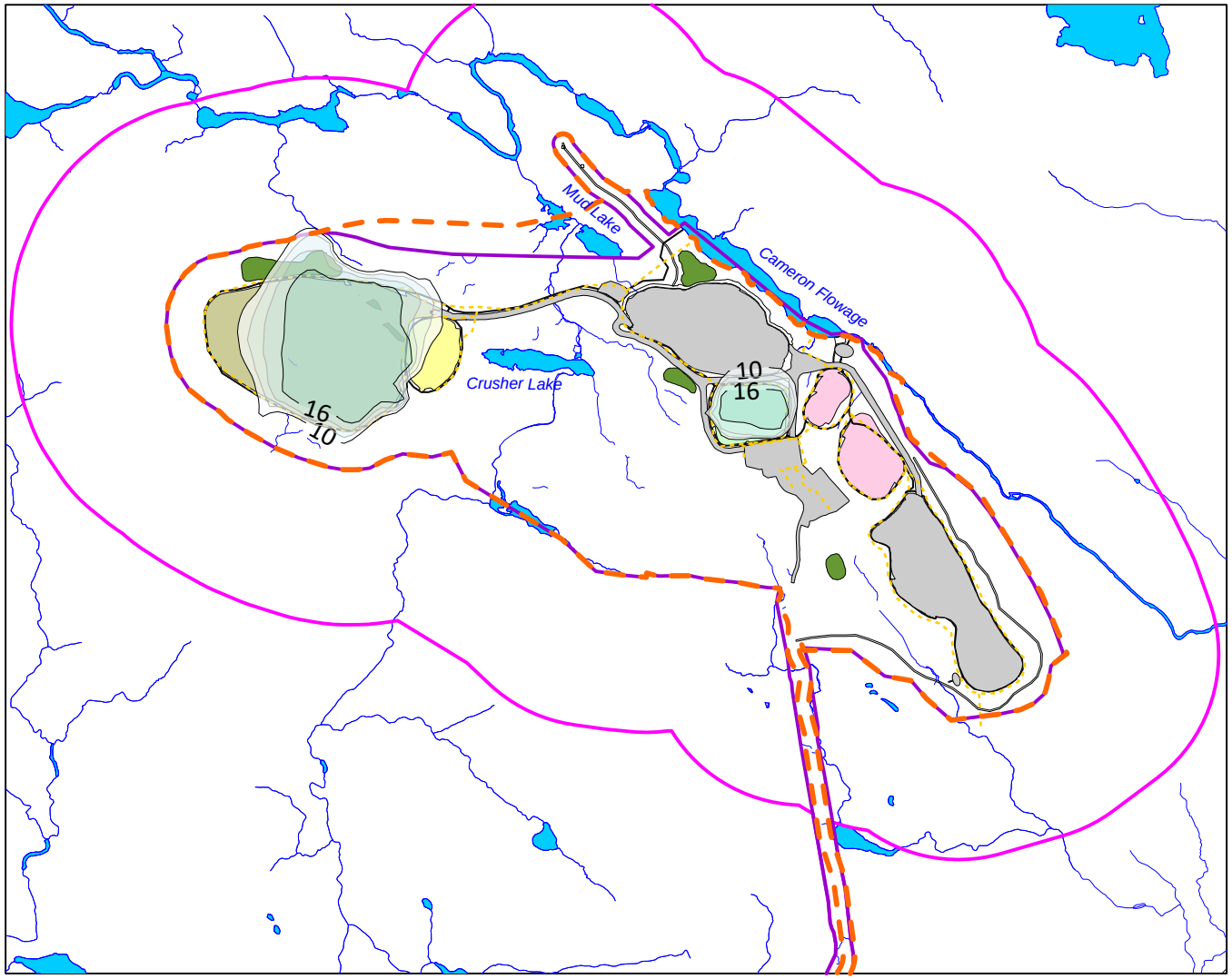
March 11, 2021

SIMULATED DRAWDOWN THROUGH OPEN PIT (PC - WET CONDITION)

FIGURE 7.6b

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.6b - Simulated Drawdown Wet Condition - PC.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

N

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SIMULATED ARSENIC CONCENTRATION VERSUS POTABLE CRITERIA
EOM - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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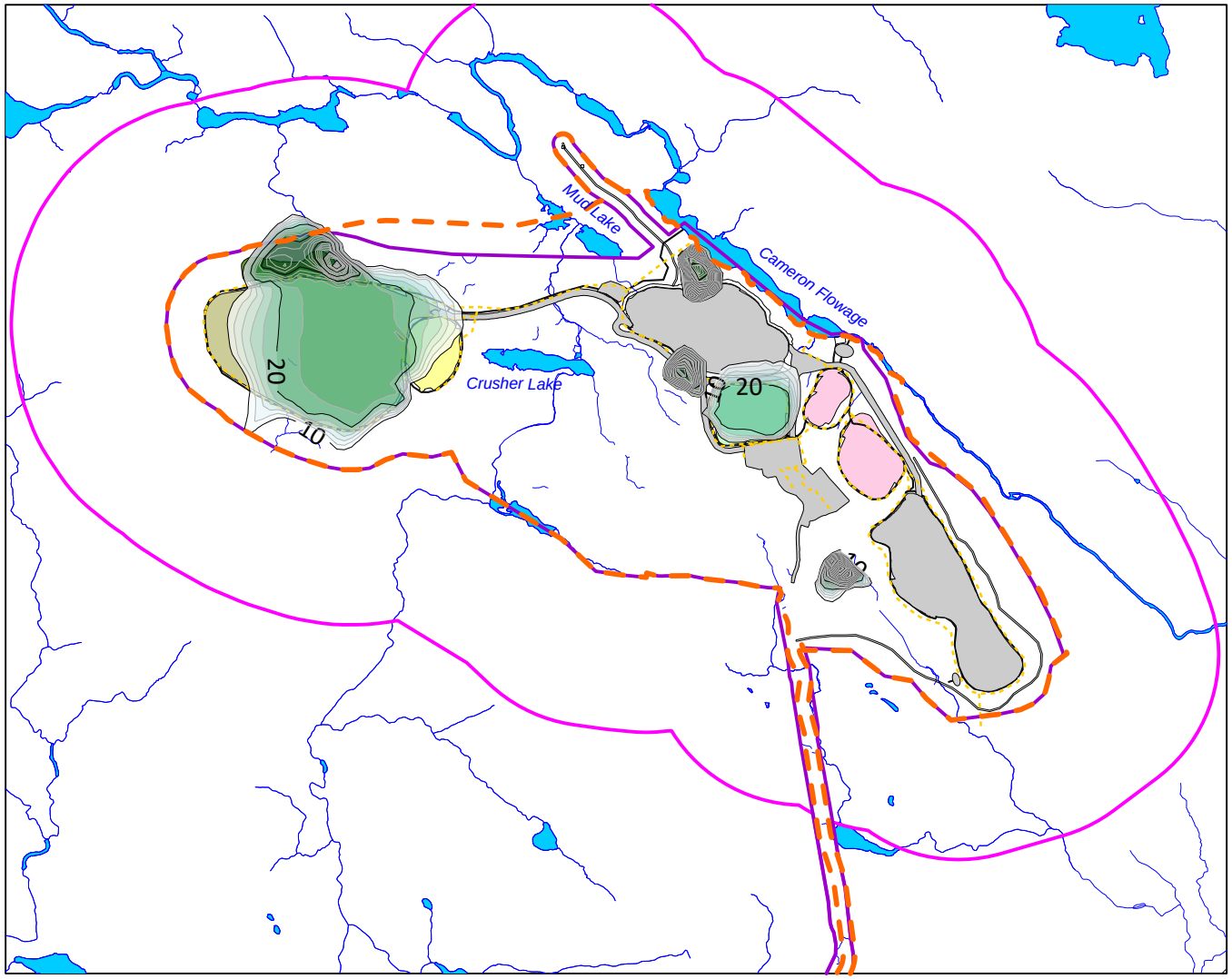
FIGURE 7.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.7 - Simulated Arsenic Concentration Versus Potable Criteria - EOM- BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

N

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SIMULATED ARSENIC CONCENTRATION VERSUS POTABLE CRITERIA
EOM - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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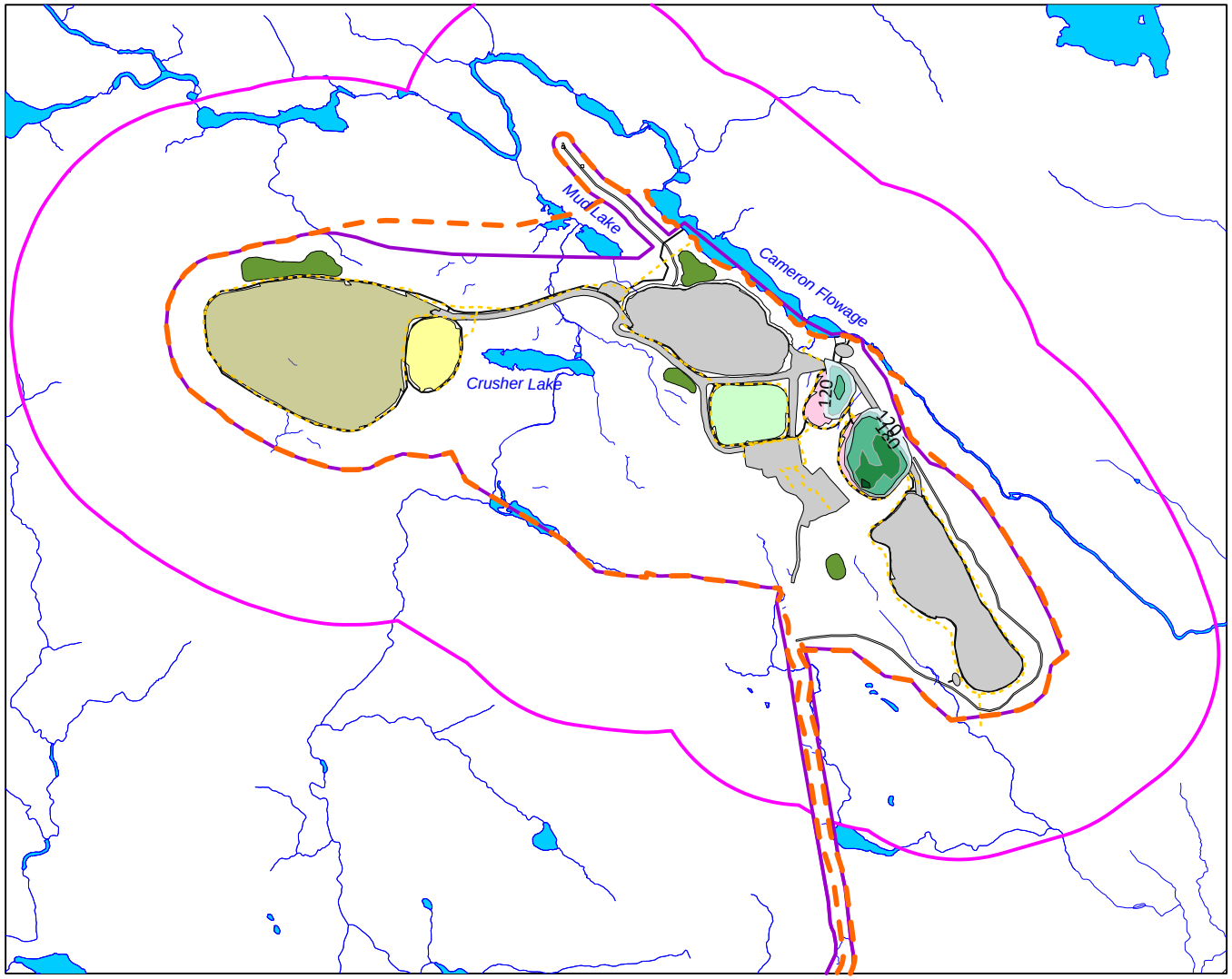
FIGURE 7.8

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.8 - Simulated Arsenic Concentration Versus Potable Criteria - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

N

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SIMULATED MANGANESE CONCENTRATION VERSUS POTABLE CRITERIA
EOM - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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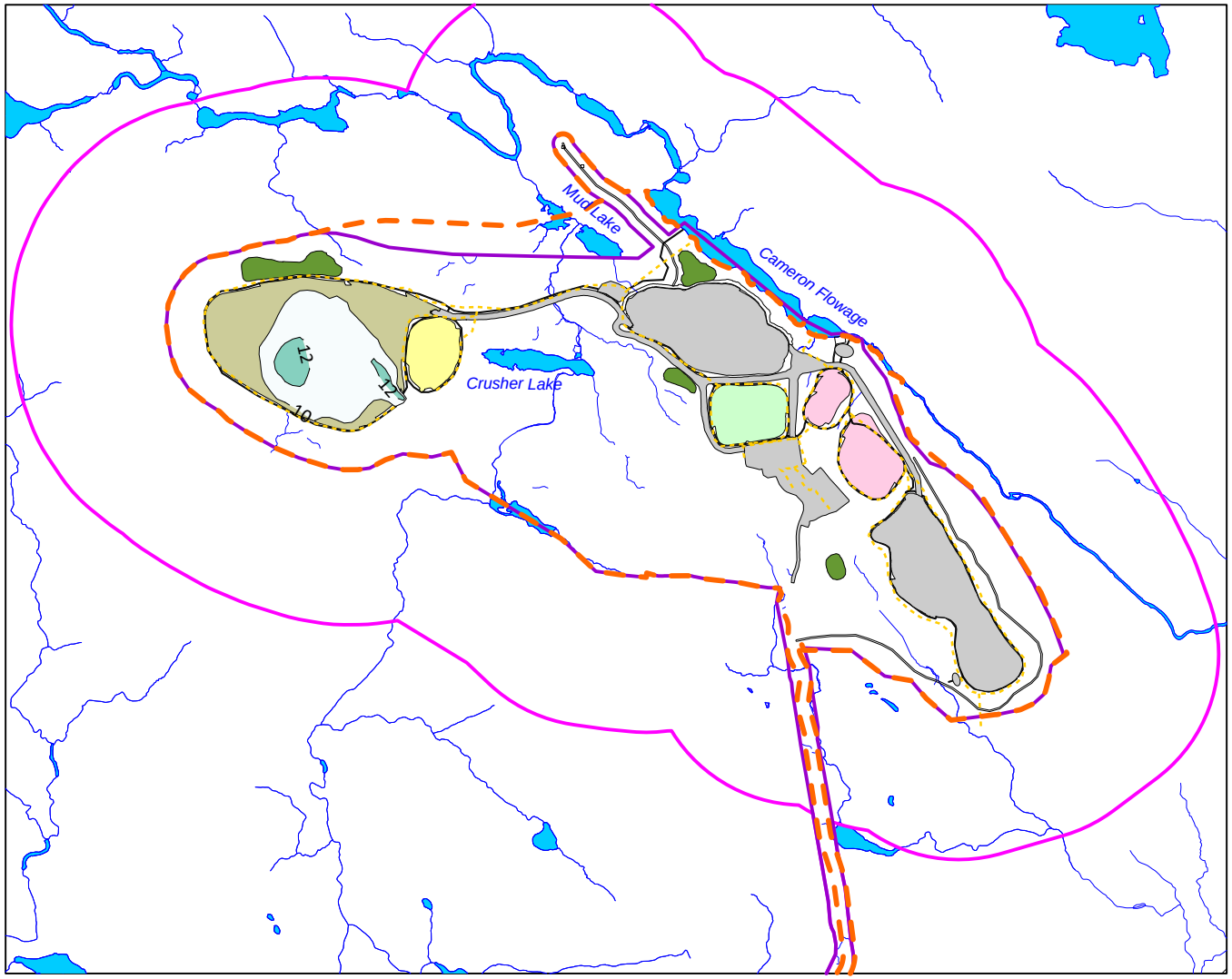
FIGURE 7.9

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.9 - Simulated Manganese Concentration Versus Potable Criteria - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED NITRATE CONCENTRATION (mg/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nitrate GCDWQ for potable groundwater is 10 mg/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
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BEAVER DAM MINE

SIMULATED NITRATE CONCENTRATION VERSUS POTABLE CRITERIA
EOM - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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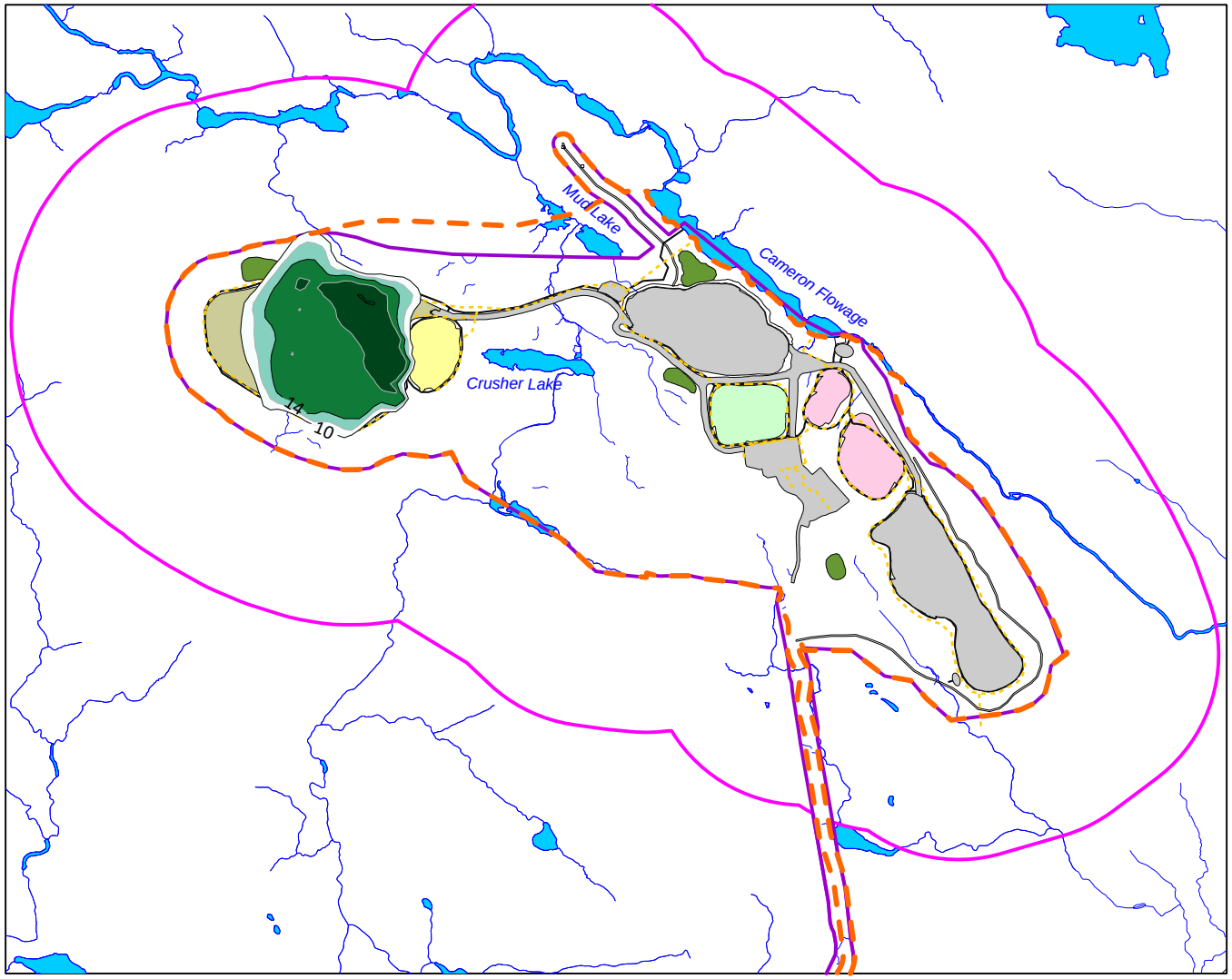
FIGURE 7.10

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.9 - Simulated Manganese Concentration Versus Potable Criteria - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED NITRATE CONCENTRATION (mg/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nitrate GCDWQ for potable groundwater is 10 mg/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED NITRATE CONCENTRATION VERSUS POTABLE CRITERIA
EOM - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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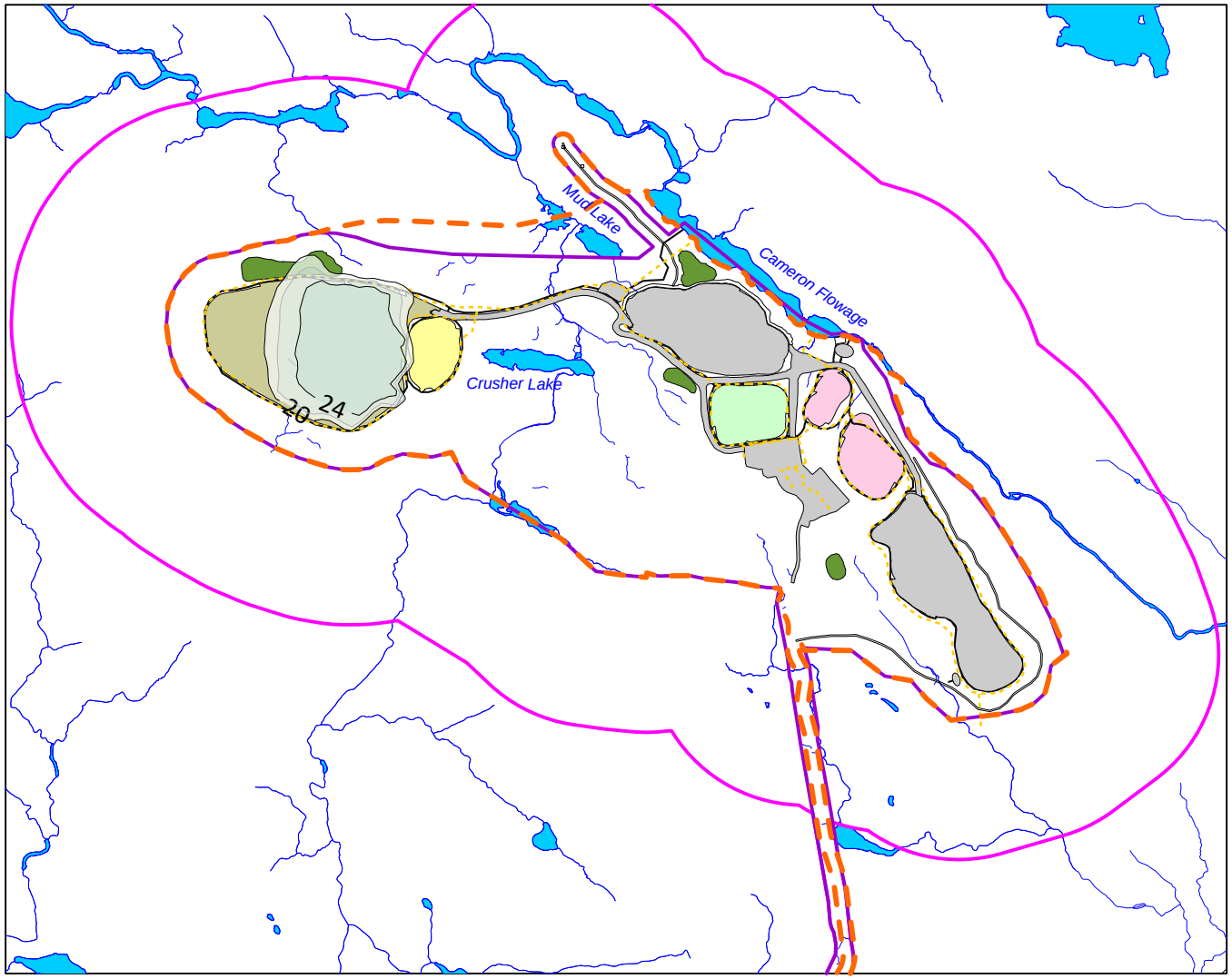
FIGURE 7.11

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.9 - Simulated Manganese Concentration Versus Potable Criteria - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
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BEAVER DAM MINE

SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
EOM - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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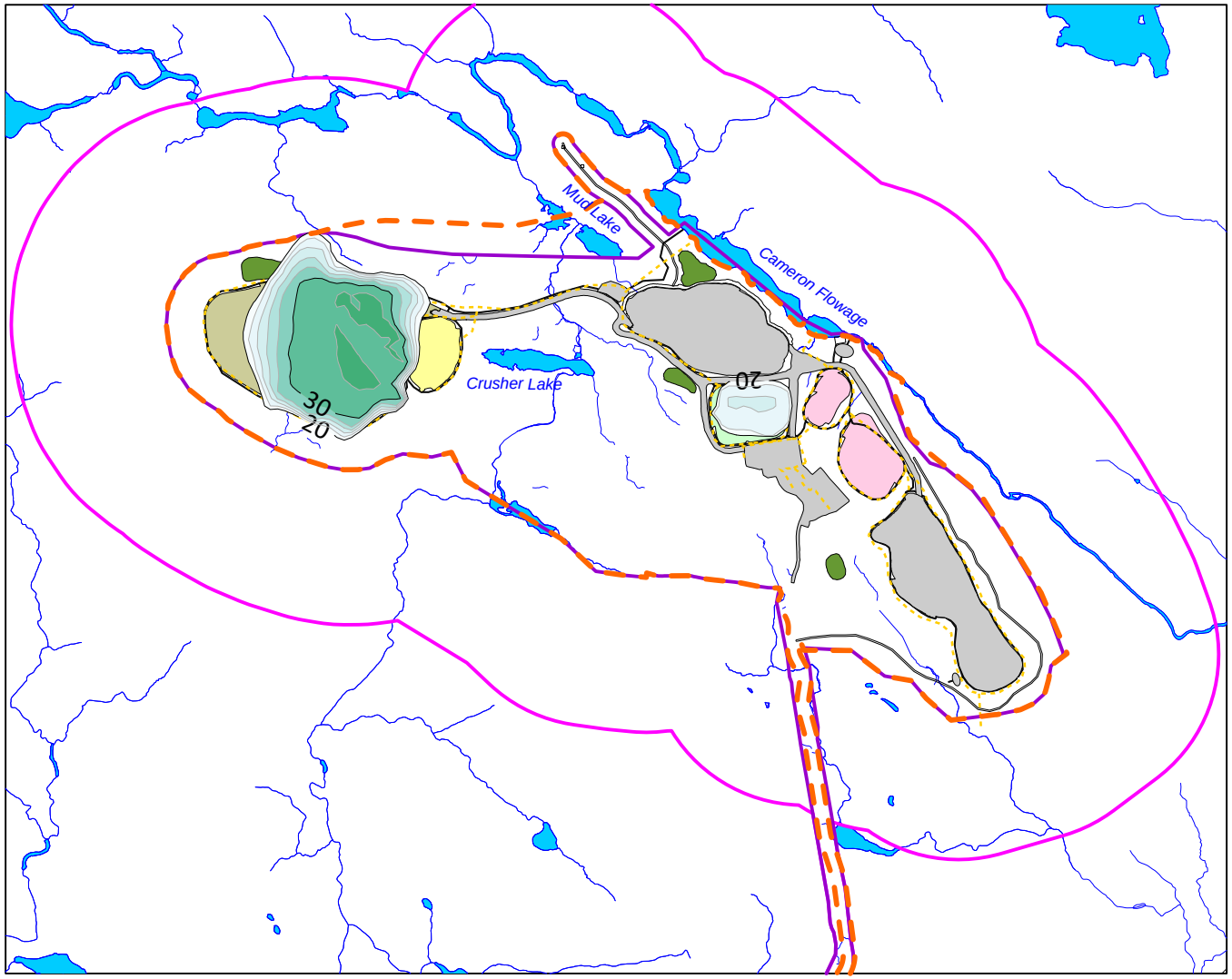
FIGURE 7.12

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.10 - Simulated Uranium Concentration Versus Potable Criteria - EOM - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
EOM - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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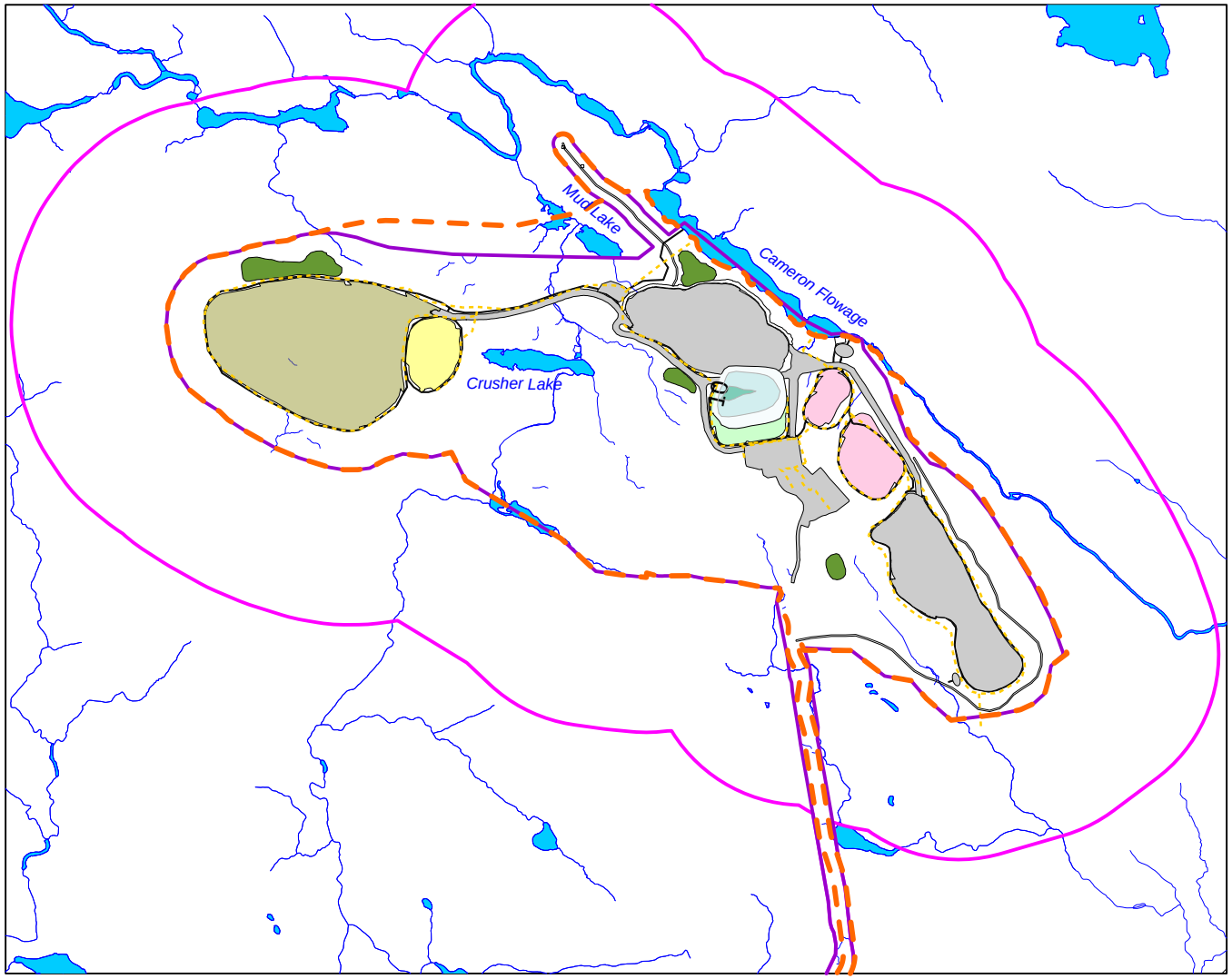
FIGURE 7.13

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.11 - Simulated Uranium Concentration Versus Potable Criteria - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED ARSENIC CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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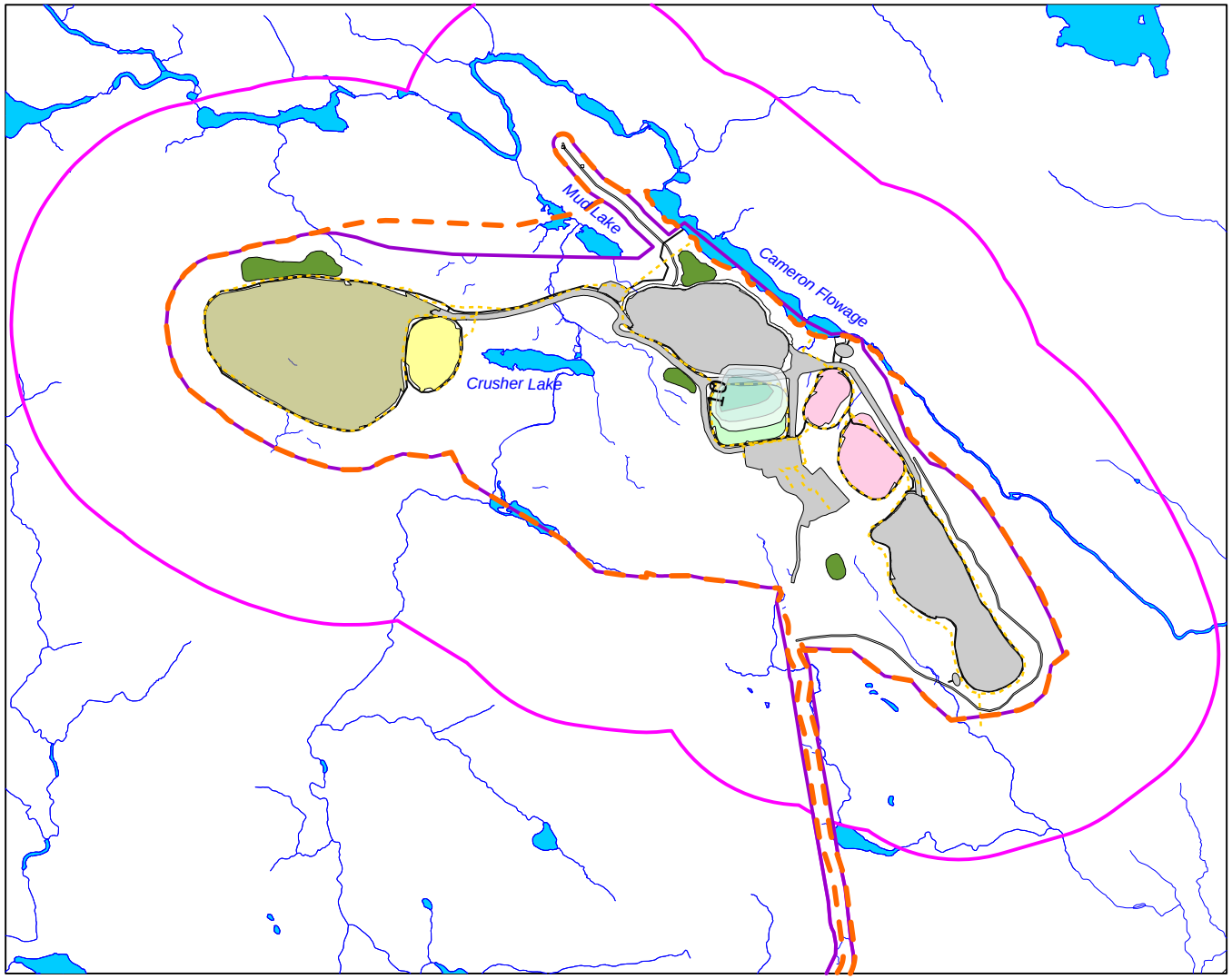
FIGURE 7.14

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.12 - Simulated Arsenic Concentration Versus Potable Criteria - PC - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED ARSENIC CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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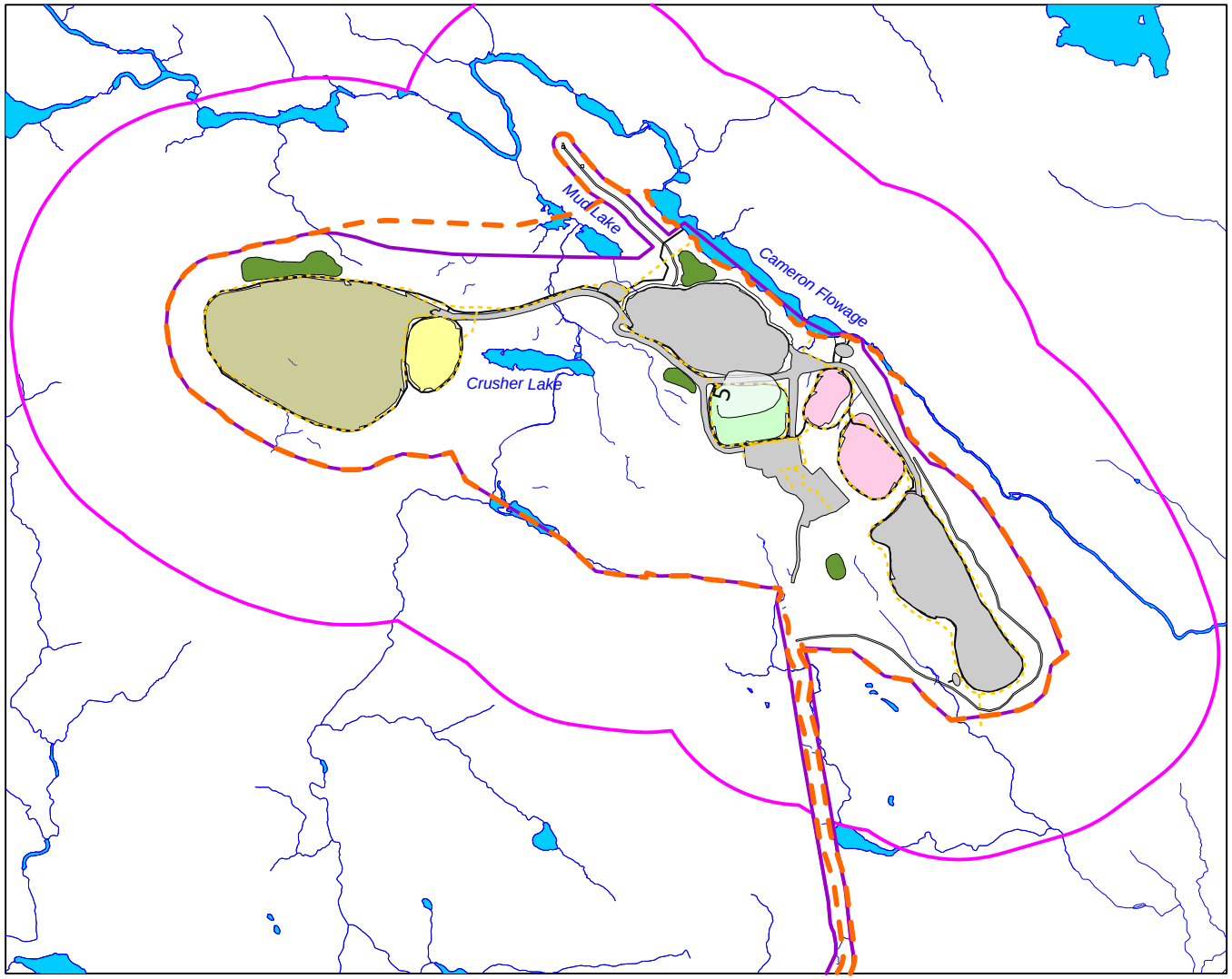
FIGURE 7.15

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\Figure 7.13 - Simulated Arsenic Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 1 EQS for potable groundwater is 5 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED CADMIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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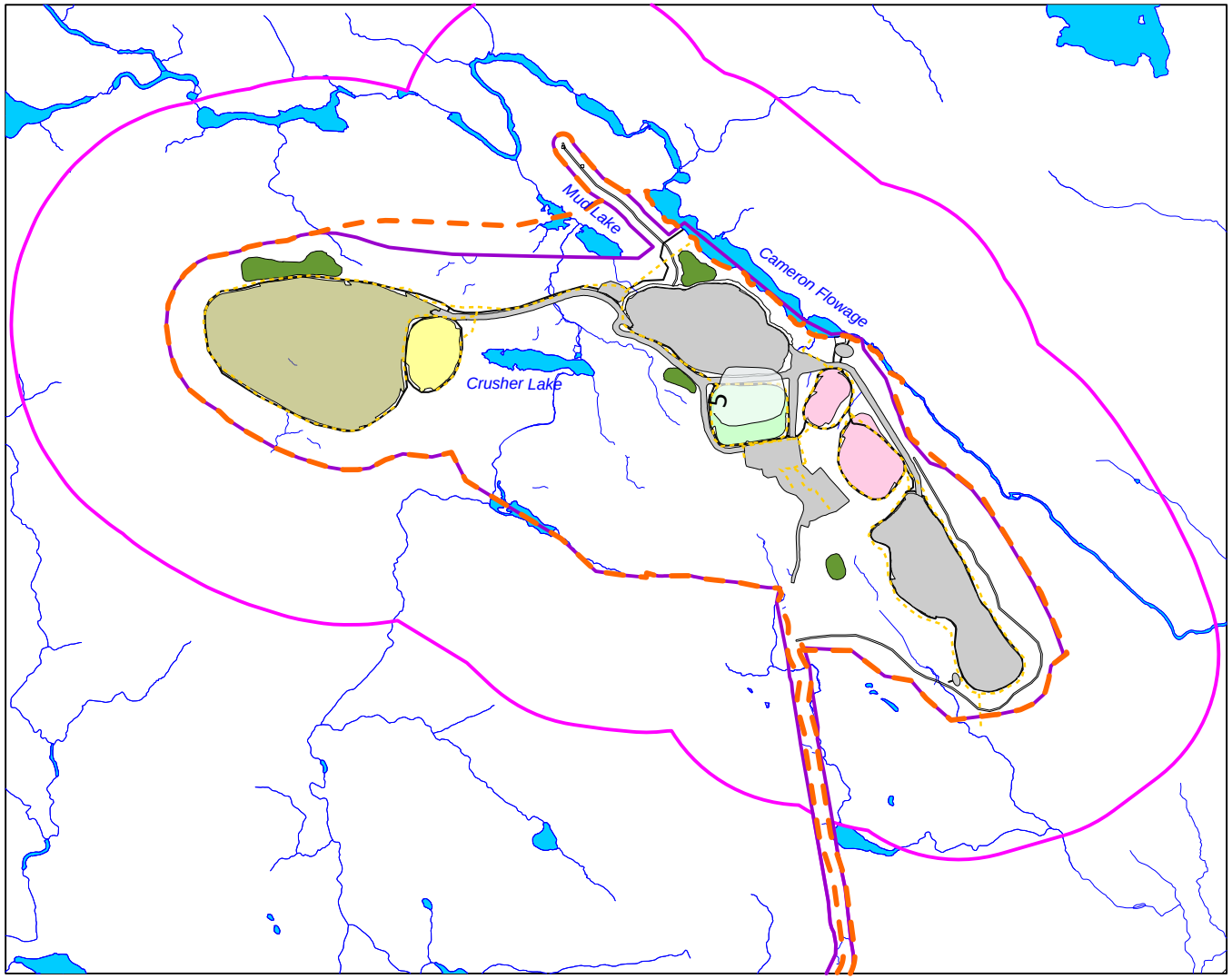
FIGURE 7.16

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.14 - Simulated Cadmium Concentration Versus Potable Criteria - PC - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 1 EQS for potable groundwater is 5 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED CADMIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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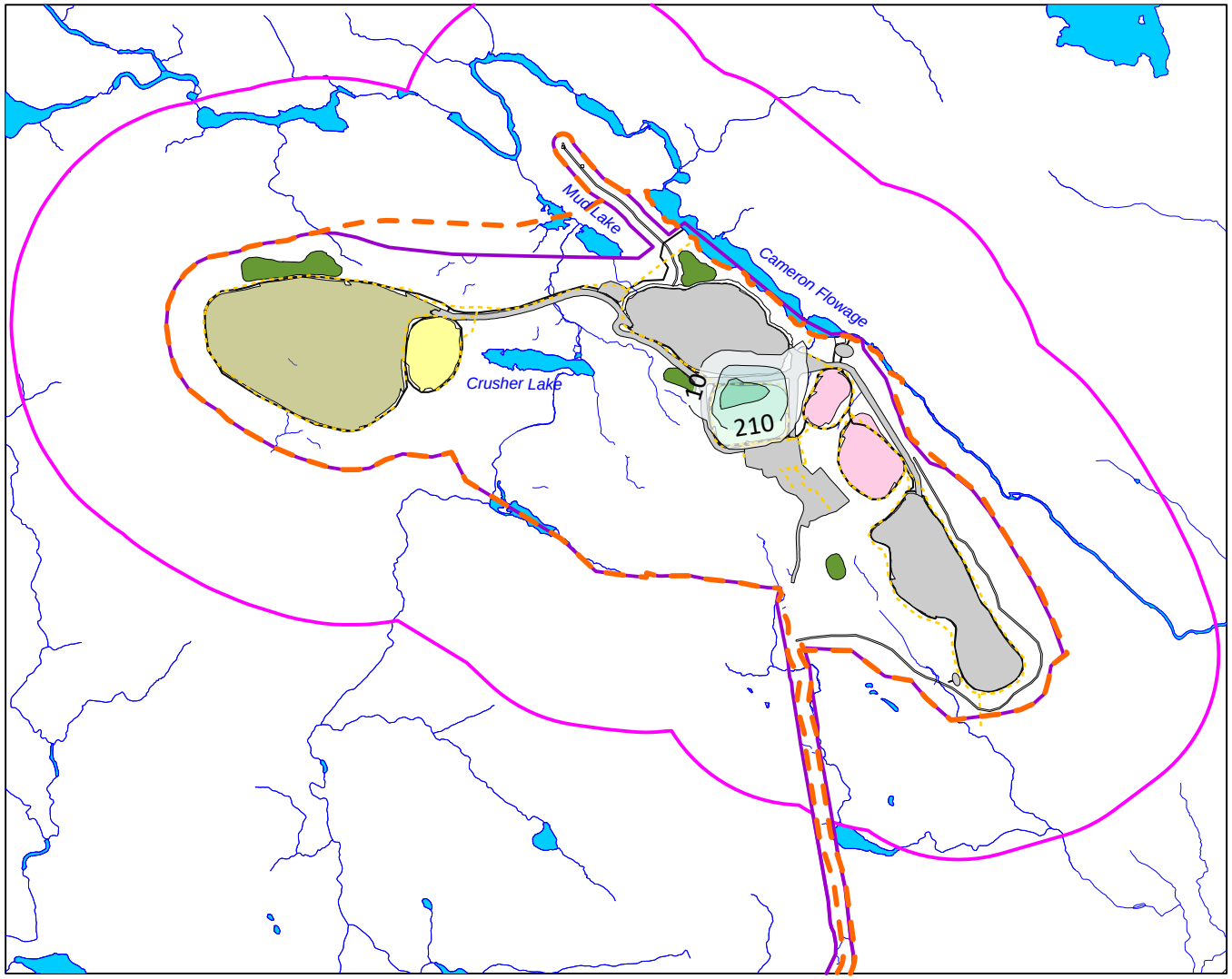
FIGURE 7.17

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.15 - Simulated Cadmium Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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SIMULATED COBALT CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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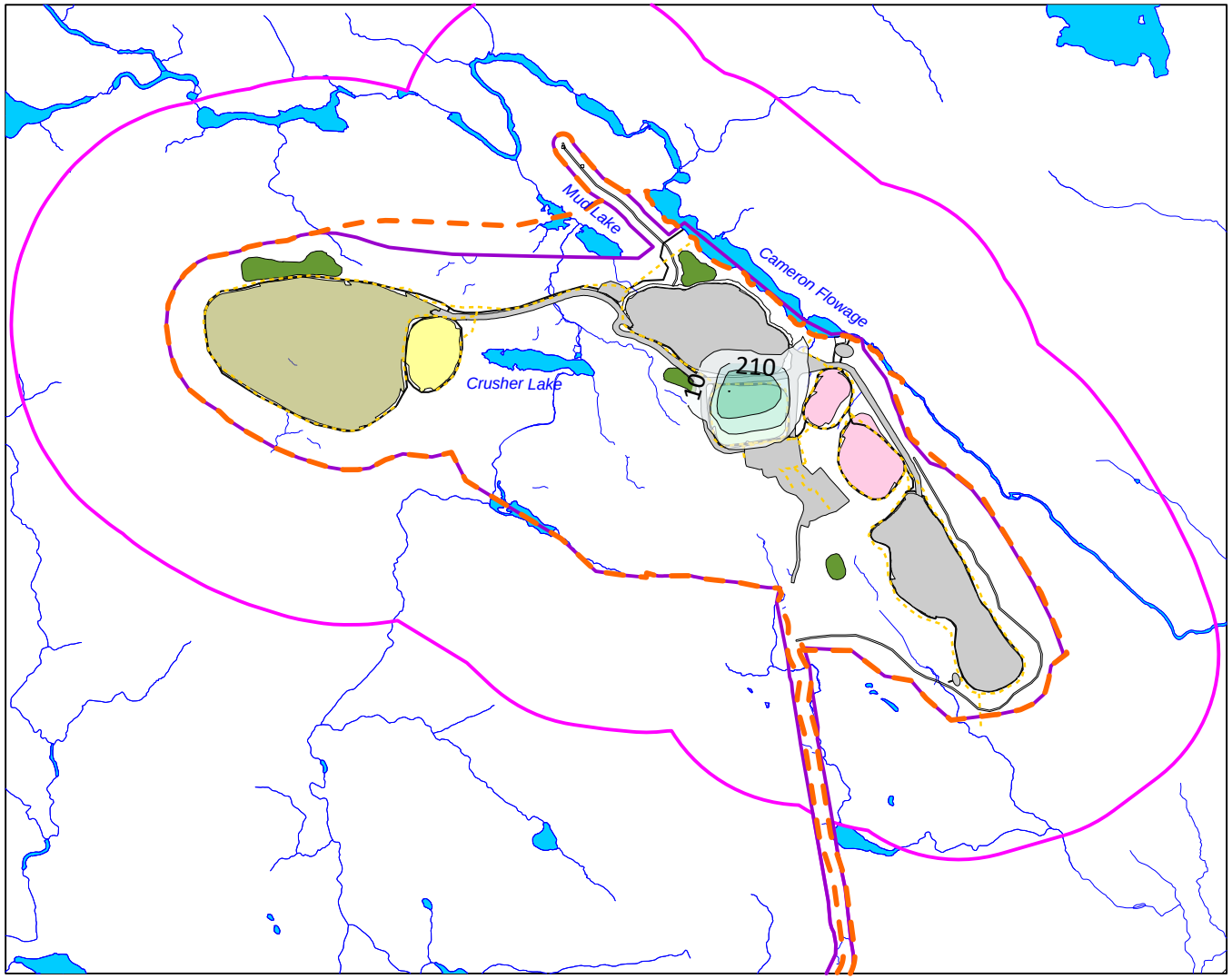
FIGURE 7.18

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.16 - Simulated Cobalt Concentration Versus Potable Criteria - PC - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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SIMULATED COBALT CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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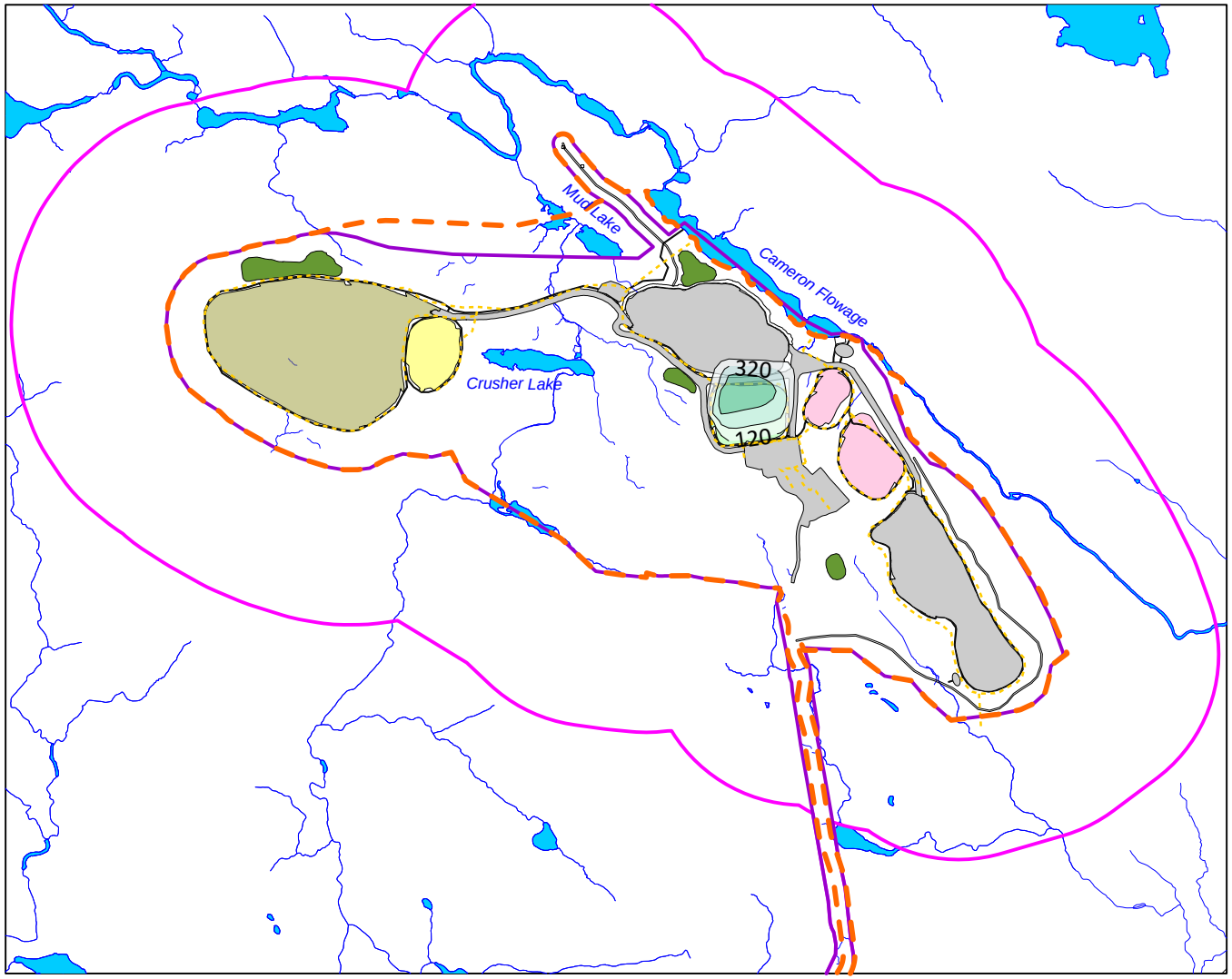
FIGURE 7.19

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.17 - Simulated Cobalt Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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SIMULATED MANGANESE CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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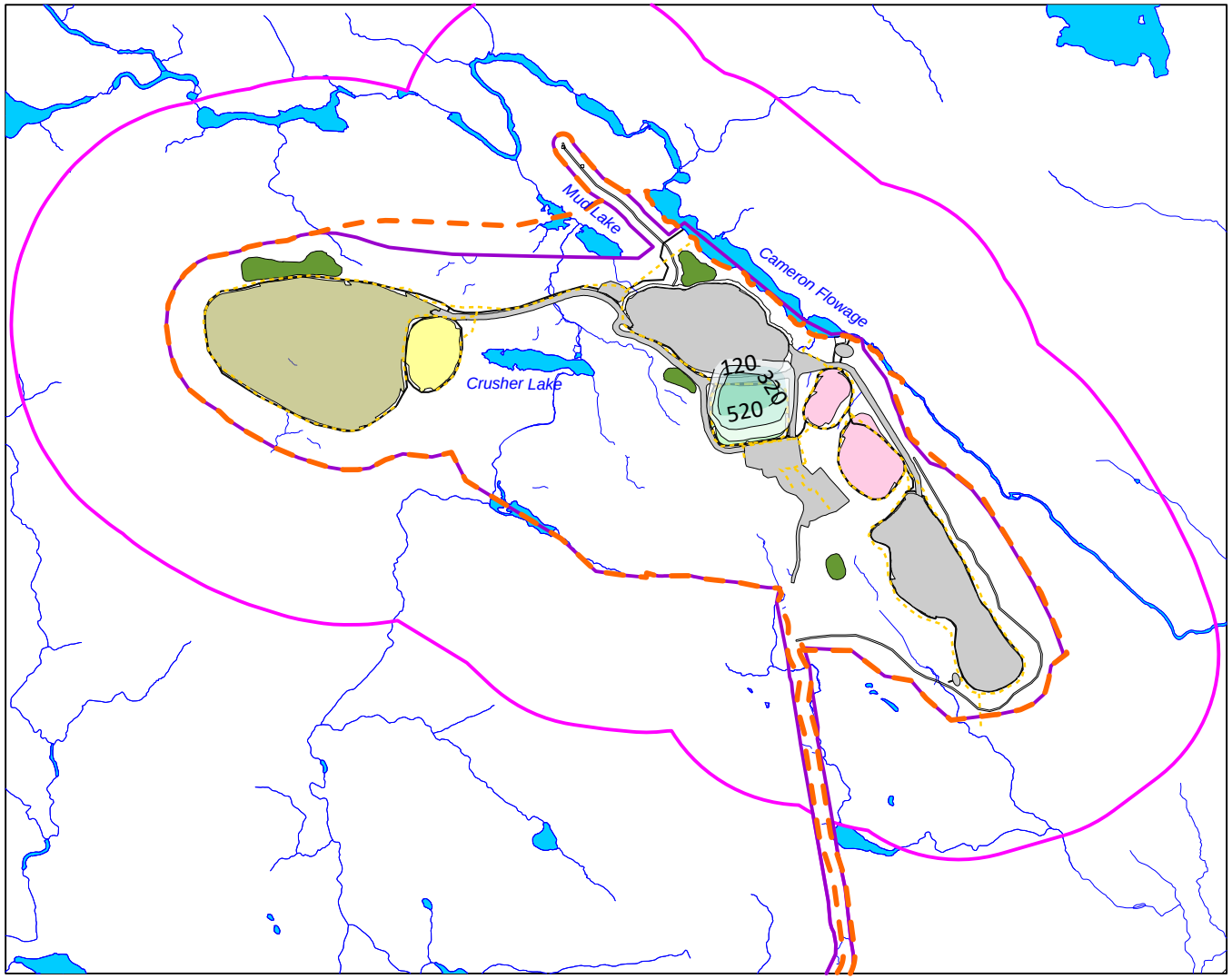
FIGURE 7.20

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.18 - Simulated Manganese Concentration Versus Potable Criteria - PC - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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SIMULATED MANGANESE CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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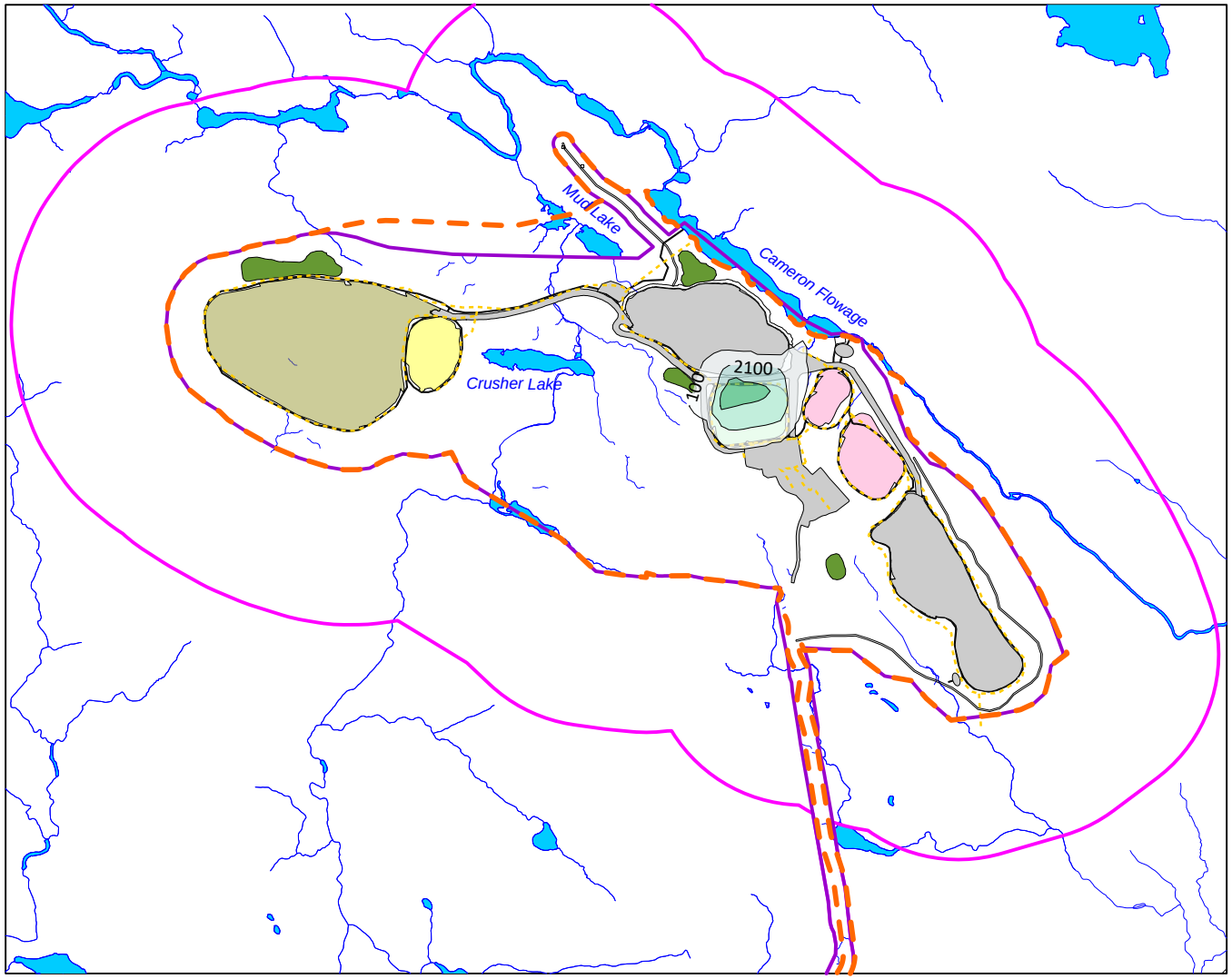
FIGURE 7.21

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.19 - Simulated Manganese Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 1 EQS for potable groundwater is 100 ug/L.

0 300 600 900m

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SIMULATED NICKEL CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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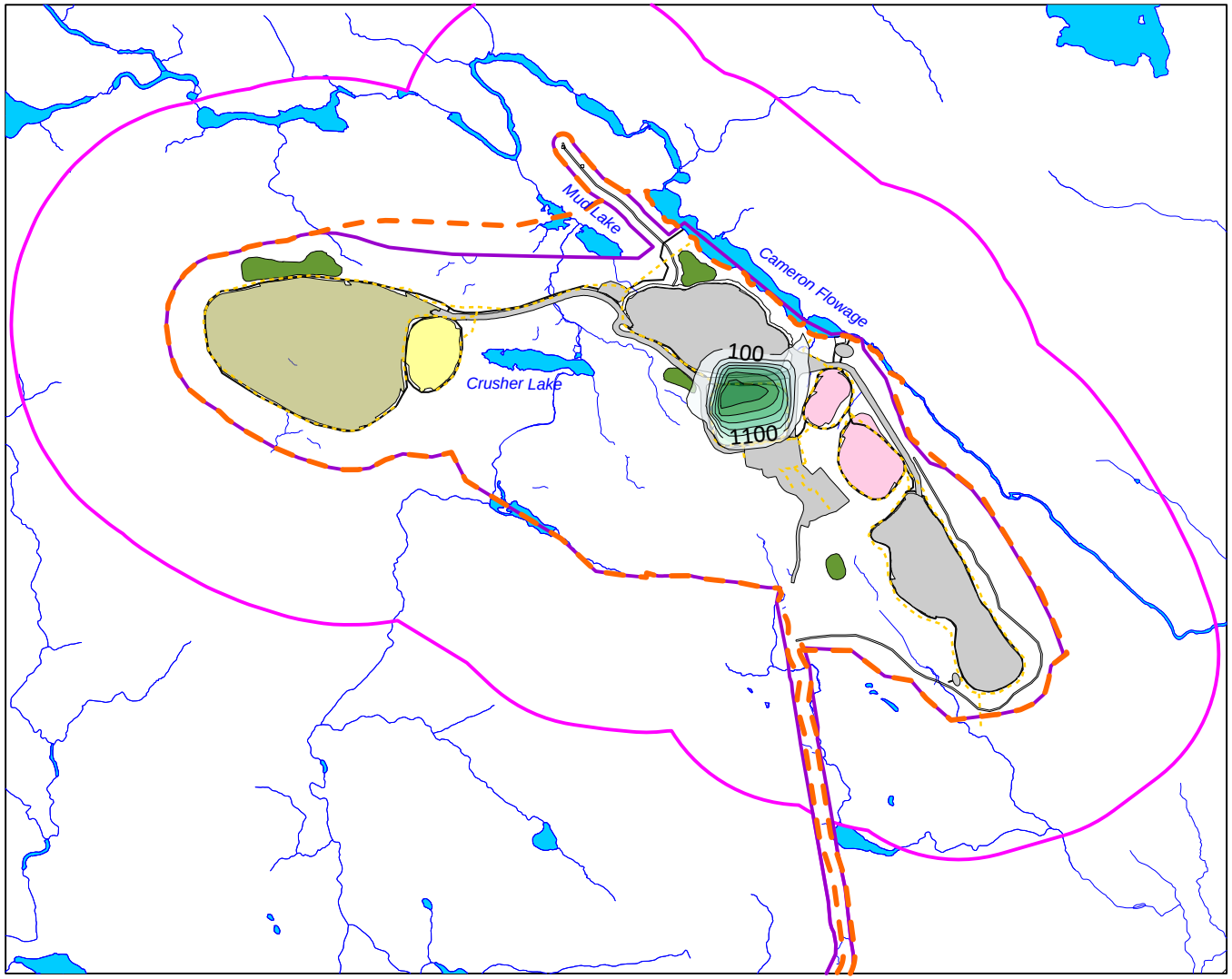
FIGURE 7.22

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.20 - Simulated Nickel Concentration Versus Potable Criteria - PC - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 1 EQS for potable groundwater is 100 ug/L.

0 300 600 900m

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SIMULATED NICKEL CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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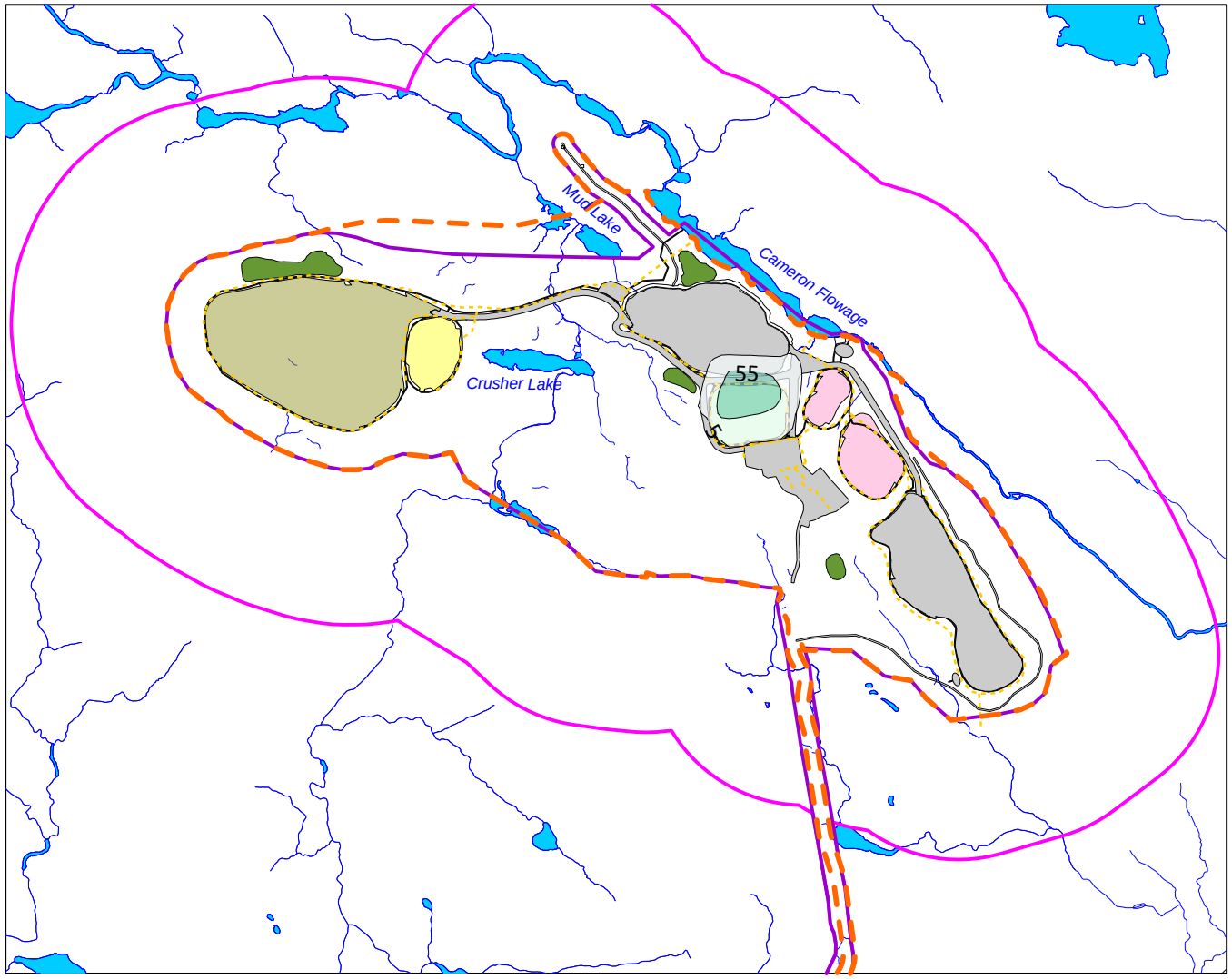
FIGURE 7.23

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.21 - Simulated Nickel Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead GCDWQ is 5 ug/L.

0 300 600 900m

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SIMULATED LEAD CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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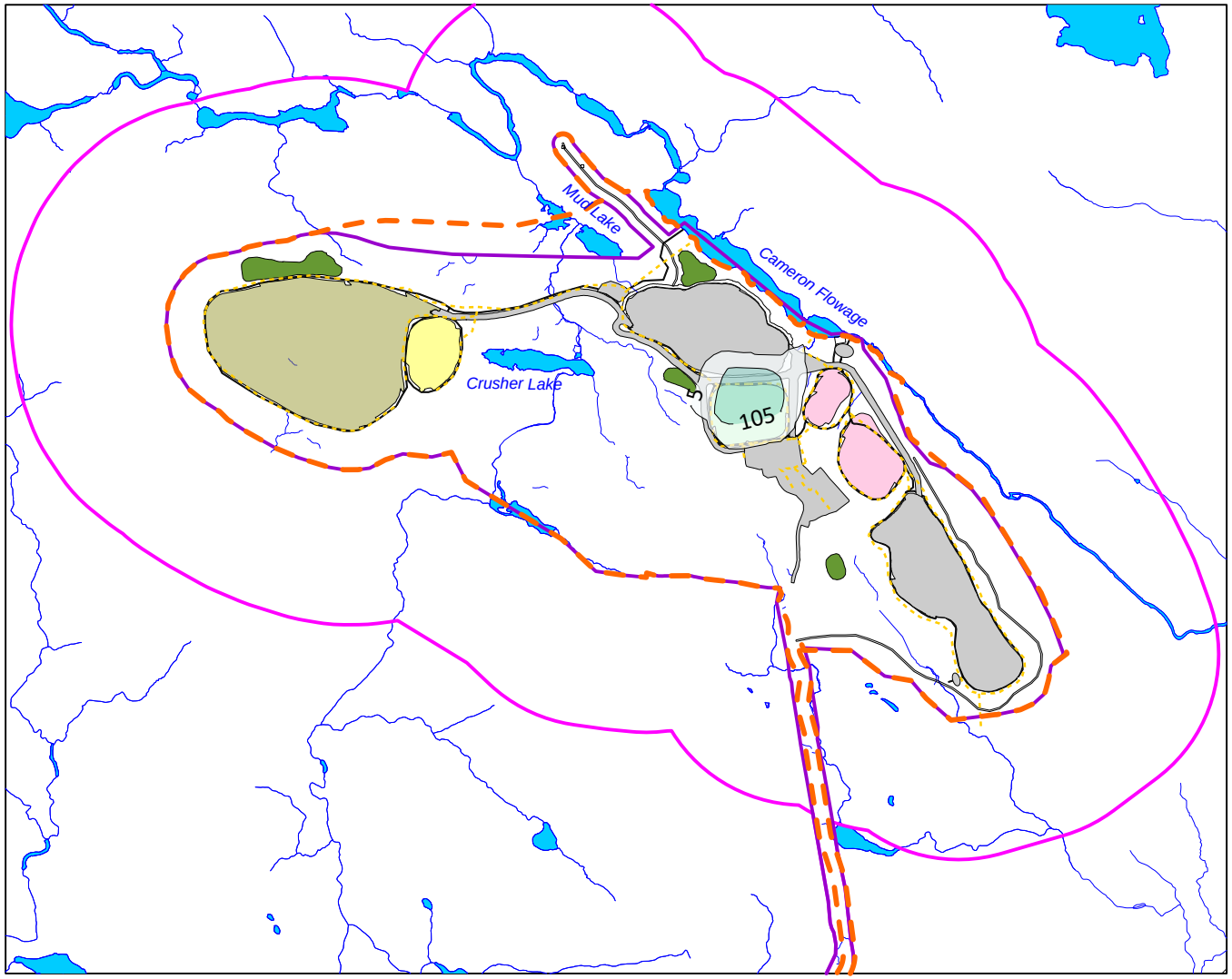
FIGURE 7.24

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.22 - Simulated Lead Concentration Versus Potable Criteria - PC - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead GCDWQ is 5 ug/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
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BEAVER DAM MINE

SIMULATED LEAD CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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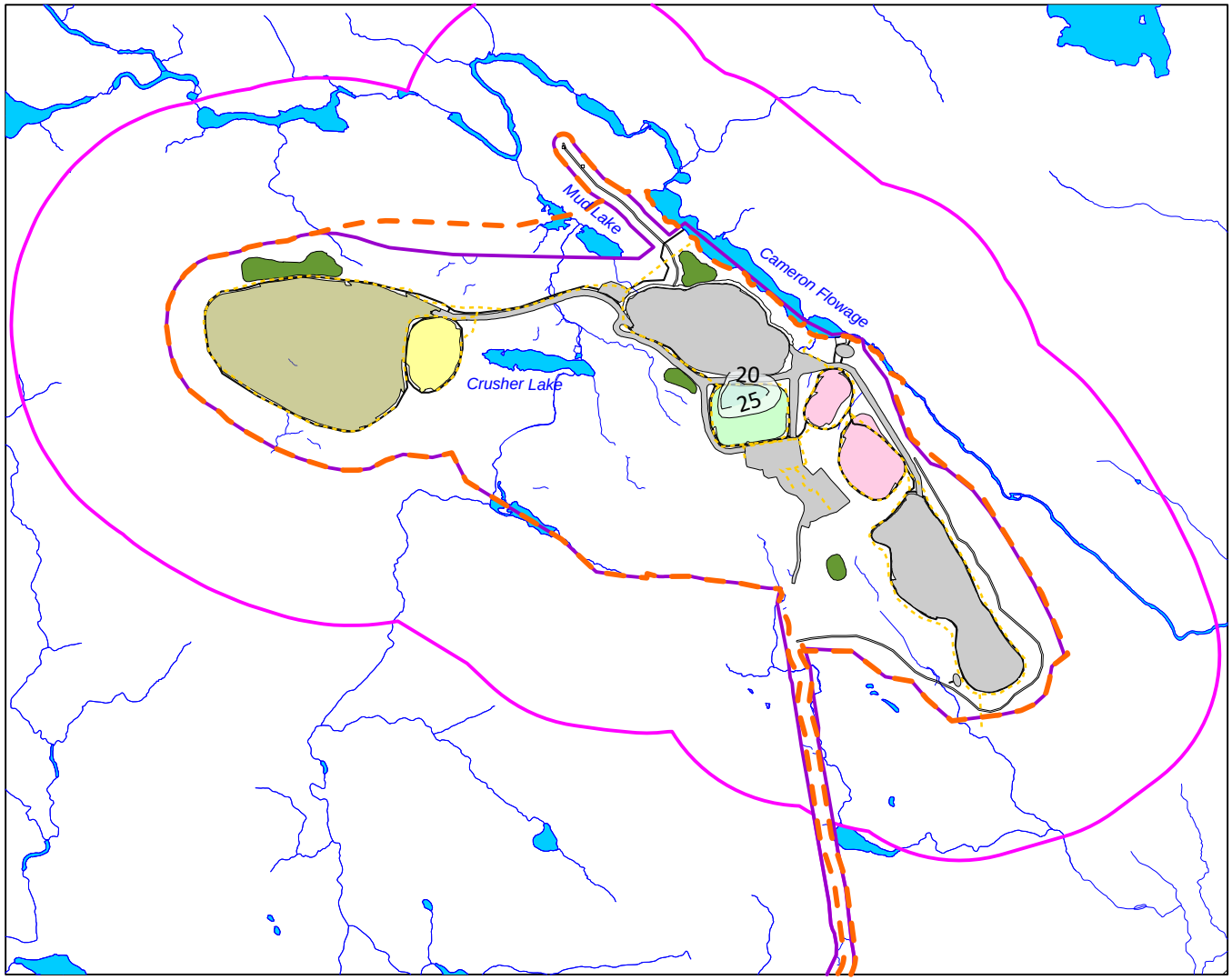
FIGURE 7.25

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.23 - Simulated Lead Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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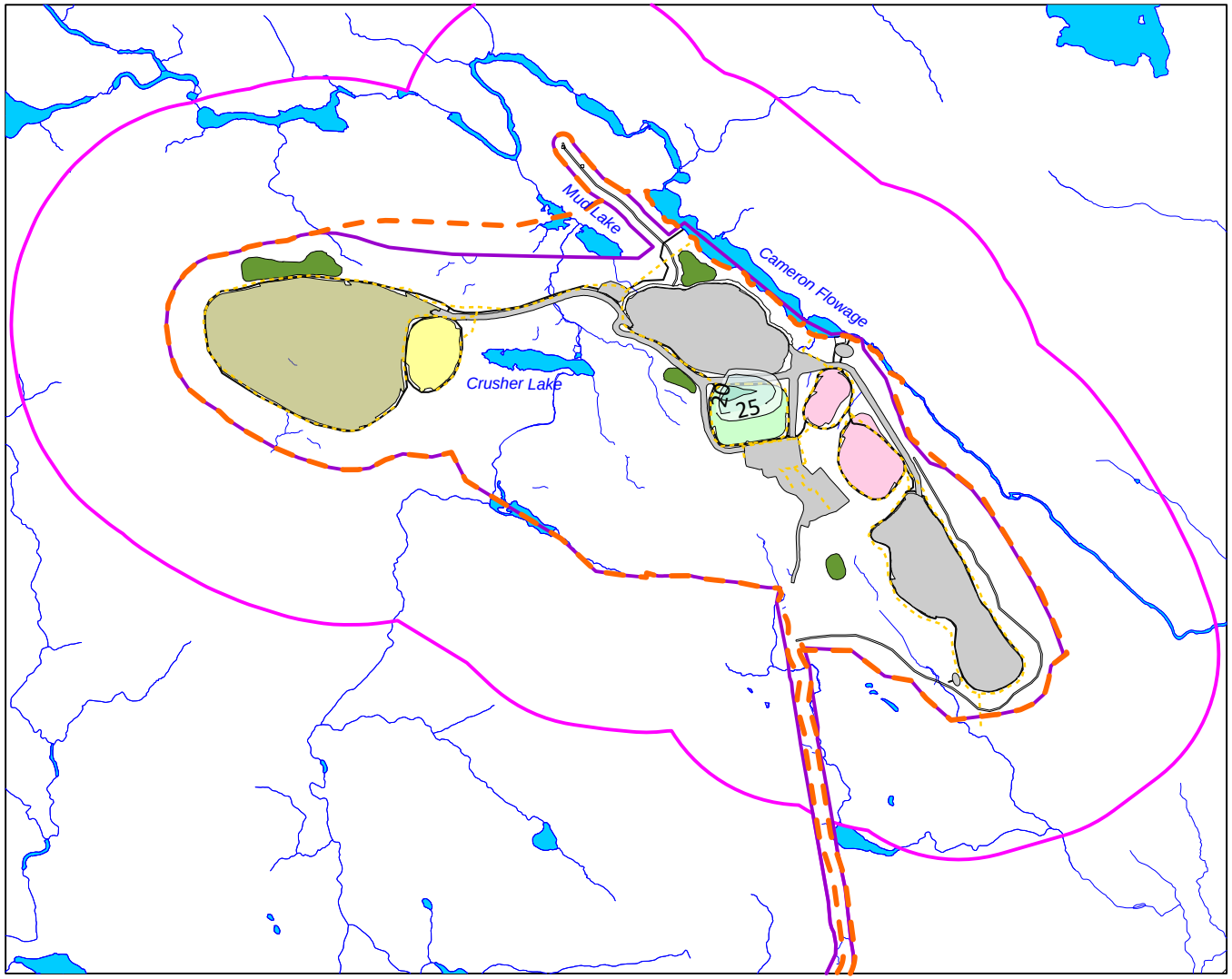
FIGURE 7.26

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.25 - Simulated Uranium Concentration Versus Potable Criteria - PC - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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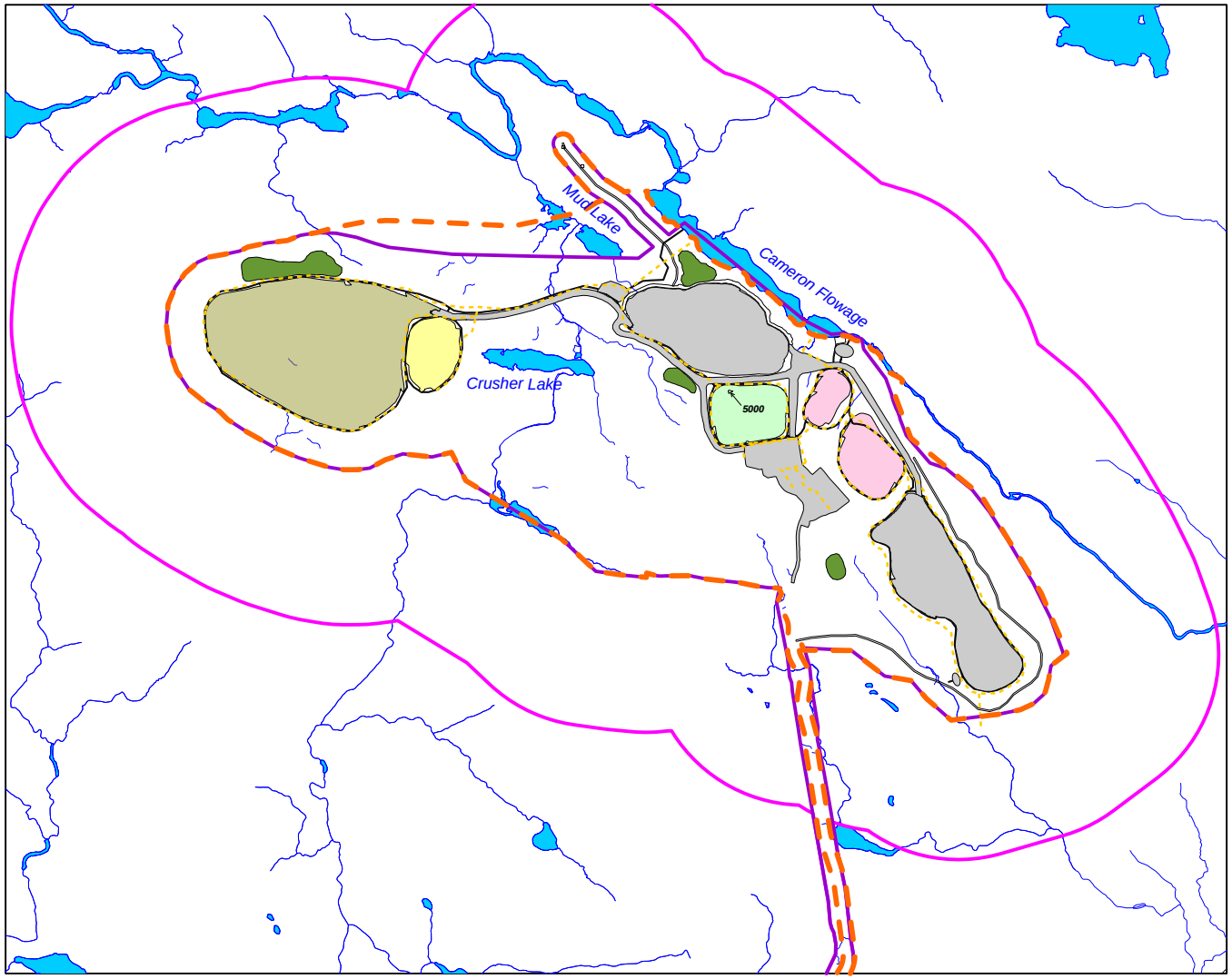
FIGURE 7.27

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.26 - Simulated Uranium Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 1 EQS for potable groundwater is 5000 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED ZINC CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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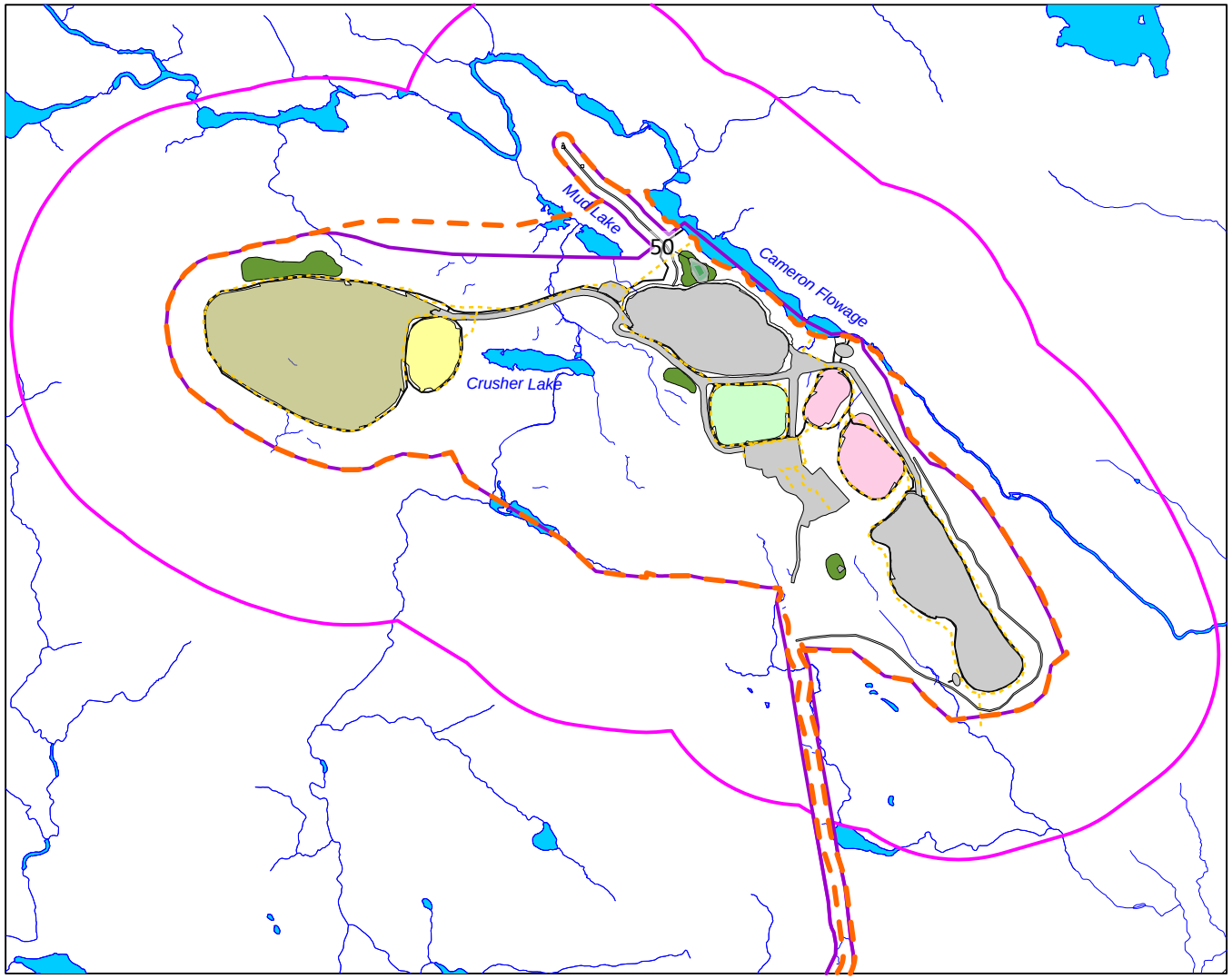
FIGURE 7.28

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.28 - Simulated Zinc Concentration Versus Potable Criteria - PC - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
EOM - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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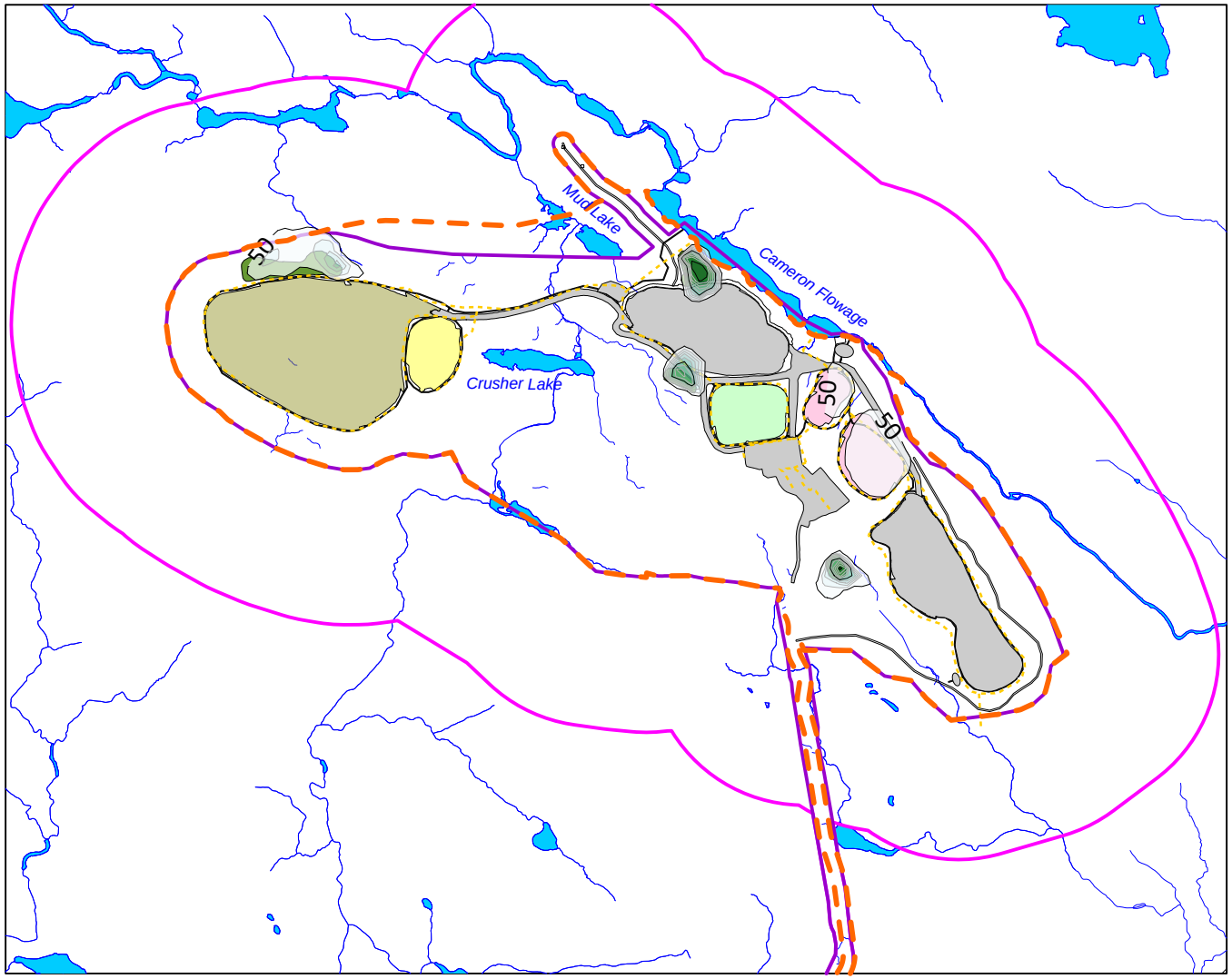
FIGURE 7.29

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.29 - Sim_Aluminum_PSS - EOM - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
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BEAVER DAM MINE

SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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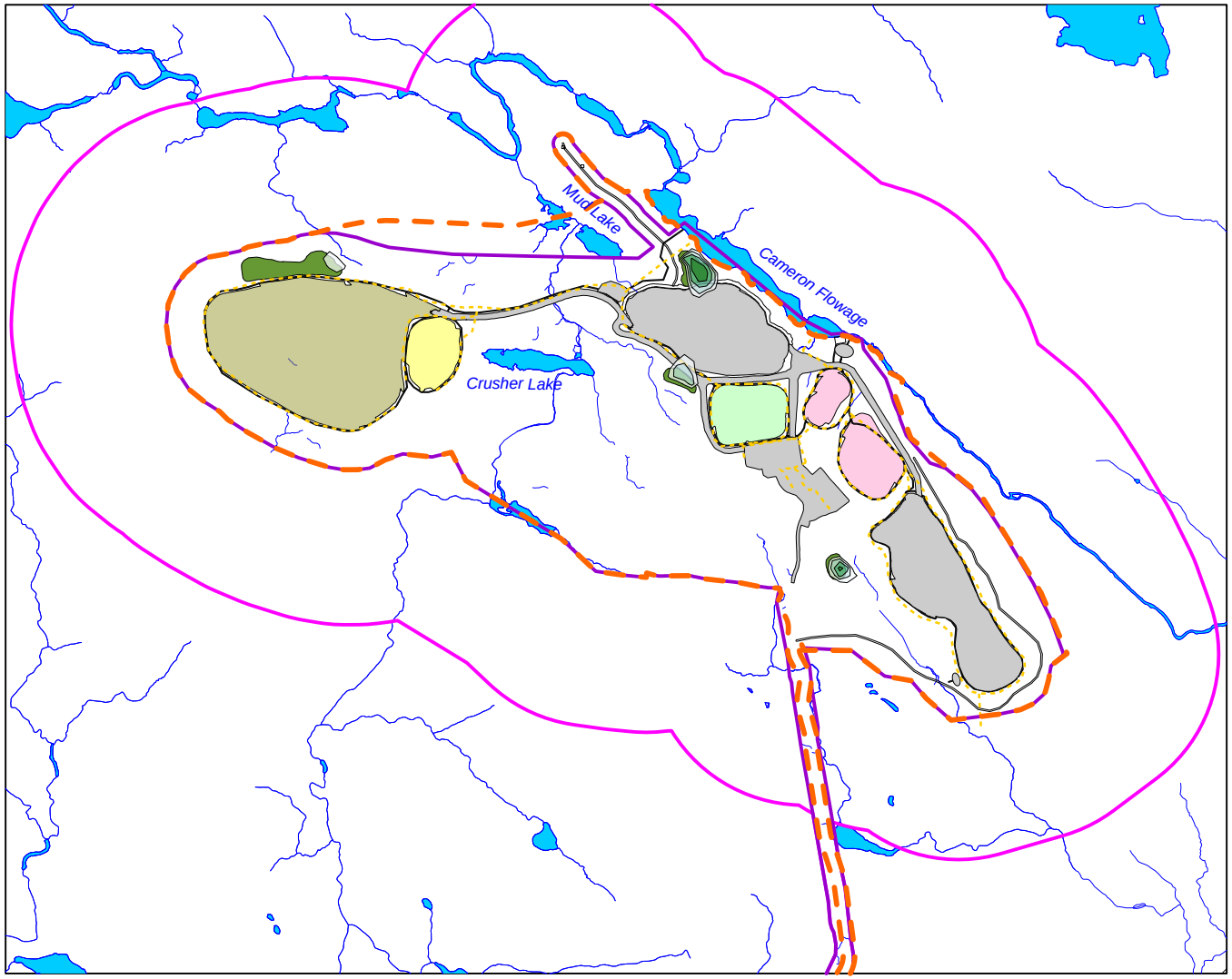
FIGURE 7.30

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.30 - Sim_Aluminum_PSS - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED ARSENIC CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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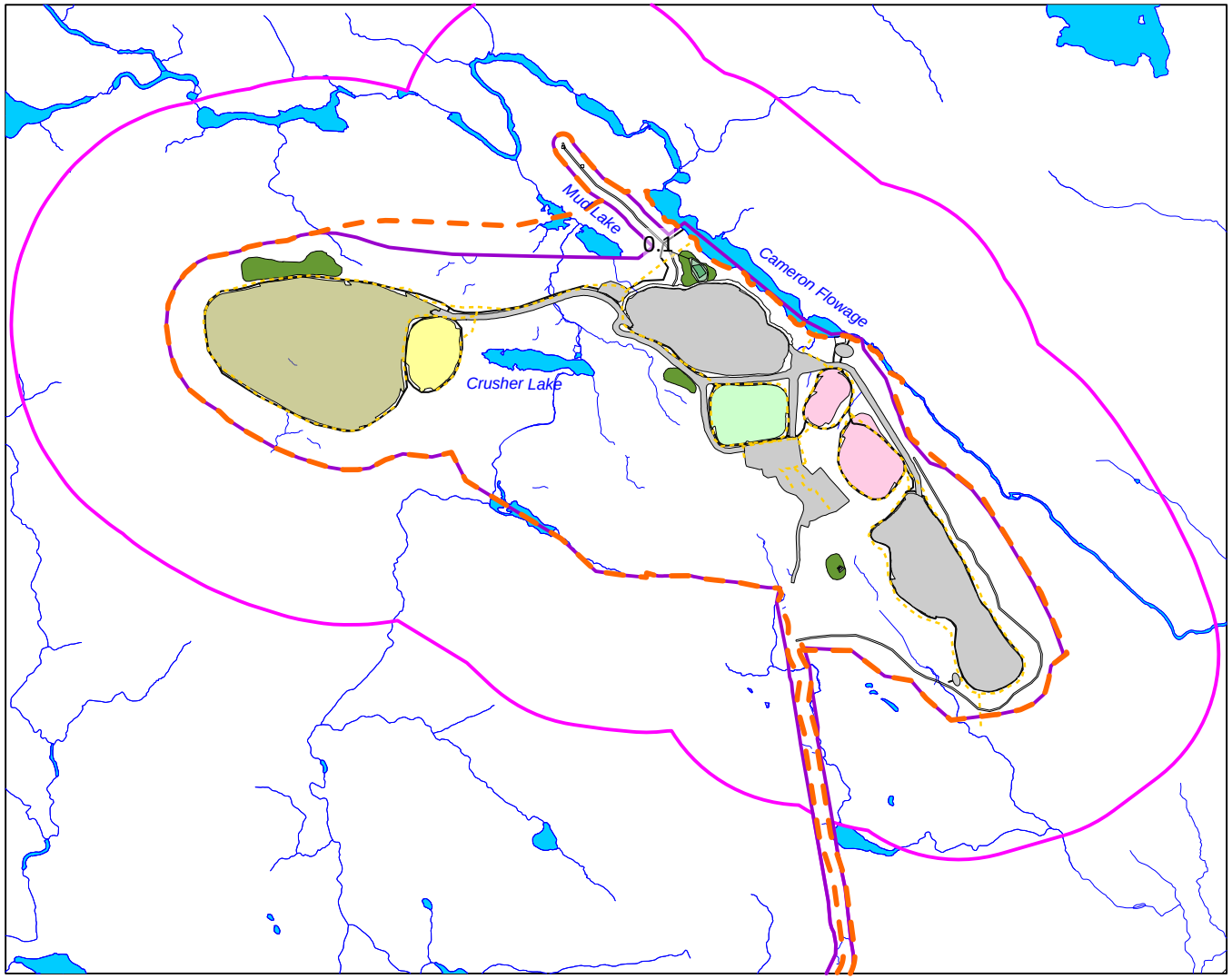
FIGURE 7.31

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.31 - Sim_Arsenic_PSS - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

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SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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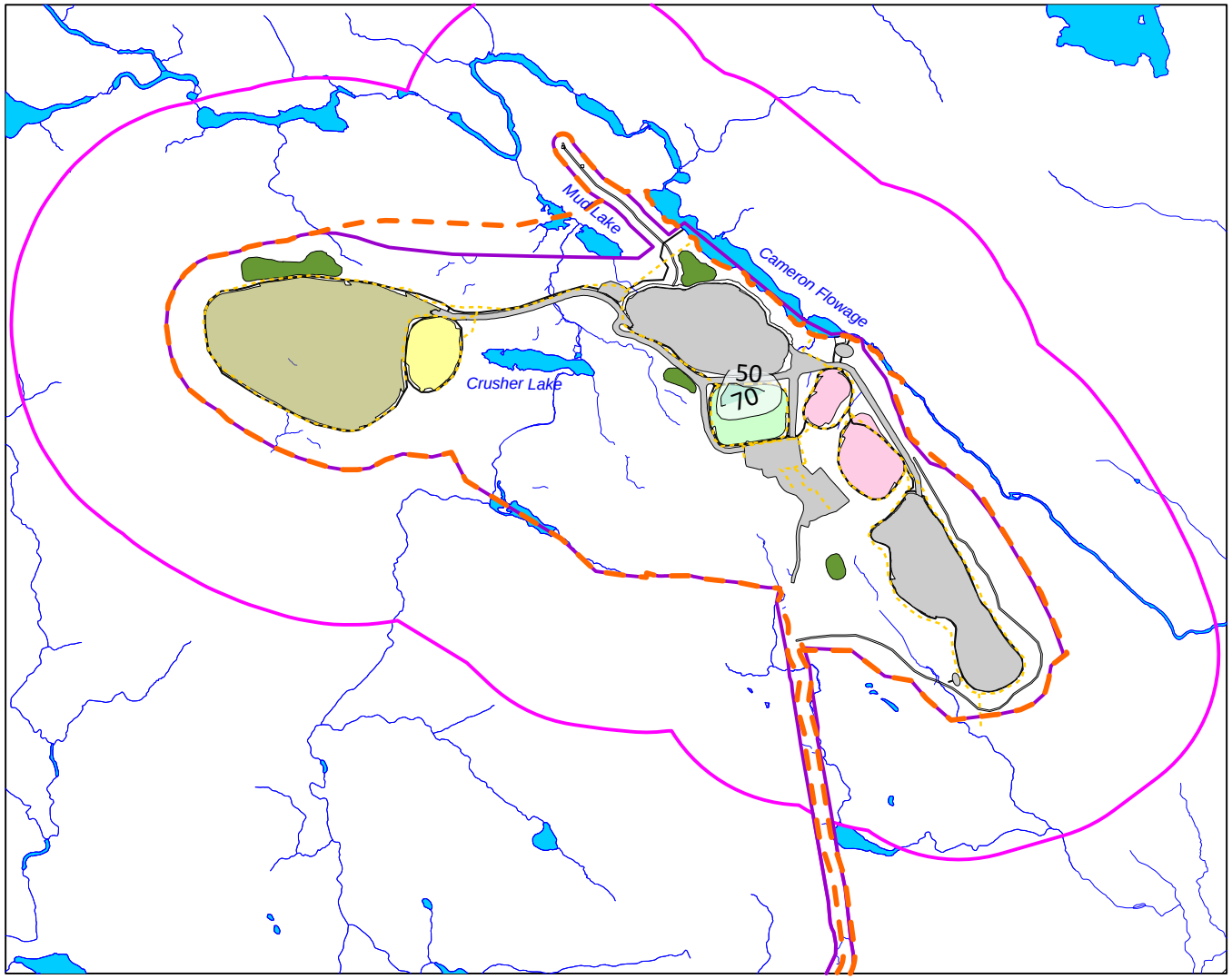
FIGURE 7.32

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.32 - Sim_Cadmium_PSS-EOM-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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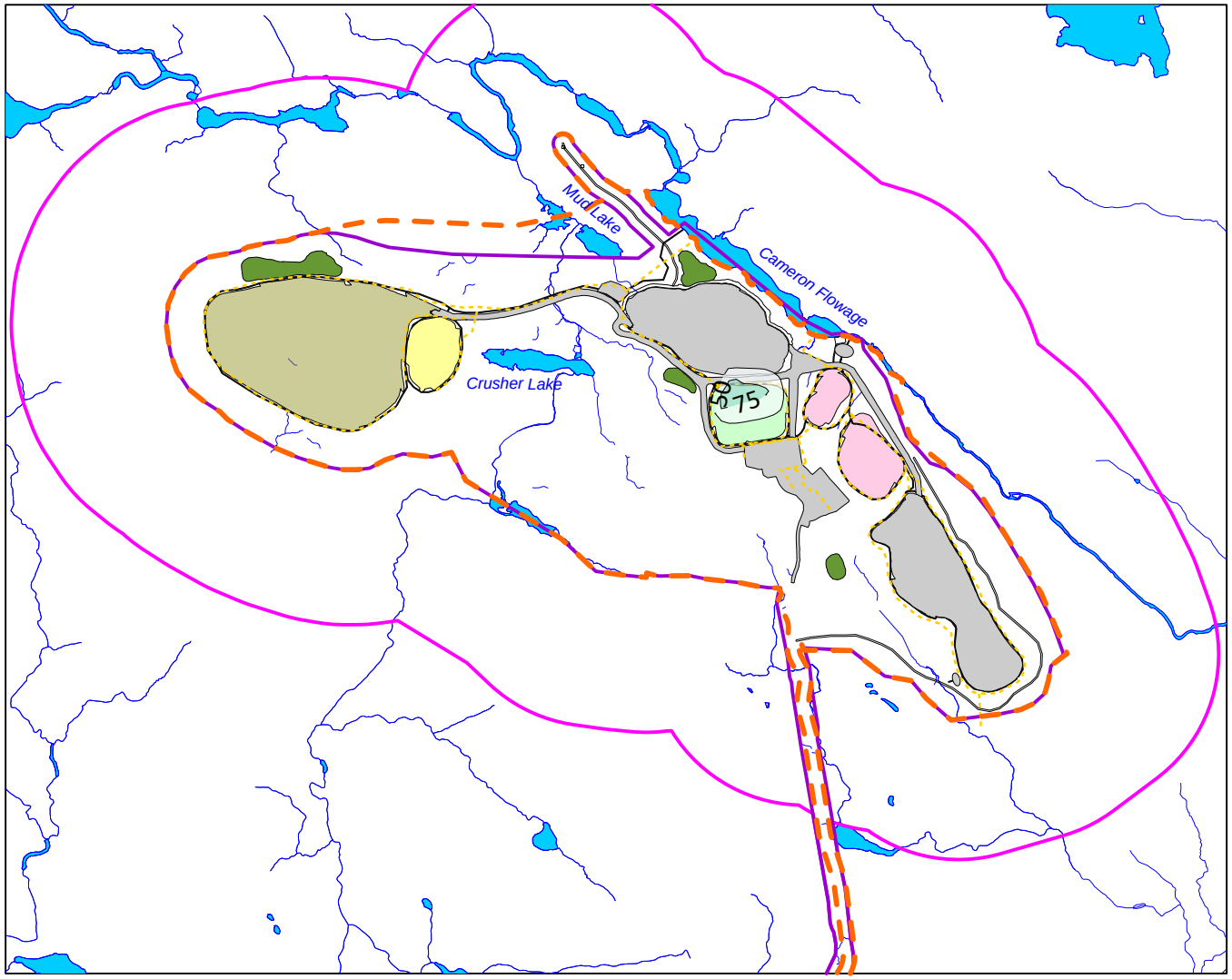
FIGURE 7.33

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.33 - Sim_Aluminum_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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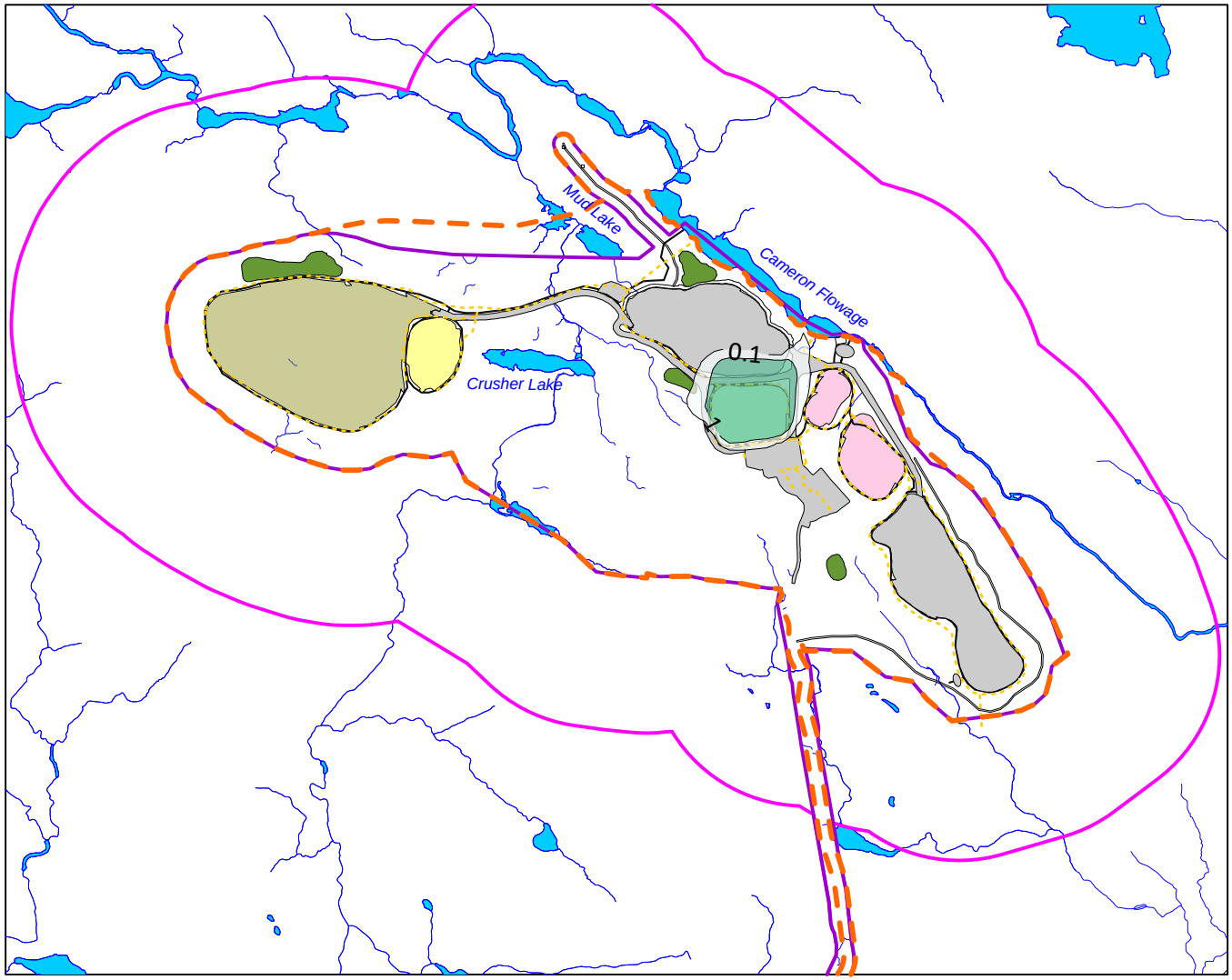
FIGURE 7.34

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.34 - Sim_Aluminum_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

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SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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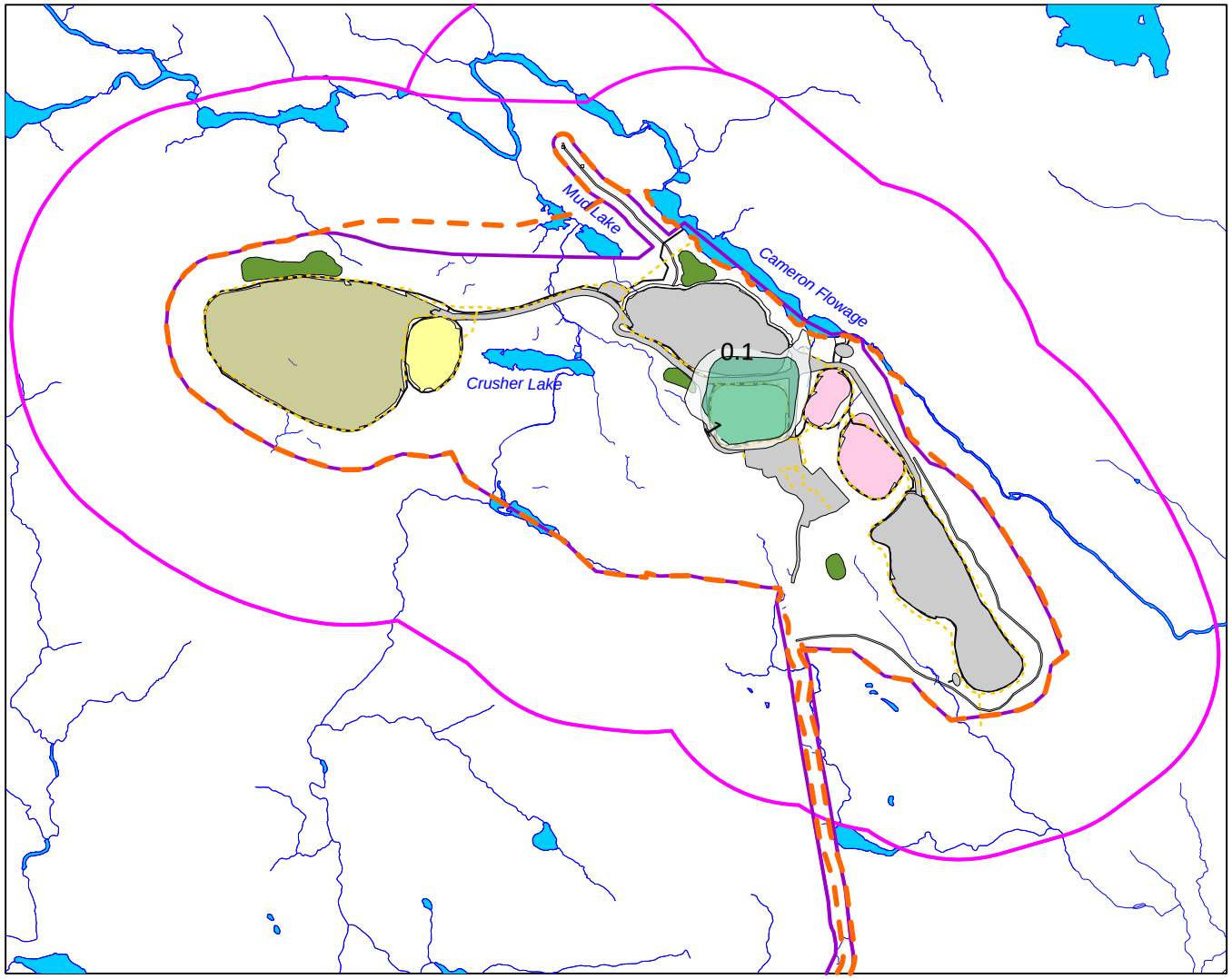
FIGURE 7.35

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.35 - Sim_Cadmium_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

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SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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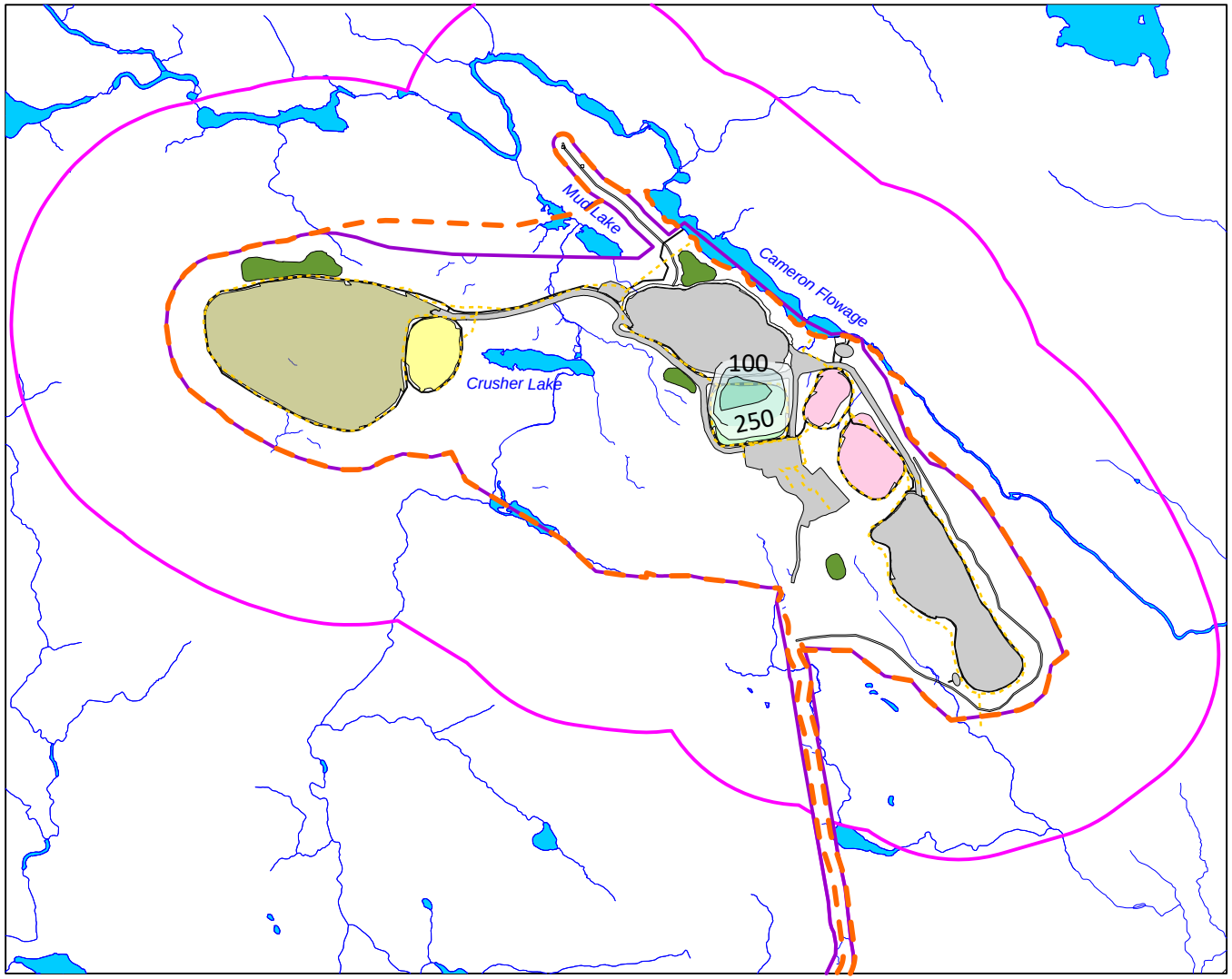
FIGURE 7.36

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.36 - Sim_Cadmium_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 2 PSS for groundwater discharge to surface water (>10 m) is 100 ug/L.

0 300 600 900m

N

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SIMULATED COBALT CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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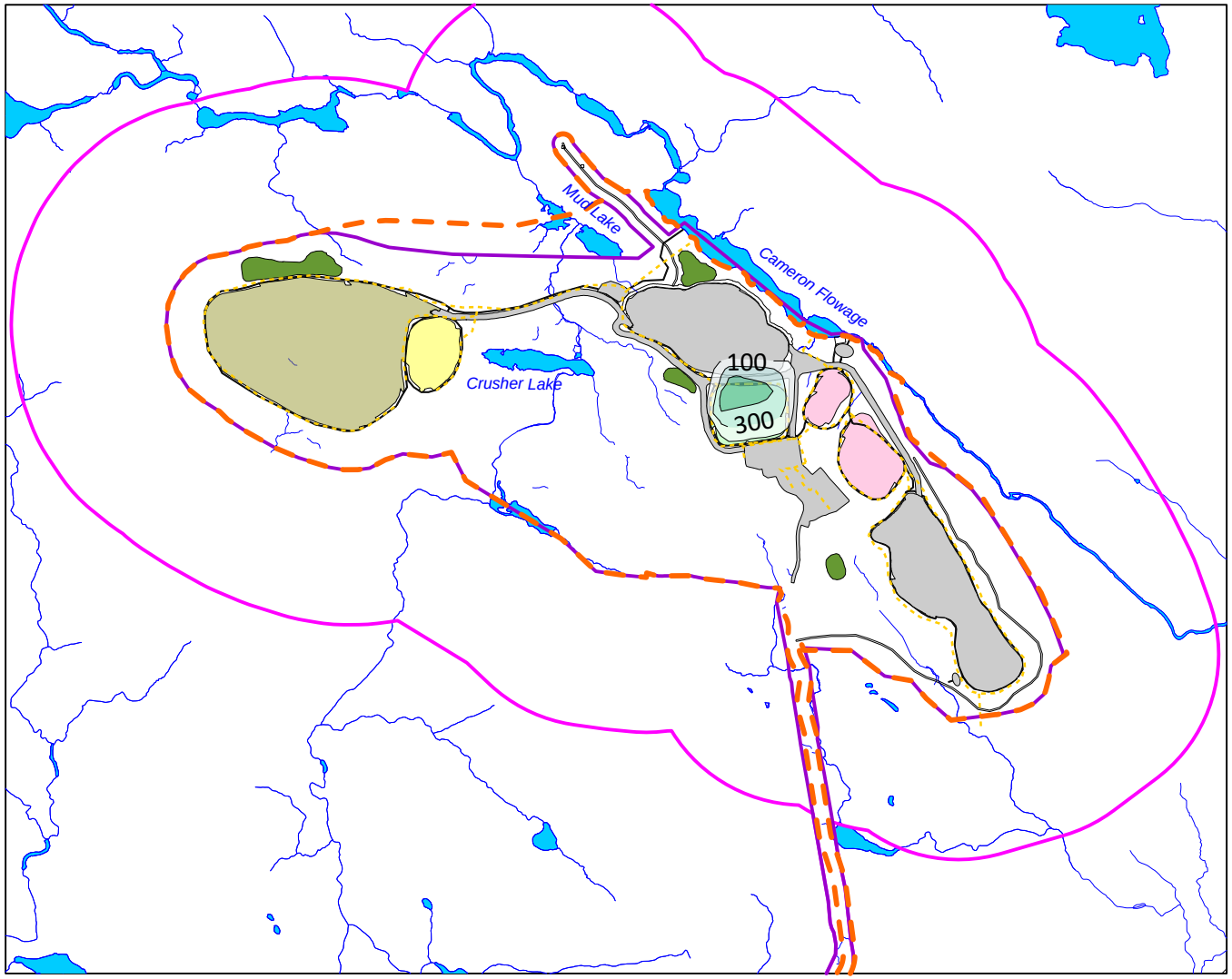
FIGURE 7.37

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.37 - Sim_Cobalt_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 2 PSS for groundwater discharge to surface water (>10 m) is 100 ug/L.

0 300 600 900m

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SIMULATED COBALT CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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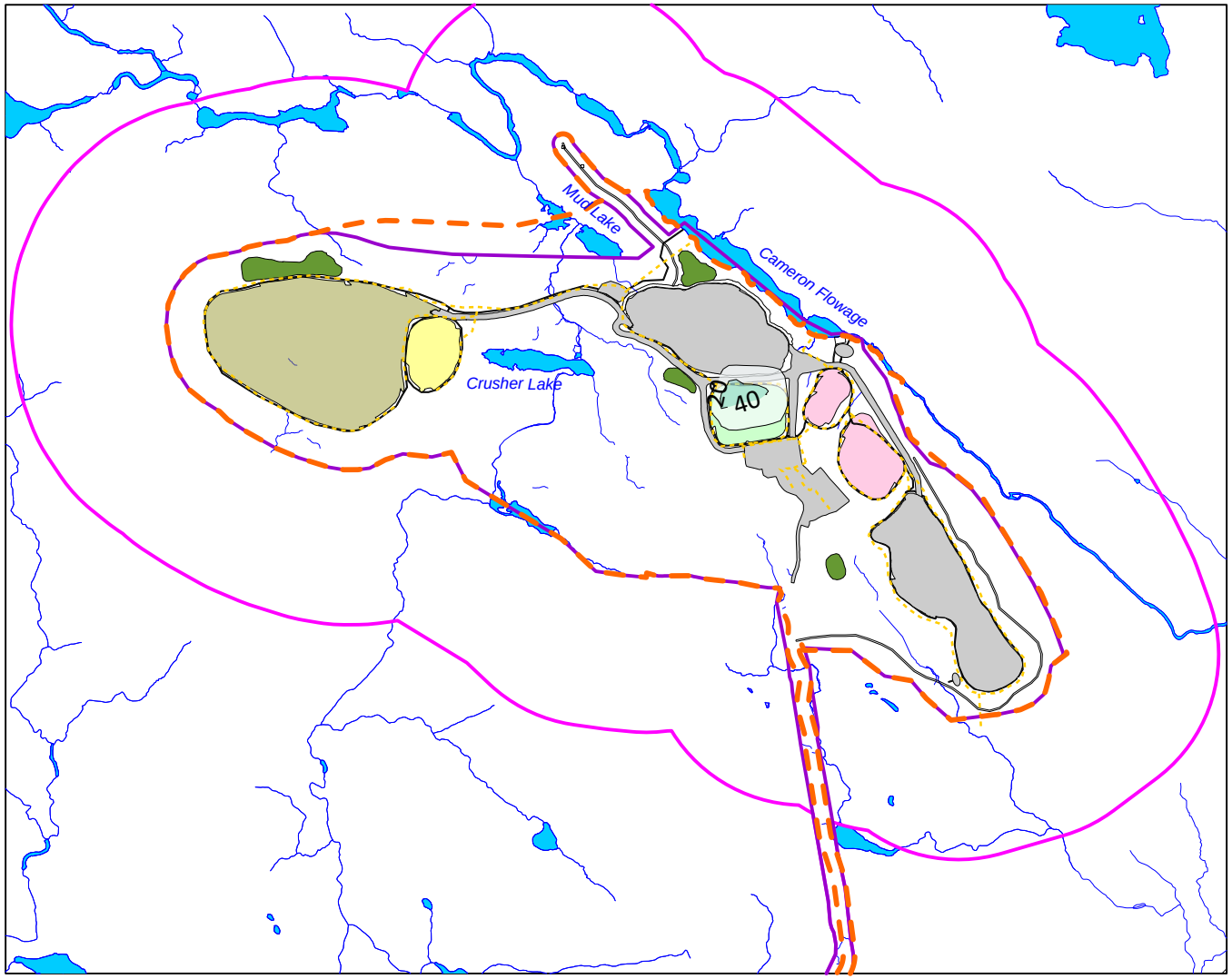
FIGURE 7.38

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.38 - Sim_Cobalt_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COPPER CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The copper Tier 2 PSS for groundwater discharge to surface water (>10 m) is 20 ug/L.

0 300 600 900m

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SIMULATED COPPER CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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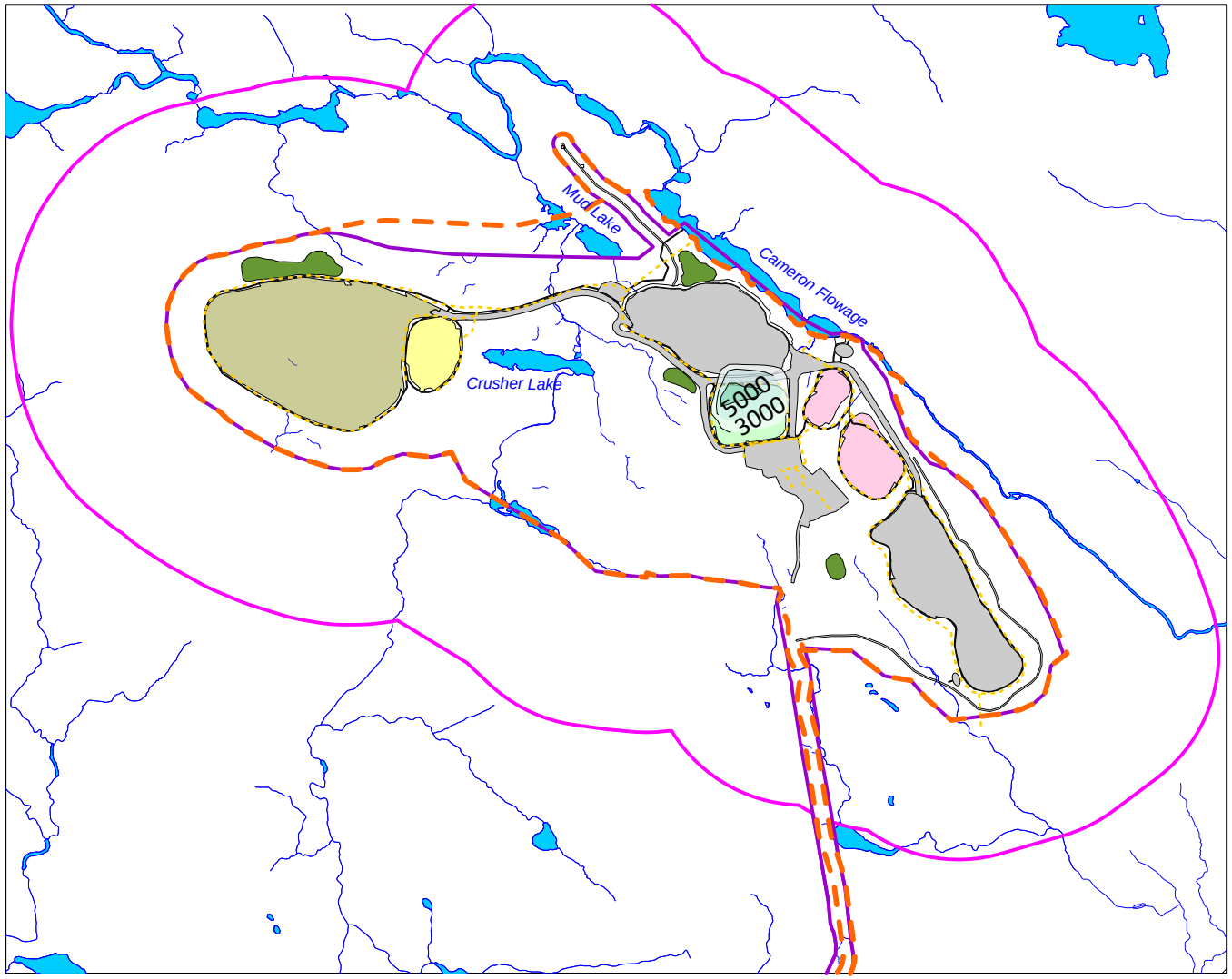
FIGURE 7.39

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.40 - Sim_Copper_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED IRON CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The iron Tier 2 PSS for groundwater discharge to surface water (>10 m) is 3,000 ug/L.

0 300 600 900m

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SIMULATED IRON CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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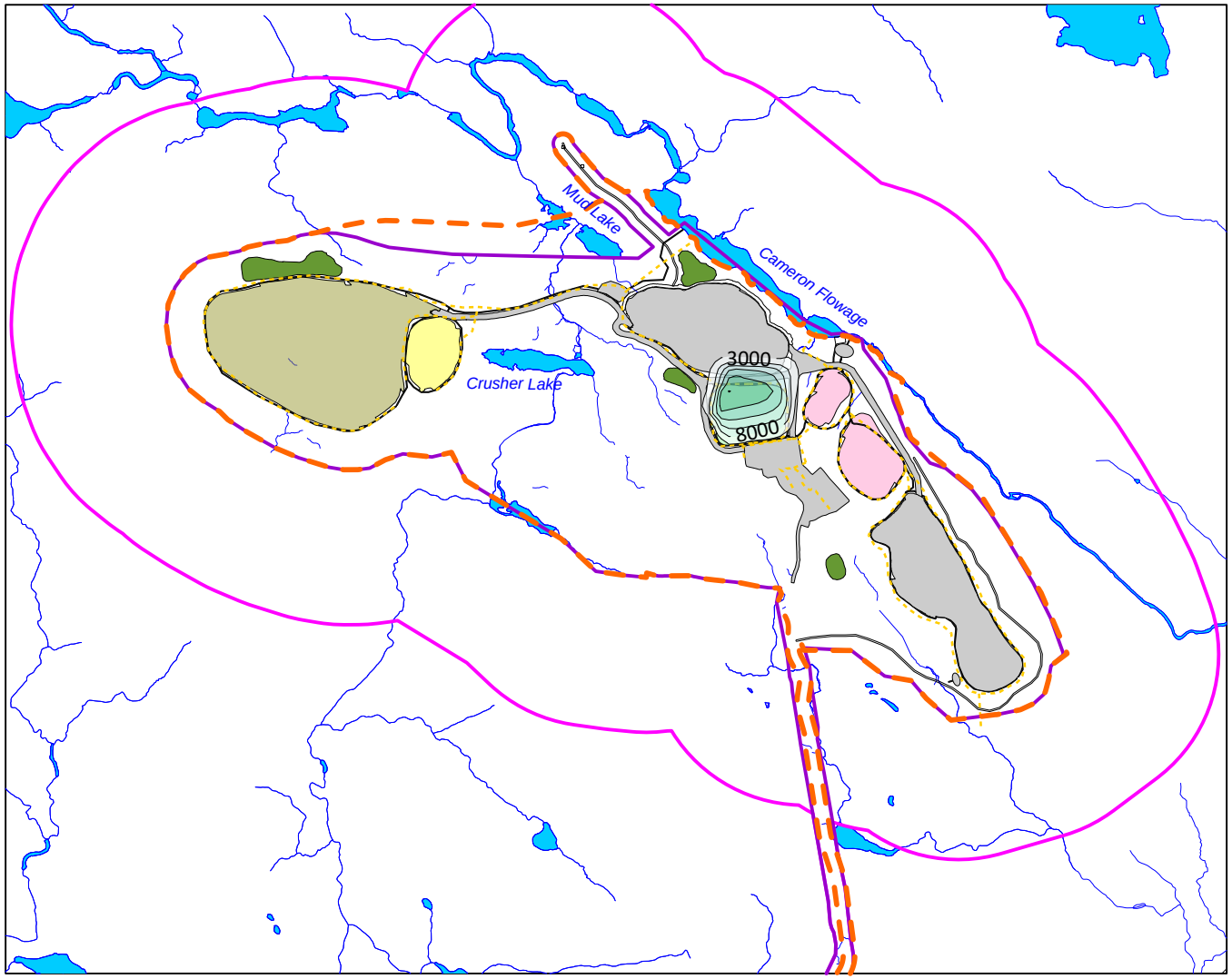
FIGURE 7.40

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.41 - Sim_Iron_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED IRON CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The iron Tier 2 PSS for groundwater discharge to surface water (>10 m) is 3,000 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED IRON CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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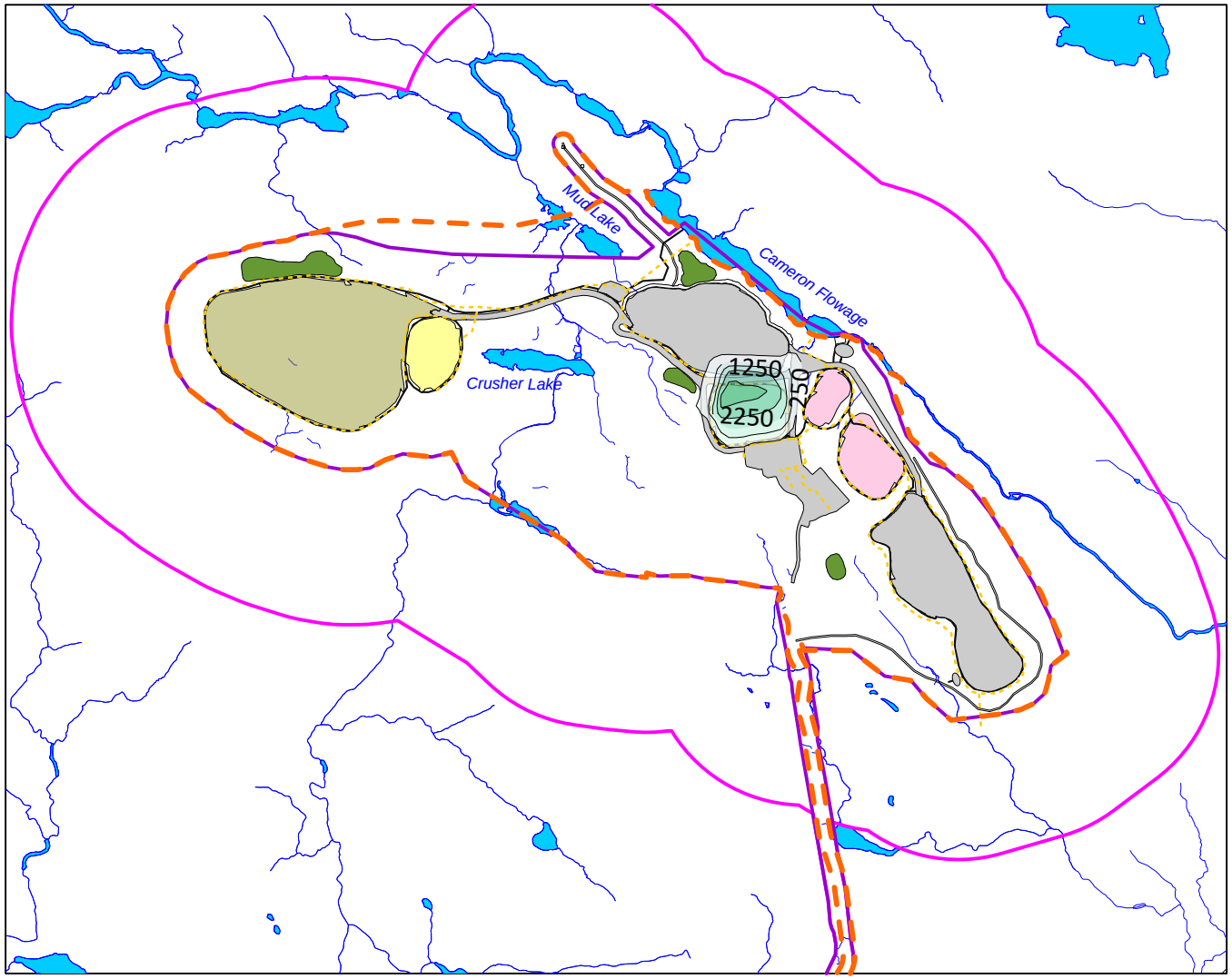
FIGURE 7.41

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.42 - Sim_Iron_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 2 PSS for groundwater discharge to surface water (>10 m) is 250 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED NICKEL CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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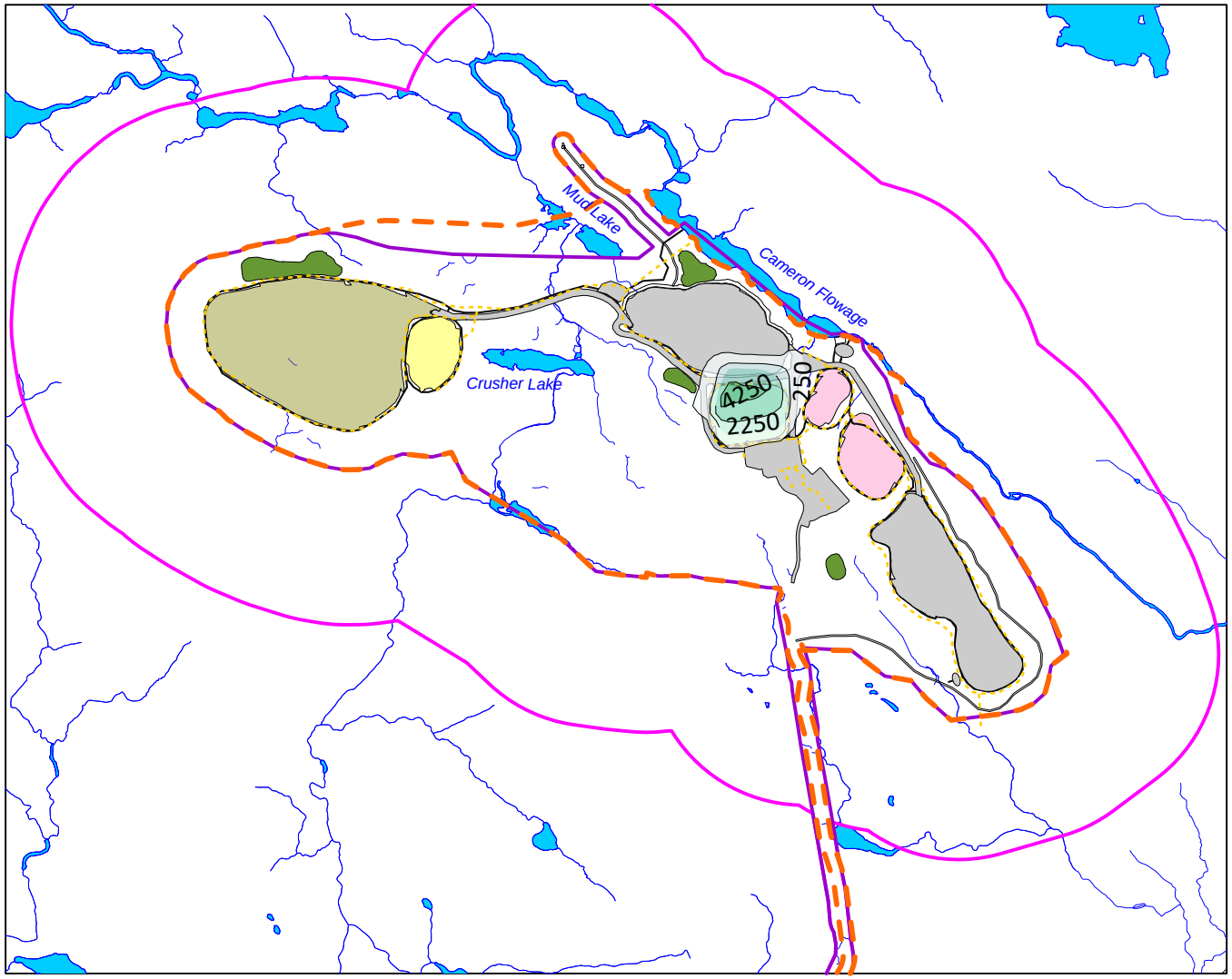
FIGURE 7.42

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.43 - Sim_Nickel_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 2 PSS for groundwater discharge to surface water (>10 m) is 250 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED NICKEL CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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FIGURE 7.43

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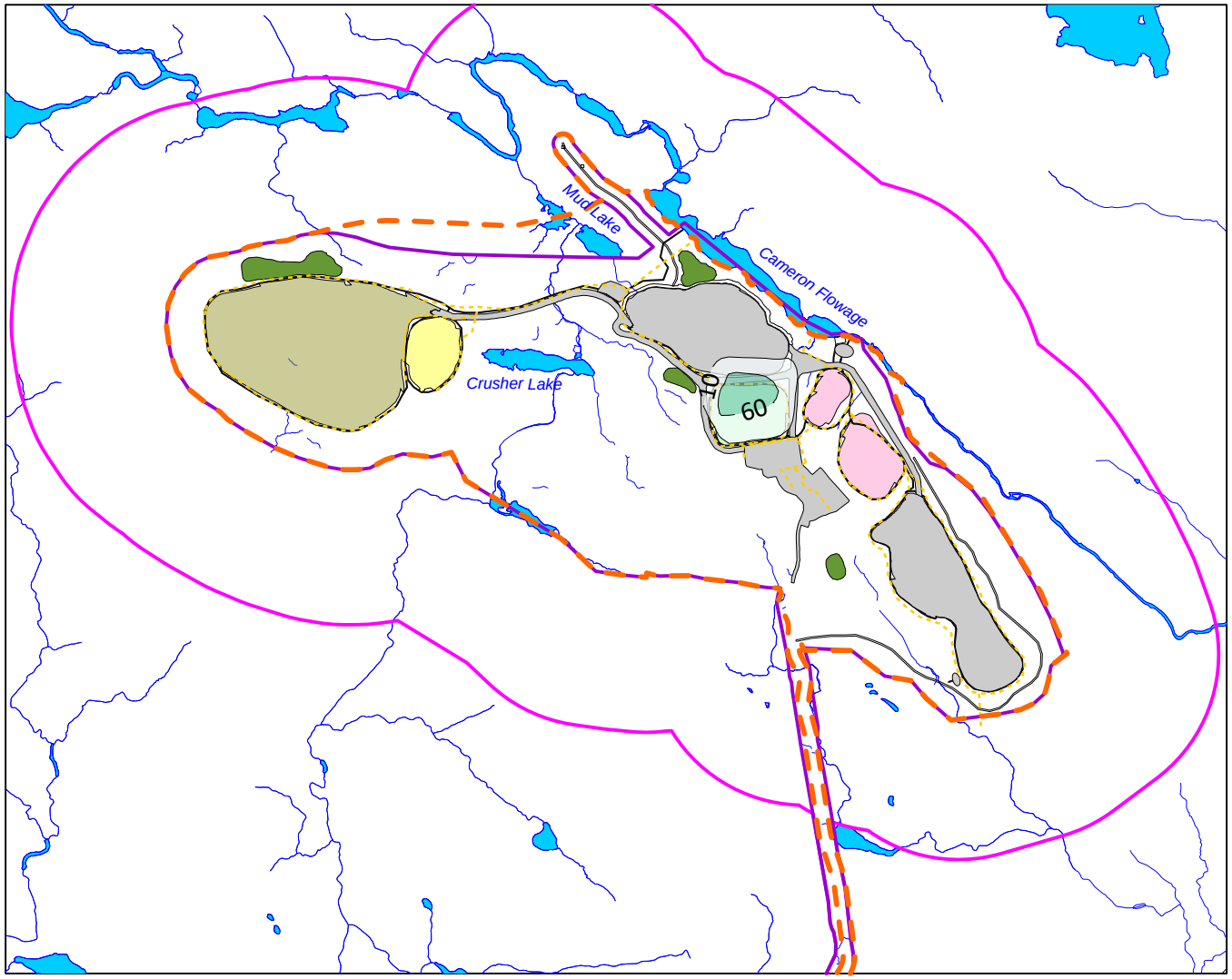

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead Tier 2 PSS for groundwater discharge to surface water (>10 m) is 10 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED LEAD CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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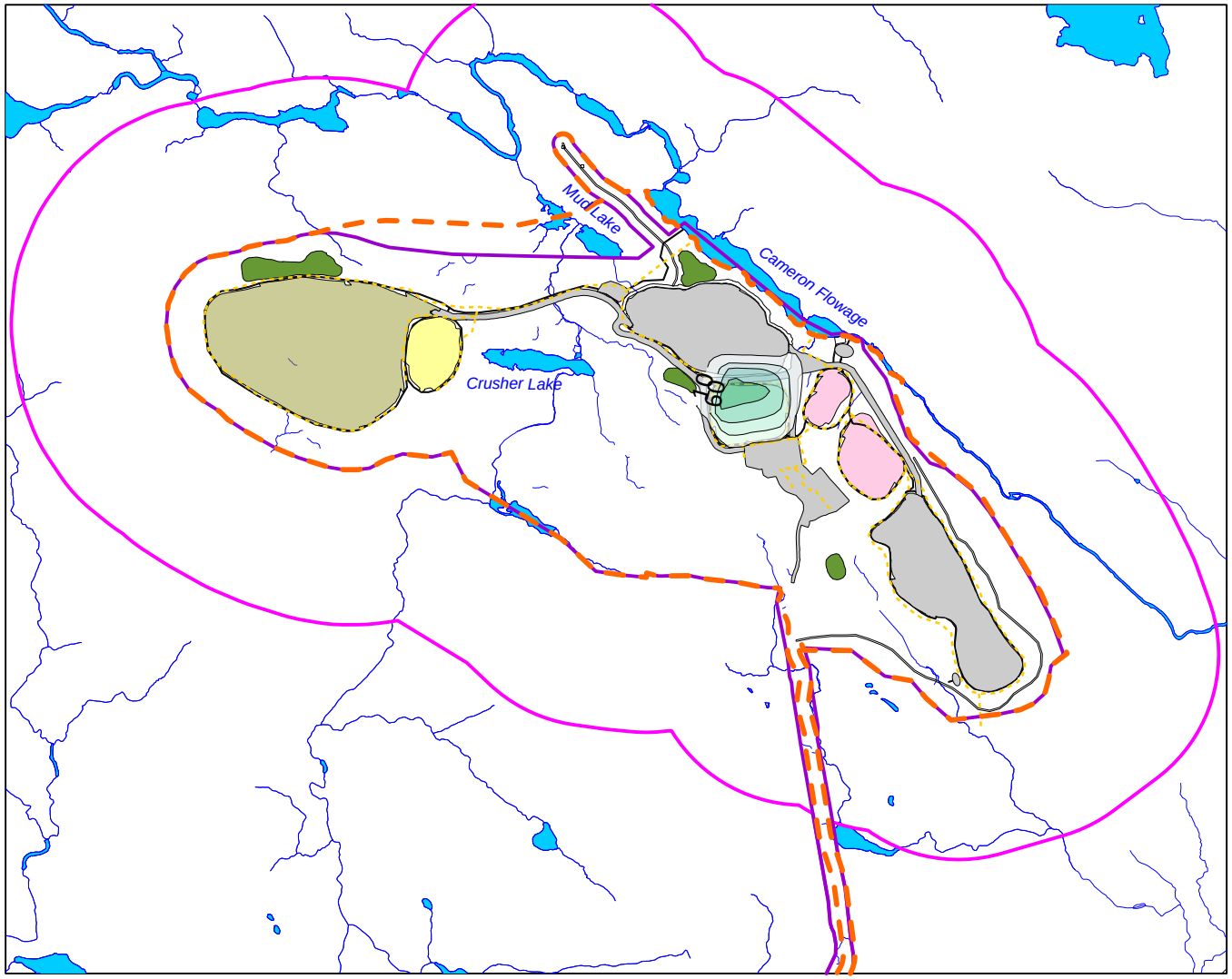
FIGURE 7.44

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.45 - Sim_Lead_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead Tier 2 PSS for groundwater discharge to surface water (>10 m) is 10 ug/L.

0 300 600 900m

N

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ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED LEAD CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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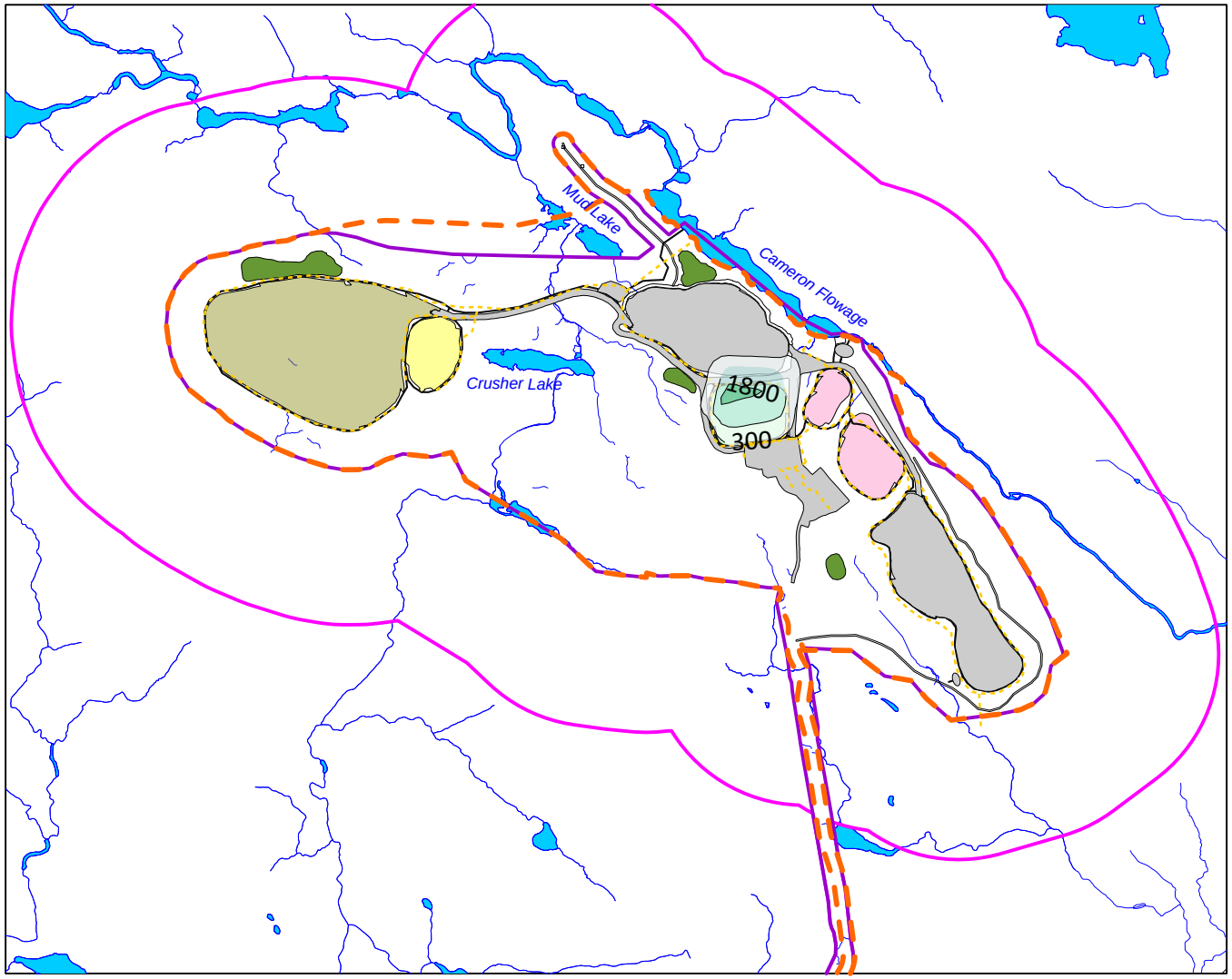
FIGURE 7.45

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.45 - Sim_Lead_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 2 PSS for groundwater discharge to surface water (>10 m) is 300 ug/L.

0 300 600 900m

N

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ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED ZINC CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - BASE CASE CONDITION

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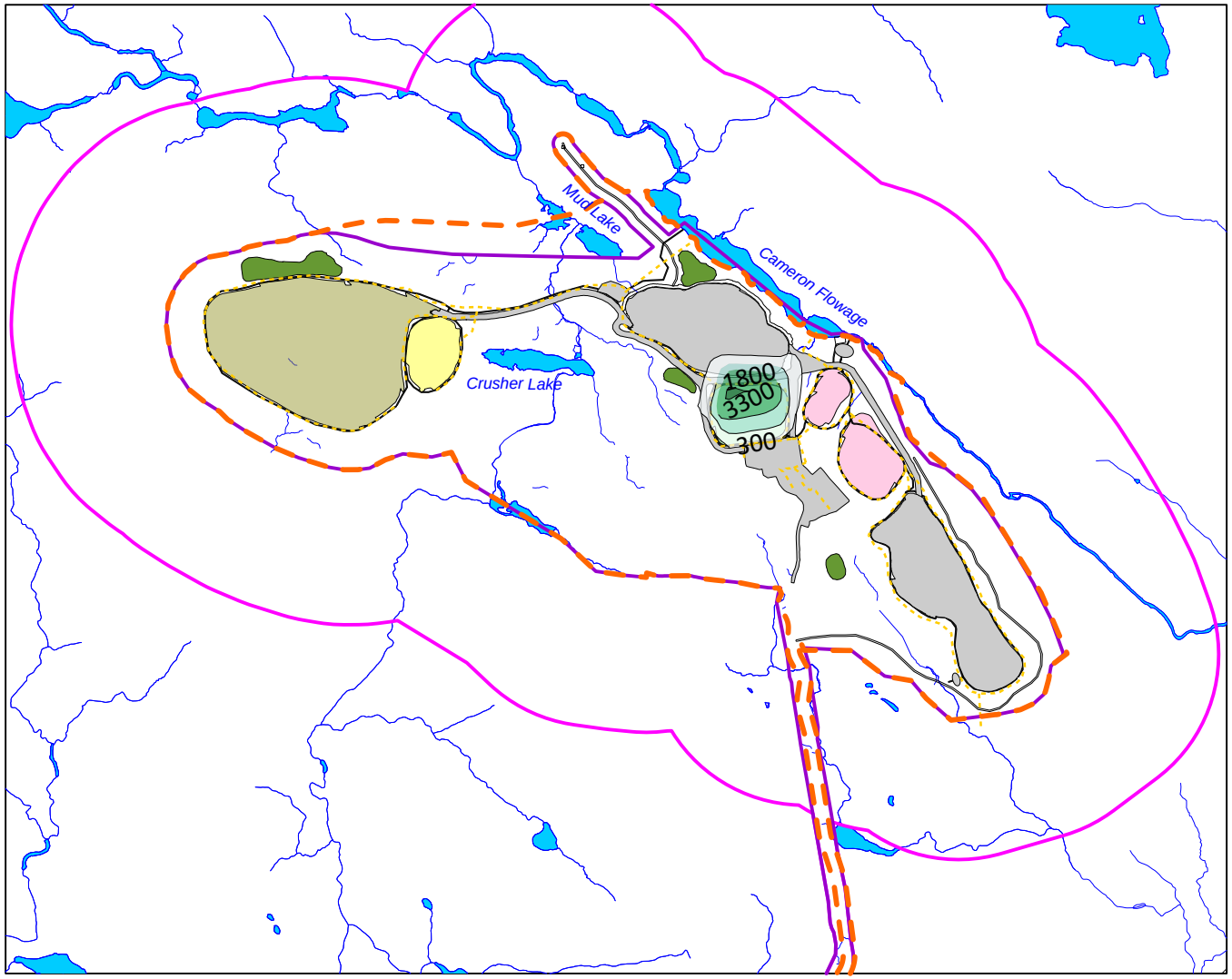
FIGURE 7.46

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.48 - Sim_Zinc_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 2 PSS for groundwater discharge to surface water (>10 m) is 300 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED ZINC CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - BASE CASE CONDITION

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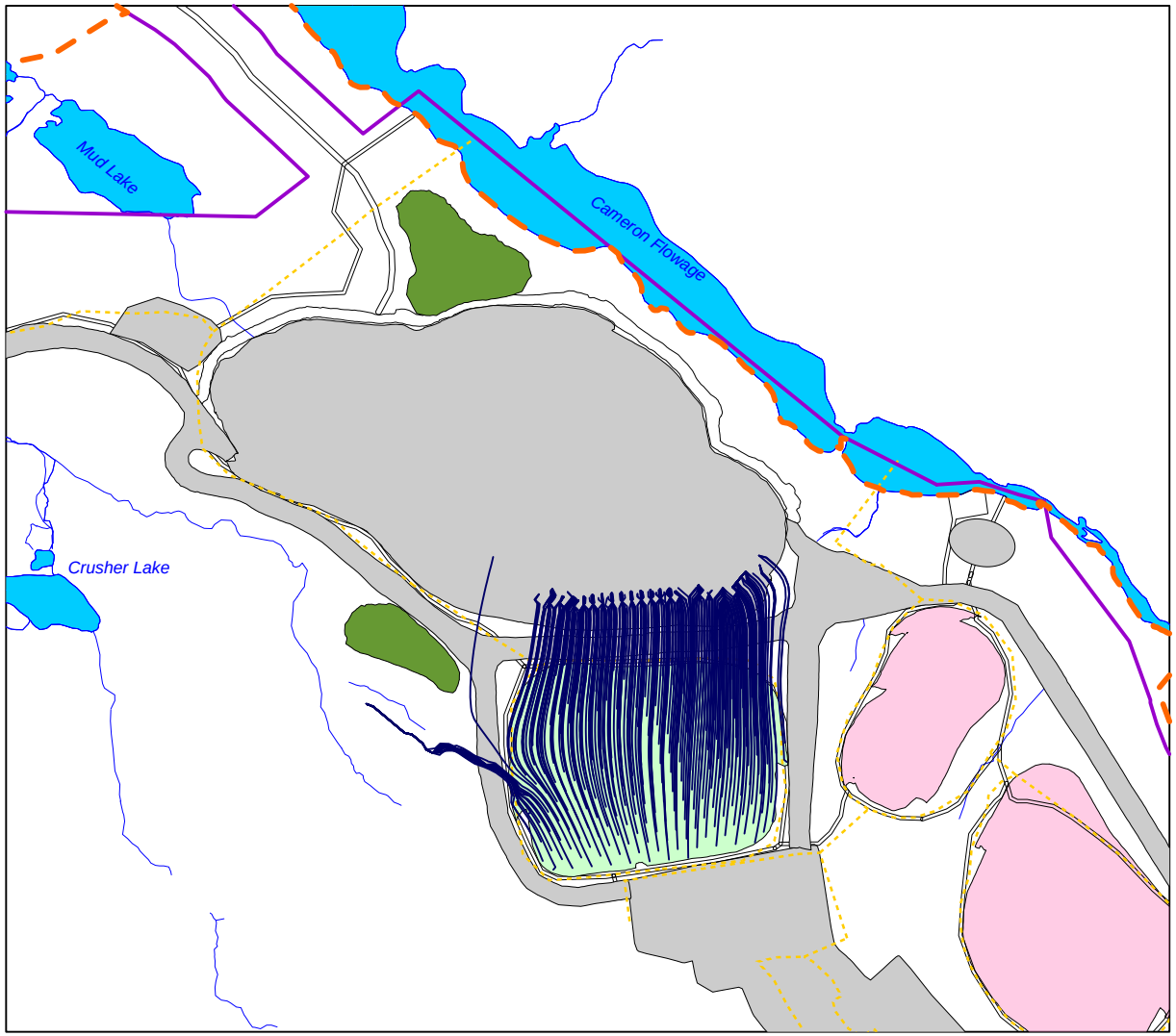
FIGURE 7.47

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.49 - Sim_Zinc_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- PARTICLE PATHWAY
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- PAG WASTE ROCK STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 90 180 270m

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BEAVER DAM MINE

SIMULATED PARTICLE PATHWAYS WITHOUT MITIGATION
PC - BASE CASE CONDITION

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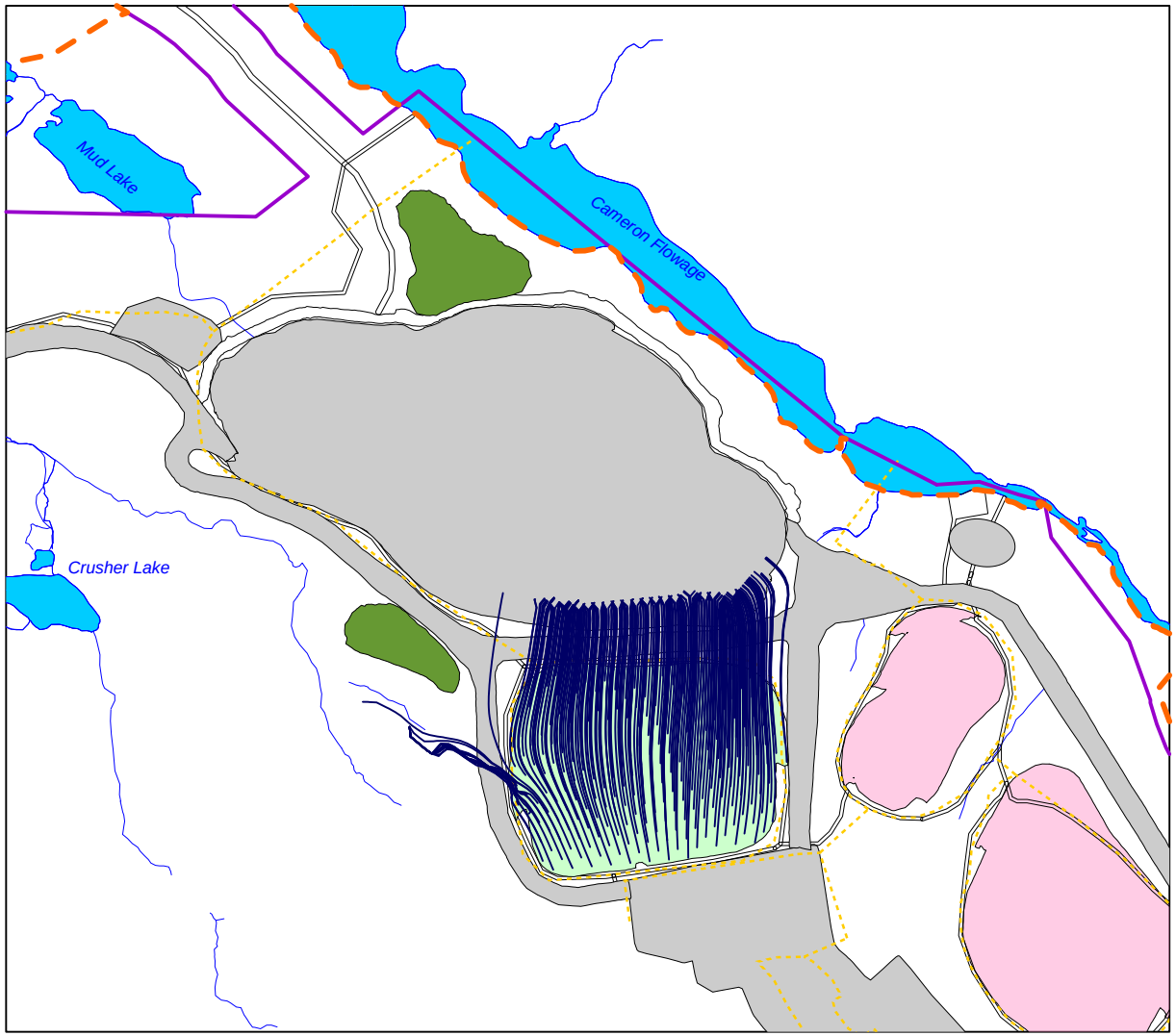
FIGURE 7.48

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.50 - pathways-PC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- PARTICLE PATHWAY
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- PAG WASTE ROCK STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 90 180 270m

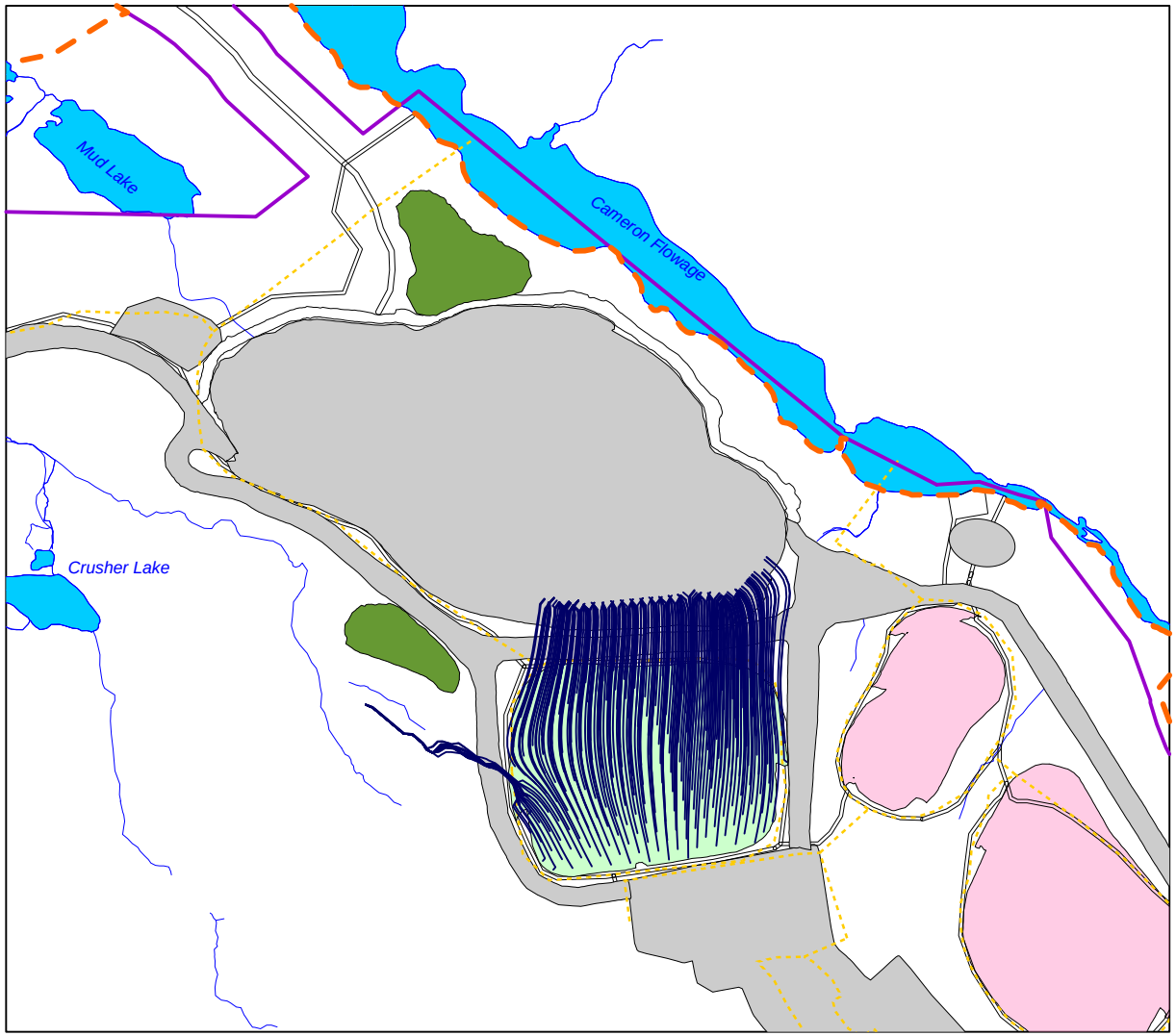
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED PARTICLE PATHWAYS WITHOUT MITIGATION
PC - DRY CASE CONDITION

088664-031
March 11, 2021

FIGURE 7.49

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.51 - Pathways-PC-DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- PARTICLE PATHWAY
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- PAG WASTE ROCK STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

0 90 180 270m

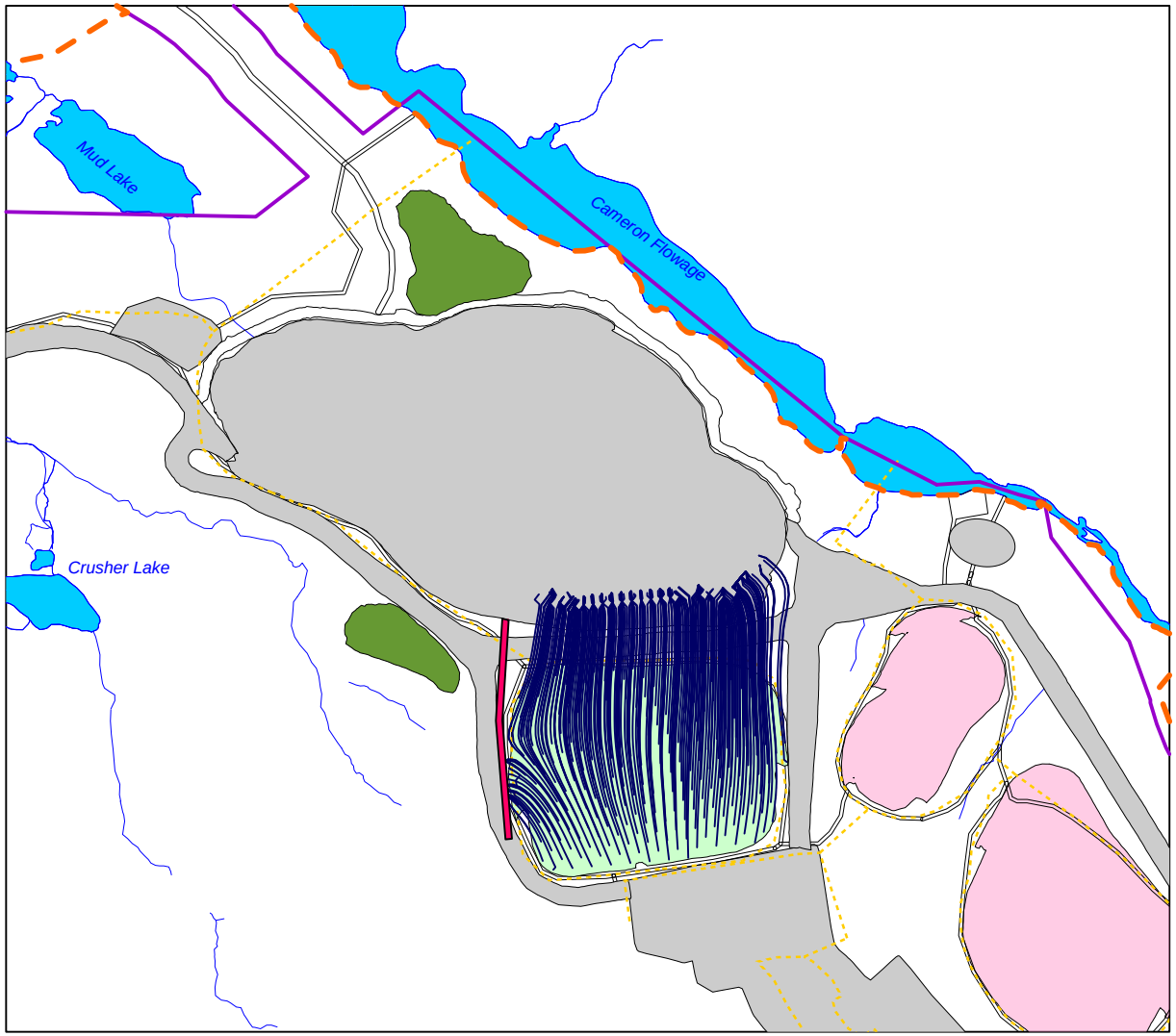
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED PARTICLE PATHWAYS WITHOUT MITIGATION
PC - WET CASE CONDITION

088664-031
March 11, 2021

FIGURE 7.50

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.52 - Pathways-PC-WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- PARTICLE PATHWAY
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- PAG WASTE ROCK STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- POTENTIAL INTERCEPTOR TRENCH LOCATION

0 90 180 270m

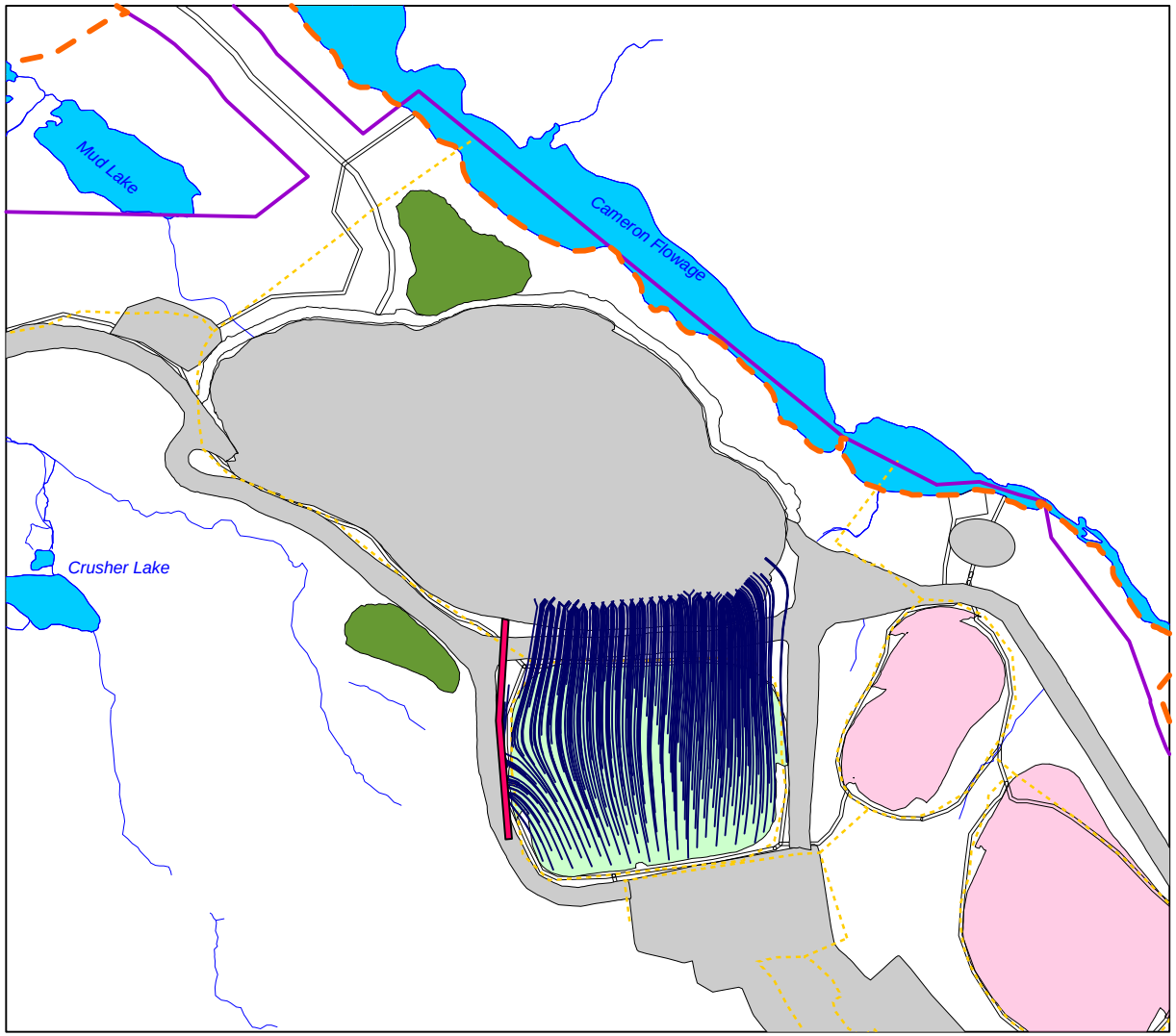
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED PARTICLE PATHWAYS WITH MITIGATION
PC - BASE CASE CONDITION

088664-031
March 11, 2021

FIGURE 7.51

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.53 - Pathways-PC-AVG-mitigation.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- PARTICLE PATHWAY
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- PAG WASTE ROCK STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- POTENTIAL INTERCEPTOR TRENCH LOCATION

0 90 180 270m

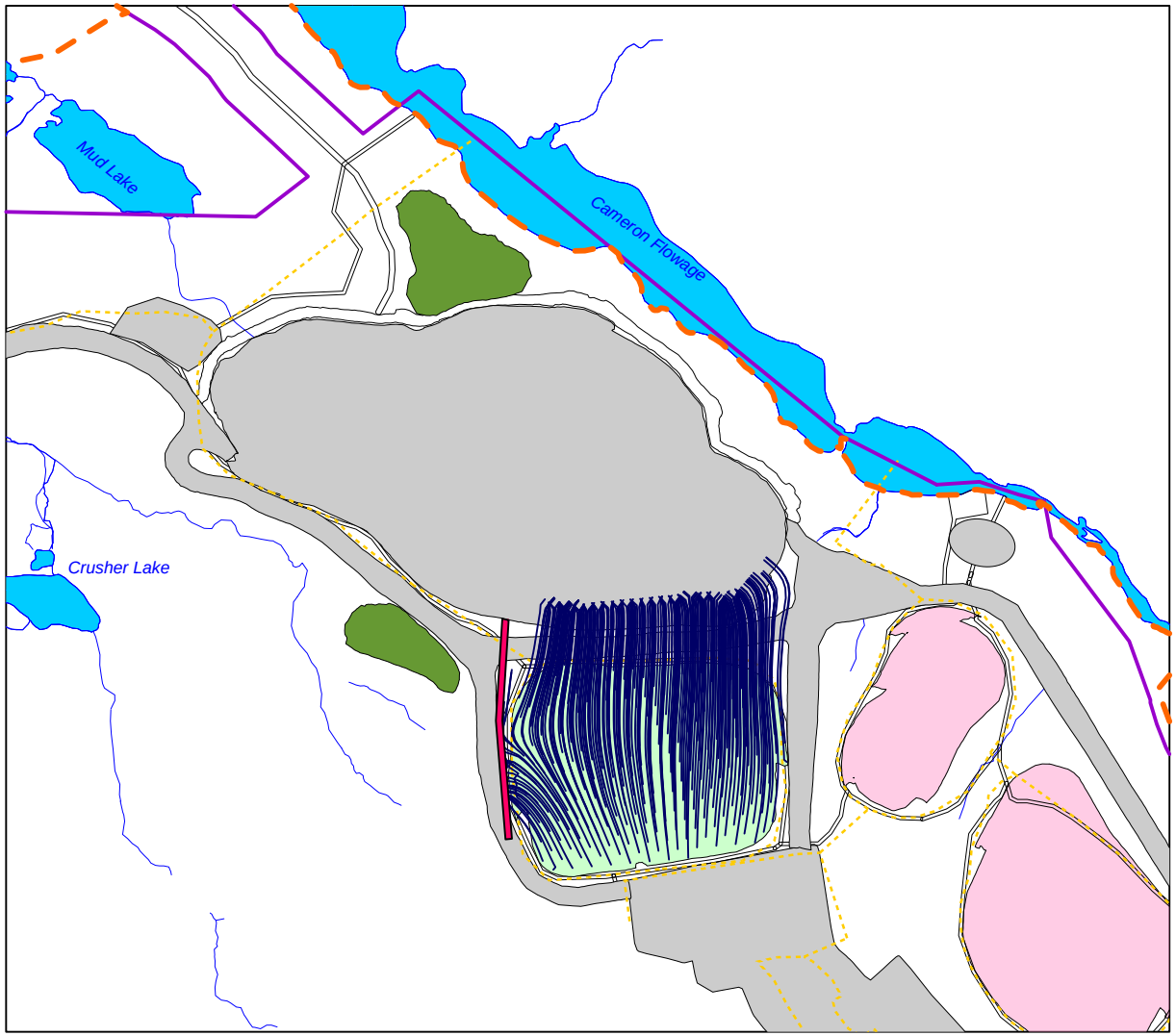
ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED PARTICLE PATHWAYS WITH MITIGATION
PC - DRY CASE CONDITION

088664-031
March 11, 2021

FIGURE 7.52

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.54 - Pathways-PC-DRY-mitigation.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- PARTICLE PATHWAY
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- PAG WASTE ROCK STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES
- POTENTIAL INTERCEPTOR TRENCH LOCATION

0 90 180 270m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED PARTICLE PATHWAYS WITH MITIGATION
PC - WET CASE CONDITION

088664-031
March 11, 2021

FIGURE 7.53

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.55 - Pathways-PC-WET-mitigation.srf

Table 2.1

Overburden Slug Test Hydraulic Conductivity Results
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Lithology / Structure	Hydraulic Test Method/Type	Hydraulic Conductivity (m/s)	Overburden Thickness[(1)] (m)	Monitoring Well Screened (m BGS)
MW-02A	overburden	Bouwer-Rice/Falling Head	1.8E-05	5.10	3.20
MW-02A	overburden	Bouwer-Rice/Rising Head	1.7E-05	5.10	3.20
MW-12A	overburden	Bouwer-Rice/Rising Head	8.8E-07	20.78	3.51
MW-12A	overburden	Dagan/Rising Head	8.9E-07	20.78	3.51
MW-14A	overburden	Bouwer-Rice/Falling Head	9.7E-07	18.10	3.80
MW-14A	overburden	Bouwer-Rice/Rising Head	6.1E-07	18.10	3.80
MW-14A	overburden	Bouwer-Rice/Falling Head	1.2E-06	18.10	3.80
MW-14A	overburden	Bouwer-Rice/Rising Head	9.4E-07	18.10	3.80
MW-17A	overburden	Bouwer-Rice/Falling Head	6.7E-06	4.67	2.67
MW-17A	overburden	Bouwer-Rice/Rising Head	2.1E-06	4.67	2.67
MW-19A	overburden	Bouwer-Rice/Rising Head	8.5E-05	4.72	2.67
MW-19A	overburden	Springer-Gelhar/Rising Head	1.7E-04	4.72	2.67
MW-19A	overburden	Dagan/Rising Head	7.7E-05	4.72	2.67
MW-19A	overburden	Bouwer-Rice/Rising Head	1.1E-04	4.72	2.67
MW-19A	overburden	Springer-Gelhar/Rising Head	3.8E-04	4.72	2.67
MW-19A	overburden	Dagan/Rising Head	9.3E-05	4.72	2.67
		Geometric Mean	1.0E-05		
		Minimum Value	6.1E-07		
		Maximum Value	3.8E-04		

Notes:

m/s Metres per second
m BGS Metres below ground surface
(1) Where the tested well did not contact bedrock, the overburden thickness is taken as the average of the overburden thickness encountered at each well within a given well nest that contacted bedrock.

Table 2.2

Shallow Bedrock Hydraulic Conductivity Testing Results
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Lithology / Structure	Hydraulic Test Method/Type	Hydraulic Conductivity (m/s)	Depth Below Top of Bedrock to Midpoint of Test Interval (m)
MW-05C	Greywacke	Packer Test	5.0E-07	1.4
MW-16A	Overburden/Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Falling Head	7.2E-06	2.0
MW-16A	Overburden/Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.9E-06	2.0
MW-04A	Bedrock - Greywacke	Bouwer-Rice/Falling Head	1.0E-04	2.6
MW-04A	Bedrock - Greywacke	Springer-Gelhar/Rising Head	1.6E-04	2.6
MW-07A	Bedrock - Greywacke	Bouwer-Rice/Falling Head	5.7E-07	2.8
MW-07A	Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.0E-05	2.8
MW-21A	Bedrock - Greywacke	Bouwer-Rice/Falling Head	3.4E-06	2.8
MW-21A	Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.9E-06	2.8
MW-20A	Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Falling Head	3.7E-05	2.8
MW-20A	Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.4E-05	2.8
MW-05A	Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Rising Head	2.6E-06	2.9
MW-05A	Weathered Bedrock/Bedrock - Greywacke	Dagan/Rising Head	1.7E-06	2.9
MW-05A	Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.8E-06	2.9
MW-05A	Weathered Bedrock/Bedrock - Greywacke	Dagan/Rising Head	4.4E-06	2.9
MW-18A	Bedrock - Greywacke	Bouwer-Rice/Falling Head	4.7E-05	2.9
MW-18A	Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.6E-05	2.9
MW-17B	Weathered Upper Bedrock - Greywacke	Bouwer-Rice/Falling Head	5.0E-05	3.0
MW-17B	Weathered Upper Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.5E-05	3.0
MW-17B	Weathered Upper Bedrock - Greywacke	Bouwer-Rice/Falling Head	2.6E-05	3.0
MW-17B	Weathered Upper Bedrock - Greywacke	Bouwer-Rice/Rising Head	2.8E-05	3.0
MW-11A	Bedrock - Greywacke	Bouwer-Rice/Falling Head	2.8E-06	3.3
MW-11A	Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.6E-05	3.3
MW-07C	Greywacke	Packer Test	2.1E-06	3.4
MW-12B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	8.2E-07	3.5
MW-12B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	9.4E-07	3.5
MW-05C	Greywacke	Packer Test	8.3E-08	4.4
MW-09A	Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Falling Head	9.8E-07	4.5
MW-09A	Weathered Bedrock/Bedrock - Greywacke	Bouwer-Rice/Rising Head	8.3E-07	4.5
MW-07C	Greywacke	Packer Test	1.3E-06	6.4
MW-14B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	7.7E-08	6.5
MW-14B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.5E-08	6.5
MW-05C	Greywacke	Packer Test	4.3E-07	7.5
MW-09C	Greywacke	Packer Test	1.3E-07	7.7
BD85-016	Greywacke, Quartzite	Packer Test	8.0E-07	8.2
MW-17C	Bedrock - Greywacke	Bouwer-Rice/Falling Head	6.4E-06	8.7
MW-17C	Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.6E-06	8.7
MW-02B	Bedrock - Granite	Bouwer-Rice/Falling Head	5.0E-07	8.9
MW-02B	Bedrock - Granite	Bouwer-Rice/Rising Head	4.2E-07	8.9
MW-05C	Greywacke	Packer Test	3.8E-07	10.5
MW-07C	Greywacke	Packer Test	4.6E-07	10.7
MW-09C	Greywacke	Packer Test	2.7E-07	10.8
MW-18B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	7.0E-07	11.1
MW-18B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.7E-07	11.1
MW-07B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	1.3E-07	11.2
MW-07B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	1.2E-07	11.2
BD14-188	Greywacke Hanging wall	Packer Test	1.0E-08	11.3
MW-16B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	5.1E-07	11.4
MW-16B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.1E-07	11.4
BD85-029	Argillite	Packer Test	4.7E-07	11.5
MW-21B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	9.3E-07	11.8
MW-21B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.5E-07	11.8
MW-11B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	3.2E-07	11.8
MW-11B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	2.4E-07	11.8
BD85-005	Argillite	Packer Test	5.2E-07	12.0
BD85-016	Quartzite	Packer Test	1.6E-06	12.2

Table 2.2

Shallow Bedrock Hydraulic Conductivity Testing Results
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Lithology / Structure	Hydraulic Test Method/Type	Hydraulic Conductivity (m/s)	Depth Below Top of Bedrock to Midpoint of Test Interval (m)
MW-04B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	2.0E-05	12.3
MW-04B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	1.4E-05	12.3
BD85-090	Quartzite	Packer Test	3.1E-08	12.5
MW-22B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	1.8E-06	12.8
MW-22B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	1.3E-06	12.8
MW-05B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	9.6E-06	12.9
MW-05B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	8.2E-06	12.9
MW-09B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	3.0E-08	13.0
MW-09B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	2.3E-08	13.0
MW-01B	Bedrock - Greywacke	Bouwer-Rice/Falling Head	2.3E-07	13.1
MW-01B	Bedrock - Greywacke	Bouwer-Rice/Rising Head	2.5E-07	13.1
BD85-013	Greywacke	Packer Test	2.0E-08	13.3
BD85-082	Greywacke	Packer Test	3.6E-08	13.5
MW-05C	Greywacke	Packer Test	8.2E-07	13.6
BD85-007	Argillite	Packer Test	4.7E-08	13.6
MW-07C	Greywacke	Packer Test	3.3E-09	13.7
MW-09C	Greywacke	Packer Test	5.5E-09	13.9
MW-18C	Overburden/Weathered Bedrock - Greywacke	Bouwer-Rice/Falling Head	1.5E-08	15.1
MW-18C	Overburden/Weathered Bedrock - Greywacke	Bouwer-Rice/Rising Head	1.1E-08	15.1
BD85-016	Quartzite	Packer Test	4.9E-08	16.2
BD85-005	Argillite	Packer Test	9.0E-08	16.2
MW-05C	Greywacke	Packer Test	1.6E-07	16.6
BD85-090	Greywacke	Packer Test	3.0E-08	16.7
MW-07C	Greywacke	Packer Test	7.4E-08	16.8
MW-09C	Greywacke	Packer Test	1.7E-09	16.9
BD85-013	Greywacke, Quartzite	Packer Test	2.4E-08	17.0
BD85-043	Quartzite	Packer Test	8.3E-09	17.4
BD85-082	Greywacke	Packer Test	1.1E-06	17.7
BD85-007	Argillite, Quartzite	Packer Test	1.1E-08	17.8
MW-09C	Greywacke	Packer Test	1.1E-08	20.0
BD85-005	Argillite	Packer Test	1.8E-07	20.4
BD85-090	Greywacke, Quartzite	Packer Test	2.4E-08	20.8
BD85-029	Greywacke	Packer Test	9.9E-08	21.1
MW-14C	Bedrock - Greywacke	Bouwer-Rice/Falling Head	2.7E-07	21.5
MW-14C	Bedrock - Greywacke	Bouwer-Rice/Rising Head	1.6E-07	21.5
MW-14C	Bedrock - Greywacke	Bouwer-Rice/Falling Head	5.0E-06	21.5
MW-14C	Bedrock - Greywacke	Bouwer-Rice/Rising Head	2.3E-07	21.5
BD85-043	Greywacke, Argillite	Packer Test	2.6E-08	21.7
BD85-082	Quartzite / Fault	Packer Test	1.9E-06	21.8
BD85-007	Quartzite	Packer Test	8.4E-07	22.0
		Geometric Mean	5.6E-07	
		Minimum Value	1.7E-09	
		Maximum Value	1.6E-04	

Notes:

m	Metres
m/s	Metres per second
1.0E-08	Hydraulic conductivity test result did not provide an exact hydraulic conductivity value, but indicated that the hydraulic conductivity is less than the specified value.

Table 2.3

Deep Bedrock Hydraulic Conductivity Testing Results
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Lithology / Structure	Hydraulic Test Method/Type	Hydraulic Conductivity (m/s)	Depth Below Top of Bedrock to Midpoint of Test Interval (m)
MW-07C	Greywacke	Packer Test	4.3E-08	22.9
MW-11C	Greywacke	Slug Test	1.0E-10	23.3
MW-19C	Bedrock - Greywacke	Bouwer-Rice/Falling Head	3.7E-06	24.2
MW-19C	Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.3E-06	24.2
BD85-090	Greywacke, Quartzite	Packer Test	8.1E-08	24.9
MW-09C	Greywacke	Packer Test	3.5E-09	26.0
MW-07D	Greywacke	Bouwer-Rice/Falling Head	3.0E-07	26.4
MW-07D	Greywacke	Bouwer-Rice/Rising Head	2.9E-07	26.4
MW-22C	Bedrock - Greywacke	Bouwer-Rice/Falling Head	5.0E-07	26.4
MW-22C	Bedrock - Greywacke	Bouwer-Rice/Rising Head	4.2E-07	26.4
BD85-082	Greywacke	Packer Test	8.0E-07	27.3
MW-05D	Bedrock - Greywacke	Bouwer-Rice/Rising Head	1.2E-07	28.0
MW-05D	Bedrock - Greywacke	Bouwer-Rice/Rising Head	1.0E-07	28.0
MW-09D	Bedrock - Greywacke	Bouwer-Rice/Falling Head	3.0E-08	28.1
MW-09D	Bedrock - Greywacke	Bouwer-Rice/Rising Head	2.4E-08	28.1
MW-03C	Bedrock - Greywacke	Bouwer-Rice/Falling Head	5.4E-06	28.1
MW-03C	Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.6E-06	28.1
MW-07C	Greywacke	Packer Test	4.4E-09	29.0
BD85-029	Greywacke	Packer Test	9.4E-07	29.7
BD14-188	Greywacke Hanging wall	Packer Test	5.0E-09	32.0
MW-09C	Greywacke	Packer Test	4.5E-09	32.1
BD85-083	Greywacke / Fault	Packer Test	1.5E-08	34.3
BD85-029	Greywacke	Packer Test	9.0E-08	35.3
BD85-082	Quartzite	Packer Test	6.1E-07	36.8
MW-05C	Greywacke	Packer Test	6.8E-09	37.9
BD85-082	Quartzite	Packer Test	4.6E-07	40.9
MW-07C	Greywacke	Packer Test	2.2E-08	41.2
MW-09C	Greywacke	Packer Test	7.2E-10	41.3
BD85-083	Greywacke / Fault	Packer Test	1.0E-08	43.2
BD85-043	Greywacke	Packer Test	1.0E-06	43.2
BD85-005	Greywacke	Packer Test	1.4E-06	43.8
MW-05C	Greywacke	Packer Test	2.3E-09	44.0
MW-07C	Greywacke	Packer Test	2.8E-08	44.2
MW-05C	Greywacke	Packer Test	7.9E-10	47.1
BD85-043	Greywacke	Packer Test	2.3E-07	47.5
MW-09C	Greywacke	Packer Test	1.2E-08	50.4
BD85-007	Greywacke / Fault	Packer Test	2.0E-09	51.2
BD85-083	Greywacke / Fault	Packer Test	1.2E-09	52.1

Table 2.3

Deep Bedrock Hydraulic Conductivity Testing Results
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Lithology / Structure	Hydraulic Test Method/Type	Hydraulic Conductivity (m/s)	Depth Below Top of Bedrock to Midpoint of Test Interval (m)
MW-07C	Greywacke	Packer Test	2.0E-07	53.4
MW-05C	Greywacke	Packer Test	1.0E-08	56.2
BD85-043	Greywacke	Packer Test	2.7E-09	57.6
MW-05C	Bedrock - Greywacke	Bouwer-Rice/Rising Head	3.4E-08	57.8
BD85-007	Greywacke	Packer Test	5.4E-07	59.5
MW-09C	Greywacke	Packer Test	4.2E-09	59.6
BD85-043	Greywacke	Packer Test	3.4E-09	61.9
BD85-016	Greywacke, Argillite	Packer Test	2.5E-07	65.3
BD85-013	Greywacke, Argillite	Packer Test	5.8E-08	65.4
BD85-083	Argillite	Packer Test	7.1E-09	65.4
BD85-013	Argillite	Packer Test	4.1E-08	69.1
BD85-016	Greywacke, Argillite	Packer Test	3.0E-07	69.2
BD85-013	Argillite	Packer Test	2.8E-08	72.7
BD85-016	-	Packer Test	3.9E-07	73.2
BD85-083	Greywacke, Argillite	Packer Test	2.7E-08	74.3
BD85-013	Argillite	Packer Test	2.5E-08	76.4
BD85-013	Argillite	Packer Test	4.3E-08	80.2
BD85-007	Argillite	Packer Test	3.0E-08	80.5
BD85-029	Greywacke, Argillite	Packer Test	4.9E-08	92.9
BD85-029	Greywacke	Packer Test	1.6E-08	97.1
BD14-188	Fault	Packer Test	1.0E-08	100.5
BD85-043	Greywacke	Packer Test	1.0E-09	109.3
BD85-043	Greywacke	Packer Test	7.6E-10	113.6
BD85-043	Greywacke	Packer Test	2.6E-09	118.0
BD85-043	Greywacke, Argillite	Packer Test	1.6E-09	122.3
BD85-043	Argillite	Packer Test	5.5E-10	126.5
BD14-188	Foot wall	Packer Test	2.0E-09	128.5
BD85-043	Argillite	Packer Test	3.7E-10	130.9
BD14-188	Foot wall	Packer Test	4.0E-10	150.0
		Geometric Mean	2.9E-08	
		Minimum Value	1.0E-10	
		Maximum Value	5.4E-06	

Notes:

m	Metres
m/s	Metres per second
2.0E-09	Hydraulic conductivity test result did not provide an exact hydraulic conductivity value, but indicated that the hydraulic conductivity is less than the specified value

Table 2.4

Bedrock Packer Test Hydraulic Conductivity Results by Lithology and Structure
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Lithology / Structure	Hydraulic Test Method/Type	Hydraulic Conductivity (m/s)	Depth Below Top of Bedrock to Midpoint of Test Interval (m)
Greywacke				
MW-05C	Greywacke	Packer Test	5.0E-07	1.4
MW-07C	Greywacke	Packer Test	2.1E-06	3.4
MW-05C	Greywacke	Packer Test	8.3E-08	4.4
MW-07C	Greywacke	Packer Test	1.3E-06	6.4
MW-05C	Greywacke	Packer Test	4.3E-07	7.5
MW-09C	Greywacke	Packer Test	1.3E-07	7.7
MW-05C	Greywacke	Packer Test	3.8E-07	10.5
MW-07C	Greywacke	Packer Test	4.6E-07	10.7
MW-09C	Greywacke	Packer Test	2.7E-07	10.8
BD85-013	Greywacke	Packer Test	2.0E-08	13.3
BD85-082	Greywacke	Packer Test	3.6E-08	13.5
MW-05C	Greywacke	Packer Test	8.2E-07	13.6
MW-07C	Greywacke	Packer Test	3.3E-09	13.7
MW-09C	Greywacke	Packer Test	5.5E-09	13.9
MW-05C	Greywacke	Packer Test	1.6E-07	16.6
BD85-090	Greywacke	Packer Test	3.0E-08	16.7
MW-07C	Greywacke	Packer Test	7.4E-08	16.8
MW-09C	Greywacke	Packer Test	1.7E-09	16.9
BD85-082	Greywacke	Packer Test	1.1E-06	17.7
MW-09C	Greywacke	Packer Test	1.1E-08	20.0
BD85-029	Greywacke	Packer Test	9.9E-08	21.1
MW-07C	Greywacke	Packer Test	4.3E-08	22.9
MW-11C	Greywacke	Packer Test	1.0E-10	23.3
MW-09C	Greywacke	Packer Test	3.5E-09	26.0
BD85-082	Greywacke	Packer Test	8.0E-07	27.3
MW-07C	Greywacke	Packer Test	4.4E-09	29.0
BD85-029	Greywacke	Packer Test	9.4E-07	29.7
MW-09C	Greywacke	Packer Test	4.5E-09	32.1
BD85-029	Greywacke	Packer Test	9.0E-08	35.3
MW-05C	Greywacke	Packer Test	6.8E-09	37.9
MW-07C	Greywacke	Packer Test	2.2E-08	41.2
MW-09C	Greywacke	Packer Test	7.2E-10	41.3
BD85-043	Greywacke	Packer Test	1.0E-06	43.2
BD85-005	Greywacke	Packer Test	1.4E-06	43.8
MW-05C	Greywacke	Packer Test	2.3E-09	44.0
MW-07C	Greywacke	Packer Test	2.8E-08	44.2
MW-05C	Greywacke	Packer Test	7.9E-10	47.1
BD85-043	Greywacke	Packer Test	2.3E-07	47.5
MW-09C	Greywacke	Packer Test	1.2E-08	50.4
MW-07C	Greywacke	Packer Test	2.0E-07	53.4
MW-05C	Greywacke	Packer Test	1.0E-08	56.2
BD85-043	Greywacke	Packer Test	2.7E-09	57.6
BD85-007	Greywacke	Packer Test	5.4E-07	59.5
MW-09C	Greywacke	Packer Test	4.2E-09	59.6
BD85-043	Greywacke	Packer Test	3.4E-09	61.9
BD85-029	Greywacke	Packer Test	1.6E-08	97.1
BD85-043	Greywacke	Packer Test	1.0E-09	109.3
BD85-043	Greywacke	Packer Test	7.6E-10	113.6
BD85-043	Greywacke	Packer Test	2.6E-09	118.0
BD14-188	Greywacke Hanging wall	Packer Test	1.0E-08	11.3
BD14-188	Greywacke Hanging wall	Packer Test	5.0E-09	32.0
BD85-016	Greywacke, Quartzite	Packer Test	8.0E-07	8.2
BD85-013	Greywacke, Quartzite	Packer Test	2.4E-08	17.0
BD85-090	Greywacke, Quartzite	Packer Test	2.4E-08	20.8
BD85-090	Greywacke, Quartzite	Packer Test	8.1E-08	24.9
		Greywacke Geometric Mean	3.4E-08	
		Greywacke Minimum Value	1.0E-10	
		Greywacke Maximum Value	2.1E-06	

Table 2.4

Bedrock Packer Test Hydraulic Conductivity Results by Lithology and Structure
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Lithology / Structure	Hydraulic Test Method/Type	Hydraulic Conductivity (m/s)	Depth Below Top of Bedrock to Midpoint of Test Interval (m)
Argillite				
BD85-029	Argillite	Packer Test	4.7E-07	11.5
BD85-005	Argillite	Packer Test	5.2E-07	12.0
BD85-007	Argillite	Packer Test	4.7E-08	13.6
BD85-005	Argillite	Packer Test	9.0E-08	16.2
BD85-005	Argillite	Packer Test	1.8E-07	20.4
BD85-083	Argillite	Packer Test	7.1E-09	65.4
BD85-013	Argillite	Packer Test	4.1E-08	69.1
BD85-013	Argillite	Packer Test	2.8E-08	72.7
BD85-013	Argillite	Packer Test	2.5E-08	76.4
BD85-013	Argillite	Packer Test	4.3E-08	80.2
BD85-007	Argillite	Packer Test	3.0E-08	80.5
BD85-043	Argillite	Packer Test	5.5E-10	126.5
BD85-043	Argillite	Packer Test	3.7E-10	130.9
BD85-007	Argillite, Quartzite	Packer Test	1.1E-08	17.8
		Argillite Geometric Mean	2.7E-08	
		Argillite Minimum Value	3.7E-10	
		Argillite Maximum Value	5.2E-07	
Mud Lake Fault Zone				
BD14-188	Fault	Packer Test	1.0E-08	100.5
BD85-082	Quartzite / Fault	Packer Test	1.9E-06	21.8
BD85-083	Greywacke / Fault	Packer Test	1.5E-08	34.3
BD85-083	Greywacke / Fault	Packer Test	1.0E-08	43.2
BD85-007	Greywacke / Fault	Packer Test	2.0E-09	51.2
BD85-083	Greywacke / Fault	Packer Test	1.2E-09	52.1
		Mud Lake Fault Geometric Mean	1.4E-08	
		Mud Lake Fault Minimum Value	1.2E-09	
		Mud Lake Fault Maximum Value	1.9E-06	
Uncategorized Lithologies				
BD85-016	-	Packer Test	3.9E-07	73.2
BD85-016	Quartzite	Packer Test	1.6E-06	12.2
BD85-090	Quartzite	Packer Test	3.1E-08	12.5
BD85-016	Quartzite	Packer Test	4.9E-08	16.2
BD85-043	Quartzite	Packer Test	8.3E-09	17.4
BD85-007	Quartzite	Packer Test	8.4E-07	22.0
BD85-082	Quartzite	Packer Test	6.1E-07	36.8
BD85-082	Quartzite	Packer Test	4.6E-07	40.9
BD14-188	Foot wall	Packer Test	2.0E-09	128.5
BD14-188	Foot wall	Packer Test	4.0E-10	150.0
Greywacke and Argillite				
BD85-043	Greywacke, Argillite	Packer Test	2.6E-08	21.7
BD85-016	Greywacke, Argillite	Packer Test	2.5E-07	65.3
BD85-013	Greywacke, Argillite	Packer Test	5.8E-08	65.4
BD85-016	Greywacke, Argillite	Packer Test	3.0E-07	69.2
BD85-083	Greywacke, Argillite	Packer Test	2.7E-08	74.3
BD85-029	Greywacke, Argillite	Packer Test	4.9E-08	92.9
BD85-043	Greywacke, Argillite	Packer Test	1.6E-09	122.3

Notes:

m	Metres
m/s	Metres per second
2.0E-09	Hydraulic conductivity test result did not provide an exact hydraulic conductivity value, but indicated that the hydraulic conductivity is less than the specified value

Table 6.1

Model Calibration Targets and Residuals - Base Case Condition
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Model Layer	Observed Groundwater Elevation[1] (m AMSL)	Simulated Groundwater Elevation (m AMSL)	Residual[2] (m)
MW-01A	2	147.47	148.59	-1.11
MW-01B	2	147.30	148.63	-1.32
MW-01C	3	147.65	148.43	-0.79
MW-02A	1	149.88	149.31	0.57
MW-02B	2	148.78	149.30	-0.52
MW-03A	2	163.62	164.67	-1.05
MW-03B	2	162.68	164.74	-2.06
MW-03C	3	162.60	164.24	-1.64
MW-04A	2	163.23	162.82	0.41
MW-04B	2	163.47	162.83	0.64
MW-05A	2	139.90	139.42	0.49
MW-05B	2	139.94	139.48	0.46
MW-05C	4	140.69	140.30	0.39
MW-05D	3	140.68	139.99	0.68
MW-07A	2	128.88	128.70	0.18
MW-07B	2	129.17	128.72	0.45
MW-07C	4	128.82	130.33	-1.51
MW-07D	3	129.04	129.26	-0.22
MW-09A	2	130.49	130.78	-0.29
MW-09B	2	130.44	130.78	-0.34
MW-09C	4	129.90	130.42	-0.52
MW-09D	3	130.41	130.62	-0.21
MW-11A	2	146.66	146.09	0.57
MW-11B	2	145.44	145.79	-0.36
MW-11C	2	146.57	145.89	0.67
MW-12A	1	145.98	145.29	0.69
MW-12B	2	141.01	140.09	0.93
MW-14A	1	135.79	134.73	1.05
MW-14B	2	135.10	134.91	0.20
MW-14C	3	135.77	135.42	0.35
MW-16A	2	151.31	150.64	0.67
MW-16B	2	151.47	150.62	0.84
MW-17A	1	151.60	151.35	0.25
MW-17B	2	151.66	151.22	0.44
MW-17C	2	151.22	151.24	-0.02
MW-18A	2	145.92	144.79	1.13
MW-18B	2	145.82	144.79	1.04
MW-18C	2	146.11	144.87	1.24
MW-19A	1	131.98	131.96	0.03
MW-19B	2	132.00	131.98	0.02
MW-19C	3	132.04	132.07	-0.03

Table 6.1

Model Calibration Targets and Residuals - Base Case Condition
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Model Layer	Observed Groundwater Elevation[(1)] (m AMSL)	Simulated Groundwater Elevation (m AMSL)	Residual[(2)] (m)
MW-20A	2	150.02	149.72	0.30
MW-20B	2	150.10	149.72	0.37
MW-21A	2	154.90	154.05	0.86
MW-21B	2	152.62	154.01	-1.39
MW-21C	3	146.72	154.05	-7.34
MW-22A	2	137.71	137.98	-0.28
MW-22B	2	137.35	137.95	-0.60
MW-22C	3	137.31	137.97	-0.66

Notes:

m	Metres
m AMSL	Metres above mean sea level
0.58	Positive groundwater elevation residual - over prediction of observed groundwater elevation
-1.58	Negative groundwater elevation residual - under prediction of observed groundwater elevation
(1)	Average observed groundwater elevation for June 12, 2018 to June 12, 2019.
(2)	Residual is calculated as observed groundwater elevation minus the simulated groundwater elevation.

Table 6.2

Model Calibration Targets and Residuals - Dry Case Condition
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Model Layer	Observed Groundwater Elevation[1] (m AMSL)	Simulated Groundwater Elevation (m AMSL)	Residual[2] (m)
MW-01A	2	146.72	148.46	-1.74
MW-01B	2	146.51	148.50	-1.98
MW-01C	3	146.90	148.31	-1.41
MW-02A	1	148.43	148.97	-0.54
MW-02B	2	147.77	148.96	-1.19
MW-03A	2	162.62	164.26	-1.63
MW-03B	2	162.44	164.33	-1.89
MW-03C	3	162.34	163.84	-1.50
MW-04A	2	161.68	162.71	-1.03
MW-04B	2	161.95	162.72	-0.76
MW-05A	2	139.23	139.28	-0.05
MW-05B	2	139.27	139.35	-0.09
MW-05C	4	140.27	140.13	0.14
MW-05D	3	139.92	139.84	0.08
MW-07A	2	128.63	128.55	0.07
MW-07B	2	128.87	128.57	0.30
MW-07C	4	128.66	130.13	-1.47
MW-07D	3	128.77	129.10	-0.32
MW-09A	2	129.48	130.53	-1.05
MW-09B	2	129.29	130.52	-1.23
MW-09C	4	128.93	130.15	-1.22
MW-09D	3	129.30	130.36	-1.06
MW-11A	2	145.35	144.99	0.36
MW-11B	2	144.21	144.69	-0.48
MW-11C	2	145.16	144.79	0.37
MW-12A	1	144.07	143.05	1.02
MW-12B	2	139.62	138.40	1.22
MW-14A	1	134.91	133.83	1.07
MW-14B	2	134.32	134.02	0.31
MW-14C	3	134.93	134.59	0.35
MW-16A	2	149.93	150.02	-0.08
MW-16B	2	150.25	150.00	0.26
MW-17A	1	150.70	151.06	-0.36
MW-17B	2	150.79	150.94	-0.15
MW-17C	2	150.41	150.95	-0.54
MW-18A	2	144.86	144.56	0.30
MW-18B	2	144.80	144.56	0.24
MW-18C	2	145.06	144.63	0.43
MW-19A	1	130.83	131.50	-0.67
MW-19B	2	130.82	131.52	-0.70
MW-19C	3	130.86	131.64	-0.78

Table 6.2

Model Calibration Targets and Residuals - Dry Case Condition
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Model Layer	Observed Groundwater Elevation[1] (m AMSL)	Simulated Groundwater Elevation (m AMSL)	Residual[2] (m)
MW-20A	2	148.68	149.45	-0.77
MW-20B	2	148.51	149.45	-0.94
MW-21A	2	153.77	154.01	-0.25
MW-21B	2	150.22	153.97	-3.75
MW-21C	3	146.46	154.01	-7.55
MW-22A	2	137.11	137.88	-0.77
MW-22B	2	137.09	137.85	-0.76
MW-22C	3	137.09	137.86	-0.77

Notes:

m	Metres
m AMSL	Metres above mean sea level
0.52	Positive groundwater elevation residual - over prediction of observed groundwater elevation
-1.74	Negative groundwater elevation residual - under prediction of observed groundwater elevation
(1)	Average observed groundwater elevation during dry period from September 13, 2018 through September 26, 2018.
(2)	Residual is calculated as observed groundwater elevation minus the simulated groundwater elevation.

Table 6.3

Model Calibration Targets and Residuals - Wet Case Condition
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Model Layer	Observed Groundwater Elevation[1] (m AMSL)	Simulated Groundwater Elevation (m AMSL)	Residual[2] (m)
MW-01A	2	148.01	148.65	-0.64
MW-01B	2	147.75	148.69	-0.95
MW-01C	3	148.16	148.50	-0.34
MW-02A	1	150.39	149.52	0.87
MW-02B	2	149.16	149.51	-0.34
MW-03A	2	164.02	164.89	-0.88
MW-03B	2	162.81	164.96	-2.15
MW-03C	3	162.73	164.47	-1.74
MW-04A	2	163.93	162.90	1.03
MW-04B	2	164.20	162.91	1.29
MW-05A	2	140.16	139.50	0.66
MW-05B	2	140.23	139.57	0.66
MW-05C	4	141.37	140.41	0.96
MW-05D	3	141.31	140.09	1.23
MW-07A	2	129.04	128.78	0.26
MW-07B	2	129.38	128.80	0.58
MW-07C	4	129.16	130.44	-1.27
MW-07D	3	129.25	129.35	-0.11
MW-09A	2	131.22	130.95	0.27
MW-09B	2	131.19	130.94	0.25
MW-09C	4	131.05	130.59	0.47
MW-09D	3	131.18	130.78	0.40
MW-11A	2	147.13	146.84	0.29
MW-11B	2	145.96	146.55	-0.59
MW-11C	2	147.09	146.65	0.44
MW-12A	1	146.42	146.90	-0.48
MW-12B	2	141.10	141.33	-0.23
MW-14A	1	136.11	135.39	0.72
MW-14B	2	135.28	135.56	-0.28
MW-14C	3	136.03	136.02	0.00
MW-16A	2	151.97	151.12	0.84
MW-16B	2	152.11	151.10	1.01
MW-17A	1	152.29	151.55	0.74
MW-17B	2	152.23	151.42	0.82
MW-17C	2	151.66	151.43	0.23
MW-18A	2	146.53	144.95	1.58
MW-18B	2	146.46	144.94	1.51
MW-18C	2	146.75	145.02	1.73
MW-19A	1	132.52	132.10	0.43
MW-19B	2	132.60	132.12	0.48
MW-19C	3	132.64	132.21	0.44

Table 6.3

Model Calibration Targets and Residuals - Wet Case Condition
Atlantic Gold Corporation
Marinette, Nova Scotia

Monitoring Well ID	Model Layer	Observed Groundwater Elevation[(1)] (m AMSL)	Simulated Groundwater Elevation (m AMSL)	Residual[(2)] (m)
MW-20A	2	150.85	149.89	0.95
MW-20B	2	150.66	149.90	0.76
MW-21A	2	155.77	154.07	1.70
MW-21B	2	153.45	154.03	-0.58
MW-21C	3	146.94	154.08	-7.15
MW-22A	2	138.02	138.05	-0.03
MW-22B	2	137.47	138.02	-0.55
MW-22C	3	137.43	138.04	-0.61

Notes:

m	Metres
m AMSL	Metres above mean sea level
1.21	Positive groundwater elevation residual - over prediction of observed groundwater elevation
-0.84	Negative groundwater elevation residual - under prediction of observed groundwater elevation
(1)	Average observed groundwater elevation during wet period from November 1, 2018 through November 14, 2018.
(2)	Residual is calculated as observed groundwater elevation minus the simulated groundwater elevation.

Table 6.4

Calibrated Parameter Values
Atlantic Gold Corporation
Marinette, Nova Scotia

Parameter	Parameter Value		Observed Parameter Range			
			Maximum		Minimum	
	(m/s)	(m/d)	(m/s)	(m/d)	(m/s)	(m/d)
Average Overburden K_H (1)	1.40E-04	1.21E+01	3.82E-04	3.30E+01	6.08E-07	5.25E-02
Shallow Greywacke K_H (1)	4.25E-07	3.67E-02	1.57E-04	1.35E+01	1.67E-09	1.44E-04
Deep Greywacke K_H (1)	3.33E-09	2.87E-04	5.44E-06	4.70E-01	1.00E-10	8.64E-06
Shallow Granite K_H (1)	3.71E-07	3.20E-02	1.57E-04	1.35E+01	1.67E-09	1.44E-04
Deep Granite K_H (1)	3.34E-09	2.88E-04	5.44E-06	4.70E-01	1.00E-10	8.64E-06
Shallow Argillite K_H (1)	3.70E-07	3.20E-02	1.57E-04	1.35E+01	1.67E-09	1.44E-04
Deep Argillite K_H (1)	3.32E-09	2.87E-04	5.44E-06	4.70E-01	1.00E-10	8.64E-06
Shallow Mud Lake Fault Zone K_H (1)	3.69E-07	3.19E-02	1.57E-04	1.35E+01	1.67E-09	1.44E-04
Deep Mud Lake Fault Zone K_H (1)	3.32E-09	2.87E-04	5.44E-06	4.70E-01	1.00E-10	8.64E-06
Shallow Cameron Flowage Fault Zone K_H (1)	4.25E-07	3.67E-02	1.57E-04	1.35E+01	1.67E-09	1.44E-04
Deep Cameron Flowage Fault Zone K_H (1)	3.33E-09	2.87E-04	5.44E-06	4.70E-01	1.00E-10	8.64E-06
River Conductivity K_H (1)	2.44E-04	2.10E+01	3.82E-04	3.30E+01	6.08E-07	5.25E-02
	(mm/yr)		(mm/yr)		(mm/yr)	
Dry Condition Recharge	197		77		377	
Base Case Condition Recharge	230		77		377	
Wet Condition Recharge	255		77		377	

Notes:

m/s Metres per second
m/d Meters per day
mm/yr Millimetres per year
(1) K_H is horizontal hydraulic conductivity.

Table 6.5

Model Calibration Sensitivity Analysis
Atlantic Gold Corporation
Marinette, Nova Scotia

Sensitivity Analysis Simulation No.	Parameter	Units	Parameter Value For Sensitivity Simulation	Dry Condition: Sensitivity Simulation RSS_{SENS} (ft^2)	Dry Condition: Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)	Base Case Condition: Sensitivity Simulation RSS_{SENS} (ft^2)	Base Case Condition: Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)	Wet Condition: Sensitivity Simulation RSS_{SENS} (ft^2)	Wet Condition: Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)
1.1	Average Overburden K_H	m/d	33.0048	179.69	63.99%	198.53	137.99%	210.41	137.34%
1.2	Average Overburden K_H	m/d	26.04396513	156.48	42.81%	164.08	96.69%	172.58	94.67%
1.3	Average Overburden K_H	m/d	19.08313027	129.96	18.61%	122.35	46.67%	127.54	43.86%
-	Average Overburden K_H	m/d	12.1222954	109.57	-	83.42	-	88.66	-
1.4	Average Overburden K_H	m/d	8.0990436	125.78	14.80%	95.56	14.55%	115.95	30.79%
1.5	Average Overburden K_H	m/d	4.0757918	319.61	191.69%	324.57	289.08%	415.05	368.17%
1.6	Average Overburden K_H	m/d	0.05254	1100597.71	1004348.19%	1505229.96	1804308.72%	1850112.60	2086763.13%
2.1	Shallow Greywacke KH	m/d	4.323456	1939.50	1670.06%	2237.40	2582.10%	2373.30	2577.00%
2.2	Shallow Greywacke KH	m/d	2.89453457	1794.70	1537.91%	2061.90	2371.72%	2176.30	2354.79%
2.3	Shallow Greywacke KH	m/d	1.46561314	1485.10	1255.36%	1689.20	1924.94%	1763.80	1889.51%
-	Shallow Greywacke KH	m/d	0.03669171	109.57	-	83.42	-	88.66	-
2.4	Shallow Greywacke KH	m/d	0.02447266	131.64	20.14%	99.55	19.34%	120.73	36.18%
2.5	Shallow Greywacke KH	m/d	0.01225361	262.70	139.75%	269.37	222.91%	362.77	309.19%
2.6	Shallow Greywacke KH	m/d	0.00003456	79163.00	72147.23%	6166.40	7292.03%	5842.80	6490.48%
3.1	Deep Greywacke KH	m/d	0.16416	1528.20	1294.69%	1622.60	1845.11%	1638.10	1747.72%
3.2	Deep Greywacke KH	m/d	0.109535818	1226.90	1019.72%	1289.40	1445.68%	1289.50	1354.51%
3.3	Deep Greywacke KH	m/d	0.054911636	735.72	571.45%	745.96	794.23%	723.39	715.96%
-	Deep Greywacke KH	m/d	0.000287454	109.57	-	83.42	-	88.66	-
3.4	Deep Greywacke KH	m/d	0.000194516	108.72	-0.78%	82.42	-1.20%	88.08	-0.64%
3.5	Deep Greywacke KH	m/d	0.000101578	107.34	-2.04%	80.95	-2.96%	87.16	-1.68%
3.6	Deep Greywacke KH	m/d	0.00000864	104.35	-4.77%	78.05	-6.43%	85.22	-3.87%
4.1	Shallow Granite KH	m/d	4.323456	103.41	-5.62%	94.90	13.76%	107.34	21.08%
4.2	Shallow Granite KH	m/d	2.892978207	102.72	-6.25%	92.40	10.76%	103.88	17.17%
4.3	Shallow Granite KH	m/d	1.462500413	101.93	-6.97%	87.90	5.37%	97.70	10.20%
-	Shallow Granite KH	m/d	0.03202262	109.57	-	83.42	-	88.66	-
4.4	Shallow Granite KH	m/d	0.021359933	110.04	0.43%	83.60	0.21%	88.73	0.09%
4.5	Shallow Granite KH	m/d	0.010697247	110.57	0.91%	83.83	0.49%	88.86	0.23%
4.6	Shallow Granite KH	m/d	0.00003456	112.15	2.35%	84.89	1.77%	89.74	1.23%
5.1	Deep Granite KH	m/d	0.16416	96.40	-12.02%	80.76	-3.19%	89.83	1.33%
5.2	Deep Granite KH	m/d	0.109536141	97.49	-11.03%	79.52	-4.67%	87.69	-1.09%
5.3	Deep Granite KH	m/d	0.054912281	100.01	-8.73%	78.72	-5.63%	85.67	-3.37%
-	Deep Granite KH	m/d	0.000288422	109.57	-	83.42	-	88.66	-
5.4	Deep Granite KH	m/d	0.000195161	110.36	0.72%	84.17	0.89%	89.37	0.81%
5.5	Deep Granite KH	m/d	0.000101901	111.52	1.78%	85.27	2.22%	90.44	2.01%
5.6	Deep Granite KH	m/d	0.00000864	113.44	3.53%	87.10	4.41%	92.21	4.01%
6.1	Shallow Argillite KH	m/d	4.323456	126.88	15.80%	105.54	26.52%	108.88	22.81%
6.2	Shallow Argillite KH	m/d	2.892967007	126.33	15.29%	104.99	25.86%	108.41	22.28%
6.3	Shallow Argillite KH	m/d	1.462478013	124.59	13.71%	103.08	23.57%	106.68	20.33%
-	Shallow Argillite KH	m/d	0.03198902	109.57	-	83.42	-	88.66	-
6.4	Shallow Argillite KH	m/d	0.021337533	109.82	0.23%	83.28	-0.17%	89.33	0.76%
6.5	Shallow Argillite KH	m/d	0.010686047	112.51	2.68%	86.30	3.45%	93.81	5.81%
6.6	Shallow Argillite KH	m/d	0.00003456	134.12	22.40%	107.32	28.65%	117.96	33.05%
7.1	Deep Argillite K_H	m/d	0.16416	109.58	0.01%	84.08	0.79%	89.38	0.81%
7.2	Deep Argillite K_H	m/d	0.109535688	109.55	-0.02%	83.99	0.68%	89.27	0.69%
7.3	Deep Argillite K_H	m/d	0.054911376	109.48	-0.08%	83.80	0.45%	89.07	0.47%
-	Deep Argillite K_H	m/d	0.000287065	109.57	-	83.42	-	88.66	-
7.4	Deep Argillite KH	m/d	0.000194256	109.55	-0.02%	83.38	-0.04%	88.61	-0.05%
7.5	Deep Argillite KH	m/d	0.000101448	109.50	-0.07%	83.31	-0.13%	88.54	-0.13%
7.6	Deep Argillite KH	m/d	0.00000864	109.30	-0.25%	83.10	-0.39%	88.37	-0.32%

Table 6.5

Model Calibration Sensitivity Analysis
Atlantic Gold Corporation
Marinette, Nova Scotia

Sensitivity Analysis Simulation No.	Parameter	Units	Parameter Value For Sensitivity Simulation	Dry Condition		Base Case Condition		Wet Condition	
				Sensitivity Simulation RSS_{SENS} (ft^2)	Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)	Sensitivity Simulation RSS_{SENS} (ft^2)	Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)	Sensitivity Simulation RSS_{SENS} (ft^2)	Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)
8.1	Shallow Mud Lake Fault Zone K_H	m/d	4.323456	125.40	14.44%	105.18	26.09%	102.92	16.09%
8.2	Shallow Mud Lake Fault Zone K_H	m/d	2.892938383	122.95	12.21%	101.72	21.94%	99.97	12.76%
8.3	Shallow Mud Lake Fault Zone K_H	m/d	1.462420767	119.45	9.01%	96.99	16.26%	96.40	8.74%
-	Shallow Mud Lake Fault Zone K_H	m/d	0.03190315	109.57	-	83.42	-	88.66	-
8.4	Shallow Mud Lake Fault Zone K_H	m/d	0.021280287	108.99	-0.53%	82.66	-0.91%	89.65	1.12%
8.5	Shallow Mud Lake Fault Zone K_H	m/d	0.010657423	109.77	0.18%	83.58	0.19%	95.44	7.65%
8.6	Shallow Mud Lake Fault Zone K_H	m/d	0.00003456	136.82	24.87%	125.33	50.24%	168.04	89.54%
9.1	Deep Mud Lake Fault Zone K_H	m/d	0.16416	116.15	6.00%	89.99	7.88%	90.29	1.85%
9.2	Deep Mud Lake Fault Zone K_H	m/d	0.109535599	114.29	4.31%	88.10	5.61%	89.53	0.99%
9.3	Deep Mud Lake Fault Zone K_H	m/d	0.054911199	112.06	2.27%	85.95	3.03%	88.90	0.27%
-	Deep Mud Lake Fault Zone K_H	m/d	0.000286798	109.57	-	83.42	-	88.66	-
9.4	Deep Mud Lake Fault Zone K_H	m/d	0.000194079	109.53	-0.04%	83.34	-0.09%	88.57	-0.09%
9.5	Deep Mud Lake Fault Zone K_H	m/d	0.000101359	109.39	-0.17%	83.14	-0.34%	88.37	-0.32%
9.6	Deep Mud Lake Fault Zone K_H	m/d	0.00000864	108.15	-1.30%	81.82	-1.92%	87.37	-1.45%
10.1	Shallow Cameron Flowage Fault Zone K_H	m/d	4.323456	124.72	13.82%	99.73	19.55%	96.87	9.26%
10.2	Shallow Cameron Flowage Fault Zone K_H	m/d	2.89453457	123.18	12.42%	97.84	17.29%	95.42	7.63%
10.3	Shallow Cameron Flowage Fault Zone K_H	m/d	1.46561314	120.38	9.86%	94.58	13.38%	93.18	5.10%
-	Shallow Cameron Flowage Fault Zone K_H	m/d	0.03669171	102.93	-	83.42	-	88.66	-
10.4	Shallow Cameron Flowage Fault Zone K_H	m/d	0.02447266	108.74	-0.76%	82.68	-0.89%	88.87	0.24%
10.5	Shallow Cameron Flowage Fault Zone K_H	m/d	0.01225361	107.48	-1.91%	81.71	-2.05%	89.88	1.38%
10.6	Shallow Cameron Flowage Fault Zone K_H	m/d	0.00003456	106.85	-2.48%	83.90	0.57%	101.98	15.03%
11.1	Deep Cameron Flowage Fault Zone K_H	m/d	0.16416	111.95	2.17%	85.96	3.05%	88.29	-0.41%
11.2	Deep Cameron Flowage Fault Zone K_H	m/d	0.109535818	111.13	1.42%	85.11	2.03%	88.03	-0.71%
11.3	Deep Cameron Flowage Fault Zone K_H	m/d	0.054911636	110.03	0.42%	84.01	0.71%	87.80	-0.96%
-	Deep Cameron Flowage Fault Zone K_H	m/d	0.000287454	102.93	-	83.42	-	88.66	-
11.4	Deep Cameron Flowage Fault Zone K_H	m/d	0.000194516	109.59	0.02%	83.43	0.01%	88.70	0.05%
11.5	Deep Cameron Flowage Fault Zone K_H	m/d	0.000101578	109.58	0.01%	83.41	-0.01%	88.76	0.12%
11.6	Deep Cameron Flowage Fault Zone K_H	m/d	0.00000864	109.59	0.02%	83.39	-0.04%	89.14	0.55%

Table 6.5

Model Calibration Sensitivity Analysis
Atlantic Gold Corporation
Marinette, Nova Scotia

Sensitivity Analysis Simulation No.	Parameter	Units	Parameter Value For Sensitivity Simulation	Dry Condition: Sensitivity Simulation RSS_{SENS} (ft^2)	Dry Condition: Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)	Base Case Condition: Sensitivity Simulation RSS_{SENS} (ft^2)	Base Case Condition: Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)	Wet Condition: Sensitivity Simulation RSS_{SENS} (ft^2)	Wet Condition: Percent Change in RSS From Calibrated Model ΔRSS_{SENS} (1) (%)
12.1	River Conductivity K_H	m/d	33.0048	109.56	-0.01%	83.42	0.00%	88.67	0.01%
12.2	River Conductivity K_H	m/d	29.01956667	109.56	-0.01%	83.42	0.00%	88.66	0.01%
12.3	River Conductivity K_H	m/d	25.03433333	109.57	0.00%	83.42	0.00%	88.66	0.01%
-	River Conductivity K_H	m/d	21.0491	109.57	-	83.42	-	88.66	-
12.4	River Conductivity K_H	m/d	14.05024661	109.58	0.01%	83.41	-0.01%	88.64	-0.01%
12.5	River Conductivity K_H	m/d	7.051393227	109.60	0.03%	83.40	-0.02%	88.62	-0.04%
12.6	River Conductivity K_H	m/d	0.05253984	110.09	0.47%	82.82	-0.72%	86.62	-2.29%
13.1	Dry Condition Recharge	mm/yr	376.7510574	434.20	296.27%	83.42	0.00%	88.66	0.00%
13.2	Dry Condition Recharge	mm/yr	316.7393637	256.29	133.90%	83.42	0.00%	88.66	0.00%
13.3	Dry Condition Recharge	mm/yr	256.7276699	146.70	33.88%	83.42	0.00%	88.66	0.00%
-	Dry Condition Recharge	mm/yr	196.7159762	109.57	-	83.42	-	88.66	-
13.4	Dry Condition Recharge	mm/yr	156.655428	131.18	19.72%	83.42	0.00%	88.66	0.00%
13.5	Dry Condition Recharge	mm/yr	116.5948797	200.84	83.29%	83.42	0.00%	88.66	0.00%
13.6	Dry Condition Recharge	mm/yr	76.53433147	349.55	219.01%	83.42	0.00%	88.66	0.00%
14.1	Base Case Recharge	mm/yr	376.7510574	109.57	0.00%	269.98	223.64%	88.66	0.00%
14.2	Base Case Recharge	mm/yr	327.7971749	109.57	0.00%	159.76	91.51%	88.66	0.00%
14.3	Base Case Recharge	mm/yr	278.8432925	109.57	0.00%	96.40	15.55%	88.66	0.00%
-	Base Case Recharge	mm/yr	229.88941	109.57	-	83.42	-	88.66	-
14.4	Base Case Recharge	mm/yr	178.7710505	109.57	0.00%	128.18	53.66%	88.66	0.00%
14.5	Base Case Recharge	mm/yr	127.652691	109.57	0.00%	251.02	200.91%	88.66	0.00%
14.6	Base Case Recharge	mm/yr	76.53433147	109.57	0.00%	500.86	500.41%	88.66	0.00%
15.1	Wet Condition Recharge	mm/yr	376.7510574	109.57	0.00%	83.42	0.00%	242.13	173.11%
15.2	Wet Condition Recharge	mm/yr	336.0207198	109.57	0.00%	83.42	0.00%	157.55	77.71%
15.3	Wet Condition Recharge	mm/yr	295.2903823	109.57	0.00%	83.42	0.00%	105.54	19.05%
-	Wet Condition Recharge	mm/yr	254.5600447	109.57	-	83.42	-	88.66	-
15.4	Wet Condition Recharge	mm/yr	195.2181403	109.57	0.00%	83.42	0.00%	132.69	49.67%
15.5	Wet Condition Recharge	mm/yr	135.8762359	109.57	0.00%	83.42	0.00%	275.53	210.79%
15.6	Wet Condition Recharge	mm/yr	76.53433147	109.57	0.00%	83.42	0.00%	584.16	558.91%

Notes:

ft^2	Square feet
m/d	Metres per day
mm/yr	Millimetres per year
RSS	Residual Sum of Squares
	Results for calibrated model
	The RSS for a given model improves by over 1% relative to the calibrated model
(1)	Change in RSS from calibrated model is calculated as RSS_{SENS} minus RSS_{CALIB}. A negative change represents a reduction in the RSS from that of the calibrated model.

Table 7.1

Source Concentrations
Atlantic Gold Corporation
Marinette, Nova Scotia

		BD Pit walls				NAG WRSF				PAG WRSF				Low-Grade Ore				Topsoil Stockpile		Till Stockpile	
		Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case	Base Case	Upper Case
		EOM		PC		EOM		PC		EOM		PC		EOM		PC		EOM/PC		EOM/PC	
Sulphate	**mg/L**	433	541	333	344	631	873	414	445	638	872	701	856	582	758	565	564	9.0	33	65	127
Al	**mg/L**	0.0058	0.0058	0.0058	0.0058	0.0058	0.0059	0.0058	0.0058	0.0058	0.0059	0.13	0.14	0.0058	0.0058	0.027	0.051	0.081	0.83	0.0078	0.11
Ag	**mg/L**	0.000070	0.000080	0.000070	0.000070	0.000050	0.00010	0.000050	0.00010	0.000050	0.00010	0.00012	0.00012	0.000050	0.00010	0.00014	0.00014	0.000030	0.000030	0.000030	0.000030
As	**mg/L**	0.018	0.023	0.0074	0.0089	0.018	0.023	0.0071	0.0083	0.017	0.022	0.035	0.041	0.016	0.027	0.0084	0.012	0.0038	0.19	0.0021	0.0076
Ca	**mg/L**	83	74	96	94	70	61	86	82	70	61	67	62	73	65	74	73	1.0	5.7	22	41
Cd	**mg/L**	0.000010	0.000020	0.000090	0.00012	0.000030	0.000050	0.000040	0.000060	0.000030	0.000060	0.012	0.016	0.000040	0.000071	0.0039	0.0045	0.000030	0.00016	0.000030	0.000040
B	**mg/L**	0.15	0.22	0.086	0.11	0.025	0.050	0.025	0.050	0.025	0.050	0.30	0.42	0.025	0.050	0.31	0.47	0.0050	0.011	0.0050	0.011
Co	**mg/L**	0.0024	0.0034	0.0096	0.015	0.0026	0.0037	0.0029	0.0038	0.0029	0.0041	0.80	1.0	0.0019	0.0026	0.25	0.24	0.00084	0.0050	0.00019	0.00097
Cr	**mg/L**	0.00050	0.0010	0.00050	0.0010	0.00050	0.0010	0.00050	0.0010	0.00050	0.0010	0.0015	0.0034	0.00050	0.0010	0.0015	0.0025	0.00088	0.0012	0.00025	0.00098
Cu	**mg/L**	0.0010	0.0020	0.0010	0.0020	0.0010	0.0020	0.0010	0.0020	0.0010	0.0020	0.032	0.077	0.0010	0.0020	0.0082	0.011	0.0014	0.0064	0.0020	0.0034
Fe	**mg/L**	0.0040	0.0041	0.0040	0.0040	0.0041	0.0042	0.0040	0.0040	0.0041	0.0042	13	46	0.0041	0.0041	0.13	0.40	0.26	0.46	0.023	0.16
Hg	**mg/L**	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000020	0.000020	0.000030	0.000030	0.000030	0.000030
K	**mg/L**	41	57	20	21	45	63	25	27	48	67	27	28	53	82	40	44	0.79	2.4	0.81	1.3
Mg	**mg/L**	26	32	12	12	59	73	29	30	62	76	79	84	60	76	62	50	0.47	1.1	2.3	5.5
Mn	**mg/L**	0.035	0.042	0.043	0.046	0.085	0.10	0.11	0.12	0.088	0.11	1.1	1.2	0.11	0.13	0.56	0.64	0.11	0.12	0.11	0.30
Mo	**mg/L**	0.048	0.11	0.21	0.23	0.015	0.033	0.059	0.064	0.014	0.032	0.0028	0.0032	0.011	0.025	0.0090	0.0070	0.000050	0.00016	0.0027	0.012
Na	**mg/L**	56	97	31	37	101	190	48	64	97	181	72	113	67	115	42	62	1.6	3.3	3.6	2.4
Ni	**mg/L**	0.039	0.050	0.17	0.44	0.035	0.046	0.024	0.040	0.039	0.052	8.0	12	0.028	0.032	2.7	2.5	0.0015	0.022	0.00046	0.0015
Pb	**mg/L**	0.00045	0.0011	0.0016	0.0096	0.00025	0.00050	0.00025	0.00050	0.00025	0.00050	0.14	0.31	0.00025	0.00050	0.032	0.044	0.00013	0.0011	0.00010	0.00019
Sb	**mg/L**	0.00024	0.00052	0.00013	0.00024	0.00023	0.00049	0.00013	0.00027	0.00020	0.00044	0.00012	0.00028	0.00034	0.00081	0.00014	0.00033	0.000050	0.00011	0.00020	0.00051
Se	**mg/L**	0.00094	0.0016	0.00045	0.0017	0.0015	0.0027	0.00071	0.0021	0.0015	0.0027	0.0055	0.012	0.0018	0.0025	0.0020	0.0026	0.00079	0.00095	0.00058	0.0014
Tl	**mg/L**	0.000050	0.00010	0.000050	0.000080	0.000050	0.00010	0.000050	0.00010	0.000050	0.00010	0.00088	0.0011	0.000050	0.00010	0.00047	0.00038	0.000050	0.000050	0.000050	0.000050
U	**mg/L**	0.049	0.063	0.016	0.018	0.026	0.033	0.0068	0.0075	0.019	0.024	0.048	0.053	0.015	0.017	0.017	0.019	0.000090	0.00010	0.000090	0.00099
Zn	**mg/L**	0.0044	0.0051	0.096	0.25	0.0077	0.0086	0.0076	0.013	0.0076	0.0082	6.0	8.4	0.0070	0.014	1.2	2.1	0.0050	0.032	0.0050	0.0050
Nitrate[(1)]	**mg/L**	5.5	18	N/A	N/A	22.2	40.3	N/A	N/A	6.7	13.1	N/A	N/A	10.5	21.5	N/A	N/A	N/A	N/A	N/A	N/A
Nitrite[(1)]	**mg/L**	0.17	0.54	N/A	N/A	0.51	0.93	N/A	N/A	0.15	0.3	N/A	N/A	0.24	0.49	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia[(1)]	**mg/L**	1	6.9	N/A	N/A	2.8	5.1	N/A	N/A	0.8	1.7	N/A	N/A	1.3	2.7	N/A	N/A	N/A	N/A	N/A	N/A

Note:

mg/L Milligrams per liter
(1) Nitrate, Nitrite, and Ammonia are assigned a post-closure annual decay rate of 24%, 38%, 38% and 80% for the NAG WRSF, PAG WRSF, Low-Grade Ore Stockpile and Pit Walls, respectively.

Table 7.2

Predicted Pit Inflow Rates by Hydrostratigraphic Unit
Atlantic Gold Corporation
Marinette, Nova Scotia

Hydrostratigraphic Unit	Model Layer	Layer Thickness (m)	Dry Condition Pit Inflow (m^3/d)	Base Case Condition Pit Inflow (m^3/d)	Wet Condition Pit Inflow (m^3/d)
Overburden	1	Variable	-23	-47	-62
Shallow Bedrock	2	22	-359	-391	-414
Deep Bedrock	3 to 9	160	-150	-167	-179
		Total	**-531**	**-605**	**-655**

Notes:

m Metres
m^3/d Cubic metres per day

Table 7.3

Estimated Groundwater Inflow Rate into Open Pit
Atlantic Gold Corporation
Marinette, Nova Scotia

Top of Stage Elevation (masl)	Groundwater Inflow Rate into Open Pit (m^3/d)
127	385
120	541
110	584
100	592
90	594
80	597
70	599
60	600
50	601
40	602
30	603
20	604
10	604
0	604
-10	605
-20	605
-30	605

Notes:

masl Metres above sea level
m^3/d Cubic metres per day

Table 7.4

Simulated Change in Baseflow
Atlantic Gold Corporation
Marinette, Nova Scotia

	Simulated Baseflow Baseline Condition (m^3/d)	Simulated Baseflow EOM (m^3/d)	Simulated Baseflow Difference Baseline and EOM (m^3/d)	Percent Change EOM[1] (%)	Simulted BaseFlow PC (Stage 127m) (m^3/d)	Simulated Baseflow Difference Baseline and PC (m^3/d)	Percent Change PC[1] (%)
Base Case Condition							
Total Model Domain	-49,227	-48,498	-729	-1%	-48,679	-548	-1%
Cameron Flowage	-749	-446	-304	-41%	-582	-168	-22%
Killag River[2]	-4,058	-3,992	-67	-2%	-3,992	-66	-2%
Crusher Lake Area	-57	-58	1	1%	-58	1	2%
Mud Lake	-442	-242	-200	-45%	-272	-170	-39%
WC2	-53	-49	-4	-8%	-38	-15	-28%
WC3	-101	-85	-16	-16%	-82	-19	-19%
WC5	-415	-396	-19	-5%	-406	-10	-2%
WC19	-431	-425	-6	-1%	-425	-6	-1%
WC27	-78	-78	0	0%	-78	0	0%
Dry Condition							
Total Model Domain	-42,124	-41,446	-677	-2%	-41,678	-446	-1%
Cameron Flowage	-719	-445	-274	-38%	-579	-140	-20%
Killag River[2]	-3,446	-3,393	-53	-2%	-3,393	-53	-2%
Crusher Lake Area	-45	-46	1	2%	-47	1	3%
Mud Lake	-380	-214	-166	-44%	-243	-136	-36%
WC2	-44	-39	-5	-11%	-30	-14	-32%
WC3	-83	-70	-14	-16%	-69	-15	-17%
WC5	-355	-336	-19	-5%	-346	-9	-3%
WC19	-372	-367	-5	-1%	-367	-5	-1%
WC27	-64	-64	0	0%	-64	0	0%
Wet Condition							
Total Model Domain	-54,509	-53,756	-754	-1%	-53,890	-620	-1%
Cameron Flowage	-774	-452	-322	-42%	-590	-184	-24%
Killag River[2]	-4,322	-4,246	-76	-2%	-4,246	-76	-2%
Crusher Lake Area	-67	-67	0	0%	-67	0	0%
Mud Lake	-485	-262	-223	-46%	-292	-193	-40%
WC2	-60	-56	-4	-7%	-44	-16	-27%
WC3	-114	-96	-17	-15%	-91	-23	-20%
WC5	-458	-437	-20	-4%	-446	-11	-2%
WC19	-474	-467	-7	-1%	-467	-7	-1%
WC27	-86	-86	0	0%	-86	0	0%

Note:
m^3/d Cubic metres per day
(1) A negative (-) percentage indicates a predicted reduction in baseflow and a positive (+) percent indicates an increase in baseflow
(2) Killag River refers to the section of the Killag River downstream of Cameron Flowage and within the groundwater model flow domain

Simulated COC Loading to Surface Water from Groundwater
Atlantic Gold Corporation
Marinette, Nova Scotia

COC	Simulated EOM Loading - Base Case Source Term (kg/d)	Simulated EOM Loading - Upper Case Source Term (kg/d)	Simulated PC Loading - Base Case Source Term (kg/d)	Simulated PC Loading - Upper Case Source Term (kg/d)
Sulphate	8.71E+01	1.20E+02	1.09E+02	1.17E+02
Al	3.35E-03	2.72E-02	1.66E-03	1.68E-03
Ag	8.23E-06	1.52E-05	1.33E-05	2.65E-05
As	2.59E-03	9.24E-03	1.90E-03	2.23E-03
Ca	1.01E+01	9.17E+00	2.25E+01	2.15E+01
Cd	5.72E-06	1.29E-05	2.41E-05	3.37E-05
B	3.69E-03	7.44E-03	6.87E-03	1.36E-02
Co	3.69E-04	6.48E-04	1.66E-03	2.13E-03
Cr	9.92E-05	1.88E-04	1.33E-04	2.66E-04
Cu	2.06E-04	5.14E-04	2.99E-04	6.13E-04
Fe	8.77E-03	1.66E-02	1.55E-02	5.31E-02
Hg	2.66E-06	2.67E-06	2.65E-06	2.65E-06
K	6.53E+00	9.39E+00	6.70E+00	7.11E+00
Mg	8.27E+00	1.03E+01	7.54E+00	7.82E+00
Mn	1.72E-02	2.23E-02	3.01E-02	3.22E-02
Mo	1.95E-03	4.54E-03	1.54E-02	1.67E-02
Na	1.31E+01	2.44E+01	1.26E+01	1.69E+01
Ni	4.78E-03	6.73E-03	1.53E-02	2.37E-02
Pb	3.99E-05	1.06E-04	2.18E-04	4.80E-04
Sb	3.88E-05	8.61E-05	3.44E-05	7.15E-05
Se	2.51E-04	4.13E-04	1.93E-04	5.59E-04
Tl	9.08E-06	1.61E-05	1.42E-05	2.75E-05
U	3.23E-03	4.08E-03	1.84E-03	2.04E-03
Zn	1.26E-03	2.36E-03	8.72E-03	1.27E-02
Nitrate	2.87E+00	5.15E+00	5.82E+00	1.06E+01
Nitrite	2.46E-02	4.47E-02	1.34E-01	2.44E-01
Ammonia	4.58E-02	8.17E-02	7.34E-01	1.34E+00

Notes:
kg/d Kilograms per day

Table 7.6

Sensitivity Analysis of Simulated Pit Inflow Rate Relative to Calibrated Wet Condition
Atlantic Gold Corporation
Marinette, Nova Scotia

Sensitivity Analysis Scenario Under Wet Conditions	Pit Inflow (m^3/d)	Percent Increase in Pit Inflow	Increase in RSS[1]	Description of Sensitivity Analysis Scenario
Pit Conductance	-655	0%	N/A[2]	Pit conductance increased from 1000 to 2000
MLF-1	-678	3%	4%	Hydraulic conductivity of Mud Lake Fault increased by an order of magnitude
MLF-2	-815	24%	14%	Hydraulic conductivity of Mud Lake Fault increased by two orders of magnitude
CFF-2	-656	0%	8%	Hydraulic conductivity of Cameron Flowage Fault increased by two orders of magnitude
Deep Argillite	-667	2%	0%	Hydraulic conductivity of deep argillite unit increased by an order of magnitude
Deep Greywacke	-829	26%	9%	Hydraulic conductivity of deep greywacke unit increased by an order of magnitude
Shallow Argillite	-699	7%	11%	Hydraulic conductivity of shallow argillite unit increased by an order of magnitude
Shallow Greywacke[3]	-1,835	180%	661%	Hydraulic conductivity of shallow greywacke unit increased by an order of magnitude

Notes:

m^3/d Cubic metres per day
(1) Percent increase in Residual Sum of Square Errors (RSS) relative to the calibrated wet condition model.
(2) The wet calibrated model targets correspond to pre-development conditions, therefore it is not applicable to compare a post-development condition with pre-development calibration targets.
(3) Calibration statistics deteriorate significantly indicating that increasing the conductivity of the weathered fractured greywacke unit by an order of magnitude is not supported by observed groundwater elevation.

Percent Change in Simulated COC Loadings to Surface Water from Groundwater - EOM
Atlantic Gold Corporation
Marinette, Nova Scotia

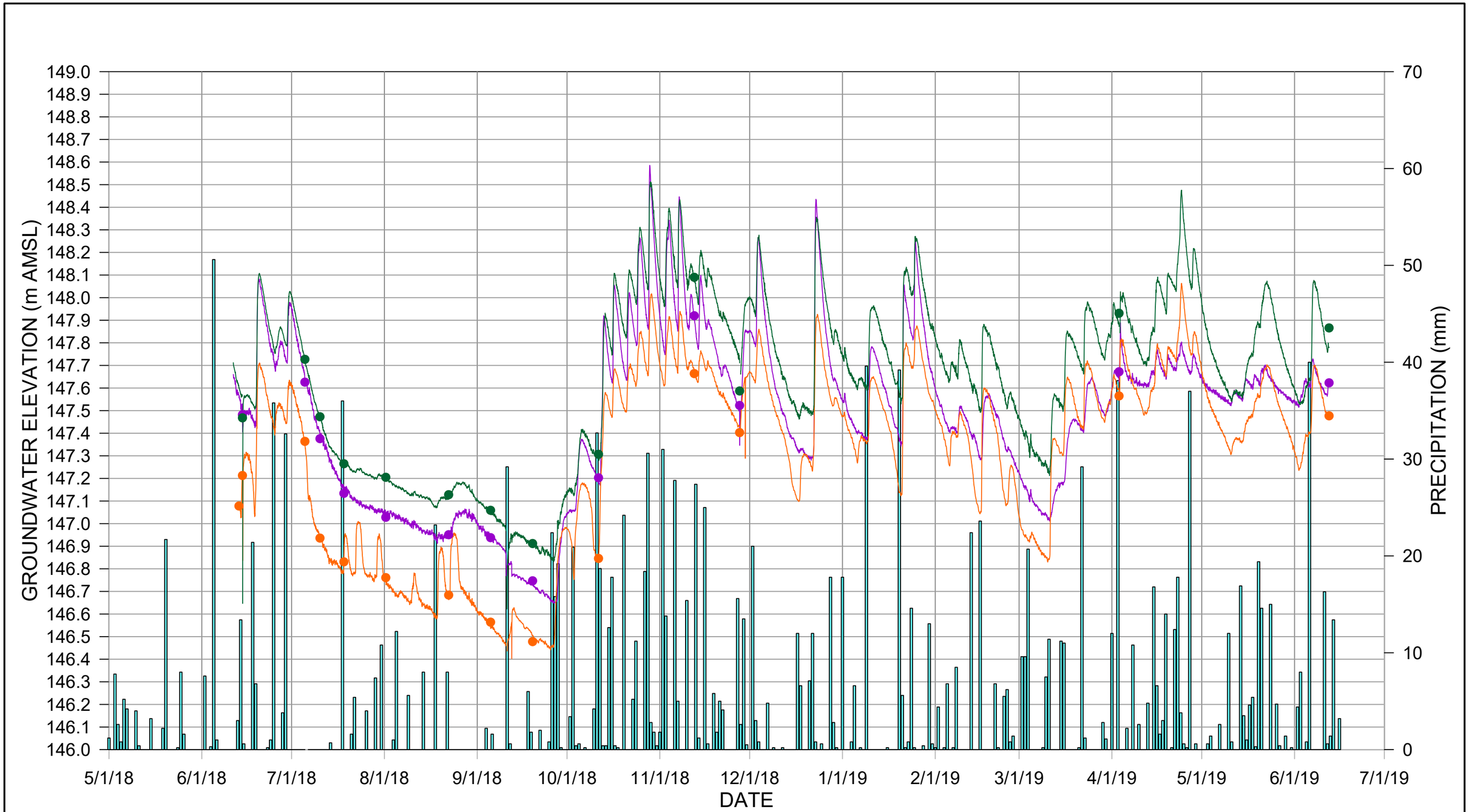
COC	Sens 1	Sens 2	Sens 3	Sens 4	Sens 5	Sens 6	Sens 7	Sens 8	Sens 9	Sens 10	Sens 11	Sens 12	Sens 13
Sulphate	0.00%	-0.02%	-0.01%	0.01%	-0.03%	-0.10%	-0.26%	-0.63%	0.55%	0.85%	-28.25%	-17.67%	0.01%
Al	0.00%	-0.06%	0.00%	0.05%	-0.15%	-0.54%	-1.31%	-3.11%	0.34%	0.54%	-18.36%	-9.79%	0.10%
Ag	-0.01%	-0.09%	-0.03%	0.07%	-0.11%	-0.41%	-1.13%	-3.40%	0.54%	0.83%	-25.77%	-15.90%	0.03%
As	0.00%	-0.02%	0.00%	0.01%	-0.04%	-0.12%	-0.30%	-0.74%	0.51%	0.79%	-28.06%	-17.46%	0.02%
Ca	0.00%	-0.05%	-0.02%	0.04%	-0.07%	-0.23%	-0.64%	-1.89%	0.55%	0.84%	-27.16%	-16.98%	0.01%
Cd	-0.01%	-0.13%	-0.04%	0.10%	-0.15%	-0.59%	-1.61%	-4.96%	0.52%	0.80%	-23.32%	-14.27%	0.04%
B	0.00%	-0.03%	-0.01%	0.02%	-0.05%	-0.17%	-0.45%	-1.22%	0.53%	0.83%	-27.25%	-16.96%	0.02%
Co	0.00%	-0.01%	0.00%	0.01%	-0.04%	-0.10%	-0.25%	-0.49%	0.58%	0.89%	-28.53%	-17.71%	0.02%
Cr	0.00%	-0.06%	-0.01%	0.05%	-0.10%	-0.36%	-0.94%	-2.58%	0.48%	0.75%	-24.34%	-14.67%	0.04%
Cu	-0.02%	-0.24%	-0.08%	0.18%	-0.26%	-1.06%	-2.92%	-9.29%	0.56%	0.88%	-22.70%	-13.77%	0.05%
Fe	0.01%	-0.08%	0.00%	0.06%	-0.18%	-0.66%	-1.60%	-3.77%	0.28%	0.46%	-15.62%	-7.59%	0.13%
Hg	-0.02%	-0.28%	-0.09%	0.22%	-0.32%	-1.30%	-3.55%	-11.20%	0.54%	0.85%	-20.49%	-12.09%	0.07%
K	0.00%	0.00%	0.00%	0.00%	-0.02%	-0.04%	-0.10%	-0.08%	0.54%	0.83%	-27.01%	-16.89%	0.01%
Mg	0.00%	-0.01%	0.00%	0.01%	-0.02%	-0.06%	-0.14%	-0.22%	0.55%	0.85%	-27.82%	-17.40%	0.01%
Mn	-0.01%	-0.16%	-0.05%	0.12%	-0.19%	-0.74%	-2.03%	-6.35%	0.53%	0.83%	-22.53%	-13.71%	0.04%
Mo	0.00%	-0.03%	-0.01%	0.02%	-0.05%	-0.16%	-0.43%	-1.19%	0.54%	0.84%	-29.32%	-18.34%	0.01%
Na	0.00%	-0.01%	0.00%	0.01%	-0.02%	-0.05%	-0.14%	-0.22%	0.55%	0.85%	-30.03%	-18.78%	0.01%
Ni	0.00%	0.00%	0.00%	0.00%	-0.02%	-0.04%	-0.10%	-0.06%	0.58%	0.90%	-28.96%	-18.09%	0.01%
Pb	0.00%	-0.06%	-0.02%	0.05%	-0.08%	-0.30%	-0.80%	-2.33%	0.53%	0.82%	-26.27%	-16.23%	0.03%
Sb	-0.01%	-0.12%	-0.04%	0.09%	-0.13%	-0.53%	-1.46%	-4.66%	0.50%	0.78%	-24.00%	-14.94%	0.02%
Se	0.00%	-0.05%	-0.02%	0.04%	-0.08%	-0.28%	-0.75%	-2.15%	0.51%	0.79%	-25.41%	-15.70%	0.02%
Tl	-0.01%	-0.13%	-0.04%	0.10%	-0.16%	-0.62%	-1.69%	-5.22%	0.54%	0.83%	-24.54%	-15.01%	0.04%
U	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.02%	-0.06%	0.00%	0.47%	0.73%	-30.92%	-19.34%	0.01%
Zn	-0.01%	-0.09%	-0.03%	0.07%	-0.12%	-0.45%	-1.22%	-3.71%	0.54%	0.83%	-26.00%	-16.02%	0.03%
Nitrate	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.02%	0.01%	0.32%	0.49%	-32.40%	-20.27%	0.00%
Nitrite	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.02%	0.01%	0.31%	0.48%	-32.43%	-20.29%	0.00%
Ammonia	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.02%	0.01%	0.31%	0.48%	-32.49%	-20.32%	0.00%
Average Change	**0.00%**	**-0.06%**	**-0.02%**	**0.05%**	**-0.09%**	**-0.33%**	**-0.89%**	**-2.57%**	**0.49%**	**0.76%**	**-26.30%**	**-16.16%**	**0.03%**
Minimum Change	**0.01%**	**0.00%**	**0.00%**	**0.22%**	**-0.01%**	**-0.01%**	**-0.02%**	**0.01%**	**0.58%**	**0.90%**	**-15.62%**	**-7.59%**	**0.13%**
Maximum Change	**-0.02%**	**-0.28%**	**-0.09%**	**0.00%**	**-0.32%**	**-1.30%**	**-3.55%**	**-11.20%**	**0.28%**	**0.46%**	**-32.49%**	**-20.32%**	**0.00%**

Percent Change in Simulated COC Loadings to Surface Water from Groundwater - PC
Atlantic Gold Corporation
Marinette, Nova Scotia

COC	Sens 1	Sens 2	Sens 3	Sens 4	Sens 5	Sens 6	Sens 7	Sens 8	Sens 9	Sens 10	Sens 11	Sens 12	Sens 13
Sulphate	0.00%	0.00%	0.00%	0.00%	-0.08%	-0.14%	0.00%	-0.01%	0.22%	0.33%	4.35%	0.23%	0.00%
Al	0.00%	0.00%	-0.01%	-0.01%	-0.94%	-1.62%	-0.03%	-0.09%	0.79%	1.21%	3.99%	0.21%	0.08%
Ag	0.00%	0.00%	0.00%	0.00%	-0.11%	-0.19%	-0.01%	-0.01%	0.24%	0.36%	4.32%	0.22%	0.01%
As	0.00%	0.00%	0.00%	0.00%	-0.23%	-0.39%	-0.01%	-0.02%	0.32%	0.48%	4.28%	0.22%	0.02%
Ca	0.00%	0.00%	0.00%	0.00%	-0.04%	-0.07%	0.00%	-0.01%	0.19%	0.29%	4.37%	0.23%	0.00%
Cd	0.02%	0.03%	-0.04%	-0.08%	-6.10%	-10.52%	-0.21%	-0.56%	4.22%	6.50%	1.91%	0.10%	0.55%
B	0.00%	0.00%	-0.01%	-0.01%	-0.54%	-0.92%	-0.02%	-0.05%	0.52%	0.80%	4.19%	0.22%	0.05%
Co	0.02%	0.03%	-0.04%	-0.07%	-5.82%	-10.03%	-0.20%	-0.54%	4.03%	6.21%	2.02%	0.10%	0.52%
Cr	0.00%	0.00%	0.00%	0.00%	-0.14%	-0.23%	-0.01%	-0.01%	0.25%	0.39%	4.33%	0.22%	0.01%
Cu	0.00%	0.00%	-0.01%	-0.02%	-1.30%	-2.24%	-0.05%	-0.12%	1.03%	1.58%	3.84%	0.20%	0.12%
Fe	0.03%	0.05%	-0.07%	-0.13%	-10.10%	-17.41%	-0.35%	-0.93%	6.87%	10.60%	0.29%	0.01%	0.91%
Hg	0.00%	0.00%	0.00%	0.00%	-0.05%	-0.08%	0.00%	-0.01%	0.20%	0.30%	4.35%	0.23%	0.00%
K	0.00%	0.00%	0.00%	0.00%	-0.05%	-0.09%	0.00%	-0.01%	0.20%	0.30%	4.36%	0.23%	0.00%
Mg	0.00%	0.00%	0.00%	0.00%	-0.13%	-0.22%	-0.01%	-0.01%	0.25%	0.38%	4.33%	0.23%	0.01%
Mn	0.00%	0.00%	0.00%	-0.01%	-0.45%	-0.78%	-0.02%	-0.04%	0.47%	0.71%	4.19%	0.22%	0.04%
Mo	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%	0.00%	0.00%	0.17%	0.25%	4.37%	0.23%	0.00%
Na	0.00%	0.00%	0.00%	0.00%	-0.07%	-0.12%	0.00%	-0.01%	0.21%	0.32%	4.36%	0.23%	0.00%
Ni	0.02%	0.03%	-0.04%	-0.08%	-6.34%	-10.94%	-0.22%	-0.59%	4.38%	6.75%	1.81%	0.09%	0.57%
Pb	0.02%	0.04%	-0.05%	-0.10%	-7.57%	-13.05%	-0.27%	-0.70%	5.19%	8.00%	1.32%	0.07%	0.68%
Sb	0.00%	0.00%	0.00%	0.00%	-0.05%	-0.08%	0.00%	-0.01%	0.20%	0.29%	4.35%	0.23%	0.00%
Se	0.00%	0.00%	0.00%	-0.01%	-0.35%	-0.60%	-0.01%	-0.03%	0.39%	0.60%	4.23%	0.22%	0.03%
Tl	0.00%	0.00%	-0.01%	-0.01%	-0.75%	-1.30%	-0.03%	-0.07%	0.67%	1.02%	4.07%	0.21%	0.07%
U	0.00%	0.00%	0.00%	-0.01%	-0.32%	-0.55%	-0.01%	-0.03%	0.38%	0.58%	4.24%	0.22%	0.03%
Zn	0.03%	0.04%	-0.06%	-0.11%	-8.36%	-14.41%	-0.29%	-0.77%	5.71%	8.82%	1.00%	0.05%	0.75%
Nitrate	0.00%	0.00%	0.00%	0.00%	-0.02%	-0.03%	0.00%	0.00%	0.18%	0.26%	4.38%	0.23%	0.00%
Nitrite	0.00%	0.00%	0.00%	0.00%	-0.02%	-0.03%	0.00%	0.00%	0.18%	0.26%	4.38%	0.23%	0.00%
Ammonia	0.00%	0.00%	0.00%	0.00%	-0.02%	-0.03%	0.00%	0.00%	0.18%	0.26%	4.38%	0.23%	0.00%
Average Change	**0.00%**	**0.01%**	**-0.01%**	**-0.02%**	**-1.85%**	**-3.19%**	**-0.07%**	**-0.17%**	**1.39%**	**2.14%**	**3.63%**	**0.19%**	**0.16%**
Minimum Change	**0.03%**	**0.05%**	**0.00%**	**0.00%**	**0.00%**	**-0.01%**	**0.00%**	**0.00%**	**6.87%**	**10.60%**	**4.38%**	**0.23%**	**0.91%**
Maximum Change	**0.00%**	**0.00%**	**-0.07%**	**-0.13%**	**-10.10%**	**-17.41%**	**-0.35%**	**-0.93%**	**0.17%**	**0.25%**	**0.29%**	**0.01%**	**0.00%**

Appendices

Appendix A
Groundwater Elevation Hydrographs



Legend

MW-01A
MW-01B
MW-01C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-01 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

088664-031
Oct 28, 2019

FIGURE A.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.1 - MW-01 Hydrograph.grf

GROUNDWATER ELEVATION (m AMSL)

151.0
150.9
150.8
150.7
150.6
150.5
150.4
150.3
150.2
150.1
150.0
149.9
149.8
149.7
149.6
149.5
149.4
149.3
149.2
149.1
149.0
148.9
148.8
148.7
148.6
148.5
148.4
148.3
148.2
148.1
148.0
147.9
147.8
147.7
147.6
147.5

PRECIPITATION (mm)

70
60
50
40
30
20
10
0

5/1/18
6/1/18
7/1/18
8/1/18
9/1/18
10/1/18
11/1/18
12/1/18
1/1/19
2/1/19
3/1/19
4/1/19
5/1/19
6/1/19
7/1/19

DATE

Legend

MW-02A
MW-02B
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-02 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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FIGURE A.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\APPENDIX A\Figure A.2 - MW-02 Hydrograph.grf

GROUNDWATER ELEVATION (m AMSL)

164.5
164.4
164.3
164.2
164.1
164.0
163.9
163.8
163.7
163.6
163.5
163.4
163.3
163.2
163.1
163.0
162.9
162.8
162.7
162.6
162.5
162.4
162.3
162.2
162.1
162.0

PRECIPITATION (mm)

70
60
50
40
30
20
10
0

5/1/18 6/1/18 7/1/18 8/1/18 9/1/18 10/1/18 11/1/18 12/1/18 1/1/19 2/1/19 3/1/19 4/1/19 5/1/19 6/1/19 7/1/19

DATE

Legend

MW-03A
MW-03B
MW-03C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-03 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

088664-031
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FIGURE A.3

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.3 - MW-03 Hydrograph.grf

GROUNDWATER ELEVATION (m AMSL)

165.0
164.9
164.8
164.7
164.6
164.5
164.4
164.3
164.2
164.1
164.0
163.9
163.8
163.7
163.6
163.5
163.4
163.3
163.2
163.1
163.0
162.9
162.8
162.7
162.6
162.5
162.4
162.3
162.2
162.1
162.0
161.9
161.8
161.7
161.6
161.5

PRECIPITATION (mm)

70
60
50
40
30
20
10
0

5/1/18
6/1/18
7/1/18
8/1/18
9/1/18
10/1/18
11/1/18
12/1/18
1/1/19
2/1/19
3/1/19
4/1/19
5/1/19
6/1/19
7/1/19

DATE

Legend

MW-04A
MW-04B
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-04 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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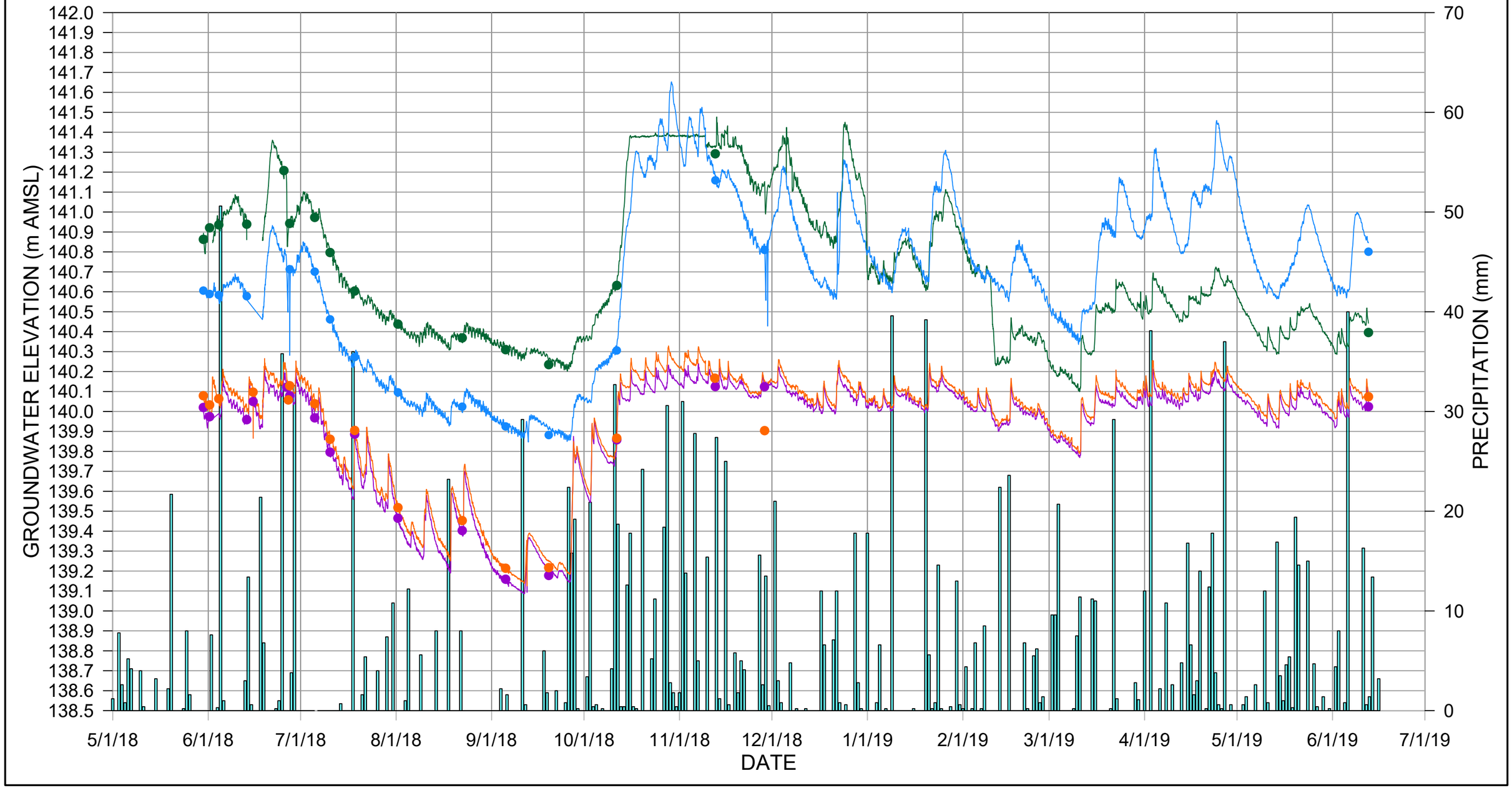
FIGURE A.4

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.4 - MW-04 Hydrograph.grf



Legend

MW-05A
MW-05B
MW-05C
MW-05D
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-05 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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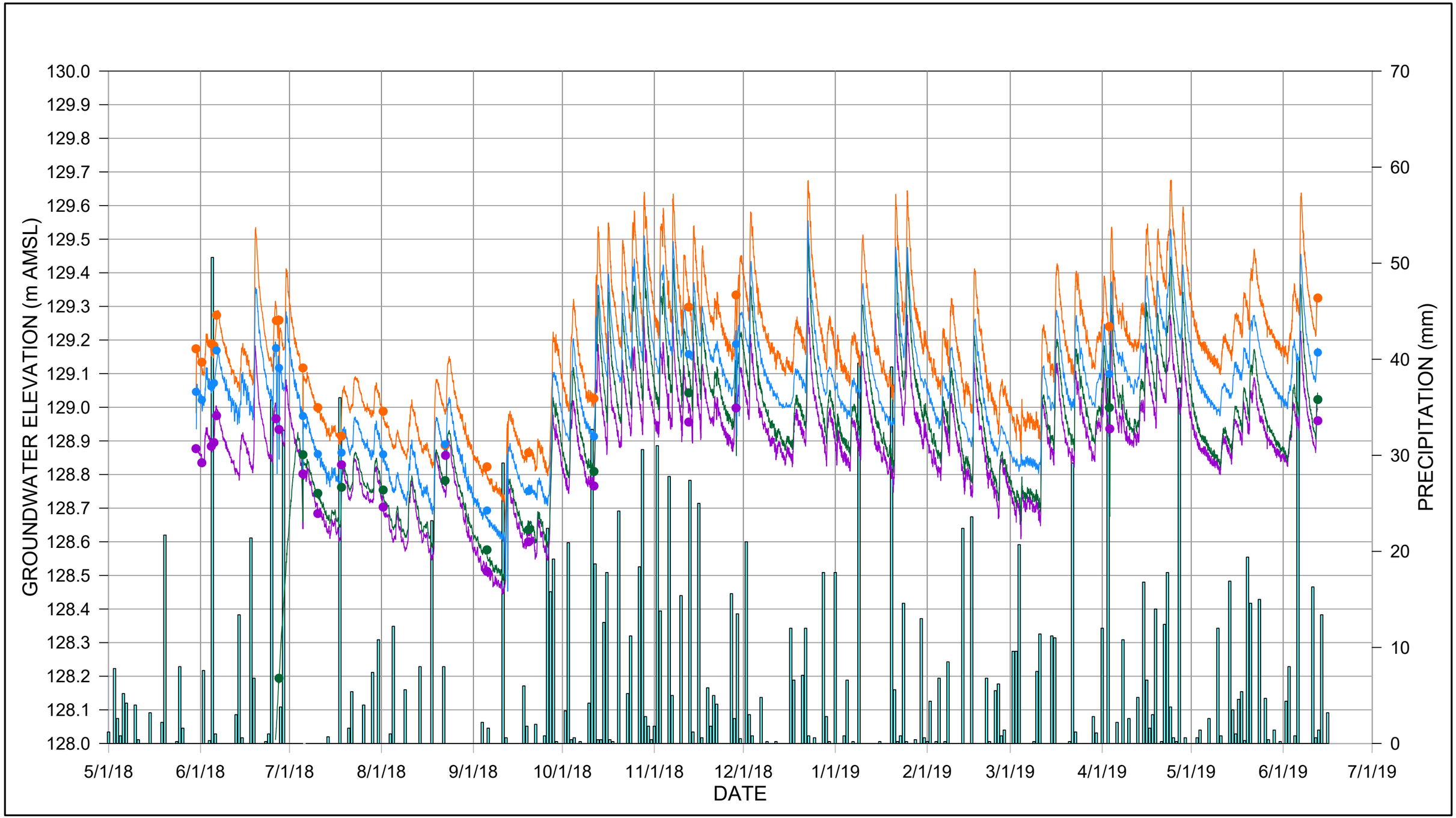
FIGURE A.5

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.5 - MW-05 Hydrograph.grf



Legend

MW-07A — MW-07C — PRECIPITATION (mm)

MW-07B — MW-07D — MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-07 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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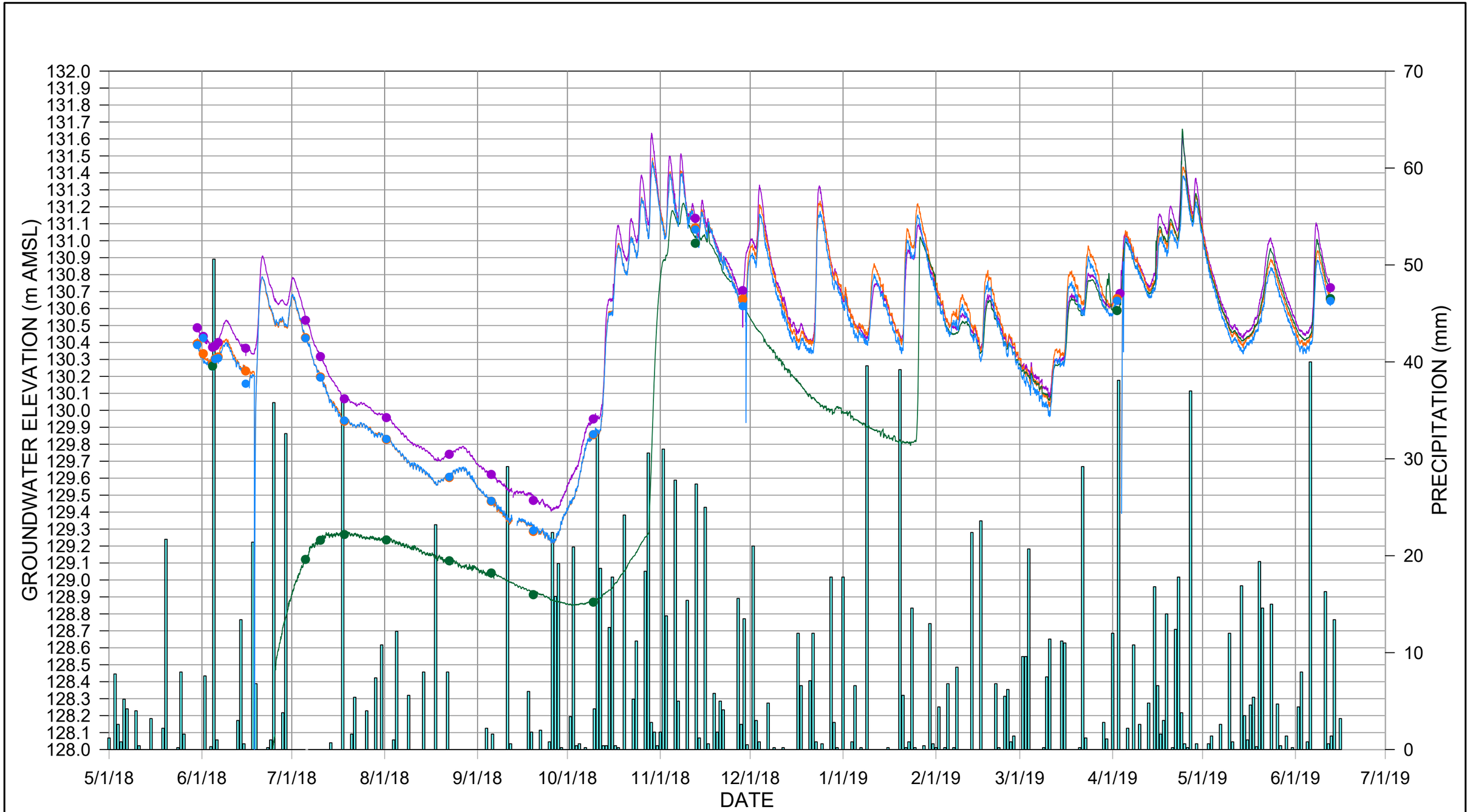
FIGURE A.6

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.6 - MW-07 Hydrograph.grf



Legend

MW-09A
MW-09B
MW-09C
MW-09D
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-09 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

088664-031
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FIGURE A.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.7 - MW-09 Hydrograph.grf

GROUNDWATER ELEVATION (m AMSL)

148.0
147.9
147.8
147.7
147.6
147.5
147.4
147.3
147.2
147.1
147.0
146.9
146.8
146.7
146.6
146.5
146.4
146.3
146.2
146.1
146.0
145.9
145.8
145.7
145.6
145.5
145.4
145.3
145.2
145.1
145.0
144.9
144.8
144.7
144.6
144.5
144.4
144.3
144.2
144.1
144.0

PRECIPITATION (mm)

70
60
50
40
30
20
10
0

5/1/18
6/1/18
7/1/18
8/1/18
9/1/18
10/1/18
11/1/18
12/1/18
1/1/19
2/1/19
3/1/19
4/1/19
5/1/19
6/1/19
7/1/19

DATE

Legend

MW-11A
MW-11B
MW-11C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-11 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

088664-031
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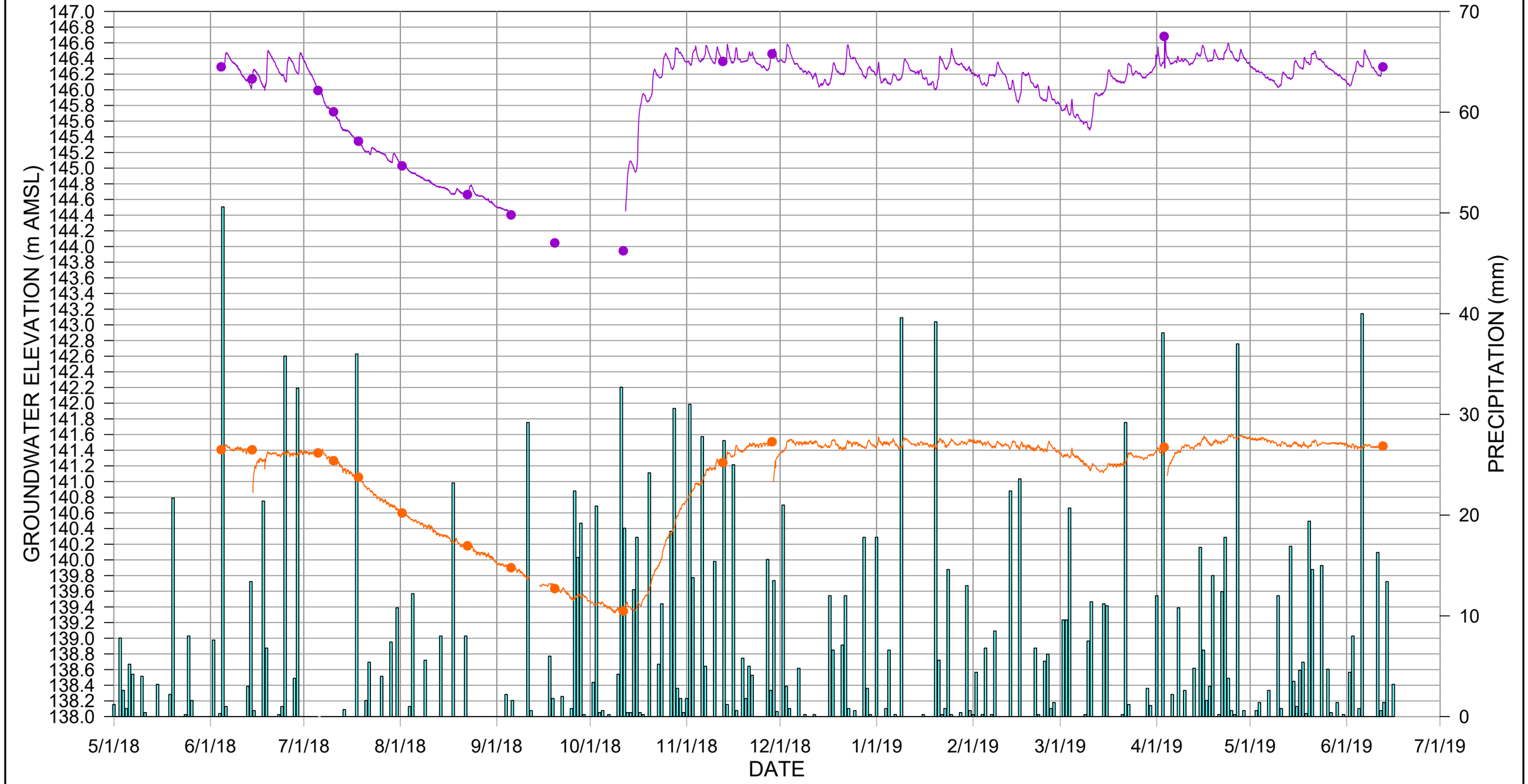
FIGURE A.8

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.8 - MW-11 Hydrograph.grf



Legend

MW-12A

MW-12B

PRECIPITATION (mm)

MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-12 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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FIGURE A.9

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.9 - MW-12 Hydrograph.grf

GROUNDWATER ELEVATION (m AMSL)

137.5
137.4
137.3
137.2
137.1
137.0
136.9
136.8
136.7
136.6
136.5
136.4
136.3
136.2
136.1
136.0
135.9
135.8
135.7
135.6
135.5
135.4
135.3
135.2
135.1
135.0
134.9
134.8
134.7
134.6
134.5
134.4
134.3
134.2
134.1
134.0
133.9
133.8
133.7
133.6
133.5

PRECIPITATION (mm)

70
60
50
40
30
20
10
0

5/1/18 6/1/18 7/1/18 8/1/18 9/1/18 10/1/18 11/1/18 12/1/18 1/1/19 2/1/19 3/1/19 4/1/19 5/1/19 6/1/19 7/1/19

DATE

Legend

MW-14A
MW-14B
MW-14C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-14 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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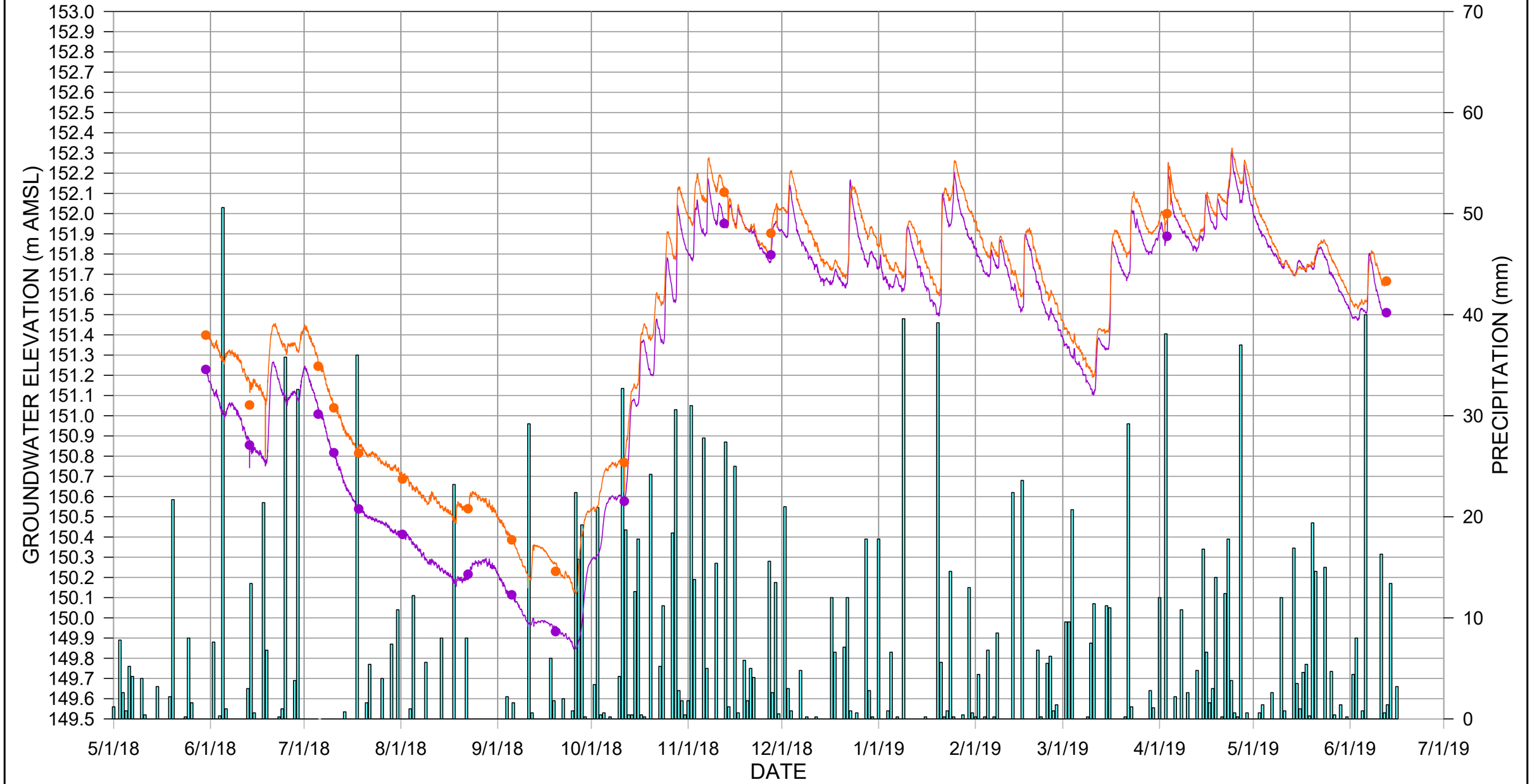
Oct 28, 2019

FIGURE A.10

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.10 - MW-14 Hydrograph.grf



Legend

MW-16A
MW-16B
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-16 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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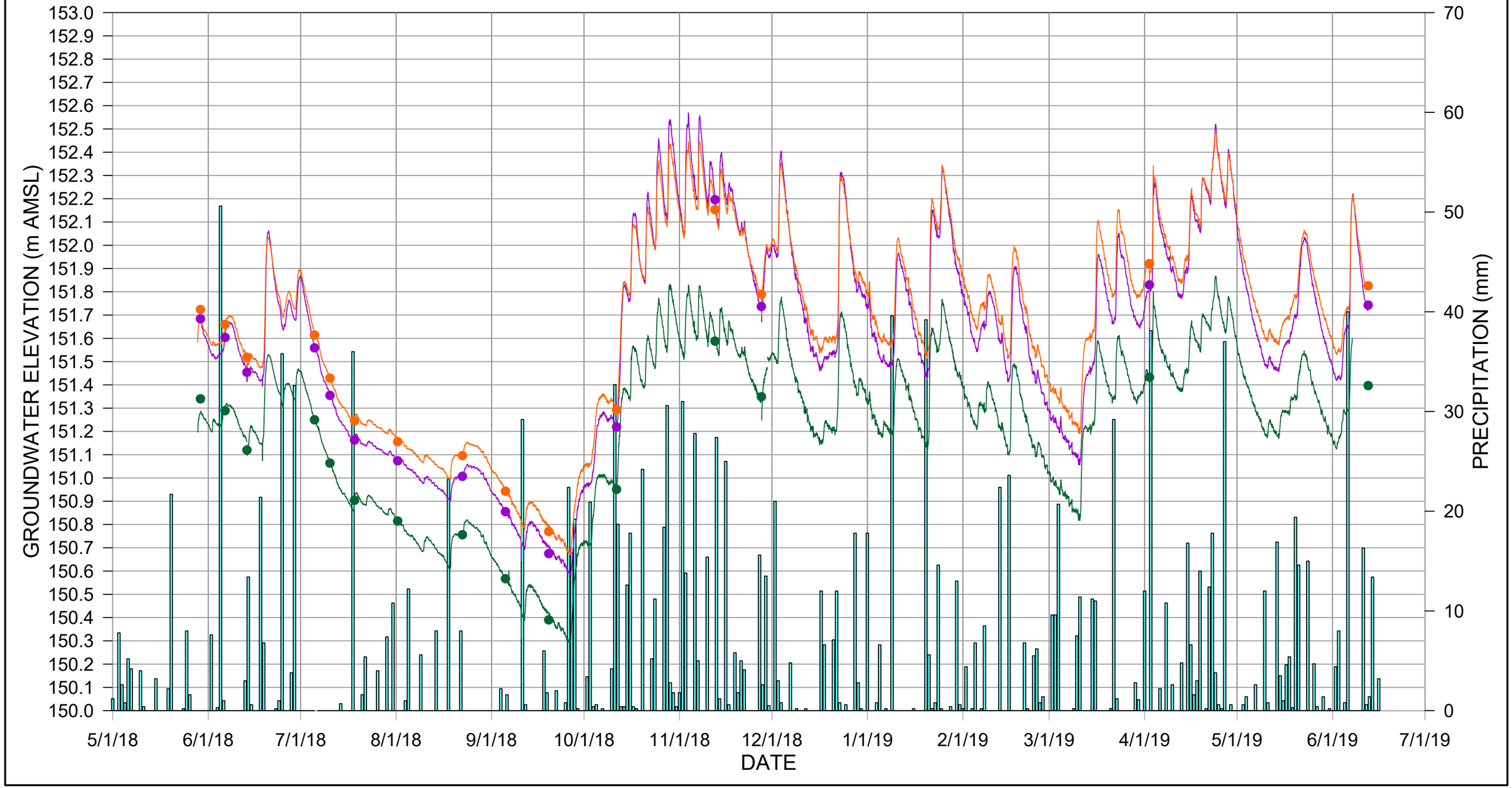
FIGURE A.11

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.11 - MW-16 Hydrograph.grf



Legend

MW-17A
MW-17B
MW-17C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-17 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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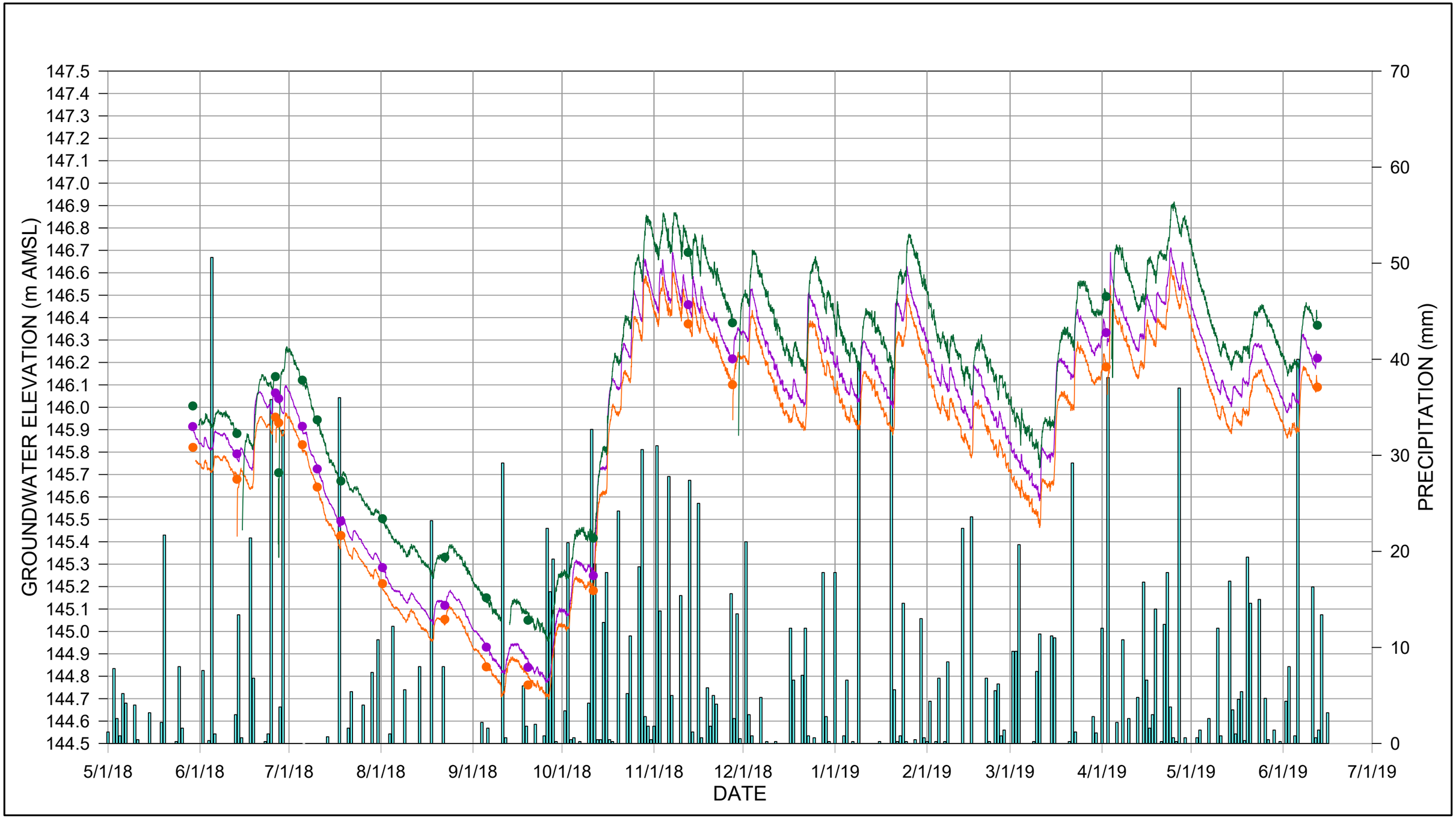
Oct 28, 2019

FIGURE A.12

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.12 - MW-17 Hydrograph.grf



Legend

MW-18A — MW-18C — MW-18B — PRECIPITATION (mm) — MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-18 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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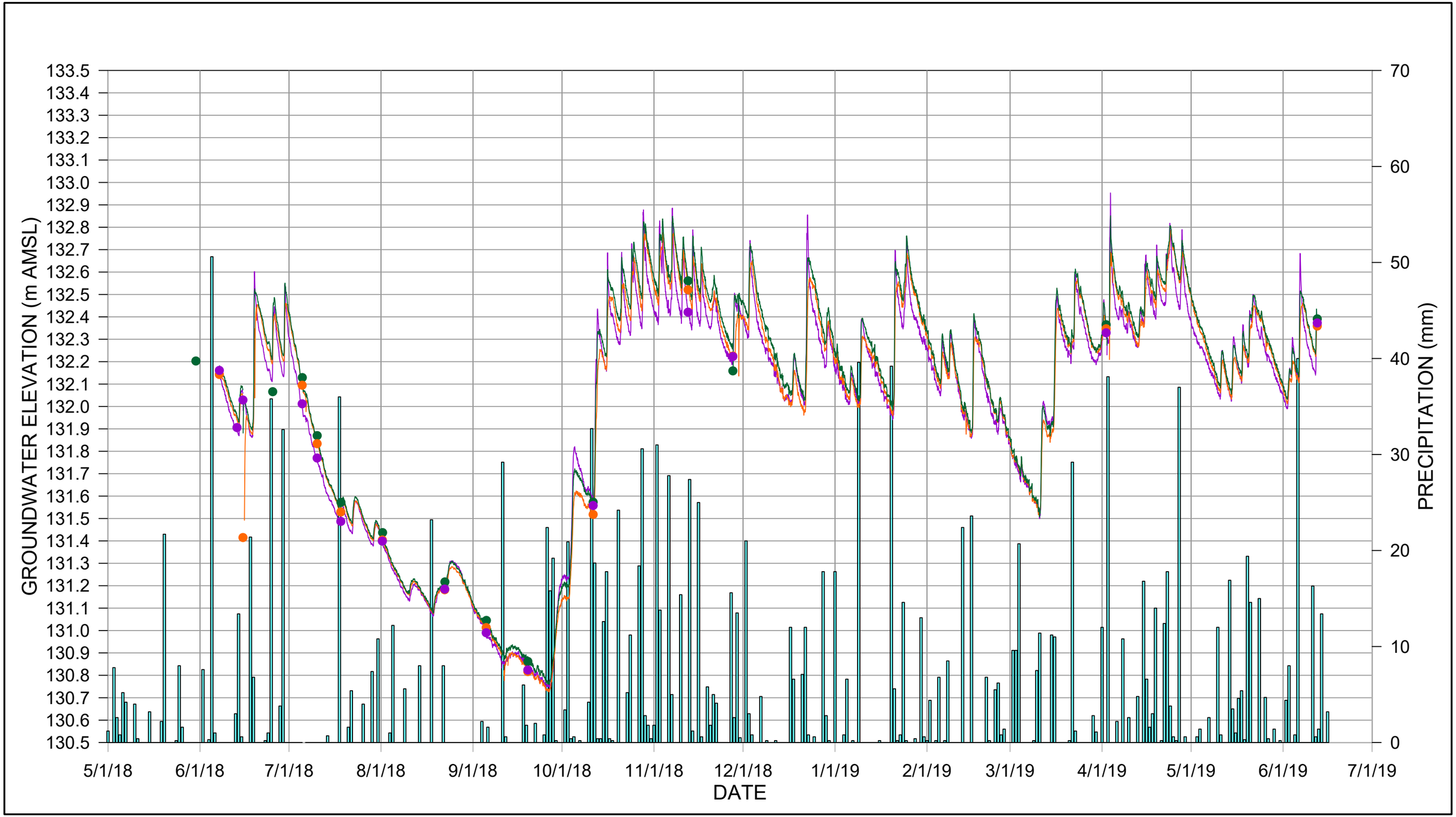
FIGURE A.13

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.13 - MW-18 Hydrograph.grf



Legend

MW-19A
MW-19B
MW-19C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-19 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

088664-031
Oct 28, 2019

FIGURE A.14

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.14 - MW-19 Hydrograph.grf

GROUNDWATER ELEVATION (m AMSL)

151.5
151.4
151.3
151.2
151.1
151.0
150.9
150.8
150.7
150.6
150.5
150.4
150.3
150.2
150.1
150.0
149.9
149.8
149.7
149.6
149.5
149.4
149.3
149.2
149.1
149.0
148.9
148.8
148.7
148.6
148.5

PRECIPITATION (mm)

70
60
50
40
30
20
10
0

5/1/18
6/1/18
7/1/18
8/1/18
9/1/18
10/1/18
11/1/18
12/1/18
1/1/19
2/1/19
3/1/19
4/1/19
5/1/19
6/1/19
7/1/19

DATE

Legend

MW-20A
MW-20B
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-20 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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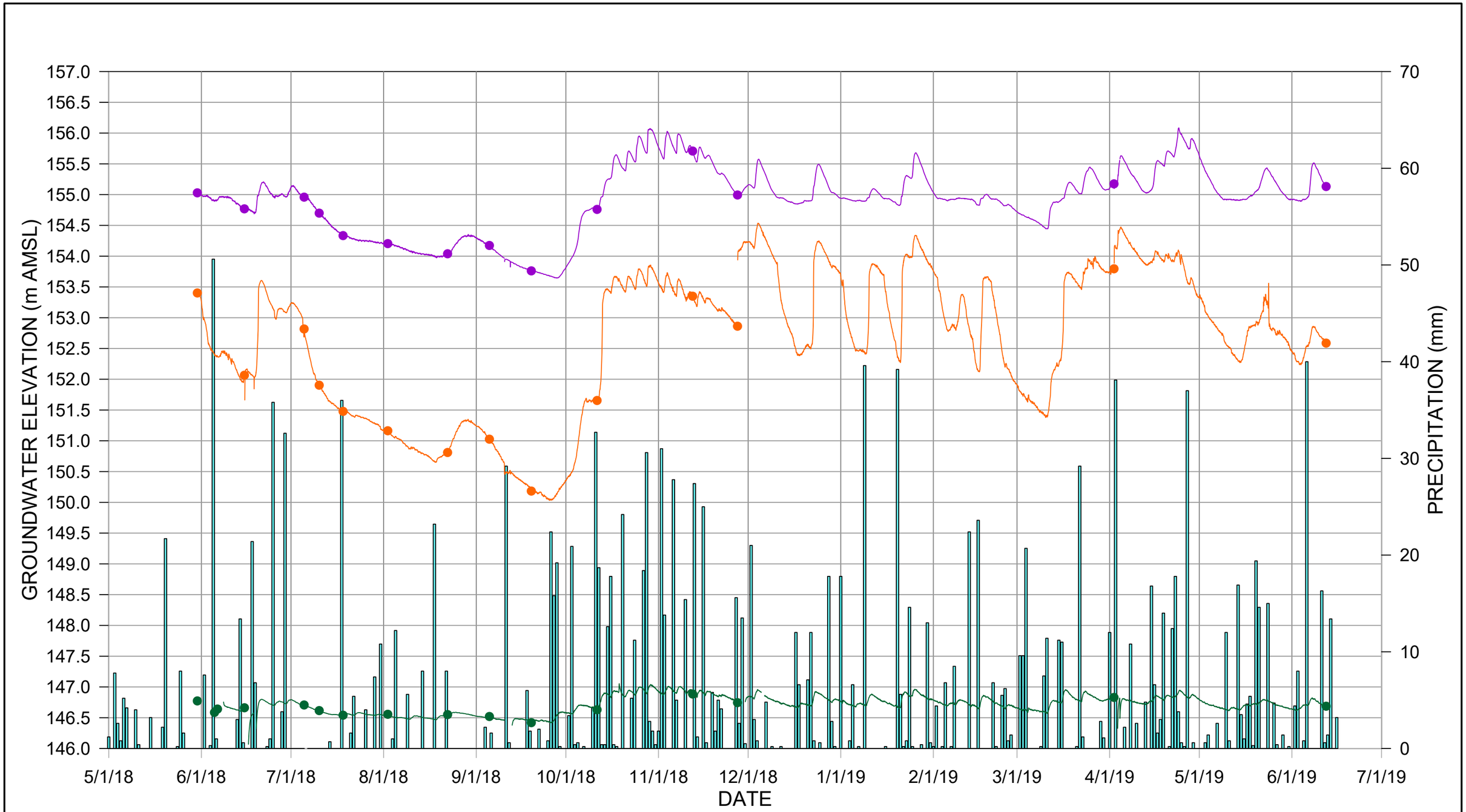
Oct 28, 2019

FIGURE A.15

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.15 - MW-20 Hydrograph.grf



Legend

MW-21A
MW-21B
MW-21C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

MW-21 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

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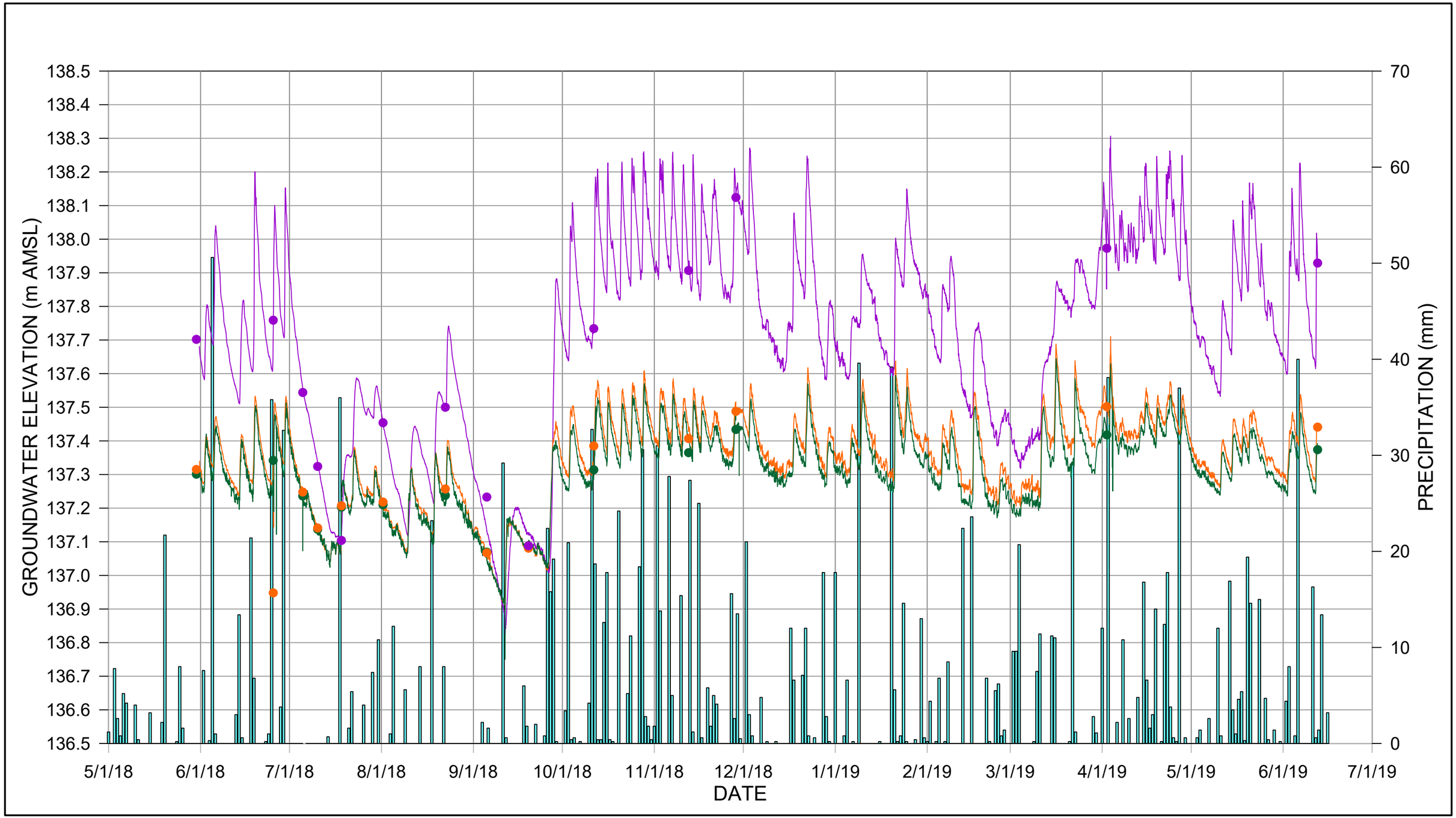
FIGURE A.16

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.16 - MW-21 Hydrograph.grf



Legend

MW-22A
MW-22B
MW-22C
PRECIPITATION (mm)
MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

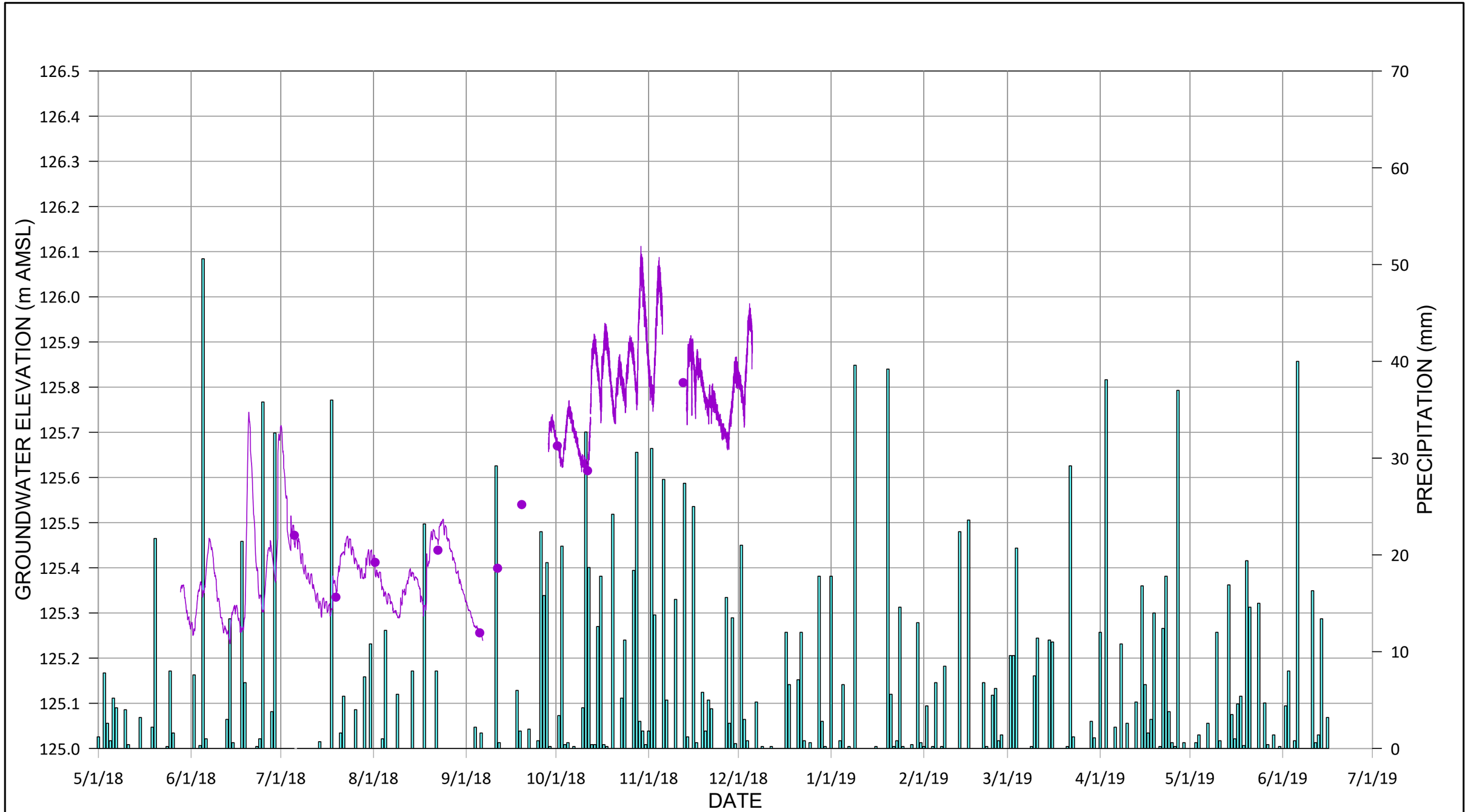
MW-22 WELL NEST
MEASURED GROUNDWATER ELEVATIONS

088664-031
Oct 28, 2019

FIGURE A.17

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix A\Figure A.17 - MW-22 Hydrograph.grf

Appendix B
Surface Water Elevation Hydrographs



Legend

SW-01 PRECIPITATION (mm) MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-01
MEASURED SURFACE WATER ELEVATIONS

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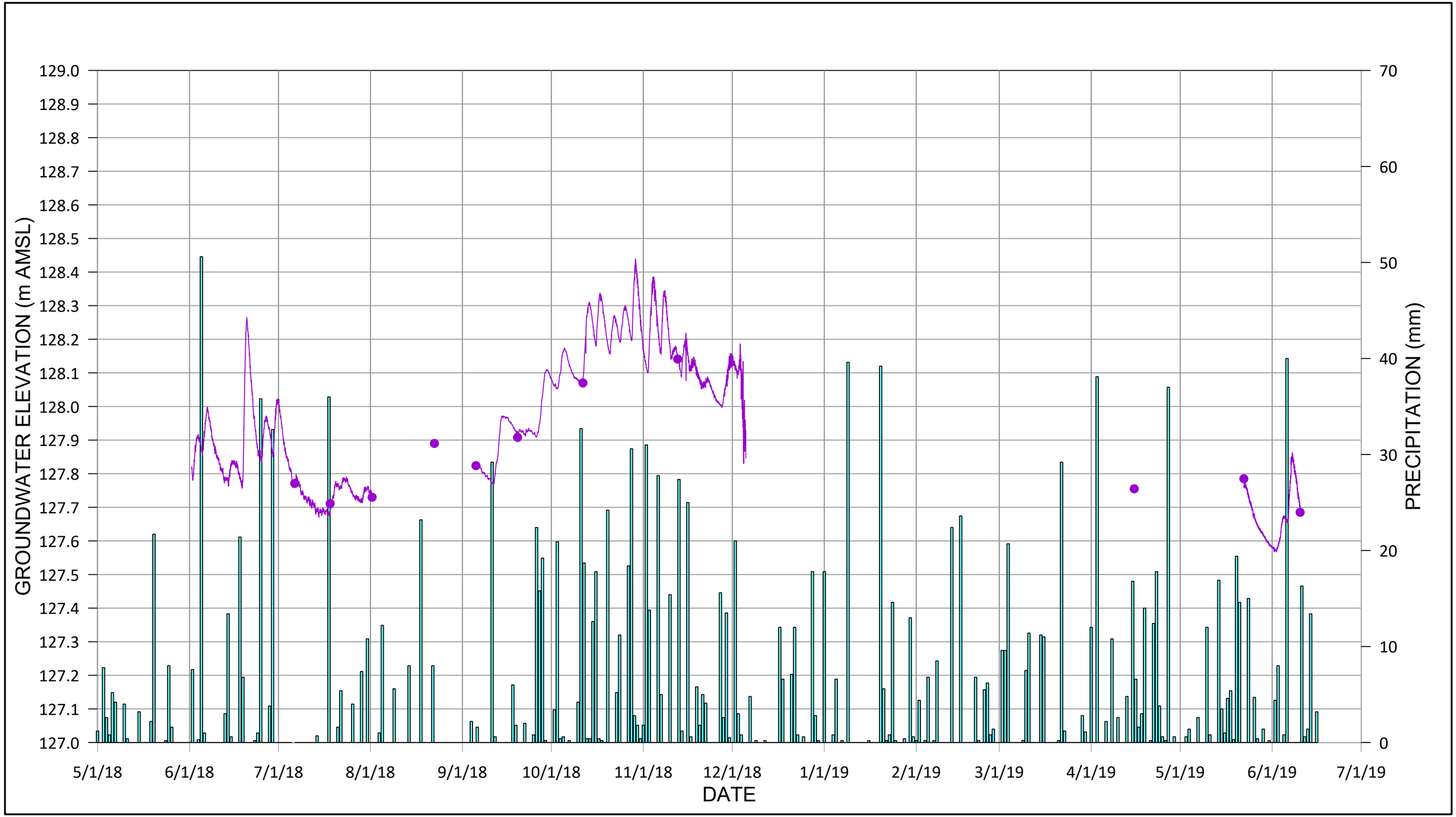
Oct 28, 2019

FIGURE B.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.1 - SW-01 Hydrograph.grf



Legend

SW-02 PRECIPITATION (mm) MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-02
MEASURED SURFACE WATER ELEVATIONS

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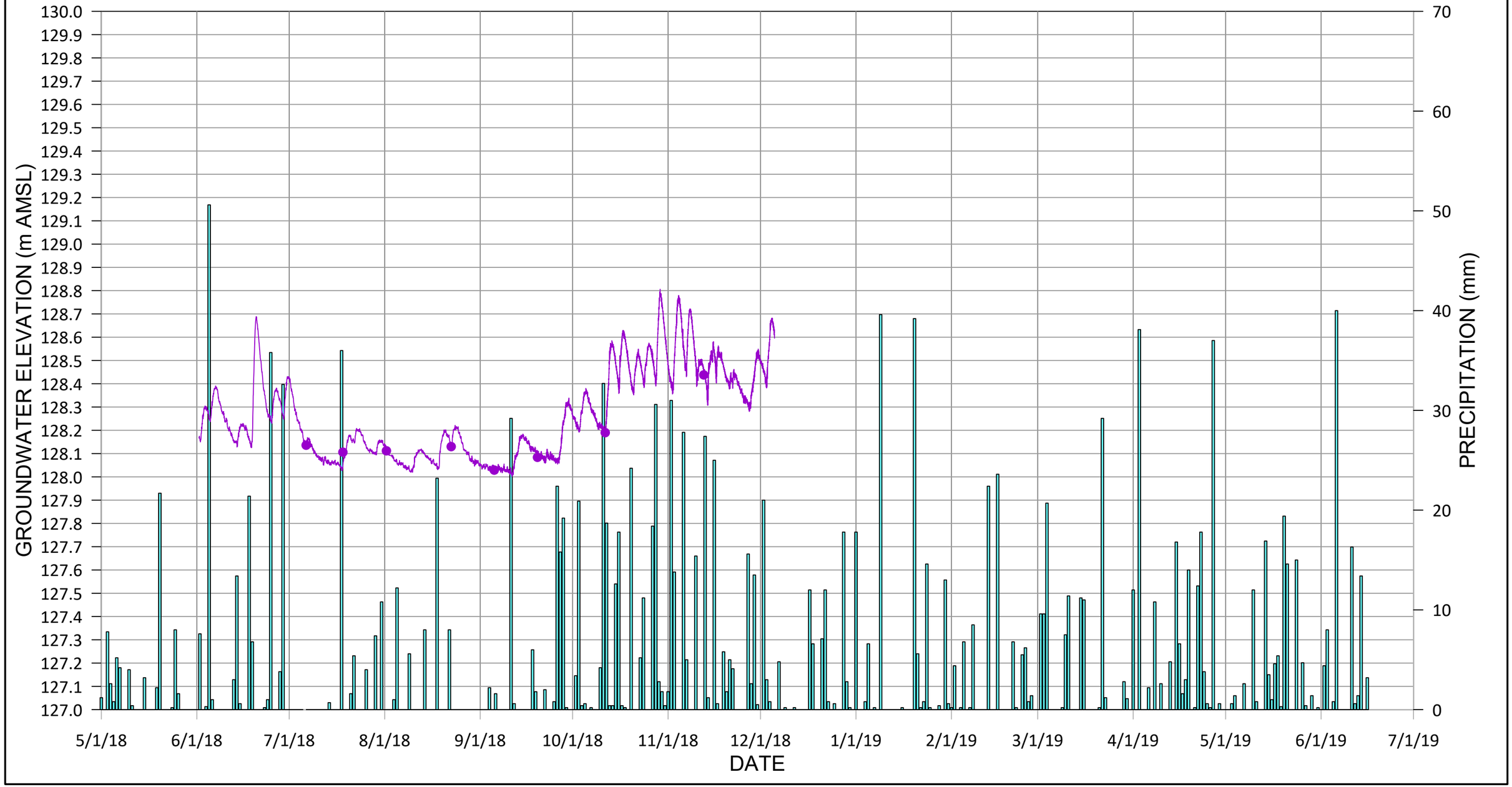
FIGURE B.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.2 - SW-02 Hydrograph.grf



Legend

SW-04A PRECIPITATION (mm) MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-04A
MEASURED SURFACE WATER ELEVATIONS

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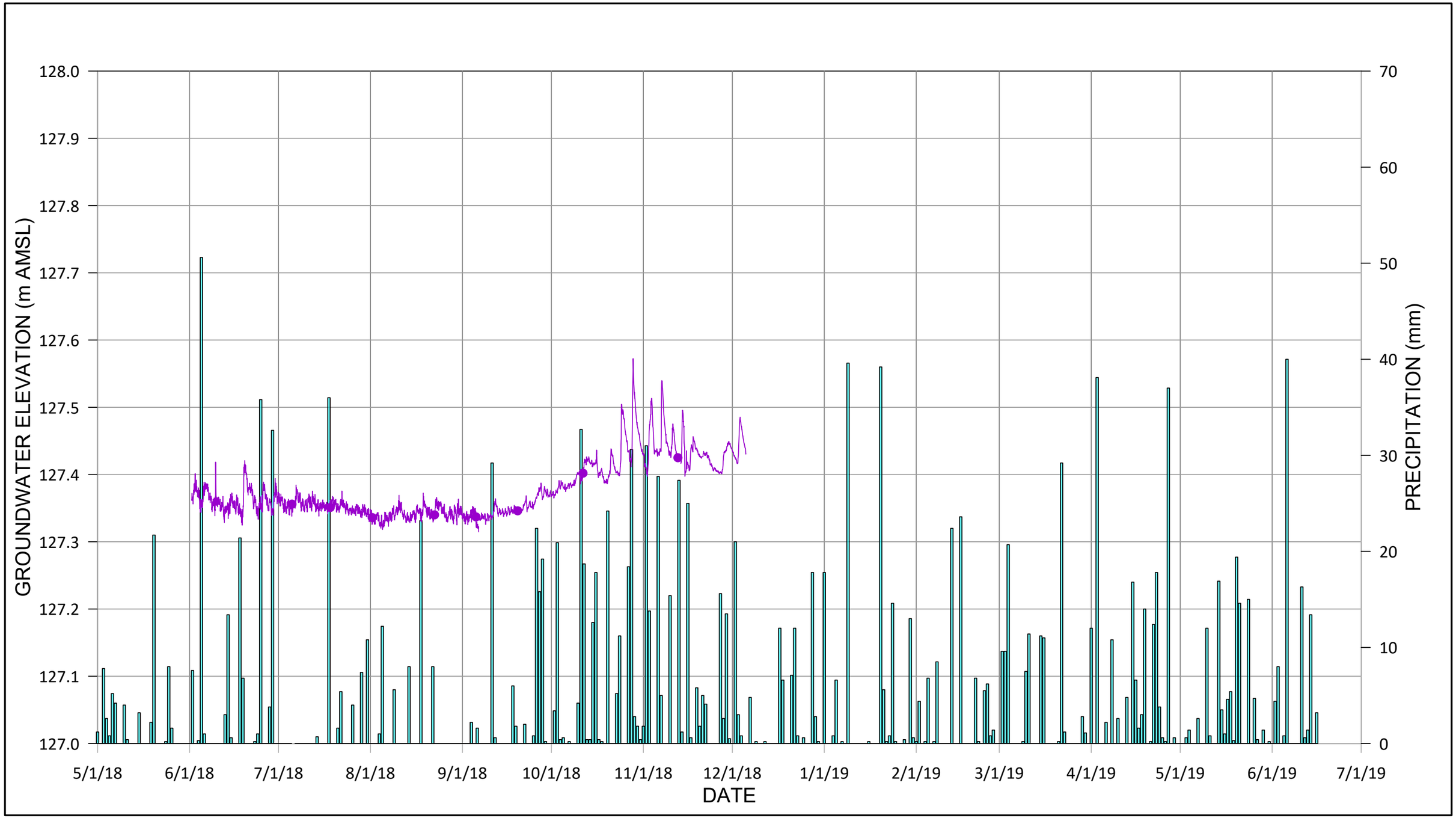
Oct 28, 2019

FIGURE B.3

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.3 - SW-04a Hydrograph.grf



Legend

SW-13 PRECIPITATION (mm) MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-13
MEASURED SURFACE WATER ELEVATIONS

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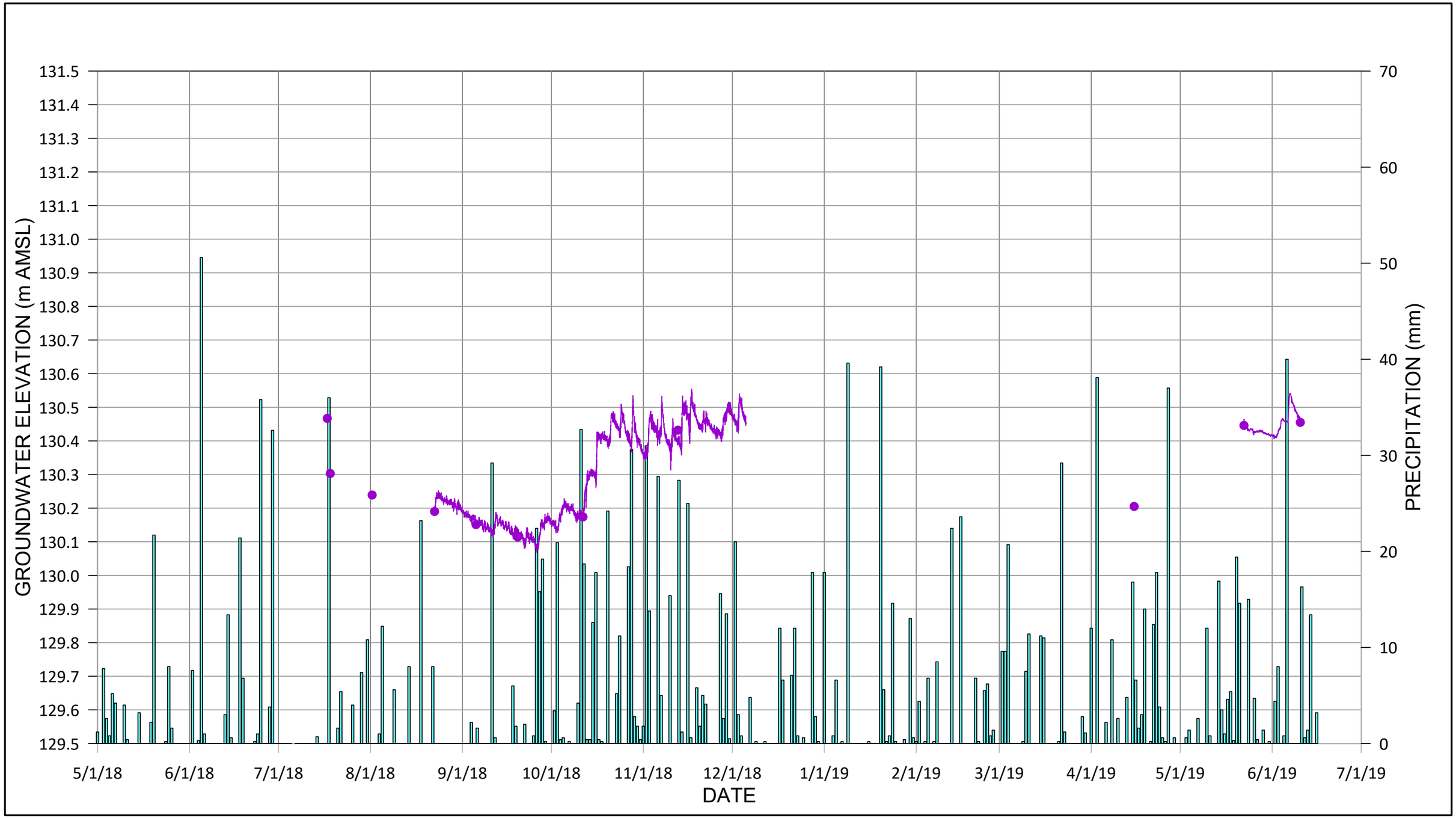
FIGURE B.4

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.4 - SW-13 Hydrograph.grf



Legend

SW-14 PRECIPITATION (mm) MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-14
MEASURED SURFACE WATER ELEVATIONS

088664-031
Oct 28, 2019

FIGURE B.5

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.5 - SW-14 Hydrograph.grf

GROUNDWATER ELEVATION (m AMSL)

145.0
144.9
144.8
144.7
144.6
144.5
144.4
144.3
144.2
144.1
144.0

PRECIPITATION (mm)

70
60
50
40
30
20
10
0

5/1/18 6/1/18 7/1/18 8/1/18 9/1/18 10/1/18 11/1/18 12/1/18 1/1/19 2/1/19 3/1/19 4/1/19 5/1/19 6/1/19 7/1/19

DATE

Legend

SW-18 PRECIPITATION (mm) MANUAL MEASUREMENTS

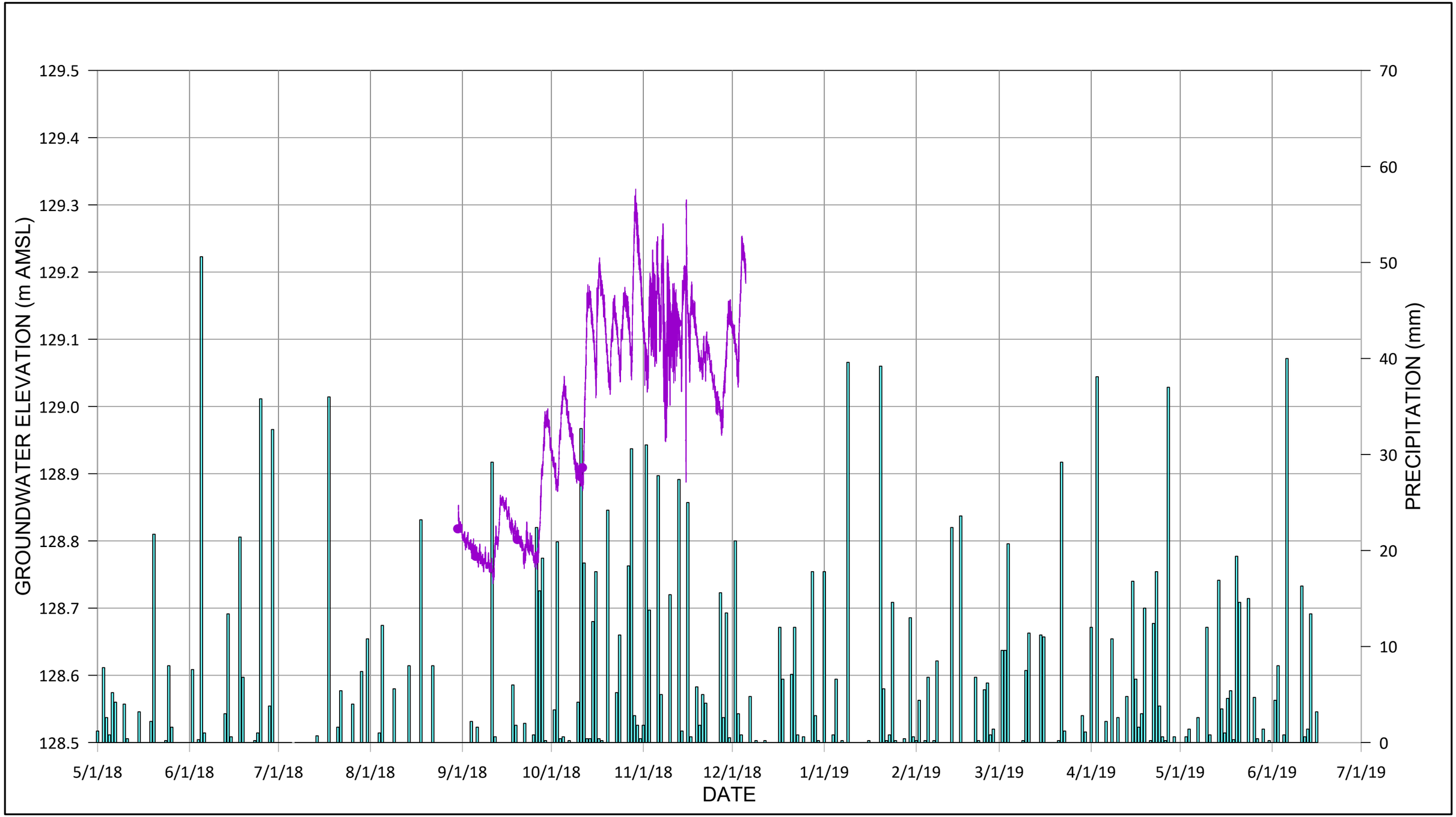
ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-18
MEASURED SURFACE WATER ELEVATIONS

088664-031
Oct 28, 2019

FIGURE B.6

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.6 - SW-18 Hydrograph.grf



Legend

SW-19 PRECIPITATION (mm) MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-19
MEASURED SURFACE WATER ELEVATIONS

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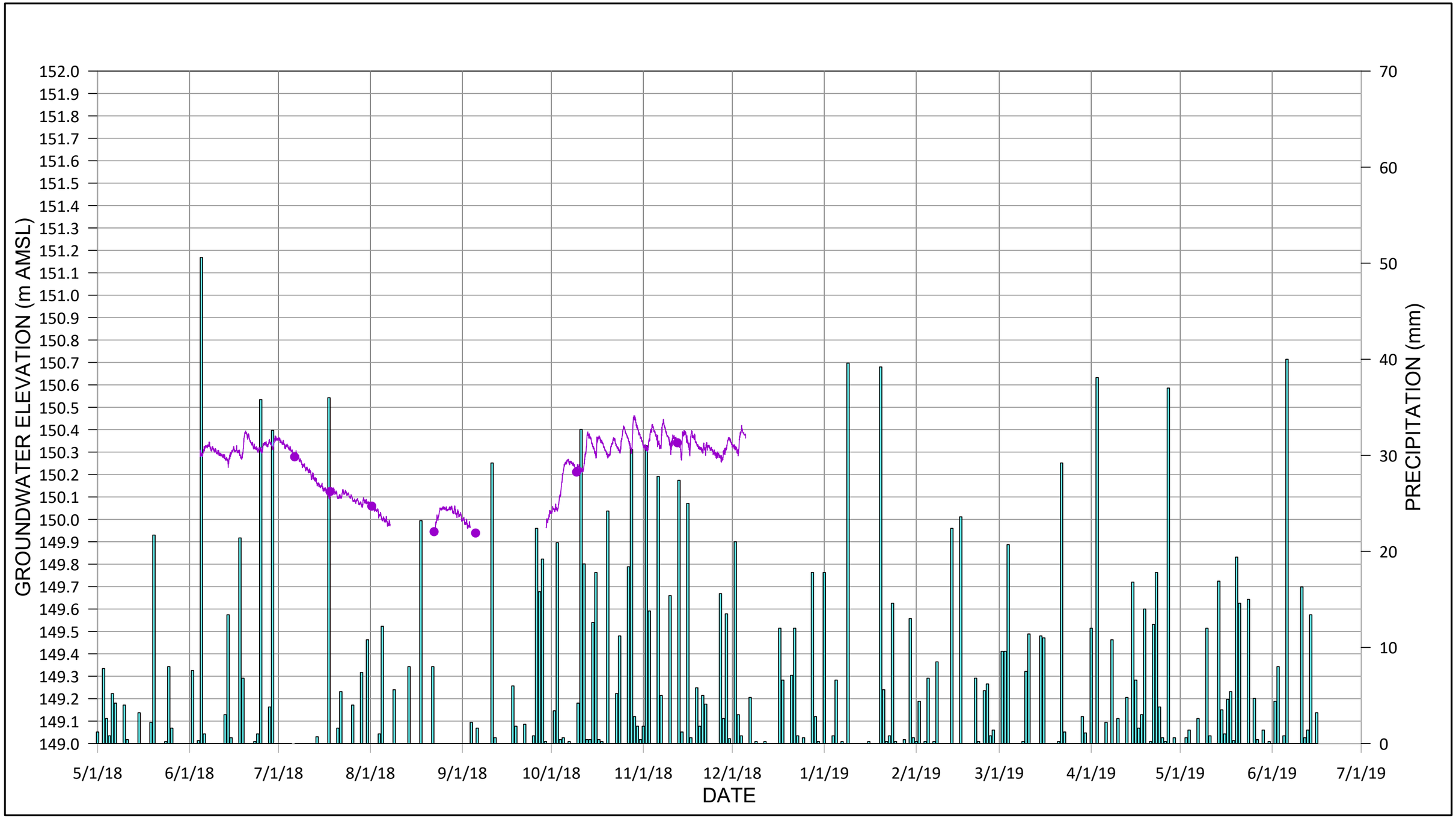
FIGURE B.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.7 - SW-19 Hydrograph.grf



Legend

SW-22 PRECIPITATION (mm) MANUAL MEASUREMENTS

ATLANTIC GOLD CORPORATION
BEAVER DAM MINE PROJECT
MARTINETTE, NOVA SCOTIA

SW-22
MEASURED SURFACE WATER ELEVATIONS

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FIGURE B.8

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Appendix B\Figure B.8 - SW-22 Hydrograph.grf

Appendix C
3D Geologic Model

Appendix C 3D Presentation Package

GHD developed a 3D Visualization presentation package for the Beaver Dam Mine Site located in Marinette, Halifax County, Nova Scotia (Beaver Dam Mine Site). The presentation package includes an interface menu and three 4DIM (4-Dimensional Interactive Model) the Beaver Dam Mine Site geology:

Please follow instructions below to download and view the models.

1. Click on link http://ghd.2big4email.com/en/downloadfiles.aspx?param=SU8kIVg6KdMDviEVVgxbYweQuAleQuAl
2. The 3DV presentation has been zipped together and is named "**074846-00(PRES001)3DV_WA_3DPRESENTATION_2016-12-12.zip**". Copy this zip file to your Hard Drive (C:\).
3. Extract zip file to root of hard drive (folder name should look like C:**074846-00(PRES001)3DV_WA_3DPRESENTATION_2016-12-12**). Maintain folder structure, the presentation will not work if it is altered (no folders or subfolders can have spaces in the names).
4. Double click on interface menu file "3DVISUALIZATION.EXE". This will automatically load up an interface menu window on your screen; from this interface menu you can access the desired 4DIM model by double clicking on the model title and the 4DIM will automatically launch in a separate window. Basic controls for the 4D interactive model player are provided below. Following this, an image is provided of the interface menu that should appear after launching the file "3DVISUALIZATION.EXE".

Basic 4D Interactive Model Player Controls

Select your desired 4DIM animation (*.4d) by doubled clicking on the file. This will automatically open up the associated 4DIM file in a separate window called the 4DIM Player.

To ZOOM IN or OUT, hold down SHIFT and the left mouse button while moving the mouse forwards or backwards.

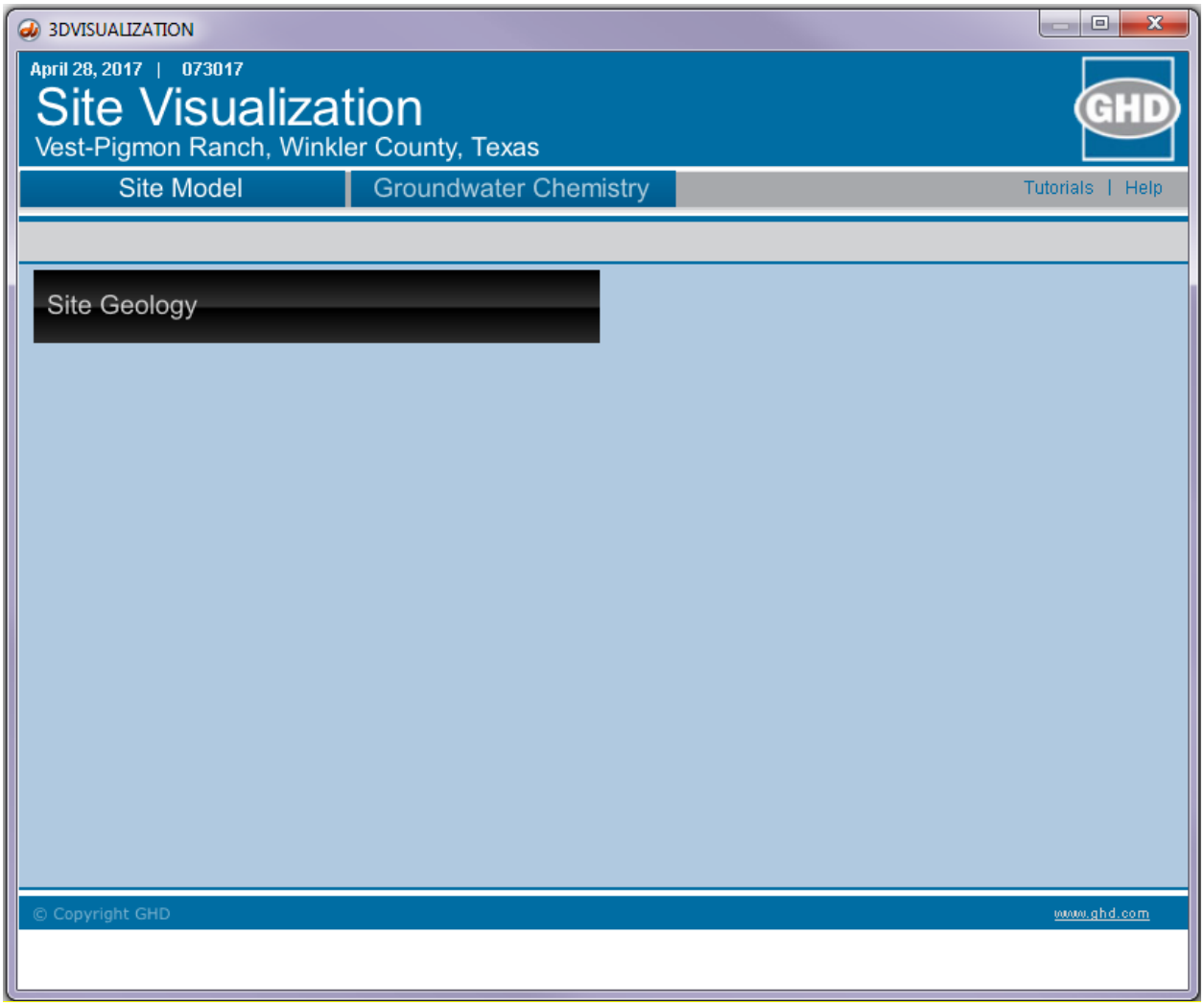
To PAN, hold down the right mouse button while moving the mouse.

To ROTATE the model, hold down the left mouse key while moving the mouse.

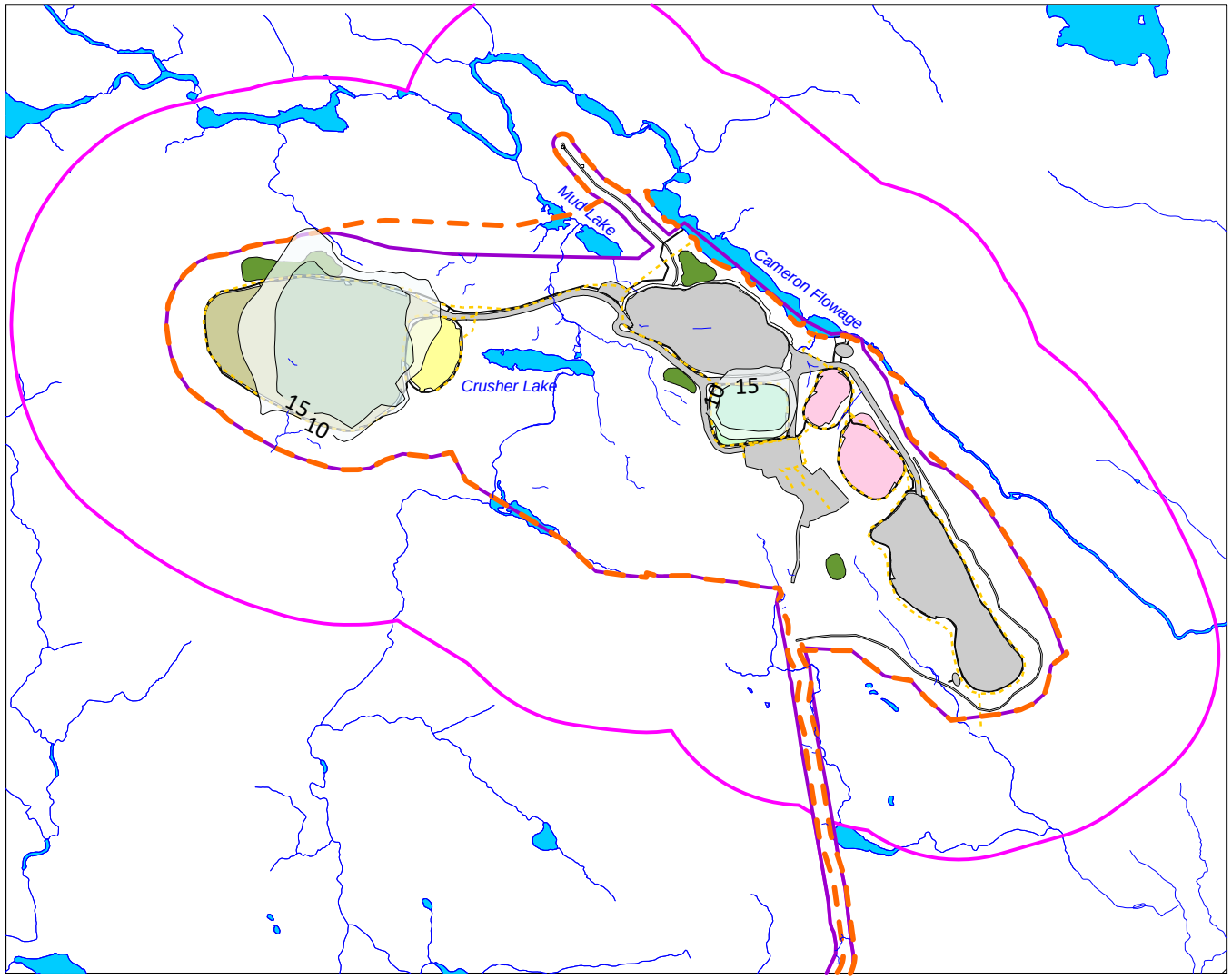
Additional player information may be accessed through the Help menu.

To CHANGE FRAMES, click on the or buttons located on the Current Frame slider bar (below) to move through the frames in the animation.

Interface Menu



Appendix D
Simulated COC Concentrations in Groundwater Versus Potable Criteria – Dry Conditions



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

N

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SIMULATED ARSENIC CONCENTRATION VERSUS POTABLE CRITERIA
EOM - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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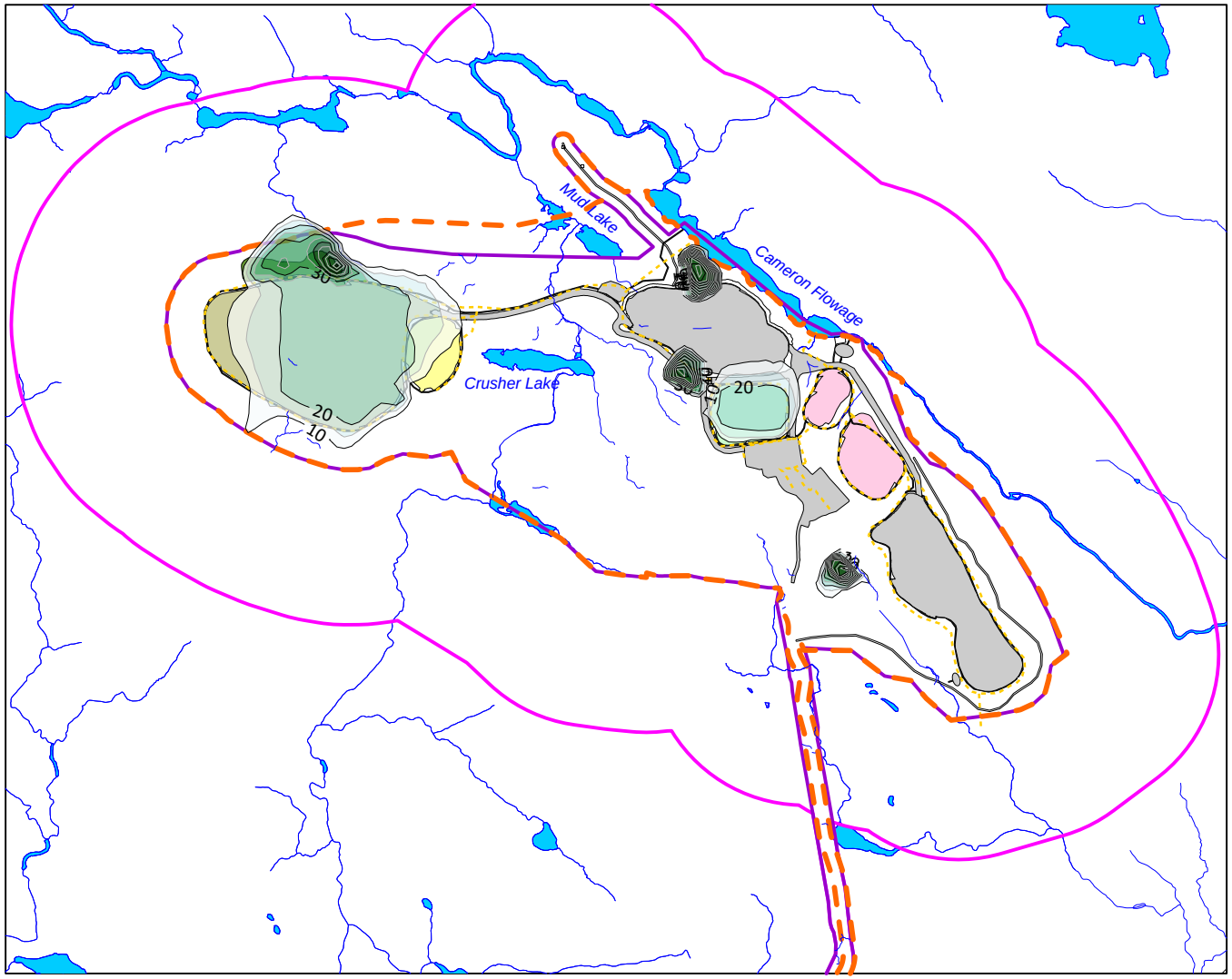
FIGURE D.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.1 - Simulated Arsenic Concentration Versus Potable Criteria - EOM- BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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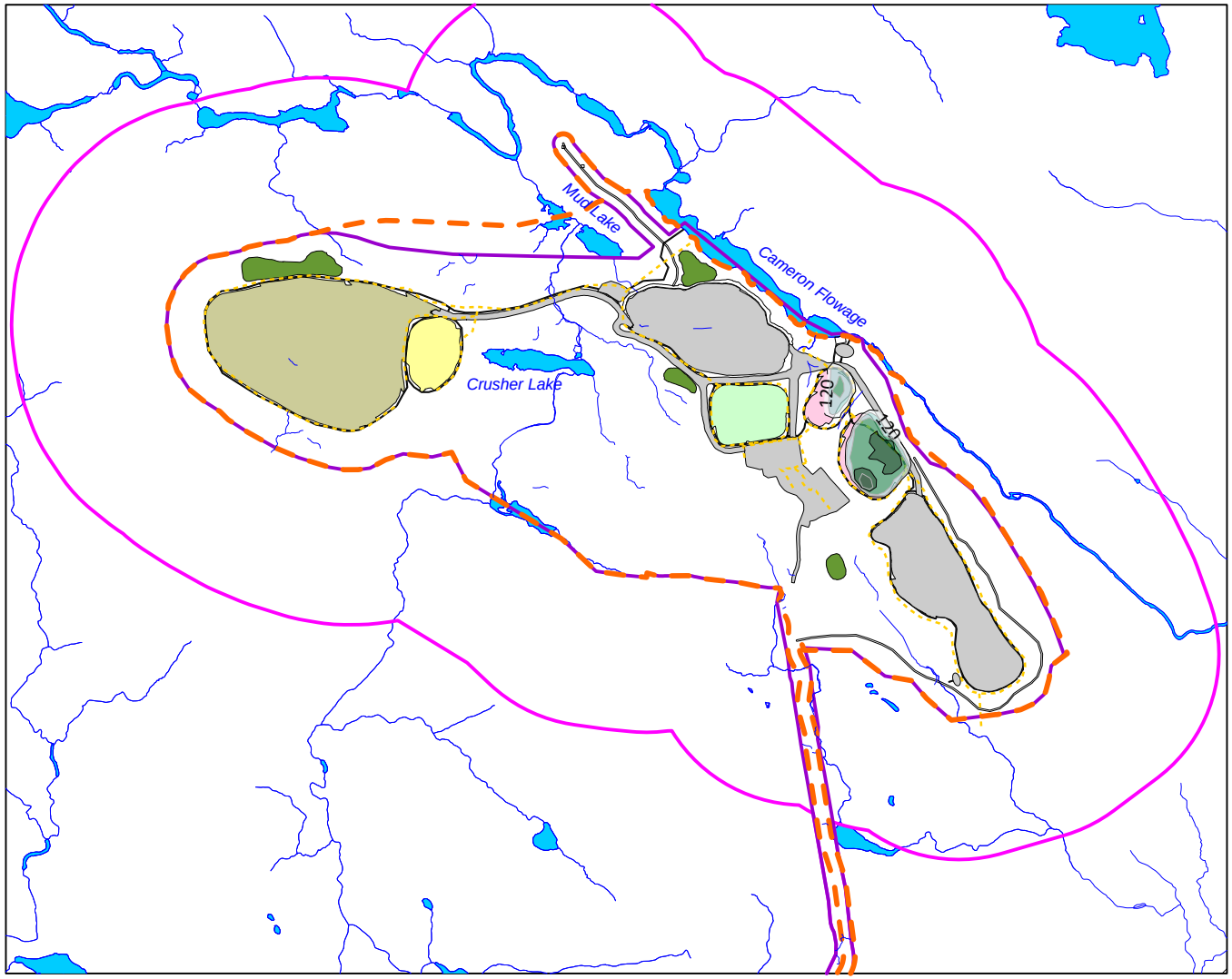
FIGURE D.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.2 - Simulated Arsenic Concentration Versus Potable Criteria - EOM - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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EOM - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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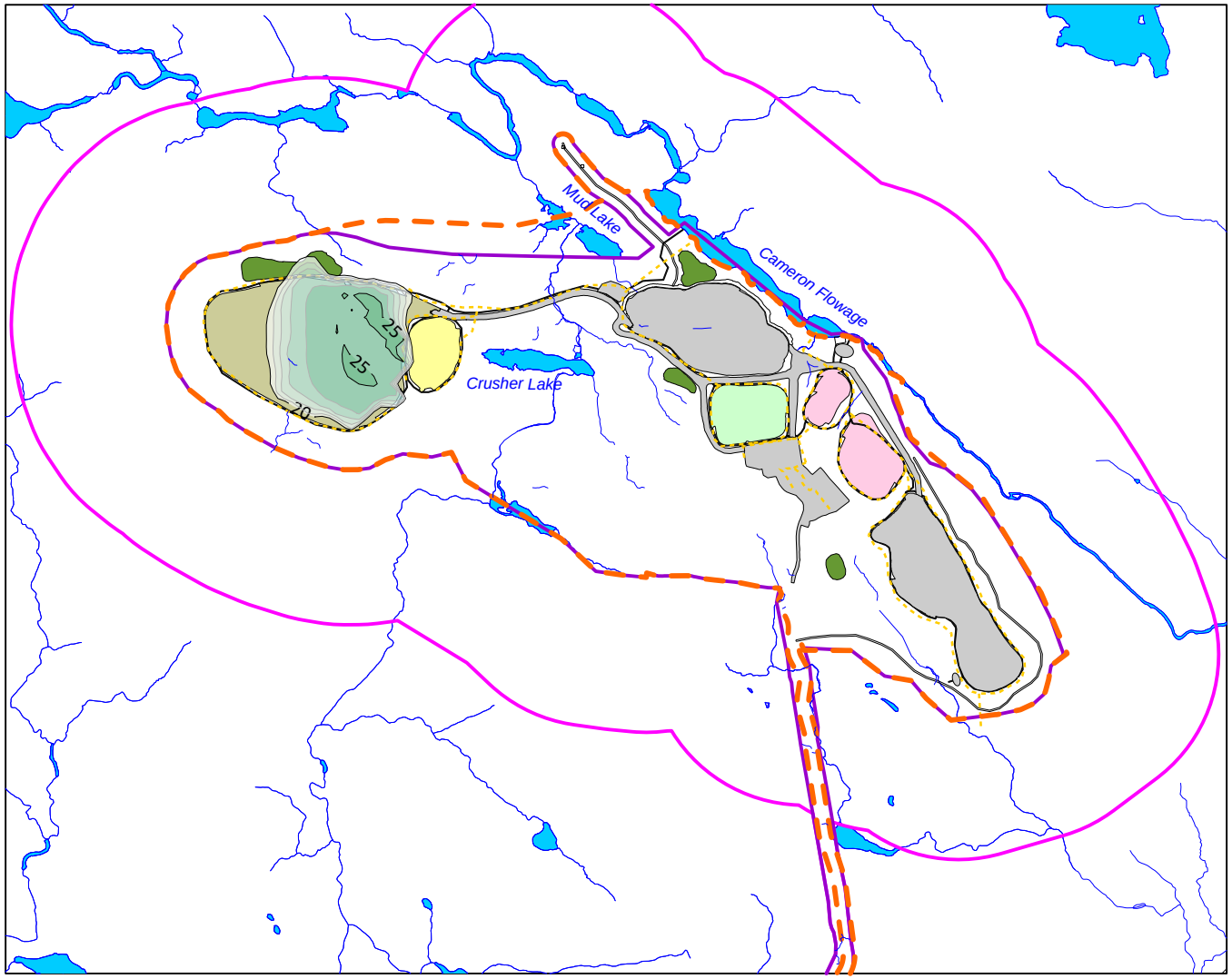
FIGURE D.3

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.3 - Simulated Manganese Concentration Versus Potable Criteria - EOM - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

N

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EOM - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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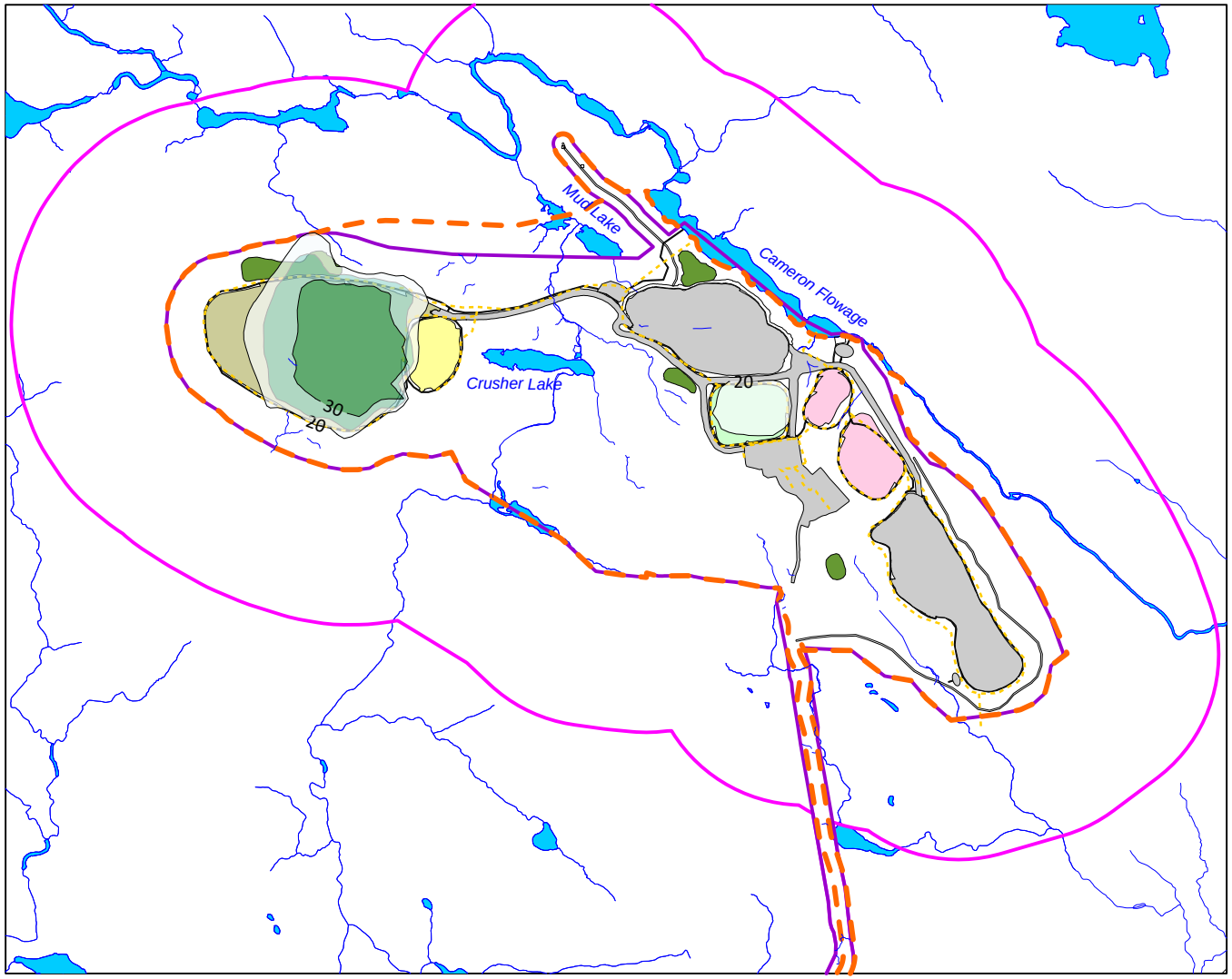
FIGURE D.4

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.4 - Simulated Uranium Concentration Versus Potable Criteria - EOM - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

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EOM - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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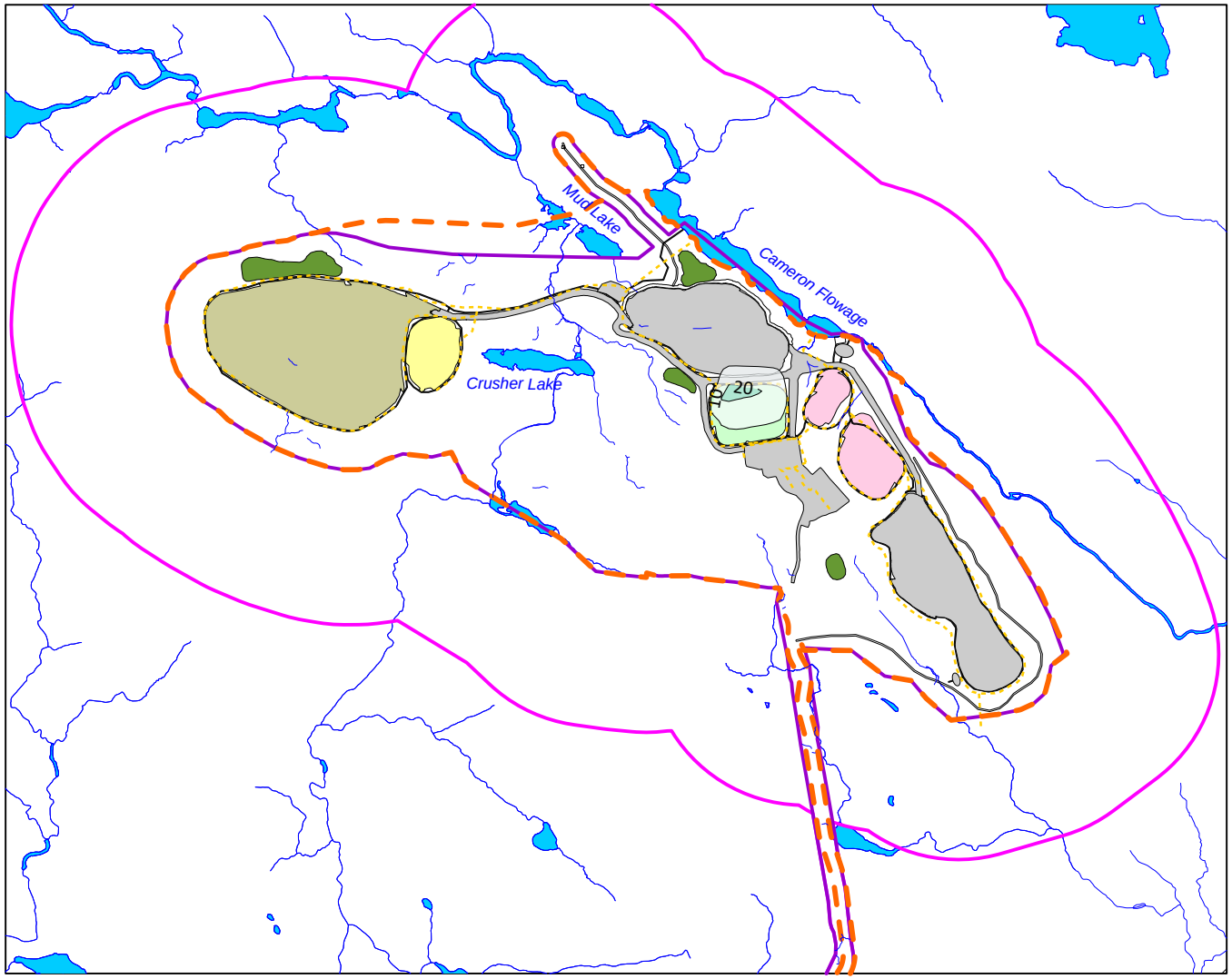
FIGURE D.5

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.5 - Simulated Uranium Concentration Versus Potable Criteria - EOM - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

N

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PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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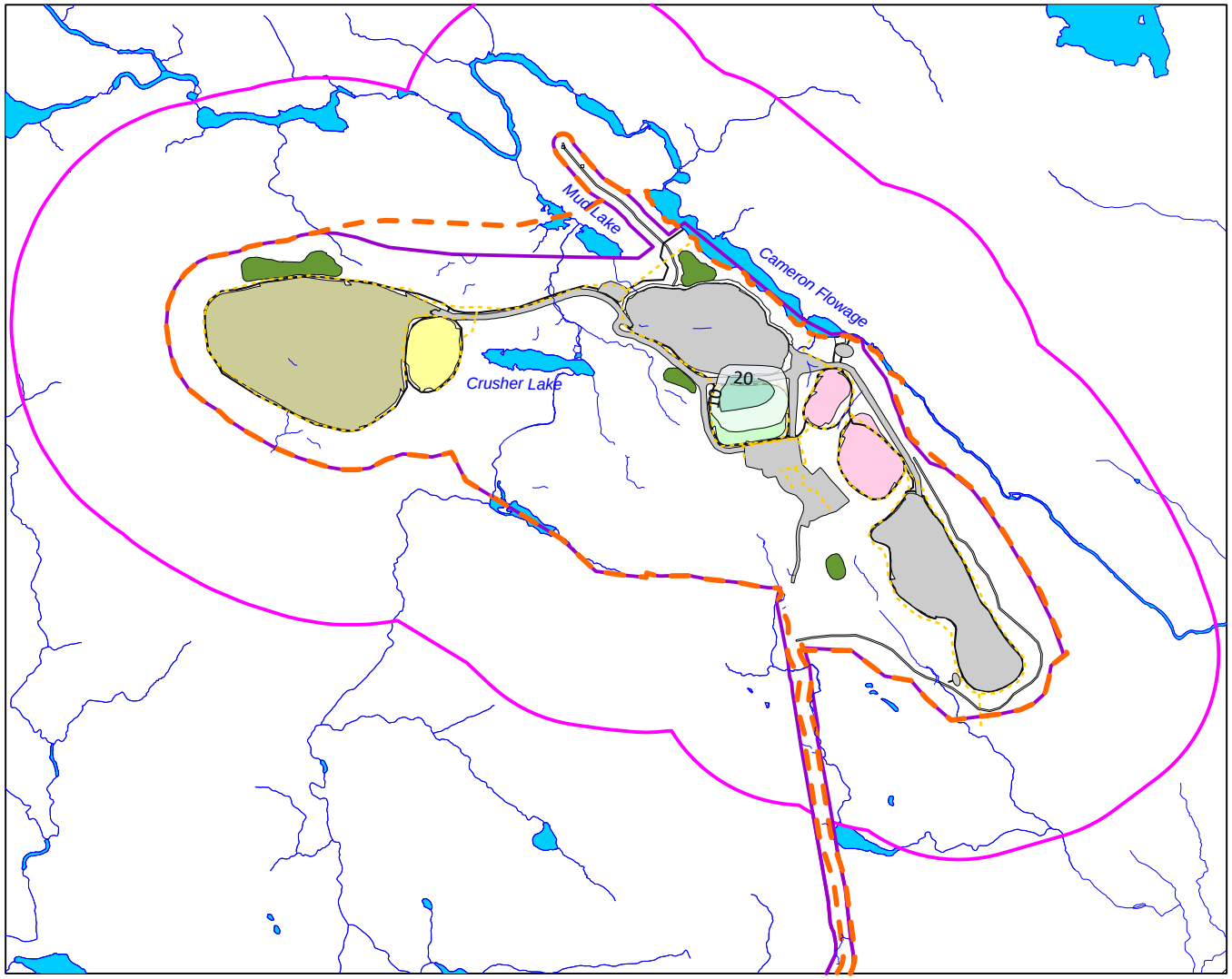
FIGURE D.6

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.6 - Simulated Arsenic Concentration Versus Potable Criteria - PC - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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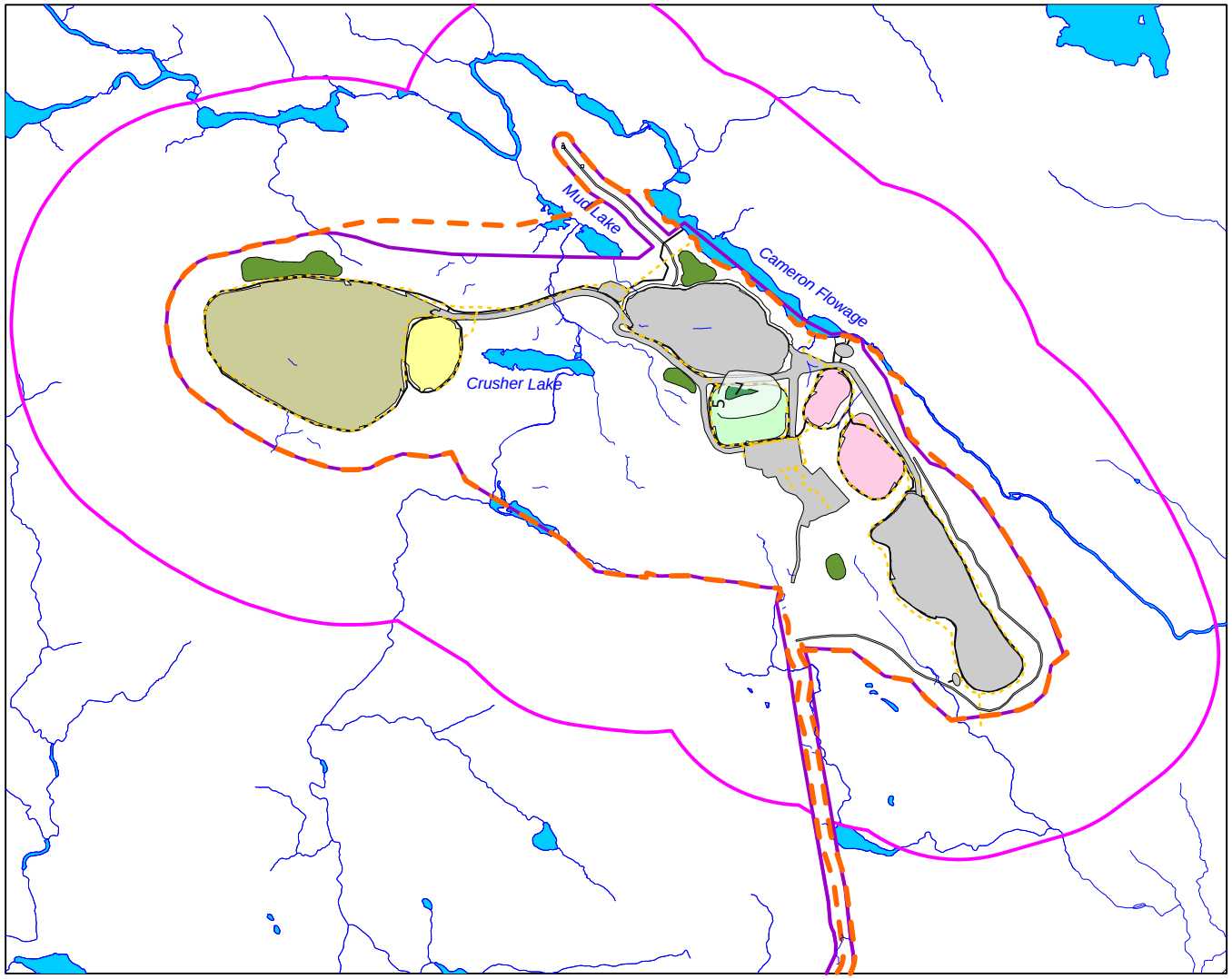
FIGURE D.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\D.7 - Simulated Arsenic Concentration Versus Potable Criteria - PC - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 1 EQS for potable groundwater is 5 ug/L.

0 300 600 900m

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PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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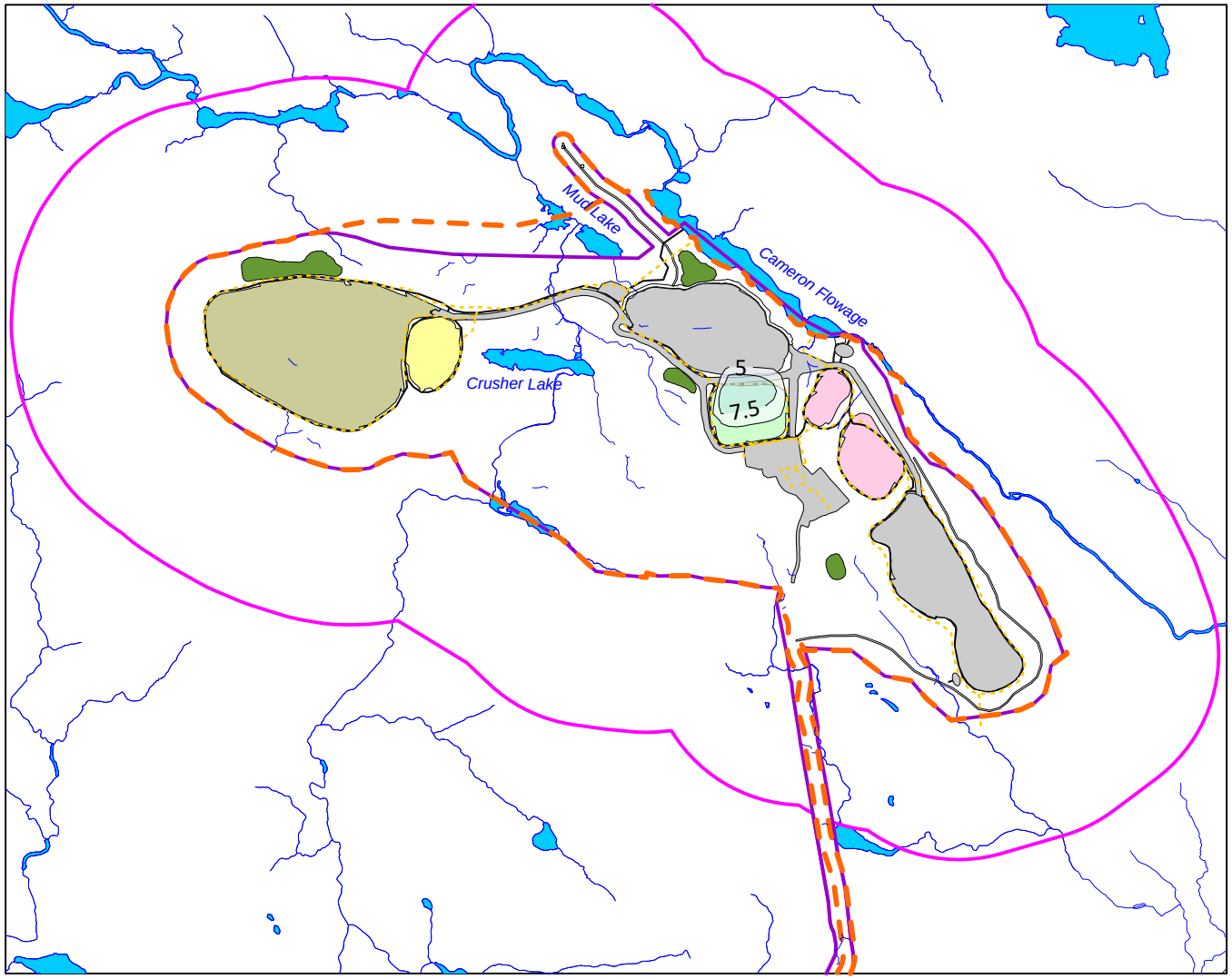
FIGURE D.8

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.8 - Simulated Cadmium Concentration Versus Potable Criteria - PC - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 1 EQS for potable groundwater is 5 ug/L.

0 300 600 900m

N

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SIMULATED CADMIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER SOURCE TERMS - DRY CASE CONDITION

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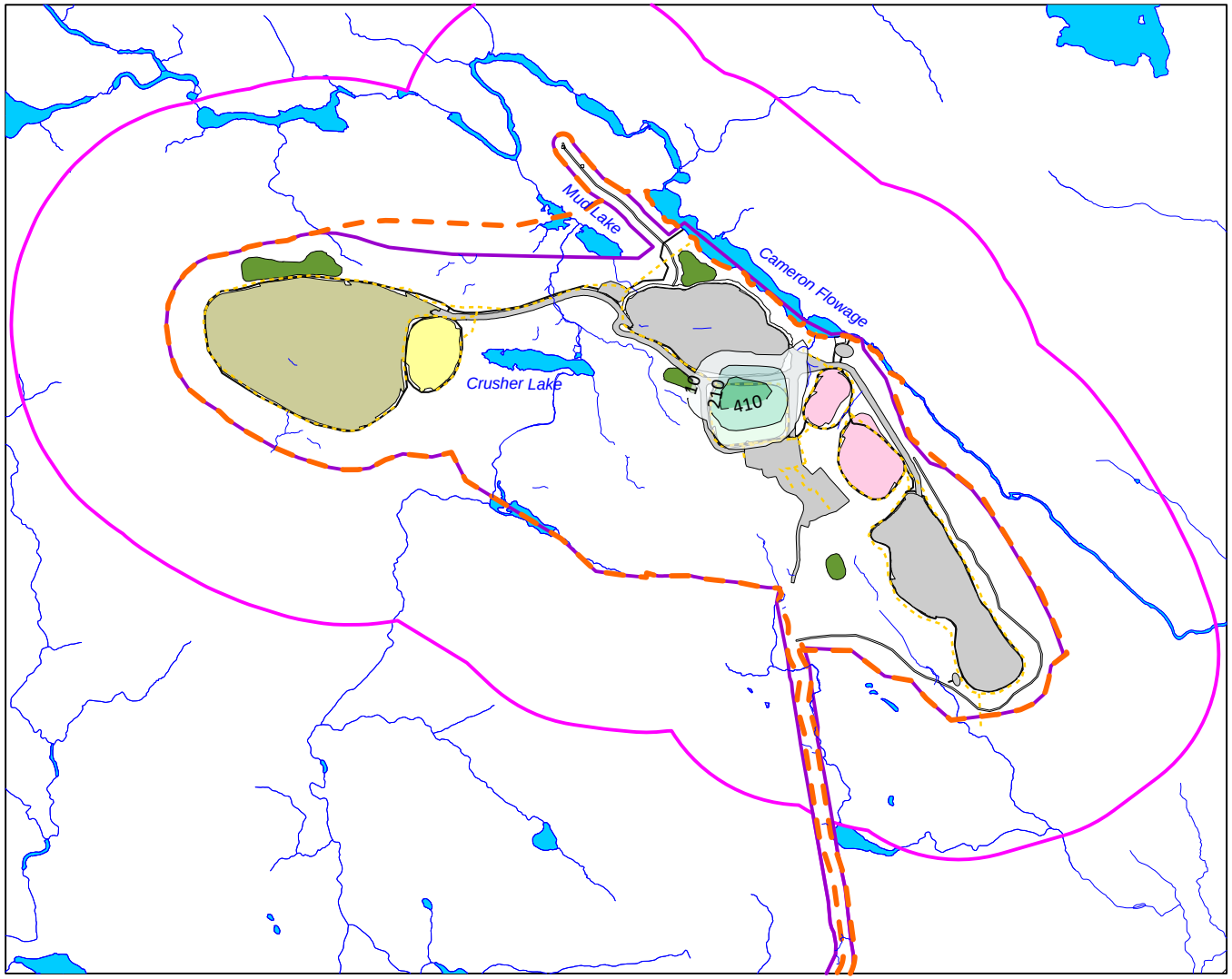
FIGURE D.9

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.9 - Simulated Cadmium Concentration Versus Potable Criteria - PC - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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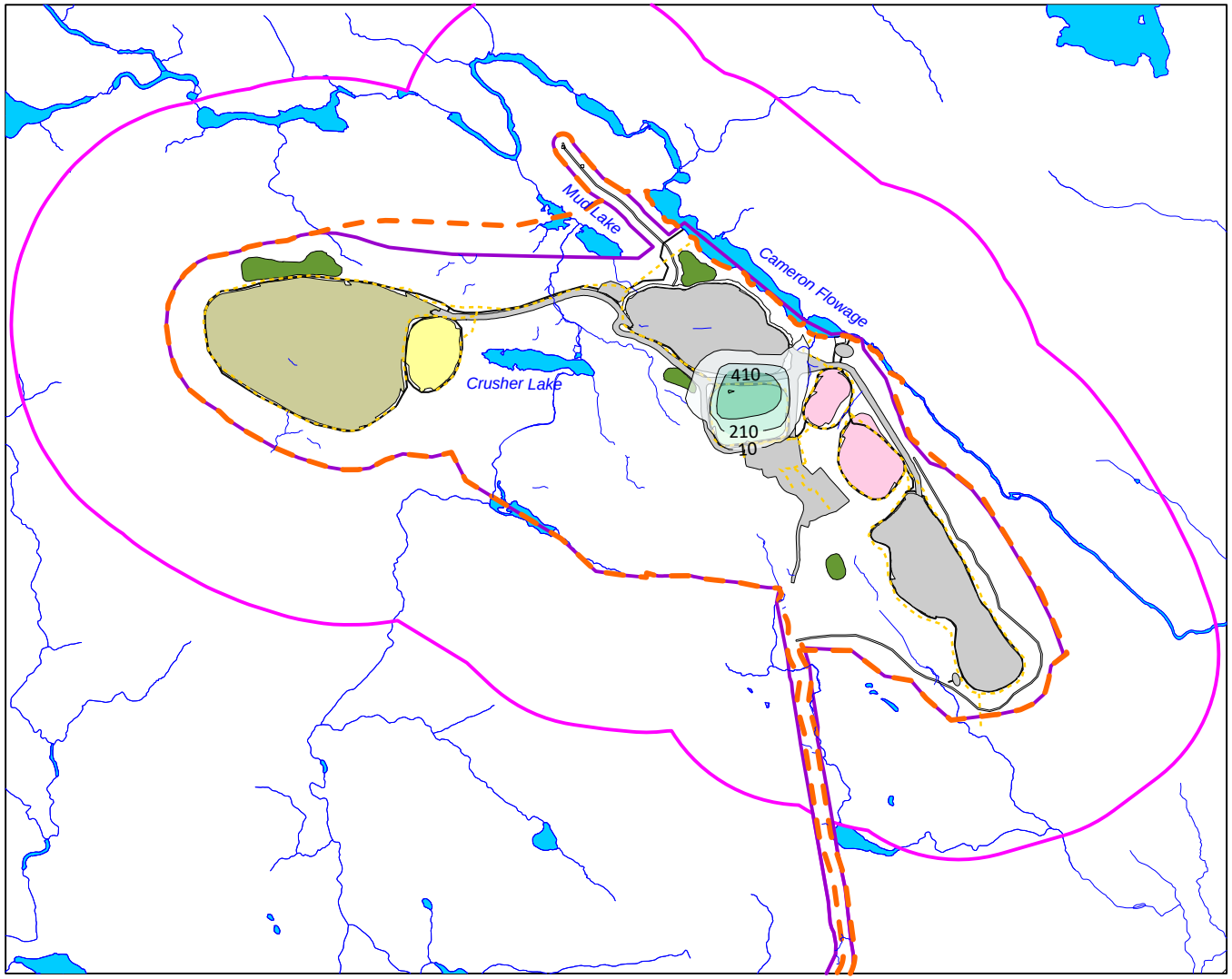
FIGURE D.10

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.10 - Simulated Cobalt Concentration Versus Potable Criteria - PC - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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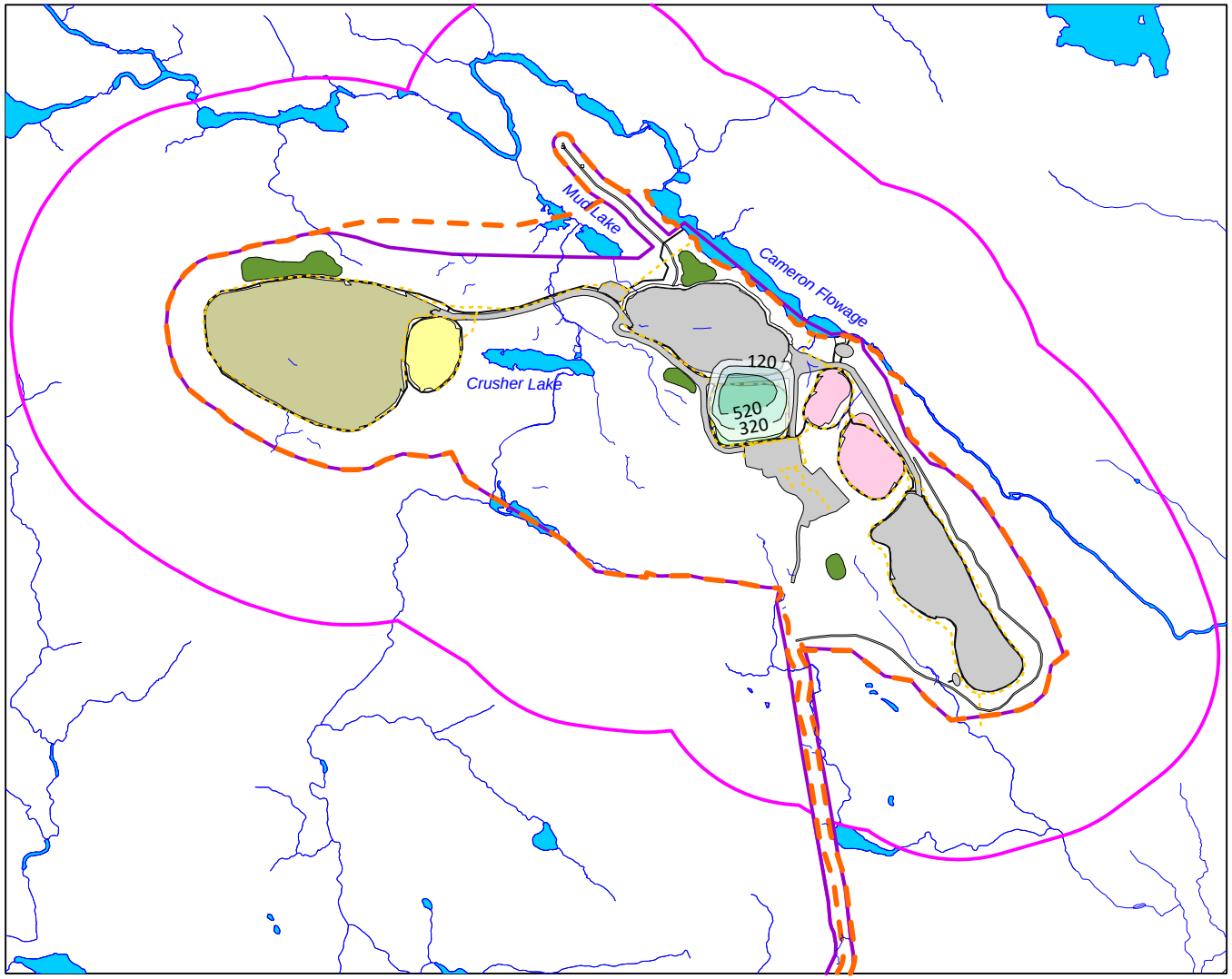
FIGURE D.11

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.11 - Simulated Cobalt Concentration Versus Potable Criteria - PC - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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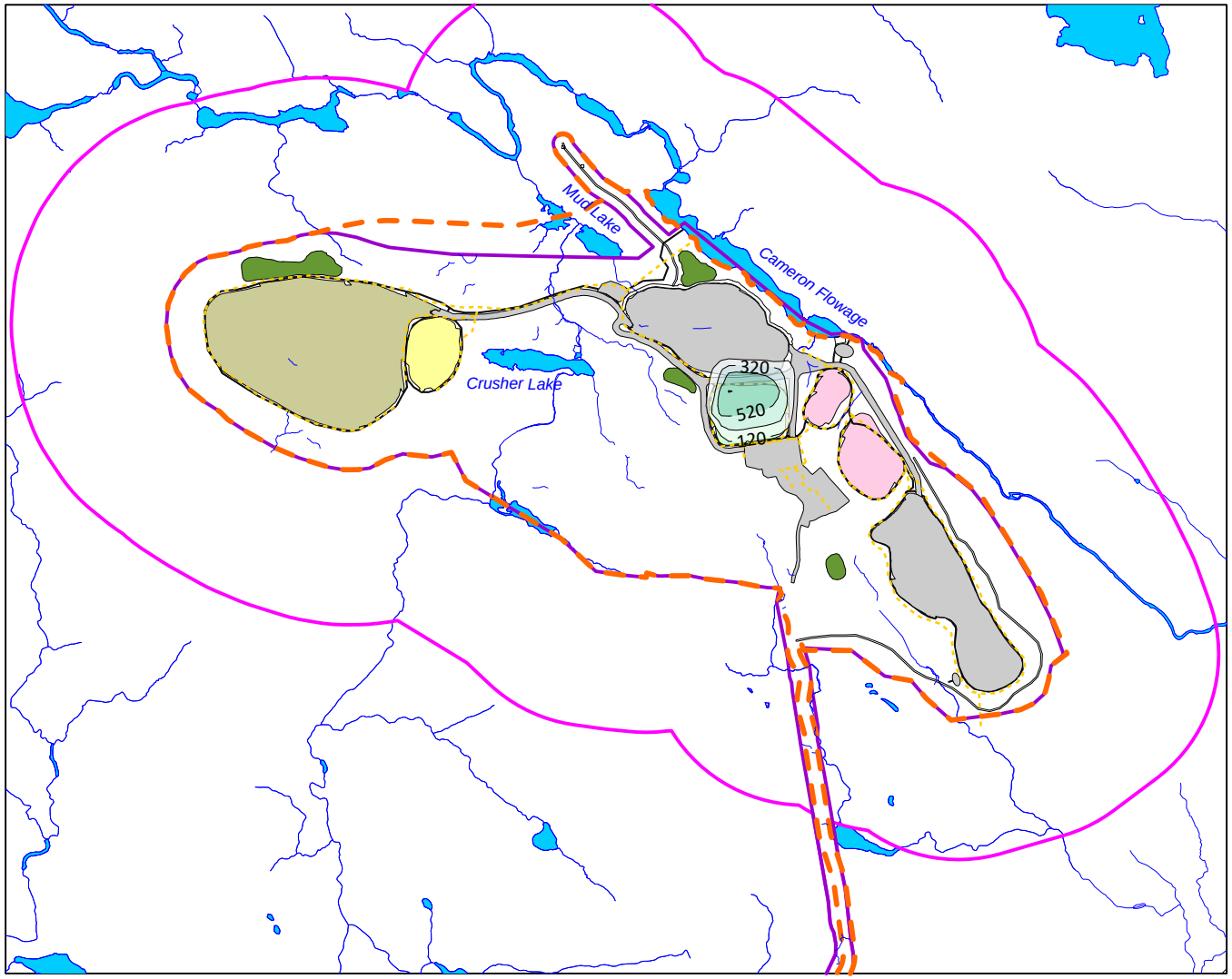
FIGURE D.12

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.12 - Simulated Manganese Concentration Versus Potable Criteria - PC - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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SIMULATED MANGANESE CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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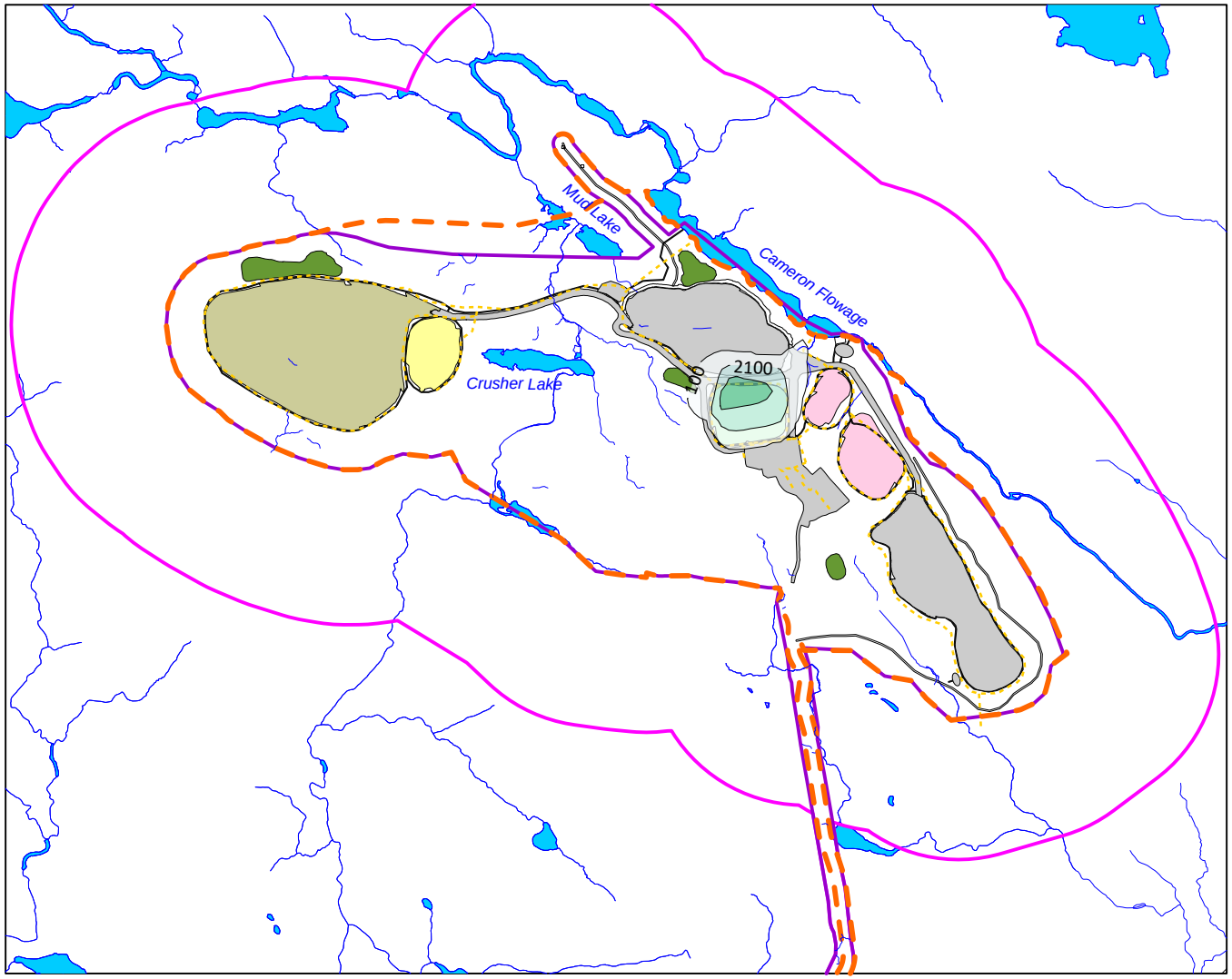
FIGURE D.13

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.13 - Simulated Manganese Concentration Versus Potable Criteria - PC - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 1 EQS for potable groundwater is 100 ug/L.

0 300 600 900m

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SIMULATED NICKEL CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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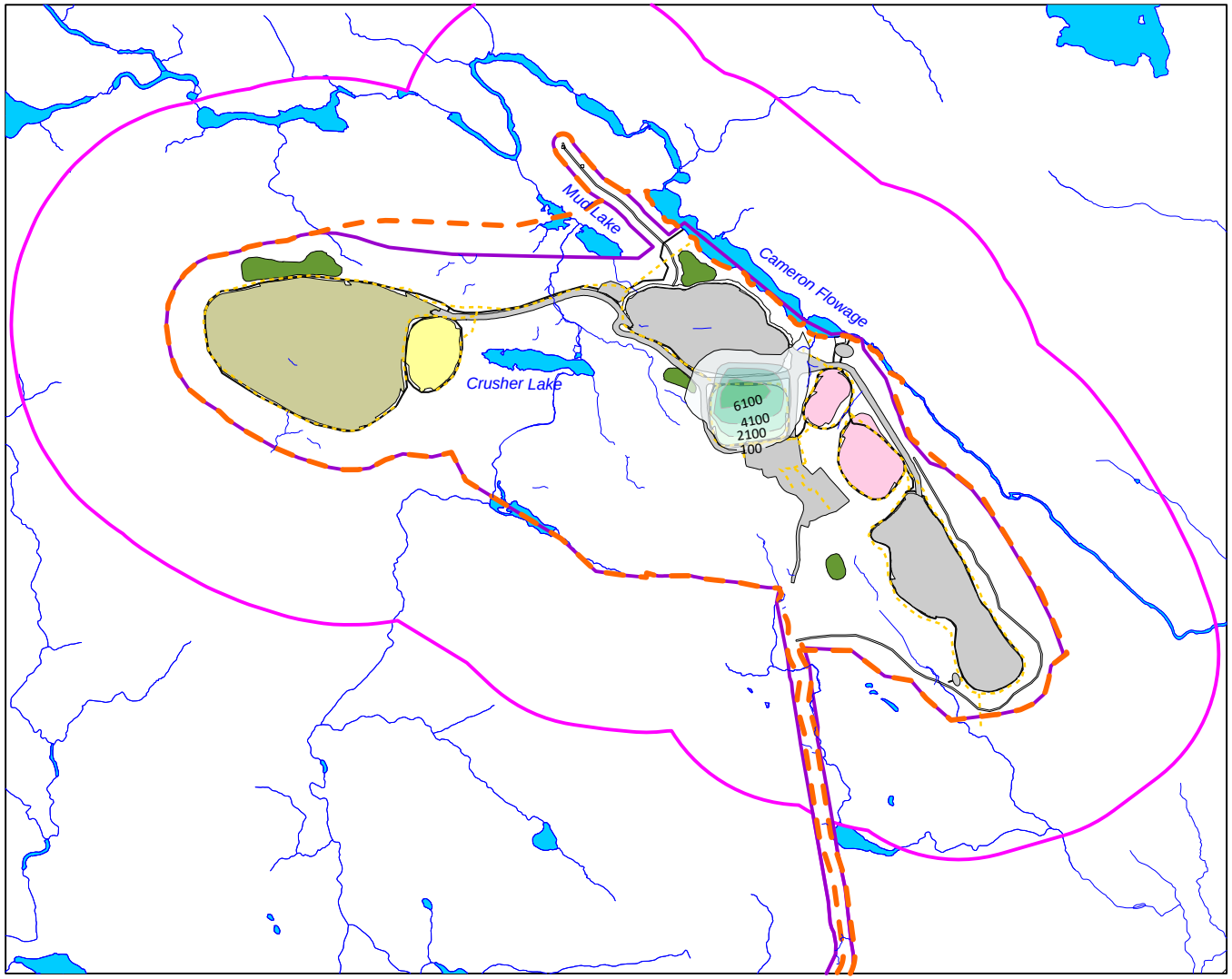
FIGURE D.14

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.14 - Simulated Nickel Concentration Versus Potable Criteria - PC - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 1 EQS for potable groundwater is 100 ug/L.

0 300 600 900m

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SIMULATED NICKEL CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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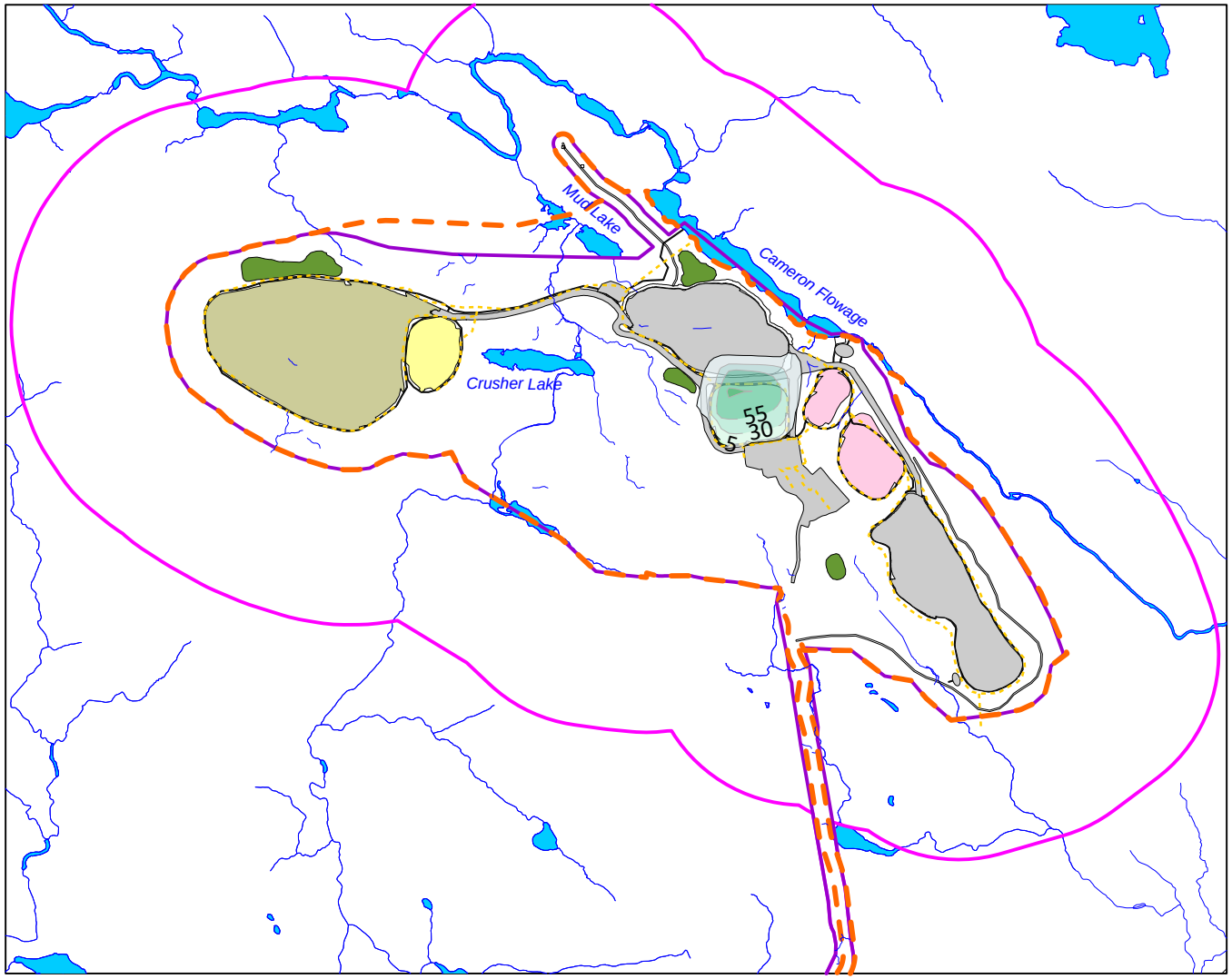
FIGURE D.15

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.15 - Simulated Nickel Concentration Versus Potable Criteria - PC - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead GCDWQ is 5 ug/L.

0 300 600 900m

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SIMULATED LEAD CONCENTRATION VERSUS POTABLE CRITERIA
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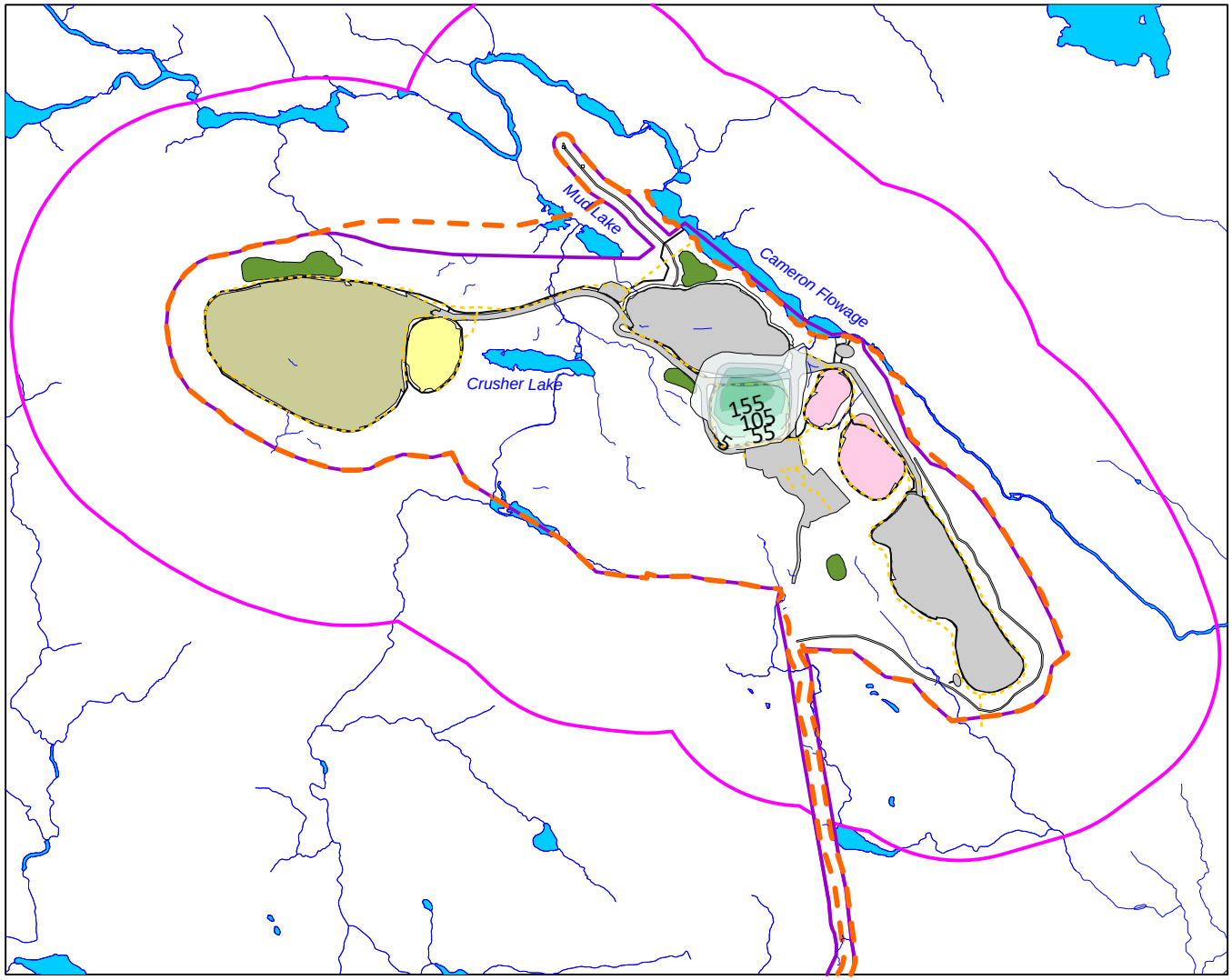
FIGURE D.16

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.16 - Simulated Lead Concentration Versus Potable Criteria - PC - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead GCDWQ is 5 ug/L.

0 300 600 900m

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SIMULATED LEAD CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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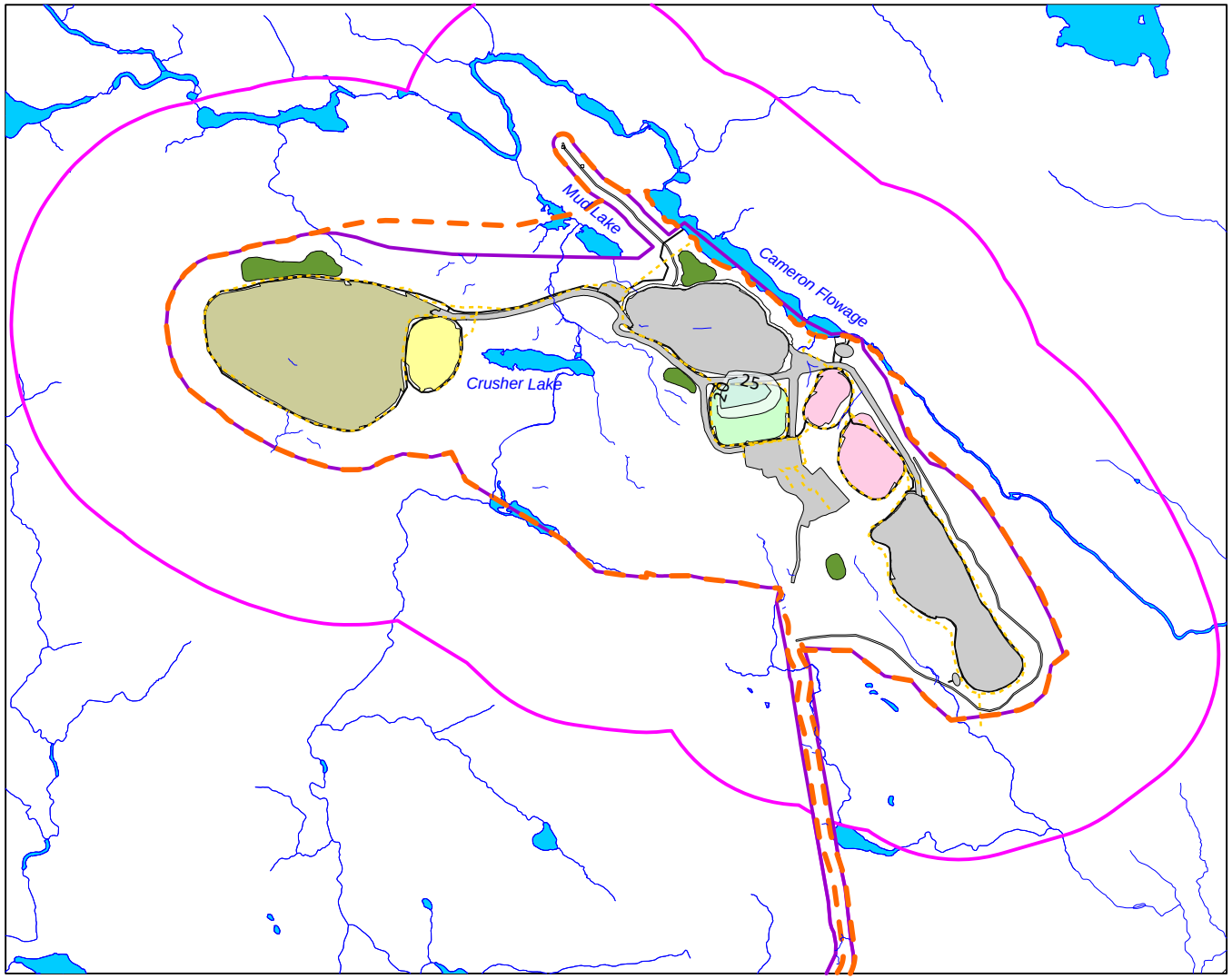
FIGURE D.17

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.17 - Simulated Lead Concentration Versus Potable Criteria - PC - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

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SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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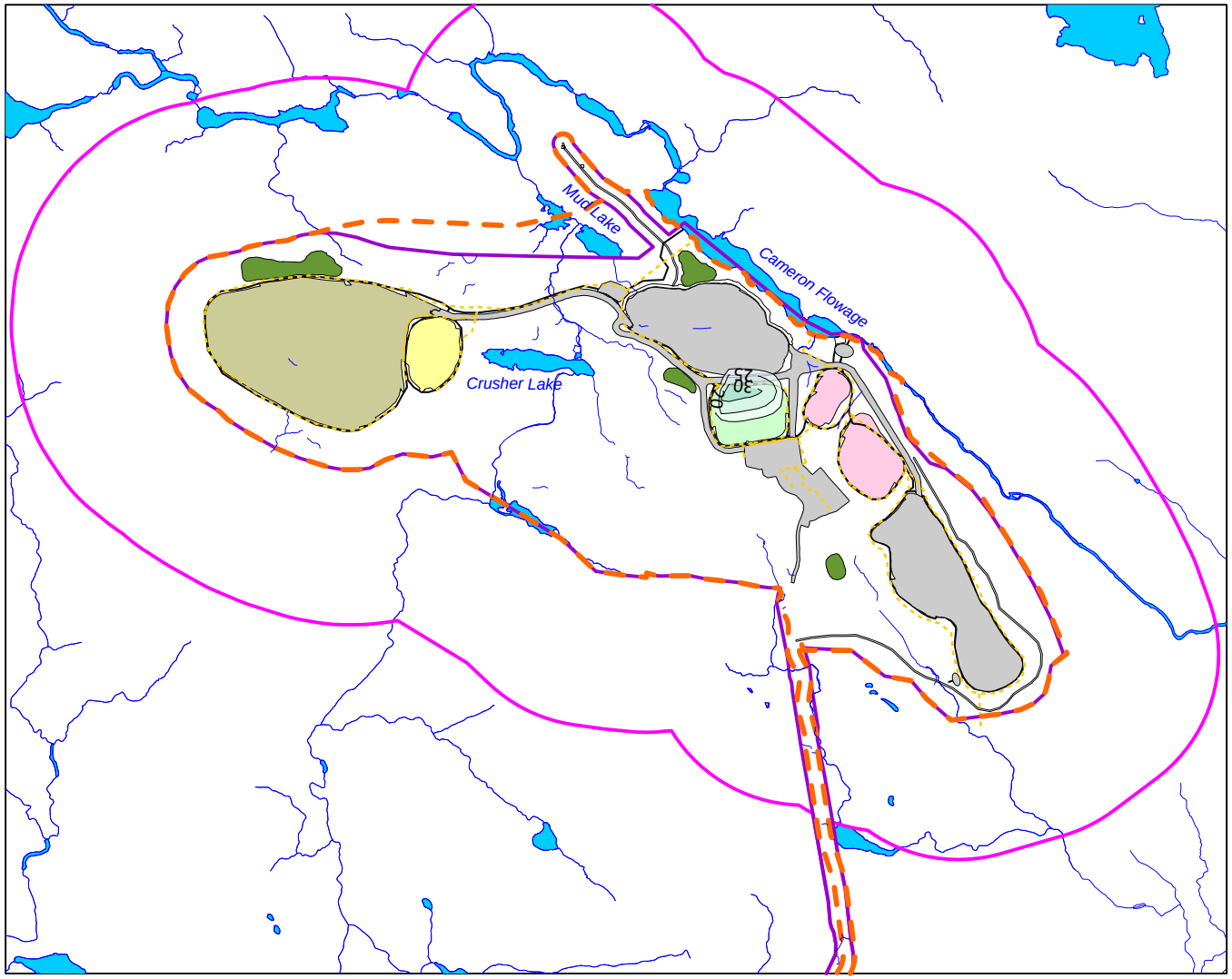
FIGURE D.18

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.19 - Simulated Uranium Concentration Versus Potable Criteria - PC - BC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

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SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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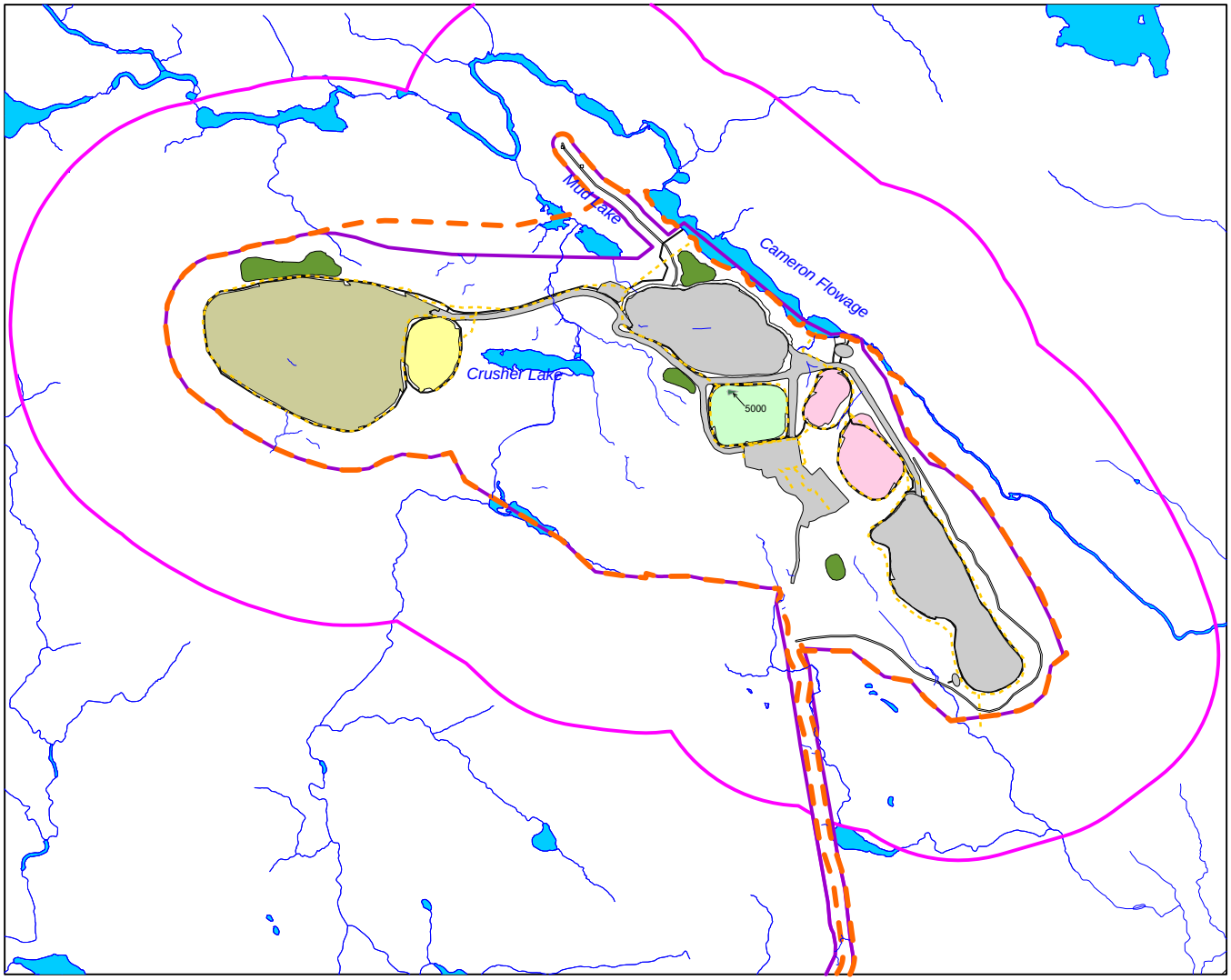
FIGURE D.19

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.20 - Simulated Uranium Concentration Versus Potable Criteria - PC - UC - DRY.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 1 EQS for potable groundwater is 5000 ug/L.

0 300 600 900m

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SIMULATED ZINC CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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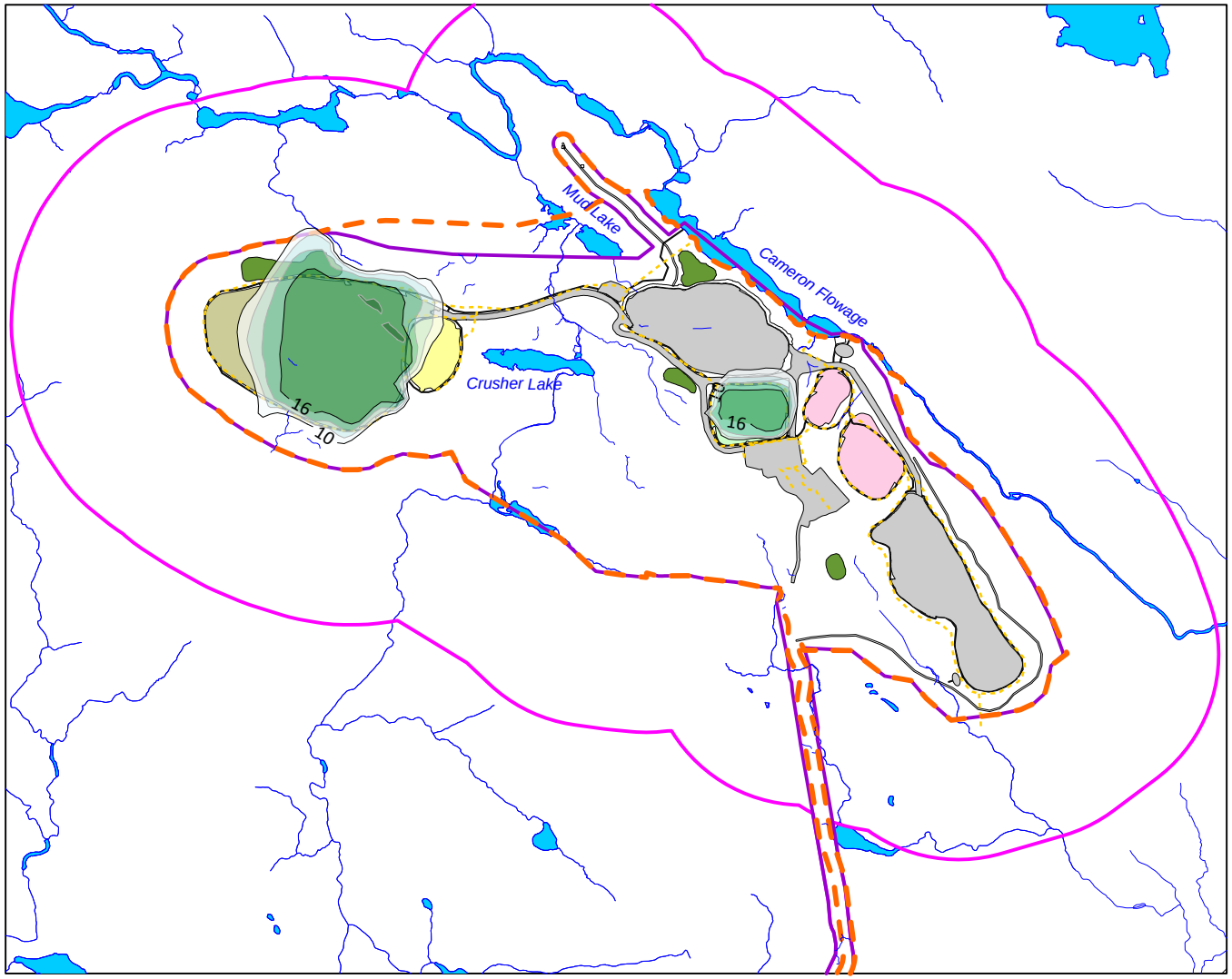
FIGURE D.20

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\D.22 - Simulated Zinc Concentration Versus Potable Criteria - PC - UC - DRY.srf

Appendix E
Simulated COC Concentrations in Groundwater Versus Potable Criteria – Wet Conditions



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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EOM - BASE CASE SOURCE TERMS - WET CASE CONDITION

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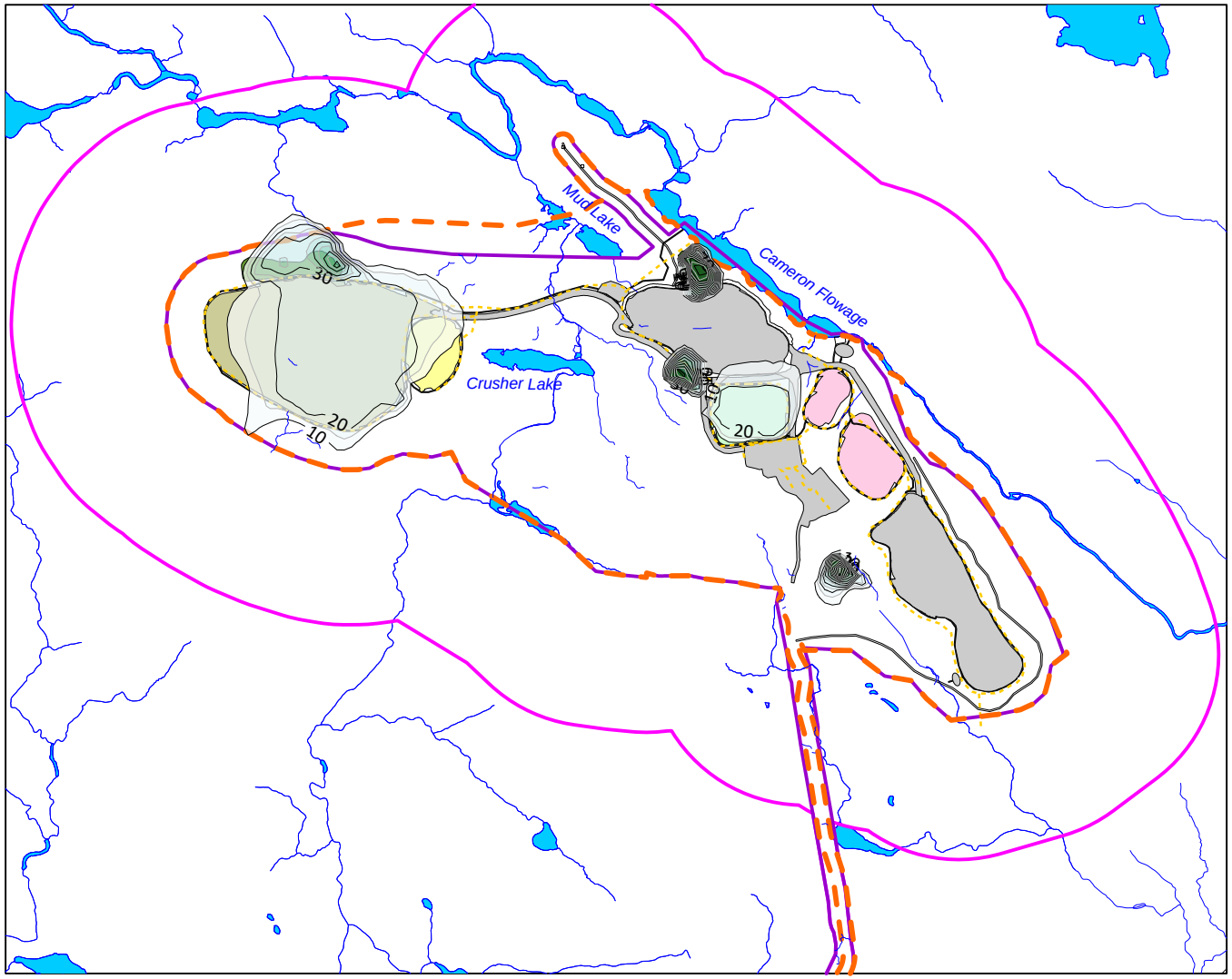
FIGURE E.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.1 - Simulated Arsenic Concentration Versus Potable Criteria - EOM- BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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EOM - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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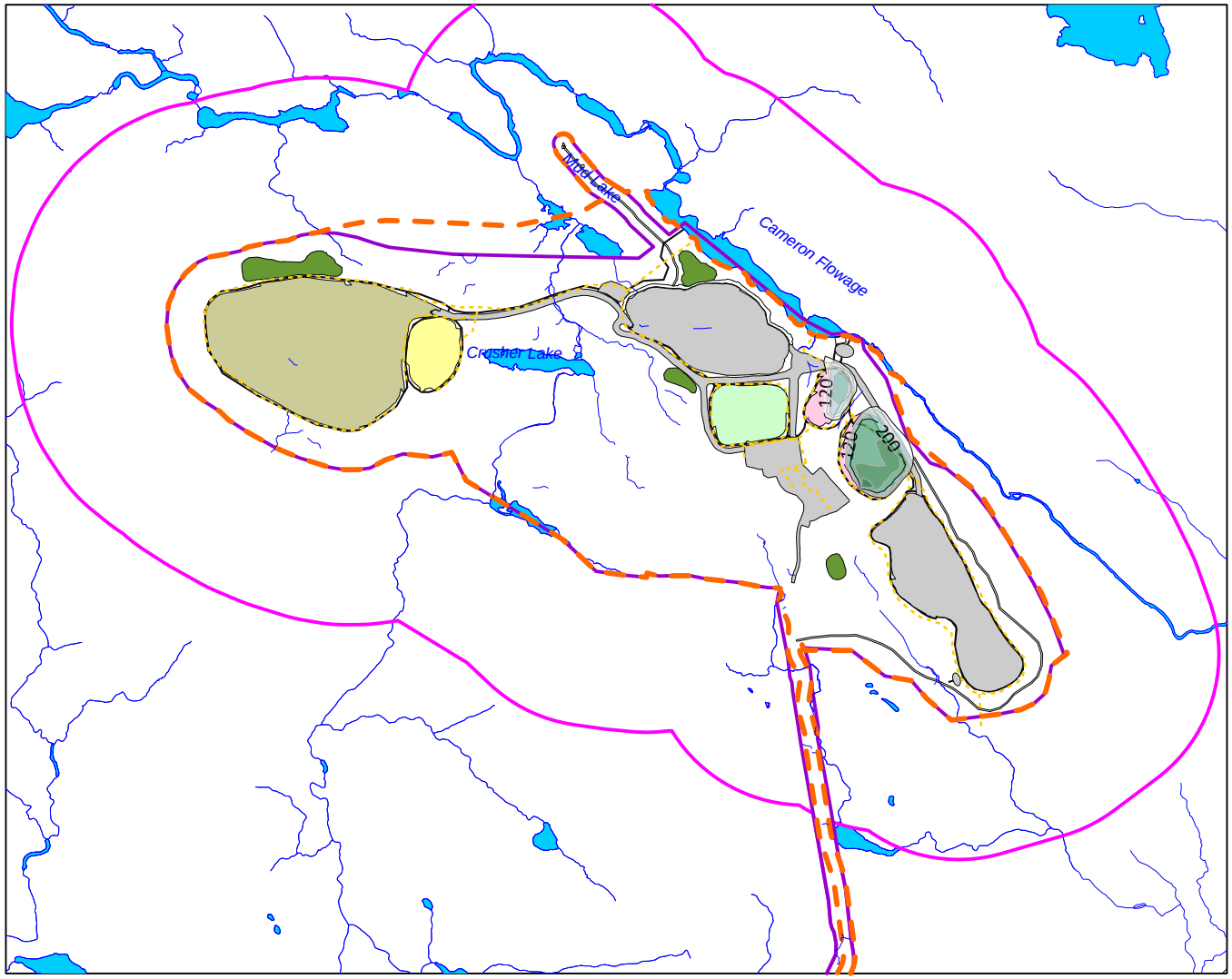
FIGURE E.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.2 - Simulated Arsenic Concentration Versus Potable Criteria - EOM - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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SIMULATED MANGANESE CONCENTRATION VERSUS POTABLE CRITERIA
EOM - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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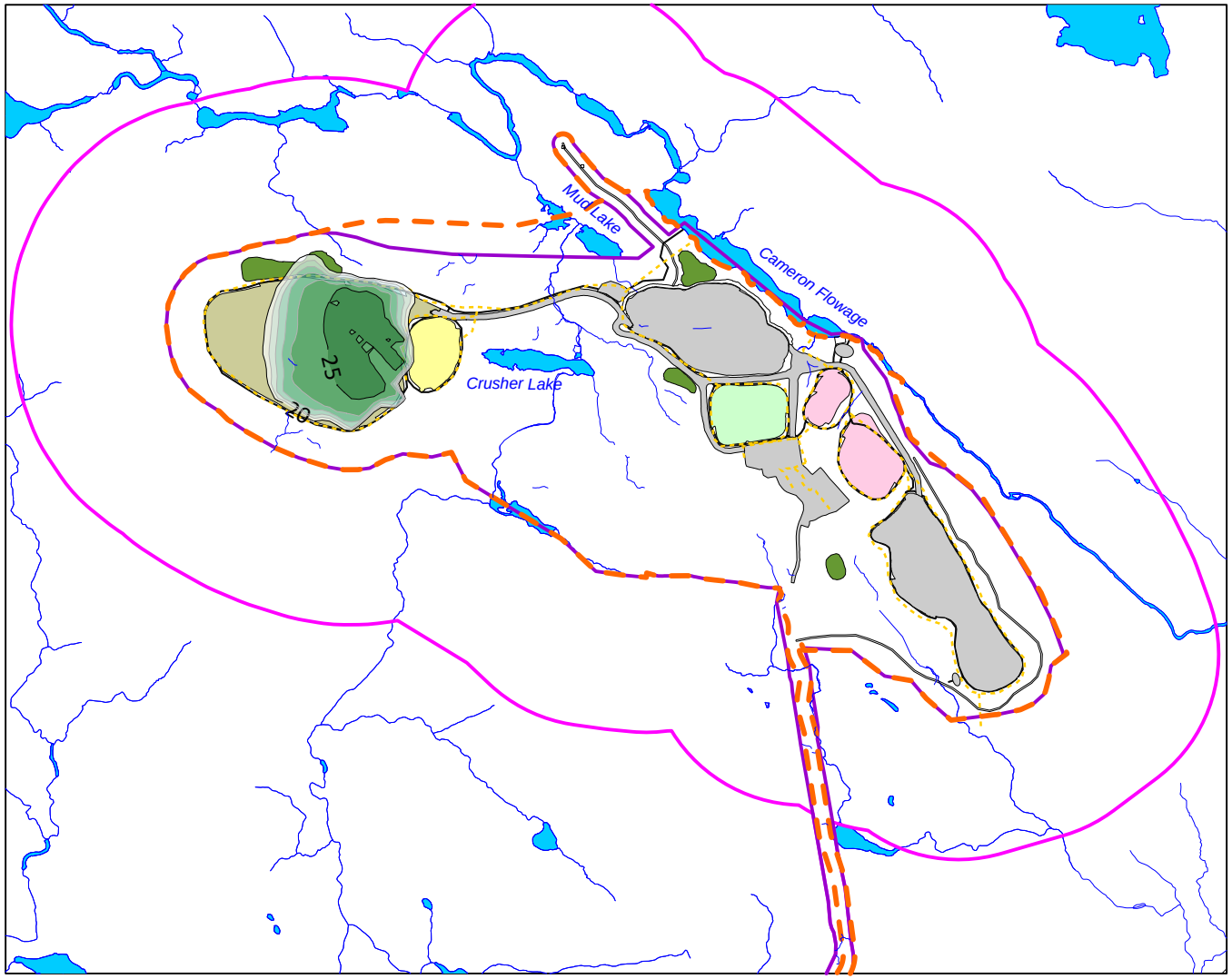
FIGURE E.3

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.3 - Simulated Manganese Concentration Versus Potable Criteria - EOM - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

N

GHD

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EOM - BASE CASE SOURCE TERMS - WET CASE CONDITION

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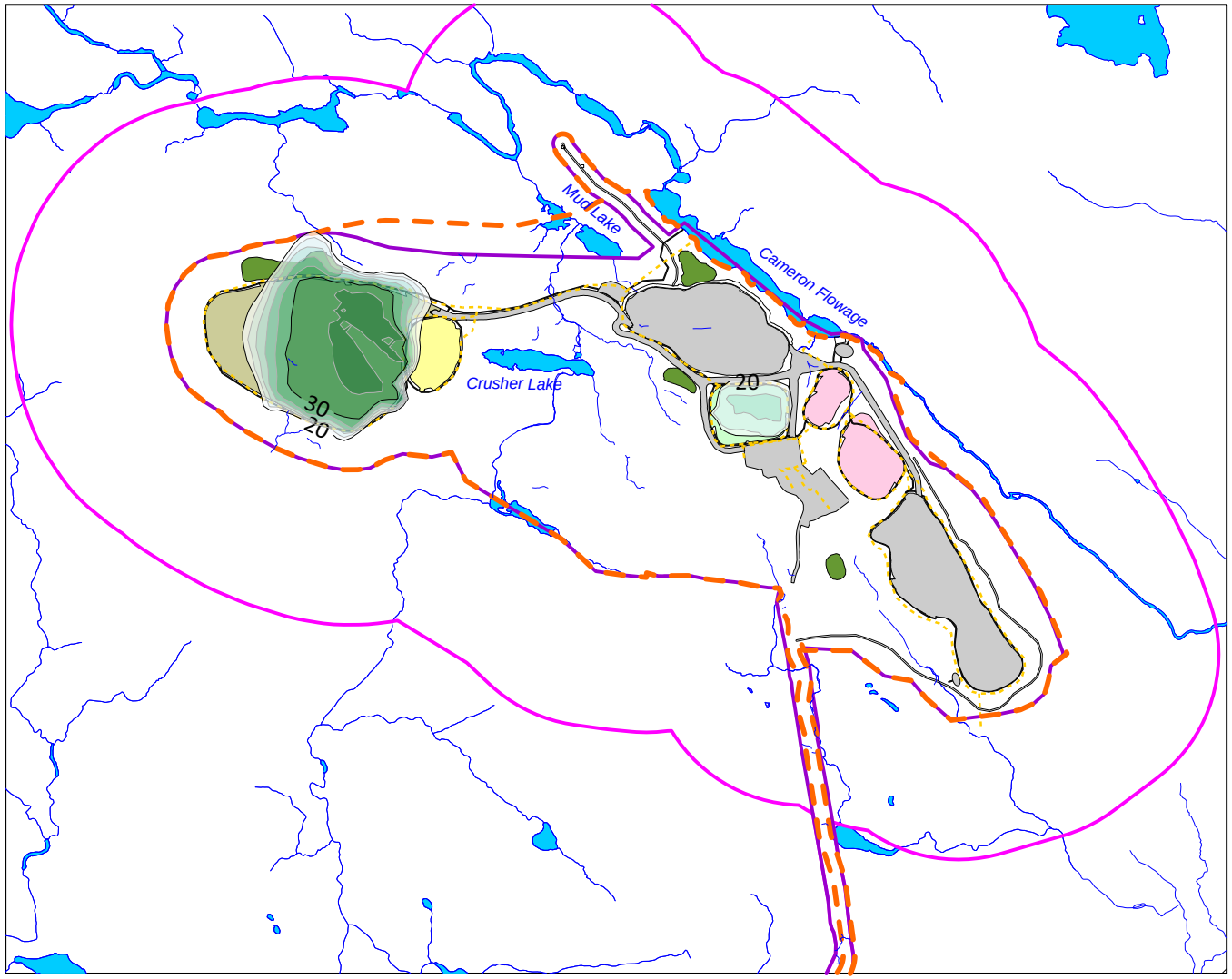
FIGURE E.4

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.4 - Simulated Uranium Concentration Versus Potable Criteria - EOM - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

N

GHD

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SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
EOM - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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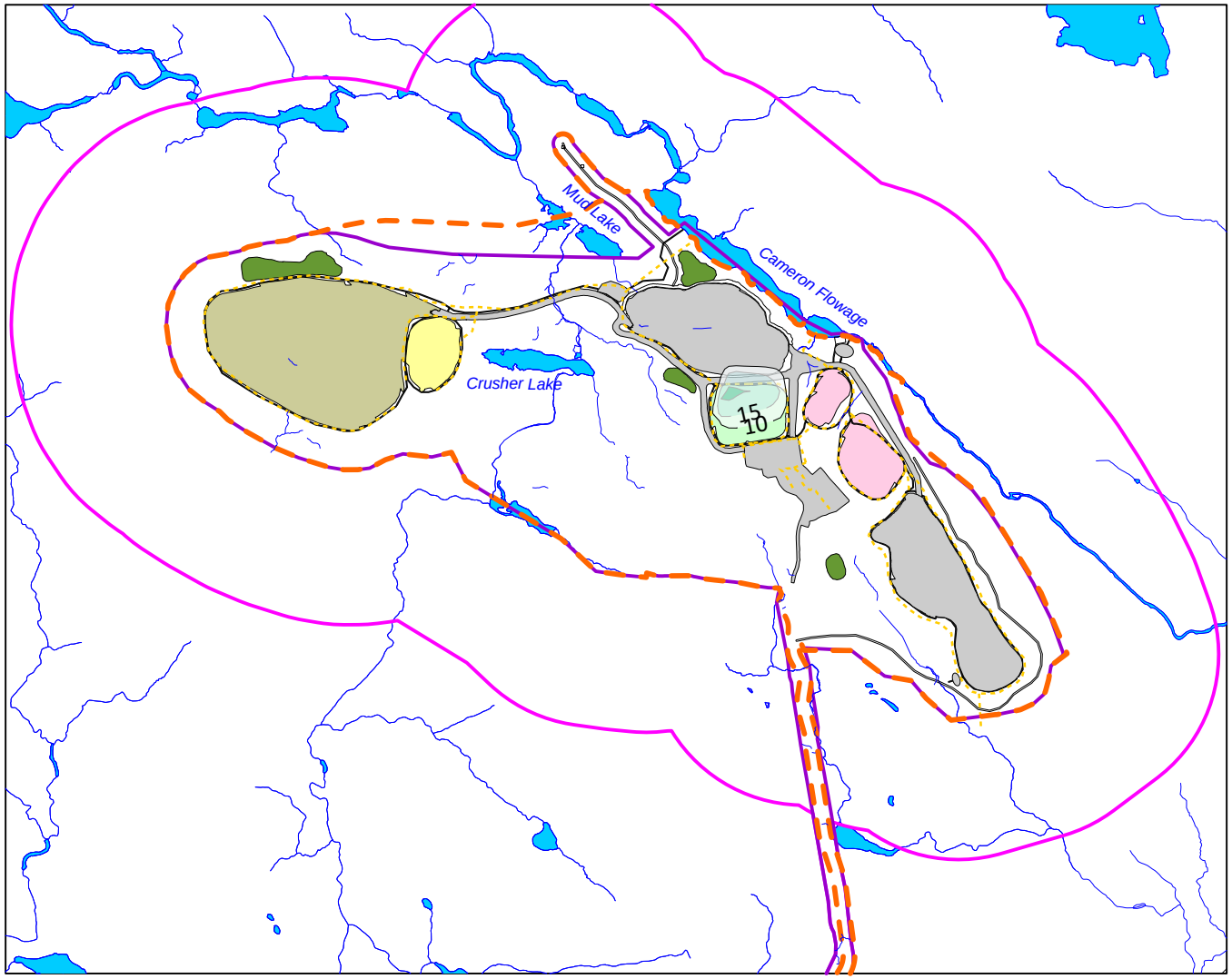
FIGURE E.5

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.5 - Simulated Uranium Concentration Versus Potable Criteria - EOM - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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SIMULATED ARSENIC CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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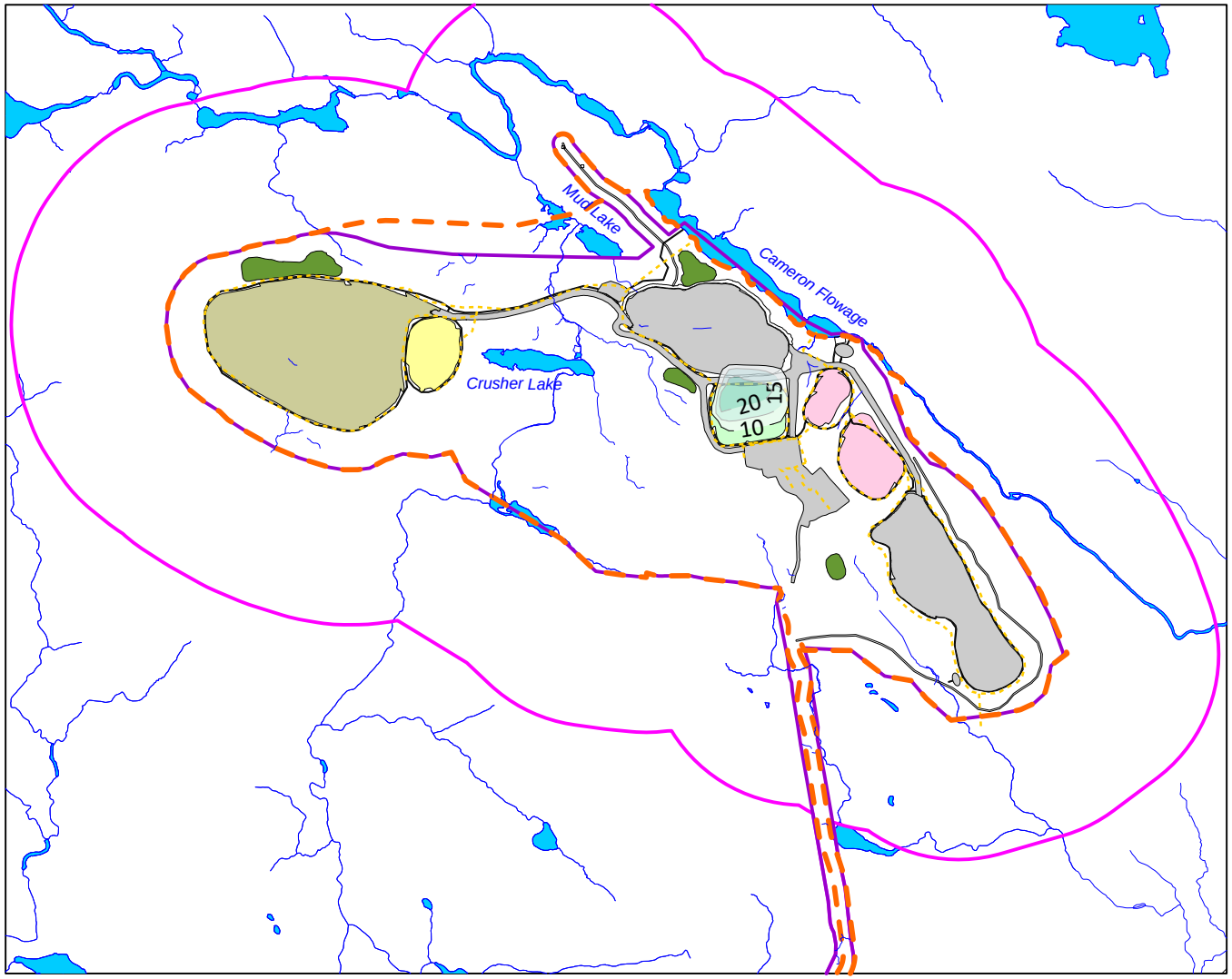
FIGURE E.6

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.6 - Simulated Arsenic Concentration Versus Potable Criteria - PC - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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SIMULATED ARSENIC CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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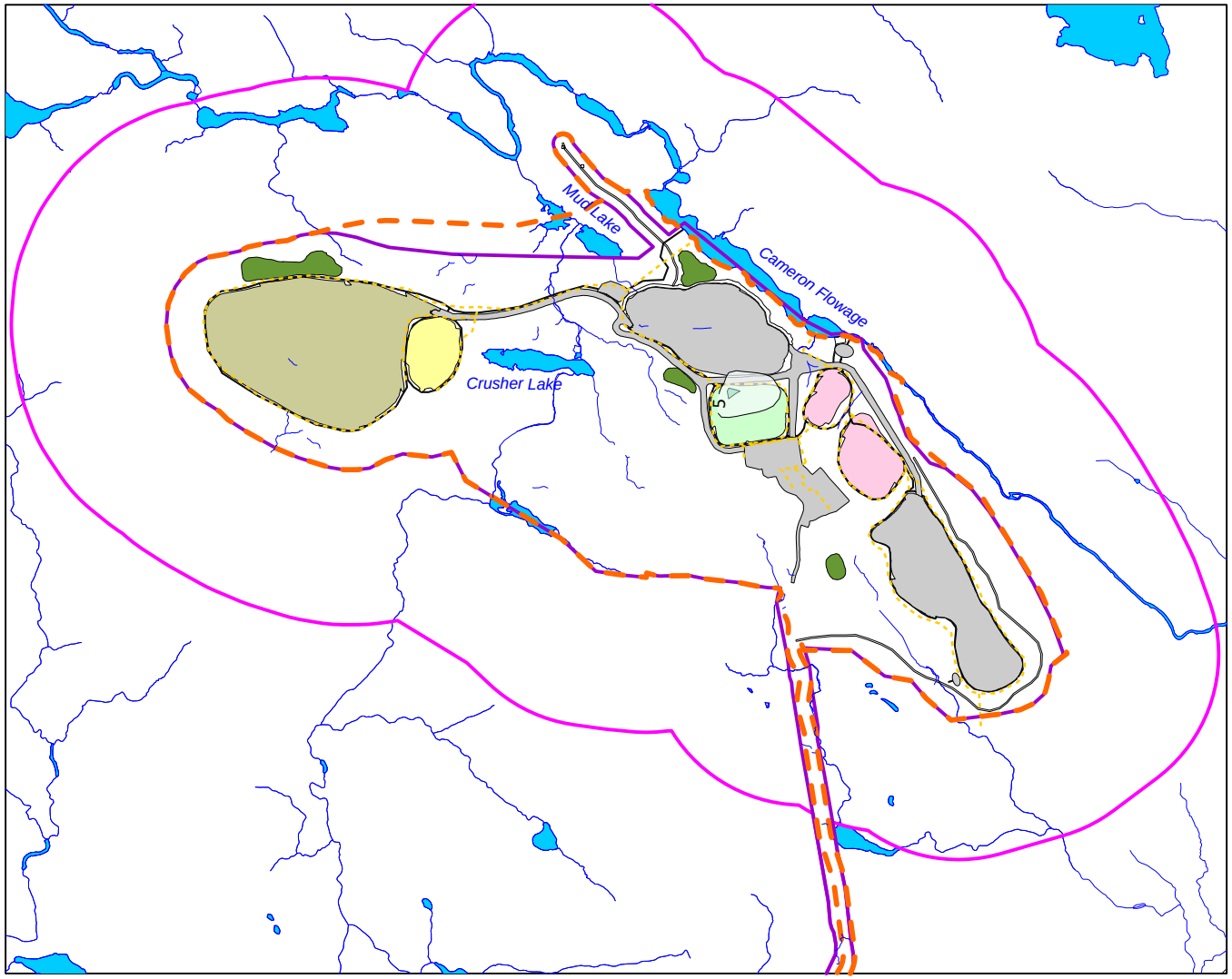
FIGURE E.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\E.7 - Simulated Arsenic Concentration Versus Potable Criteria - PC - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 1 EQS for potable groundwater is 5 ug/L.

0 300 600 900m

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SIMULATED CADMIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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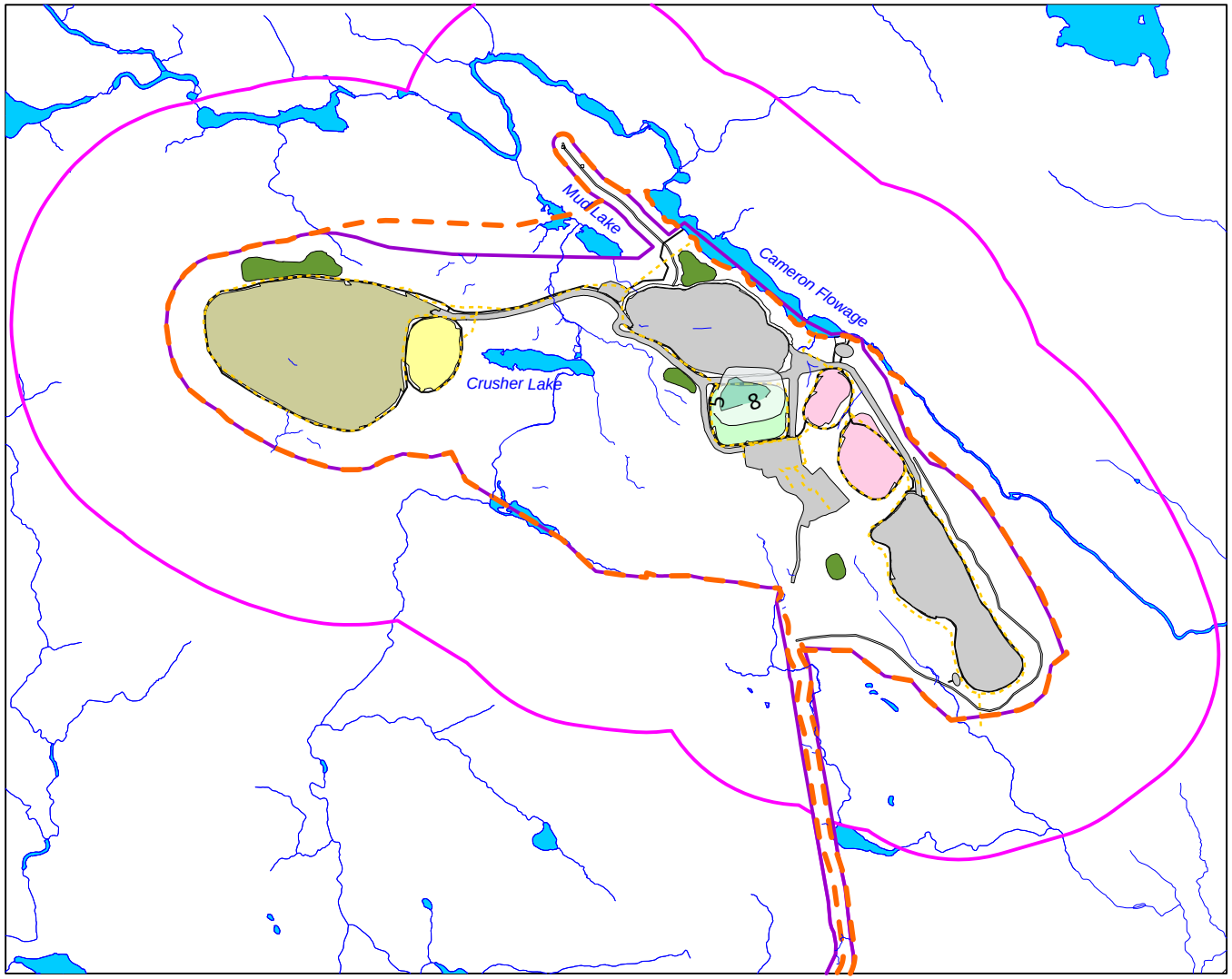
FIGURE E.8

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.8 - Simulated Cadmium Concentration Versus Potable Criteria - PC - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 1 EQS for potable groundwater is 5 ug/L.

0 300 600 900m

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SIMULATED CADMIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER SOURCE TERMS - WET CASE CONDITION

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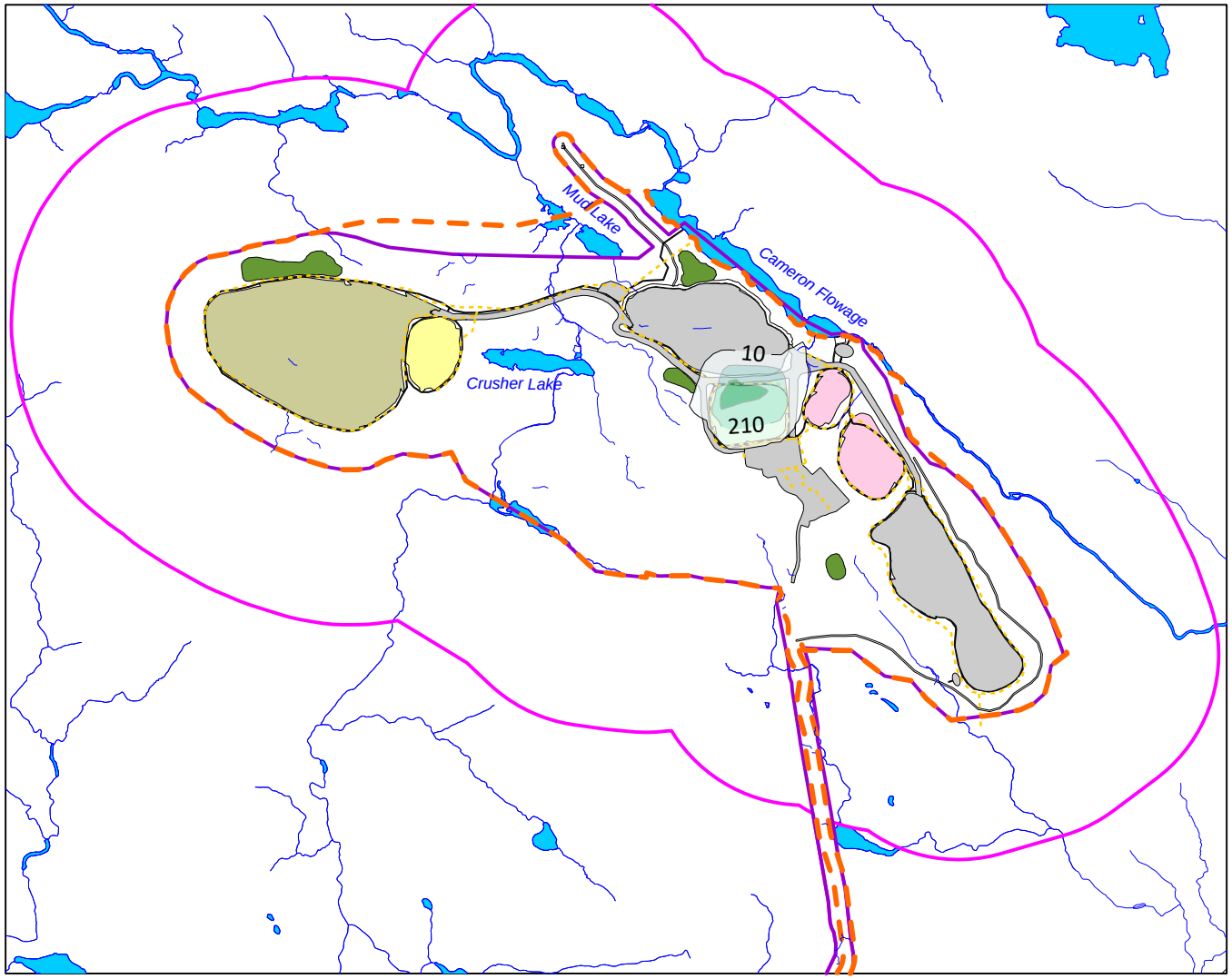
FIGURE E.9

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.9 - Simulated Cadmium Concentration Versus Potable Criteria - PC - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED COBALT CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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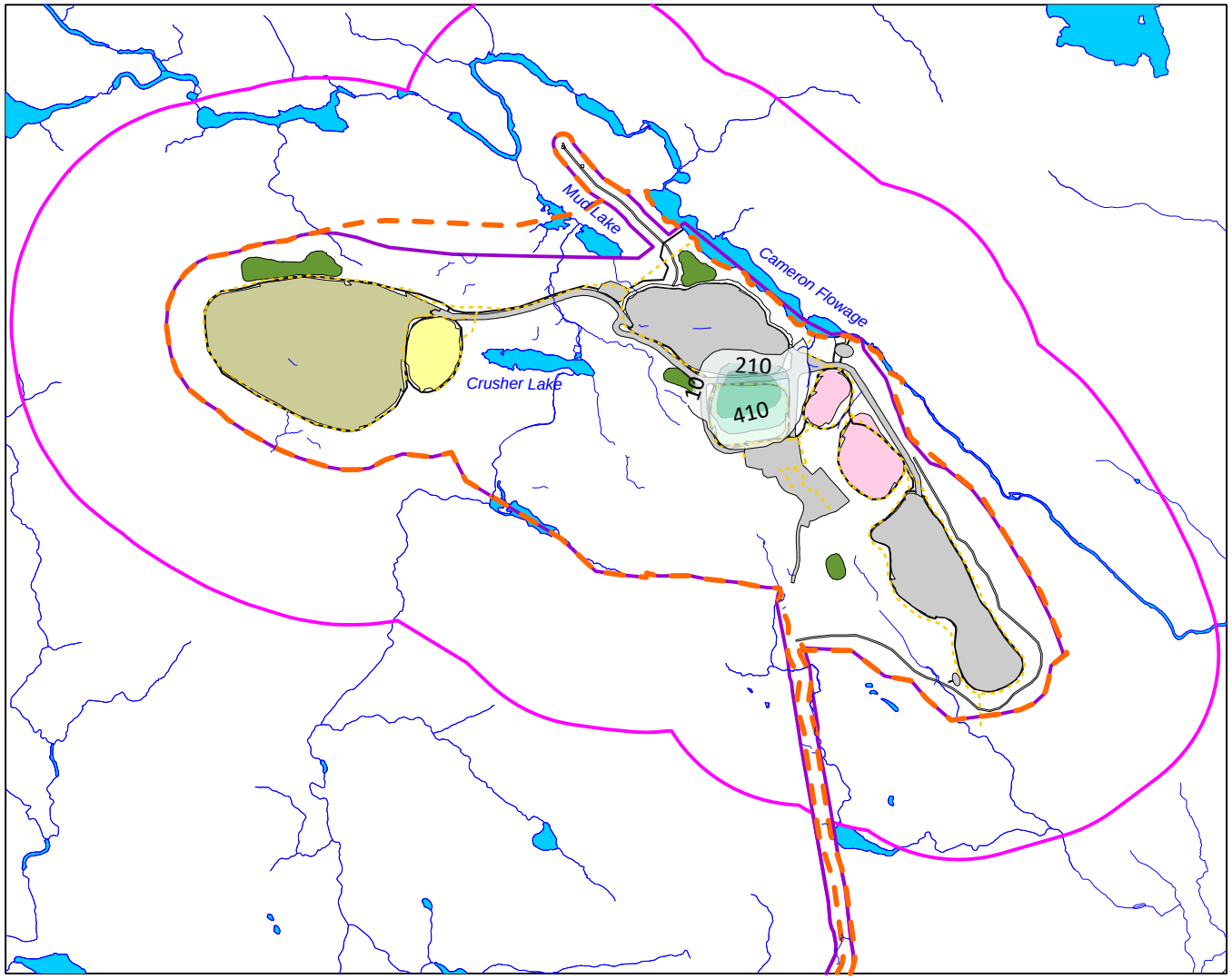
FIGURE E.10

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.10 - Simulated Cobalt Concentration Versus Potable Criteria - PC - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 1 EQS for potable groundwater is 10 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED COBALT CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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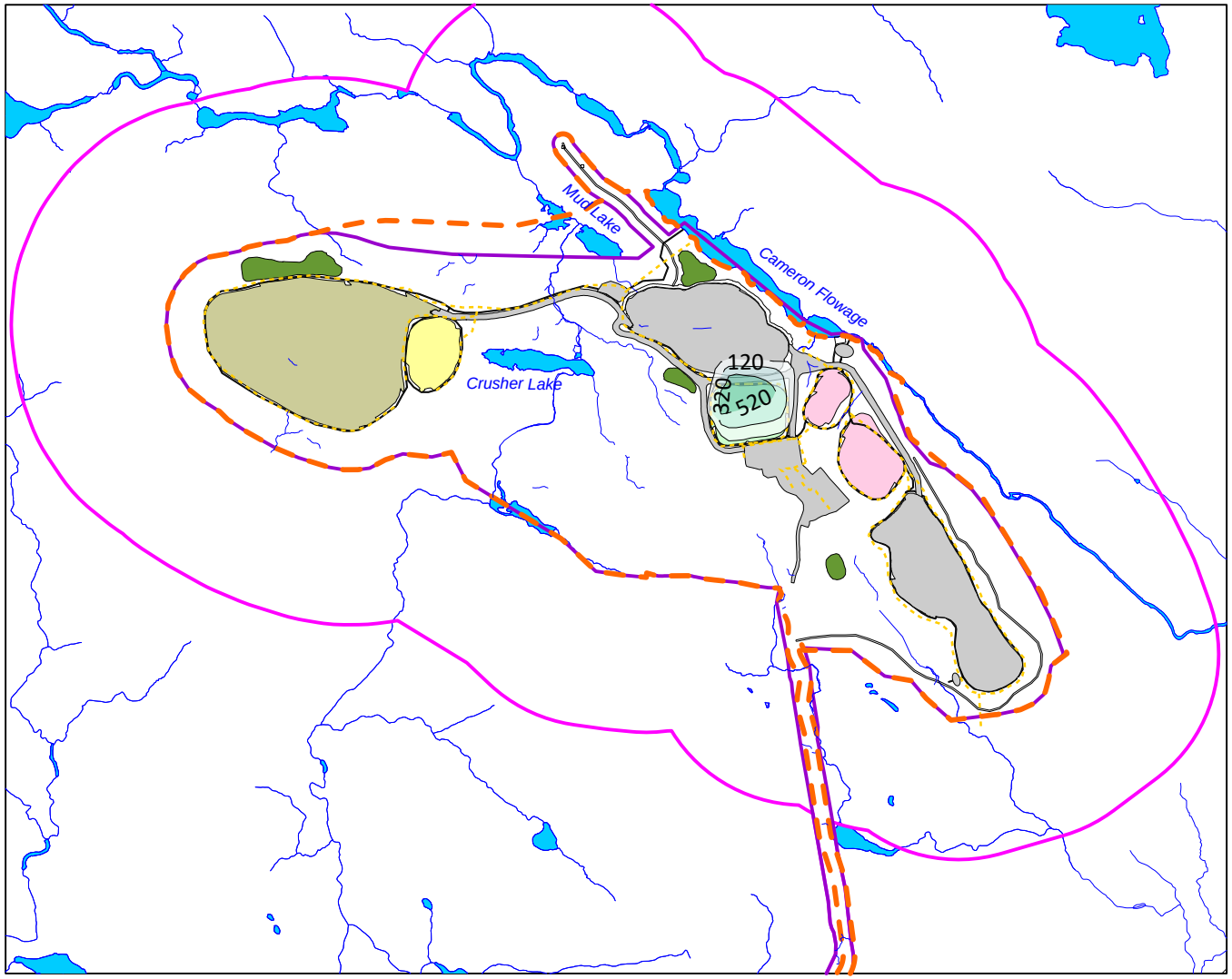
FIGURE E.11

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.11 - Simulated Cobalt Concentration Versus Potable Criteria - PC - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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SIMULATED MANGANESE CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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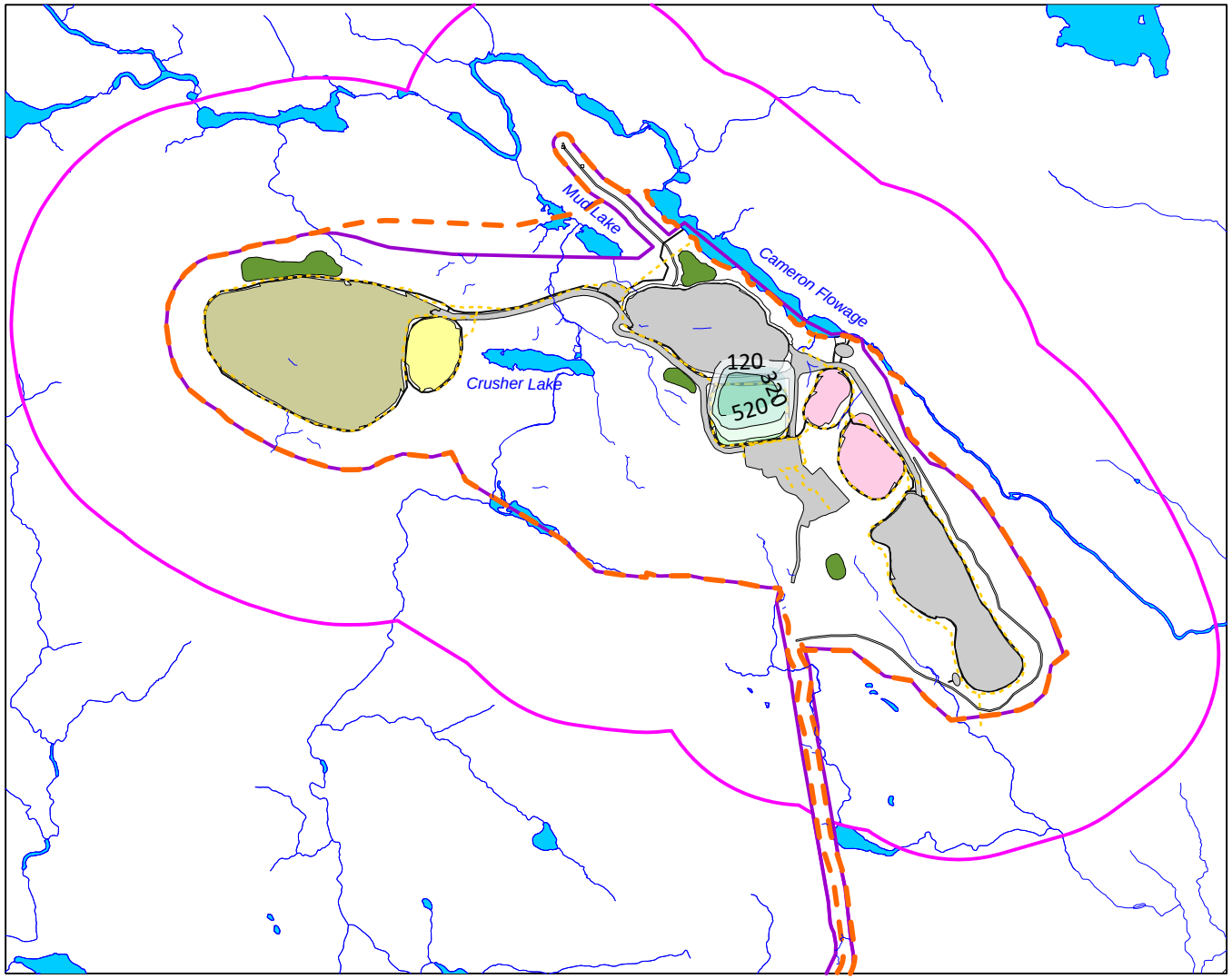
FIGURE E.12

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.12 - Simulated Manganese Concentration Versus Potable Criteria - PC - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED MANGANESE CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The manganese Tier 1 EQS for potable groundwater is 120 ug/L.

0 300 600 900m

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SIMULATED MANGANESE CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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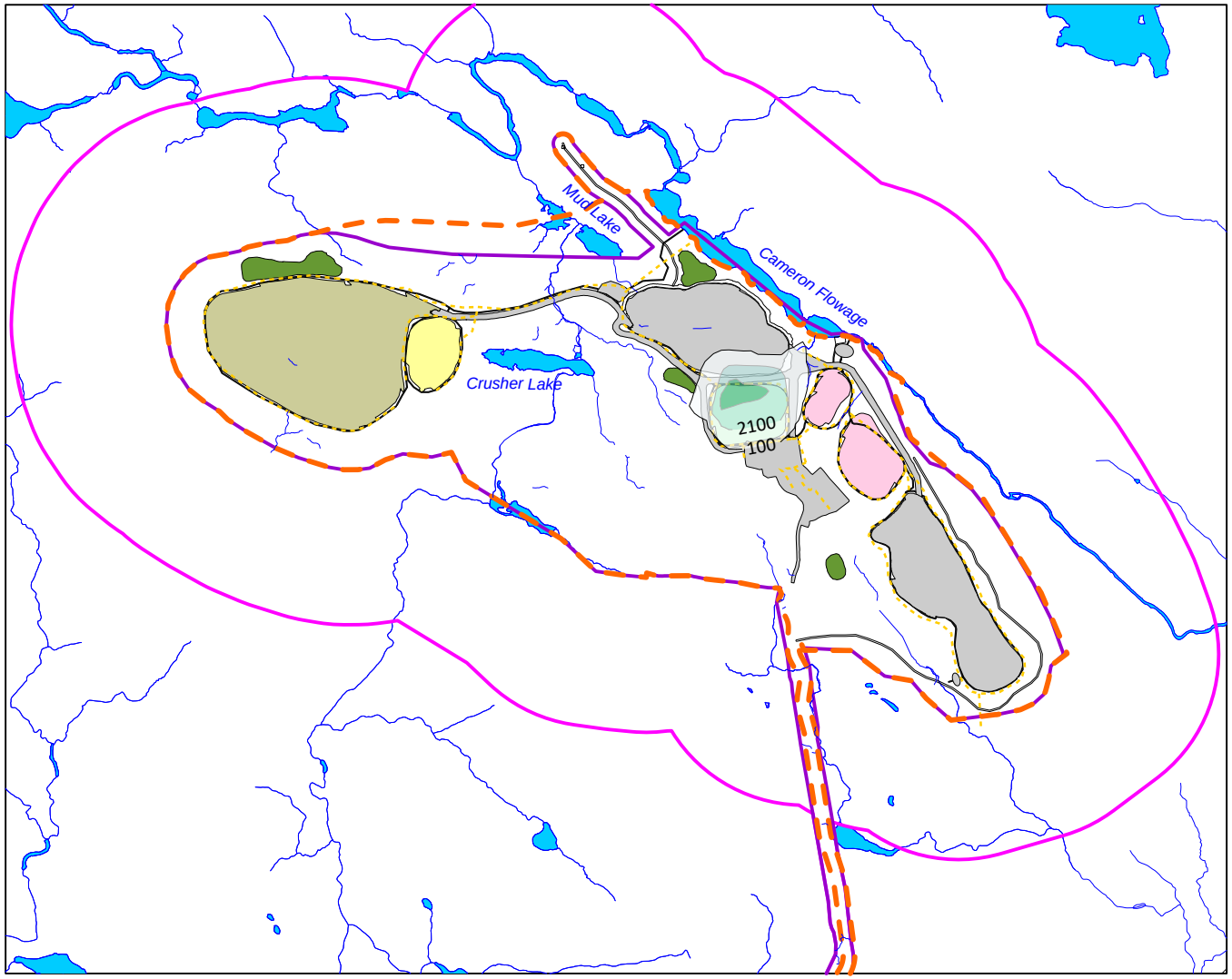
FIGURE E.13

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.13 - Simulated Manganese Concentration Versus Potable Criteria - PC - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 1 EQS for potable groundwater is 100 ug/L.

0 300 600 900m

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SIMULATED NICKEL CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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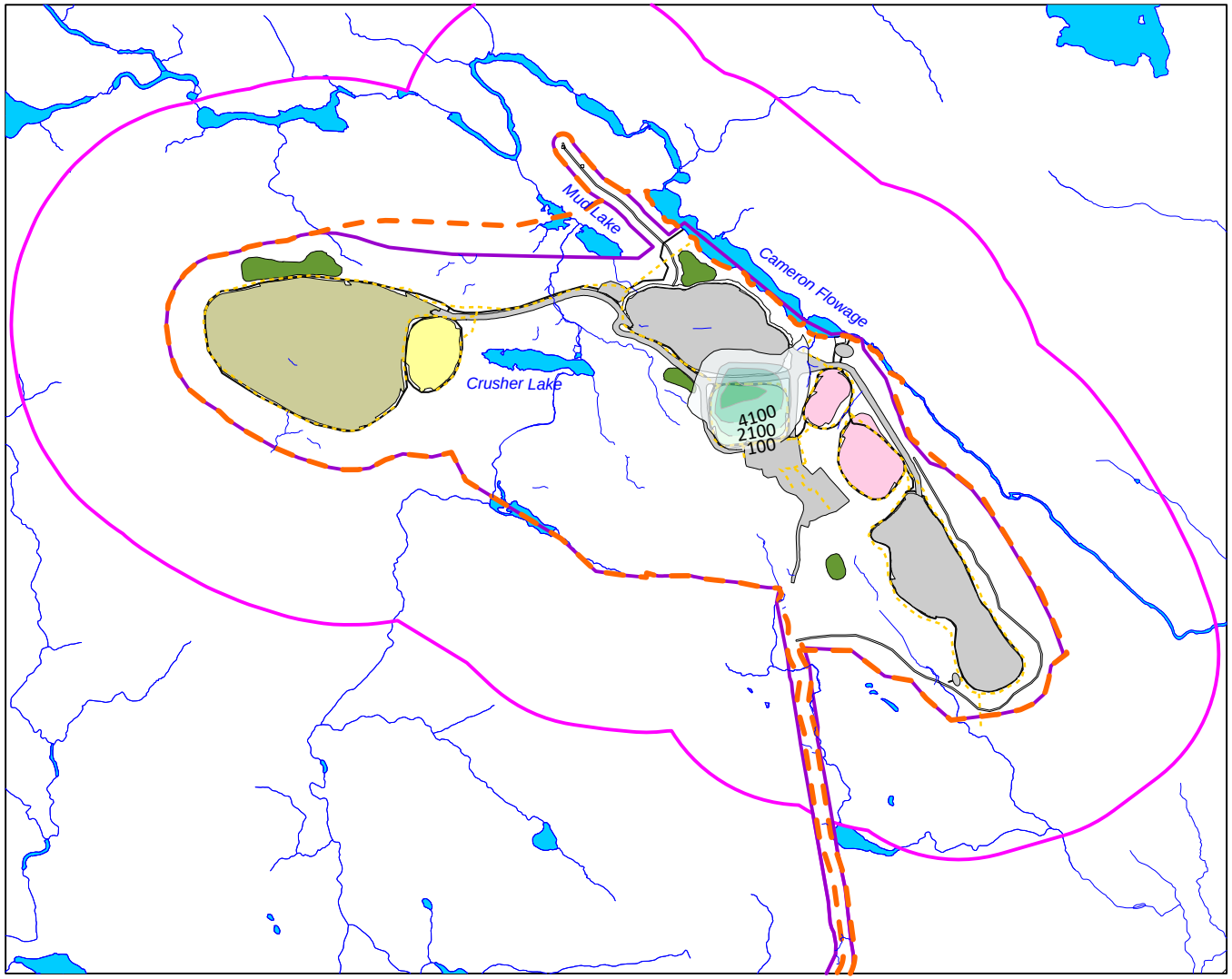
FIGURE E.14

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.14 - Simulated Nickel Concentration Versus Potable Criteria - PC - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 1 EQS for potable groundwater is 100 ug/L.

0 300 600 900m

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SIMULATED NICKEL CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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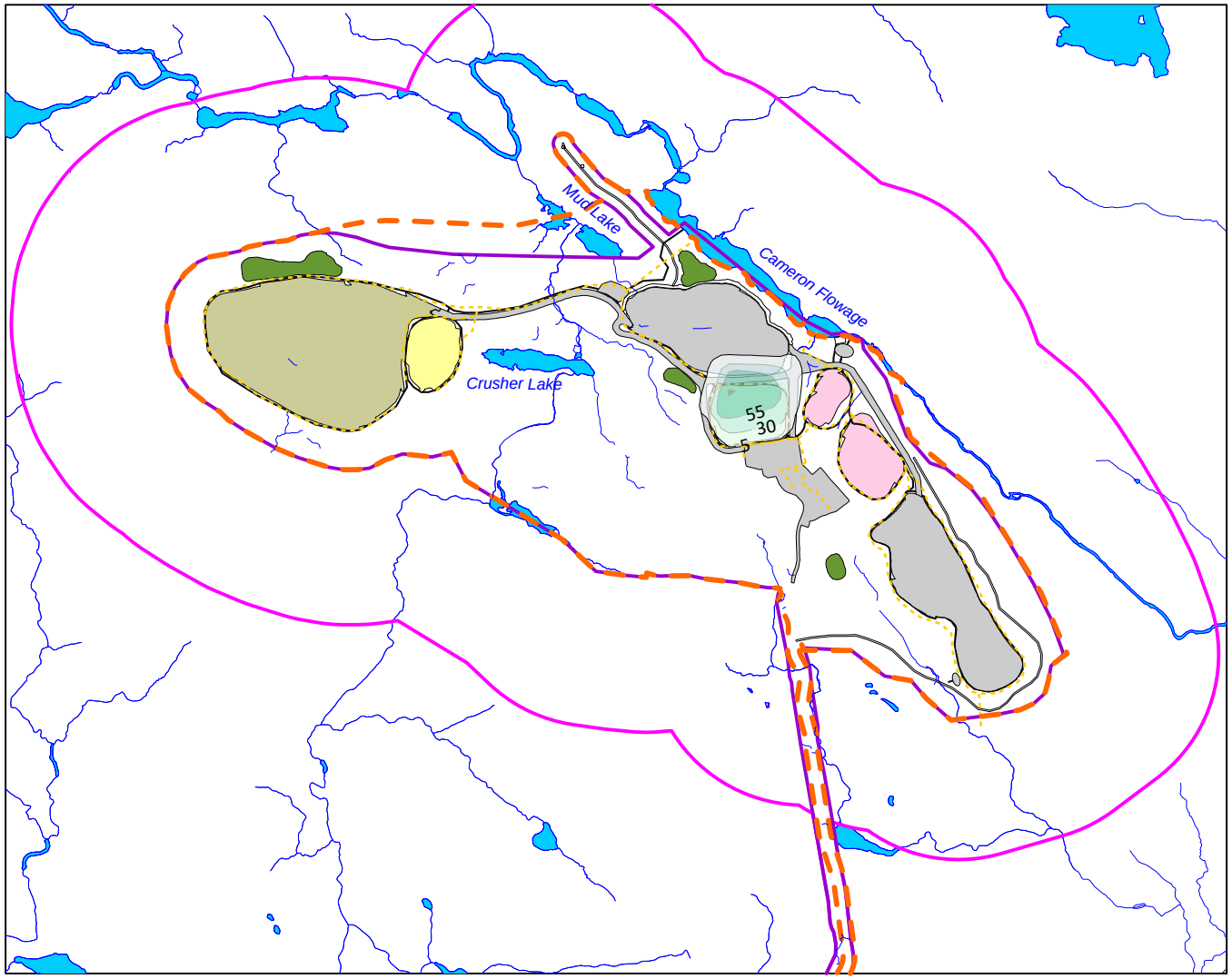
FIGURE E.15

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.15 - Simulated Nickel Concentration Versus Potable Criteria - PC - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead GCDWQ is 5 ug/L.

0 300 600 900m

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SIMULATED LEAD CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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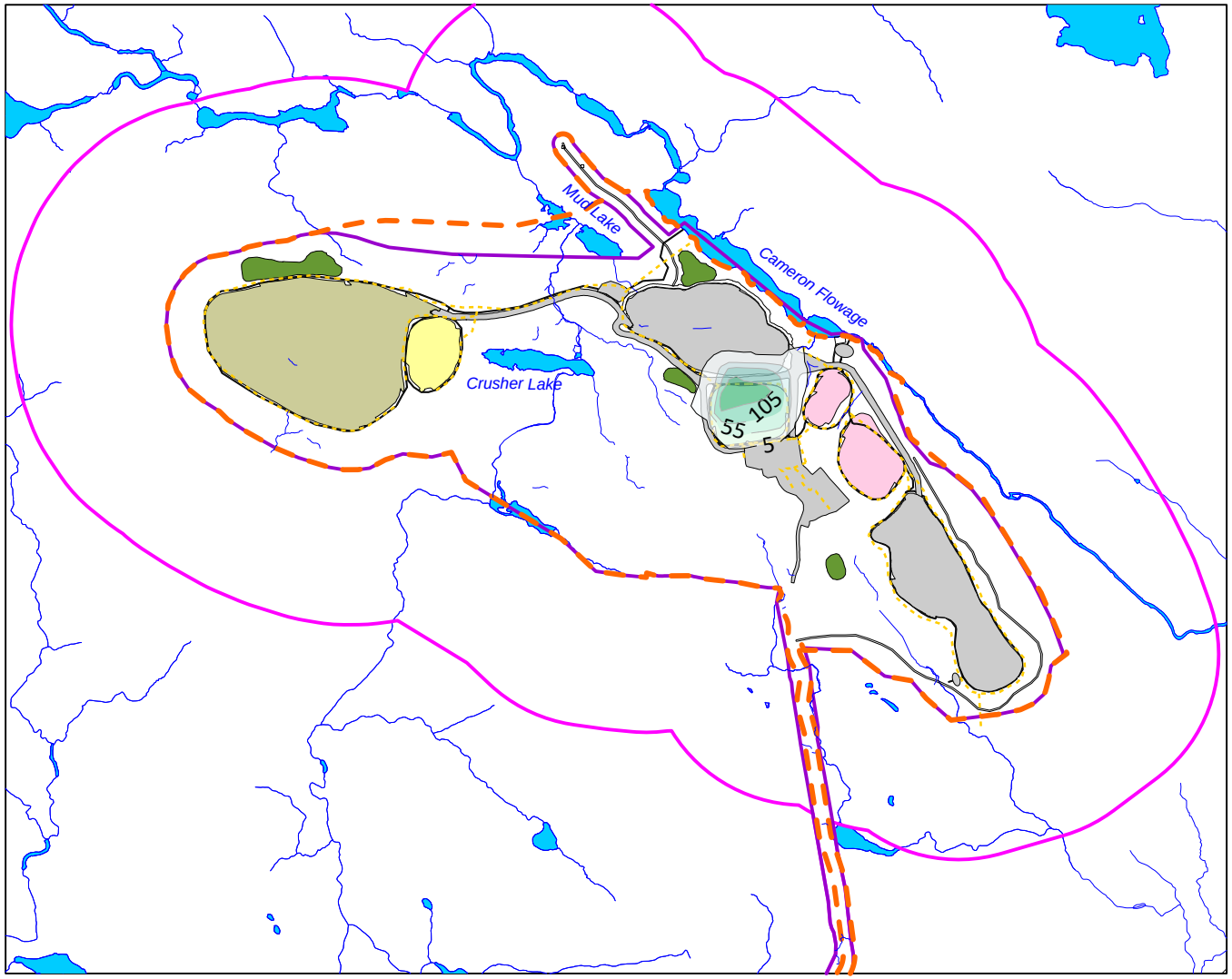
March 11, 2021

FIGURE E.16

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.16 - Simulated Lead Concentration Versus Potable Criteria - PC - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead GCDWQ is 5 ug/L.

0 300 600 900m

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SIMULATED LEAD CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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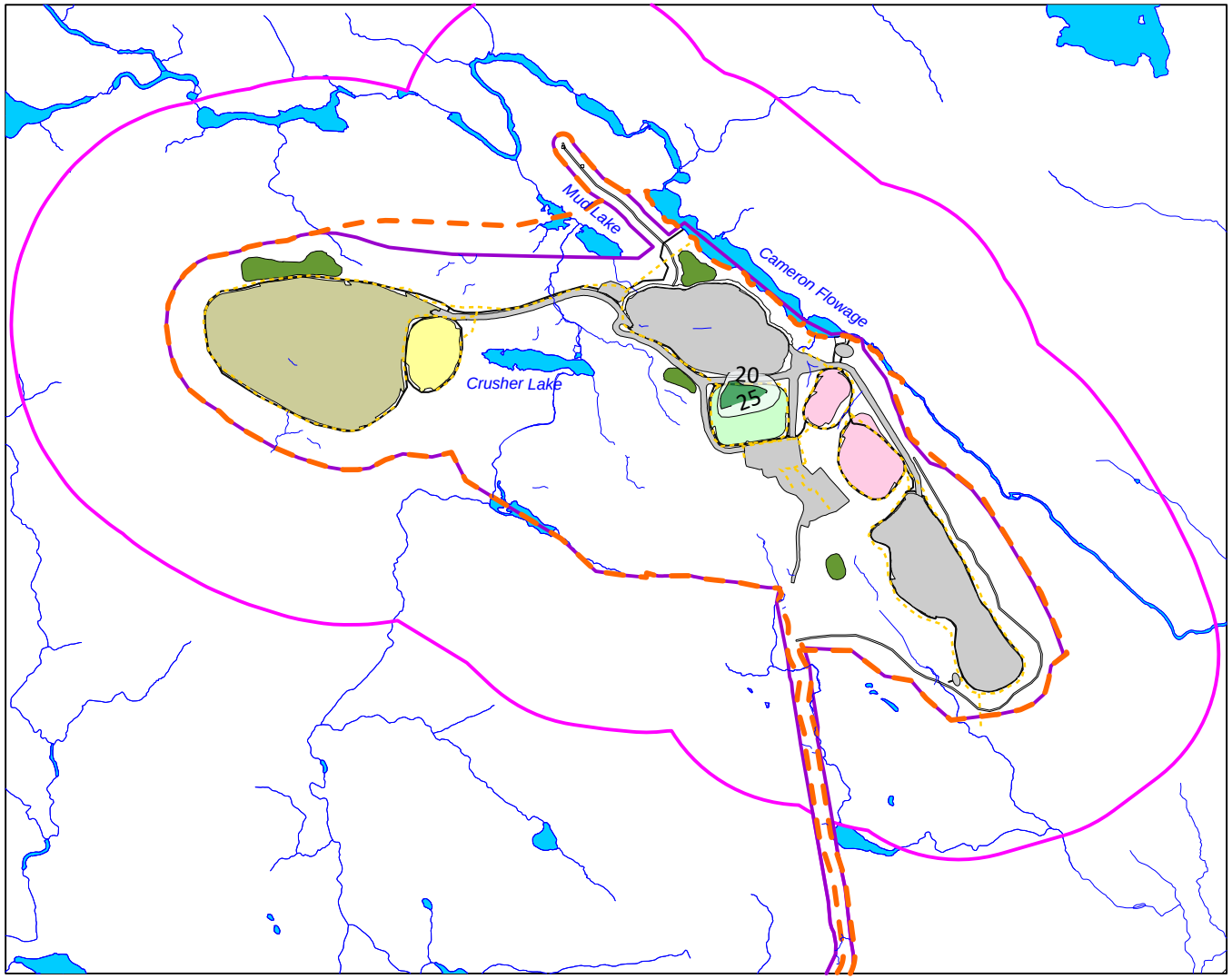
FIGURE E.17

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.17 - Simulated Lead Concentration Versus Potable Criteria - PC - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

N

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SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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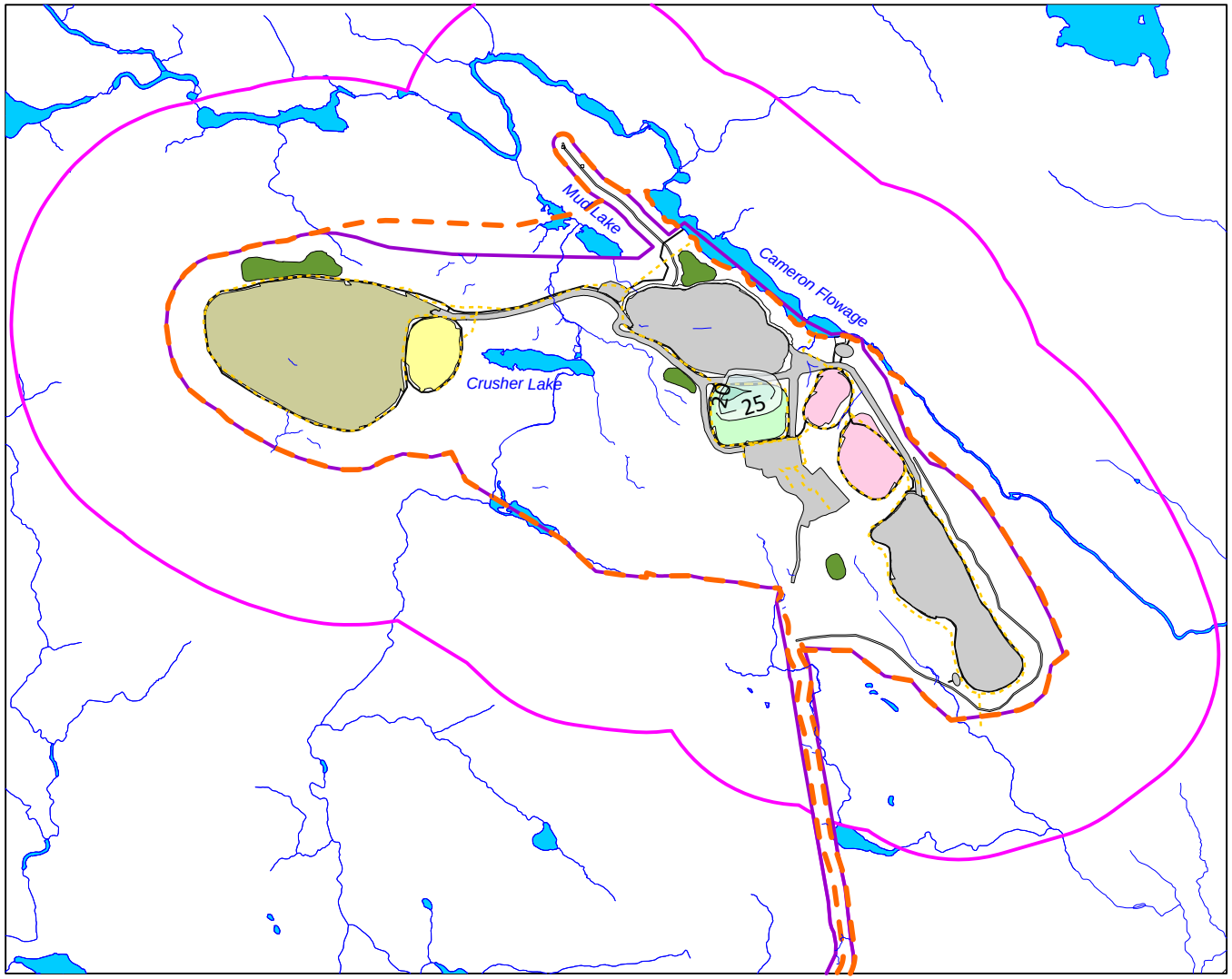
FIGURE E.18

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.19 - Simulated Uranium Concentration Versus Potable Criteria - PC - BC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED URANIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The uranium Tier 1 EQS for potable groundwater is 20 ug/L.

0 300 600 900m

N

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SIMULATED URANIUM CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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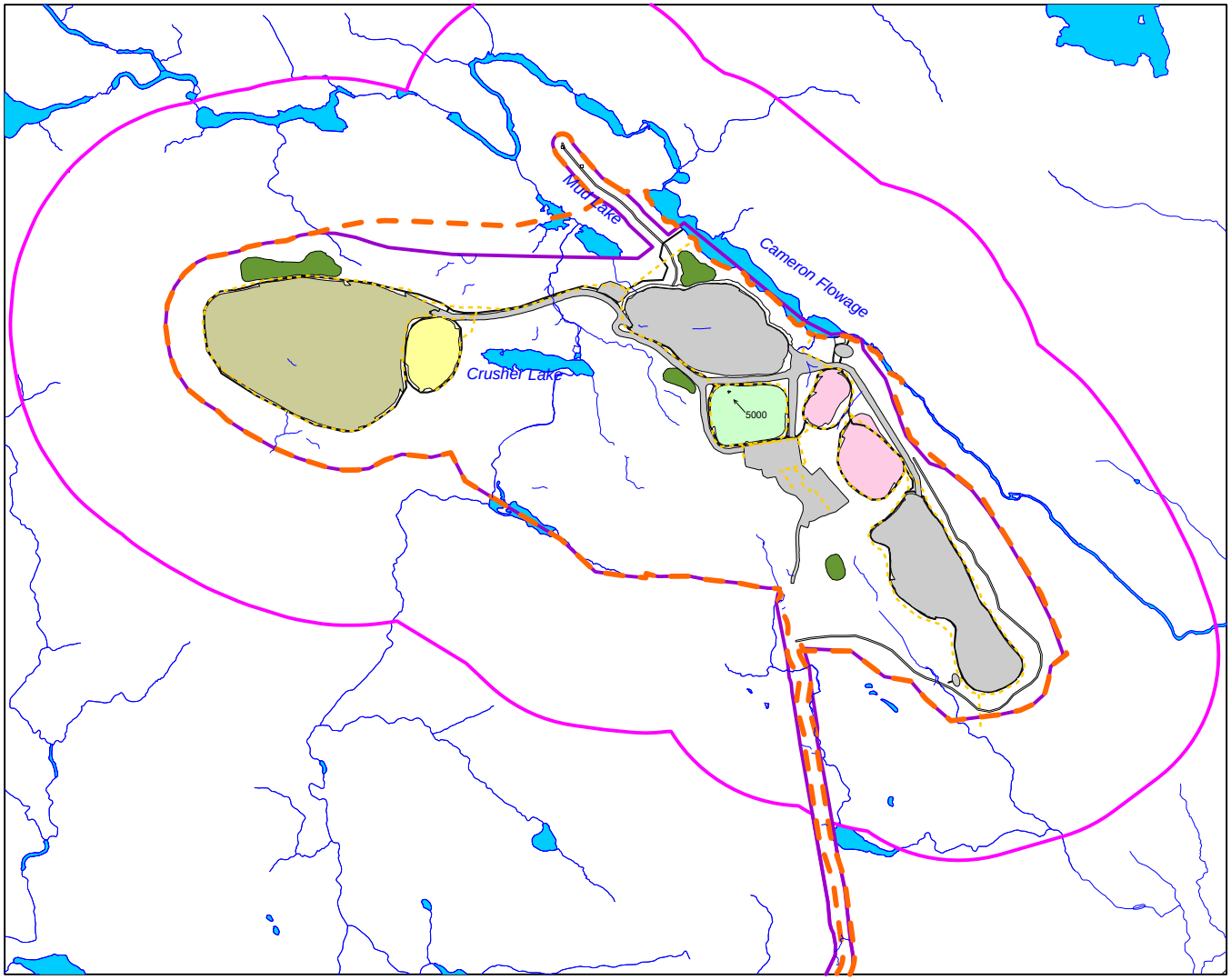
FIGURE E.19

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.20 - Simulated Uranium Concentration Versus Potable Criteria - PC - UC - WET.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 1 EQS for potable groundwater is 5000 ug/L.

0 300 600 900m

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SIMULATED ZINC CONCENTRATION VERSUS POTABLE CRITERIA
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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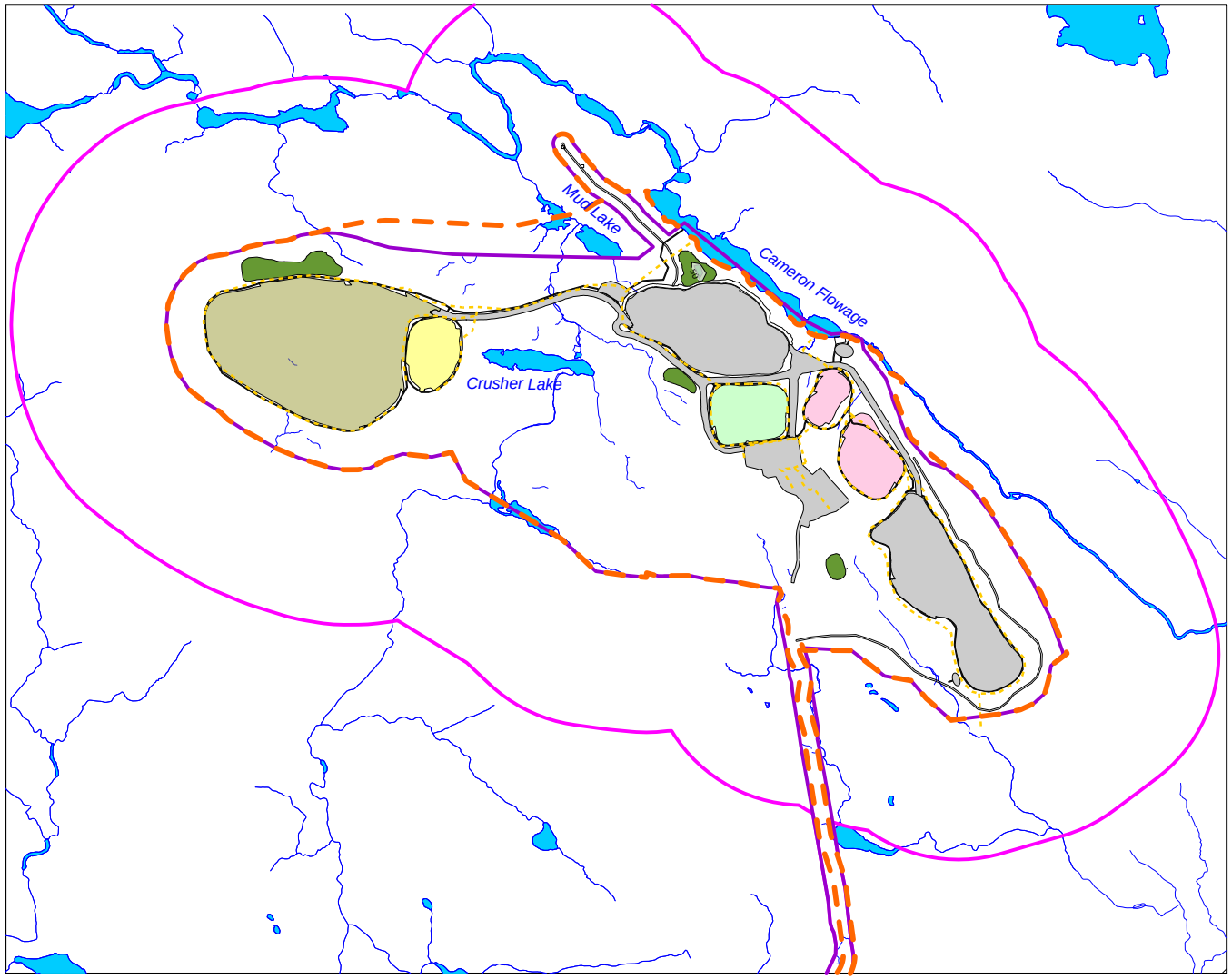
FIGURE E.20

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\E.22 - Simulated Zinc Concentration Versus Potable Criteria - PC - UC - WET.srf

Appendix F
Simulated COC Concentrations in Groundwater Versus Tier 2 PSS – Dry Conditions



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
EOM - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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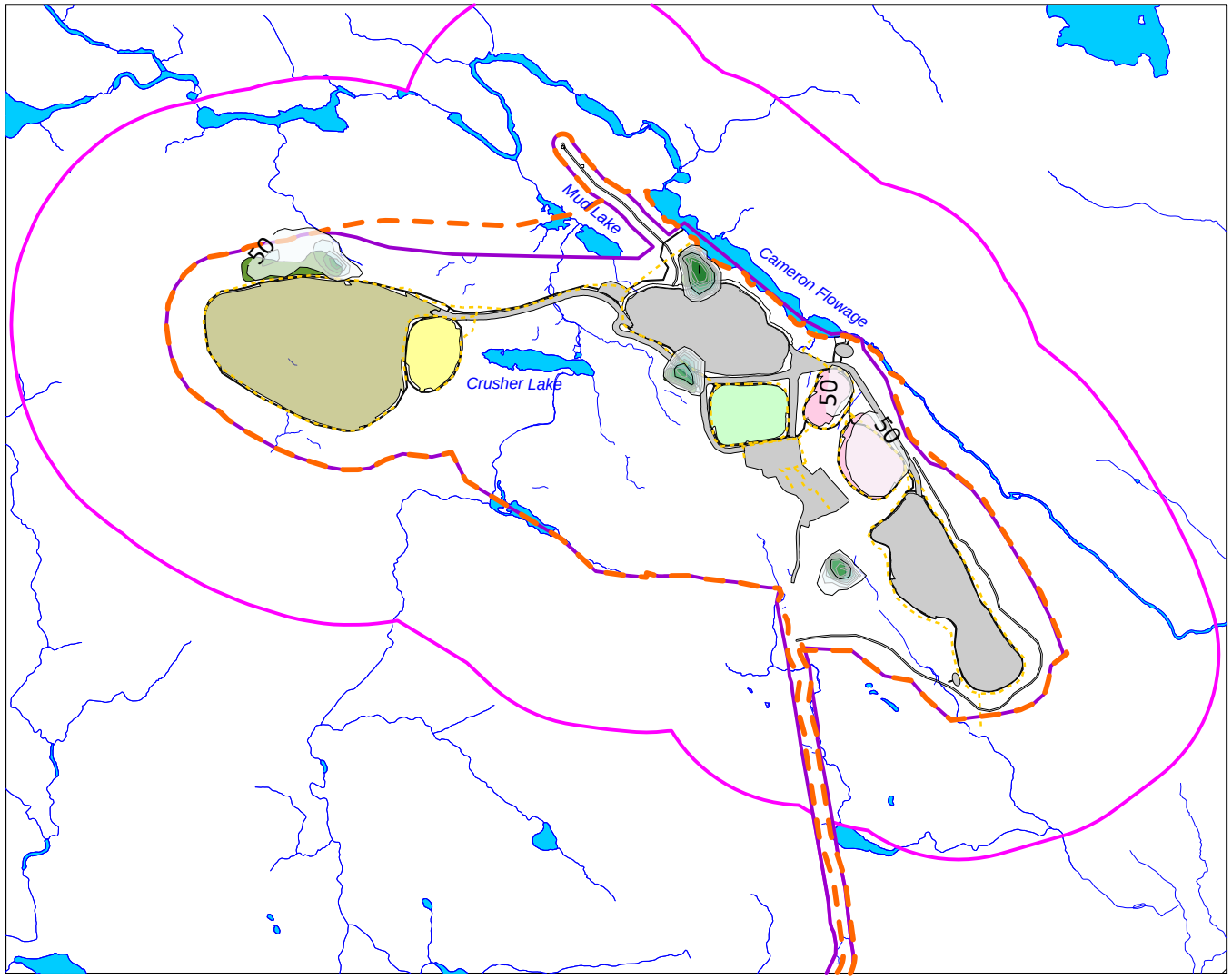
March 11, 2021

Figure F.1

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.29 - Sim_Aluminum_PSS - EOM - BC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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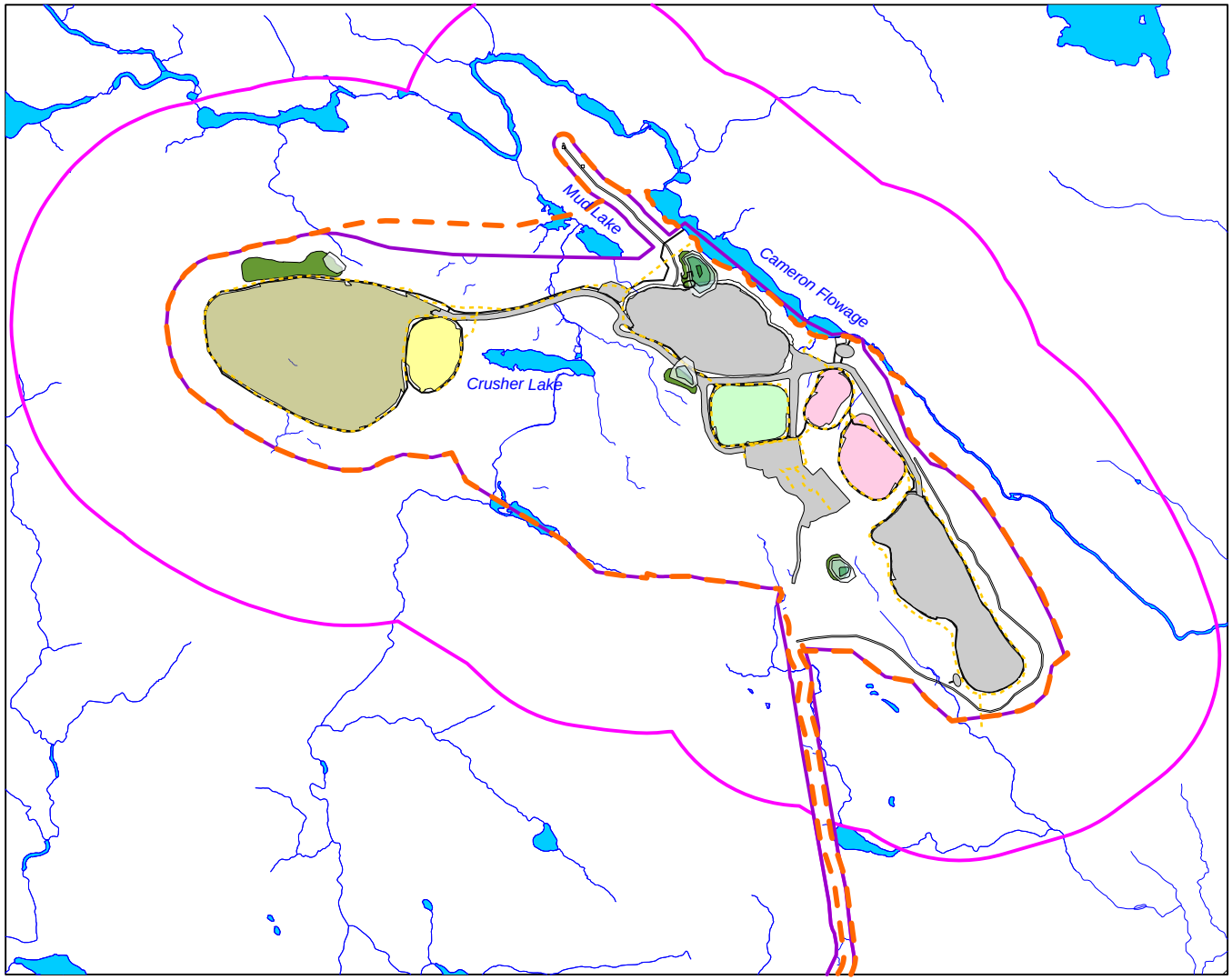
Figure F.2

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.30 - Sim_Aluminum_PSS - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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SIMULATED ARSENIC CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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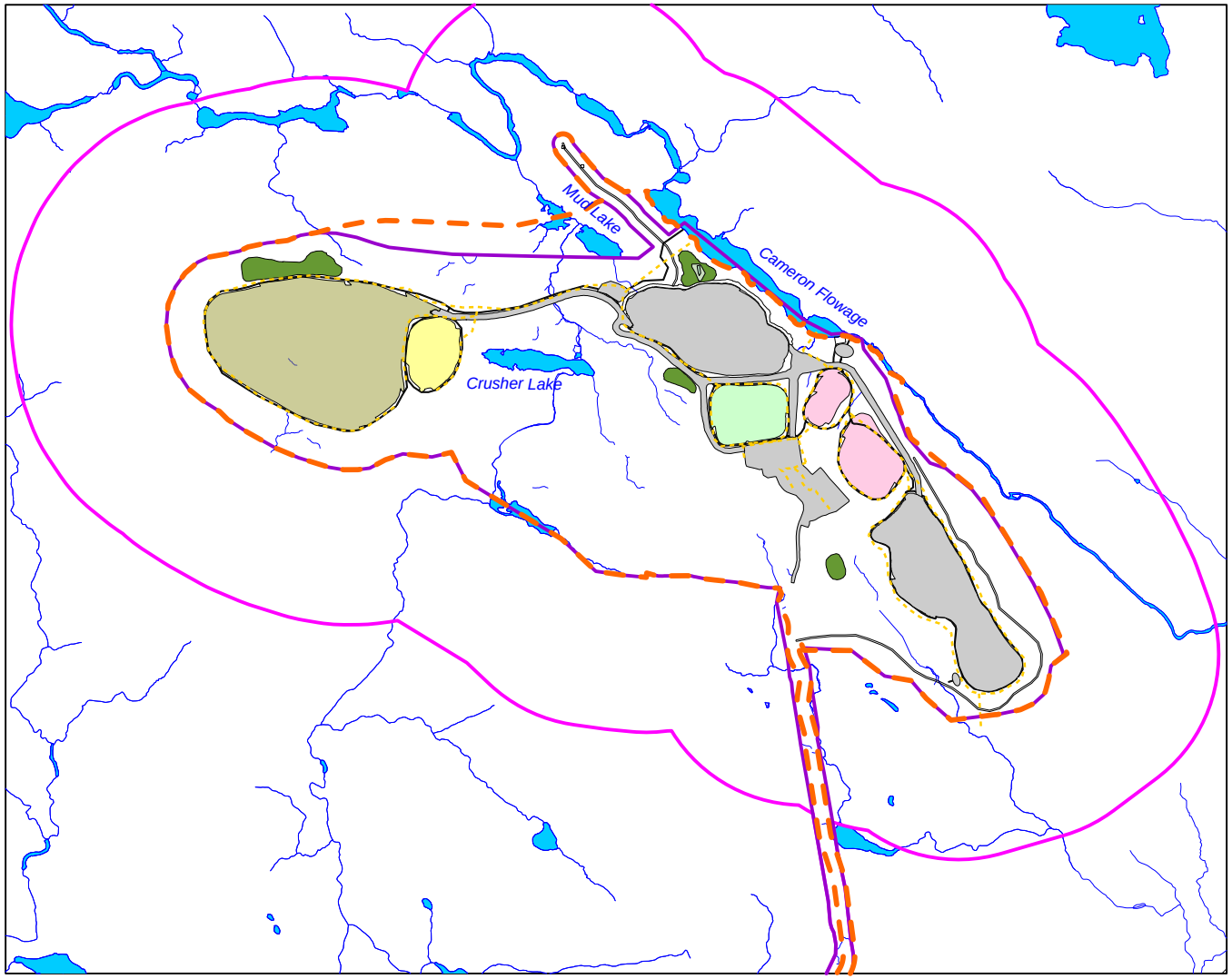
March 11, 2021

Figure F.3

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.31 - Sim_Arsenic_PSS - EOM - UC - AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

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SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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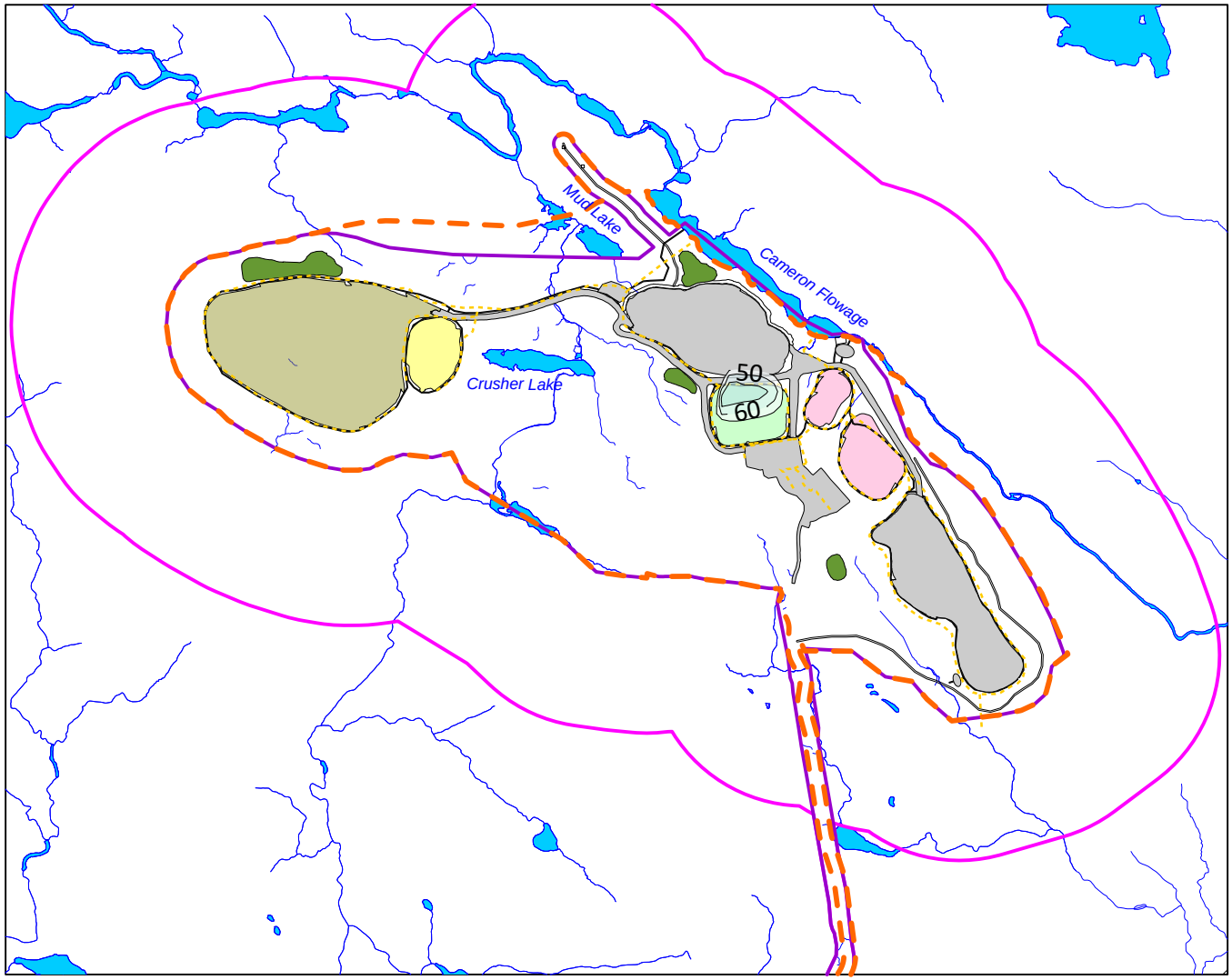
Figure F.4

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.32 - Sim_Cadmium_PSS-EOM-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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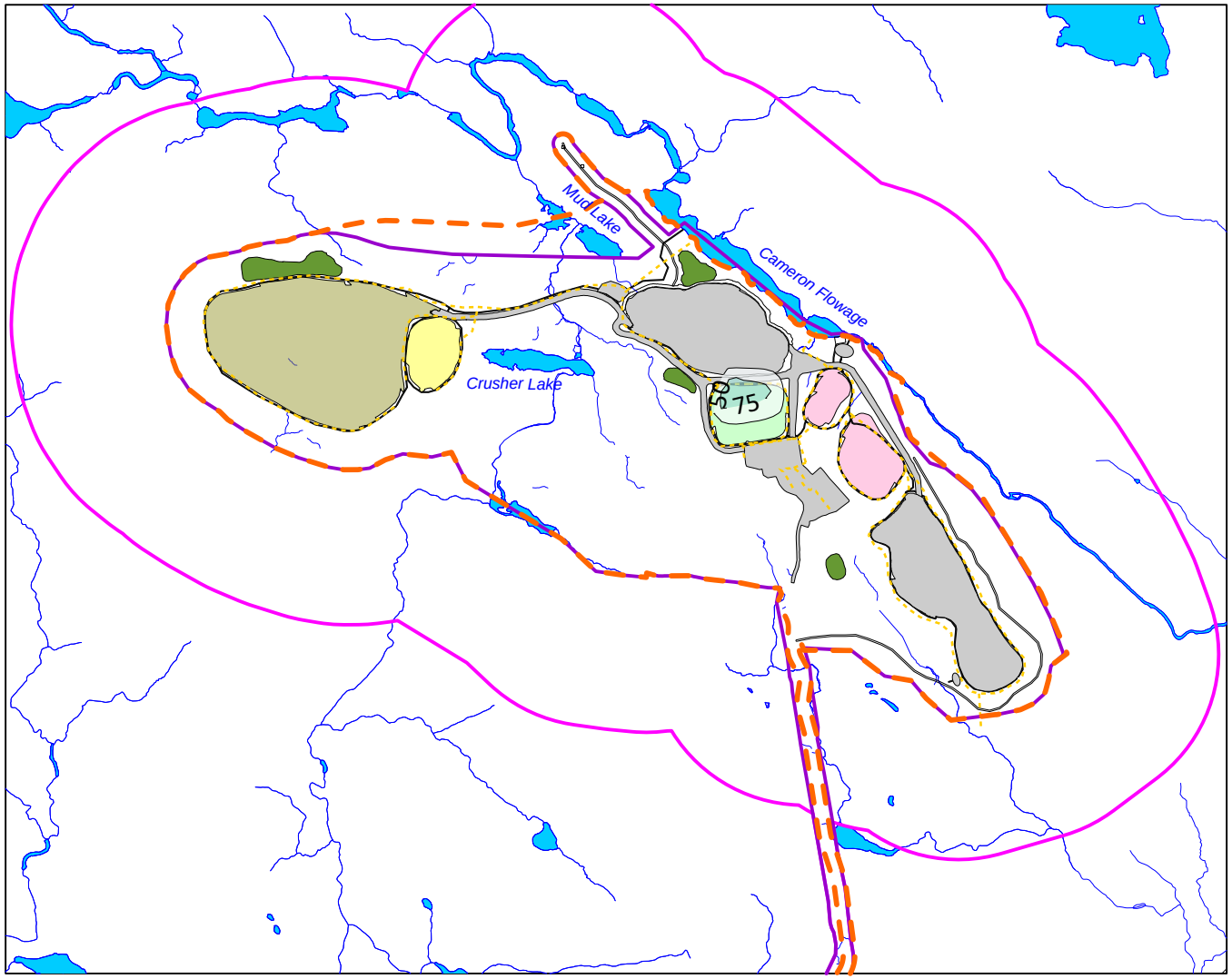
March 11, 2021

Figure F.5

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.33 - Sim_Aluminum_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
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BEAVER DAM MINE

SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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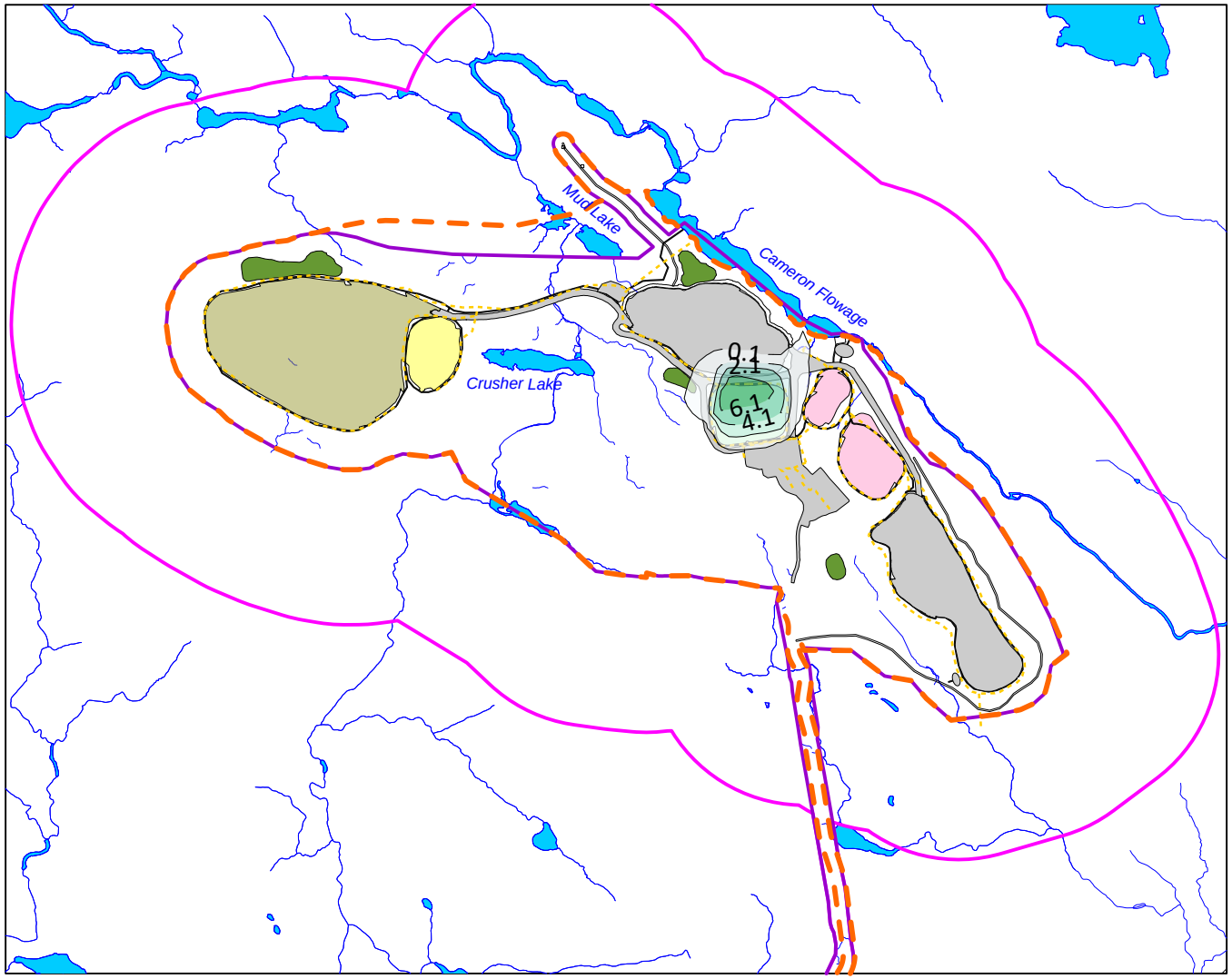
Figure F.6

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.34 - Sim_Aluminum_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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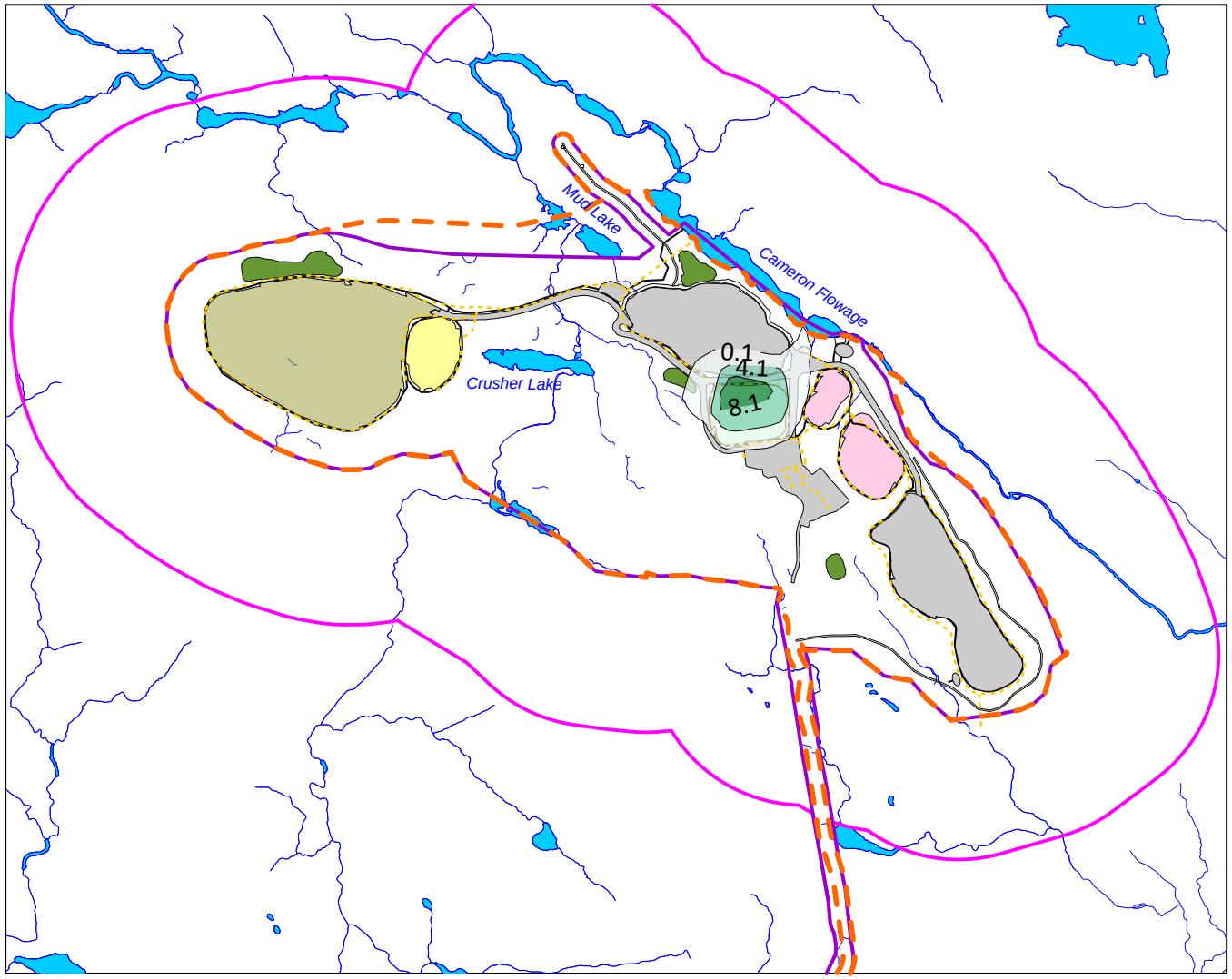
Figure F.7

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.35 - Sim_Cadmium_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

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SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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Figure F.8

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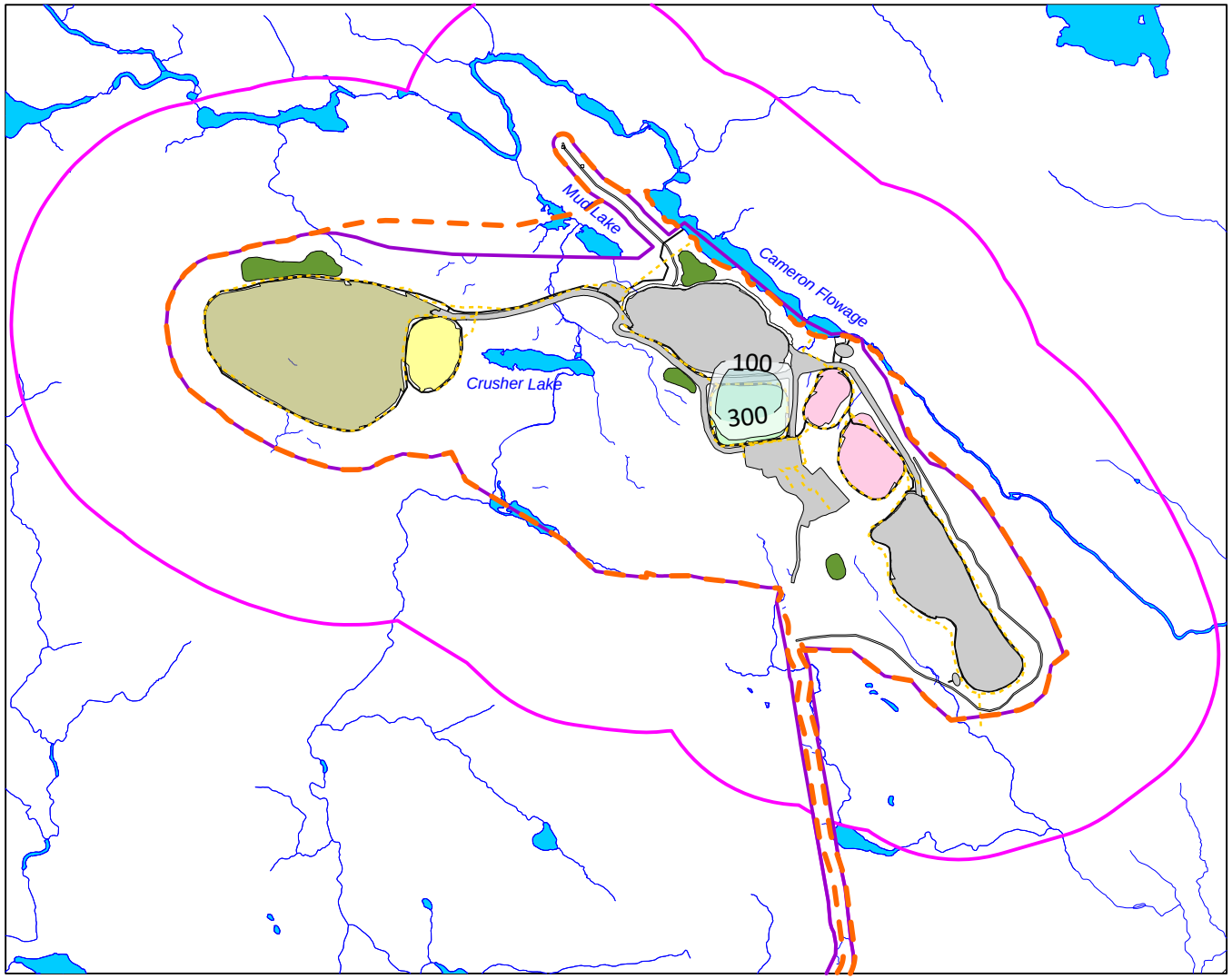

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 2 PSS for groundwater discharge to surface water (>10 m) is 100 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED COBALT CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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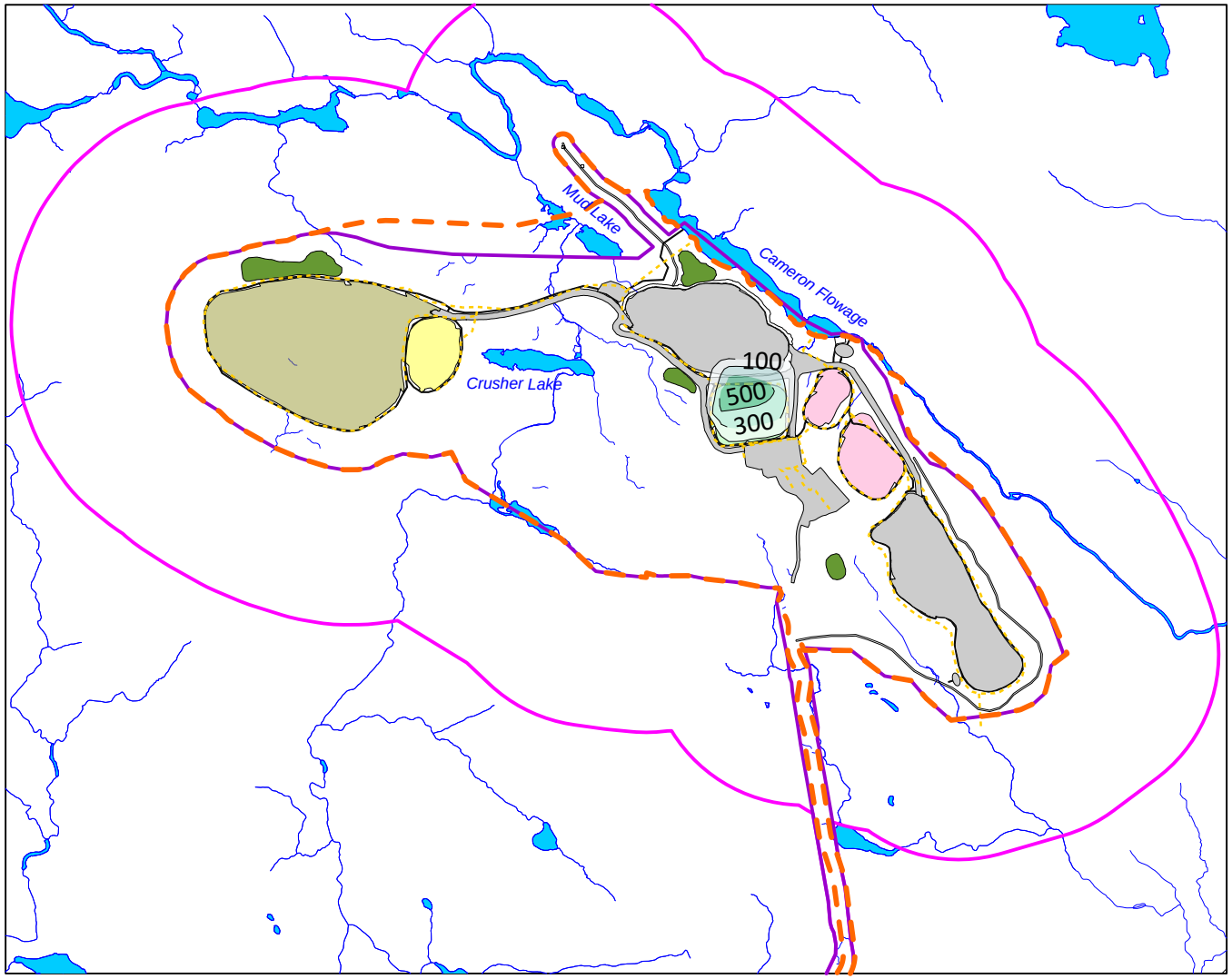
Figure F.9

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.37 - Sim_Cobalt_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 2 PSS for groundwater discharge to surface water (>10 m) is 100 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED COBALT CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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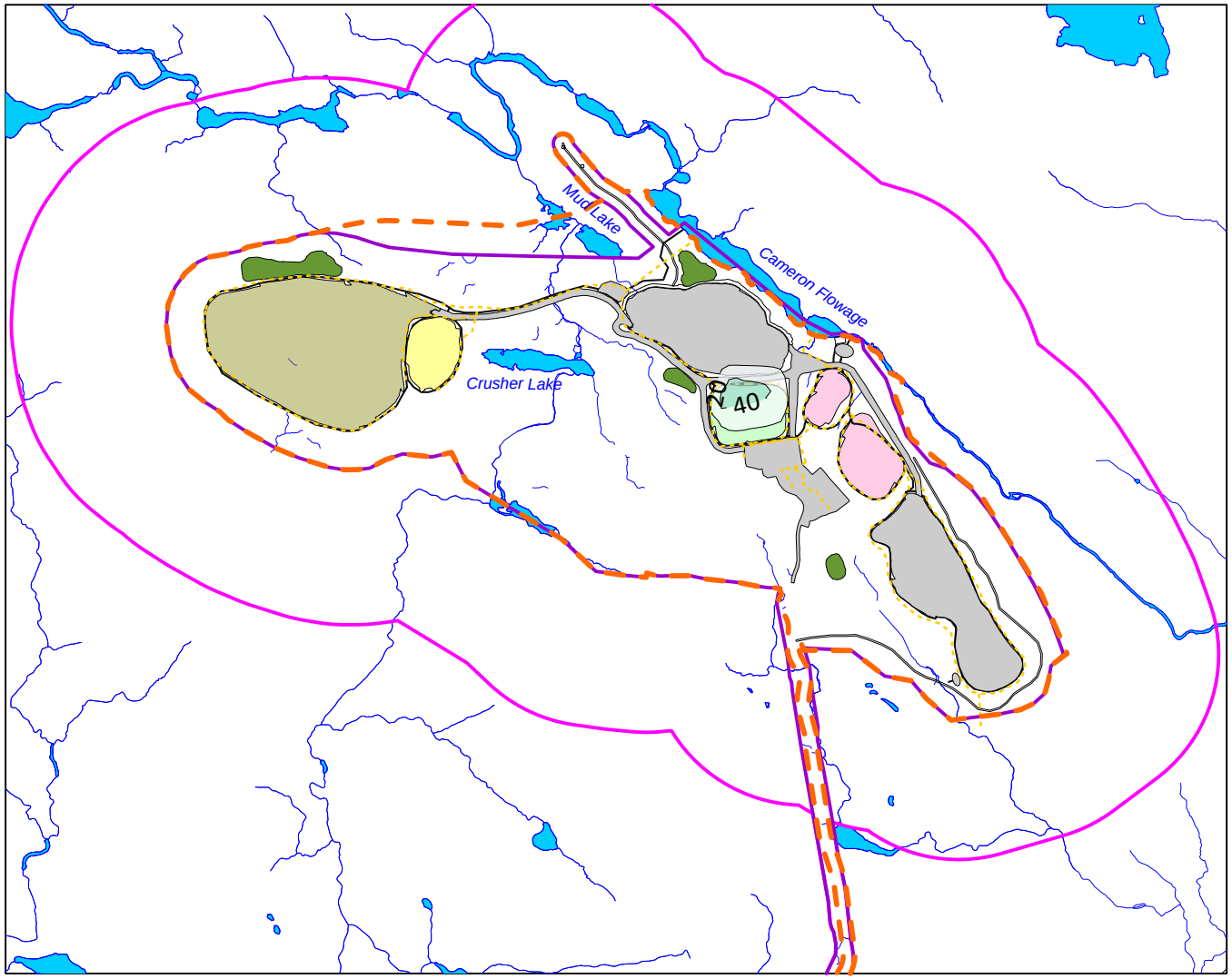
Figure F.10

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.38 - Sim_Cobalt_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COPPER CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The copper Tier 2 PSS for groundwater discharge to surface water (>10 m) is 20 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED COPPER CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

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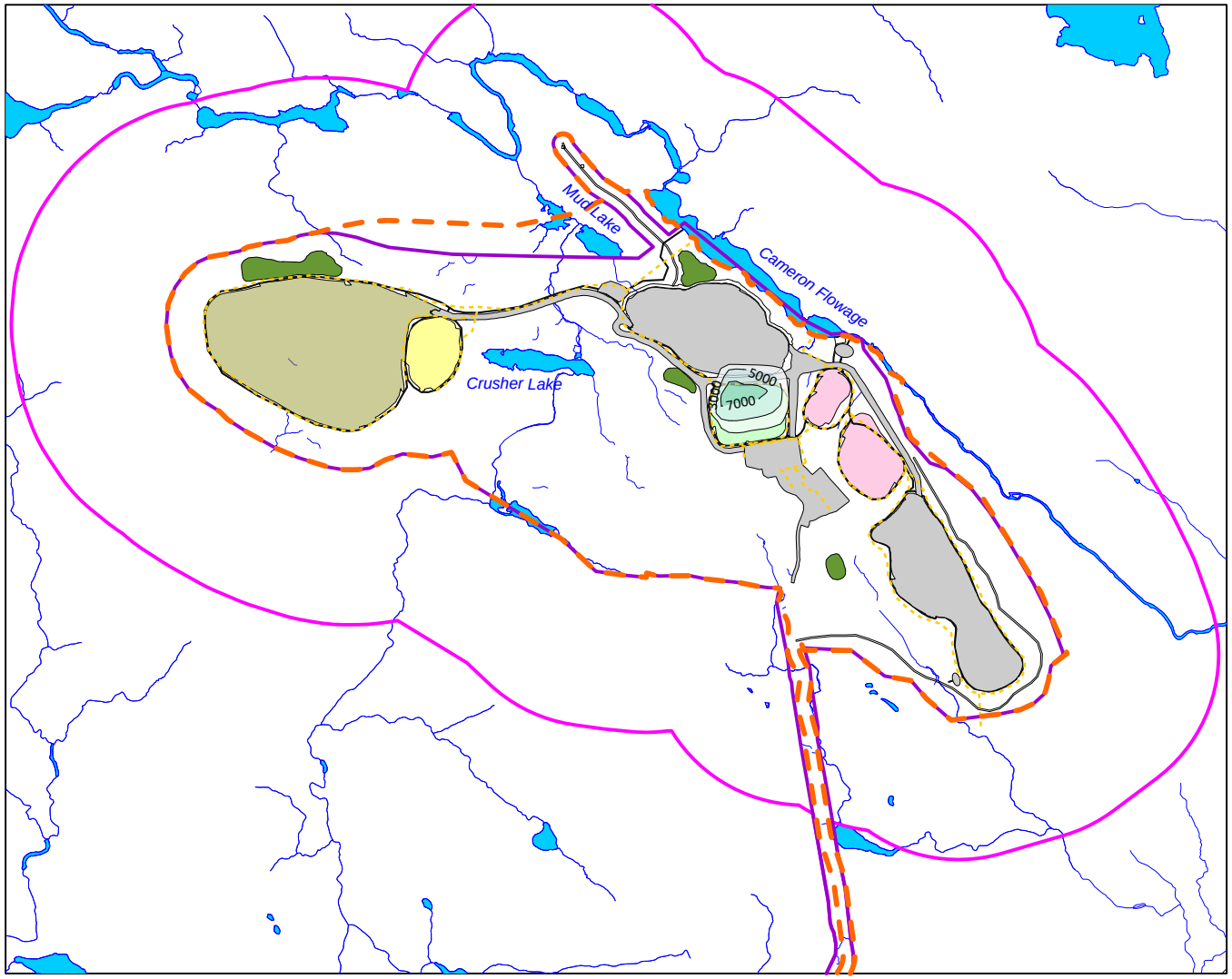
Figure F.11

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.40 - Sim_Copper_PSS-PC-UC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED IRON CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The iron Tier 2 PSS for groundwater discharge to surface water (>10 m) is 3,000 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED IRON CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

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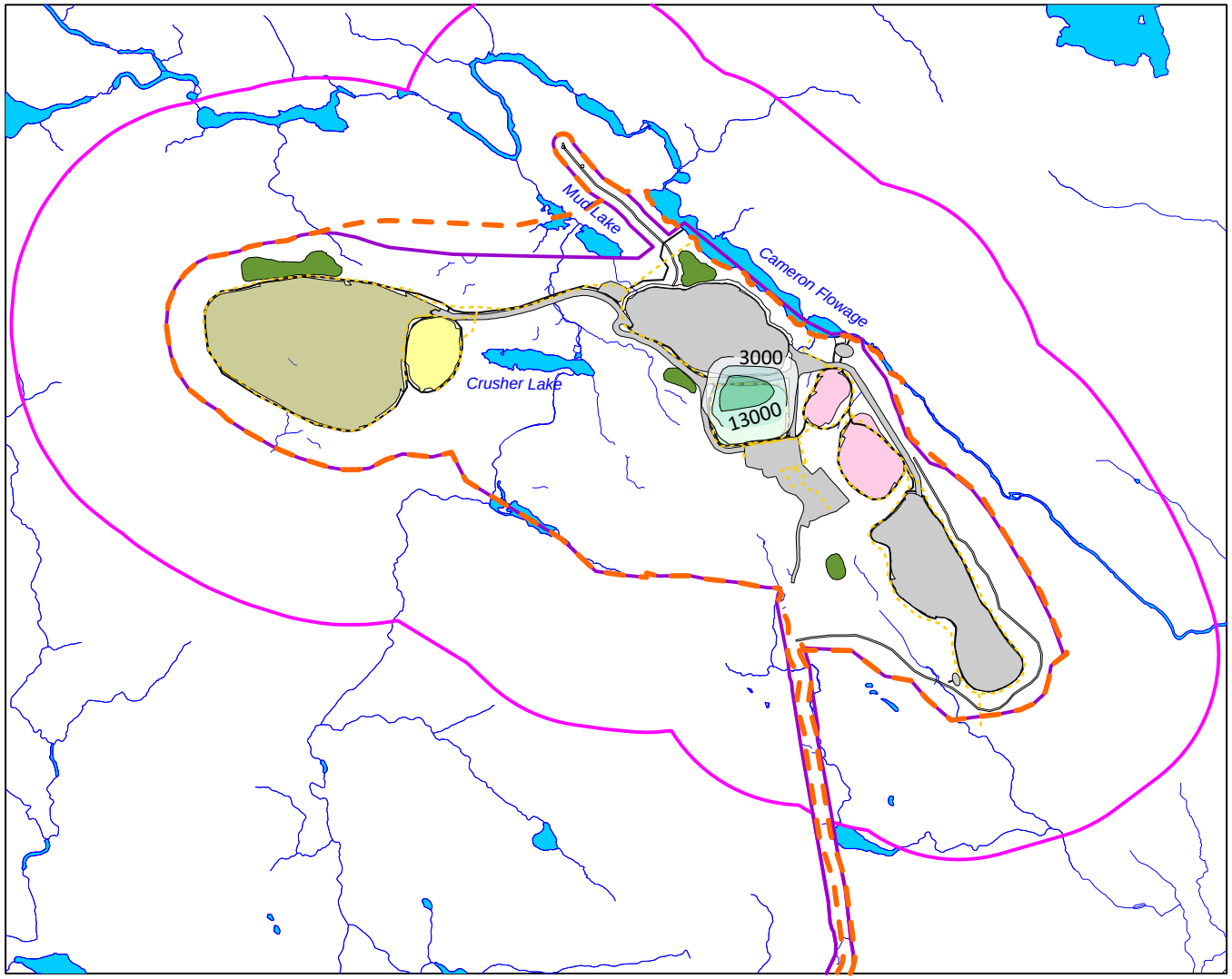
March 11, 2021

Figure F.12

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.41 - Sim_Iron_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED IRON CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The iron Tier 2 PSS for groundwater discharge to surface water (>10 m) is 3,000 ug/L.

0 300 600 900m

N

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SIMULATED IRON CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

088664-031
March 11, 2021

Figure F.13

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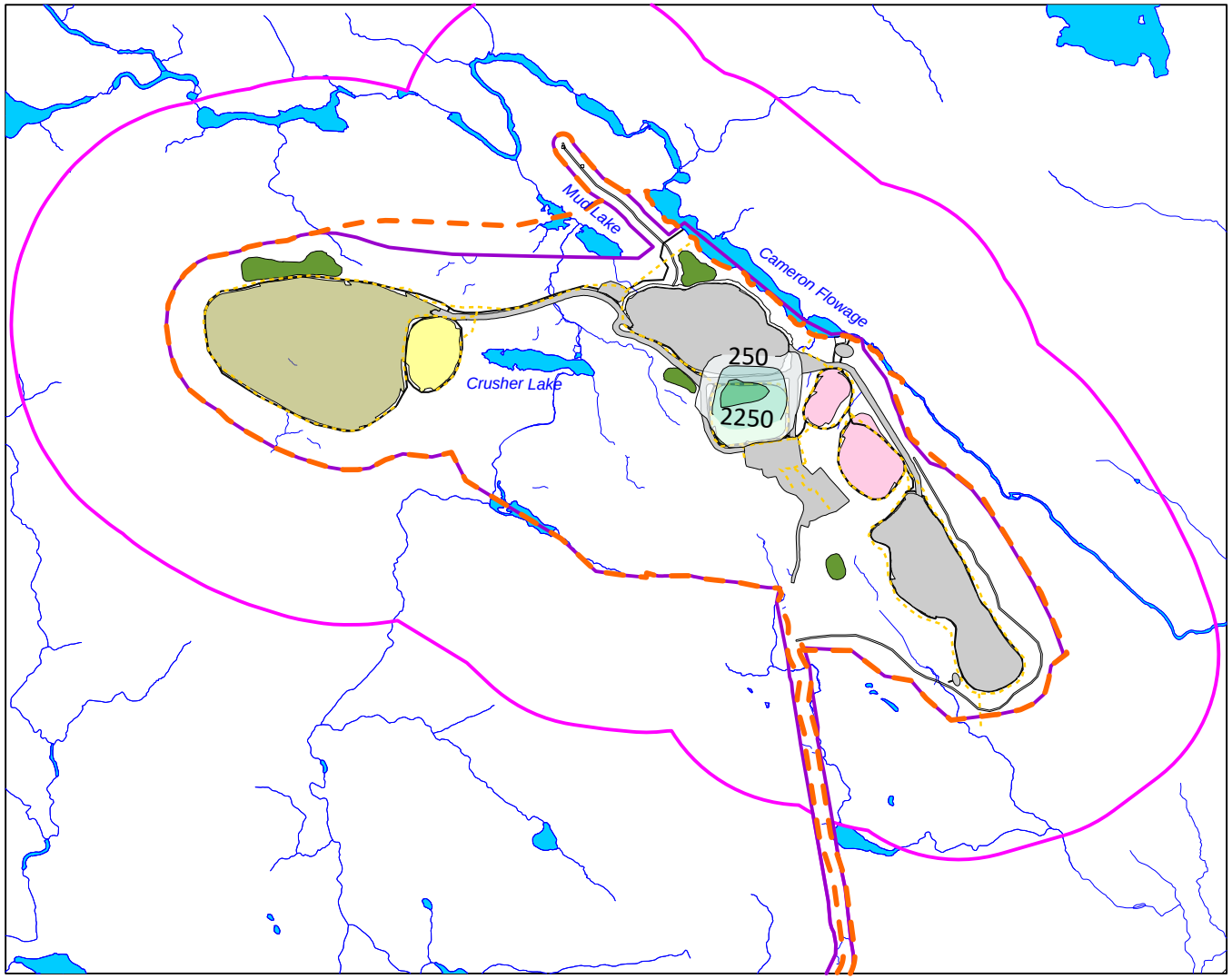

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 2 PSS for groundwater discharge to surface water (>10 m) is 250 ug/L.

0 300 600 900m

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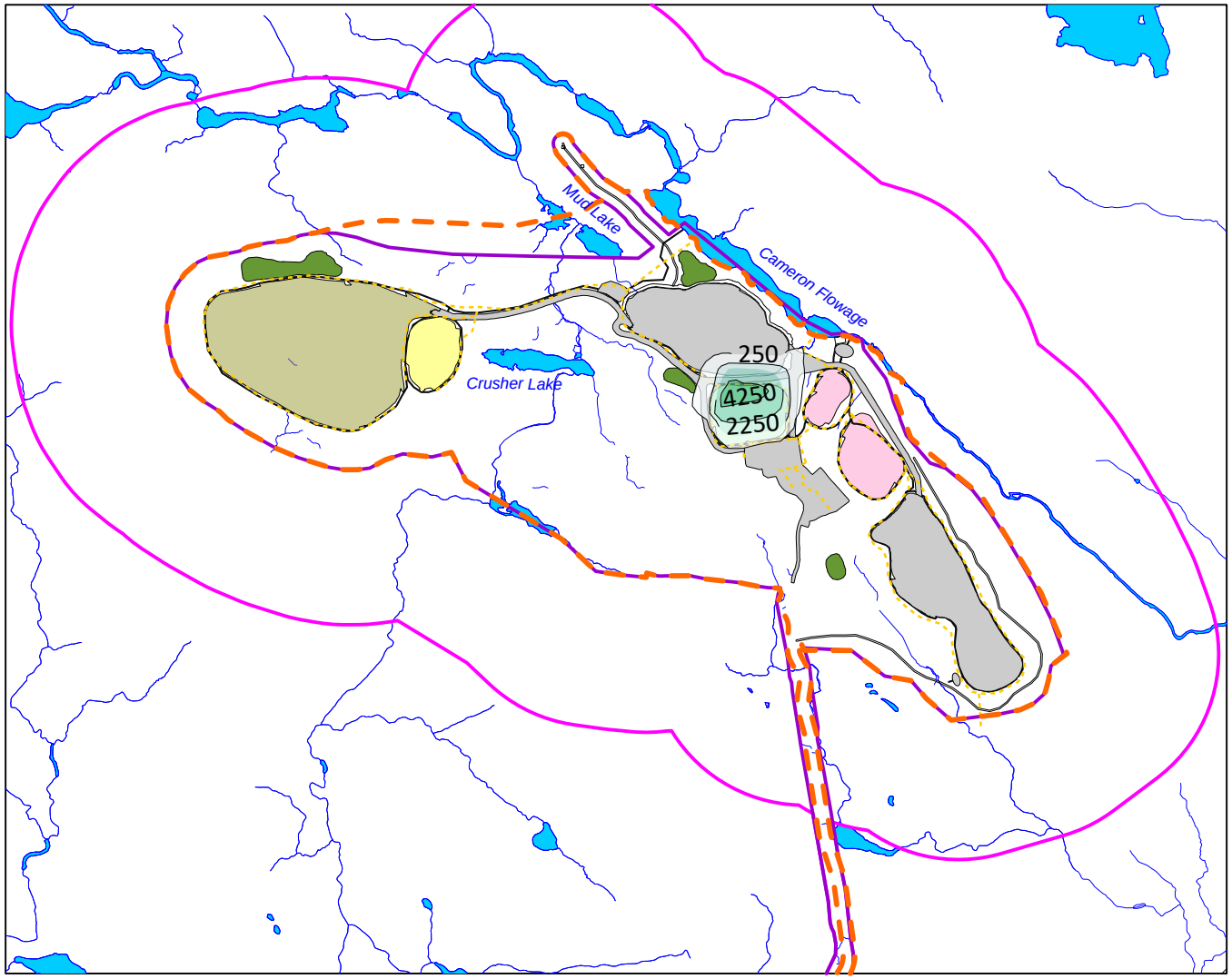
BEAVER DAM MINE

SIMULATED NICKEL CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

088664-031
March 11, 2021

Figure F.14

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.43 - Sim_Nickel_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 2 PSS for groundwater discharge to surface water (>10 m) is 250 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED NICKEL CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

088664-031
March 11, 2021

Figure F.15

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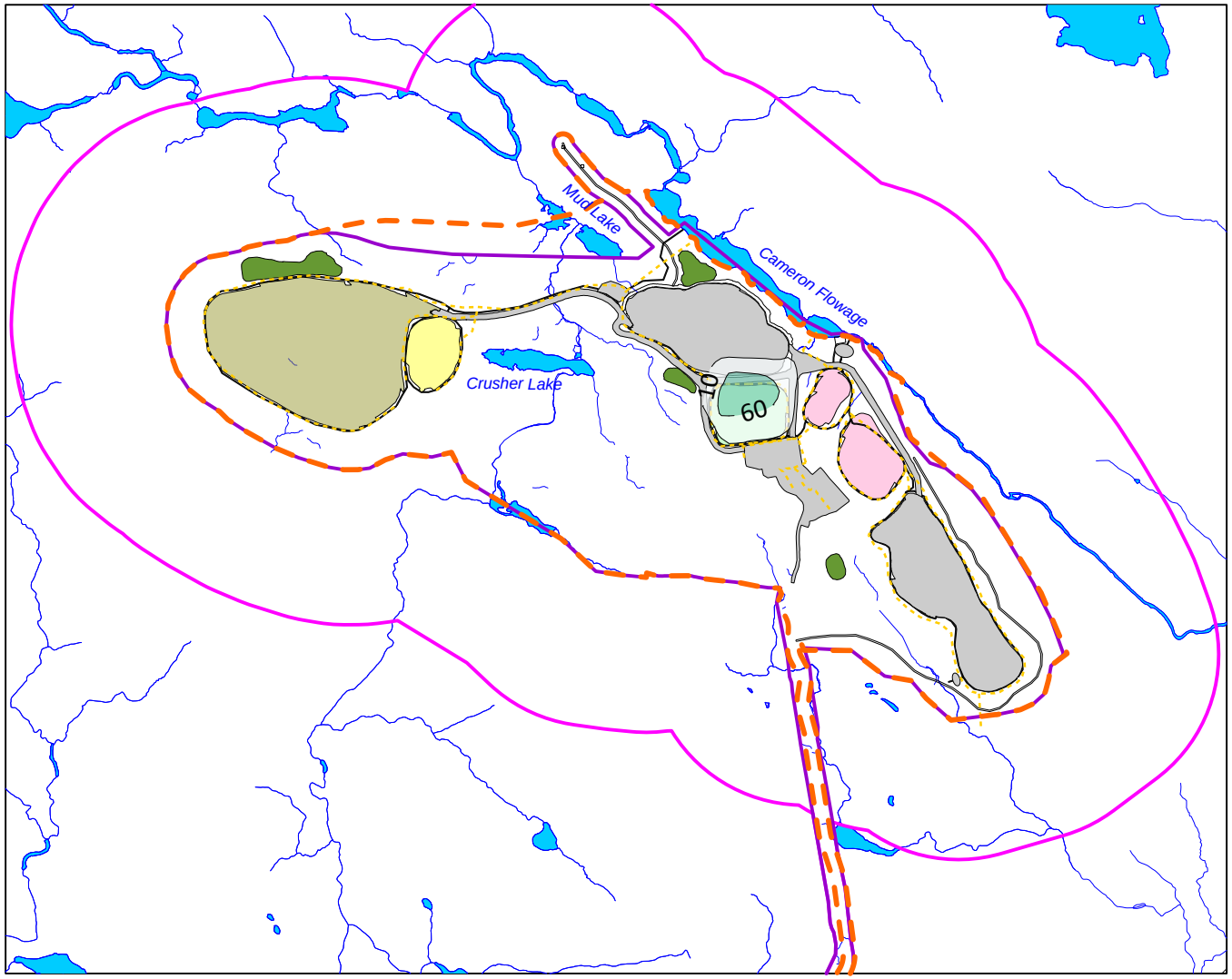

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead Tier 2 PSS for groundwater discharge to surface water (>10 m) is 10 ug/L.

0 300 600 900m

N

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BEAVER DAM MINE

SIMULATED LEAD CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

088664-031
March 11, 2021

Figure F.16

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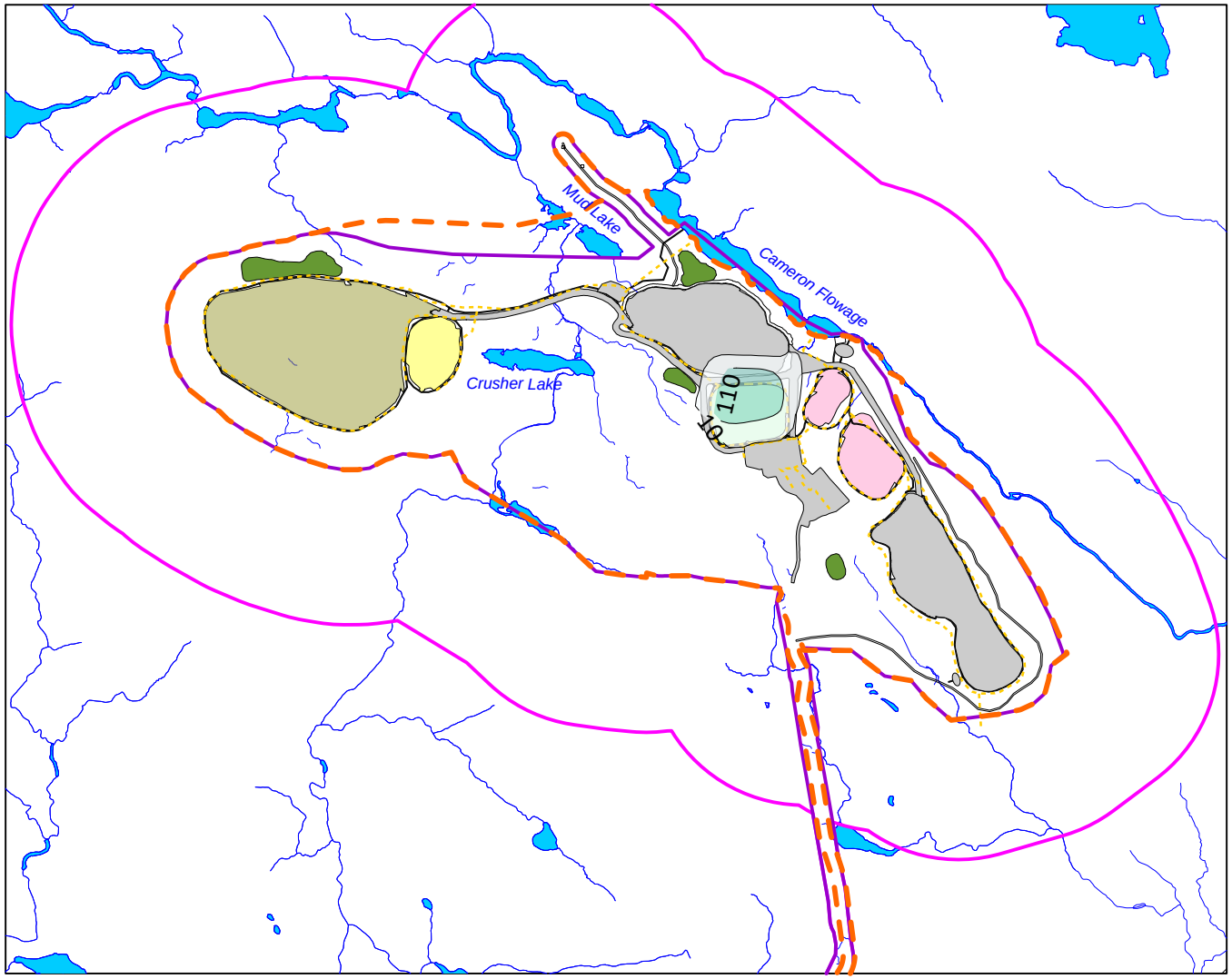

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead Tier 2 PSS for groundwater discharge to surface water (>10 m) is 10 ug/L.

0 300 600 900m

N

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SIMULATED LEAD CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

088664-031
March 11, 2021

Figure F.17

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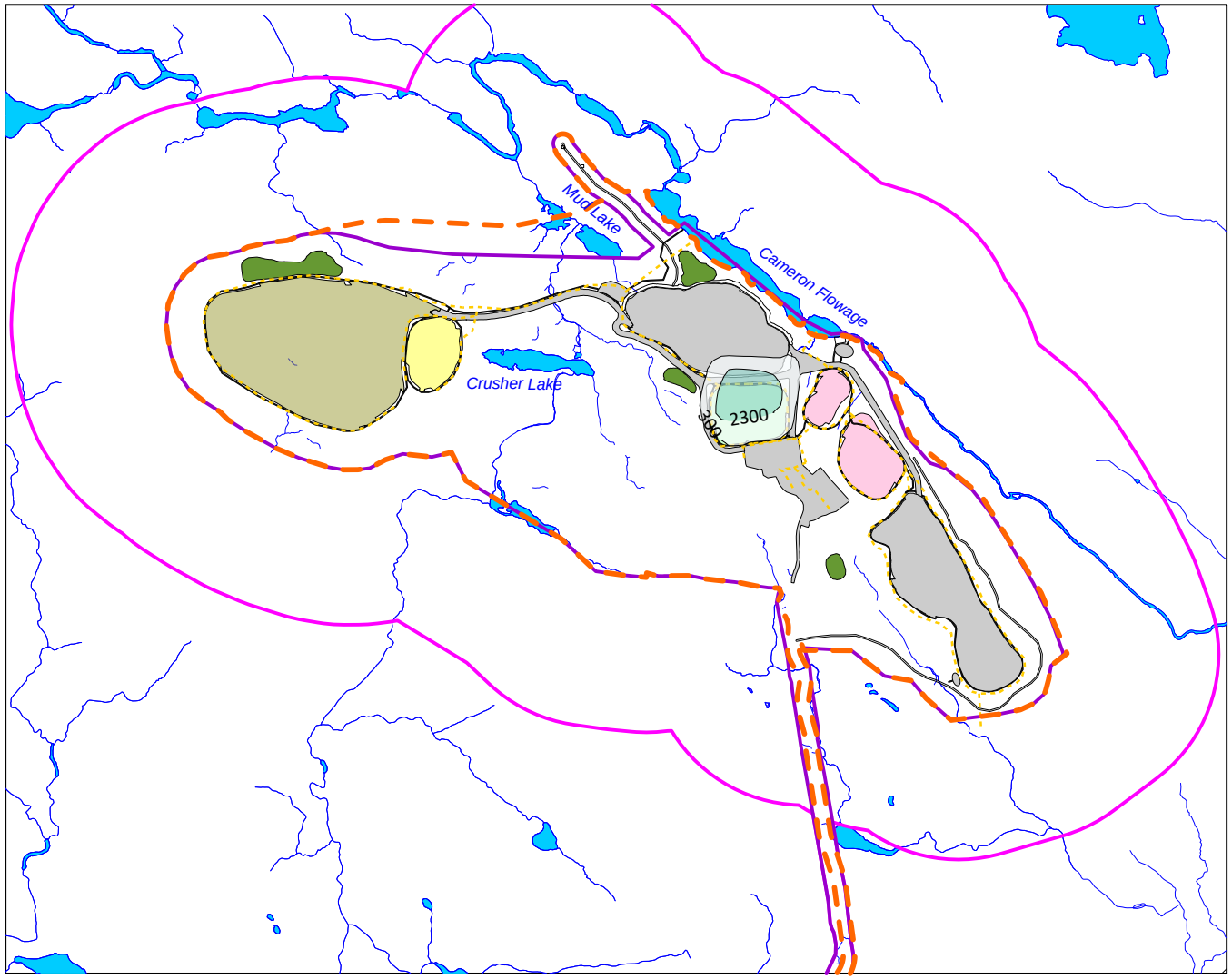

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 2 PSS for groundwater discharge to surface water (>10 m) is 300 ug/L.

0 300 600 900m

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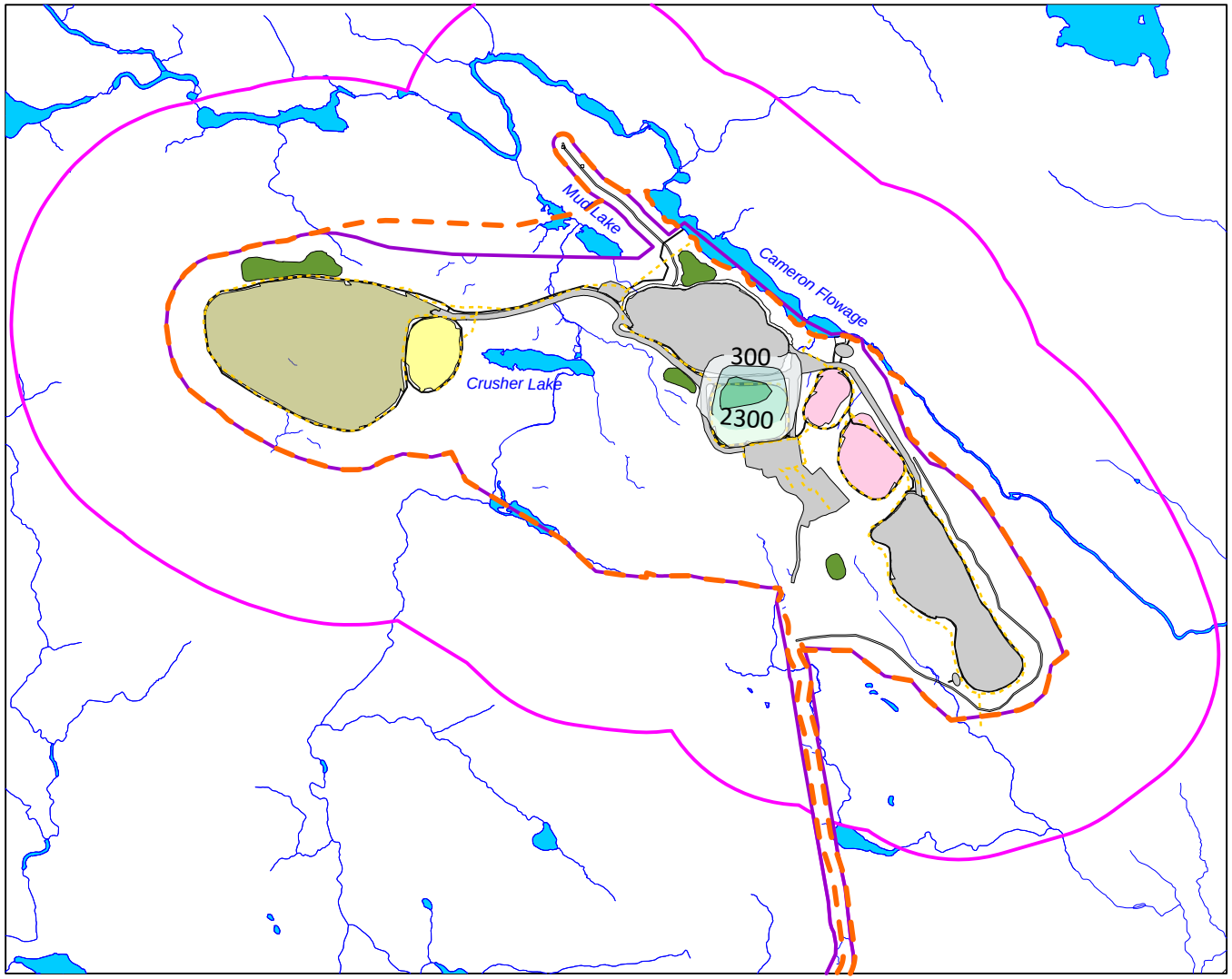
BEAVER DAM MINE

SIMULATED ZINC CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - DRY CASE CONDITION

088664-031
March 11, 2021

Figure F.18

HEG file: Z:\HEG\088664\DOCUMENTATION\RPT\088664-RPT-13\FIGURES\Figure 7.48 - Sim_Zinc_PSS-PC-BC-AVG.srf



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 2 PSS for groundwater discharge to surface water (>10 m) is 300 ug/L.

0 300 600 900m

N

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SIMULATED ZINC CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - DRY CASE CONDITION

088664-031
March 11, 2021

Figure F.19

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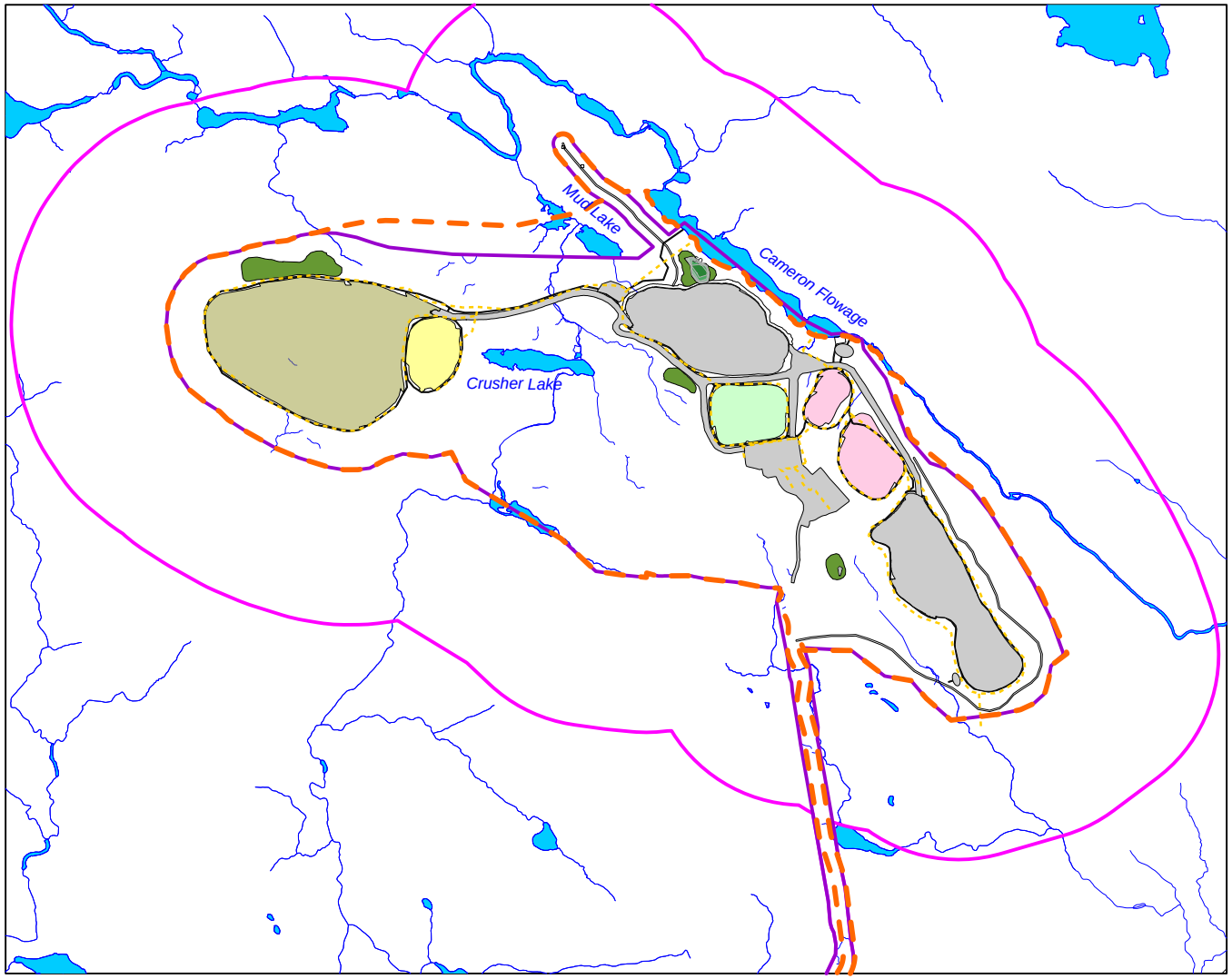
Appendix G
Simulated COC Concentrations in Groundwater Versus Tier 2 PSS – Wet Conditions



LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
EOM - BASE CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.1

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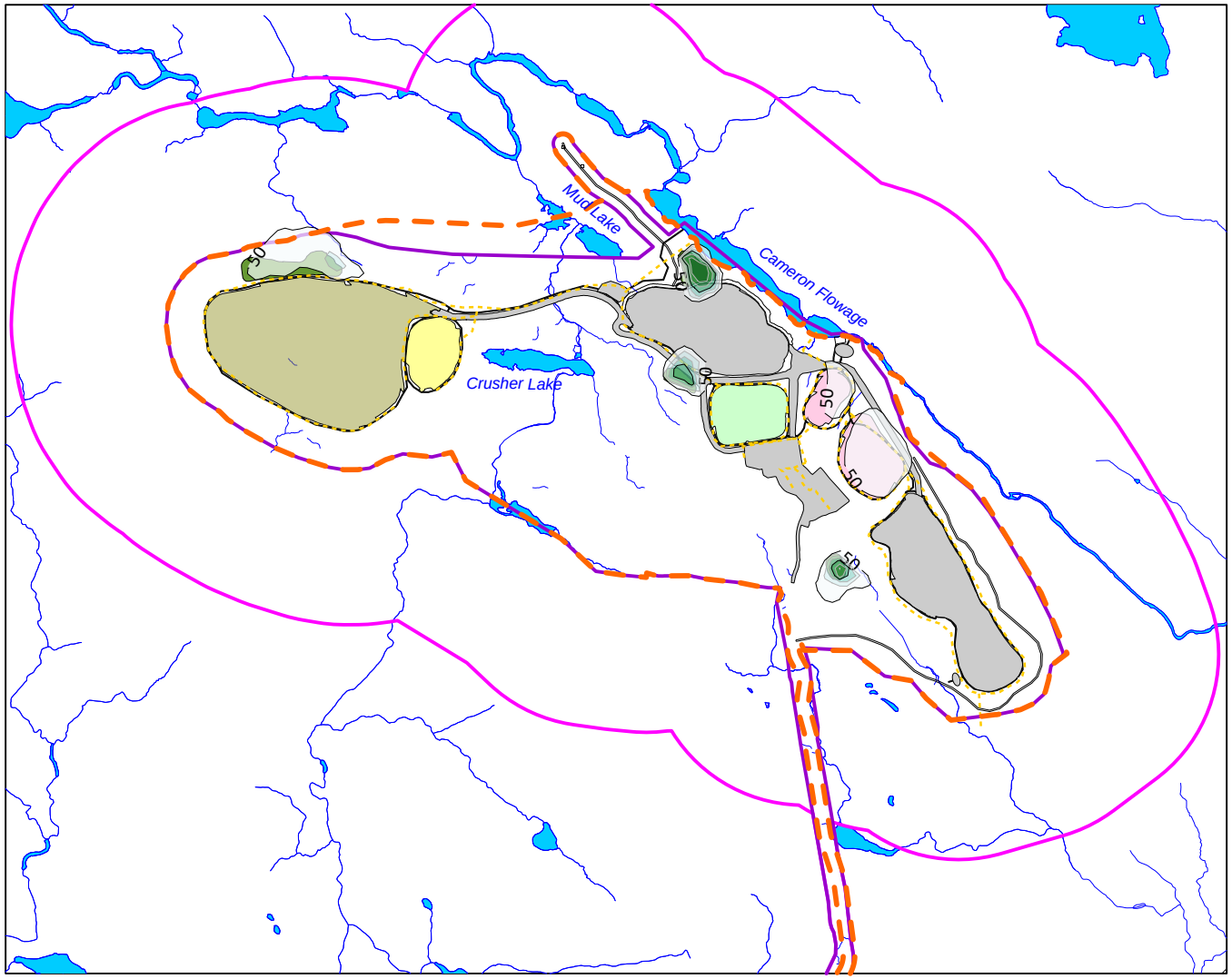

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

N

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SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.2

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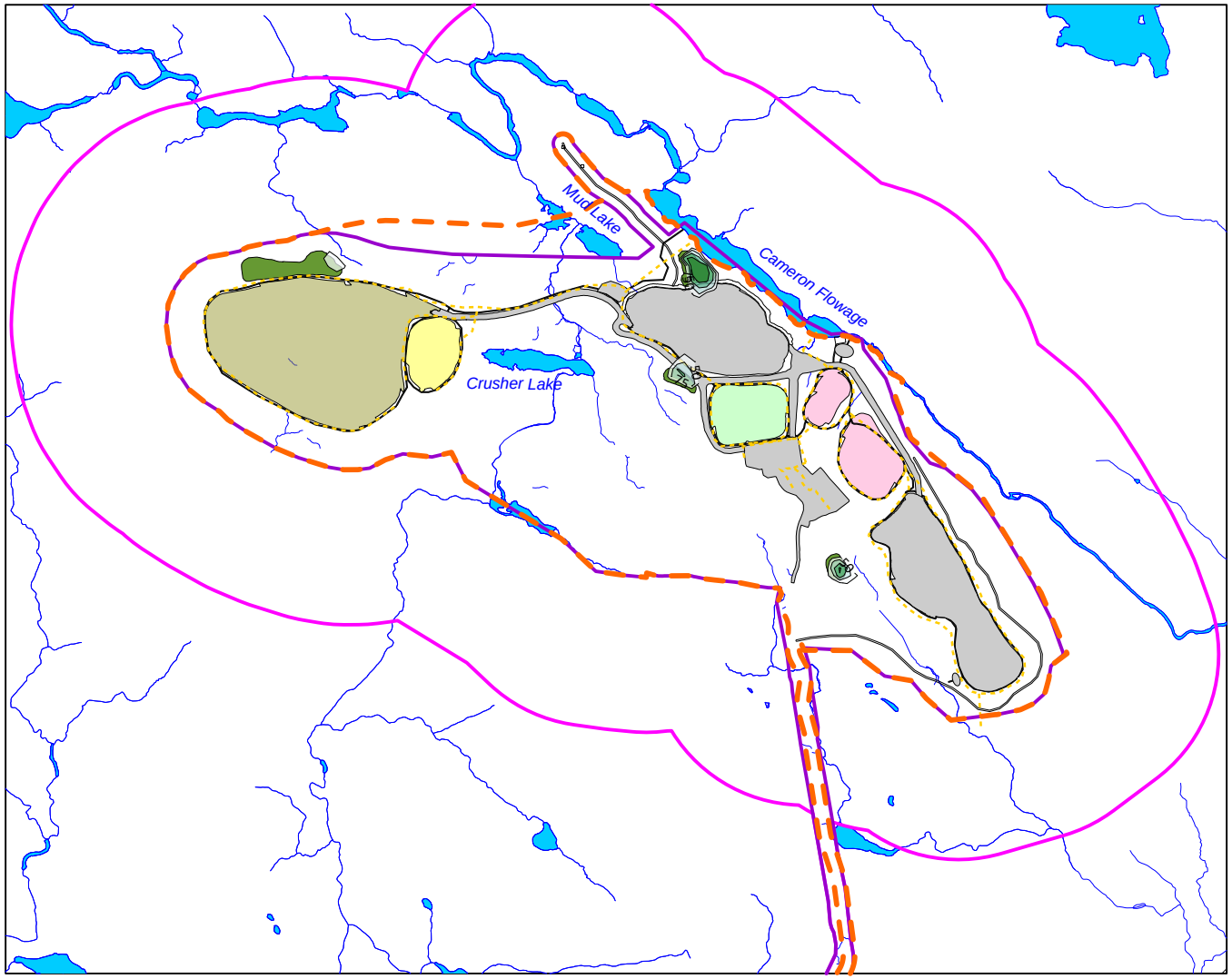

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ARSENIC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The arsenic Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED ARSENIC CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.3

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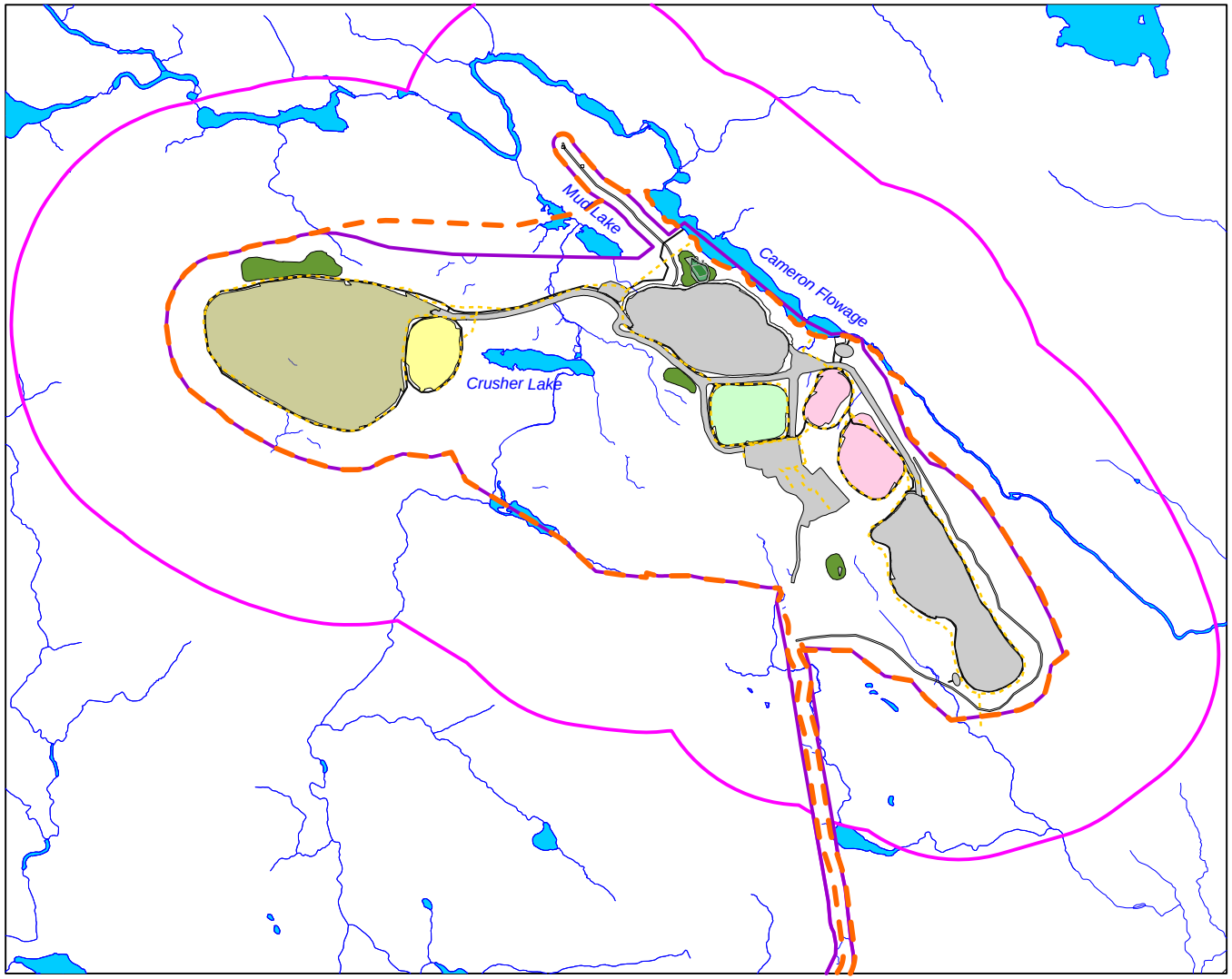

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

N

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SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
EOM - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.4

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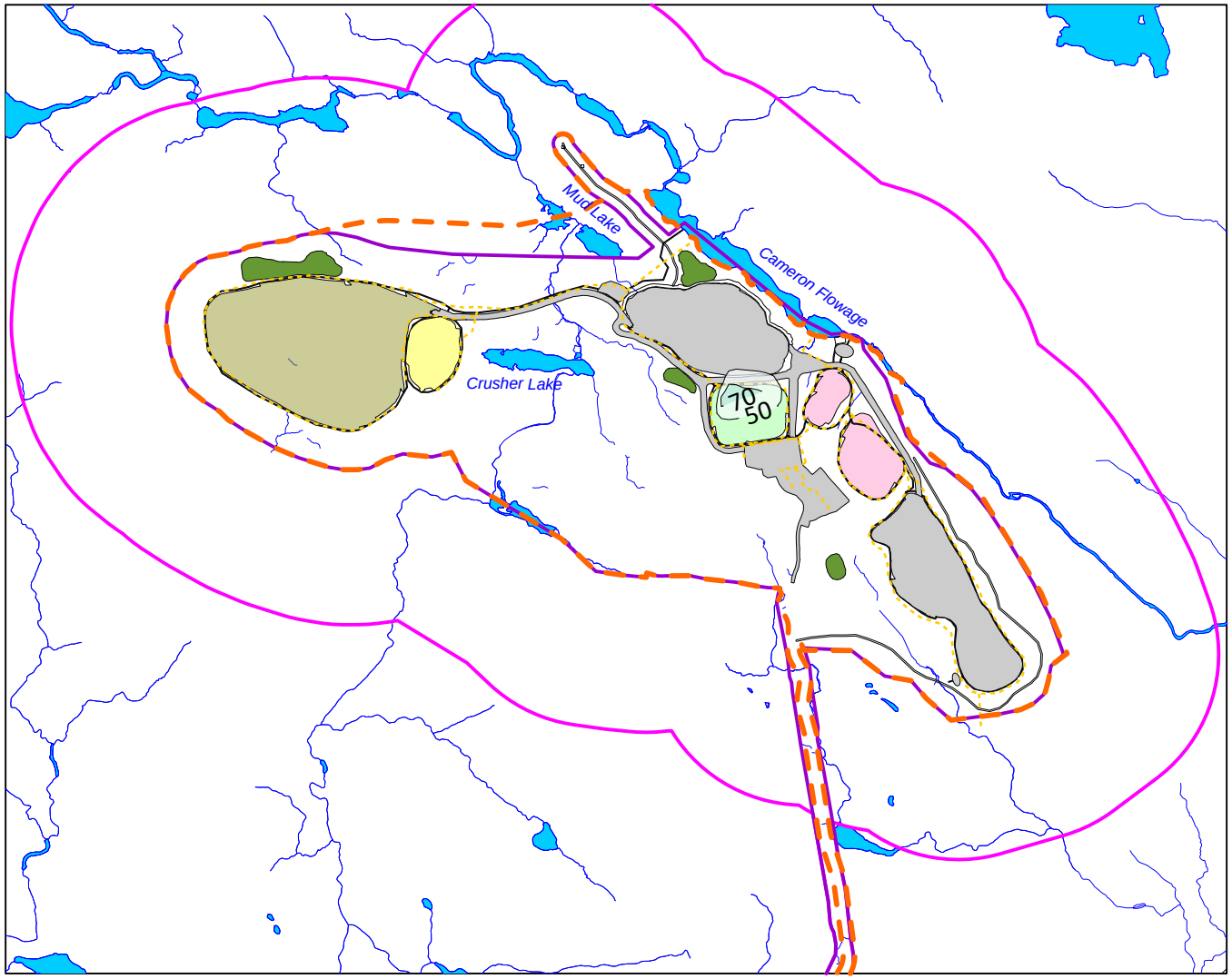

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.5

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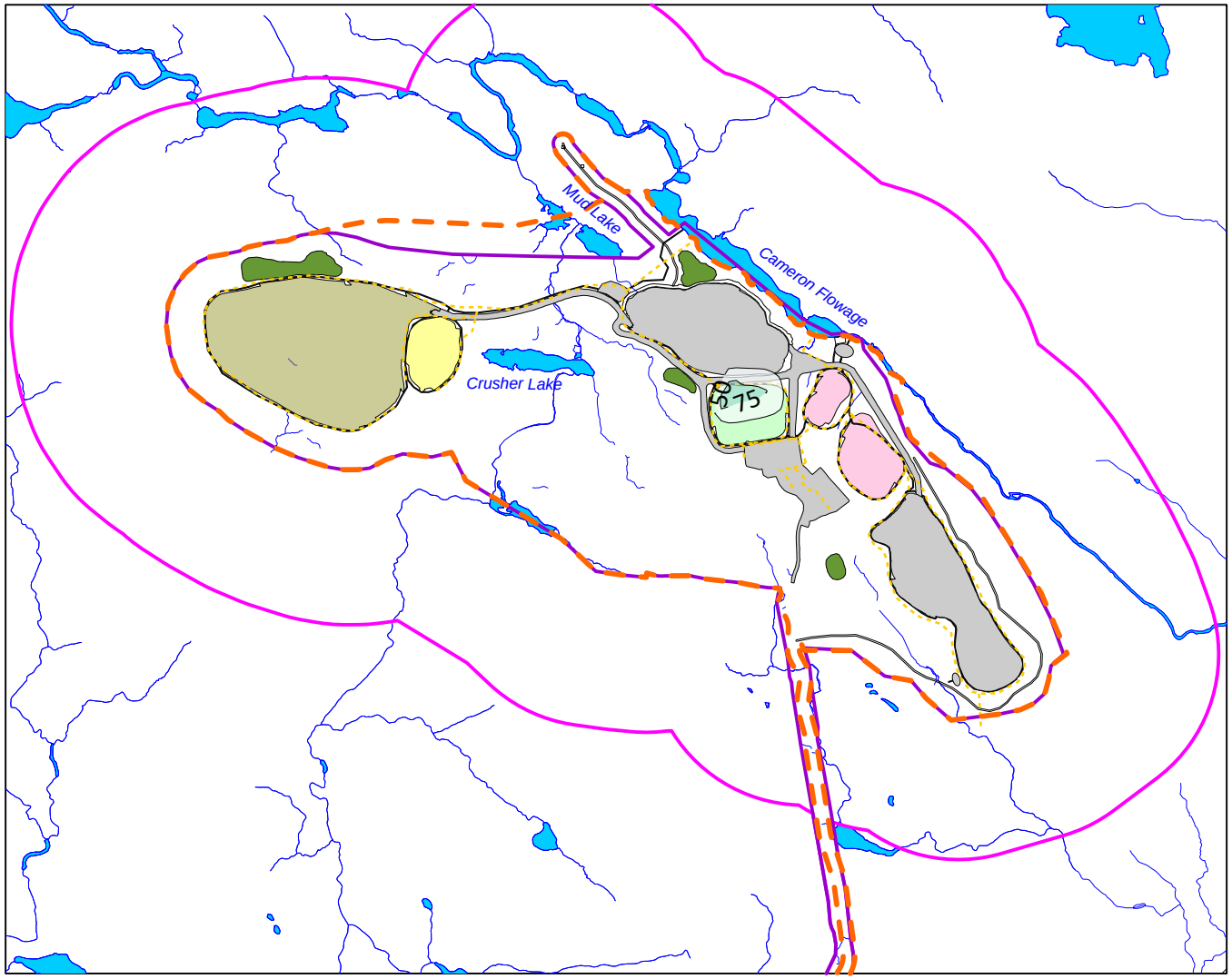

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ALUMINUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The aluminum Tier 2 PSS for groundwater discharge to surface water (>10 m) is 50 ug/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED ALUMINUM CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.6

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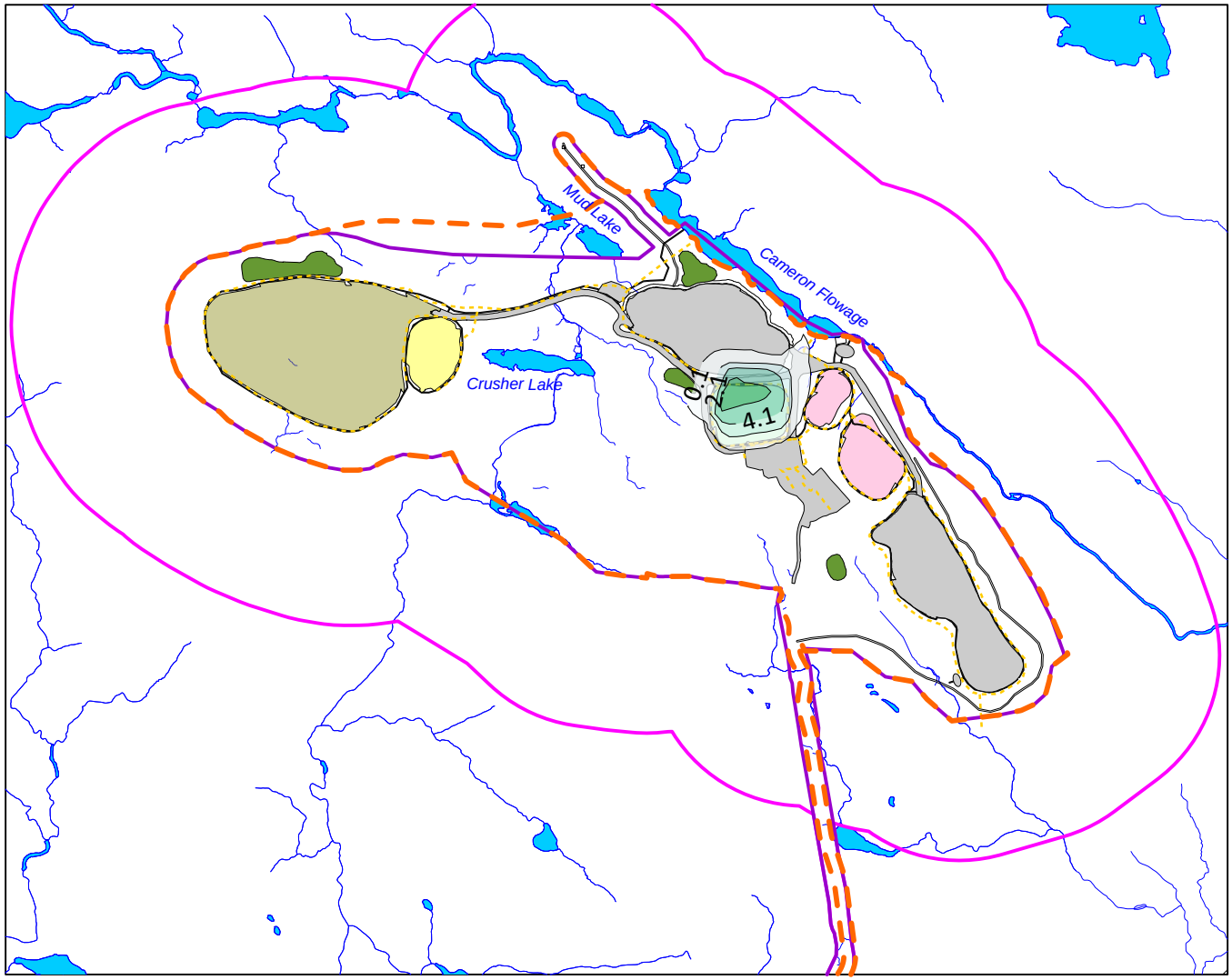

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.7

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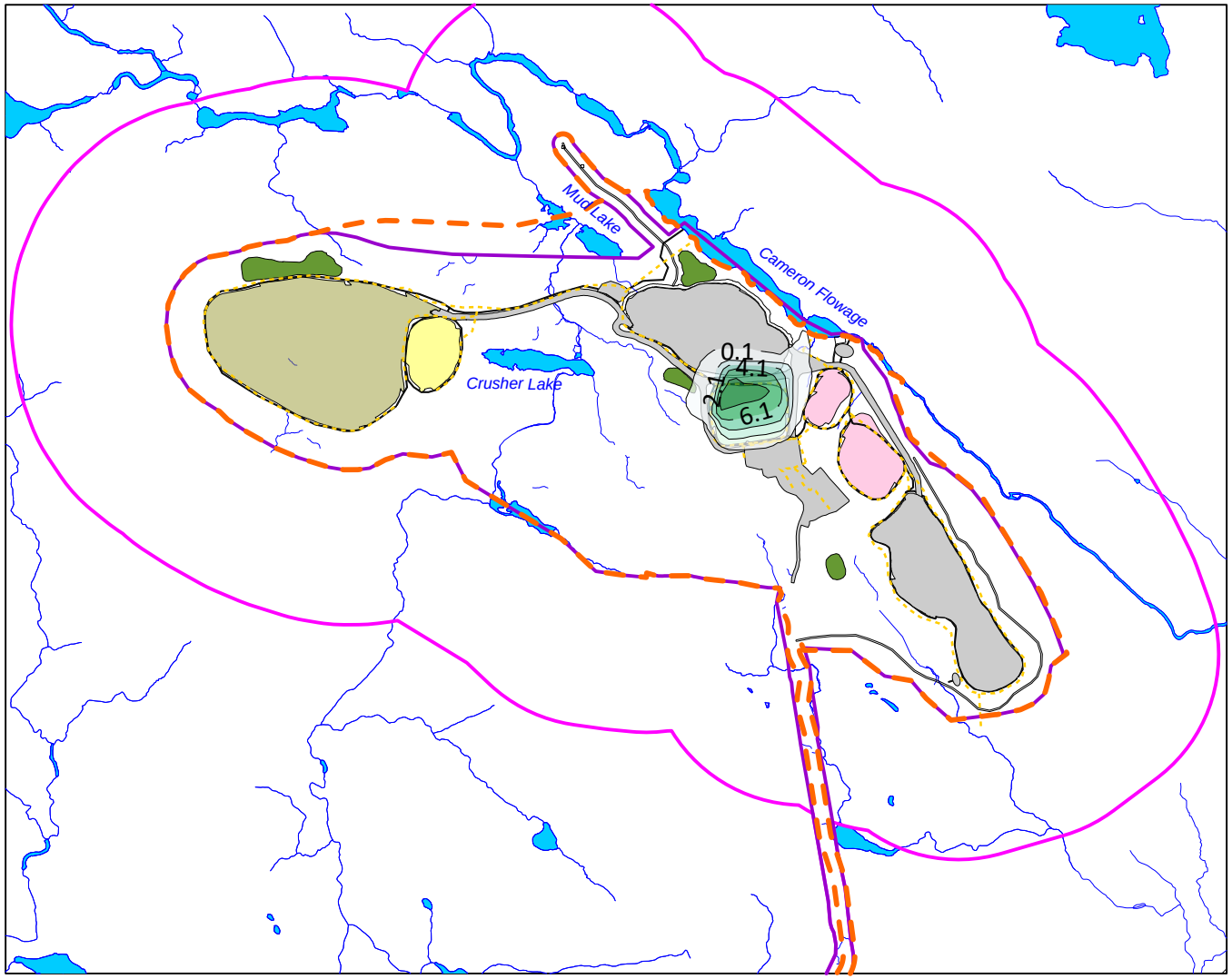

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED CADMIUM CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cadmium Tier 2 PSS for groundwater discharge to surface water (>10 m) is 0.1 ug/L.

0 300 600 900m

N

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ATLANTIC GOLD CORPORATION
MARINETTE, NOVA SCOTIA
BEAVER DAM MINE

SIMULATED CADMIUM CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.8

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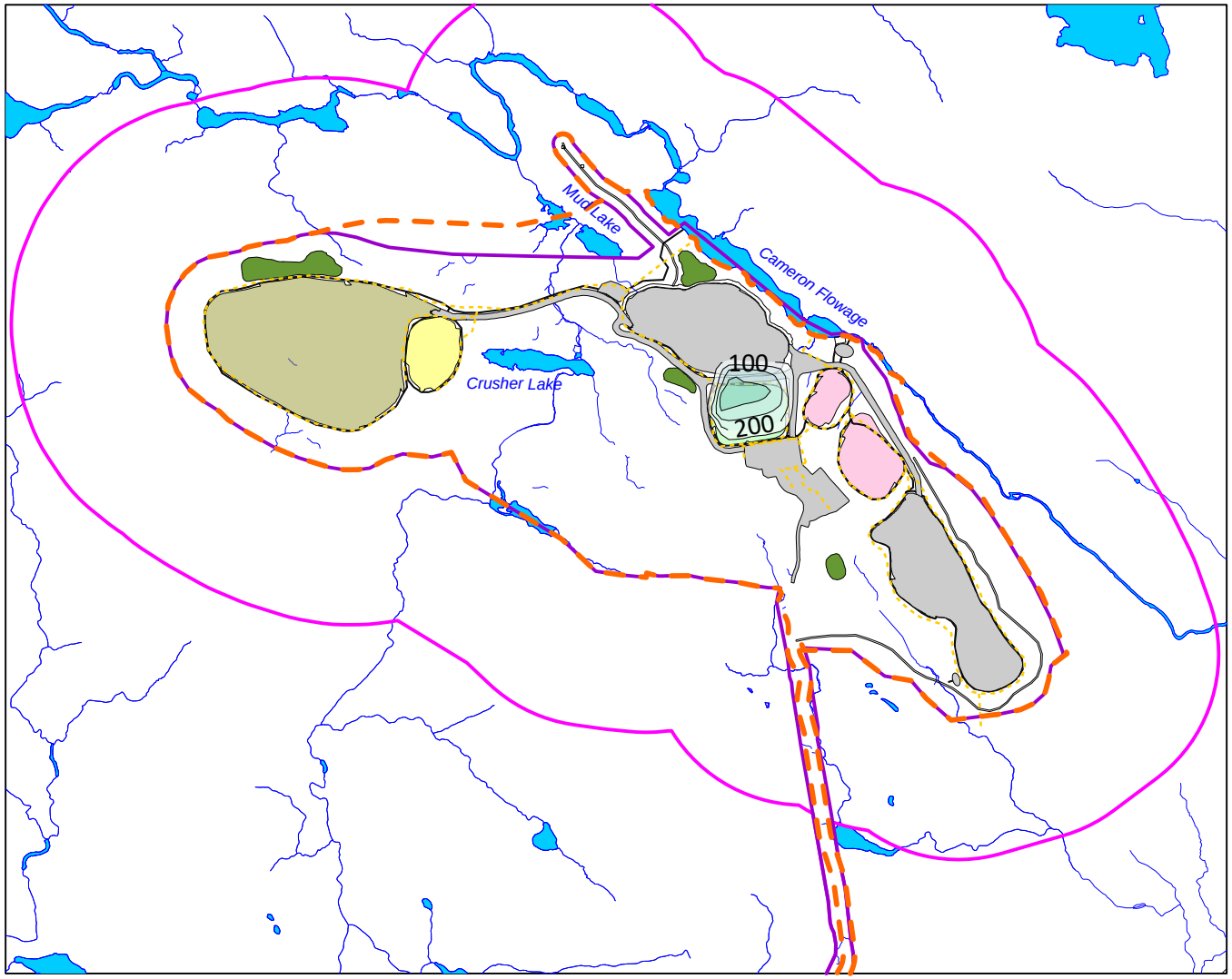

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 2 PSS for groundwater discharge to surface water (>10 m) is 100 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED COBALT CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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March 11, 2021

Figure G.9

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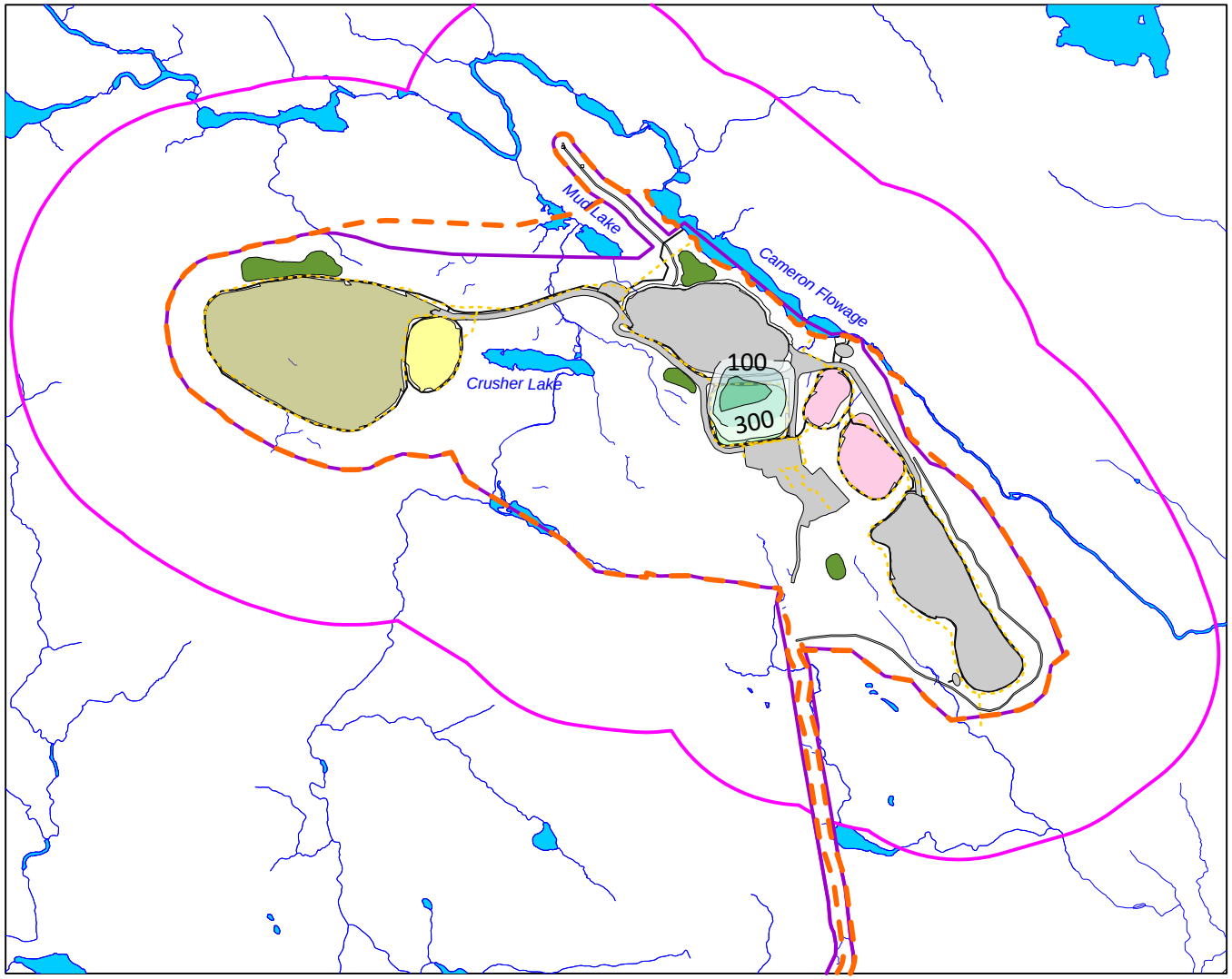

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COBALT CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The cobalt Tier 2 PSS for groundwater discharge to surface water (>10 m) is 100 ug/L.

0 300 600 900m

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SIMULATED COBALT CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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March 11, 2021

Figure G.10

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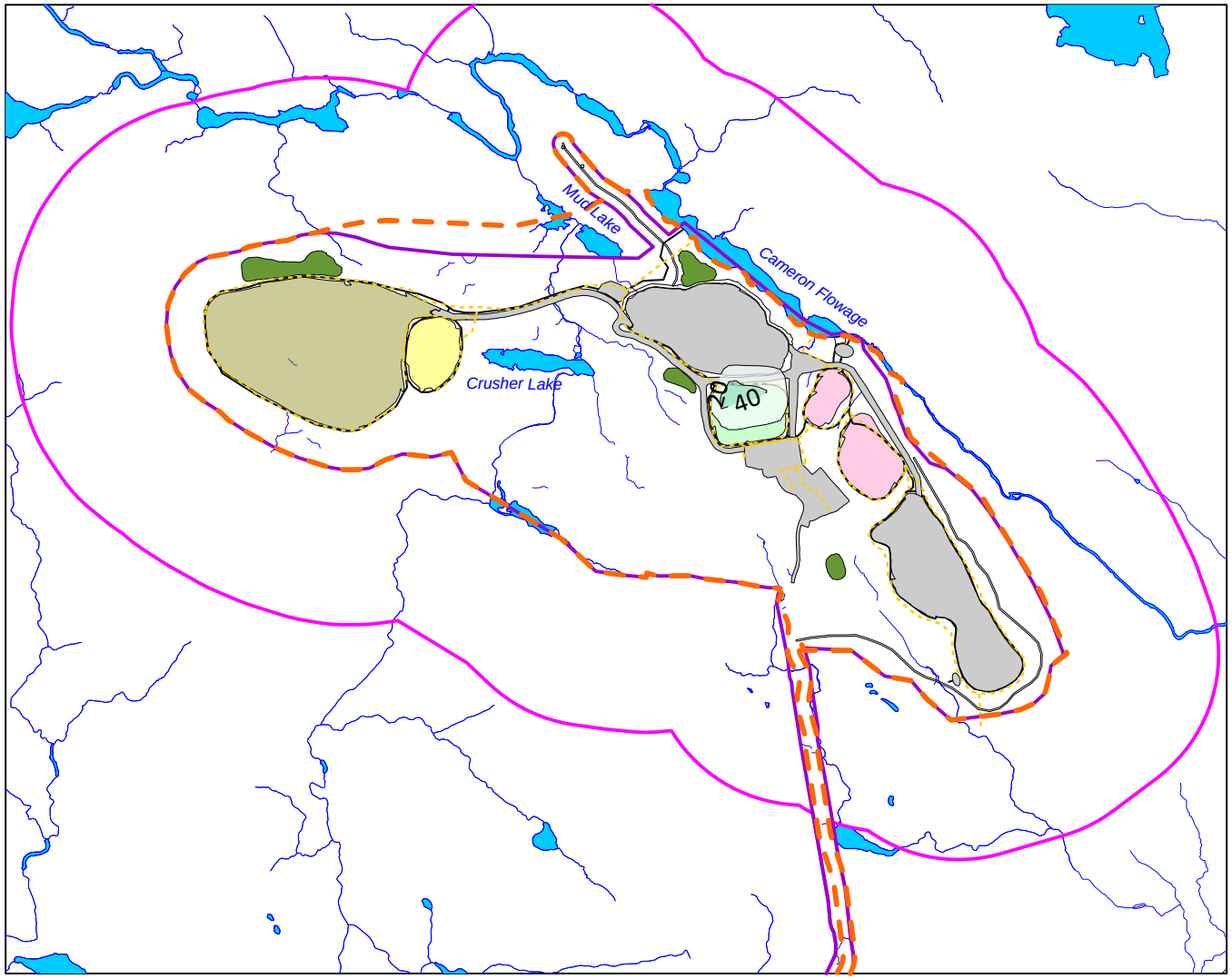

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED COPPER CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The copper Tier 2 PSS for groundwater discharge to surface water (>10 m) is 20 ug/L.

0 300 600 900m

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SIMULATED COPPER CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

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Figure G.11

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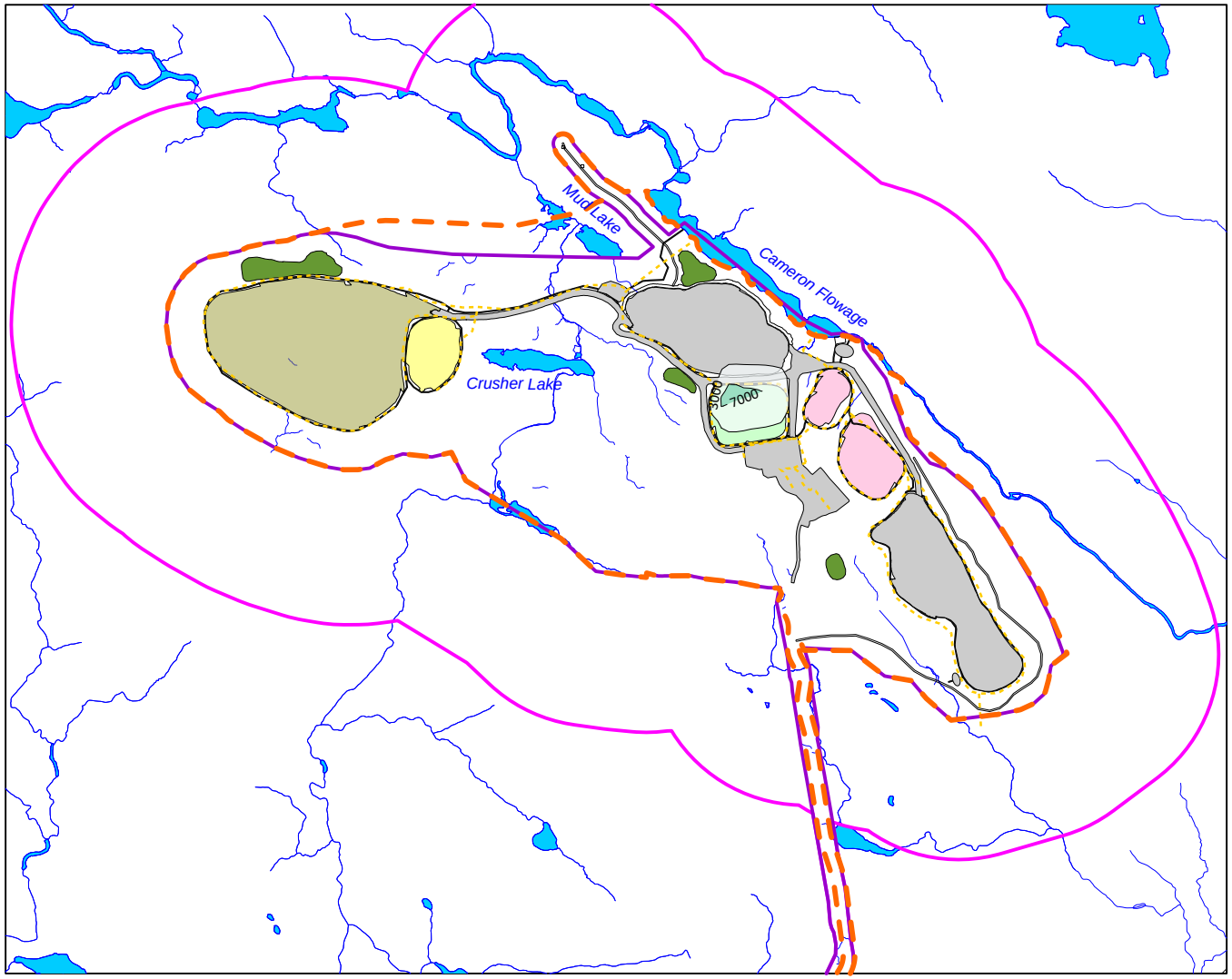

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED IRON CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The iron Tier 2 PSS for groundwater discharge to surface water (>10 m) is 3,000 ug/L.

0 300 600 900m

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SIMULATED IRON CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.12

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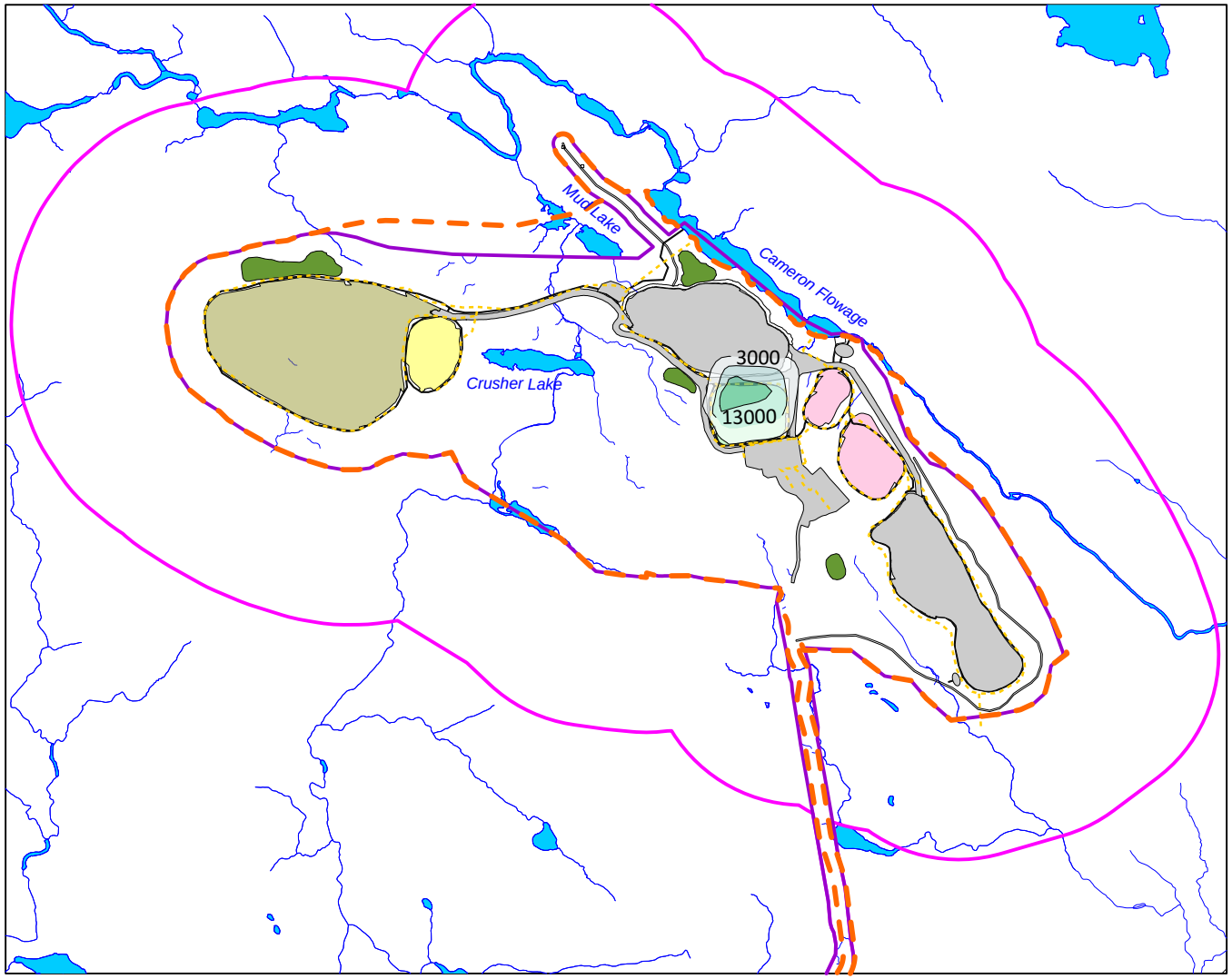

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED IRON CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The iron Tier 2 PSS for groundwater discharge to surface water (>10 m) is 3,000 ug/L.

0 300 600 900m

N

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SIMULATED IRON CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.13

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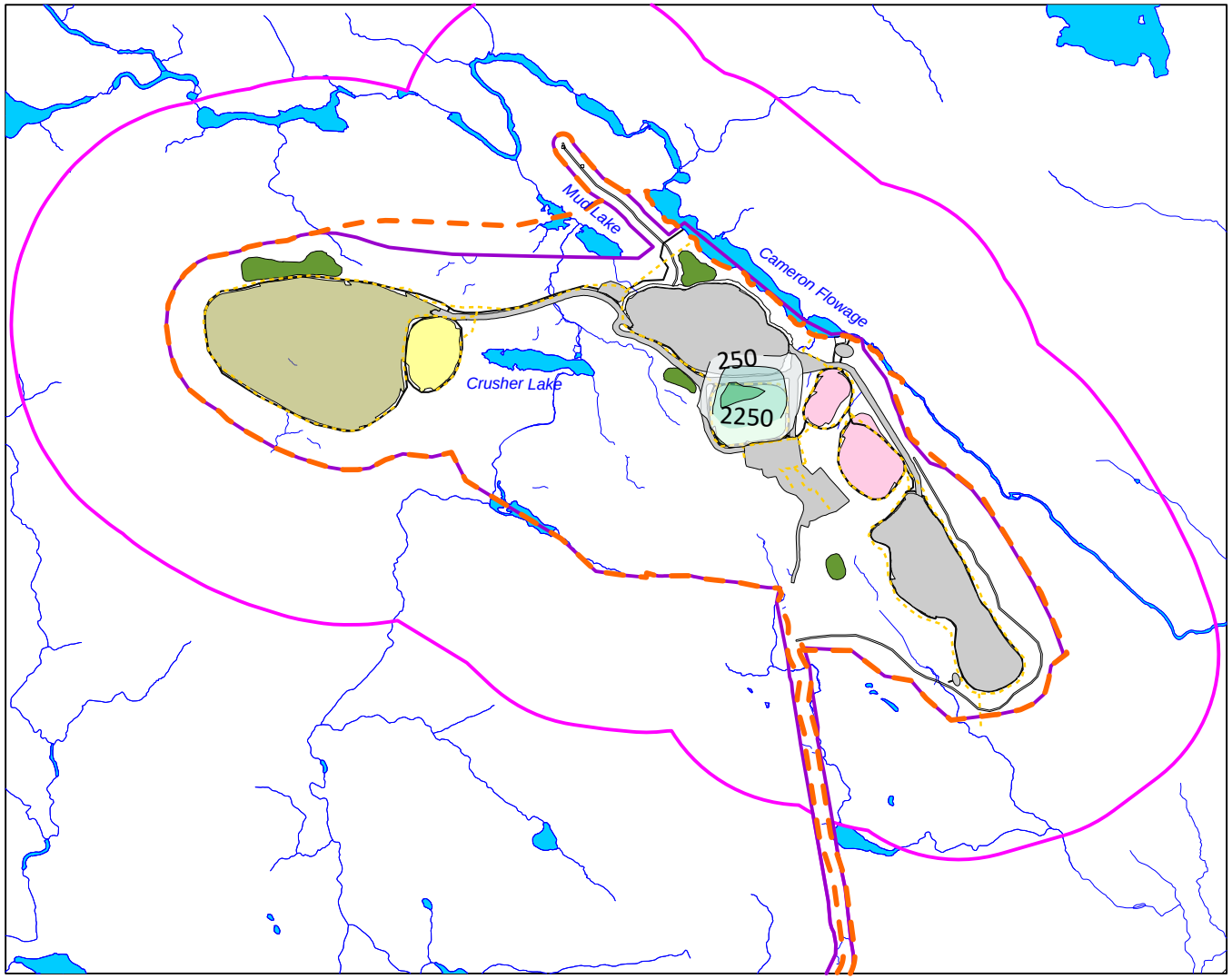

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- *0.1* SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 2 PSS for groundwater discharge to surface water (>10 m) is 250 ug/L.

0 300 600 900m

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SIMULATED NICKEL CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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March 11, 2021

Figure G.14

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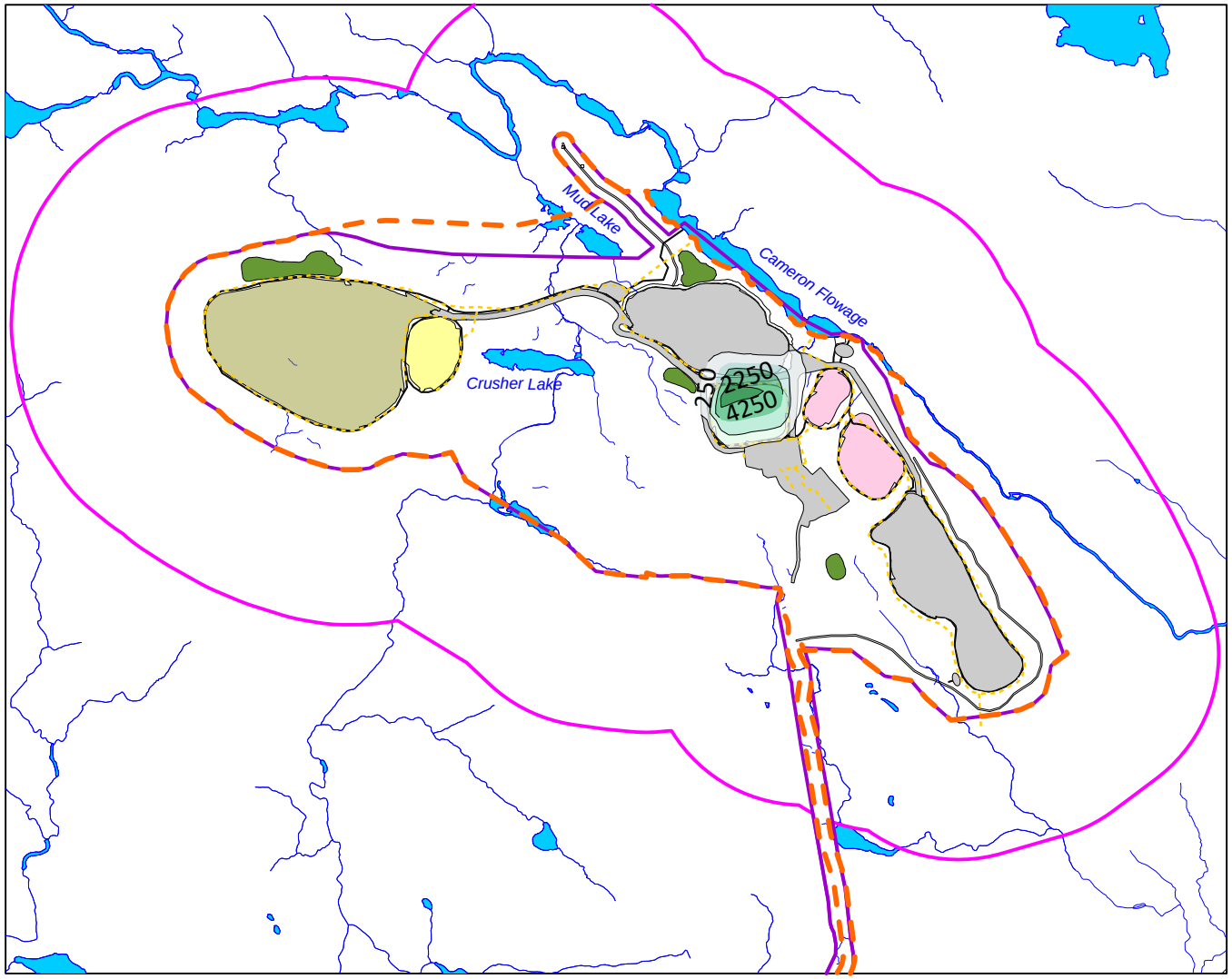

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED NICKEL CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The nickel Tier 2 PSS for groundwater discharge to surface water (>10 m) is 250 ug/L.

0 300 600 900m

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BEAVER DAM MINE

SIMULATED NICKEL CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.15

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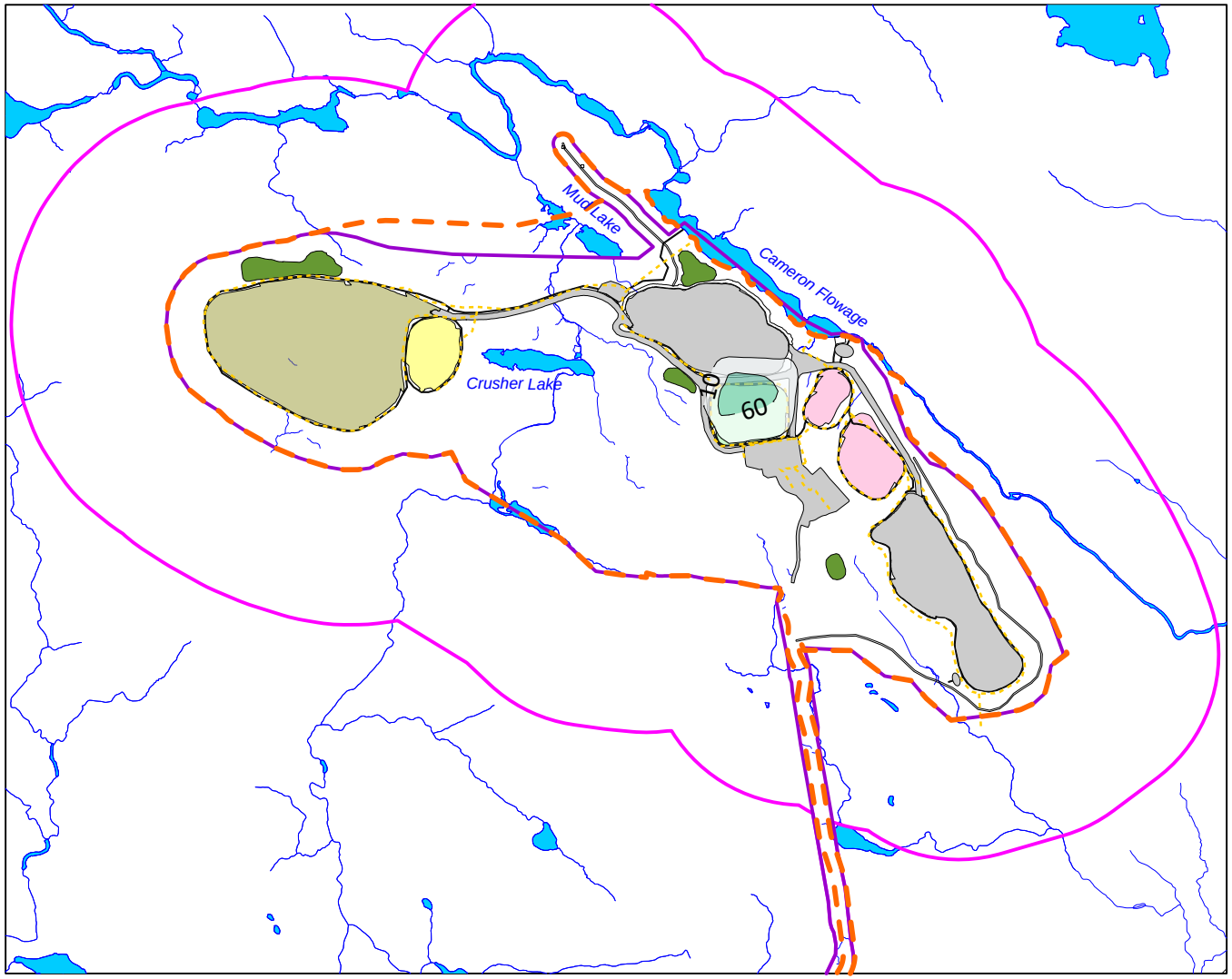

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead Tier 2 PSS for groundwater discharge to surface water (>10 m) is 10 ug/L.

0 300 600 900m

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SIMULATED LEAD CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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March 11, 2021

Figure G.16

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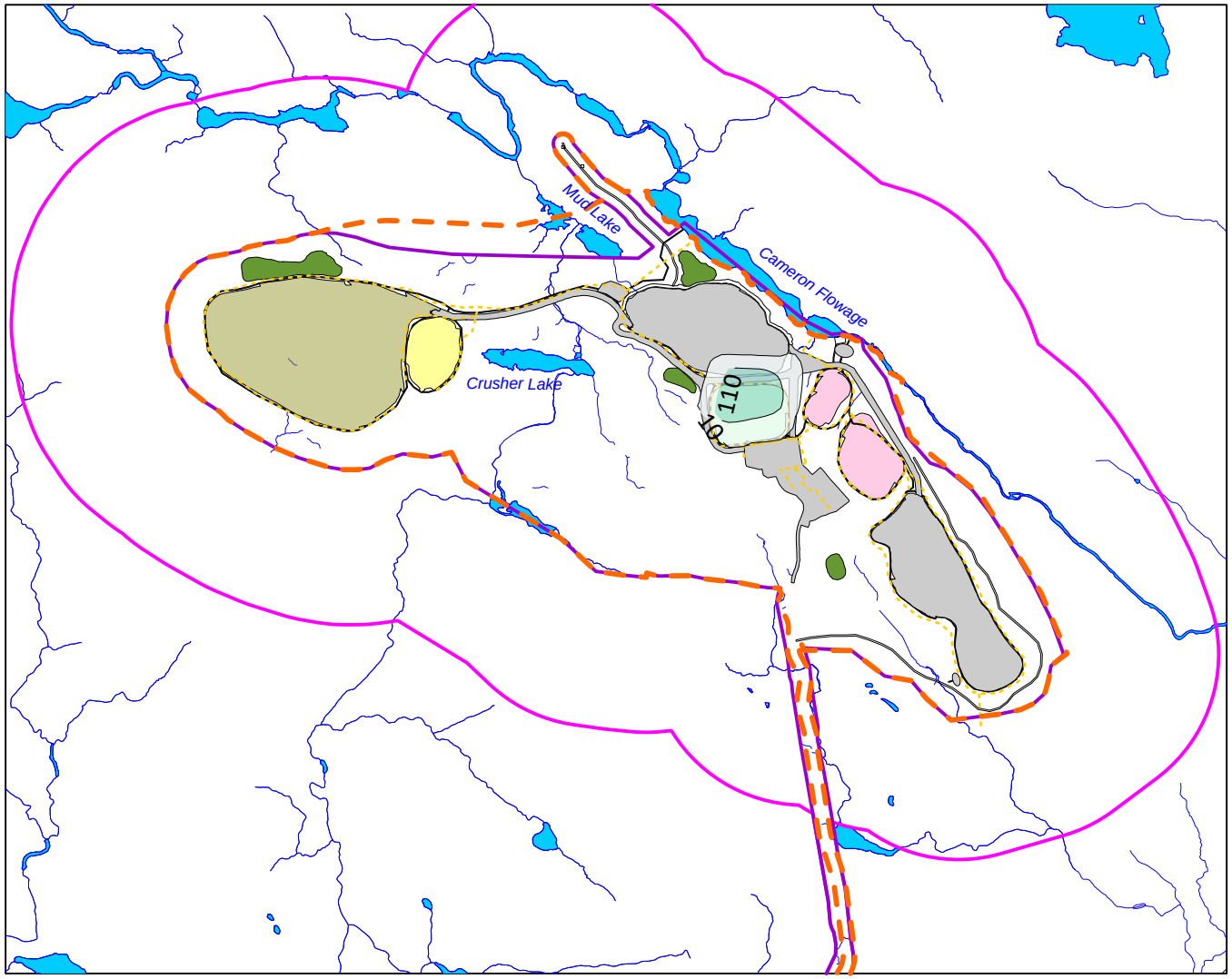

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED LEAD CONCENTRATION (ug/L)
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- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The lead Tier 2 PSS for groundwater discharge to surface water (>10 m) is 10 ug/L.

0 300 600 900m

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SIMULATED LEAD CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.17

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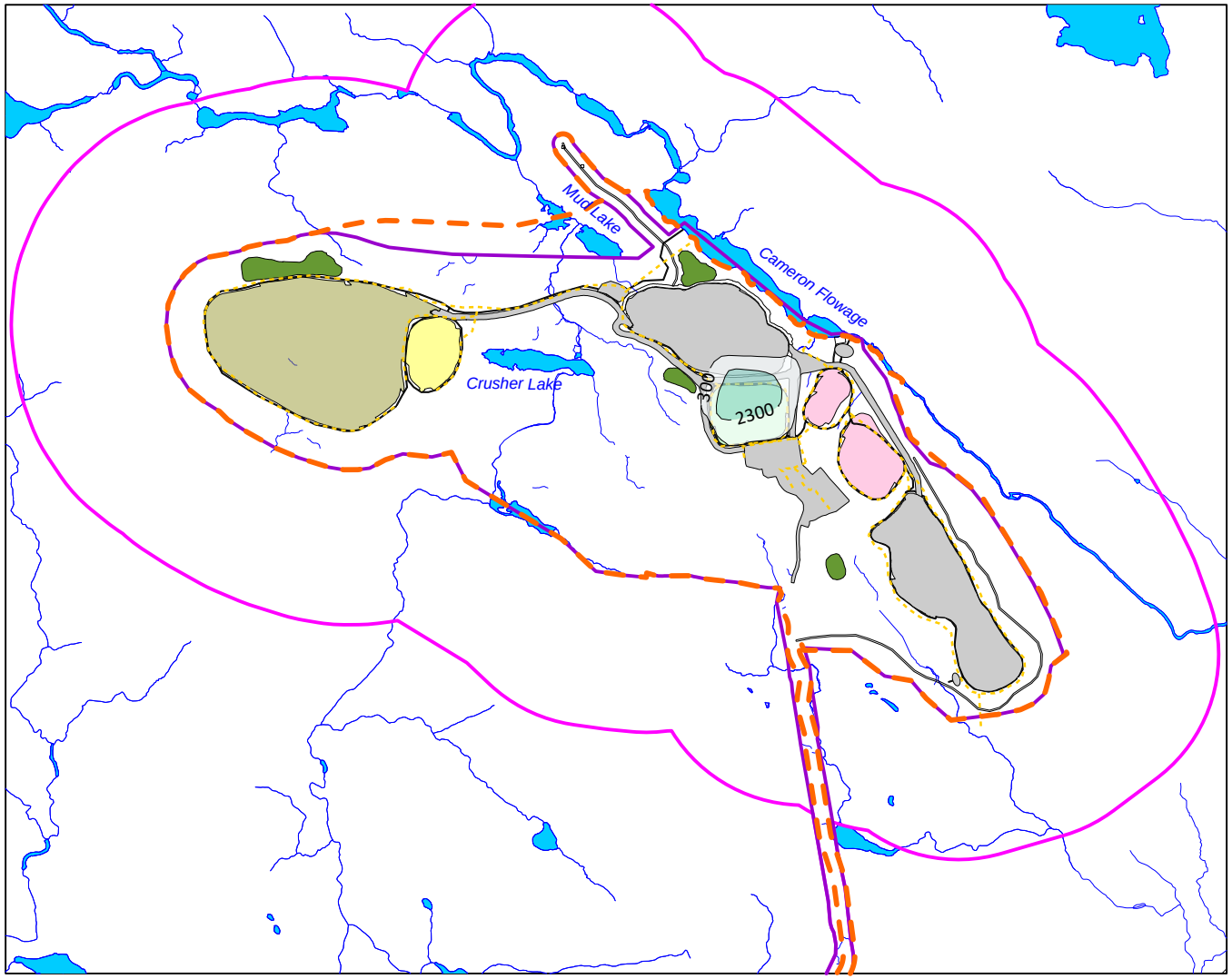

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 2 PSS for groundwater discharge to surface water (>10 m) is 300 ug/L.

0 300 600 900m

N

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SIMULATED ZINC CONCENTRATION VERSUS TIER 2 PSS
PC - BASE CASE SOURCE TERMS - WET CASE CONDITION

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March 11, 2021

Figure G.18

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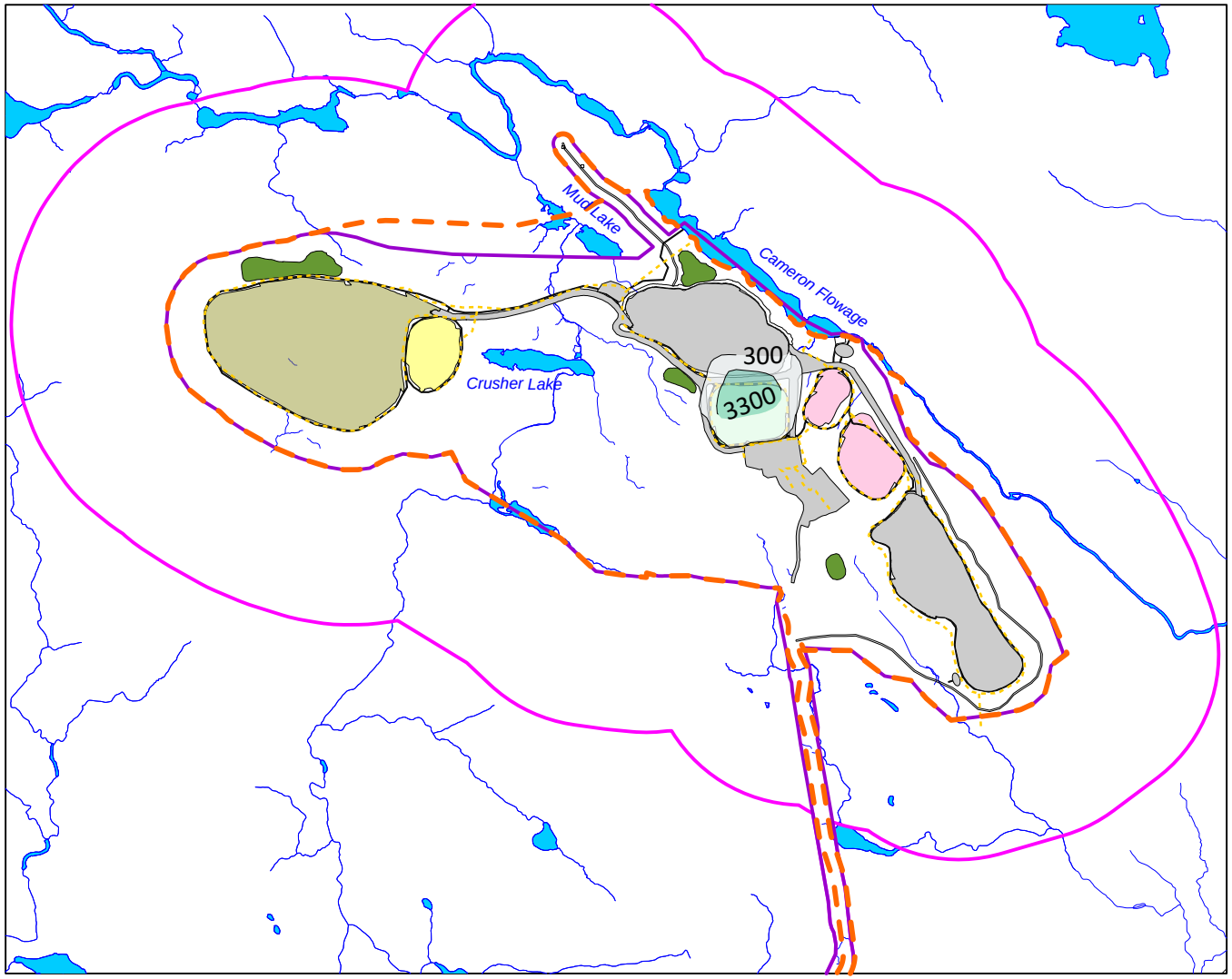

LEGEND

- SURFACE WATER BODY
- PROPOSED EXTENT OF MINE FEATURES
- 0.1 — SIMULATED ZINC CONCENTRATION (ug/L)
- SURFACE WATER MANAGEMENT DITCHES
- PROPERTY BOUNDARY
- PROJECT AREA
- LOCAL ASSESSMENT AREA
- NAG WASTE ROCK STOCKPILE
- PAG WASTE ROCK STOCKPILE
- LGO STOCKPILE
- TILL STOCKPILES
- TOPSOIL STOCKPILES

Note: The zinc Tier 2 PSS for groundwater discharge to surface water (>10 m) is 300 ug/L.

0 300 600 900m

N

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SIMULATED ZINC CONCENTRATION VERSUS TIER 2 PSS
PC - UPPER CASE SOURCE TERMS - WET CASE CONDITION

088664-031
March 11, 2021

Figure G.19

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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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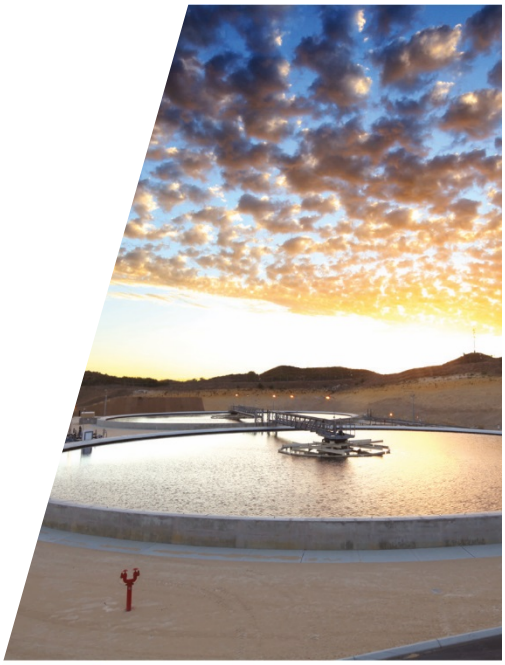
Appendix F
Water Treatment Assessments

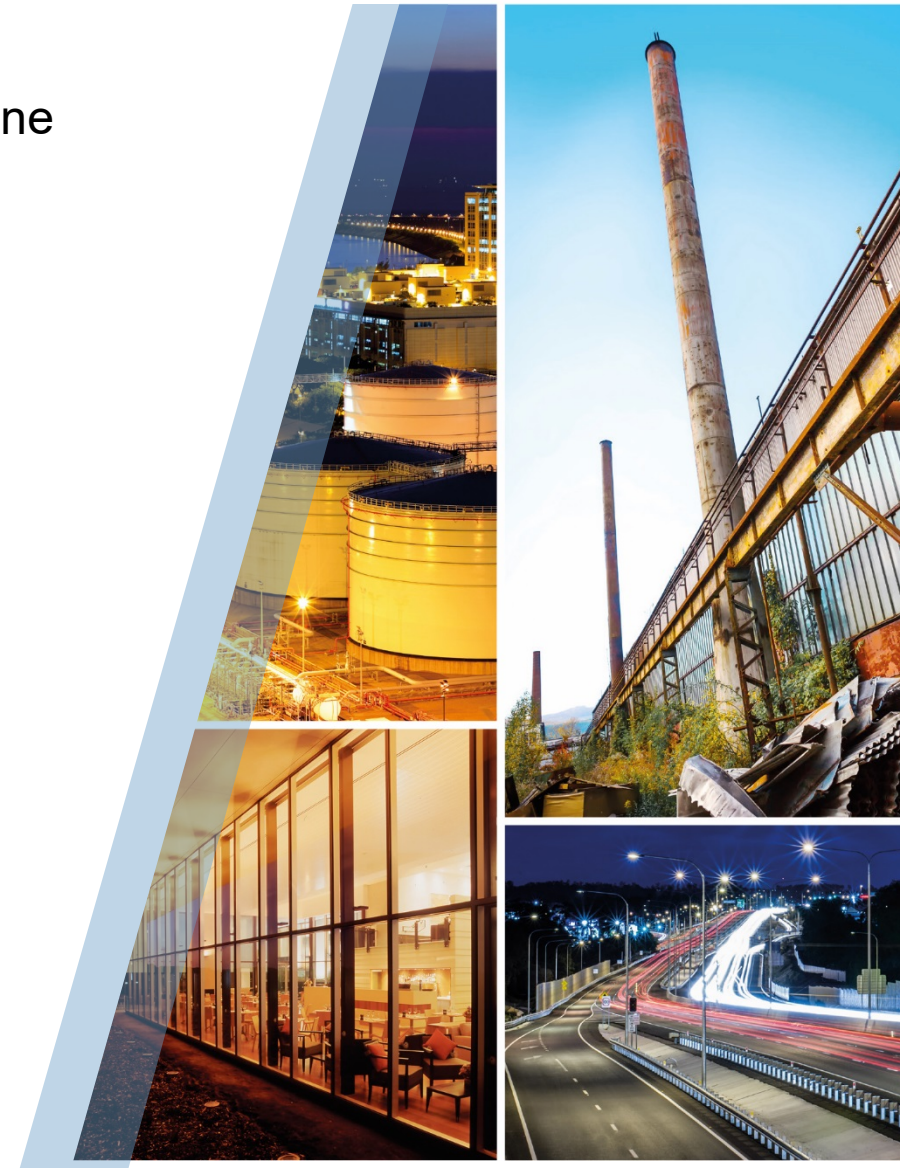
Appendix F.1
Construction Phase



Construction Phase

Water Treatment Assessment

Beaver Dam Gold Mine



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Appendix A Water Quality Analysis Results

Appendix B Process Flow Diagram (PFD) and WTS Layout

Appendix C Newterra SOQ and Spec Sheets

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 operation and post-closure (PC) phases. This report provides alternative water treatment systems for the construction 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 Post-Closure (PC) stages. For each life cycle stage, the potential effects of mine contact water on the water quality in the Killag River were assessed. However, as limited information was available for the construction phase, the water quality of a similar site (i.e. Touquoy) was used as an indication of water quality for this project during the construction phase. These results show that aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, lead, mercury, and zinc are among exceeded parameters and need to be removed prior to discharge. The same results show that polyaromatic hydrocarbons such as anthracene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, and pyrene, also exceeded Nova Scotia Environment (NSE) Tier 1 Environmental Quality Guidelines (EQS) for Surface Water. The focus of this memorandum is to identify and evaluate potential treatment techniques to address elevated concentrations of chemicals of concern (COCs) during the construction phase of the Project in order to meet Metal and Diamond Mining Environmental Regulation (MDMER) Objectives, as well as 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 (ha) 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.

There is already a body of water on the Site that needs to be removed, and it is expected that this water could be discharged out of the Site with minimal to no treatment. However, because of historical tailing/sediments at the bottom of this body of water, it is expected that the quality of the water deteriorates and needs treatment because of agitation in sediments and the effect of historical tailing use. Rainwater and surface runoff water, which comes in contact with impacted historical tailing and sediments, also will be another source of impacted water that needs to be treated.

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.

2.1 Site Climate Conditions

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 2.1 summarizes the monthly precipitation totals 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. This data was used to calculate maximum allowable concentrations at End-Of-Pipe in order to meet discharge criteria at Killag River.

Table 2.1 Monthly Precipitation, Site Runoff, and Killag River Flow Estimates

Month	Rainfall (m)	Site Runoff (m^3)
January	0.041	20,700
February	0.042	21,299
March	0.12	61,042
April	0.311	158,592
May	0.107	54,631
June	0.099	50,456
July	0.099	50,448
August	0.1	51,271
September	0.099	50,785
October	0.122	62,039
November	0.132	67,281
December	0.075	38,156

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 the downstream mixing effect. Table 3.1 summarizes the assessment criteria for selected chemicals of concern,

Table 3.1 Assessment Criteria for selected chemicals of concern

Constituent	MDMER (µg/L)	CCME (µg/L)	NS Tier 1 (µg/L)
Al	-	5	5
As	100	5	5
Cd	-	0.04	0.01
Co	-	0.78	10
Cu	100	2	2
Fe	-	300	300
Hg	-	0.026	0.026
Mn	-	190	820
Mo	-	73	73
Ni	250	25	25
Pb	80	1	1
Sb	-	-	20
Se	-	1	1
Tl	-	0.8	0.8
U	-	15	300
Zn	400	7	30
Nitrate	-	13,000	-
Nitrite	-	60	-

4. Data Review

4.1 Water Quantity

There will be three main sources of impacted water that may need treatment before discharge during the construction phase. The first source will be the existing body of water in the open pit area which is expected to require minimal to no treatment. The second source of water would be impacted water which is in contact with historical tailings and is expected to have a high concentration of metals such aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, mercury, lead, and zinc. This source of water will include any leachate that will be generated as the result of historical sediment removal. The third source of water that will need treatment during the construction phase would be precipitated water which comes in contact with impacted material.

It was assumed that the historic tailings facilities will be de-watered in 1 month. Due to uncertainty, two scenarios were considered to calculate the total impacted water volume – dewatering to 1.5 m depth and dewatering to 2.0 m depth. As the water quality in the Killag River will vary depending on the time of year, it was assumed that dewatering will be conducted in August as this would result in the worst-case water quality conditions. If the dewatering occurred at any other time of the year, the water

quality conditions would be improved (in comparison to the worst-case scenario) thereby reducing the water treatment requirements.

The volume of water to be treated is estimated at 82,500 m3/month (assuming dewatering to a depth of 1.5 m) and 110,000 m3/month (assuming dewatering to a depth of 2.0 m).

4.2 Water Quality

As limited information was available for the construction phase, the water quality of a similar site (i.e. Touquoy) was used as an indication of water quality for this project during the construction phase. These results show that aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, mercury, lead, and zinc are among exceeded parameters and need to be treated. The same results show that polyaromatic hydrocarbons such as anthracene, benzo(a)anthracene, benzo(a)pyrene, fluoranthene, and pyrene also exceeded Nova Scotia Environment (NSE) Tier 1 Environmental Quality Guidelines (EQS) for Surface Water in the historical tailing water. The concentrations of polyaromatic hydrocarbons were below the detection limit for the pit sump water. The complete water quality analytical report is presented in Appendix A.

Analysis results of two samples from the historical tailing water (HT-EXW-01 and HT-EXW-02) and one sample from the pit sump were provided by Atlantic Mining from the Touquoy site. The results show that the concentration of COCs is significantly higher in the HT-EXW-01 sample with higher turbidity (>1000 NTU). The turbidity of the HT-EXW-02 is reported at 24 NTU. By comparing these two sample results, it could generally be concluded that a significantly reduced fraction of the COC concentrations exists in dissolved form. As a result, most of the COCs are likely attached to suspended solids suggesting that a significant fraction of the COCs could be removed by physical filtration. The results show that polyaromatic hydrocarbons also could exceed NSE Tier 1 at historical tailing water. However, the concentrations of these chemicals were measured below detection limits for the pit sump sample. The concentration of exceeded elements is presented in Table 4.1.

Table 4.1 Concentration of exceeded elements in existing water and pit sump samples

Element	Unit	NSE Tier 1	HT-EXW-01	HT-EXW-02	Pit Sump
Metals					
Aluminum (Al)	µg/L	5	15,000	200	320
Arsenic (As)	µg/L	5	3,800	120	51
Cadmium (Cd)	µg/L	0.01	0.26	0.038	<0.01
Cobalt (Co)	µg/L	10	55	7.3	4.4
Copper (Cu)	µg/L	2	59	<2.0	<2.0
Iron (Fe)	µg/L	300	42,000	460	660
Manganese (Mn)	µg/L	820	7,500	3,000	340
Mercury (Hg)	µg/L	0.026	11	0.048	<0.013

Table 4.1 Concentration of exceeded elements in existing water and pit sump samples

Element	Unit	NSE Tier 1	HT-EXW-01	HT-EXW-02	Pit Sump
Metals					
Aluminum (Al)	µg/L	5	15,000	200	320
Nickel (Ni)	µg/L	25	150	30	32
Vanadium (V)	µg/L	6	11	<2.0	<2.0
Lead (Pb)	µg/L	1	82	0.78	<0.5
Zinc (Zn)	µg/L	30	73	<0.5	<0.5
Polyaromatic Hydrocarbons					
Anthracene	µg/L	0.012	0.031	N/A	<0.01
Benzo(a)anthracene	µg/L	0.015	0.043	N/A	<0.01
Benzo(a)pyrene	µg/L	0.018	0.034	N/A	<0.01
Fluoranthene	µg/L	0.04	0.15	N/A	<0.01
Pyrene	µg/L	0.025	0.12	N/A	<0.01

4.3 Level of Treatment

GHD has calculated the maximum allowable discharge limits for COCs at the end of the water treatment system by conducting a mass balance assessment. For that purpose, it was assumed that:

- The water quality of the historic tailings water is based on samples provided by Atlantic Mining
- The water quality of the Killag River is based on background sample data
- No clean water is assumed to mix with the tailings water prior to treatment

The maximum allowable concentration of exceeded elements is presented in Table 4-2.

Table 4.2 Allowable discharge concentrations at the end of the water treatment system

Constituent	Maximum Concentration (ug/L)	Allowable Discharge Concentration (ug/L)	Level of Treatment (%)
Al	15,000	371	98%
As	3,800	100.0	97%
Cd	0.26	0.18	31%
Co	55.0	4.16	92%
Cu	59.0	10.00	83%
Fe	42,000	746	98%

Table 4.2 Allowable discharge concentrations at the end of the water treatment system

Constituent	Maximum Concentration (ug/L)	Allowable Discharge Concentration (ug/L)	Level of Treatment (%)
Al	15,000	371	98%
Hg	11.0	0.14	99%
Mn	7,500	1,162	85%
Pb	82.0	5.59	93%
Zn	73.0	31.6	57%

5. Treatability Technology Review

5.1 Methodology

The development of feasible alternatives for the water treatment system 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 disadvantages and positive aspects of each alternative, as well as evaluating the feasibility of implementing each treatment option for impacted water during the construction 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:

- Lime softening/Hydroxide precipitation
- Coagulation/Flocculation
- Oxidation
- Adsorption
- Membrane Processes/Reverse osmosis

- Evaporation

Further discussion regarding each technology is provided below:

Lime softening/Hydroxide precipitation

Lime softening/hydroxide precipitation is one of the common techniques for the removal of heavy metals from wastewater (Pang et al, 2009). 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).

The pH at which a metal hydroxide has its lowest solubility is specific for each metal. For example, cobalt hydroxide has the lowest solubility at pH between 10 and 11.5. It should be noted that these values are theoretical values and could be slightly different for actual wastewater based on potential chemical interactions. The presence of other chemicals such as ammonia could negatively affect the precipitation rate of metals.

Hydroxide precipitation is usually coupled with a polymer flocculation step, which accelerates the precipitation rate. The precipitated metals are then easily removed from the water with a simple physical separation technique such as media filtration.

Available information shows that metals such as aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, mercury, lead, and zinc are among exceeded elements. Hydroxide precipitation is a feasible approach to reducing the concentration of such metals significantly. Hydroxide precipitation alone, however, will not reduce the concentrations of all the COCs below their discharge limits, so this approach will need to be coupled with other techniques such as coagulation and adsorption for further reduction of concentrations

Hydroxide precipitation is a proven technology for the reduction of metal concentrations, and it is a potential treatment step for impacted water during the construction phase of the Project.

Coagulation/Flocculation

Coagulation is another form of precipitation that involves the addition of a coagulant to wastewater such as alum or an iron-based coagulant. 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 has shown effective arsenic removal from contaminated water (Fan et al, 2003)

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 addressed by an 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.

Oxidation

Oxidation can be used to reduce metals to a small degree. Aeration is one of the cheapest and 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 issue 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 disadvantage of using aeration as an oxidation method is its low reaction rate, which makes it unsuitable for a high flow treatment system.

Adsorption

Adsorption is one of the simplest and low-tech treatment technologies for the removal of trace organics and metals such as arsenic 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 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 downstream of a clarification/media filtration step in the treatment process.

It is expected that the TSS concentration may be high enough to foul the filtration units, which means adsorption units must be protected by a pre-filtration step. Activated carbon 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.

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 the 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 the 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.

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.

Evaporation on its own is not sufficient treatment for the impacted water during the construction phase because the concentration of dissolved solids is expected to be relatively high. At a minimum, settling and pre-filtration would likely be required to pre-treat the water prior to evaporation.

There are other forms of evaporation available other than MVR units. An example of another type is natural evaporation ponds. However, this would not be feasible for the Beaver Dam Project because of slow evaporation and high precipitation rate in the area. The operation cost of this alternative is significantly high and even this method generates high concentrated slurry that needs to be managed.

5.3 Screening of Feasible Alternatives & Development of Short List

It is expected that there will be a high level of metals, such as aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, mercury, lead, and zinc, in the impacted water. 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.

The screening of the 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: In general, green represents options that are good to very good. Gray means fair to moderate options. 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
Lime softening/Hydroxide precipitation		Metals	High	Low	Low risk	Extensive	Good to very good	• Very effective for metal removal. • Neutralization might be needed afterwards. • Generates high pH sludge that needs management.
Coagulation/Flocculation		TSS, metals	Limited	High	Low risk	Extensive	Good	• Generates sludge that needs management. • Relatively expensive due to the use of coagulant and polymer.
Oxidation/Aeration		Metals	Limited	Low	Low risk	Extensive	Fair	• Effective for metals and organics oxidation. • Slow process, needs high hydraulic retention time.
Multimedia Filtration		TSS	High for TSS and associated metals	Low	Low risk	Extensive	Good	• Removing TSS and most portion of COCs throughout simple physical filtration. • Protecting GAC columns and increasing the lifetime of GAC media.
Adsorption	AC	Organic compounds, metals	High for organics and metals	Low	Low risk	Extensive	Good	• Easy to operate. • 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 compounds.
	Ultrafiltration	TSS	Limited	Moderate	Low Risk	Extensive	Poor	• Effective on TSS removal, not soluble compounds.
	Nanofiltration	TSS, larger 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 stream that needs treatment/handling.
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.

6. Potential Treatment Methods

The screening of a long list of alternatives technologies indicates that a combination of oxidation/aeration, lime softening, coagulation/flocculation, multimedia filtration, and adsorption are potential alternatives for addressing high concentrations of metals and aromatic hydrocarbons in impacted water during the construction phase.

6.1 Alternative 1. Aeration, lime softening, followed by coagulation, media and GAC filtration

This alternative is similar to alternative 1 except using aeration as the first step for metal oxidation and coagulation to accelerate the precipitation rate of formed metal hydroxide complexes. The benefit of using coagulants would be to lessen footprint requirement for particle precipitation. However, using coagulants will increase the volume of sludge generation and will have higher operating costs. The media and GAC filtration at the end will remove the remaining TSS, aromatic hydrocarbons, and dissolved metals. The main treatment steps of this alternative are metal precipitation via aeration oxidation and alkaline precipitation, precipitation of solids and colloidal particles via coagulant/polymer addition, clarification/media filtration and polishing (organic compounds removal) via activated carbon. A simplified block flow diagram of this alternative is shown in Figure 6.1.

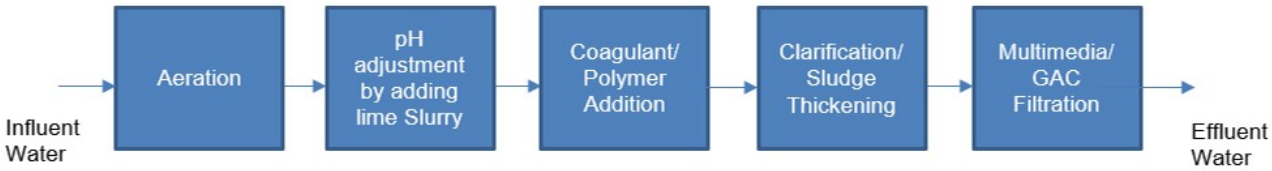

Figure 6.1 Simple Block Flow Diagram of Alternative 1 Treatment System for Construction Phase

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 air will be blown into the water to oxidize metals such as iron and manganese as well as organic compounds, and at the same time, aeration will provide enough agitation to prevent the settling of suspended solid particles. Next, an alkaline solution (lime slurry) will be added in order to precipitate dissolved metals. By increasing the pH of the water, the solubility of the metals is reduced, and they will precipitate in their hydroxide form. Bench testing will be required to determine the optimum pH level.

The second step will be to accelerate the precipitation and clarification process by adding a coagulant and polymer. The polymer binds the small particles and generates flocs that settle faster. The optimum coagulant and polymer dosage need to be identified through a bench-scale study.

Next, a lamella clarifier will separate produced flocs and clarified water. The water will then pass through a media filter to remove the remaining flocs and suspended solids. The produced sludge will be pumped out at the bottom of the clarifier and will be managed separately. Produced sludge will be thickened by gravity settling and then will be pumped into a geotextile sludge dewatering bag.

The dewatering filtrate will be pumped to the head of the water treatment system for reprocessing. Based on the optimum pH in the alkaline precipitation, a neutralization step may be needed after clarification by adding an acid solution. This will be determined during bench testing.

As the final polishing step, the filtered water will pass through a GAC filter for the removal of remaining metals and organic compounds. The pressure will be monitored at the inlet and outlet of the column and a backwash cycle will be triggered (manually or automatic) when the pressure difference reaches an assigned value. 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.

6.2 Alternative 2. Lime softening, followed by precipitation, media and GAC filtration

This treatment approach consists of three main treatment components. In the first unit, lime is added to increase the pH of the water in order to create a metal hydroxide complex which are not soluble and precipitates out of the water. In the next step, a settling pond will provide enough hydraulic retention time in order to allow those formed metal hydroxides to precipitate. And then in the third part of the system, the water will be passed through a multimedia and GAC filtration system to filter out remaining TSS and dissolved metals. A simplified block flow diagram of this alternative is shown in Figure 6.2.

Figure 6.2 Figure 6-2 Simple Block Flow Diagram of Alternative 2 Treatment System for Construction Phase

The lime slurry could be prepared on-site. A chemical dosing pump will inject the lime on a flow-paste system or by controlling the pH through a control system.

In order to achieve the removal of COCs (particularly polyaromatic hydrocarbons), granular activated carbon systems will be employed as the final treatment step of the water treatment process. It is recommended that the GAC-based treatment equipment be configured as modular treatment skids of parallel treatment trains. Each GAC treatment train will be configured with GAC vessels in a lead-lag configuration. Such an arrangement will allow for continued treatment while a GAC train is offline for maintenance/media replacement/backwashing. Additionally, the use of a lead-lag GAC vessel arrangement will allow for the identification of GAC media breakthroughs in the lead vessel and trigger the need for GAC media replacement. Each GAC column will be protected by a pre-guard multimedia filtration unit. Filtration equipment will be configured in parallel trains as well to allow for continued operation of the water treatment systems while backwash events occur.

This alternative does not include the flocculation step using polymer. However, bench-scale tests need to be conducted, in order to collect the necessary data to assess if this approach could reduce the concentration of all COCs below their allowable discharge limits.

7. Proposed Water Treatment Alternative

Alternative 1, aeration, lime softening, followed by coagulation, media and GAC filtration is proposed as the alternative water treatment system for the construction phase. This system includes an aeration phase at the beginning of treatment train which will help to oxidizing metals and will reduce chemical demand in the downstream units. A draft process flow diagram (PFD) of this alternative is presented in Appendix B.

7.1 Footprint requirement

Considering the existing impacted water volume, project schedule, and initial capital cost of water treatment system, a design treatment flow rate of 300 gallons per minute (gpm) is selected. The required footprint of such system is estimated to be around 60 ft by 120 ft. The initial layout of water treatment system is also presented in Appendix B.

7.2 List of major water treatment system equipment

The list of major equipment, approximate sizes, approximate locations and their functions are provided in Table 7.1. The size of chemical storage and dosing pumps will need to be revised once more information is collected regarding the required chemical dosing rates.

Table 7.1 The list of major water treatment equipment, construction phase

List of major equipment:	#of units	Size	Location	Function
Feed pump	2 (O/S)	300 gpm	Front head of the water treatment system	Feeding the treatment system.
Aeration Tank	1	21,000 gallons (15,000 gallons active volume)	Before chemical dosing at front head of the water treatment system	Providing at least 50 minutes HRT for oxidation for the design flow of 300 gpm.
Air blower	2 (O/S)	TBD	Beside aeration tank	Blowing ambient air to aeration tank with maximum 8 ft of water static pressure.
Mixing tank (pH adjustment/coagulation/flocculation tanks)	3	2000-3000 gallons	After aeration tank, before the clarifier	pH adjustment, coagulant and polymer dosing
Mixer	3	VFD (provides 0 to 200 rpm in the mixing tanks)	Inside mixing tanks	Agitating tanks to facilitate reaction of chemicals in the mixing tank for pH adjustment and flocculation/coagulation.

Table 7.1 The list of major water treatment equipment, construction phase

List of major equipment:	#of units	Size	Location	Function
Feed pump	2 (O/S)	300 gpm	Front head of the water treatment system	Feeding the treatment system.
Lime Slurry dosing pump	1	TBD	Chemical injection panel	Dosing lime
Polymer dosing pump	1	TBD	Chemical injection panel	Dosing polymer
Coagulant dosing pump	1	TBD	Chemical injection panel	Dosing coagulant
Lime Slurry tank	1	TBD	TBD	Lime slurry storage
Polymer tote	1	275-330 gallons (suggested a IBC tote)	Chemical injection	Polymer storage
Coagulant tote	1	275-330 gallons (suggested a IBC tote)	Chemical injection	Coagulant storage
Clarifier	1	TBD	After chemical injection.	Floc separation/clarification.
Sludge wasting pump	1	TBD	Beside clarifier	Wasting sludge from the bottom of clarifier
Sludge holding tank/Sludge thickening tank	1	20,000 gallons frac tank	Beside clarifier	Sludge thickening/holding.
Dewatering box	1	8000-10000 gallons	Beside clarifier	Clarifier underflow sludge dewatering.
Filtration unit wet well (Rolloff tank)	1	8000-10000 gallons	After clarifier, before media filters	Provide a 30 minutes HRT between clarifier and filtration unit (sump).
Filtration feed pump	1	300 gpm	Wet well	Feeding filtration system
Backwash pump	1	TBD	Wet well	Backwashing multimedia and GAC columns.
Note: O/S: Operation/Standby, TBD: To be determined, gpm: Gallons per minute.				

7.3 Initial capital cost estimate

GHD has contacted different vendors to get quotation for water treatment system. Newterra has provided an un-official quotation to supply water treatment system explained above. The list of main equipment presented in Table 7.1. It is expecting that such water treatment system cost approximately 1.2 million minus plus 30 percent. This cost estimate does not include any applicable

taxes, transportation or even field installation support. The Newterra's statement of qualification (SOQ) along with related equipment cut sheets are presented in Appendix C.

7.4 Electrical power requirement

Table 7.2 shows the individual component of proposed water treatment system and their power requirement. It is estimated that a total power of 24.7 HP (18.4 KW) will be required to run the system. A maximum power of 42.8 HP (32 KW) is estimated in scenarios when all the equipment as well as enclosure's heating system is running.

Table 7.2 Electricity power requirement for the proposed alternative

Item	HP	No. Provided	No. Active	Installed HP	Active HP	% of Time On	Total HP for O&M	Maximum HP for O&M
Blower of aeration tank	6.0	2	1	12.0	6.0	100%	6.0	6.0
Feed pump	3.0	2	1	6.0	3.0	100%	3.0	3.0
Mix tank agitator	1.0	3	3	3.0	3.0	100%	3.0	3.0
Backwash pump	3.0	2	1	6.0	3.0	10%	0.3	3.0
Sludge disposal pump	2.0	1	1	2.0	2.0	10%	0.2	2.0
Enclosure HVAC system (1)	8.0	2	2	16.0	16.0	15%	2.4	16.0
Chemical dosing pump	0.1	3	3	0.3	0.3	100%	0.3	0.3
Filtration pump	8.0	2	1	16.0	8.0	100%	8.0	8.0
Control instrumentation	1.5	1	1	1.5	1.5	100%	1.5	1.5
Total (HP)							**24.7**	**42.8**
Total (MW)							**0.018**	**0.032**
Total (MW-Hr/year)							**161**	**280**

8. Conclusions and Recommendations

It is expected that metals such as aluminum, arsenic, cadmium, cobalt, copper, iron, manganese, mercury, lead, and zinc will be among the elements that need treatment during the construction 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 components. Three alternative treatment schemes are proposed for further evaluation which include aeration (oxidation), lime softening, coagulation/flocculation, multimedia and GAC filtration. The Alternative 1, aeration, lime softening, followed by coagulation, media and GAC filtration is proposed as the water treatment system. It is believed that this alternative will address the high concentration of COCs with the optimum capital and operational cost. It is highly recommended that the selected alternative technology 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.

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All of Which is Respectfully Submitted,

GHD

Hojat Seyedy

Heather Brewer

Appendices

Appendix A
Water Quality Analysis Results

		Location ID Sample Date Type	HT-EXW 10/9/2018 N	HT-EXW 10/23/2018 N	Pit Sump 10/23/2018 N
Parameter	**Unit**	**NSE-EQS[1]**			
Anion Sum	me/L	-	6.63	4	8.63
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	99	57	99
Calculated TDS	mg/L	-	470	250	550
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	<1.0	<1.0	<1.0
Cation Sum	me/L	-	8.63	3.7	8.38
Hardness (CaCO3)	mg/L	-	330	170	370
Ion Balance (% Difference)	%	-	13.1	3.9	1.47
Langelier Index (@ 20C)	N/A	-	-0.183	-0.273	0.5
Langelier Index (@ 4C)	N/A	-	-0.431	-0.522	0.252
Nitrate (N)	mg/L	-	<0.050	0.18	8.5
Saturation pH (@ 20C)	N/A	-	7.45	7.89	7.41
Saturation pH (@ 4C)	N/A	-	7.7	8.14	7.66
Total Alkalinity (Total as CaCO3)	mg/L	-	99	58	100
Dissolved Chloride (Cl-)	mg/L	-	12	5.7	17
Colour	TCU	-	16	<5.0	<5.0
Nitrate + Nitrite (N)	mg/L	-	<0.050	0.18	8.7
Nitrite (N)	mg/L	-	<0.010	<0.010	0.22
Nitrogen (Ammonia Nitrogen)	mg/L	-	0.4	0.16	1.9
Total Organic Carbon (C)	mg/L	-	<50 (1)	1.6	0.77
Orthophosphate (P)	mg/L	-	0.012	0.019	0.015
pH	pH	-	7.27	7.62	7.91
Reactive Silica (SiO2)	mg/L	-	6.4	14	12
Dissolved Sulphate (SO4)	mg/L	-	210	130	270
Turbidity	NTU	-	>1000	24	<0.10
Conductivity	uS/cm	-	600	380	790

Notes:

Type: N=Normal Sample; FD=Field Duplicate

"-" = No Standard Avaliable

mg/l = milligram per litre

TDS = Total dissolved Solids

me/L = milliequivalent per litre

TCU = True colour units

NTU = nephelometric turbidity units

uS/cm = microsiemens per centimetre

N/A = no applicable units

< indicates result less than Reporting Detection Limit (RDL)

[1] Nova Scotia Environment (NSE) Tier 1 Environmental Quality Standards for Surface Water

MAXXAM COA NOTE FOR TOC <50(1)

				Location ID Sample Date Type	HT-EXW 10/9/2018 N	HT-EXW 10/23/2018 N	Pit Sump 10/23/2018 N
Parameter	**Unit**	**NSE EQS[1]**	**NSE PSS[2]**				
Benzene	mg/l	20	2.1	< 0.0010	n/a	n/a
Toluene	mg/l	20	0.77	< 0.0010	n/a	n/a
Ethylbenzene	mg/l	20	0.32	< 0.0010	n/a	n/a
Xylenes	mg/l	20	0.33	< 0.0020	n/a	n/a
F1 (C6-C10) - BTEX	mg/l	-	-	< 0.010	n/a	n/a
F2 (C10-C16)	mg/l	-	-	< 0.050	n/a	n/a
C16-C21	mg/l	-	-	< 0.050	n/a	n/a
C21-C32	mg/l	-	-	< 0.10	n/a	n/a
Modified TPH (Tier 1)	mg/l	Gas=20; Fuel=20; Lube=20	Gas=1.5; Fuel=0.1; Lube=0.1	< 0.10	n/a	n/a
Reached Baseline at C32	mg/l	-	-	NA	n/a	n/a
Hydrocarbon Resemblance	mg/l	-	-	NA	n/a	n/a

Notes:

Type: N=Normal Sample; FD=Field Duplicate

n/a = not analyzed

"-" = No Standard Avaliable

mg/l = milligram per litre

NA = Not Applicable

TPH - Total Petroleum Hydrocarbons

< indicates result less than Reporting Detection Limit (RDL)

[1] Nova Scotia Environment (NSE) Tier 1 Environmental Quality Standards for Surface Water

[2] Nova Scotia Environment (NSE) PSS for Groundwater,discharge to surface water body within 0-10 metres, discharge to fresh water

					Location ID Sample Date Type	HT-EXW 10/9/2018 N	HT-EXW 10/23/2018 N	Pit Sump 10/23/2018 N
Parameter	**Unit**	**MMER[1]**	**NSE-EQS[2]**	**NSE-PSS[3]**	**Mean Concentrations from Background Monitoring Locations**			
Total Aluminum	ug/l	-	5	5	127.2-183.7	15000	200	320
Total Antimony	ug/l	-	20	20	n/a	1.3	<1.0	5.3
Total Arsenic	ug/l	1000	5	5	<1-12.26	***3800***	120	51
Total Barium	ug/l	-	1000	1000	n/a	93	14	21
Total Beryllium	ug/l	-	5.3	5.3	n/a	<1.0	<1.0	<1.0
Total Bismuth	ug/l	-	-	-	n/a	<2.0	<2.0	<2.0
Total Boron	ug/l	-	1200	1200	n/a	<50	<50	<50
Total Cadmium	ug/l	-	0.01	0.01	0.01 - 0.02	0.26	0.038	<0.010
Total Calcium	ug/l	-	-	-	n/a	100000	56000	110000
Total Chromium	ug/l	-	-	-	n/a	15	<1.0	<1.0
Total Cobalt	ug/l	-	10	10	n/a	55	7.3	4.4
Total Copper	ug/l	600	2	2	n/a	59	<2.0	<2.0
Total Iron	ug/l	-	300	300	238-564	42000	460	660
Total Lead	ug/l	400	1	1	n/a	82	0.78	<0.50
Total Magnesium	ug/l	-	-	-	n/a	18000	6500	20000
Total Manganese	ug/l	-	820	820	n/a	7500	3000	340
Total Molybdenum	ug/l	-	73	73	n/a	<2.0	<2.0	7
Total Mercury	ug/l	-	0.026	0.026	n/a	11	0.048	<0.013
Total Nickel	ug/l	1000	25	25	n/a	150	30	32
Total Phosphorus	ug/l	-	-	-	n/a	1400	<100	<100
Total Potassium	ug/l	-	-	-	n/a	5100	2200	10000
Total Selenium	ug/l	-	1	1	n/a	<1.0	<1.0	<1.0
Total Silver	ug/l	-	0.1	0.1	n/a	0.14	<0.10	<0.10
Total Sodium	ug/l	-	-	-	n/a	7100	5800	11000
Total Strontium	ug/l	-	21000	21000	n/a	320	160	440
Total Thallium	ug/l	-	0.8	0.8	n/a	<0.10	<0.10	<0.10
Total Tin	ug/l	-	-	-	n/a	<2.0	<2.0	<2.0
Total Titanium	ug/l	-	-	-	n/a	75	2.7	2.5
Total Uranium	ug/l	-	300	300	n/a	1.4	0.23	12
Total Vanadium	ug/l	-	6	6	n/a	11	<2.0	<2.0
Total Zinc	ug/l	1000	30	30	n/a	73	<5.0	<5.0

Notes:

Type: N=Normal Sample; FD=Field Duplicate

n/a = not analyzed

"-"= No Standard Avaliable

ug/l = Microgram per litre

< indicates result less than Reporting Detection Limit (RDL)

Bold Idicates Parameter Exceeded the MMER guideline

Underline Indcates the Parameter Exceeds the NSE Tier 1 EQS and PSS Guidlines

[1] MMER = Metal Mining Effluent Regulations, Schedule 4 - Authorized Limits of Deleterious Substances, maximum monthly mean concentration/maximum composite sample concentration/maximum grab sample concentration

[2] Nova Scotia Environment (NSE) Environmental Quality Standards for Surface Water

[3] Nova Scotia Environment (NSE) PSS for Groundwater,discharge to surface water body within 0-10 metres, discharge to fresh water

					Location ID Sample Date Type	HT-EXW 10/9/2018 N	HT-EXW 10/23/2018 N	Pit Sump 10/23/2018 N
Parameter	**Unit**	**MMER[1]**	**NSE-EQS[2]**	**NSE-PSS[3]**	**Mean Concentrations from Background Monitoring Locations**			
Dissolved Aluminum	ug/l	-	5	5	127.2-183.7	n/a	**10**	**14**
Dissolved Antimony	ug/l	-	20	20	NA	n/a	<1.0	5.8
Dissolved Arsenic	ug/l	1000	5	5	<1-12.26	n/a	**89**	**47**
Dissolved Barium	ug/l	-	1000	1000	NA	n/a	14	22
Dissolved Beryllium	ug/l	-	5.3	5.3	NA	n/a	<1.0	<1.0
Dissolved Bismuth	ug/l	-	-	-	NA	n/a	<2.0	<2.0
Dissolved Boron	ug/l	-	1200	1200	NA	n/a	<50	<50
Dissolved Cadmium	ug/l	-	0.01	0.01	0.01 - 0.02	n/a	**0.034**	<0.010
Dissolved Calcium	ug/l	-	-	-	NA	n/a	57000	120000
Dissolved Chromium	ug/l	-	-	-	NA	n/a	<1.0	<1.0
Dissolved Cobalt	ug/l	-	10	10	NA	n/a	6.9	4
Dissolved Copper	ug/l	600	2	2	NA	n/a	<2.0	<2.0
Dissolved Iron	ug/l	-	300	300	238-564	n/a	<50	<50
Dissolved Lead	ug/l	400	1	1	NA	n/a	<0.50	<0.50
Dissolved Magnesium	ug/l	-	-	-	NA	n/a	6600	20000
Dissolved Manganese	ug/l	-	820	820	NA	n/a	**2900**	340
Dissolved Molybdenum	ug/l	-	73	73	NA	n/a	n/a	n/a
Dissolved Mercury	ug/l	-	0.026	0.026	NA	n/a	<2.0	**7**
Dissolved Nickel	ug/l	1000	25	25	NA	n/a	29	31
Dissolved Phosphorus	ug/l	-	-	-	NA	n/a	<100	<100
Dissolved Potassium	ug/l	-	-	-	NA	n/a	2300	11000
Dissolved Selenium	ug/l	-	1	1	NA	n/a	<1.0	<1.0
Dissolved Silver	ug/l	-	0.1	0.1	NA	n/a	<0.10	<0.10
Dissolved Sodium	ug/l	-	-	-	NA	n/a	5700	11000
Dissolved Strontium	ug/l	-	21000	21000	NA	n/a	160	450
Dissolved Thallium	ug/l	-	0.8	0.8	NA	n/a	<0.10	<0.10
Dissolved Tin	ug/l	-	-	-	NA	n/a	<2.0	<2.0
Dissolved Titanium	ug/l	-	-	-	NA	n/a	<2.0	<2.0
Dissolved Uranium	ug/l	-	300	300	NA	n/a	0.2	12
Dissolved Vanadium	ug/l	-	6	6	NA	n/a	<2.0	<2.0
Dissolved Zinc	ug/l	1000	30	30	NA	n/a	<5.0	<5.0

Notes:

Type: N=Normal Sample; FD=Field Duplicate

n/a = not analyzed

"-" = No Standard Avaliable

ug/l = Microgram per litre

NA = Data not available

< indicates result less than Reporting Detection Limit (RDL)

Bold indicates result exceeds NSE EQS and PSS

Underline indicates results RDL exceeds NSE EQS and PSS

[1] Metal Mining Effluent Regulations, Schedule 4 - Authorized Limits of Deleterious Substances, maximum monthly mean concentration/maximum composite sample concentration/maximum grab sample concentration

[2] Nova Scotia Environment (NSE) Tier 1 Environmental Quality Standards for Surface Water

[3] Nova Scotia Environment (NSE) PSS for Groundwater,discharge to surface water body within 0-10 metres, discharge to fresh water

			Location ID Sample Date Type	HT-EXW 10/9/2018 N	HT-EXW 10/23/2018 N	Pit Sump 10/23/2018 N
Parameter	**Unit**	**NSE-EQS[1]**	**NSE-PSS[2]**			
1-Methylnaphthalene	ug/l	2	2	<0.050	n/a	<0.050
2-Methylnaphthalene	ug/l	2	2	<0.050	n/a	<0.050
Acenaphthene	ug/l	5.8	5.8	0.014	n/a	<0.010
Acenaphthylene	ug/l	4.6	4.6	<0.010	n/a	<0.010
Anthracene	ug/l	0.012	0.012	**0.031**	n/a	<0.010
Benzo(a)anthracene	ug/l	0.018	0.018	**0.043**	n/a	<0.010
Benzo(a)pyrene	ug/l	0.015	0.015	**0.034**	n/a	<0.010
Benzo(b)fluoranthene	ug/l	-	-	0.028	n/a	<0.010
Benzo(b/i)fluoranthene	ug/l	-	-	0.046	n/a	<0.020
Benzo(g,h,i)perylene	ug/l	0.17	0.17	0.02	n/a	<0.010
Benzo(j)fluoranthene	ug/l	-	-	0.018	n/a	<0.010
Benzo(k)fluoranthene	ug/l	-	-	0.02	n/a	<0.010
Chrysene	ug/l	1.4	1.4	0.046	n/a	<0.010
Dibenz(a,h)anthracene	ug/l	0.26	0.26	<0.010	n/a	<0.010
Fluoranthene	ug/l	0.04	0.04	**0.15**	n/a	<0.010
Fluorene	ug/l	3	3	0.015	n/a	<0.010
Indeno(1,2,3-cd)pyrene	ug/l	0.21	0.21	0.017	n/a	<0.010
Naphthalene	ug/l	1.1	1.1	<0.20	n/a	<0.20
Perylene	ug/l	-	-	0.013	n/a	<0.010
Phenanthrene	ug/l	0.4	0.4	0.097	n/a	<0.010
Pyrene	ug/l	0.025	0.025	**0.12**	n/a	<0.010

Notes:

Type: N=Normal Sample; FD=Field Duplicate

n/a = not analyzed

"-" = No Standard Avaliable

ug/l = Microgram per litre

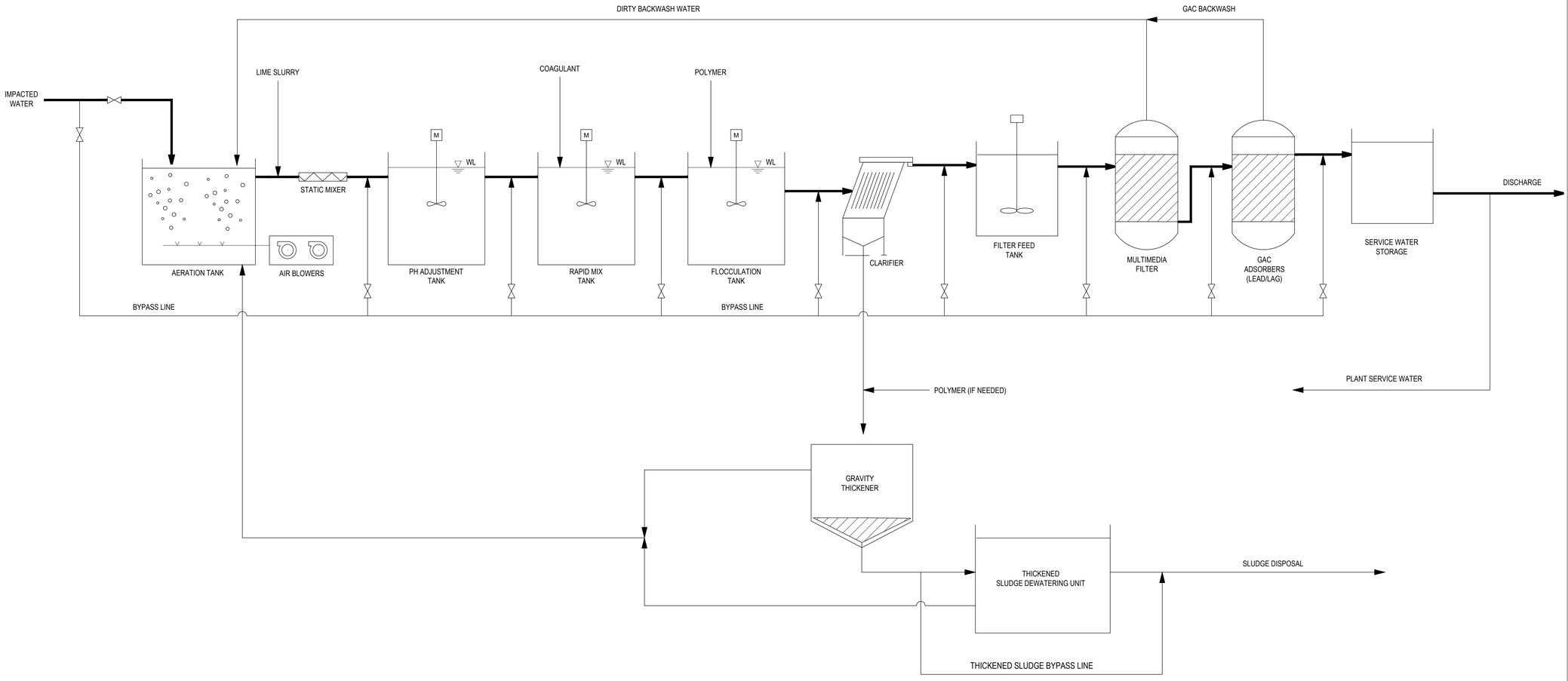
< indicates result less than Reporting Detection Limit (RDL)

Bold indicates result exceeds NSE EQS and PSS

[1] Nova Soctia Environment (NSE) Tier 1 Environmental Quality Guidelines (EQS) for Surface Water

[2] Nova Scotia Environment (NSE) PSS for Groundwater, discharge to surface water body within 0-10 metres, discharge to fresh water

Appendix B
Process Flow Diagram (PFD) and WTS Layout



NOTE:
1. THE TREATMENT SYSTEM DESIGNS ARE PRELIMINARY AND SUBJECT TO CHANGE. FINAL DESIGNS SHALL BE BASED ON CONTACT WATER FLOW RATE SELECTED BY THE CONTRACTOR.
2. INTERMITTENT FLOWS SUCH AS FILTER BACKWASHES ARE TO BE CONFIRMED BY CONTRACTOR BASED ON FILTER VESSELS SIZING.

DRAFT

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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	02/26/2021

Drawn **JS**	Designer **HS**
Drafting Check **MW**	Design Check **HB**
Project Manager **AB**	Date **Feb 26, 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

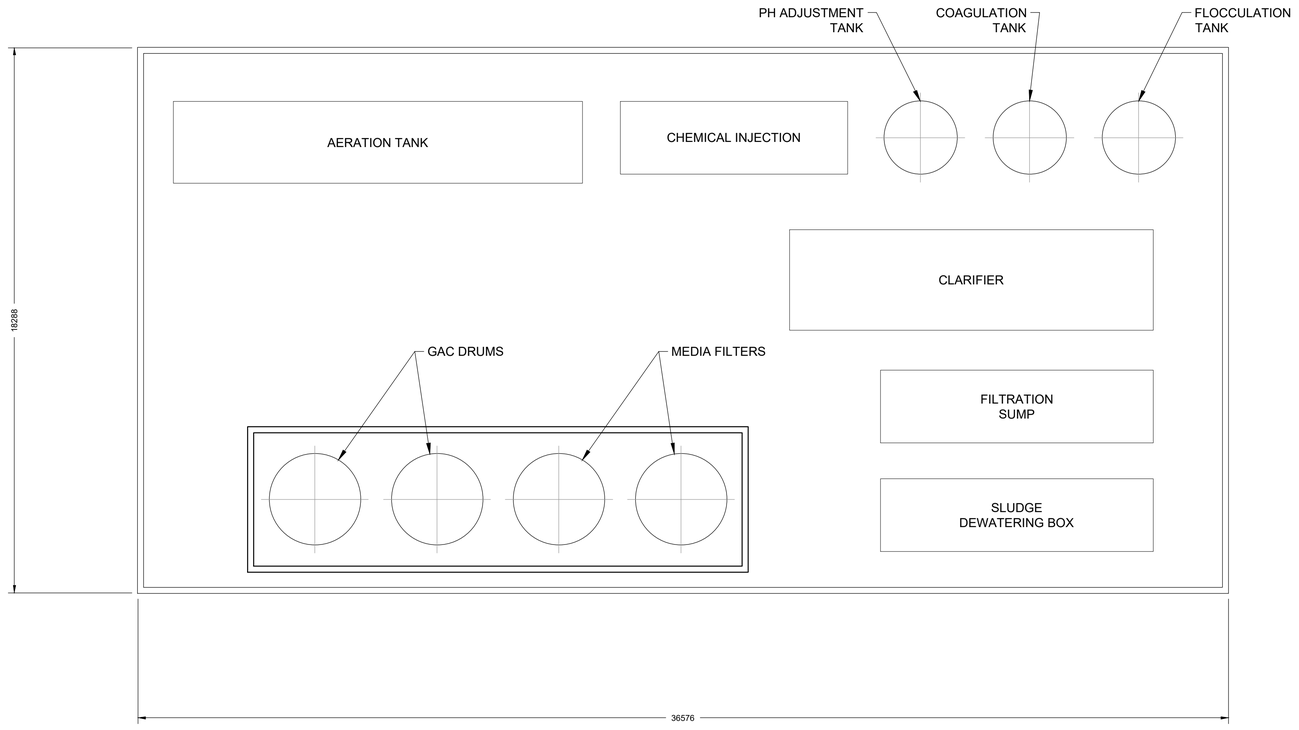
Project No. **88664**

Title
WATER TREAMENT SYSTEM PROCESS FLOW DIAGRAM

Sheet No.
P-01

Sheet **1** of **3**

Plot Date: 26 February 2021 - 2:00 PM Plotted By: Jason Spenler CAD File: N:\CA\Waterloo\Legacy\CAD\drawings\88000s\88664\88664-reports\88664-52(000)\88664-52(000)PR-WA001.dwg



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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	02/26/2021

Drawn	JS	Designer	HS
Drafting Check	MW	Design Check	HB
Project Manager	AB	Date	Feb 25, 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
WATER TREAMENTMENT SYSTEM LAYOUT

Sheet No.
G-01

Sheet **1** of **1**

DRAFT

Plot Date: 26 February 2021 - 2:11 PM Plotted By: Jason Spenler CAD File: N:\CA\Waterloo\Legacy\CAD\drawings\88000s\88664\88664-reports\88664-52(000)\88664-52(000)GN-WA001.dwg

Appendix C
Newterra SOQ and Spec Sheets

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Statement of Qualifications

Modular Groundwater & Dewatering Treatment Solutions

July, 2020

newterra.com

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1.0

Company Overview

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1.0 Overview: Over Two Decades of Water Expertise

Newterra is recognized as a leader in providing sustainable water and wastewater treatment solutions for industrial clients and the land development market. In operation since 1992, we have designed, engineered and manufactured over 3,000 treatment and groundwater remediation systems for use throughout the world. Over the course of two decades, our team has grown to over 225+ employees worldwide – all focused on our Total Commitment to Project Success. Headquartered in Brockville, Canada, Newterra has over 300,000 sq feet of manufacturing space in four locations in North America and Europe.

We Control the Full Process

At Newterra, we specialize in providing custom solutions to a wide range of complex water treatment challenges. Our expertise in water chemistry and the associated technologies to remove organic and inorganic contaminants is built on our extensive history in multiple markets. The unique nature of these projects inspired our integrated operational philosophy.

We take full control of every aspect of the treatment systems we build – from process design and engineering to Manufacturing,tanks, systems and membranes for our Sewage Treatment systems. We also install and commission our systems, and offer post-installation parts and service. This ensures that every Newterra system meets our high standards for quality and on-time delivery.

With thousands of installations worldwide for both systems and products, our large installed base reflects our reputation in various markets and the trust our many repeat customers place in Newterra over and over again. Our role in sustaining the world's fresh water supply is a responsibility that drives everything we do. Newterra is opening up new possibilities for decentralized water treatment with re-deployable systems. Our modular *"plug & play"* solutions can be located virtually anywhere and be scaled up and down in parallel with capacity requirements.

Along with our innovative technology, this industry-leading approach has been acknowledged with Newterra's selection from over 9,000 nominations and input from an expert panel as a **Global Cleantech Top 100 Company** and has also earned us **Deliotte's 50 Best Managed Companies Award** for 10 consecutive years.

Newterra has designed, engineered, and manufactured a significant installed base of modular MBR-based wastewater treatment systems – many of which operate in some of the most extreme environments on the planet, such as Baffinland, Nunavut in the Canadian Arctic.

Newterra engineered and built a large-scale, modular plant to treat domestic wastewater for a copper mine and the surrounding community in Zambia, Africa. The pre-built system was deployed, installed and operational with minimal site work at the remote location and is designed for future expansion at the site.

Overview: Solutions & Support on a Global Scale

Newterra has a growing number of offices, manufacturing facilities and service centers around the world with our family of recognized global brands. We believe that our family of companies can offer real solutions in most industry sectors and geographical locations.

COCHRANE by newterra

COCHRANE® by newterra is more than a name. It's an industrial water treatment legend. Throughout the world today, you'll find thousands of COCHRANE® by newterra systems hard at work. The COCHRANE legacy continues to be a driving force at newterra in our commitment to serving the Industrial water treatment market.

Aeration Industries a newterra company

Aeration Industries International has the expertise and reliable equipment to provide a full range of wastewater and aeration treatment solutions to optimize municipal, industrial, and aquaculture applications. Let's partner to create a customized solution that fits your needs.

MicroClear by newterra

MicroClear® by newterra, a subsidiary of Newterra, Ltd is the Technology and Competence Centre for the MicroClear® filtration system for membrane bioreactor applications (MBR) which has met with great success throughout the world.

stormwateRx a newterra company

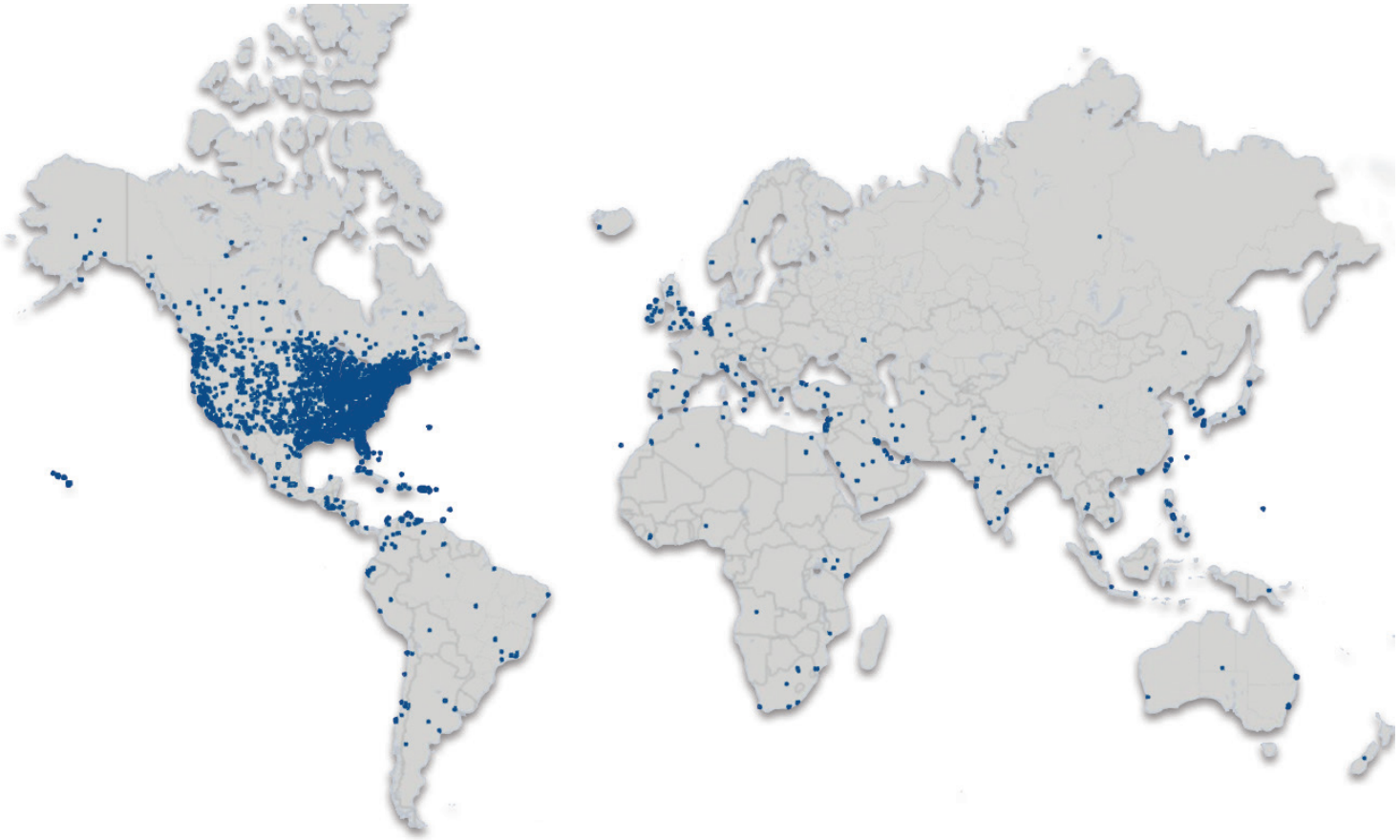
StormwateRx® manufactures, installs and mantains stormwater treatment facilities for customers in industrial sectors worldwide. These systems are designed specifically to help achieve industrial facilities comply with the National Pollutant Discharge requirements.

TIGG a newterra company

TIGG® has manufactured activated carbon adsorption equipment and provided liquid and vapor treatment solutions for municipal water, environmental remediation applications, and industrial manufacturing facilities. TIGG's engineers and technical experts are among the best in the field. TIGG regularly treats water sources contaminated with PFAS, 1,4 Dioxane, trace metals, and hydrocarbons.

Overview: Thousands of Installations Worldwide

With **thousands of installations worldwide**, our large installed base reflects our reputation in various markets and the trust our many repeat customers place in Newterra over and over again. Our role in sustaining the world's fresh water supply is a responsibility that drives everything we do. Newterra is opening up new possibilities for decentralized water treatment with re-deployable systems. Our modular *"plug & play"* solutions can be located virtually anywhere and be scaled up and down in parallel with capacity requirements.



2.0

Strategic Manufacturing and Inventory Management

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2.0 Strategic Manufacturing & Inventory Management

Newterra Primary Manufacturing Facilities - Brockville, Ontario
With over three acres of heated manufacturing space (135,000 sq. ft.), our main manufacturing centre in Brockville enables Newterra to build and test multiple, large scale treatment systems simultaneously. Our Production Team is comprised of certified tradespeople who work in dedicated customer-focused teams to see a system through from start-to-finish. A philosophy of continuous improvement and Lean manufacturing techniques guide our processes and allow us to maintain very high quality levels. Our Brockville operations feature ground level loading docks for ease of shipping, and our overall electrical capacity allows us to fully test the designed equipment. Newterra systems leave our facility with MET- and UL-certifications, eliminating the need for electrical inspections at the installation site. They are undergo rigorous hydraulic testing in our plant before being released. Newterra is located close to the Port of Montreal for international shipments by container ship, reducing the costs of delivery.

Newterra MicroClear® Membrane Plant - Langgöns, Germany
Our application of this proprietary membrane technology, along with our significant engineering strength and ongoing R&D programs, has allowed Newterra to be selected for large scale sewage treatment projects of Fortune 500 resource companies. Case in point, the 8,000-person wastewater treatment plant in Africa and a 10,000 person camp in Northern Canada that Newterra had engineered, built and installed.

TIGG® Corporation - Oakdale, PA & Heber Springs, AR
TIGG has nearly 40 years of experience in developing a broad range of activated carbon filters, activated carbon adsorption equipment, systems, and services for environmental remediation and the removal of trace contaminants from air, water, and process liquids, and gases. In addition to activated carbon equipment, TIGG designs and manufactures integrated liquid and vapor treatment systems in their 155,000 square foot manufacturing plant situated on 40 acres of property in Heber Springs, Arkansas.

We Don't Outsource Production

At Newterra, we are not beholden to subcontractors. By having direct control over every phase of a project - including membrane, tank and system production – we can design, build, test and install treatment systems within very short lead times.

Another benefit of managing all aspects directly is that our Engineering, Production and Service Teams are constantly collaborating. This results in ongoing improvements that streamline assembly, increase efficiency, and optimize quality. Integrating Newterra Service professionals in our team approach also ensures that our systems are built with the operator in mind – so our control systems are intuitive, and maintenance procedures can be completed safely and efficiently.

UL MET c us ISO 9001:2008 certified NSF Certified to NSF/ANSI 61

Our Brockville facilities feature over three acres of manufacturing space. Each system is built from start-to-finish by a customer-focused team to maximize quality, and is shipped with MET and UL electrical certifications

TIGG is capable of fabricating tanks up to 14 feet in diameter in their offer state-of-the-art manufacturing facility in Heber Springs, AR

Newterra owns and manufactures MicroClear UF membranes at its facility in Langgöns, Germany.

3.0

A Culture of Commitment

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3.0 A Culture of Commitment

Our culture is one of celebrating and supporting the success of our teammates and partners in an environment where we enjoy what we do, the people we work with and are proud of the accomplishments of our company. Our guiding philosophy at Newterra is to build long term relationships with our employees, our customers and our suppliers. We do not treat our partners, nor expect to be treated by our partners, as a one time transaction.

Equally important, we approach our opportunities and challenges with a sense of urgency that demonstrates Newterra's commitment to success and our customers.

The Newterra Core Values

We Decide to Win

- *We* will be #1 in our markets
- Results Matter – Winning is a choice, not an outcome
- *We* deliver on our commitments 100% of the time

We Will Be Better

- *We* improve each day
- Why tomorrow, when today is available?
- *We* listen, learn, then lead

We Think "Inside" the Box

- *We* thrive on solving the impossible
- *We* exceed our customers' expectations
- *We* remain ahead of our competition

We Do What's Right

- No excuses
- Zero Accidents
- Unwavering ethics
- *We* earn the right to work here

Excellent Track Record for Safety

Health and safety are fundamental components of our training programs and workplace protocols at Newterra. Protecting employees, contractors, business partners and visitors to our facilities and job sites from the risk of workplace injury or illness is a primary objective.

We rigidly follow Lockout-Tagout (LOGO) protocols, Arc Flash safety and other procedures, and conduct weekly safety meetings with all production employees. Additionally, monthly safety meetings are held on a company-wide basis, along with formal Health & Safety training sessions annually. We are proud of our safety record (see Newterra safety stats below) and our vigilance for continuous improvement in safety processes. We reinforce that training through routine inspections throughout our operations, and an annual audit of our Health & Safety Program that is based on the Workplace Safety and Insurance Board's (WSIB) Workwell Audit.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019*
Number of Deaths **(G)**	0	0	0	0	0	0	0	0	0	0	0	0
Number of Cases involving Days Away From Work (Lost Workday cases) **(H)**	0	0	0	1	0	1	0	0	0	0	0	0
Number of Days Away From Work (Days Lost Time)	0	0	0	0	0	[21]	0	0	0	0	0	0
Number of Days Involving Restricted Work Activities (Number of Restricted Workdays Cases) **(I)**	0	1	0	0	0	1	1	1	0	0	1	1
Number of Days of Restricted Work	0	[102]	0	0	0	[49]	[60]	[50]	0	0	[142]	[10]
Total Number of Cases Involving Days Away From Work, Restricted Activity or Job Transfer Rate **(H&J)**	0	1	0	1	0	2	1	1	0	0	1	1
Number of Other Recordable Injuries **(J)**	3	2	0	0	1	0	3	2	1	2	1	0

**January-June data only.*

4.0

Groundwater & Dewatering Treatment Solutions

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Soil & Groundwater Installation Examples

Newterra is extremely well suited to bring technology expertise and innovative solutions to a wide range of remediation challenges. Our **experience engineering and manufacturing groundwater treatment systems** dates back to 1992, and includes more than a thousand projects over our twenty-two year history. In that time, we've worked closely with major consulting firms, including CH2M Hill, Arcadis and others.

A sample of remediation projects for which we've supplied equipment design, engineering, manufacturing, installation and support includes the following:

Pump & Treat System, Lac Mégantic, Quebec

In operation since December 2013

On July 6, 2013, an unattended 74-car freight train carrying crude oil slowly rolled from a Quebec rail yard, picking up speed as it descended the rail line towards the small town of Lac Mégantic. As it reached the center of town, travelling at over 60 miles per hour, it derailed and exploded violently – killing 42 people and destroying almost half of the downtown area.

Over 1.5 million gallons of crude oil escaped the ruptured and burning tanker cars, resulting in a significant environmental disaster. Emergency measures were taken immediately to control water and oil. Five months later, in December 2013, a longer term water treatment solution was implemented, including the installation of two **Newterra** water treatment systems.

Each **Newterra** system, packaged in 40" sea containers, is capable of treating 120 USGPM. The treatment systems include oil water separation, bag filtration, clay filtration media and, finally, carbon vessels. The first system was delivered within a week and the second followed a week later. Start-up services were provided immediately after installation during the third week.

The start-up included testing to demonstrate the effectiveness of the process train in removing hydrocarbons, and the systems have been running since that time. Currently estimates have the units running until October 2014.

Newterra's understanding of the process needs and associated risks, our significant rental inventory, and rapid response to set-up and test has helped accelerate the remediation efforts in the aftermath of this tragedy.

In the aftermath of a tragic train derailment in Lac Mégantic that spilled 1.5 million gallons of crude oil, Newterra was able to respond with an effective remediation solution within weeks

Retail Gas Station Remediation, Washington State

The site, a former retail gas station located in a residential area of a Washington State, required remediation due to contamination by gasoline range organics and benzene.

Newterra was called upon by Arcadis for a system to remediate the site. Stringent local permitting was a key issue in developing the solution. Newterra was able to engineer a cost-effective approach to providing a Dual Phase Extraction and Groundwater Treatment System that complied with local codes. The two skid system consisted of an oil-water separator, air stripper and liquid phase carbon for groundwater treatment. A catalytic oxidizer was incorporate for vapor treatment.

Newterra overcame challenging local permitting issues to address contamination at the site of a former retail gas station.

Fort Drum US Army Base, New York State

In operation: 2011

At some point in 2001 or 2002, a faulty valve on a sump beneath a helicopter refueling oasis began leaking jet fuel at the Wheeler-Sack Army Airfield of Fort Drum. When it was discovered in April 2006, it was estimated that approximately 350,000 gallons of jet fuel had spilled into the ground, contaminating a three acre area of the base.

Rapid deployment of remediation technologies for groundwater treatment and product recovery, as well as soil vapor extraction was required for the cleanup operation – which was limited to warmer months. This seasonal limitation was due to the fact that all sub-surface piping was existing and installed above grade due to cost constraints associated with installing new piping below the frost line for winter operation.

Newterra's on-site remediation solution consists of a combination of equipment from our extensive rental fleet, along with customized systems we designed and built specifically for the project. We have modified several of our rental systems over time in response to changes in site conditions and end-user requirements.

Over the course of the multi-year project, Newterra has become a consistent entity based on our responsiveness and the quality of our solutions. Despite different prime contractors at various phases of the cleanup, newterra has been chose consistently to be the preferred equipment supplier over the contract periods.

Newterra has been instrumental in the remediation efforts at Fort Drum in New York state. Three acres of the base were contaminated by 350,000 gallons of jet fuel following an undetected leak at a helicopter refueling station.

Double Stacked Dewatering Treatment – 300 gpm (1,640 m3/day)

In operation: 2017

Newterra, designs a double stacked containerized plant for treating dewatering groundwater prior to discharging to the storm sewer for the Eglington tunnel project in Toronto, ON Canada.

Newterra was called upon by Crosslinx Transit Solutions for a system to remediate the site. With space constraint being the biggest challenge at this downtown construction site, Newterra designed a double stacked plant including green sand filtration filter for solids removal followed by activated carbon for hydrocarbon treatment prior to discharging to the storm sewer.

This expansion is the largest transit expansion in Canada and Newterra is proud to be a part of this project

Parameter	Inlet to Treatment System	Outlet of Treatment System
Total Suspended Solids mg/L	1000 mg/L	<50 mg/L
pH	12	10

***Newterra** overcame challenging space constraints to address contamination at the Eglinton Crosstown Light Rail Transit Expansion*

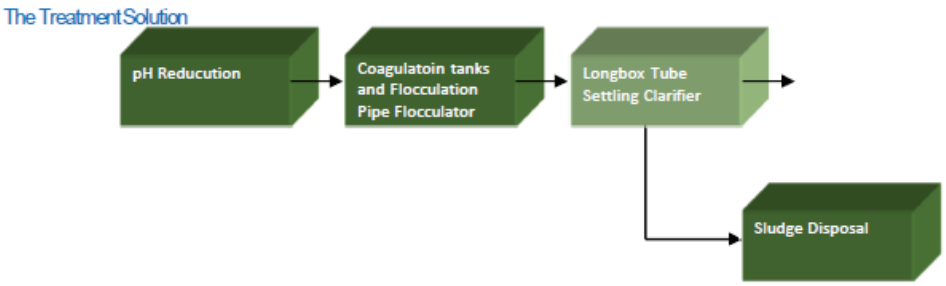
Shotcrete Waste Water Treatment Plant – 70 gpm (380 m3/day)

In operation: 2017

Newterra, designs, and supplies a solids treatment system for removal of TSS and concrete dust on a tunneling project prior to discharging to sewer.

This system was built in two modules a containerized building for pH adjustment, coagulation and flocculation and an exterior insulated longbox clarifier. The treated water leaving the longbox clarifier is discharged to the sanitary sewer while the sludge is pumped off to a holding tank and hauled away for offsite disposal.

***Newterra** has been instrumental in the remediation and dewatering efforts at the Eglinton Crosstown Light Rail Transit Expansion lead by Crosslinx Transit Solutions*



Getting to Non-Detect PFAS as Quickly as Possible, Issaquah, Washington

Washington Issaquah, is a Seattle-area suburb that provides drinking water to its customers using a combination of its four groundwater wells. As part of EPA's Third Unregulated Contaminant Monitoring Rule (UCMR 3), the City detected PFCs in one of its 250 gallons per minute (GPM) well supply, the primary compound being PFOS and PFOA. Concentrations of both contaminates were detected well above the EPA acceptable guidelines forcing them to shut down one of their wells. TIGG's CP-20K-10 deep bed, dual vessel skid adsorption system with granular activated carbon (GAC) was installed and initiated operation, therefore, allowing Issaquah to begin to again pump from the well. Monthly test results show the system is working as expected and that there are no detections of PFCs from the finished water of the well before it enters the City's distribution system.

Solar-Powered Groundwater Pump & Treat System, Lockheed Martin Missiles & Fire Control, Orlando, Florida

In operation: 2010

Located near Orlando,Florida, the Lockheed Martin Missiles & Fire Control site had groundwater with moderate levels of contamination by chlorinated solvents. They required a customized system that would prevent migration of the contaminants and begin the remediation process. A key requirement of the project was that the system be powered completely by renewable energy – in this instance, solar power.

Assessment of the contaminants led to the selection of air stripping as the most effective remediation technology. However, based on the moderately high flow rates and the heavy energy consumption of traditional air strippers, a customized system would need to be developed. Partnering with HSW Engineering, **Newterra** developed a modified tower-type air stripper that incorporated a unique venturi effect to enhance air flow and minimize the electrical requirements of the DC fan.

Groundwater extraction was addressed with seven Grundfos 5 GPM electric pumps which, like the air stripper and controller, were solar powered. The control system featured battery backup and integrated alarms.

Another critical element of the system was the **Newterra**-designed enclosure. The roof was angled to maximize energy capture of the integrated solar panels. Natural passive lighting and ventilation by convection were also instrumental in the design of the wind load certified enclosure.

Newterra's partnership approach resulted in an effective remediation system powered completely by solar energy and packaged in a highly efficient enclosure.

Chemical Treatment / TSS Removal

TSS (Total Suspended Solids) removal is important when the water source is from rivers, canals or low land reservoirs, which tend to have high suspended solids, numerous dissolved constituents, and often a significant bacterial load.

Typical processes for removal of Suspended Solids include:

•pH Adjustment

•Coagulation and Flocculation

•Clarification

•Sand filtration or media filtration

Newterra has significant experience and numerous projects in this technology – from small to large flow rates.

Project - Directline: *TSS removal from waste water prior to secondary treatment. Included pre-screen, pH adjustment, polymer flocculation, clarification, sludge removal. Contact: Tony Ricciutto*

Project - Bennett: *TSS removal from waste water prior to reuse or discharge. Included pre-screen, pH adjustment, polymer flocculation, clarification, sludge removal, media filtration.*

Project - Krispy Kernel: *TSS removal from wash water prior to reuse or discharge. Included pre-screen, pH adjustment, polymer flocculation, clarification, sludge removal.*

Project - MRCan (Alberta-Peyto): *TSS removal from gas condensate water prior to methanol recovery. Included pH adjustment, polymer flocculation, clarification, TSS measurement.*
Contact: Rod Vinner

Iron & Metals Removal

When dealing with deep and shallow groundwater, the water may be rich in dissolved solids, especially carbonates and sulphates of calcium and magnesium. In addition to this, iron and manganese are often present, which must be removed to make the water palatable for drinking, cooking and laundry use. Typically these must be removed prior to subsequent membrane treatment.

Newterra has significant experience in the removal of these constituents from water. Both greensand filtration and our proprietary deferrum technology have been used.

Project - City of Belleville:
Iron removal system 800 m^3/day.

Project - Imperial Oil (IOCO) Site:
Iron removal system 100 m^3/day
Contact: Linda Eastcott

Media Filtration

Media filtration can be used in several areas in the treatment process, including greensand filtration, TSS removal, post filtration with sand and carbon.

Newterra has two decades of experience building media filtration systems. These include systems for metals removal, iron removal, and hydrocarbon removal. Our media filtration systems have included automated backwash, chemical feed and other ancillary systems.

Project - Sydney Tar Ponds:
Media filtration systems
Contact: John Armistead (AECOM)

Membrane Filtration

Membrane filtration is often used as a post treatment after iron/metals removal. Membrane systems use a membrane filter in place of granular media to filter water without coagulants. Membranes are classified as micro, ultra, nano or RO. Each has a particular role to play depending on the process design criteria.

Newterra has over two decades of experience engineering and manufacturing systems that employ membrane filtration. Depending on the dynamics of a specific project will will outsource the membrane filtration skid or build it in-house. To date, we have completed over 30 membrane filtration systems in-house.

Project - Eaton Corporation:
Ultrafiltration system.
Contact: Tim Fitzgerald (Pabsco)

Project - Chrysler Canada:
Ultrafiltration system (GE membranes).
***Newterra** is a Tier 1 supplier to Chrysler.*
Contact: Joan Gauthier

5.0

Quality Assurance Protocols

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5.0 Quality Assurance Protocols

A Commitment to Continuous Improvement

To utilize our cross functional quality team to continually improve the quality of our systems and implement permanent solutions to issues affecting quality as they are identified.

Our Quality Objective

- Ensure all issues affecting quality are captured and brought to the meeting
- Ensure each issue is assigned to a specialist to implement a solution.
- Ensure all issues are resolved to ensure that they do not reoccur.

Newterra Inspection & Factory Acceptance Testing (FAT) Protocol

					Inspection Date (What/Who)	
Plan Step	**Detail/ Document**	**Standard/ Specification**	**Acceptance Criteria**	**Inspection/Test Procedure**	**Newterra**	**Customer**
Process Design	Design Review	Manufacturer Specifications	Required Effluent Characteristics	PID and Technical Submittals		
Factory Commissioning (FAT – Installation Qualification)	Civil	Container Drawing Requirements DPT	Dimensional Specifications and Codes Certification if Applicable	FAT		
	Mechanical	PID/Equipment Verification	Specifications and Codes Vendor Certificates	FAT		
	Electrical	Electrical Schematics	Specifications and Codes	FAT		
	Program/Controls	Electrical Schematics	Specifications	FAT		
Factory Functional Test (FAT – Operational Qualification)	System	Control Narrative	Control narrative functional requirements are met	FAT		
	Non-Conformity Reports		All NCRs are addressed and approved	NA		
FAT – Pre-Shipment Inspection	System	Pre-Shipment Requirements	Specifications	FAT		
Site Installation	System Installation	Installation Site Inspection (Level and Layout) Electrical Site Inspection (Power and Control) Mechanical Site Inspection (Piping and Tanks)	Specification and Code	Installation Checklists		
Site Testing	System Wet Test	Fill System With Water	No Leaks	Site Testing Checklist		
Site Commissioning/ Handover	System Start Up/AB Ethernet Data Comm.	Process Design Report	Design Criteria Met	Commissioning Checklist		
Documentation	OM Manual/As Built Drawings/Spare Parts List		As Built Complete	NA		

6.0

Newterra Total Quality Management (TQM) Program

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6.0 Newterra Total Quality Management (TQM) Program

Quality Mission Statement

At Newterra, we firmly believe the primary mission of a quality system is to maintain a satisfied customer base by providing customers with superior quality and service at a fair price. In order to maintain superiority in the quality of our products and services, we commit ourselves to the following:

Key Measures

A commitment to focus upon those key measures which reflect upon customer satisfaction and on continuous effort toward improvement in these measures.

Quality Standards

A commitment to establish product quality standards which satisfy the customer's wants and needs through mutual communications and understanding.

Statistical Methods

A commitment to use professional and statistical methods to control, monitor and document the product quality levels.

Employee Involvement

A commitment to provide all employees with the opportunity and responsibility to be involved and control the quality aspects of their jobs via continuous education, training and communication techniques.

Technical Excellence

A commitment to provide a technically competent and contemporary staff for supporting the development and production of high quality, cost effective product.

Value Added Service

A commitment to progressively pursue those services for our customers that provide them the ability to maintain a competitive posture in their industry.

"Controlling the process – from design through manufacturing and commissioning – allows Newterra to integrate Total Quality Management at every stage."

Former Ontario Premier Kathleen Wynne tours Newterra's six-acre manufacturing facility with CTO Robert Kennedy.

Celebrating 25 Years of manufacturing in Brockville, ON location are Bruce Lounsbury, Gord Brown, Steve Clark, David Henderson, and Tom Vossman.

Down the hatch! Newterra staff demonstrate their confidence in Newterra's water treatment technology, toasting and drinking water produced by the 'toilet-to-tap' reuse system in its Brockville, ON facility.

About Newterra

Newterra is a leading provider of decentralized water and wastewater treatment and remediation solutions to the industrial and municipal markets. With its suite of patented and proprietary technologies, Newterra offers a broad range of solutions to the world's most demanding industrial end users including mining, oil & gas, and food & beverage companies. Newterra's capabilities – from design & engineering to manufacturing in its own facilities – allow the company to maintain full control over the quality of its systems while achieving on-time delivery. With operations in Canada, the United States, and Germany, Newterra can address its customers' needs on a global basis. Newterra is a distinguished recipient of **Deloitte's 50 Best Managed Companies** for the past 9 consecutive years. Newterra was also selected from over 9,000 nominations and input from an expert panel to be a **Global Cleantech Top 100 Company**.

CANADA'S BEST MANAGED COMPANIES Platinum member

Global Cleantech 100 TOP 100 COMPANY

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technical datasheet

LongBox® Clarifiers

Modular, High Flow Sediment & Suspended Solids Removal

newterra's patent pending LongBox® high-flow clarifiers are designed specifically for efficient sediment and suspended-solids removal on groundwater treatment and dewatering projects. These innovative, rectangular clarifiers are built for easy transport on flat-bed trucks to construction sites or groundwater-treatment projects. Once on-site, installation, setup and operation are fast and simple – even on uneven ground. Available with tube settlers or inclined plates, **newterra** LongBox® Series Clarifiers provide excellent removal efficiencies compared to traditional weir tanks and settling or frac tanks commonly used for sediment treatment on construction sites.

This chemical-free approach offers excellent sediment removal without the high cost and regulatory requirements associated with dosing chemicals for flocculation and coagulation.

LongBox® Advantages

- Pre-built & fully assembled
- Multiple configurations with flow rates up to 2,500 GPM
- Available as insulated, self-contained system for cold weather applications
- Fast, simple on-site set-up
- Operates on non-level ground
- Easy sludge monitoring and removal
- Operator access platform for easy access and maximum safety
- Durable carbon steel construction
- Designed for easy shipping

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Innovative, Operator-Friendly Clarification Technology

Quick Leveling On-Site: Level ground is not required. **newterra** LongBox® Clarifiers allow simple field adjustments to accommodate non level ground up +/-2” on the width of the tank and +/-4” across the length of the tank.

Operator Access Platform: A integrated, fold-away catwalk provides safe, convenient access to the top of the clarifiers for inspection, determining sludge depth, cleaning and operational adjustments.

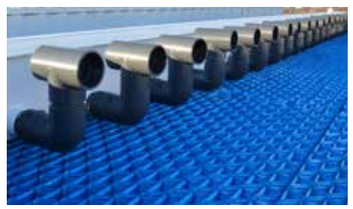
Easy-Access Sludge-Removal: Side-access to the clarifier allows access to the sludge below the clarifier media while standing on the operator access platform. Sludge can be pumped out without removing the media, draining the tank or even stopping the process flow.

Higher Solids Load Handling Capacity: The innovative design features a shorter plate pack – allowing tighter plate spacing than long or tall lamella clarifiers. The result: LongBox® Clarifiers are capable of treating higher solids loads without risk of overloading the clarifier. Shorter plate packs are also easier to remove, with lower headspace required above the clarifier.

Quiescent Settling Zone Configuration: Sludge from the quiescent zone and plate pack fall into same location for easier sludge removal.

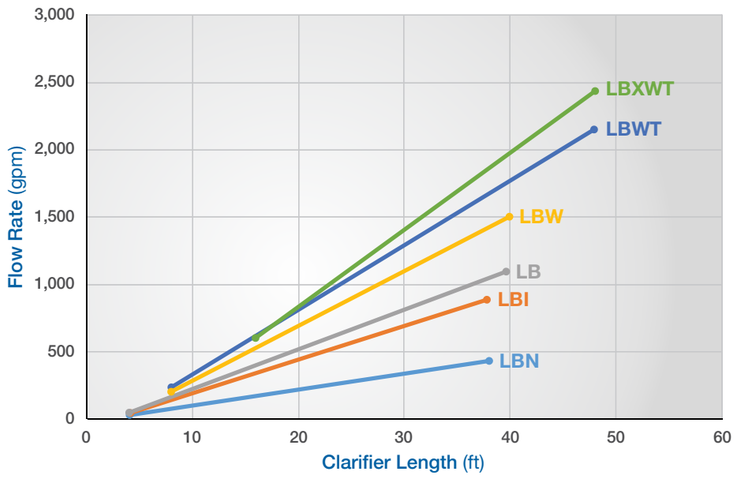
Durable, Carbon Steel Construction: Sand-blasted epoxy liner provides long-term chemical resistance. Other materials of construction are available.

newterra Sludge Extractor: This flexible, broom-like wand features a suction head for easy removal of sludge from below the clarifier media. The optional accessory can pump sludge to a chemical-treatment process for dewatering or directly back into an excavation, where permitted.



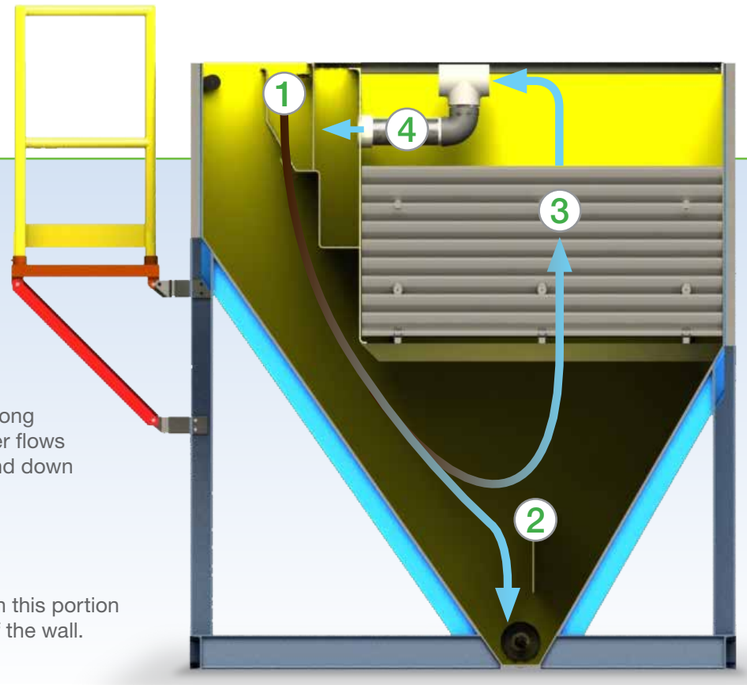
Space-Efficient Performance

newterra LongBox® Clarifiers provide fast, effective removal of suspended solids in an extremely compact, self-contained unit. They offer almost **three times** the settling area of conventional weir tanks m ore than twice their size, and **25% more** settling area than similarly sized convention tube clarifiers.



Performance of all clarifiers is dependent on the types of suspended solids and the temperature of the water. The Performance Curves above illustrate the nominal flow of newterra LongBox® Series Clarifiers at a water temperature of 16 °C and particles of 10 microns and larger with a specific gravity of 2.65.

Operating Principles



1 Inlet

Solids-laden water enters the clarifier and is distributed along the inlet trough. The inlet trough has strategically-placed distribution holes to achieve even flow along the clarifier, even at maximum flow. Water flows out of the trough through these holes, and down towards the bottom of the unit.

2 Settling Area

Larger, heavier solids will settle quickly in this portion of the clarifier, aided by the high slope of the wall.

3 Settling Media

The water flows up through the settling media (tube or slant plates) that is designed to dramatically increase the available settling area for solids particles, and to decrease the distance particles need to fall before contacting this settling area. Upon settling, finer particles contact each other, forming increasingly larger particles which ultimately fall to the Settling Area **(2)**

4 Skimming Tees

Upon exiting the settling media, the water flows to the outlet trough via the adjustable skimming tees – which help achieve distributed flow, and serve as levelling elements for the clarifier. Settled solids can be manually removed from the operator platform by lowering an extraction hose down to the Settling Area **(2)**. Automated sludge-removal options are also available.

Flexible Configurations

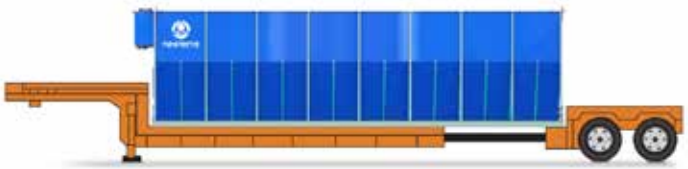
newterra LongBox® Clarifiers are available in several different configurations to address a wide range of flow rates, sites and operational considerations:

Series	Length	Width	Height	Advantages & Shipping Notes
LBN	4’ to 38’	5’4”	6’4”	• Insulated for cold weather applications, and fully enclosed for operation & maintenance within ISO shipping container • Flatbed trailer
LBI	4’ to 38’	7’7”	8’5”	• Fits within an ISO shipping container for simplified international transport • Flatbed trailer; configured for use with tilt & load trucks for easy deployment
LB	4’ to 40’	7’10”	9’8”	• Drop deck trailer; configured for use with tilt & load trucks for easy deployment • No permits req’d
LBW	8’ to 40’	11’	9’8”	• High flow rate • Drop deck trailer; no permits or escort req’d;
LBWT	8’ to 48’	10’8”	11’4”	• High flow rate • Stretch double drop trailer; permit req’d; no escort req’d
LBXWT	16’ to 40’	12’4”	11’4”	• High flow rate • Stretch double drop trailer; permit & escort req’d

LBN

LBI

LB, LBN



LBWT/LBXWT

Optional Features

Insulated Clarifier: Available as a stand-alone, cold-weather product where the tank is enclosed in rigid, insulated steel panels. Panels are removable, providing access to the top of the tank and equipment spaces around the clarifier. Heating can be incorporated for cold-weather applications.

Enclosed Top: Features hatches and removable sections to facilitate maintenance requirements.

Inclined-Plate Settlers: Standard equipment tube settling media can be replaced with optional flat inclined plates made from carbon steel, stainless steel or PVC.

Open Gravity Clarifier: Available without settling media for applications where there is high potential of plugging the settling media.

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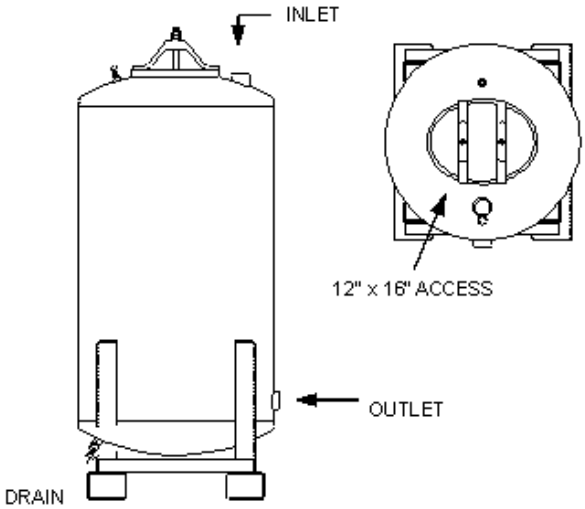
HIGH PRESSURE LIQUID PHASE CARBON STEEL VESSELS – HPLPC SERIES

Application:

newterra High Pressure Liquid Phase Carbon filters are media filter vessels designed to treat liquid streams. While the typical design application is an activated carbon absorption unit, the filter can easily accommodate many types of media. Some applications include:

- Dissolved Organic Removal (Activated Carbon)
- Suspended Solids Removal (Sand Filter)
- Dissolved Minerals (Softener Resin)
- Oil and Grease Removal (Organo-Clays)
- Dissolved and Precipitated Metals Removal
- Special Organics (Resin/Carbon Blend)
- Catalytic Reactor (Chlorine and Peroxide Removal)
- Bio-Remediation Contactor Unit



Construction:

All HPLPC vessels are made using SA-36 Carbon Steel with corrosion resistant SCH 40 PVC internals.

Standard Features:

- Corrosion resistant SCH 40 PVC internal piping
- Epoxy-coated interior for corrosion resistance
- Designed to maximum operating conditions of 75 psig and 140°F

Dimension and Specification Chart:

Model Number	HPLPC500	HPLPC1000	HPLPC2000	HPLPC3000
Overall Height	5’ 11”	7’ 2”	8’ 6”	8’ 11”
Footprint	2’ 6” x 2’ 6”	3’ x 3’	4’ x 4’	5’ x 5’
Diameter	30”	36”	48”	60”
Inlet / Outlet (FNPT)	2” / 2”	2” / 2”	3” / 3”	3” / 3”
Drain / Vent (FNPT)	½” / ¼”	½” / ¼”	¾” / ½”	1” / ½”
GAC Fill	500 lb	1000 lb	2000 lb	3000 lb
Shipping Weight	850 lb	1535 lb	3020 lb	4525 lb
Operational Weight	1770 lb	3295 lb	6775 lb	10635 lb
Cross Sectional Bed Area	4.9 ft^2	7 ft^2	12.5 ft^2	19.5 ft^2
Bed Depth (using 8*30 GAC)	3.4 ft	5 ft	5.5 ft	5.5 ft
Bed Volume (using 8*30 GAC)	16.7 ft^3	33 ft^3	68.7 ft^3	107 ft^3

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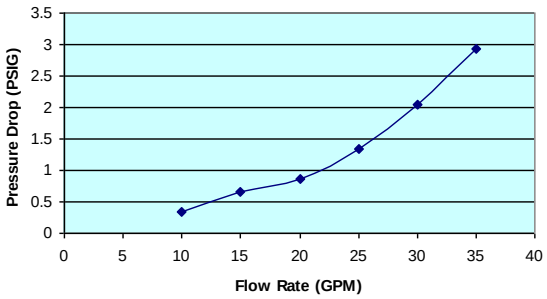
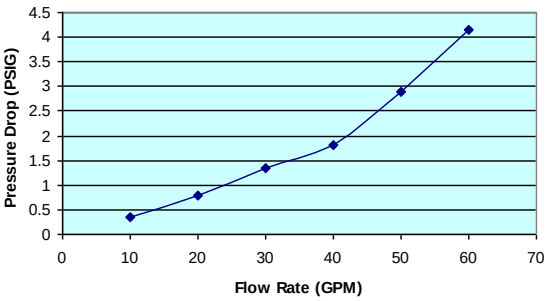
HIGH PRESSURE LIQUID PHASE CARBON STEEL VESSELS – HPLPC SERIES

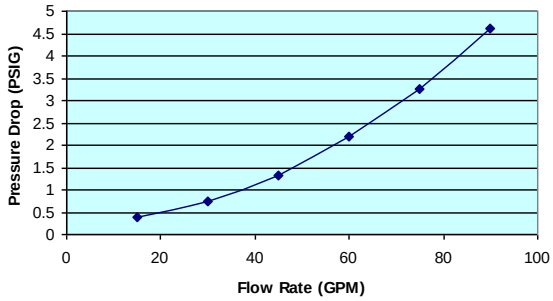
Pressure Drop Graphs
(As Filled - 8*30 GAC)



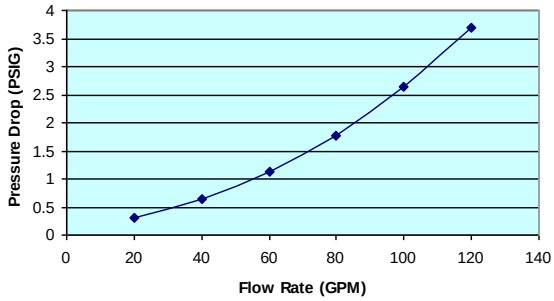
HPLPC500



HPLPC1000



HPLPC2000



HPLPC3000

Contact Time vs. Flow Rate
(8*30 GAC)

Flow Rate	Single Bed	Dual Bed
10 gpm	12 minutes	24 minutes
20 gpm	6 minutes	12 minutes
30 gpm	4 minutes	8 minutes
40 gpm	3 minutes	6 minutes

Flow Rate	Single Bed	Dual Bed
15 gpm	16 minutes	32 minutes
30 gpm	8 minutes	16 minutes
45 gpm	6 minutes	12 minutes
60 gpm	4 minutes	8 minutes

Flow Rate	Single Bed	Dual Bed
25 gpm	20 minutes	40 minutes
50 gpm	10 minutes	20 minutes
75 gpm	7 minutes	14 minutes
100 gpm	5 minutes	10 minutes

Flow Rate	Single Bed	Dual Bed
35 gpm	22 minutes	44 minutes
70 gpm	11 minutes	22 minutes
105 gpm	7 minutes	15 minutes
140 gpm	5 minutes	11 minutes

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technical datasheet

SBD Series Box Filters

Sludge Dewatering Rolloff Box Filters

newterra SDB series Sludge Dewatering Rolloff Box Filters are designed for filtering flocculated solids from water streams providing a concentrated sludge for easy low cost disposal.

This unique design is developed around the industry standard frames for rolloff box dumpsters allowing the filters to be picked up by a local waste hauler with a rolloff truck who can dispose of large volumes of sludge easily at a local landfill.

This product provides a solution for storing and managing sludge that significantly reduces O&M costs and allows for more cost effective disposal of sludge waste compared to other solutions.

Standard Features:

- Designed to be unloaded by a standard “cable and hook“ hoist truck
- Epoxy coated for long life and durability
- Water tight sludge storage
- Reusable filter panels integrated into the wal
- Dewaters down to a 12-16% solids content

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SBD Series Box Filters

Construction

These filters are fabricated from A36 Carbon Steel. They are sand blasted and epoxy coated on the interior and exterior for long lasting durability. Patented permanently installed, re-usable, filter membranes are integrated into the sides of the filter boxes allowing the clean water to drain leaving behind a thick sludge (12-15% solids) for disposal at your local landfill. Optional disposable filter liners can be supplied to line the Sludge Dewatering rolloff box filter to improve the clarity of the filtrate.

Dimensions and Specifications

newterra SBD Series Box Filters are available in several different configurations to address a wide range of flow rates, sites and operational considerations:

Part Number	Overall Length	Overall Width	Overall Height	Storage Volume	Dry Weight
SDB–15	12’-6”	8’-6”	5’-6”	15 cu yards	7,000 lb
SDB-20	16’-6”	8’-6”	5’-6”	20 cu yards	10,500 lb
SDB-25	20’-6”	8’-6”	5’-6”	25 cu yards	11,500 lb
SDB-30	23’-6”’	8’-6”	5’-6”	30 cu yards	12,000 lb
SDB-40	23’-6”	8’-6”	6’-6”	40 cu yards	12,500 lb

Customized packages are available for your specific project needs.
Dimensions and layout can vary depending on specific project requirements.

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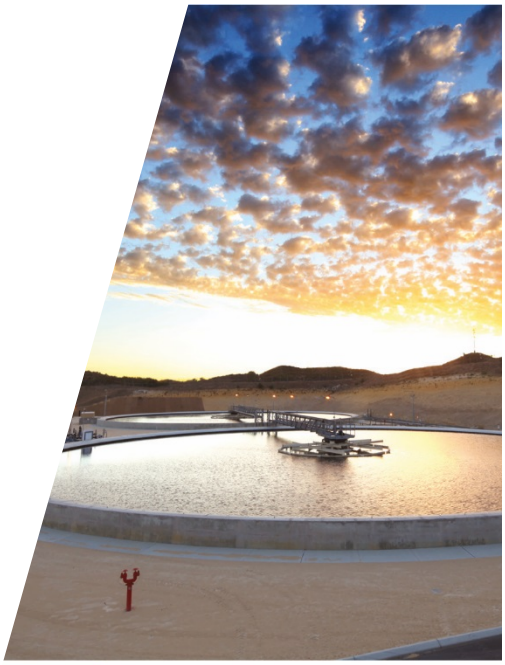
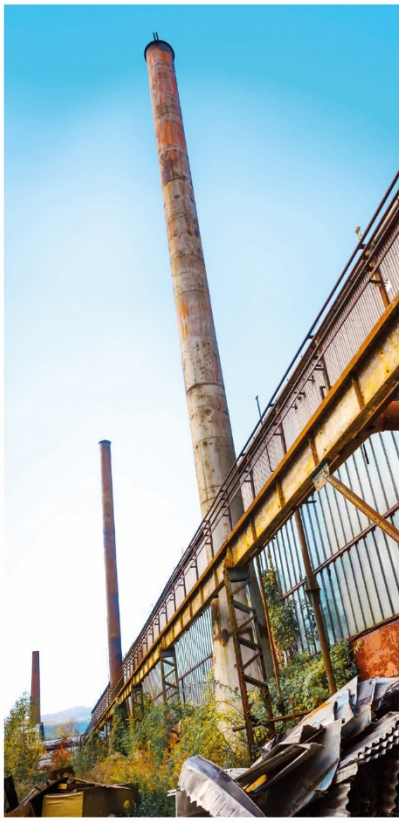
Appendix F.2
Operation Phase



Operation Phase

Water Treatment Assessment

Beaver Dam Gold Mine



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1. Introduction

GHD Limited (GHD) was retained by Atlantic Gold Corporation (AGC) to develop a technical memorandum to identify and evaluate potential nitrite removal techniques for the Beaver Dam Gold Mine (Project) in Marinette, Halifax County (Site), Nova Scotia. GHD already 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 Post-Closure (PC) stages. For each life cycle stage the potential effects of mine contact water to the water quality in the Killag River was assessed under base case (median) and upper case (90th percentile) concentration scenarios. The water quality assessment indicates that nitrite level will be the only exceeded parameter for EOM scenario and zinc and cobalt are the exceedances for the PC scenario at Killag River. The focus of this memorandum is to identify and evaluate potential treatment techniques to address elevated nitrite level above objective water quality in the EOM scenario. Ammonia, nitrite and nitrate concentrations are expressed as nitrogen equivalent throughout this report.

2. Site Background

The Project Site comprises approximately 145 hectares (ha) 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.

Site stormwater will be directed to three ponds under operating conditions; the North Pond, East Pond and South Pond. The North Pond will receive water from the Potentially Acid Generating (PAG) stockpile and as such will experience the highest loading of constituents of concern (COCs) from the Site. It is proposed that water treatment will occur at the North Pond prior to discharge into the Killag River. The approximate locations of the North Pond and potential treatment infrastructure location are shown in Figure 2.1. As shown in this Figure, an approximate area of 6,000 m^2 at the west side of the North Pond could be utilized for a potential water treatment system. This area was considered as available space in the evaluation of alternative treatment options.

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.

2.1 Site Climate Conditions

Average daily temperature values and daily precipitation totals were 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.

Table 2-1 summarizes the monthly precipitation totals and average temperatures at the Project Site. The snow precipitation was converted to mm of rain and the results are presented as mm of rain throughout the whole year. This data was used in the water quality assessment modelling to develop the predicted water quality, and may also be relevant to potential treatment options.

Table 2-1 Climate Normals (Data from Middle Musquodoboit and Truro Environment Canada Climate Stations)

	January	February	March	April	May	June	July	August	September	October	November	December
Average Temperature (°C)	-6.0	-5.6	-1.3	4.1	9.8	14.8	18.5	18.3	14.0	8.5	3.6	-2.4
Precipitation (mm of rain)	127.4	101.2	124.5	105.9	102.4	95.7	96.8	98.6	99.9	124.2	135.8	138.2

3. Data Review

3.1 Water Quality

Models have predicted the water quality (metals, nitrate, nitrite, and ammonia) for EOM and PC scenarios for different months and for two different discharge locations (East and North Ponds). The North Settling Pond is one of two Project Site discharge points with potential for elevated constituent concentrations into the Killag River during EOM conditions. A water quality assessment was completed at the end of the mixing zone, approximately 100m downstream of the discharge point. The analysis assumed no treatment of mine contact water in the North Settling Pond (i.e. no constituent removals occurring by settling as a “worst case” assumption) and only analyzed the results from a mass balance (dilution) calculation at the extent of the predicted mixing zone. The predicted concentrations where screened against two potential discharge criteria, Metal and 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 mixing. Result showed no exceedance considering the site-specific criteria (MDMER); however, models predict that the concentration of nitrite will exceed the CCME guideline for the protection of aquatic life at Killag River point for EOM scenario. Furthermore, models predict that the concentration of cobalt and zinc will exceed the Killag River criteria (CCME) for the PC scenario. Table 3-1 summarizes the maximum predicted concentrations at the North Pond’s discharge, as well as at Killag River location for the EOM scenario.

Table 3-1 Predicted maximum concentrations at North Pond and Killag River discharge points for EOM scenario

Parameter	Exceedance Criteria			Predicted Maximum Concentration @ North Pond Discharge (µg/L)	Predicted Maximum Concentration @ Killag River (µg/L)	Months Exceedance
	CCME (µg/L)	Background (µg/L)	Site Specific Guideline (µg/L)			
Ag	0.25			0.08	0.05	--
Al		254	-	6.21	245.26	--
As			30	19.09	4.70	--
Cd	0.04		-	0.08	0.022	--
Co			0.87	4.61	0.73	--
Cu	2		-	1.63	0.98	--
Fe		509	-	4.25	492.24	--
Hg	0.026		-	0.01	0.01	--
Mn	190		-	75.58	51.55	--
Mo	73		-	45.38	8.28	--
Ni	25		-	59.49	7.21	--
Pb	1		-	1.45	0.37	--
Sb	-	0.5	-	0.42	0.49	--
Se	1		-	1.99	0.70	--
Tl	0.8		-	0.08	0.06	--
U	15		-	31.35	5.38	--
Zn	7		-	34.60	4.05	--
Nitrate	13000		-	28,561.86	4,461	--
Nitrite	60		-	495	**90.78**	July, August, September
Ammonia	27550		-	2,744.27	473.2	--
Note: Red Bold indicates exceeded concentrations.						

Nitrite was the only element for which the maximum predicted concentration exceeded the Killag River discharge limit for the EOM scenario. The model predicted that the exceedances would happen in the months of July, August, and September. The maximum nitrite concentration was predicted to be at 90.78 µg/L while the CCME criteria is 60 µg/L. It is noted that the model does not account for any nitrogen transformations (i.e. between ammonia, nitrite, nitrate and nitrogen gas) that may be mediated naturally in the environment.

Nitrite concentration was predicted for each month of year and for the North and East Ponds. This element also predicted the near field and far field concentrations at Killag River for both North and East Ponds. The predictive water quality assessment showed that the nitrite level could be raised

above the CCME discharge limits for the Killag River for three months of a year (July, August, and September). A summary of nitrite concentration for different locations for the EOM scenario for the months of July, August and September is presented in Table 3-2.

Table 3-2 Nitrite Concentrations at Different Locations for the EOM Scenario

Location	EOM - Upper Case (µg/L)		
	July	August	September
North Pond	491	495	494
East Pond	0.03	0.03	0.03
North Pond - Near Field	75.99	90.78	67.21
East Pond- Near Field	72.36	85.74	64.34
Killag River - Far Field	74.19	88.49	65.69
Note:			

As shown in Table 3-2, the nitrite level is significantly higher at the North Pond compared to the East Pond. It was predicted that if the nitrite level was being controlled at the North Pond discharge to the Killag, the level of nitrite at Killag River will meet the CCME criteria (refer to Figure 2.1). For that reason, the influent water volume to the North Pond was used in this water treatment assessment.

The difference between concentrations at the pond discharge and for the Killag River is because of mixing effects of other streams that contribute to the river flow downstream of the pond discharge location. As the model predicted, the concentration of nitrite could be as high as 495 µg/L at the North Pond discharge location. The model was also used to predict the highest nitrite concentration at the North Pond discharge that could occur without exceeding the CCME criteria at Killag River. These data are presented in Table 3-3 for the months of July, August and September when the nitrite exceedances are predicted. These data illustrate that 22, 38, and 12 percent of nitrite needs to be removed for the month of July, August, and September (respectively) in order to meet the criteria at Killag River.

Table 3-3 Maximum Allowed Nitrite Level at North Pond Discharge without Exceeding Criteria at Killag River

Month	Current Predicted Nitrite Concentration (ug/L)	Required Nitrite Concentration (ug/L)	Required percentage Nitrite removal (%)
July	491	385	22
August	495	309	38
September	494	434	12

Iron concentrations did not exceed any discharge limits at any of the assessment points (refer to Table 3-1). However, the concentration of iron was predicted as high as 492.24 µg/L at Killag River which is very close to the CCME discharge limit of 509 µg/L. This is another factor that was considered in this water treatment assessment.

3.2 Water Volume

A monthly water balance assessment was performed by GHD to calculate the average volume of water that will be discharged into the Killag River from the North Pond. Figure 3-1 summarizes the volume of water entering the North Pond for EOM scenario in different months of the year. The lowest water flow from the site was predicted to be between June and September, while the highest flow would occur in April and May once the snow is melted and groundwater is contributing more than other times of the year. The high nitrite concentrations would occur during the months of July, August, and September with lowest flow into the Killag River.

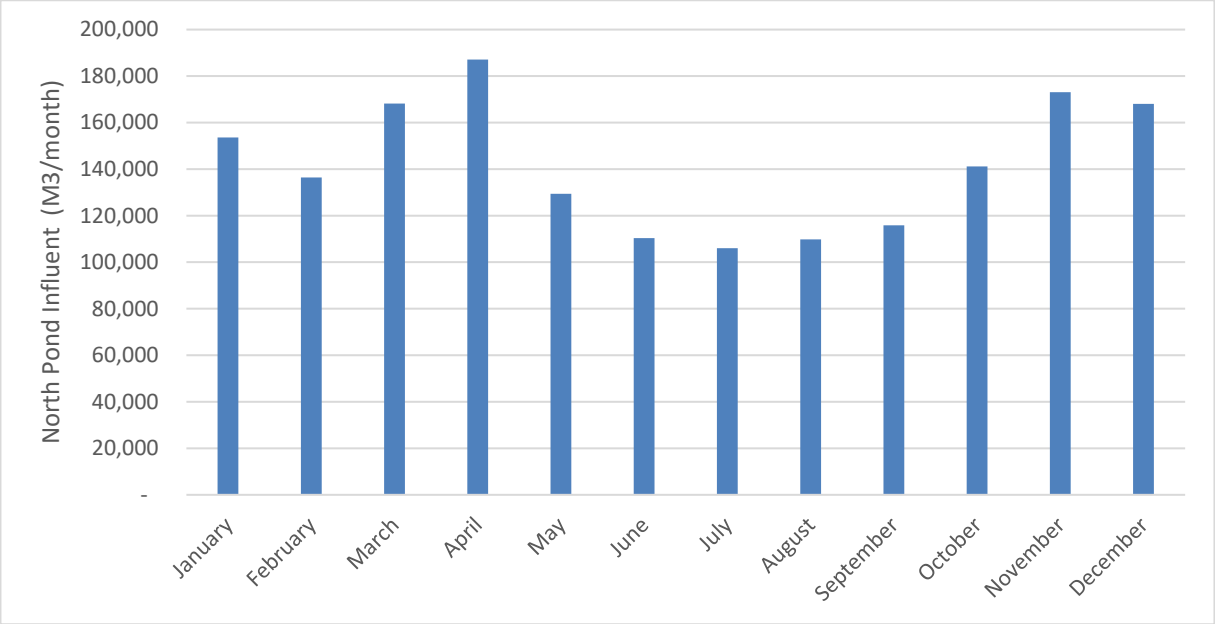

Figure 3-1 Predicted influent water into the North Pond in different months of year

4. Nitrogen Compounds Transformation

Nitrogen is present in most water resources. It exists in various oxidation states. The chemistry of nitrogen is complex because of the several oxidation states that nitrogen can assume and the fact that changes in oxidation state can occur by living organisms. Nitrogen can exist in several oxidation states which could combine with water and form water soluble species – ammonium, nitrite and nitrate are among these species. Nitrogen-based compounds can result in water quality issues such as toxicity or oxygen depletion

Adding to the complexity, nitrogen could be changed in oxidation state and in chemical form through natural, biological, chemical and photochemical processes. Relationships between these various nitrogen forms and transformations are expressed as nitrogen cycle. Principal biological

transformations are fixation, deamination (ammonification), assimilation, nitrification and denitrification. Each involves a particular set of organisms (principally microorganisms) and results in net gain or loss of energy which is an important factor in determining the type of reaction which occurs.

It should be noted that the concentration of nitrogen compounds such as nitrate, nitrite, and ammonia are not constant and are changing based on environmental conditions such as temperature and pH which influence states of equilibrium. Ammonia is converted to nitrate and nitrite in the nitrification process and nitrite could be oxidized to nitrate as well. There are microbial communities that convert nitrite/nitrate to nitrogen gas in a denitrification process. These microbial interchanges and conversions play a critical role in the final concentrations of each of these nitrogen compounds.

4.1 Nitrification

Ammonia is oxidized to nitrate in the environment and in biological wastewater treatment by two groups of chemoautotrophic bacteria which operate in sequence. The first group of bacteria in this process of nitrification, represented principally by members of the genus *Nitrosomonas*, oxidize ammonia to nitrite which is then further oxidized to nitrate by the second group, usually represented by members of the genus *Nitrobacter*. Any disruption in operation of the second group of bacteria will results in accumulation of nitrite.

Oxygen demand in nitrification is an important factor and may also be important in effluent receiving waters. Acid production in nitrification may result in depression of the pH in poorly buffered wastewaters and lead to the loss of process stability. Nitrification can be achieved in any aerobic biological process at low organic loadings and where suitable environmental conditions are provided. Nitrifying bacteria are slower growing than the heterotrophic bacteria which comprise the greater proportion of the biomass in both fixed film and suspended growth systems. The key requirement for nitrification to occur, therefore, is that the process should be so controlled that the net rate of accumulation of biomass, and hence the net rate of withdrawal of biomass from the system, is less than the growth rate of the nitrifying bacteria. If biomass growth rate, exceeds nitrifier growth rate, the proportion of nitrifiers in the biomass will gradually decline until nitrification is lost entirely, a condition is known as washout.

Nitrite could be created as the result of incomplete nitrification of ammonia. Nitrification is biological oxidation of ammonia to nitrite by ammonia oxidizing bacteria (AOB) followed by oxidation of nitrite to nitrate. These reactions are shown in equation 1 and 2. As nitrification depends on dissolved oxygen (DO) level, DO is one of the key factors affecting nitrification rate (Jechalke et al. 2011). In certain circumstances such as low dissolved oxygen (DO), ammonia oxidation rate is smaller than nitrite oxidation which results in nitrite accumulation (Sanchez et al., 2007). To avoid a high nitrite concentration, conditions should be suitable for further oxidation of nitrite to nitrate followed by a denitrification process to convert nitrate to nitrogen gas.

$NH_4^+ + 1.5O_2 \rightarrow 2H^+ + 2H_2O + NO_2^-$ Equation 1

$NO_2^- + 0.5O_2 \rightarrow NO_3$ Equation 2

Nitrifier growth can be maximized by providing optimum values of the environmental factors, dissolved oxygen (DO) concentration, pH and temperature, while various compounds should not be present in concentrations that may be toxic. Control of both DO and pH is relatively simple. Bulk water pH value is an important factor in nitrification activity for two reasons. First, a reduction of total alkalinity may accompany nitrification because a significant amount of bicarbonate is consumed in the conversion of ammonia to nitrite. Secondly, nitrifying bacteria are very sensitive to pH. Nitrifier growth rate is greatly reduced at low temperature, so that allowance must be made in design for the minimum growth rate, at the lowest winter temperature. Nitrification can be achieved in an aerated pond, trickling filter, rotating disk contactor (RDC), or moving bed biofilm reactor (MBBR).

4.1.1 Effect of Dissolved Oxygen

During nitrification step, ammonium is oxidized to nitrate under aerobic conditions, while during denitrification step, nitrate is reduced to molecular nitrogen (nitrogen gas) under anaerobic conditions. Lack of dissolved oxygen could potentially cause an incomplete nitrification process which could result in nitrite accumulation. Nitrification consists of two independent microbial facilitated reactions. In the first reaction, ammonium oxidizers oxidize ammonium to nitrite. These bacteria known as “nitrifiers” are strict “aerobes,” meaning they must have free dissolved oxygen to perform their work. Nitrification occurs only under aerobic conditions at dissolved oxygen levels of 1.0 mg/L or more. At dissolved oxygen concentrations less than 0.5 mg/L, the growth rate is minimal. Nitrification requires a long retention time, a low food to microorganism ratio (F:M), a high mean cell residence time. In the second reaction, nitrite oxidizers oxidize nitrite to nitrate. Denitrification would be converting nitrite to nitrate and then molecular nitrogen, using a carbon substrate. In general, low DO in the nitrification step, and high DO in the denitrification step could result in nitrite accumulation (Thakur and Medhi, 2019). As nitrite is the only exceeded element for this project, a nitrification process could potentially convert nitrite to nitrate and there is no need for the denitrification step as the nitrate concentration is well below discharge limits. However, a nitrification process could also convert ammonia to nitrite under certain conditions, such that design of treatment systems may need to consider the predicted ammonia concentrations as well as nitrite concentrations.

4.1.2 Effect of pH

The nitrification process produces acid. This acid formation lowers the pH of the biological population in the aeration tank and can cause a reduction of the growth rate of nitrifying bacteria. *Nitrosomonas* has an optimal pH between approximately 7.0 and 8.0, and the optimum pH range for *Nitrobacter* is approximately 7.5 to 8.0 (EPA, Nitrification 2002).

4.2 Denitrification

Among the techniques available for the removal of nitrate from water, microbial denitrification is highlighted as an economical and environmentally sound approach, as well as for being feasible on a large scale. Biological denitrification is the reduction of nitrate to nitrogen gas, through a sequence of enzymatic reactions. Many bacteria are capable of growing, by reducing ionic nitrogenous oxides to gaseous products. The bacteria use nitrate for respiration, converting it to nitrogen gas by a sequence

of reactions. This respiratory process, in which nitrates or nitrites serve as terminal electron acceptors instead of oxygen, is termed denitrification. An essential requirement for the reduction of nitrate is the presence of a carbon source that can be oxidized as an electron donor. Various solid, liquid and gaseous carbon sources have been evaluated such as ethanol, methanol, glycerol, etc., Denitrification is carried out by facultative aerobic bacteria which in the absence of oxygen utilize nitrate as a terminal electron acceptor in respiration. The majority of microbial denitrification treatments rely on heterotrophic bacteria which require an organic carbon substrate. The most important environmental factors affecting the activity of denitrifying bacteria (and hence the reactors' denitrification rates) are temperature, pH, toxic compounds, carbon source and concentration, and nitrate concentration.

4.2.1 Denitrifying Microbiology

Many bacteria are capable of growing anaerobically by reducing ionic nitrogenous oxides to gaseous products. This respiratory process, in which nitrates or nitrites serve as terminal electron acceptors instead of oxygen results in generation of adenosine triphosphate (ATP) and is termed denitrification or dissimilatory nitrate reduction. When electrons are transferred from the donor to the acceptor, the organism gains energy which can be applied for the synthesis of a new cell mass and the maintenance of the existing cell mass.

The most detailed investigations into denitrification have involved a limited group of specialized bacteria. This has resulted in a view that denitrification can only occur under anaerobic conditions. However, it has been shown that denitrification can occur in the presence of oxygen in certain species too. Most of the organisms known to denitrify belong to bacterial genera are *Achromobacter, Acinetobacter, Aeromonas, Gallionella, Halobacterium, Halomona, Hyphomicrobium, Janthinobacterium, Neisseria, Paracoccus (*formerly *Micrococcus), Propionibacterium, Pseudomonas, Rhizobium, Rhodobacter (*formerly *Rhodopseudomonas), Thiobacillus, Thiosphaera, Vibrio, Xanthomonas* (Burghate et al. 2013).

5. Potential Treatment Methods

5.1 UV Peroxide Oxidation

The application of ultraviolet (UV) light with hydrogen peroxide addition is a chemical oxidation technology developed to destroy dissolved organic contaminants in water. The technology uses ultraviolet (UV) radiation and hydrogen peroxide to oxidize organic compounds present in water. The technology uses mercury vapor lamps to generate UV radiation. The principal oxidants in the system, hydroxyl radicals, are produced by direct photolysis of hydrogen peroxide at UV wavelengths.

A UV peroxide oxidation process could oxidize nitrite and general reactive radicals (Bilski et al. 1992). The generated radicals then could destruct organic compounds in the water. Ammonia is the other compound that will be removed during UV peroxide oxidation. Ammonia can be completely converted to NOx ions (nitrite and nitrate) and nitrite could be converted to nitrate in relatively fast reaction (Wang et al. 2017). Water quality assessment data for the Site showed that even if all influent

ammonia into the North Pond was being oxidized and converted to nitrate, the nitrate level still will be well below CCME criteria. It was predicted that ammonia concentration could be as high as 2744.3 µg/L at the North Pond discharge. Considering conversion of all ammonia to nitrate through oxidation, it is expect that the nitrate level would still be lower than 13000 µg/L which is the CCME criteria.

This technology is usually followed by a biological denitrification step for nitrate removal. However, the nitrate level is predicted to be well below discharge limits (both MDMER and CCME) and even by converting all influent ammonia and nitrite to nitrate, the concentration of nitrate will remain well below the nitrate discharge limits. As the result, there is no need for biological nitrate removal in this application.

During UV oxidation, nitrate present in raw water may transform to nitrite and potentially could increase nitrite concentration (Lu et al. 2009). Lu et al. investigated different conditions such as initial nitrate concentration, pH, and hydrogen peroxide dosage on conversion of nitrate to nitrite. They found that nitrite generation depends on the initial concentration of nitrate and this reaction is improved in higher pHs. However, introducing titanium dioxide and hydrogen peroxide could inhibit nitrite formation to a certain degree. This could be because of the effects of hydrogen peroxide and titanium dioxide to produce additional hydroxyl radical that could scavenge nitrite.

One concern with UV disinfection of water is the production of nitrite when polychromatic UV sources are utilized (Sharpless et al. 2003). Predicted concentrations for the North Pond shows a high concentration of nitrate, with the nitrate level estimated to be at 28,562 µg/L. The risk of nitrate conversion to nitrite is high in an UV peroxide oxidation system and it depends on pH and the hydrogen peroxide concentration. Nitrate irradiation with UV light (at wavelengths <240 nm and 300–325 nm) generates hydroxyl radicals, and nitrite ions which may further photo-generate hydroxyl radicals, as well as other products such as peroxinitrite (Lester et al. 2018). Nitrite is an intermediate product of UV oxidation system and needs to be monitored closely. There are techniques for controlling nitrite level during UV peroxide oxidation. For example, adding sulfite could generate reducing radicals that could potentially further degrade nitrite (Lester et al. 2018). As predicted, the nitrate level will be significantly higher than the nitrite level for the impacted water at the Site and the risk of increasing the nitrite level in an UV-peroxide treatment system should be investigated in a bench or pilot scale before full scale design.

5.2 Biological Nitrification

Water quality assessment showed that the nitrate concentration in all assessed points are well below both MDMER and CCME limits. On the other hand, as shown in Table 3-2, the nitrite concentration at Killag River could reach as high as 90.78 µg/L. Considering the discharge limit of 60 µg/L, only 30.78 µg/L of nitrite needs to be removed in order to meet the criteria. Ammonia also could be oxidized and generate nitrate in any biological nitrification unit. The maximum nitrate concentration is projected to be at 4461 µg/L at Killag River while the CCME discharge limit is at 13000 µg/L. These data shows that even if all nitrite and ammonia converted to nitrate, the nitrate level will stay well below discharge limit. That means there is no need for denitrification step to convert produced nitrate to nitrogen gas.

The efficiency of a nitrification process highly depends on general chemistry of the wastewater. Parameters such as biological oxygen demand (BOD) and alkalinity will define if external chemical sources are required, and it could drive the operation cost of a nitrification process. The most common techniques and treatment units which could provide nitrification are presented below.

5.2.1 Aerated Treatment Pond

An aeration pond is the simplest way of increasing DO level to facilitate the nitrification process which could oxidize nitrite to nitrate. Aeration could be implemented by surface agitators or by blowing air through diffusers into the pond. In a surface-aerated system, the aerators provide two functions: they transfer air into the basins required by the biological oxidation reactions, and they provide the mixing required for dispersing the air and for contacting the reactants. Submerged diffused air is essentially a form of a diffuser grid inside a pond. There are two main types of submerged diffused aeration systems for pond applications: floating lateral and submerged lateral. Both these systems utilize fine or medium bubble diffusers to provide aeration and mixing to the process water. The diffusers can be suspended slightly above the lagoon floor or may rest on the bottom. Flexible airline or weighted air hose supplies air to the diffuser unit from the air lateral. This technique could potentially reduce iron concentration through oxidation process as well. It is predicted that iron concentration could be as high as 492 µg/L which very close to the CCME discharge limit of 509 µg/L.

However, the nitrous acid form of nitrite could inhibit nitrite oxidizing bacteria (NOB), so oxidizing the nitrite to nitrate may be challenging and needs further bench and pilot scale investigation before large-scale implementation. It is also noted that ammonia may be oxidized to nitrite if the complete two-step conversion of ammonia to nitrate is limited by the system simplicity.

5.2.2 Trickling Filter

Trickling filters (TFs) are used to remove organic matter, nitrate and nitrite from wastewater. The TF is an aerobic treatment system that utilizes microorganisms attached to a medium to remove organic matter, nitrate and nitrite from wastewater. TFs enable organic material in the wastewater to be adsorbed by a population of microorganisms (aerobic, anaerobic, and facultative bacteria, fungi, algae, and protozoa) attached to the medium as a biological film or slime layer.

Trickling filters may have a variety of types of filter media used to support the biofilm. Types of media most commonly used include coke, plastic matrix material, open-cell polyurethane foam, clinker, gravel, sand and geotextiles. Ideal filter medium optimizes surface area for microbial attachment, wastewater retention time, allows air flow, and resists plugging. Some residential systems require forced aeration units which will increase maintenance and operational costs.

As the wastewater flows over the medium, microorganisms already in the water gradually attach themselves to the rock, slag, or plastic surface and form a film. The organic material is then degraded by the aerobic microorganisms in the outer part of the slime layer (EPA Fact Sheet 832-F-00-014). As the layer thickens through microbial growth, oxygen cannot penetrate the medium face, and anaerobic organisms develop. As the biological film continues to grow, the microorganisms near the surface lose their ability to cling to the medium, and a portion of the slime layer falls off the filter. This process is

known as sloughing. The sloughed solids are picked up by the underdrain system. Trickling filter effluent always passes through a secondary clarifier to allow for capture of solids generated as a result of treating the wastewater.

A typical trickling filter is circular and between 10 meters and 20 meters across and between 2 meters to 3 meters deep. A circular wall, often of brick, contains a bed of filter media which in turn rests on a base of under-drains. These under-drains function both to remove liquid passing through the filter media but also to allow the free passage of air up through the filter media. Mounted in the center over the top of the filter media is a spindle supporting two or more horizontal perforated pipes which extend to the edge of the media. The perforations on the pipes are designed to allow an even flow of liquid over the whole area of the media and are also angled so that when liquid flows from the pipes the whole assembly rotates around the central spindle

5.2.3 Rotating Biological Contactor (RBC)

A rotating biological contactor (RBC) is an attached growth bioreactor that offers an alternative technology to the conventional activated sludge process. A RBC unit typically consists of a series of closely spaced large flat or corrugated discs that are mounted on a common horizontal shaft and are partially or completely submerged in wastewater. A drum filled with some lightweight packed supports can also be used in place of conventional discs. The shaft continually rotates by a mechanical motor or a compressed air drive and a biofilm is established onto the entire surface area of the media, which metabolizes the organic materials contained in the wastewater. In aerobic processes the rotation of the media promotes oxygen transfer and maintains the biomass in aerobic conditions. They have also been used to nitrify municipal wastewater, either in combined carbon oxidation and nitrification applications or in separate stage nitrification applications, denitrification and phosphorus removal (Cortez et al, 2008).

The organic loading affects nitrification in a RBC unit. In the initial stages, where the organic load is high, heterotrophic bacteria offer strong competition to nitrifiers displacing them within the bioreactor. Therefore, the maximum nitrification rate occurs when the soluble BOD load reduces sufficiently. It is expect that the BOD level would not be high in the Beaver Dam application and the results the risk of displacing nitrifiers would be low. However no information regarding the BOD or COD, total phosphorous and general chemistry of impacted water for the Site is available. Selection of the final alternative solution highly depends on the general chemistry of impacted water.

5.2.4 Moving Bed Biofilm Reactor (MBBR)

The MBBR system consists of an aeration tank (similar to an activated sludge tank) with special plastic carriers that provide a surface where a biofilm can grow. The carriers are made of a material with a density close to the density of water. An example is high-density polyethylene (HDPE). The carriers will be mixed in the tank by the aeration system and thus will have good contact between the substrate in the influent wastewater and the biomass on the carriers. To prevent the plastic carriers from escaping the aeration system it is necessary to have a sieve on the outlet of the tank.

Nitrification with an MBBR process requires a rather low BOD concentration in order to favor the nitrifying bacteria in the biomass attached to the carrier. As the BOD of the impacted water at North Pond is not available, it is unknown at this time if any BOD removal step or external source of carbon is needed. The nitrification process is a function of temperature and the kinetics are slower at lower temperatures. Hoang et al. found that the nitrifying bacteria with higher activities at warm temperatures and a slightly greater quantity of nitrifying bacteria with lower activities at cold temperatures in a nitrifying MBBR biofilms. In their research, they found *Nitrospira* (nitrite oxidizer) bacteria in a MBBR biofilm. Zafarzadeh et al. investigated performance of MBBR for biological nitrogen compounds removal from wastewater by partial nitrification-denitrification process. Since nitrite and nitrate are intermediary compounds in both processes (nitrification/denitrification), a partial nitrification to nitrite and a denitrification from this nitrite, instead of nitrate, would be suitable. They believed this approach will produce savings in oxygen demands during nitrification and a reduction of the organic matter requirements in the denitrification process. Considering nitrite is the main concern for the Beaver Dam project, and there is potential for low BOD in the impacted water, this approach might fit the requirements of this project. However, more data regarding the water quality concentrations such as BOD and total phosphorous is needed for having a complete picture of the impacted water and selection of the most suitable alternative water treatment process.

5.3 Biological Denitrification

Traditionally, under typical conditions both nitrate and nitrite gets fully converted to atmospheric nitrogen by biological denitrification. Sometimes however, insufficient carbon sources, low dissolved oxygen (DO) and operational fluctuations or environmental conditions can lead to improper denitrification. Biological denitrification is the heterotrophic bioconversion process for the removal of nitrite and nitrate from wastewaters under oxic/anoxic conditions, usually carried out by the facultative anaerobes such as gram-negative classes of α, β and γ *Proteobacteria* mainly *Paracoccus*, *Agrobacterium, Pseudomonas, Acinetobacter* and some grampositive bacteria such as *Bacillus licheniformis*. In general, the process of denitrification is performed by NOB found in soil and waters. Nitrite is an intermediary for nitrification, so the process of nitrite removal would be similar to denitrification. Badia et al. investigated the dynamic specific denitrification rates from nitrite at various COD to nitrogen ratios in a sequencing batch reactor, continuously fed with primary effluent and nitrite solution for 3 months. They found that the carbon source needs to be at an optimum level for maximum denitrification.

Biological denitrification could be carried out in an anoxic mixing reactor. In the denitrification process, an anoxic zone is created by using an unaerated tank where the dissolved oxygen levels are kept below 1 mg/L and as close to 0 mg/L as possible. A target operating point would be between 0.2 to 0.5 mg/L. The pH of the anoxic zone should be close to neutral (7.0) and never drop below 6.5. Typically 2.7 mg BOD are required per mg of nitrate-nitrogen removed. All nitrate as well as nitrite will be transformed to nitrogen gas and will be released into the atmosphere. A denitrification process could be provided in a MBBR reactor as well. Nitrate/nitrite-nitrogen conversion in such denitrification MBBRs has been reported to be consistently greater than 90% (McQuarrie and Boltz, 2011).

The main drawback of a denitrification process compared with aeration pond (nitrification) is the significant need for additional organic material. The model predicts that the nitrate concentration would be at 28.5 mg/L while nitrite concentration is predicted at 0.5 mg/L for the North Pond discharge point. Both the nitrate and nitrite will be removed in a biological denitrification process (which requires organic material as the substrate), while only nitrite will be targeted in an aerated treatment pond providing nitrification. As a result, it is expected that much less additional chemical may be needed in an aeration treatment pond.

5.4 Nitrite and Nitrate Reduction to Ammonia by Zero Valent Iron (ZVI)

Zero-valent iron (ZVI), can be employed for the removal of various contaminants such as metals, dyes or chlorinated compounds, as well as nitrate from impacted water. ZVI could reduce nitrate and nitrite concentrations in an aqueous solution. Lin et al found that nitrite and nitrate removal efficiencies using zero valent iron nanoparticles could be 65–83% and 51–68%, respectively (Lin et al. 2008).

Predicted concentrations show the ammonia level well below CCME criteria at Killag River (there is no site specific limit for ammonia). However, converting the total amount of nitrate and nitrite to ammonia could increase the ammonia concentration above CCME discharge limit at Killag River. Nitrate concentration is estimated to be at 28,562 µg/L in the North Pond discharge. If this technique is chosen as the alternative solution, necessary controls needs to be considered to limit the conversion of nitrate/nitrite to ammonia to avoid exceedance of the ammonia criteria in the Killag River.

Application of ZVI for nitrate/nitrite remediation from wastewater has been studied in packed columns and in bench scale level. However, this technology has not been developed for larger applications so far and there is limited information available.

The other drawback of this technology is generation of exhausted media that needs regeneration or disposal. ZVI could be used in a packed column similar to activated carbon columns. The adsorption capacity is a function of pH and the pH of the water needs to be adjusted prior to the packed column for the best removal performances.

5.5 Electrodialysis Reversal (EDR)

EDR was developed as an innovation to electrodialysis with the additional feature of polarity reversal of the electrodes as a self-cleaning feature. Switching the flow of ions minimizes fouling and prolongs membrane life. However, this process is among the costliest treatment methods. The advantages of the EDR system are treatment of highly scaling flows without expensive chemical treatment, selective extraction of ions, and treatment of highly contaminated organic flows.

Electrodialysis (ED) is a new advanced separation process that is commonly utilized for producing drinking water from water bodies as well as for the treatment of industrial effluents. The ED process has been applied on a commercial scale. Basically, an ED process consists of an ion exchange membrane and the driving force necessary for applicability of the process is electric potential. Due to the presence of electric potential, ions from one solution after passing through ion selective membrane

barrier are transferred to another solution. The main factors on which ED process performance depends are the concentration of ion in raw water, flow rate, concentration of feed, current density, membrane properties and cell compartments geometry. Fouling which is produced by foulants including organics, colloids and biomass on the inside membrane internal structure or on the outside surface results in reduction of process separation efficiency and energy consumption is enhanced. Fouling increases the membrane resistance and selectivity of membrane is reduced by fouling. Therefore, some methods are proposed to reduce fouling in ED system such as pre-treatment of feed solution, zeta potential control, membrane properties modification and flowrate optimization. It is a need of an hour to suggest a reducing method less energy and thus minimum operating and investment cost. EDR system can be as regarded as best option because no extra chemicals are required and life of membrane increased by it. In EDR fouling progress is broken by revering electric potential (applied electric field). The EDR technology is mostly used for desalination of seawater as well as for drinking water deionization.

6. Advantages and Disadvantages and Feasibility of Each Option

The advantages and disadvantages of each potential treatment option are summarized in Table 6-1. Factors such as capital and operational costs, maturity of each technology and availability of resources, sensitivity to environmental conditions such as temperature fluctuations, and required footprint are among the factors that were considered in Table 6-1.

Biological nitrification and chemical oxidation are selected as the most appropriate alternatives among evaluated options for this project. Biological nitrification is a low cost nitrite removal option that has more flexibility compared to the other evaluated options. The main factor for this alternative is if the water quality of the impacted water is appropriate for biological activities. One concern for a biological nitrite removal plant would be cold weather that could cause low microbial activity and lower nitrite removal rates. Although the nitrite exceedances are predicted to occur during the warm season, the biological system would need to acclimate to the temperature variations and there can be issues with a biological nitrification system being difficult to establish/maintain at lower temperatures.

There are data gaps regarding the general chemistry of the impacted water that potentially could affect the selection of alternative solution. Different biological nitrification units such as aeration lagoon, trickling filter, RBC, and MBBR were evaluated. Aeration lagoon and MBBR could be the alternatives for a biological nitrite removal system considering the advantage and disadvantage of all evaluated option. A portion of the North Pond could be isolated to be used as the aeration lagoon for nitrite removal. This approach likely has the lowest capital cost compared with the other alternatives. However, it is not clear if external chemicals need to be added which potentially could affect the operation cost and footprint. The available area for the potential water treatment system is shown in Figure 2-1. It is predicted that this area would be sufficient for any of the evaluated alternatives.

The UV-peroxide alternative is expected to have the smallest footprint compared to the other evaluated options. However, the capital cost of this option is relatively higher than the aerated lagoon. In addition, the required peroxide dosage is not known at this point because of a lack of information. Chemical dosage could significantly affect the operation cost of this treatment process. However, existence of other organics and inorganics such as nitrate could interface with nitrite removal and increase chemical demand. The other concern of a UV-peroxide oxidation unit is generation of other organics as the result of breaking down larger molecules. As there is no data available regarding the potential organic compounds in the impacted water, this concern cannot be addressed in the evaluation of alternative treatment processes.

Biological denitrification was also evaluated as one of the alternative solutions. However, as the nitrate concentration is predicted to be significantly higher than the nitrite concentration, this option would require significantly more carbon addition to remove both nitrate and nitrite. In the denitrification process, both nitrate and nitrite are oxidized to nitrogen gas. For that reason, a biological nitrification has an advantage over a biological denitrification in this project because of no carbon requirement, potentially lower nutrient requirements and lower operation cost.

Using ZVI for reduction of nitrite and nitrate to ammonia and EDR for nitrite removal were the other two technologies that were evaluated for this project. The literature review on both methods showed that these technologies are not fully developed and most of the research are in the lab and bench-scale levels. In addition, the other drawback of using ZVI is waste generation and needs for regeneration/disposal that increase the operational cost of this technique. Further, ZVI could convert existing nitrate to ammonia which potentially could increase ammonia concentration to levels higher than the discharge limit. The other drawback of EDR technology is its high capital and operational cost that makes this options less attractive for this application. The advantages and disadvantages of all evaluated options are summarized in Table 6-1.

Table 6-1 Advantages and Disadvantages of Potential Water Treatment Processes

Technology	Maturity of Technology	Performance Sensitivity/Complexity	Footprint	Cost Factors[1]
UV Peroxide	Good	Interference of dissolved solids and organic compounds, Minimum environmental effect such as temperature and pH fluctuations	Low	High (Highly depend on concentration of ions and organics)
Nitrification	Excellent	Significantly lower nutrients and carbon source (if any) is required compared with denitrification process. Moderate level of skill and technical expertise needed to manage and operate the system, Sensitivity to environmental parameters such as ambient temperature and pH,	High	Low
Denitrification	Excellent	Sensitivity to environmental parameters such as ambient temperature and pH Significant carbon source requirement associated with nitrate concentration	High	Medium to high (depend on general chemistry of water)
Reduction by ZVI	Not fully proven	Labor intensive, Needs periodic regeneration or media change out, Minimum environmental effect such as temperature and pH fluctuations	Low	High
EDR	Not fully proven	Resistance to shock and toxic loads, Interference of dissolved ions and metals on EDR performance	Low	High

Note:
[1]Cost factors include both initial capital investment as well as operational cost

7. Uncertainty Analysis

7.1 Water Quality Prediction Uncertainties

Uncertainty is inherent in determining many of the input parameters used in the water balance and water quality modelling, especially hydrologic parameters such as hydraulic conductivity and recharge. One of the largest uncertainties derive from estimation of hydrogeologic conditions (e.g. hydraulic conductivity) across the site and within the waste rock piles. To address this and other input parameter uncertainty, it is recommended to collect water quality and flow data that is discharged from the waste rock piles and inflow to the settling ponds during mine operation stage and use this data to calibrate the model. Alternatively, this same data collected at the Touquoy mine site could be used as a surrogate site prior to construction of Beaver Dam site to validate the source term, water balance and water quality predictive models.

In addition, it is highlighted that the water quality predictions do not account for any nitrogen transformations (i.e. between ammonia, nitrite, nitrate and nitrogen gas) that may be mediated naturally in the environment. Potential transformation between these nitrogen-based compounds could affect the predicted concentrations for each parameter, thereby creating an additional level of uncertainty.

7.2 Water Treatment Uncertainties

This report has narrowed the feasible nitrite removal technologies into two main options, a chemical UV-peroxide oxidation and a biological nitrification unit. Selection of the alternative nitrite removal technology will highly depend on general chemistry and properties of the impacted water. Water quality values such as BOD, COD, and total phosphorous, as well as the alkalinity, total dissolved solids, toxicity and pH of the impacted water will determine if a biological or chemical oxidation approach would be the most appropriate alternative. These data will determine if any pre-treatment prior to the mentioned technologies or even a post-treatment unit is required. The data gaps present a limitation for completing a detailed cost analysis of the alternatives.

It was noted that the pH level at Killag River is extremely low for any potential biological water treatment system, suggesting that the pH of the impacted water may also have low pH. If so, the pH of the impacted water may need to be adjusted to neutral level in order to have an efficient biological nitrification unit (which is sensitive to pH and temperature conditions). Based on the pH level of impacted water, a pretreatment step might be needed before a biological nitrification unit.

Total suspended solids might also impact the selection of the preferred alternative approach. For any UV oxidation unit, the TSS concentration must be below certain levels in order to have an efficient oxidation unit and utilize the whole volume of the reactor. Based on the TSS concentration, a filtration step might be needed prior to an UV oxidation unit.

8. Proposed Alternative Water Treatment System

By reviewing available information and modeling data, it was found that nitrite is the only parameter that may exceed CCME criteria at Killag River during the month of July, August, and September. However, the chance of arsenic concentration being higher than discharge limit is high as the concentration of this metal is relatively high in the raw ore. Different technologies such UV peroxide oxidation, biological nitrification, biological denitrification, ZVI adsorption, and EDR were reviewed to address elevated nitrite concentration in the impacted water during operation phase. The advantages and disadvantages of each technology were summarized by considering factors such as footprint requirement, capital and operational cost factors, available resources, as well as the maturity of the technology. However, more information such as general water chemistry is needed to determine the chemical and operational cost of each of the alternatives.

By reviewing feasible alternatives, it was found that a nitrite oxidation unit such as aeration treatment pond could potentially reduce nitrite concentration and meet the nitrite removal requirement of this project. Considering initial capital investment and operation cost, aeration treatment pond needs lowest capital and operation cost. Based on chemistry of impacted water, there might be need for adding nutrition to the water. The proposed aeration treatment pond is consisting of three ponds. The first pond will act as an equalization pond and will capture the high influent water volumes during storm events. Furthermore, this pond will help to reduce total suspended particles by letting them to settle. 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. Then water will flow by gravity to an aeration pond, the air will introduce by surface agitators to oxidize nitrite, as well as metals. Then the water will flow by gravity to the third pond for settling down suspended particles that are generated as the results of oxidation in the second pond.

It is expecting that, the concentration of nitrite and metals be below discharge limits during 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 schematic figure of treatment ponds is shown in Appendix A.

In addition, to address high 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. The process flow diagram of water treatment train is presented in Appendix B.

8.1 Footprint of proposed alternative solution

An average daily flow of 5000 m^3 per day was assumed to size the aeration treatment pond. The impacted water will flow through ditches into the north settling pond and then will be directed into the aeration treatment pond. It was assumed that a total retention time of 12 hours would be required to reduce nitrite concentration below discharge criteria. Considering the average daily flow rate and retention time of 12 hours, the size of aerated treatment pond is estimated equal to 2500 m^3. Assuming an average depth of 1.5 meter for this pond, the required footprint would be 1667 m^2. The proposed location of the aeration treatment pond is shown in Figure 2.1. A bypass ditch will be

designed beside the aeration treatment lagoon for the scenarios that the water does not need nitrite removal treatment and could be directly discharged to the Killag river. A final settling pond is considering downstream of aeration treatment pond to capture potential suspended solids that is generated as the result of metals oxidation or generated microbial biomass. The hydraulic retention time of the final settling time is assumed equal to 2 hours which means a volume of 832 m^3 is required. Considering an average depth of 2 meters for the final settling pond, an area of 416 m^2 would be needed. The proposed location of the final settling pond is shown in Figure 2.1.

8.2 Power Requirement

Surface agitators are the main power consumption units for water treatment system during operation phase. It is assumed that four surface agitators with 5 HP will be required. The specification sheet of proposed surface agitator is presented in Appendix C.

However, if arsenic or other metals concentrations exceed the discharge limits and there is need to turn on the packaged water treatment system (which is considered for construction phase), an extra 25-43 HP will be needed. The maximum power requirement for the water treatment system during operation phase is summarized in Table 8.1

Table 8-1 Electricity power requirement for the proposed alternative

Item	HP	No. Provided	No. Active	Installed HP	Active HP	% of Time On	Total HP for O&M	Maximum HP for O&M
Aeration pond's surface agitator	5	4	4	20	20	100%	20	20
Blower of aeration tank	6.0	2	1	12.0	6.0	100%	6.0	6.0
Feed pump	3.0	2	1	6.0	3.0	100%	3.0	3.0
Mix tank agitator	1.0	3	3	3.0	3.0	100%	3.0	3.0
Backwash pump	3.0	2	1	6.0	3.0	10%	0.3	3.0
Sludge disposal pump	2.0	1	1	2.0	2.0	10%	0.2	2.0
Enclosure HVAC system (1)	8.0	2	2	16.0	16.0	15%	2.4	16.0
Chemical dosing pump	0.1	3	3	0.3	0.3	100%	0.3	0.3
Filtration pump	8.0	2	1	16.0	8.0	100%	8.0	8.0
Control instrumentation	1.5	1	1	1.5	1.5	100%	1.5	1.5
Total (HP)							**44.7**	**62.8**
Total (MW)							**0.033**	**0.047**
Total (MW-Hr/year)							**292**	**410**

9. Recommendations

The general chemistry of impacted water will determine if any nutrient or chemical addition would be needed. These parameters could potentially drive the operation cost of the treatment system. It is

highly recommended that the selected nitrite removal technology be tested in a bench-scale or even in a pilot-scale before designing the full-scale treatment system.

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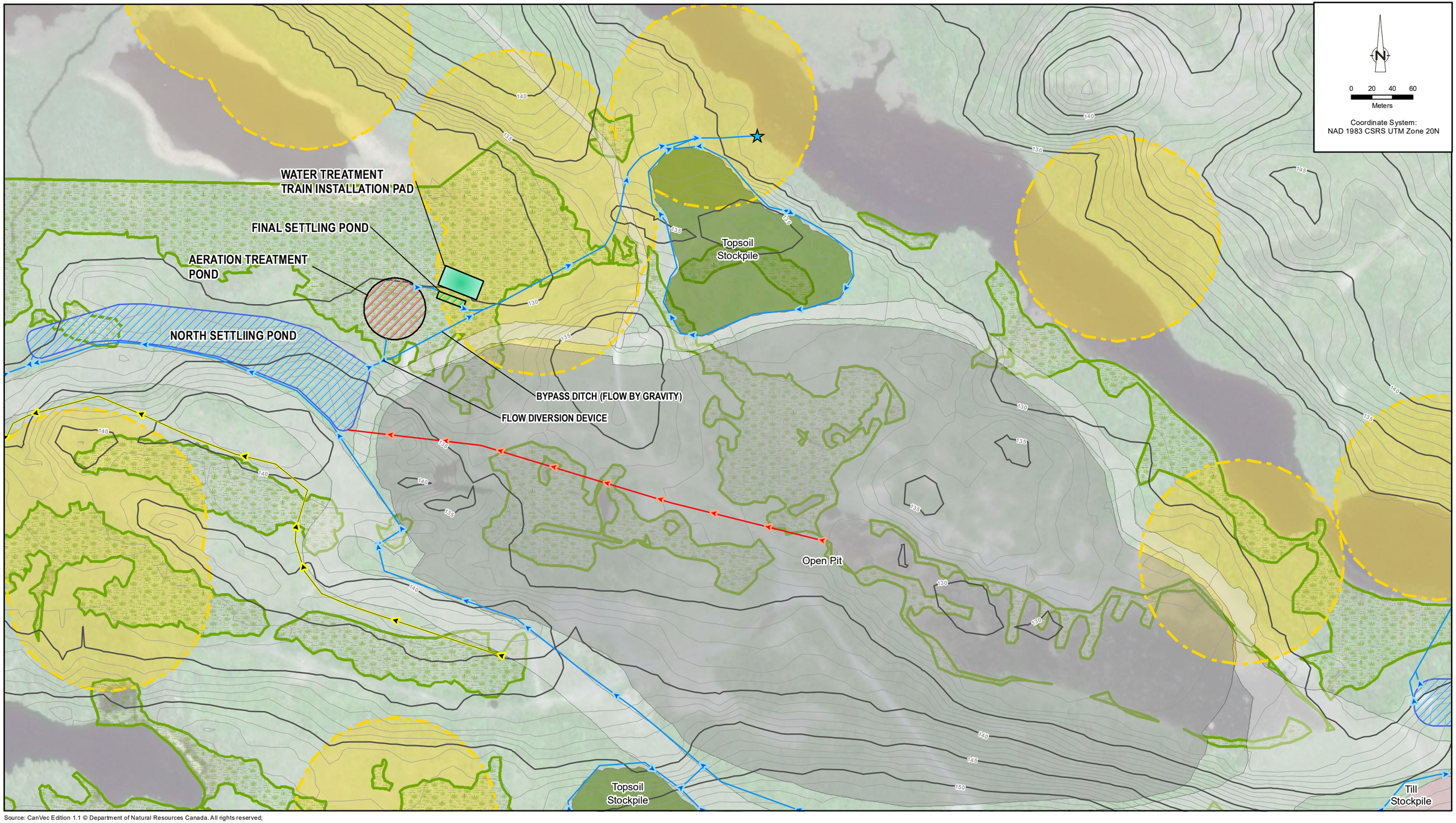
All of Which is Respectfully Submitted,

GHD

Hojat Seyedy

Heather Brewer



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LEGEND

- NORTH SETTLING POND
- AERATION TREATMENT POND
- FINAL SETTLING POND
- TRAIN INSTALLATION PAD
- CONTACT WATER DITCH
- CLEAN WATER DITCH
- PUMPING PATH
- NORTH SETTLING POND DISCHARGE
- CONTOURS (5M)
- CONTOURS (1M)
- PRIORITY LICHEN BUFFERS
- WETLANDS

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ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
WATER TREATMENT ASSESSMENT

NORTH POND AND POTENTIAL WATER TREATMENT INFRASTRUCTURE LOCATIONS

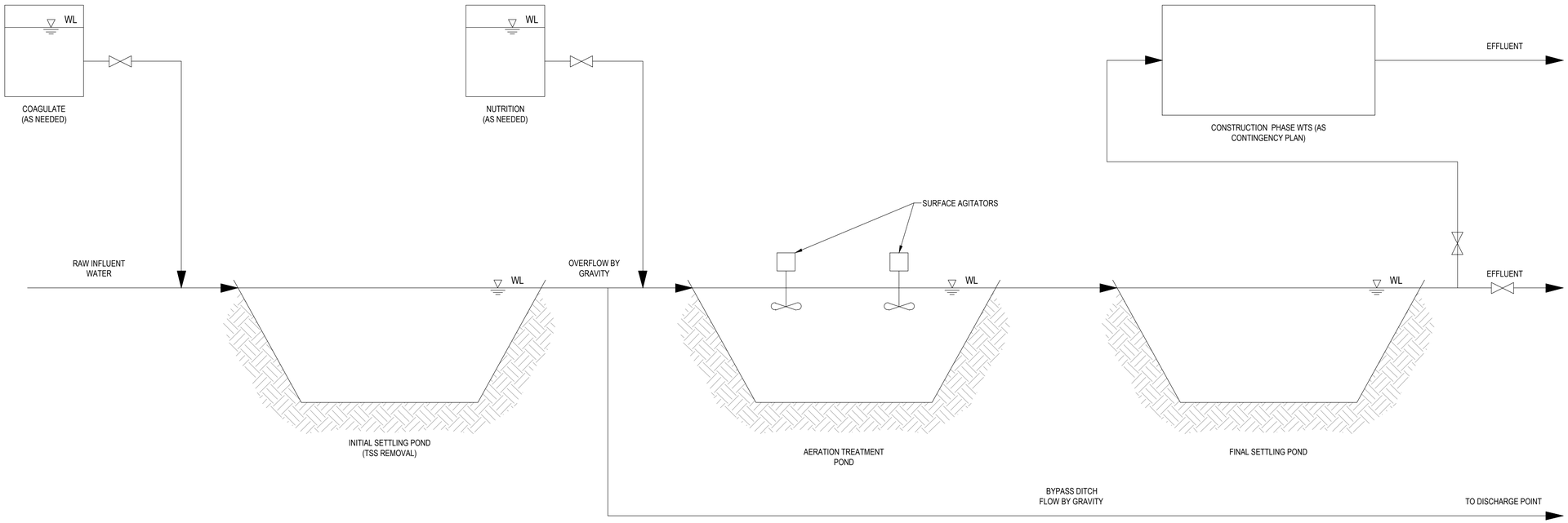
088664
Mar 8, 2021

FIGURE 2.1

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\20200915_WaterTreatmentAssessment\088664_20210302_WaterTreatmentAssessment_GIS002.mxd

Appendices

Appendix A
Schematic Figure of Treatment Ponds



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Project
BEAVER DAMN GOLD MINE WATER TREATMENT ASSESSMENT CONSTRUCTION PHASE

No.	Issue	Drawn	Approved	Date
1	CONCEPTUAL PFD	JS	HS	02/26/2021

Drawn	JS	Designer	HS
Drafting Check	MW	Design Check	HB
Project Manager	AB	Date	Feb 26, 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
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Project No. **88664**

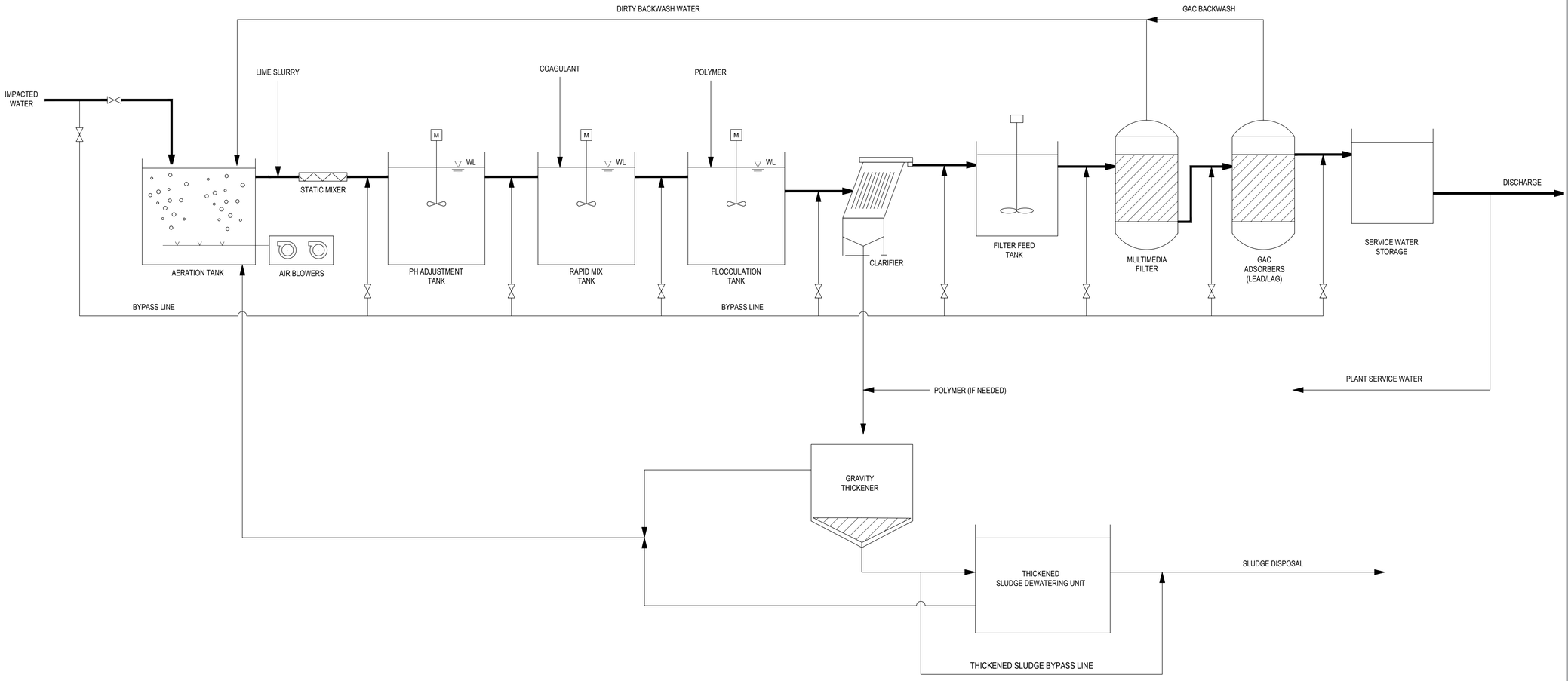
Title
WATER TREAMENT SYSTEM AERATION TREATMENT POND OPERATION PHASE

Sheet No.
P-03

Sheet **3** of **3**

Plot Date: 1 March 2021 - 9:37 AM Plotted By: Jason Spenler CAD File: N:\CA\Waterloo\Legacy\CAD\drawings\88000s\88664\88664-reports\88664-52(000)\88664-52(000)PR-WA002.dwg

Appendix B
Process Flow Diagram of WTS



NOTE:
1. THE TREATMENT SYSTEM DESIGNS ARE PRELIMINARY AND SUBJECT TO CHANGE. FINAL DESIGNS SHALL BE BASED ON CONTACT WATER FLOW RATE SELECTED BY THE CONTRACTOR.
2. INTERMITTENT FLOWS SUCH AS FILTER BACKWASHES ARE TO BE CONFIRMED BY CONTRACTOR BASED ON FILTER VESSELS SIZING.

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Drawn **JS**	Designer **HS**
Drafting Check **MW**	Design Check **HB**
Project Manager **AB**	Date **Feb 26, 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
WATER TREAMENT SYSTEM PROCESS FLOW DIAGRAM

Sheet No.
P-01

Sheet **1** of **3**

Plot Date: 26 February 2021 - 2:00 PM Plotted By: Jason Spenler CAD File: N:\CA\Waterloo\Legacy\CAD\drawings\88000s\88664\88664-reports\88664-52(000)\88664-52(000)PR-WA001.dwg

Appendix C
Surface Agitator Datasheet

EEE FA1805

5 HP 1800 RPM

MOTOR

A - MANUFACTURER	BALDOR ELECTRIC
B - HORSEPOWER	5
C - RPM	1800
D - FULL LOAD AMPS	6.5 13
E - VOLTAGE	460 230
F - PHASE	3
G - CYCLE	60
H - SERVICE FACTOR	1.15
I - INSULATION CLASS	"F" NON-HYGROSCOPIC
J - EXTERIOR FINISH	WHITE CHEMICAL RESISTANT POLYURETHANE
K - BEARINGS	DOUBLE ROW ANGULAR CONTACT
L - BEARING LIFE	100,000 HOURS
M - ENCLOSURE	TEFC

MOTOR SHAFT

A - SHAFT MATERIAL	17-4 PH S.S. HT 1150 CONDITION
B - SHAFT LENGTH	22" FROM END SHIELD FACE OF MOTOR
C - SHAFT DIAMETER	1.875 O.D.
D - MINIMUM YIELD STRENGTH	135,000 PSI

PROPELLER

A - MANUFACTURER	MICHIGAN WHEEL
B - MATERIAL	316 STAINLESS STEEL
C - BALANCING	DYNAMICALLY TO LESS THAN ½ MIL MAXIMUM

DEFLECTOR

A - MATERIAL	304 S. S. HDG STEEL AND FRP
B - EXTERIOR FINISH	CHEM. RESISTANT GEL-COAT UV STABILIZED
C - INTERNAL REINFORCING	3/8" X 30" S.S. PLATE
D - INTERNAL FILL	# 3 QUARTZITE AND RESIN MIXTURE
E - MINIMUM FRP THICKNESS	.375"
F - EXTERIOR COLOR	WHITE
G - WEIGHT	187 LBS.

EEE FA1805

5 HP 1800 RPM

POWER MODULE SUPPORT RING

A - MATERIAL	304 &HDG STEEL
B - DIMENSIONS OF FLAT RINGS	3/8" X 3" X 30" O.D.
C - DIMENSIONS OF SUPPORT RODS	1 ¼" X 4" HDG STEEL
D - METHOD OF CONSTRUCTION	WELDED

AERATOR FLOAT

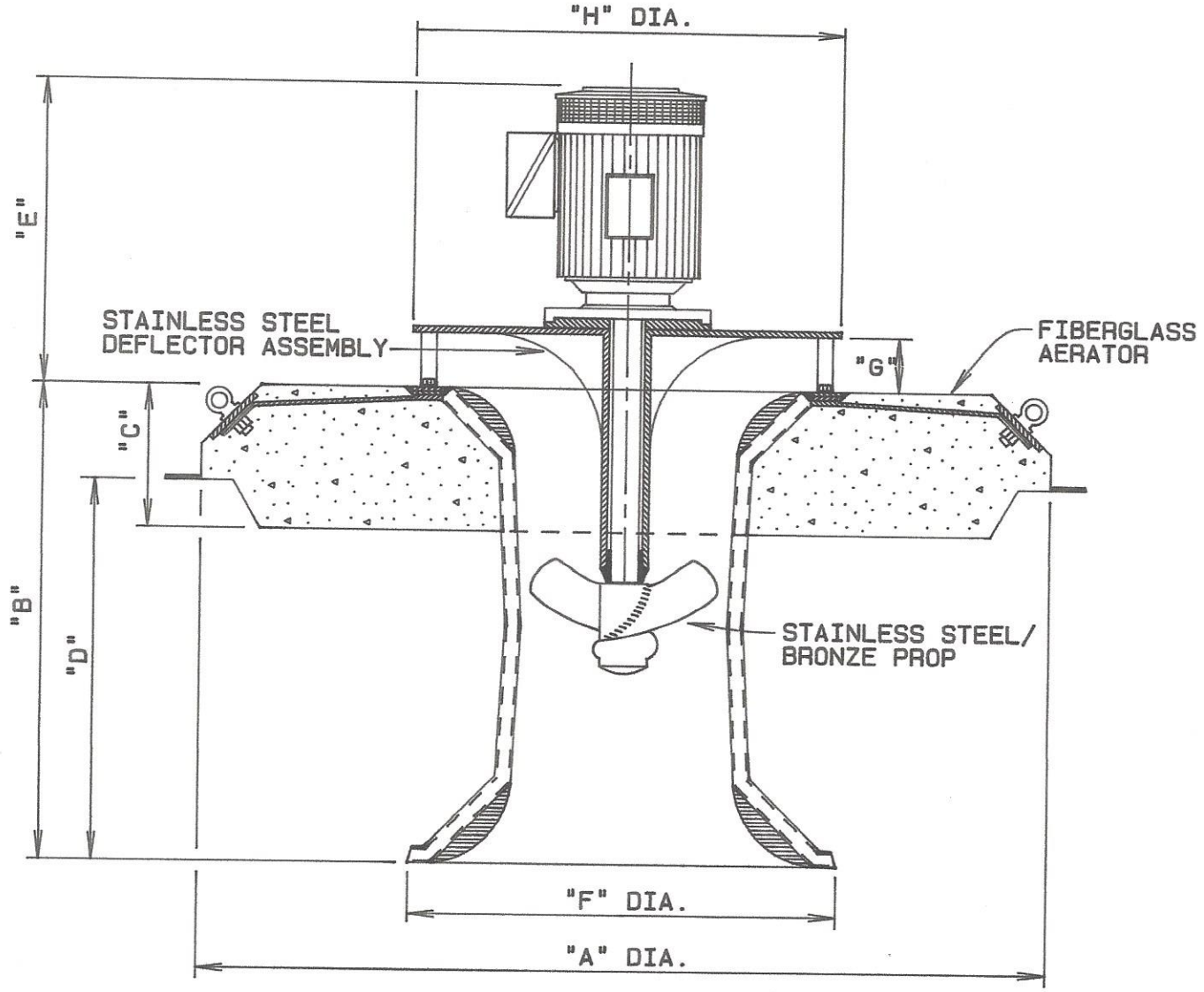
A - METHOD OF CONSTRUCTION	HAND LAY UP
B - MATERIAL	CDM 2415 PROMAT & CHEMICAL RESISTANT RESIN
C - EXTERNAL FINISH	CHEMICAL RESISTANT GEL-COAT UV STABILIZED
D - EXTERNAL COLOR	WHITE
E - INTERNAL REINFORCING (POWER MODULE SUPPORT)	3/8" X 3" X 30" O.D. RING
F - INTERNAL REINFORCING (MOORING EYES)	3/8" X 3" S.S. FLAT BAR
G - THROAT SECTION REINFORCING	2" X 2" ENCAPSULATED ST. BAR
H - INTERNAL FILL	2# DEN. POLYURETHANE CLOSED CELL FOAM
I - MINIMUM THICKNESS	¼" NON-STRESS AREAS
J - MOORING EYE DIMENSION	½" X 3" LONG
K - FLOAT DIAMETER	60"
L - FLOAT	14"
M - SINK SAFETY FACTOR	2.0
N - VOLUTE	FRP ¾ " THICK

PERFORMANCE

A - PUMPING RATE	4043 GPM
B - 0XYGEN TRANSFER RATE	3.8 LBS. OXYGEN/HP/HP (MINIMUM)
C - MINIMUM DIA. OF COMPLETE MIX AT 10' DEPTH	62 FEET
D - MINIMUM DIA. OF OXYGEN DISPERSION AT 10' DEPTH	160 FEET

MISCELLANEOUS

A - WT. OF COMPLETED UNIT	730 LBS SHIPPING WT.
B - HEIGHT OF COMPLETED UNIT	58"
C - JOB SITE ASSEMBLY	NONE
D - MAINTENANCE (MOTOR GREASE)	SEE O & M MANUAL
E - MAINTENANCE (OTHER)	SEE O & M MANUAL
F - WARRANTY	AS SPECIFIED



CUT AWAY DRAWING

NO SCALE:

FIBERGLASS AERATOR / STAINLESS STEEL DEFLECTOR									
AERATOR SIZE	HP	"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"
FA 1805	5	60	34	14	28	21	30	4	30

SOOW 600V

FLEXTREME

Portable Cord -40˚C + 90˚C UL CSA MSHA
Extra Hard Usage - High Grade Mechanical Service

RoHS COMPLIANT

SPECIFICATIONS & STANDARDS
UL 62/CSA-C 22.2 No 49

CONSTRUCTION:

Conductors:	Flexible stranded bare copper, ASTM B-174 and UL 62
Insulation:	EPR compound, 90˚C compound class 3, table 8, UL 62
Assembly:	Insulated conductors cabled together with integral filled or rubber fillers
Separator:	Paper tape or talc for 18-10 AWG / Polyester tape for 8-2 AWG
Jacket:	Black CPE 90˚C compound class 1.4, table 22, UL 62
Color code:	ICEA S-58-679, Method 1, table 1; black, white, red, green

FEATURES

- Excellent flexibility, resistance to oil, solvents, ozone, weather, sunlight and water
- Flame test meets VW-1, FT2, and MSHA
- Temperature range: -40°C to +90°C
- Suitable for shallow water immersion

APPLICATION

- Industrial and processing equipment, cranes and hoists, track systems, tools, construction equipment, motors and associated machinery, garage portable lights, battery charger and equipment exposed to oils, solvents, flame, moisture and other electrical equipment

APPROVALS:

UL:	E123366
CSA:	1534535 (LL 103932)
MSHA:	P-7K-254013

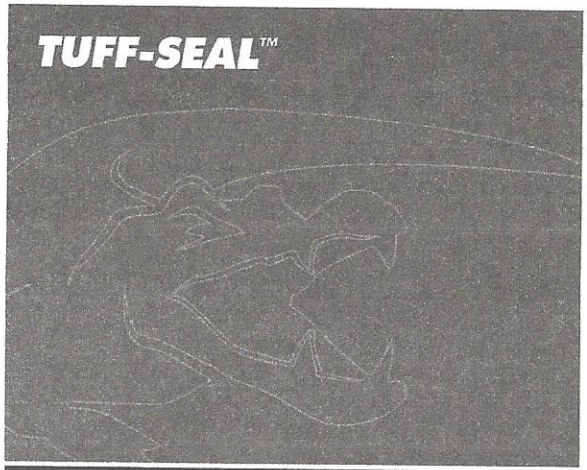
Part Number	Power Conductor Size	No. of Conductors	Power Conductor Stranding	Nominal Insulation Thickness		Nominal Jacket Thickness		Nominal O.D.		Approx. Weight	Ampacity (1) 30°C Ambient Temp.
	AWG		No. of Stranding	inches	mm	inches	mm	inches	mm	lbs/1000 ft	A
SOOW18-2 IF		2						0.34	8.6	63	10.0
SOOW18-3 IF	18	3	16 / 30	0.030	0.76	0.060	1.52	0.36	9.1	74	10.0
SOOW18-4 IF		4						0.39	9.8	87	7.0
SOOW16-2 IF		2						0.37	9.3	76	13.0
SOOW16-3 IF	16	3	26 / 30	0.030	0.76	0.060	1.52	0.39	10.1	90	13.0
SOOW16-4 IF		4						0.42	10.5	107	10.0
SOOW14-2 IF		2						0.50	12.6	137	18.0
SOOW14-3 IF	14	3	41 / 30	0.045	1.14	0.080	2.03	0.52	13.3	161	18.0
SOOW14-4 IF		4						0.57	14.4	192	15.0
SOOW12-2 IF		2						0.57	14.4	184	25.0
SOOW12-3 IF	12	3	65 / 30	0.045	1.14	0.095	2.41	0.59	15.2	217	25.0
SOOW12-4 IF		4						0.64	16.5	261	20.0
SOOW10-2 IF		2						0.62	15.6	230	30.0
SOOW10-3 IF	10	3	104 / 30	0.045	1.14	0.095	2.41	0.65	16.5	281	30.0
SOOW10-4 IF		4						0.70	17.8	336	25.0

(1) Ampacity – Free air measured; Based on continuous duty at 90°C conductor temperature

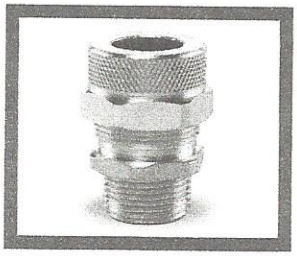
STANDARD PRINT LEGEND:
TF CABLE FLEXTREME (COND) (SIZE) (mm²) (UL) SOOW E123366 90C SUN & WATER RES 600V CSA SOOW 90C LL 103932 FT2 -40C P-7K-254013 MSHA

SPECIAL FACTORY OPTIONS:

Color jacket:	Yellow, Orange
SOOW/H07:	European harmonized dual rating



RSRS SERIES STEEL CORD GRIPS



RSRS Series Steel Cord Connectors

The Tuff Seal RSRS series of corrosion-resistant cord connectors features a body and compression nut made of zinc-chromium plated steel for added strength and durability, enhanced resistance to rust and a better physical appearance. These connectors are ideally suited for use in washdowns or high moisture environments in food processing plants, petrochemical facilities, wastewater treatment plants, pulp & paper mills and chemical manufacturing factories.

RSRS cord connectors have been designed to withstand the extremes of water, caustic materials, detergents or surfactants.

RSRS Corrosion-Resistant Connectors can be ordered with or without wire mesh and accommodate 3/8", 1/2", 3/4" and 1" conduit. The combination tightening surface on these connectors is a unique Remke design that provides a large wrenching area for easy installation. And the knurl section offers users an extra gripping surface for initial hand tightening.

NOTES

Cord Grip Accessories
- Locknuts: add "-L" to ay part number
- O-Rings: add "-R" to any part number

Special Configurations
- Special configurations and materials are available. Consult factory.

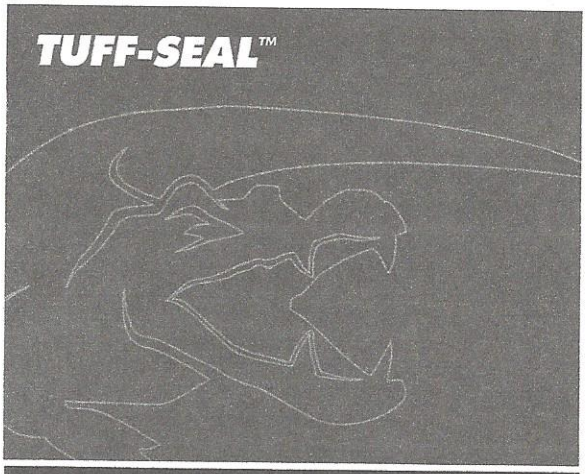
All wire mesh is stainless steel.

Dimension & certification information on pages 44 & 46 in Tuff-Seal Technical Reference. Dimensions are the same as those for RSR Straight Cord Grips.

COMPLETE ASSEMBLY PART NUMBERS

Conduit Size (NPT)	Cable Range	Cord Grip	Cord Grip With Mesh
3/8"			
	.125 – .188	RSRS-003	—
	.188 – .250	RSRS-004	RSRS-004-E
	.250 – .312	RSRS-005	RSRS-005-E
	.312 – .375	RSRS-006	RSRS-006-E
	.375 – .438	RSRS-007	RSRS-007-E
1/2"			
	.125 – .188	RSRS-103	—
	.188 – .250	RSRS-104	RSRS-104-E
	.250 – .312	RSRS-105	RSRS-105-E
	.312 – .375	RSRS-106	RSRS-106-E
	.375 – .438	RSRS-107	RSRS-107-E
	.438 – .500	RSRS-108	RSRS-108-E
	.500 – .562	RSRS-109	RSRS-109-E
	.562 – .625	RSRS-110	RSRS-110-E
3/4"			
	.438 – .500	RSRS-208	RSRS-208-E
	.500 – .562	RSRS-209	RSRS-209-E
	.500 – .625	RSRS-210	RSRS-210-E
	.562 – .688	RSRS-211	RSRS-211-E
	.625 – .750	RSRS-212	RSRS-212-E
	.688 – .812	RSRS-213*	RSRS-213-E
1"			
	.500 – .562	RSRS-309	RSRS-309-E
	.500 – .625	RSRS-310	RSRS-310-E
	.562 – .688	RSRS-311	RSRS-311-E
	.625 – .750	RSRS-312	RSRS-312-E
	.688 – .812	RSRS-313	RSRS-313-E
	.750 – .875	RSRS-314	RSRS-314-E
	.812 – .938	RSRS-315	RSRS-315-E
	.875 – 1.000	RSRS-316	RSRS-316-E
1 1/4"			
	.875 – 1.000	RSRS-416	—
	1.125 – 1.250	RSRS-420	—
1 1/2"			
	1.000 – 1.125	RSRS-518	—
	1.125 – 1.250	RSRS-520	—
	1.250 – 1.375	RSRS-522	—

*Cable may have to be stripped to pass through the bore of the body



WIRE MESH CABLE GRIPS

Standard Support Grips

Tuff Seal Support Grips are designed to hold the weight of cable that is vertical or sloping. Support grips serve an important function; electrical cables must be supported or their dead weight can cause excessive strain or pullout at the connections resulting in power failure.

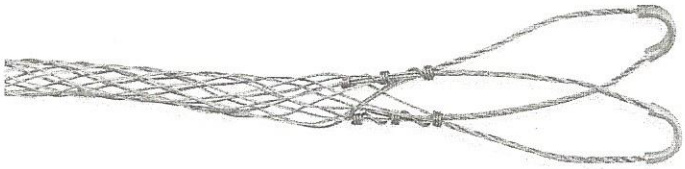
Tuff Seal Support Grips are woven with non-magnetic, tinned bronze wire that absorbs strain and flexing while resisting cable pull-out, flexing and vibration. These grips are available in a variety of eye styles and cable ranges, can be used either indoors or outdoors, and will support cable, metal rods and tubing with loads up to 600 lbs.

NOTES

All mesh is available as double weave or stainless steel, and offset and universal bale styles are available upon request. Consult factory.

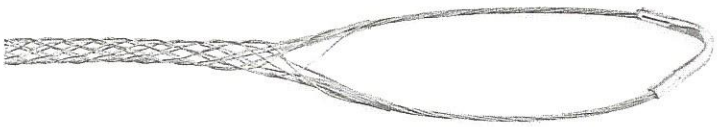
Information on Approximate Breaking Strength on page 53 in Tuff-Seal Technical Reference Section.

CLOSED MESH, DOUBLE EYE, SINGLE WEAVE

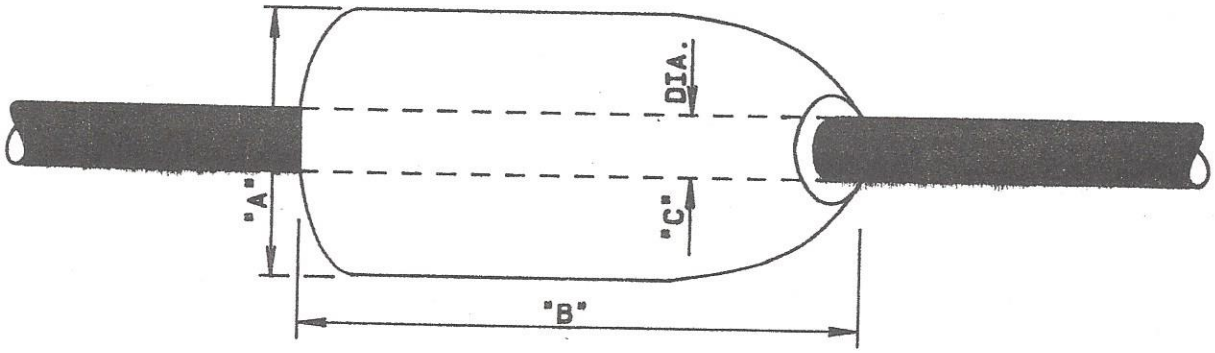


Cable Range	Part Numbers	Description	Approx.* Breaking Strength	Length (IN.) Eye	Mesh
.50 – .62	2201-001R	R050-DE	530	4	10
.63 – .74	2201-002R	R062-DE	790	4	10
.75 – .99	2201-003R	R075-DE	1020	4	13
1.00 – 1.24	2201-004R	R100-DE	1610	5	14
1.25 – 1.49	2201-005R	R125-DE	1610	5	15
1.50 – 1.74	2201-006R	R150-DE	1610	5	17
1.75 – 1.99	2201-007R	R175-DE	2150	6	19
2.00 – 2.49	2201-008R	R200-DE	3260	6	21
2.50 – 2.99	2201-009R	R250-DE	3260	6	23
3.00 – 3.49	2201-010R	R300-DE	4900	8	25
3.50 – 3.99	2201-011R	R350-DE	4900	8	27

CLOSED MESH, SINGLE EYE, SINGLE WEAVE



Cable Range	Part Numbers	Description	Approx.* Breaking Strength	Length (IN.) Eye	Mesh
.50 – .62	2201-013R	R050-SE	530	7	10
.63 – .74	2201-014R	R062-SE	790	8	10
.75 – .99	2201-015R	R075-SE	1020	8	13
1.00 – 1.24	2201-016R	R100-SE	1610	9	14
1.25 – 1.49	2201-017R	R125-SE	1610	10	15
1.50 – 1.74	2201-018R	R150-SE	1610	12	17
1.75 – 1.99	2201-019R	R175-SE	2150	14	19
2.00 – 2.49	2201-020R	R200-SE	3260	16	21
2.50 – 2.99	2201-021R	R250-SE	3260	18	23
3.00 – 3.49	2201-022R	R300-SE	4900	21	25
3.50 – 3.99	2201-023R	R350-SE	4900	24	27



CABLE FLOAT

POWER CABLE FLOATS						
CABLE SIZE	FLOAT MODEL	FLOAT DIMENSION			SPACING	BOUYANCY
		A	B	C		
AWG 10/4	CF5XX	5"	11"	3/4"	6 FT.	105 OZ.
AWG 12/4	CF5XX	5"	11"	3/4"	8 FT.	105 OZ.
AWG 6/4	CF6XX	6"	14"	1"	10 FT.	172 OZ.
AWG 8/4	CF6XX	6"	14"	1"	12 FT.	172 OZ.
AWG 2/4	CF6XX	6"	14"	1"	14 FT.	172 OZ.
AWG 4/4	CF6XX	6"	14"	1"	16 FT.	172 OZ.

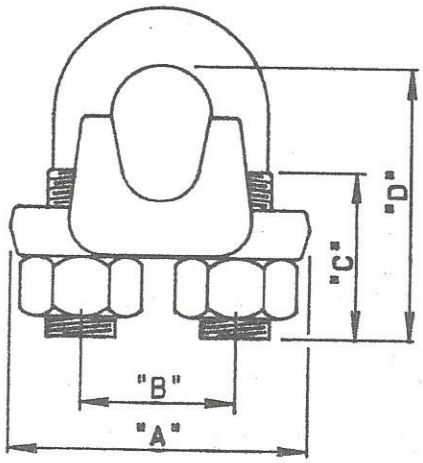
POWER CABLE FLOAT SELECTION

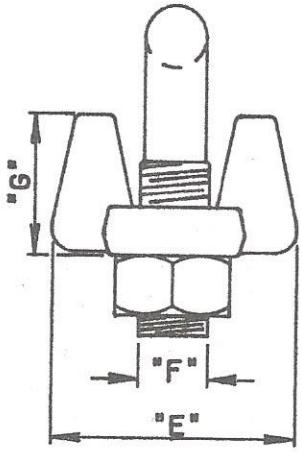
7x19 PREFORMED STAINLESS STEEL CABLE
CABLE TYPE 316 (EXTRA CORROSION-RESISTANT)

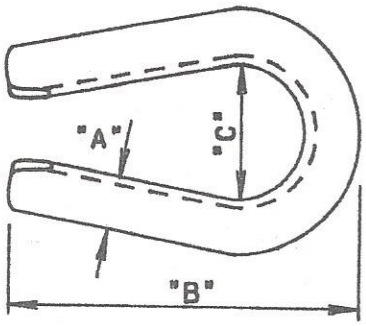
MOORING CABLE SELECTION CHART

AERATOR MODEL NO.	UNIT HP	CABLE SIZES		
		BREAK STRENGTH 3,700 LBS.	BREAK STRENGTH 6,400 LBS.	BREAK STRENGTH 12,000 LBS.
FA1801	1	3/16"	—	—
FA1802	2	3/16"	—	—
FA1803	3	3/16"	—	—
FA1805	5	3/16"	—	—
FA1807	7 1/2	3/16"	—	—
FA1810	10	3/16"	—	—
FA1215	15	3/16"	—	—
FA1220	20	—	1/4"	—
FA1225	25	—	1/4"	—
FA9030	30	—	1/4"	—
FA9040	40	—	1/4"	—
FA9050	50	—	1/4"	—
FA9060	60	—	—	3/8"
FA9075	75	—	—	3/8"

MOORING CABLE SELECTION GUIDE







CLIP

WIRE ROPE CLIPS TYPE 316 STAINLESS STEEL								
CLIP SIZE	CABLE SIZE	DIMENSIONS						
		"A"	"B"	"C"	"D"	"E"	"F"	"G"
1	3/16"	1 3/32"	5/8"	9/16"	1"	15/16"	1/4"	1/2"
2	1/4"	1 7/16"	3/4"	3/4"	1 3/8"	1 3/16"	5/16"	21/32"
3	3/8"	1 15/16"	1"	13/16"	1 1/2"	1 5/8"	7/16"	29/32"

THIMBLE

WIRE ROPE THIMBLES TYPE 316 STAINLESS STEEL				
THIMBLE SIZE	CABLE SIZE	DIMENSIONS		
		"A"	"B"	"C"
1	3/16"	13/32"	2 3/16"	7/8"
2	1/4"	1/2"	2 1/2"	1 1/16"
3	3/8"	21/32"	2 7/8"	1 1/8"

MOORING HARDWARE SELECTION CHART					
AERATOR MODEL NO.	UNIT HP	CLIPS SIZE	THIMBLES SIZE	NO. OF CLIPS PER MOORING	NO. OF THIMBLES PER MOORING
FA1801	1	1	1	4	2
FA1802	2	1	1	4	2
FA1803	3	1	1	4	2
FA1805	5	1	1	4	2
FA1807	7 1/2	1	1	4	2
FA1810	10	1	1	4	2
FA1215	15	1	1	4	2
FA1220	20	2	2	4	2
FA1225	25	2	2	4	2
FA9030	30	2	2	4	2
FA9040	40	2	2	4	2
FA9050	50	2	2	4	2
FA9060	60	3	3	4	2
FA9075	75	3	3	4	2

MOORING HARDWARE SELECTION GUIDE

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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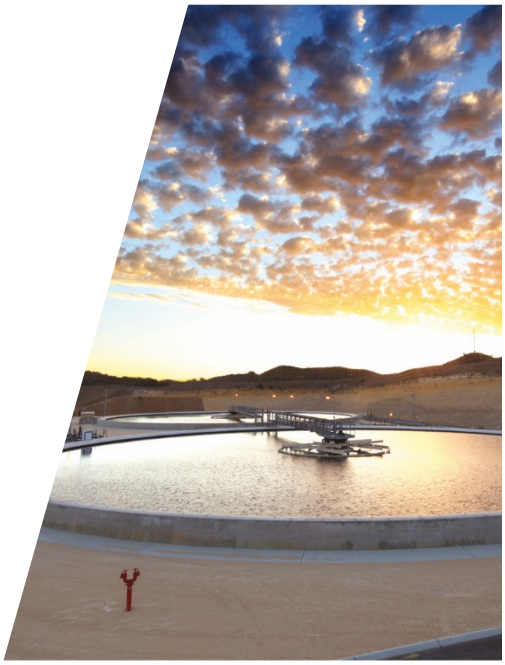
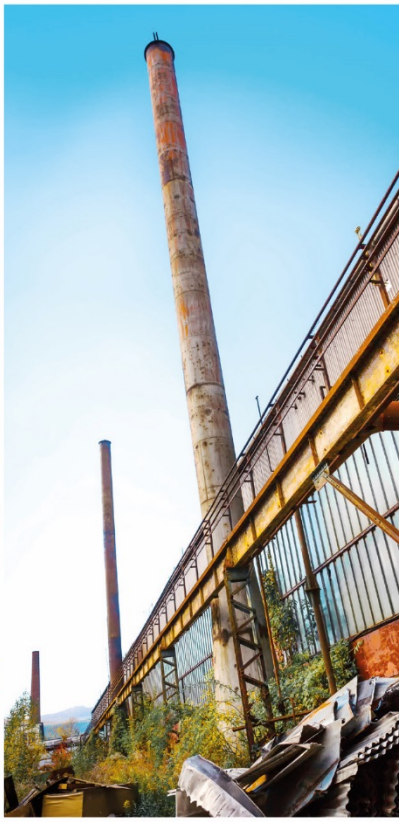
Appendix F.3
Post-Closure Phase



Post-Closure Phase

Water Treatment Assessment

Beaver Dam Gold Mine



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1. Introduction 1
2. Site Background 1
3. Treatability Criteria 2
4. Data Review 2
   - 4.1 Post-Closure (PC) Impacted Water Volume 2
   - 4.2 Water Quality 3
5. Treatability Technology Review 4
   - 5.1 Methodology 4
   - 5.2 Long List of Alternatives 4
   - 5.3 Screening of Feasible Alternatives & Development of Short List 9
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   - 6.1 Alternative 1. Anoxic limestone drains (ALDs) followed by aeration cascade and settling pond 13
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Figure Index

Figure 2.1 Post-Closure Potential Water Treatment Infrastructure Locations

Table Index

Table 4.1 Monthly Site Runoff Flow Estimates 2

Table 4.2 Concentrations of Exceeded Elements at Post-Closure Phase 3

Table 5.1 Summary of initial screening of potential treatment options 10

Appendix Index

Appendix A Schematic Figure of Treatment Ponds

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.

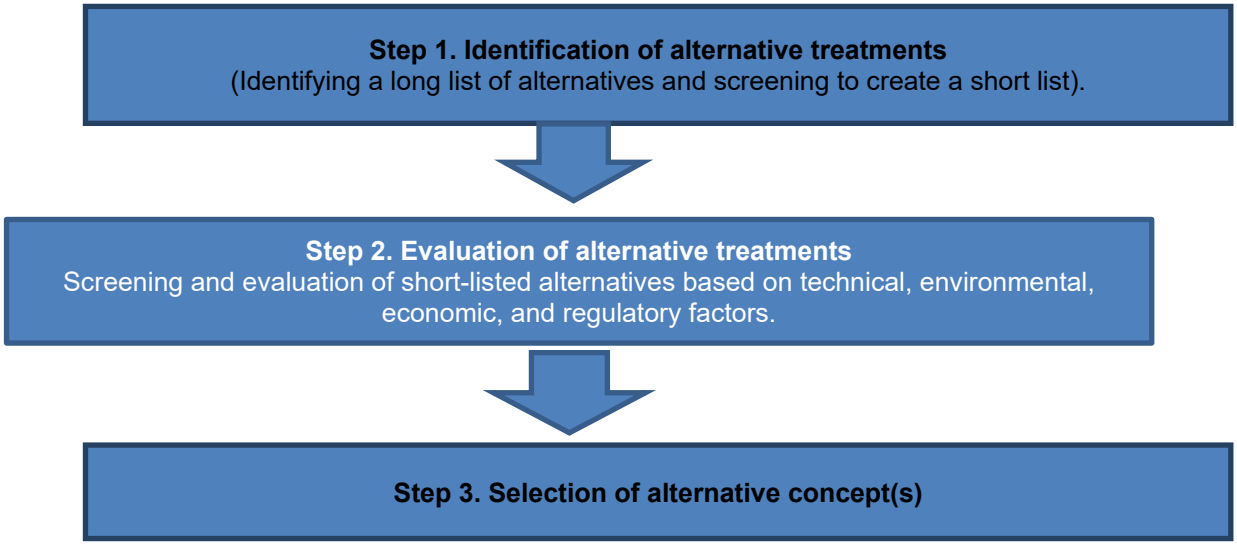
GHD also ran a worst-case scenario for the PC phase, once the precipitation is minimal and concentrations of metals are higher in impacted water. It was predicted that cadmium, nickel, lead, and nitrite will be among exceeded elements during the worst-case scenario at the PC phase that will need treatment.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

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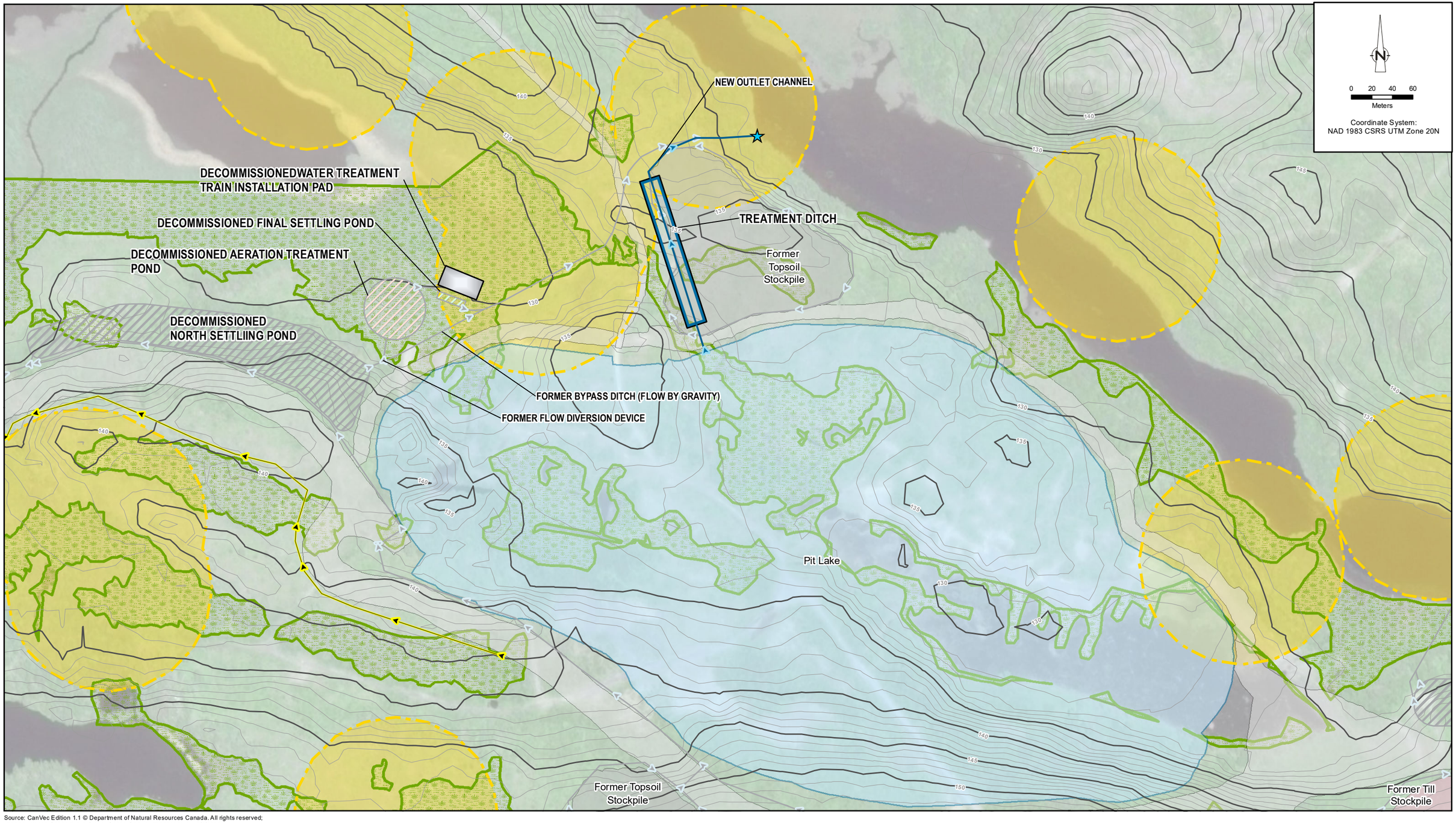

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LEGEND

- 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

GHD

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
WATER TREATMENT ASSESSMENT

POST-CLOSURE POTENTIAL WATER TREATMENT INFRASTRUCTURE LOCATIONS

088664
Mar 8, 2021

FIGURE 2.1

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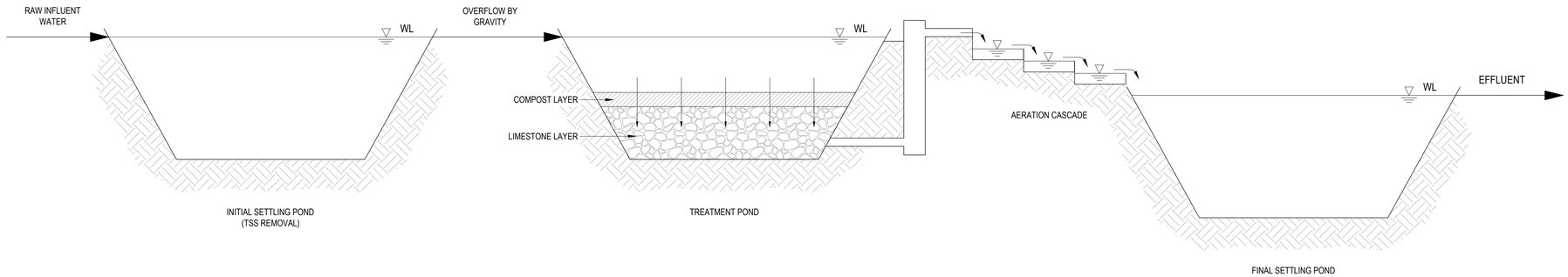
Appendix A
Schematic Figure of Treatment Ponds



INITIAL SETTLING POND
(TSS REMOVAL)

TREATMENT POND

FINAL SETTLING POND

DRAFT

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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**
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Project No. **88664**

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

Sheet No.
P-02

Sheet **2** of **3**

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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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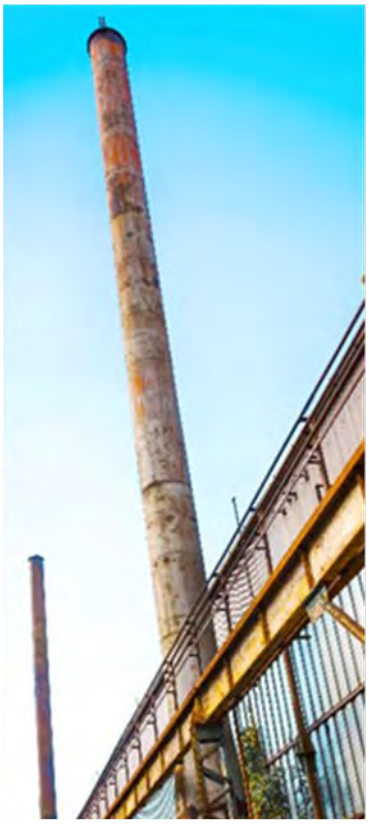
APPENDIX G
Proposed Groundwater Monitoring Plan

Proposed Groundwater Monitoring Plan

Beaver Dam Gold Mine Project
Beaver Dam Mines Road
Marinette Nova Scotia

Atlantic Mining NS Inc.



Draft for Review

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1. Introduction

The objectives of this proposed Groundwater Monitoring Plan are to:

- Identify any long-term groundwater quality trends and potential cumulative effects from current and future development of the Beaver Dam Mine.
- Detect any potential groundwater quality and quantity effects.
- Increase our understanding of background conditions.
- Gain further understanding of groundwater /surface water interactions.
- Identify high risk areas that may require further monitoring.
- Refine the list of analytes based on a review of long-term trends.

Typical mining activities such as opening a pit, storing ore material, and storing waste rock/overburden may have the potential to affect groundwater quality. The continuous dewatering associated with an open pit has the potential to lower groundwater levels near the pit. Nearby surface water bodies receiving discharge of groundwater as a component of base flow may be negatively impacted by lowered groundwater levels. GHD understands there are no nearby domestic wells.

This Groundwater Monitoring Plan recommends using a combination of existing and proposed monitoring wells to establish a network of monitoring wells near the mine to permit the collection groundwater data adjacent to key infrastructure which has the potential to affect groundwater. Measuring the groundwater level in these wells on a periodic basis will document the impact of mine activities on groundwater elevations at the mine and groundwater flow directions within the monitoring well network. Routine groundwater sampling and analysis will provide groundwater quality data to evaluate changes in groundwater quality, especially with respect to baseline conditions prior to active mining.

Effective water management requires a clear understanding of the interaction between groundwater and surface water. Surface water is a primary environmental receptor with respect to activities at the mine. Therefore, to better assess the interaction on site, the surface water monitoring should be coordinated with the groundwater monitoring and designed to complement each other.

1.1 Existing Monitoring Locations

The drilling program (series MW-01 to MW-22) was completed from March 29, 2018 to May 7, 2018 and consisted of drilling and installation of 49 nested monitoring wells at 17 locations (Figure 1). Table 1 (following text) contains a summary of the well details including coordinates (East/North), ground surface elevation, well depths, and rationale for placement or continued use.

All monitoring locations were surveyed to determine ground and casing elevation. Monitoring well logs containing information on stratigraphy, rock quality designation (RQD), and monitoring well construction details are included in letter to Atlantic re: Field Activities Report - Beaver Dam Mine Project dated November 18, 2018.

1.2 Proposed Monitoring Locations

With changes in the placement of proposed mine infrastructure since 2018, it is anticipated that some of the existing monitoring wells will be lost (decommissioned) to construction of the mine and others may no longer be required because of their distance from the mine. Figures 2 to 5 show the proposed locations and staging of groundwater monitoring wells for all phases of the Project. Table 1 (series MW-23 to MW-33) (following text) contains a summary of the proposed monitoring well details including approximate coordinates (East/North), ground surface elevation, and well depths. The placement of the proposed monitoring wells considers the mine infrastructure and their proximity to surface water features (i.e., streams, wetlands, lakes).

Monitoring well logs containing information on stratigraphy, rock quality designation (RQD), and monitoring well construction details will be provided in a field activities report.

Groundwater monitoring through the life cycle of the Project is discussed further in Section 7.

2. Monitoring Well Design and Construction

The proposed monitoring wells will be installed using conventional industry methods and standards for hydrogeologic investigations. A qualified drilling contractor will use augers to advance the hole and will collect soil samples with a split spoon sampler to install monitoring wells in the overburden. Monitoring wells installed in the bedrock will require using a diamond drill to advance the hole and a core barrel to retrieve core samples of the bedrock.

The proposed monitoring locations will be nested with either two or three wells in each nest. The core holes of selected monitoring wells adjacent to the pit will be completed to an elevation of -45 m below mean sea level. Once the core hole is complete, it will be packer tested to determine the most permeable portions of the bedrock. Based on the results of the packer testing, three separate monitoring wells will be installed in the appropriate intervals (Table 1).

The remainder of the proposed monitoring locations will have two nested wells consisting of a shallow monitoring well, corresponding to the water table, and intermediate depth monitoring well, in a deeper water bearing zone. This will monitor the most appropriate depth intervals with respect to the interaction with surface water. Nested monitoring wells will facilitate the evaluation of vertical groundwater flow.

Monitoring wells will be completed using 50-millimeter (2-inch) diameter poly vinyl chloride well materials and the borehole will be backfilled with silica sand around the well screen and bentonite clay around the riser. A lockable protective casing will be installed to secure the monitoring well, and if required a barricade to prevent damage from heavy equipment during mine construction and operation should be installed.

Following installation, the newly drilled monitoring wells will be developed using dedicated Waterra tubing and an attached foot valve. The purging procedure is intended to promote the collection of representative groundwater samples. Well development also removed any silt or clay fines from the wells in order to minimize sediment inside the monitoring well's screen.

Monitoring well drilling and installation will be overseen by a qualified engineer or hydrogeologist experienced in monitoring well installation and licensed to practice in Nova Scotia by Engineers Nova Scotia (APENS) or Geoscientists of Nova Scotia (APGNS), respectively.

Once the monitoring wells are installed, they will be surveyed to allow groundwater elevations to be calculated from the depth to water measurements.

The proposed monitoring wells will be installed no later than 275 days prior to the commencement of operation and must have had 4 rounds of quality sampling (Quarterly) completed during that period.

3. Groundwater Level Monitoring

Each of the monitoring wells should be equipped with a pressure transducer to record water levels at on an hourly frequency. In lieu of a transducer, groundwater elevations should be measured manually at all monitoring wells on a monthly frequency. If possible, these groundwater elevation monitoring events should be completed in a single day to provide a synoptic data set or "snapshot" of groundwater flow patterns beneath the mine. Surface water elevations should also be measured at the same time to determine the hydraulic relationship between groundwater and surface water.

Pressure transducer data should be downloaded during the quarterly monitoring rounds, compensated for barometric pressure effects, and compiled. Barometric transducers (barologger) are currently installed at the site.

Monitoring wells associated with the open pit (Figures 2 to 5 and Table 1) will have pressure transducers installed and levels will be recorded on an hourly basis as a minimum. Telemetry systems may be added to any transducer capability to centralize collection and monitoring of data.

4. Groundwater Quality Monitoring

The Groundwater Monitoring Standard Operating Procedure (SOP) (Atlantic Gold Corporation, May 2018 – or as may be updated from time to time) forms part of this Monitoring Plan and samples will be collected following this SOP

GHD has reviewed the Procedure and recommends utilizing conventional groundwater sampling protocols as indicated below.

During well purging, the following stabilization parameters will be measured:

- pH
- Temperature
- Conductivity

Measurements are taken after each well volume is removed. Removing a minimum of three well volumes is required before groundwater samples may be collected. Purging may cease when stabilization is achieved. The groundwater is considered stable when three successive measurements meet the following criteria.

Parameter	Units	Stabilization Criteria
pH	Standard Units	+/- 1
Specific Conductivity	µS/cm	+/- 10%
Temperature	°C	+/- 10%

If monitoring parameters fail to stabilize after the removal of five well volumes, groundwater sampling may proceed.

Alternately, when well yield is low, stabilization parameters are measured until the well pumps dry. Once the well is pumped dry, purging may cease, and groundwater sampling may proceed when the well has recovered a sufficient volume to fill the sample bottles.

If possible, wait until the day after purging to collect the groundwater samples. This will allow sediment in the well mobilized during purging to settle from the water column with a corresponding reduction in of the sample turbidity. Groundwater samples must be collected within 24 hours of the completion of purging.

Another recommendation to the Groundwater Monitoring Standard Operating Procedure is with respect to the collection of duplicate samples. Instead of filling the duplicate sample bottles sequentially, GHD recommends field duplicates be prepared by filling two sets of sample bottles with sequential aliquots of water, each approximately one third of the sample bottle volume.

5. Sampling Frequency

Atlantic Mining NS Inc has collected baseline quality data on a quarterly basis and will continue to collect data at this frequency throughout all phases of the project. This conservative approach is appropriate for the groundwater monitoring frequency, especially at newly installed monitoring wells. Quarterly monitoring can be completed in each season to determine if there are cyclic changes in groundwater quality related to weather/climate. As more groundwater data is collected and evaluated it may be appropriate to reduce the monitoring frequency. More frequent monitoring may be implemented to monitor trends or mine infrastructure changes over shorter durations that may have a potential impact to groundwater.

Whenever possible the surface water and groundwater sampling should be collected in conjunction with each other.

Sampling frequency is also identified in Table 1.

6. Groundwater Quality Monitoring Parameters

Table 2 provides the recommended groundwater quality monitoring parameters. The current program does not include hydrocarbon sampling (TPH.BTEX, etc). These parameters will be added to the analytical list prior to the commencement of mine construction. Parameters may be adjusted from time to time to meet the needs of the project as determined from analysis of the analytical data and in consultation with regulators.

7. Monitoring Life Cycle

The existing monitoring well network was established to document baseline groundwater conditions prior to the mine development. The monitoring network will be modified over time as the mine enters different stages of its life cycle.

7.1 Pre-construction (Current)

The existing monitoring well network will be utilized during this stage of the mine's life cycle. Groundwater elevation monitoring will continue at all existing monitoring well nests. Routine groundwater quality monitoring will cease at monitoring well nests MW-17, MW-18, MW-19, MW-21, and MW-22 (Figure 1).

7.2 Construction Phase

During construction, GHD assumes existing monitoring well nests MW-04, MW-11 and MW-20 will be decommissioned to facilitate construction of the pit and the mine infrastructure. Monitoring well nests MW-17, MW-18 and MW-21 will be decommissioned. Those three wells were installed to provide background hydrogeologic data for the groundwater flow and contaminant transport model and are not located in areas with a potential for adverse impacts to groundwater. Routine groundwater quality monitoring at monitoring well nests MW-03 and MW-16 will cease, but groundwater elevation monitoring will continue.

Proposed monitoring well nests MW-23 and MW-24 will be installed between Cameron Flowage and the mine infrastructure. Monitoring well nest MW-25 will be installed between the open pit and Cameron Flowage and will include a third deeper monitoring well completed at an elevation similar to the pit bottom. Monitoring well nest MW-26 will be installed the open pit and Mud Lake and will also include a third deeper monitoring well completed at an elevation similar to the pit bottom. Monitoring well nests MW-27 and MW-28 will be installed west of the mine infrastructure. Monitoring well nests MW-29, MW-30, and MW-31 will surround the location of the waste rock pile (Figure 2).

7.3 Operations Phase

During the operations phase monitoring wells MW-32 and MW-33 may be incorporated into the groundwater monitoring program if indicated by the results from nearby wells. MW-32 will be located between Cameron Flowage and the mine infrastructure. MW-33 will be located downgradient of the waste rock pile. Monitoring well nest MW-22 will be decommissioned (Figure 3).

7.4 Closure Phase (Years 1-2)

The rationale for groundwater monitoring locations will be assessed prior submission of the Industrial Approval Application when the reclamation plan is more advanced.

During the Closure Phase the mine will be remediated, and the pit will commence refilling with water from both ground and surface sources. The monitoring well network will be reduced after operations cease because the potential to impacts groundwater will be known and are unlikely to increase once operations cease. Monitoring well nests MW-03 and MW-19 will be decommissioned (Figure 4).

7.5 Post Closure Phase (Years 3-10+)

Further monitoring well network reductions will continue after rehabilitation activities are completed because the potential to impact groundwater will also be reduced. Routine groundwater quality monitoring will cease at monitoring well nests MW-12, MW-23, MW-26, MW-27, and MW-32, but groundwater elevation monitoring will continue. MW-16 will be decommissioned (Figure 5).

Groundwater monitoring may be reduced over this period as the mine stabilizes. Termination of the groundwater monitoring program would be expected following a satisfactory review of the monitoring data collected during all project phases and as directed by and/or in consultation with Nova Scotia Environment and Climate Change.

All of Which is Respectfully Submitted,

GHD

DRAFT

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Senior Hydrogeologist

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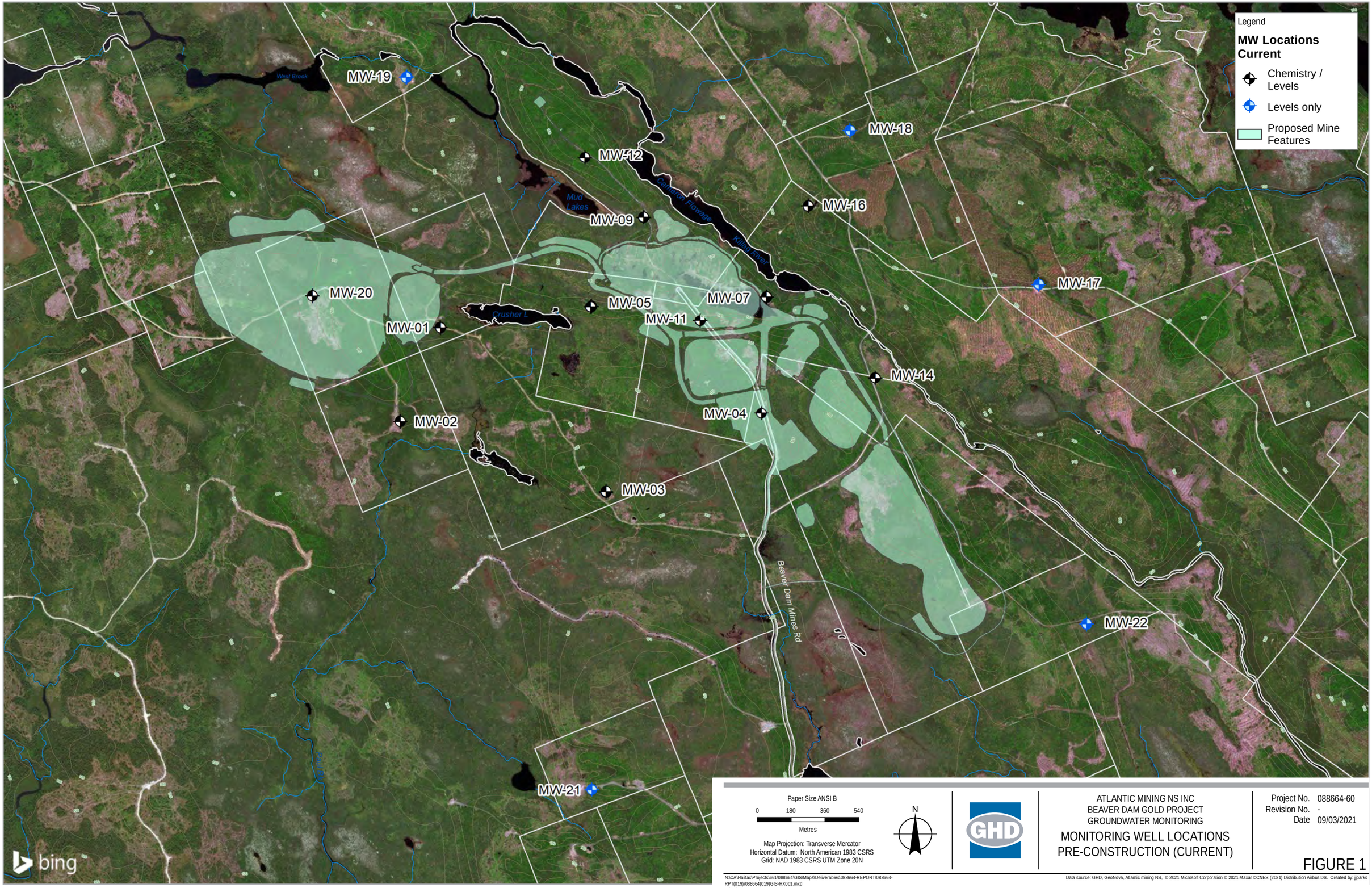
Senior Environmental Geoscientist



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ATLANTIC MINING NS INC
BEAVER DAM GOLD PROJECT
GROUNDWATER MONITORING

MONITORING WELL LOCATIONS PRE-CONSTRUCTION (CURRENT)

Project No. 088664-60
Revision No. -
Date 09/03/2021

FIGURE 1

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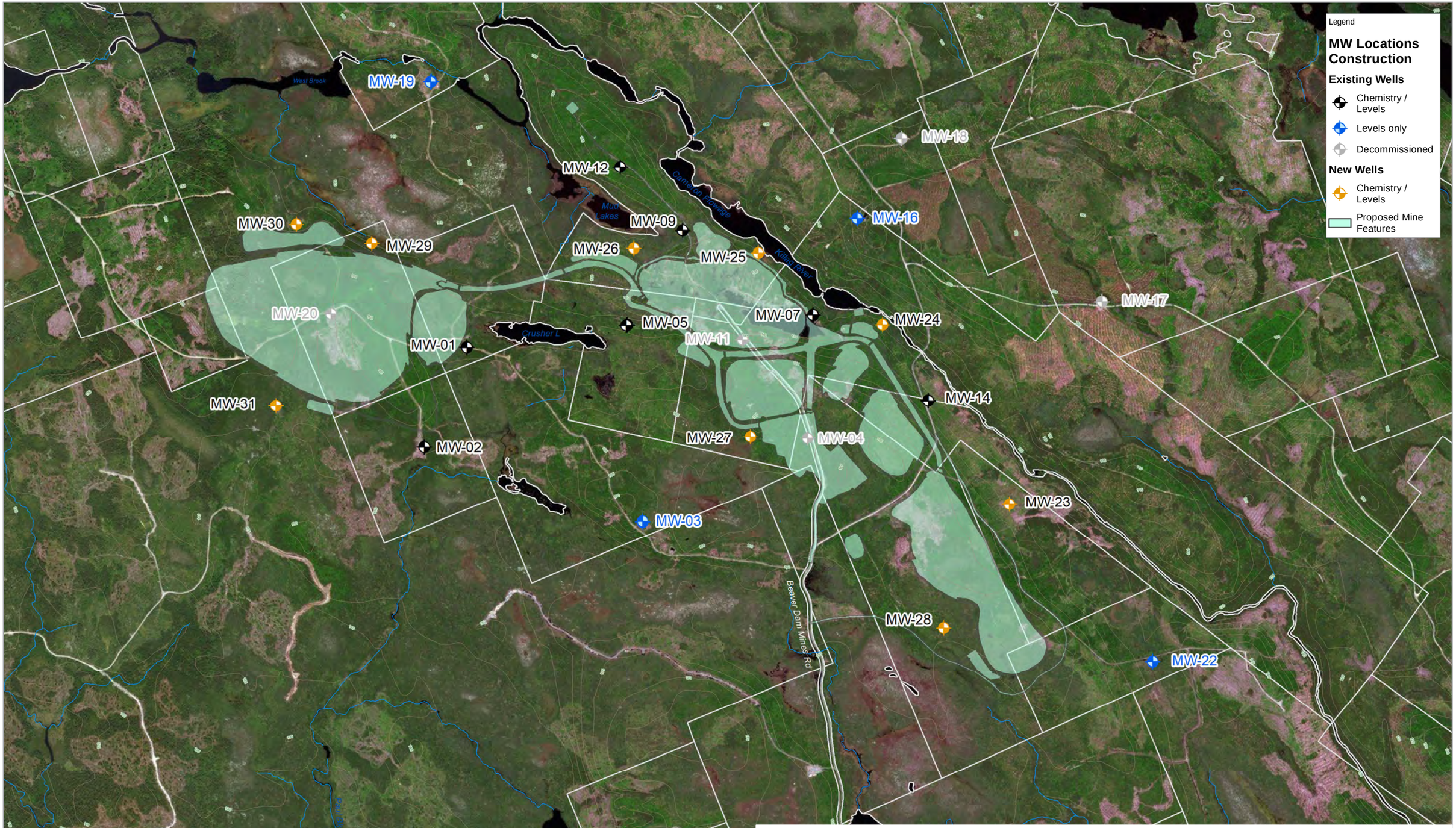

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ATLANTIC MINING NS INC
BEAVER DAM GOLD PROJECT
GROUNDWATER MONITORING

MONITORING WELL LOCATIONS CONSTRUCTION PHASE

Project No. 088664-60
Revision No. -
Date 09/03/2021

FIGURE 2

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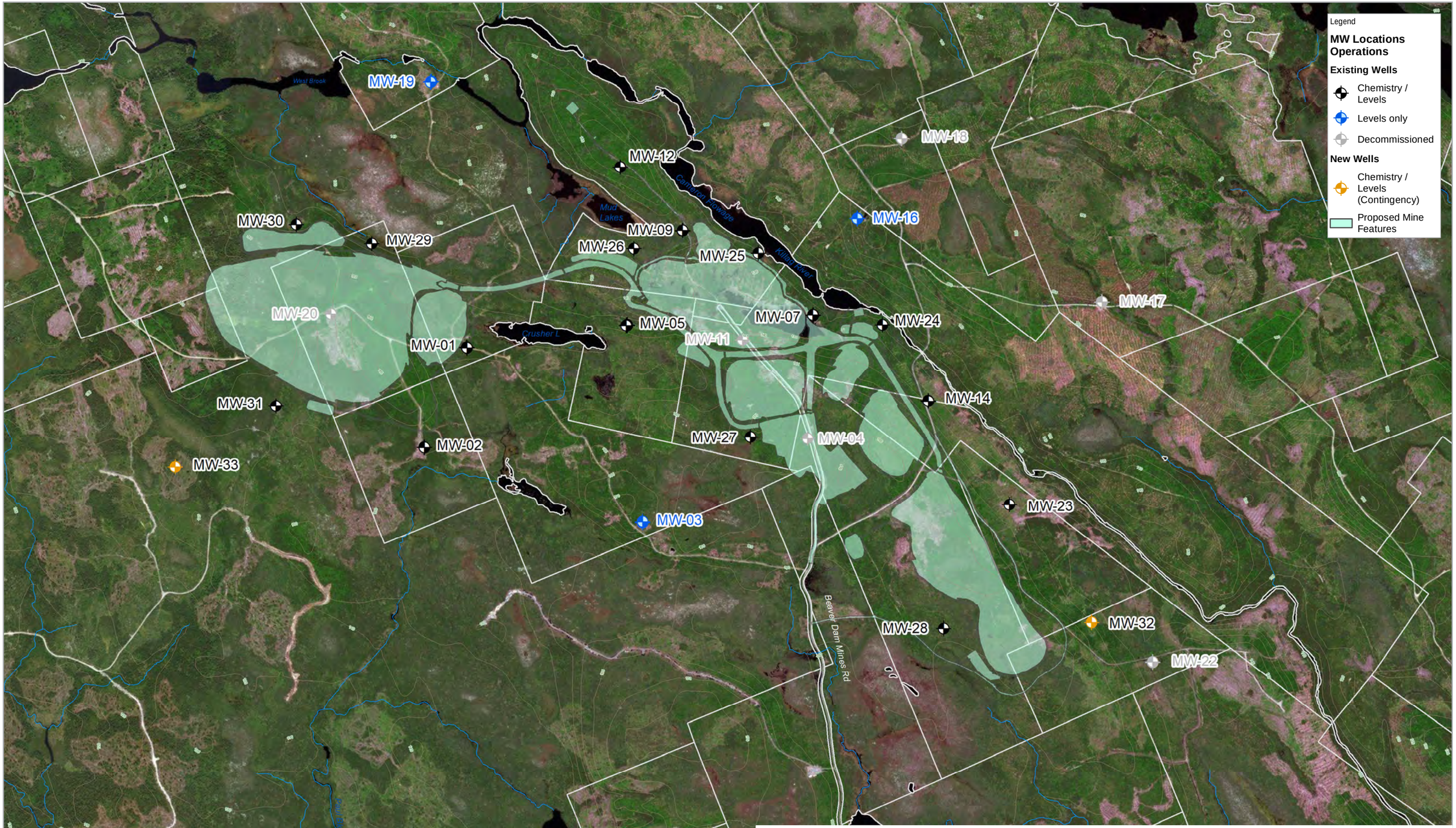

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Grid: NAD 1983 CSRS UTM Zone 20N

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ATLANTIC MINING NS INC
BEAVER DAM GOLD PROJECT
GROUNDWATER MONITORING

MONITORING WELL LOCATIONS
OPERATIONS PHASE

Project No. 088664-60
Revision No. -
Date 09/03/2021

FIGURE 3

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Map Projection: Transverse Mercator
Horizontal Datum: North American 1983 CSRS
Grid: NAD 1983 CSRS UTM Zone 20N

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ATLANTIC MINING NS INC
BEAVER DAM GOLD PROJECT
GROUNDWATER MONITORING

MONITORING WELL LOCATIONS
CLOSURE PHASE (YEARS 1-2)

Project No. 088664-60
Revision No. -
Date 09/03/2021

FIGURE 4

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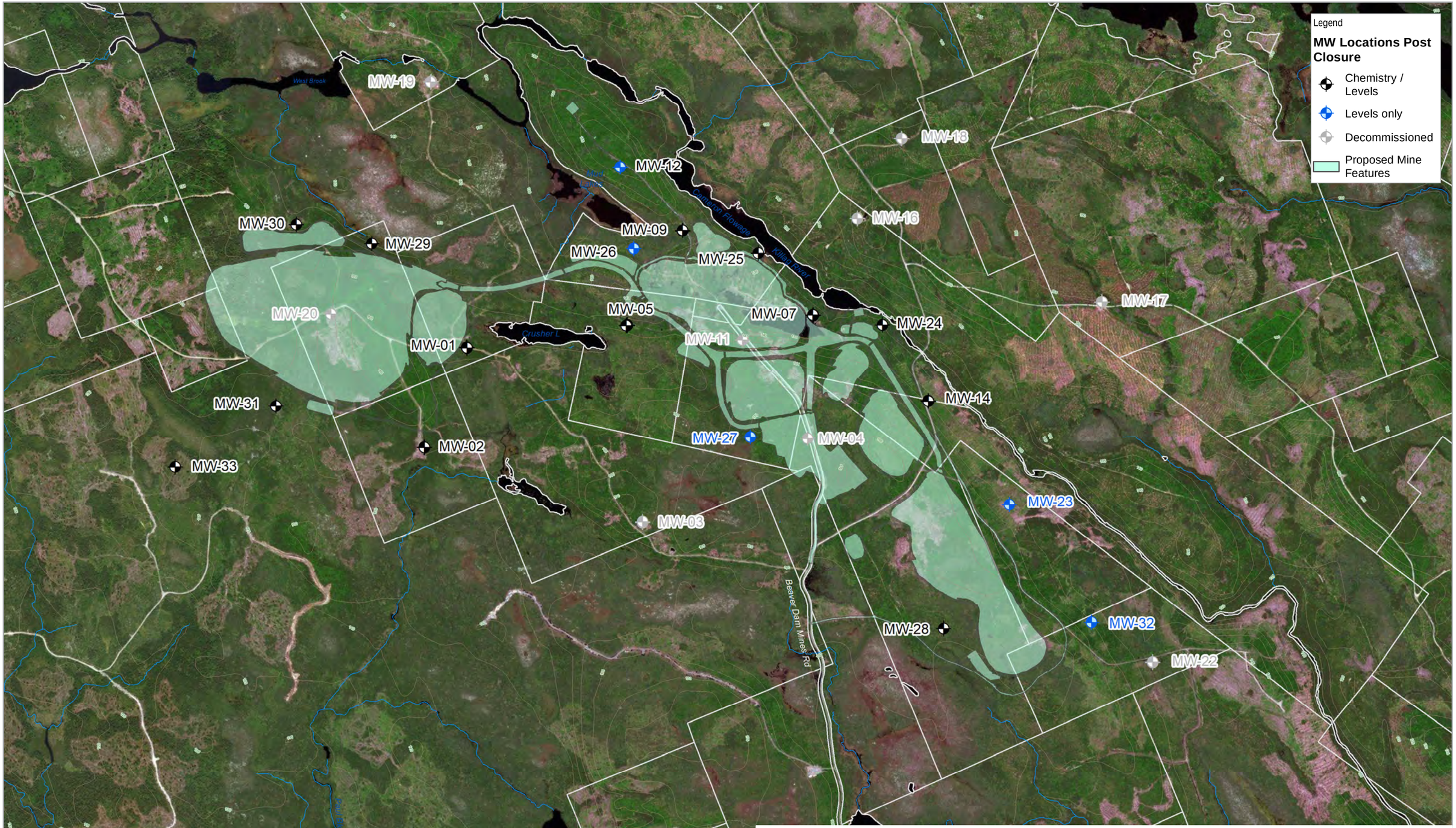

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Horizontal Datum: North American 1983 CSRS
Grid: NAD 1983 CSRS UTM Zone 20N

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ATLANTIC MINING NS INC
BEAVER DAM GOLD PROJECT
GROUNDWATER MONITORING

MONITORING WELL LOCATIONS
POST CLOSURE PHASE (YEARS 3-10+)

Project No. 088664-60
Revision No. -
Date 09/03/2021

FIGURE 5

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Table 1
Summary of the Proposed Well Details

Well ID	UTM_EAST	UTM_North	Surface Elevation	Well Depth (m bgs)	Phase					Rationale
					Current	Construction	Operations	Closure	Post Closure	
MW-01A	520942.3	4990095.1	149.838	6.1	Quality					adjacent waste rock area
MW-01B	520943	4990093.7	150.019	15.3	Quality					adjacent waste rock area
MW-01C	520944.1	4990092.5	150.056	30.2	Quality					adjacent waste rock area
MW-02A	520728.8	4989595.5	150.819	4.7	Quality					adjacent waste rock area
MW-02B	520730.4	4989594.7	150.85	15.3	Quality					adjacent waste rock area
MW-03A	521823.1	4989220.2	165.831	6.1	Quality	Elevations		Decommisioned		too far from pit
MW-03B	521823.5	4989222.2	165.784	15.2	Quality	Elevations		Decommisioned		too far from pit
MW-03C	521824.1	4989223.9	165.744	30.5	Quality	Elevations		Decommisioned		too far from pit
MW-04A	522650	4989640.3	164.066	6	Quality	Decommisioned				assumed that well will be destroyed during mine development
MW-04B	522649.4	4989639.5	164.098	15.5	Quality	Decommisioned				assumed that well will be destroyed during mine development
MW-05A*	521746.1	4990210.2	140.266	6.1	Quality					adjacent pit
MW-05B*	521747.9	4990208.6	140.305	15.8	Quality					adjacent pit
MW-05C*	521745.6	4990207	140.358	37.2	Elevations					very deep well
MW-05D	521742.1	4990206.8	140.757	30.5	Quality					adjacent pit
MW-07A*	522677	4990257.9	129.872	7.5	Quality					between pit and Cameron Flowage
MW-07B*	522677.8	4990256.7	130.011	15.2	Quality					between pit and Cameron Flowage
MW-07C*	522676.9	4990255.4	129.999	60	Elevations					very deep well
MW-07D*	522674.9	4990259.6	129.667	30.5	Quality					between pit and Cameron Flowage
MW-09A*	522024.4	4990682.6	133.305	7.1	Quality					between pit and Cameron Flowage
MW-09B*	522022.8	4990682.7	133.159	15.1	Quality					between pit and Cameron Flowage
MW-09C*	522022.5	4990681	133.202	63.4	Elevations					very deep well
MW-09D*	522023.7	4990684.2	133.116	30	Quality					between pit and Cameron Flowage
MW-11A	522324.2	4990130.6	147.255	6.1	Quality	Decommisioned				assumed that well will be destroyed during mine development
MW-11B	522325.1	4990132.9	147.129	15.2	Quality	Decommisioned				assumed that well will be destroyed during mine development
MW-11C	522323.7	4990132.4	147.206	26	Quality	Decommisioned				assumed that well will be destroyed during mine development
MW-12A	521711.7	4991000	147.314	6.1	Quality					adjacent Cameron Flowage
MW-12B	521711	4990999.2	147.226	25.8	Quality					adjacent Cameron Flowage
MW-14A	523253.3	4989830.5	136.815	6.1	Quality					between stockpiles and Cameron Flowage
MW-14B	523253.9	4989828.8	136.853	25.9	Quality					between stockpiles and Cameron Flowage
MW-14C	523254.9	4989827.9	136.897	41.1	Quality					between stockpiles and Cameron Flowage
MW-16A	522898.8	4990744.1	153.156	6.5	Quality	Elevations			Decom	north of Cameron Flowage (background)
MW-16B	522898.1	4990742.6	153.18	15.24	Quality	Elevations			Decom	north of Cameron Flowage (background)
MW-17A	524121.3	4990324.4	153.918	4.6	Elevations	Decommisioned				too far from pit
MW-17B	524123.1	4990323.4	153.819	9.2	Elevations	Decommisioned				too far from pit
MW-17C	524124.7	4990324.2	153.765	15.4	Elevations	Decommisioned				too far from pit
MW-18A	523118.9	4991142.2	146.905	7.6	Elevations	Decommisioned				too far from pit
MW-18B	523120.4	4991141.9	146.908	15	Elevations	Decommisioned				too far from pit
MW-18C	523121.8	4991141.3	146.725	35	Elevations	Decommisioned				too far from pit
MW-19A	520766	4991427.1	133.002	4.7	Elevations			Decommisioned		upgradient along strike (background)
MW-19B	520764.4	4991426.1	133.031	15.3	Elevations			Decommisioned		upgradient along strike (background)
MW-19C	520762.2	4991425.3	133.104	30.5	Elevations			Decommisioned		upgradient along strike (background)
MW-20A	520263.5	4990265	151.515	6.1	Quality	Decommisioned				assumed that well will be destroyed during mine development
MW-20B	520263.5	4990263.8	151.603	15.3	Quality	Decommisioned				assumed that well will be destroyed during mine development
MW-21A	521749.2	4987642	157.975	6.1	Elevations	Decommisioned				too far from pit
MW-21B	521747.9	4987641.7	157.927	15.3	Elevations	Decommisioned				too far from pit
MW-21C	521749.2	4987640	157.793	30.5	Elevations	Decommisioned				too far from pit
MW-22A	524377	4988520.1	138.54	6.1	Elevations		Decommisioned			downstream/down gradient of pit
MW-22B	524377.2	4988521.7	138.558	15.2	Elevations		Decommisioned			downstream/down gradient of pit

Table 1
Summary of the Proposed Well Details

Well ID	UTM_EAST	UTM_North	Surface Elevation	Well Depth (m bgs)	Phase					Rationale
					Current	Construction	Operations	Closure	Post Closure	
MW-22C	524377.5	4988523.2	138.539	29	Elevations		Decommisioned			downstream/down gradient of pit
MW-23A	523660.2	4989309.6	145	6.1	Not Installed	Quality			Elevations	between stockpiles and Cameron Flowage
MW-23B	523660.2	4989309.6	145	15.3	Not Installed	Quality			Elevations	between stockpiles and Cameron Flowage
MW-24A	523024.6	4990209.5	128	6.1	Not Installed	Quality				between infrastructure and Cameron Flowage
MW-24B	523024.6	4990209.5	128	15.3	Not Installed	Quality				between infrastructure and Cameron Flowage
MW-25A*	522403.2	4990567.9	127	6.1	Not Installed	Quality				between pit and Cameron Flowage
MW-25B*	522403.2	4990567.9	127	15.3	Not Installed	Quality				between pit and Cameron Flowage
MW-25C*	522403.2	4990567.9	127	172	Not Installed	Elevations				between pit and Cameron Flowage
MW-26A*	521779.6	4990591.6	131	6.1	Not Installed	Quality			Elevations	between pit and Mud Lake
MW-26B*	521779.6	4990591.6	131	15.3	Not Installed	Quality			Elevations	between pit and Mud Lake
MW-26C*	521779.6	4990591.6	131	176	Not Installed	Elevations				between pit and Mud Lake
MW-27A	522363.2	4989647.6	167	6.1	Not Installed	Quality			Elevations	adjacent workings and oragnics/overburdren stockpiles
MW-27B	522363.2	4989647.6	167	15.3	Not Installed	Quality			Elevations	adjacent workings and oragnics/overburdren stockpiles
MW-28A	523331	4988689.2	154	6.1	Not Installed	Quality				adjacent overburdren stockpiles
MW-28B	523331	4988689.2	154	15.3	Not Installed	Quality				adjacent overburdren stockpiles
MW-29A	520468	4990615.3	138	6.1	Not Installed	Quality				adjacent waste rock area
MW-29B	520468	4990615.3	138	15.3	Not Installed	Quality				adjacent waste rock area
MW-30A	520089.1	4990712.9	143	6.1	Not Installed	Quality				adjacent waste rock area
MW-30B	520089.1	4990712.9	143	15.3	Not Installed	Quality				adjacent waste rock area
MW-31A	519987.5	4989802.6	147	6.1	Not Installed	Quality				adjacent waste rock area
MW-31B	519987.5	4989802.6	147	15.3	Not Installed	Quality				adjacent waste rock area
MW-32A	524071	4988720.3	145	6.1	Not Installed		Quality		Elevations	between stockpiles and Cameron Flowage (contingency)
MW-32B	524071	4988720.3	145	15.3	Not Installed		Quality		Elevations	between stockpiles and Cameron Flowage (contingency)
MW-33A	519482.8	4989498.6	145	6.1	Not Installed		Quality			downgradient of waste rock area (contingency)
MW-33B	519482.8	4989498.6	145	15.3	Not Installed		Quality			downgradient of waste rock area (contingency)

Sampling Frequency

Quality	Quaterly
Elevations	Monthly Static water levels and includes quality wells
	*Wells around the pit will be monitored Hourly
MW-25A*	Proposed pit monitoring locations with three nested wells each

Table 2
Groundwater Quality Parameters

General Chemistry

Total Alkalinity (Total as CaCO3)
Dissolved Chloride (Cl)
Colour
Hardness (CaCO3)
Nitrate + Nitrite (N)
Nitrite (N)
Nitrate (N)
Nitrogen (Ammonia Nitrogen)
Dissolved Organic Carbon (C)
Total Phosphorus (P)
Orthophosphate (P)
Dissolved Phosphorous (P)
pH
Reactive Silica (SiO2)
Dissolved Sulphate (SO4)
Turbidity
Conductivity
Total Suspended Solids
Total Chemical Oxygen Demand
Ion Balance (% Difference)
Calculated Total Dissolved Solids
Total Organic Carbon (C)

*Hydrocarbons TPH+BTEX**
*Total Petroleum**

Field Parameters

Temperature
pH
Electrical Conductivity
Static water levels

Metals (Disscolved)

Aluminum (Al)
Antimony (Sb)
Arsenic (As)
Barium (Ba)
Beryllium (Be)
Bismuth (Bi)
Boron (B)
Cadmium (Cd)
Calcium (Ca)
Chromium (Cr)
Cobalt (Co)
Copper (Cu)
Iron (Fe)
Lead (Pb)
Magnesium (Mg)
Manganese (Mn)
Molybdenum (Mo)
Nickel (Ni)
Phosphorus (P)
Potassium (K)
Selenium (Se)
Silver (Ag)
Sodium (Na)
Strontium (Sr)
Thallium (Tl)
Tin (Sn)
Titanium (Ti)
Uranium (U)
Vanadium (V)
Zinc (Zn)
Mercury (Hg)

** to be added in the Construction Phase*

Additional parameteres as specified or requested by Nova Scotia Environment & Climate Change

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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Appendix H
Baseflow Mitigation Assessment

Technical Memorandum

April 13, 2021

To:	Veronica Chisholm, Jim Mallard	Ref. No.:	088664
	AJB		
From:	Andrew Betts, P. Eng., Chris Muirhead, E.I.T./aj/9	Tel:	519-340-4408
cc:	Phillip Sheffield, Meghan Milloy, Melanie MacDonald		

Subject: **Cameron Flowage – Baseflow Mitigation Assessment**
Beaver Dam Mine Water Management Plan
Marinette, Nova Scotia

1. Introduction

GHD Limited (GHD) was retained by Atlantic Mining Nova Scotia (AMNS) to develop a Mine Water Management Plan (MWMP) for the Beaver Dam Gold Mine (Project) in Marinette, Halifax County (Site). The MWMP is being developed in support of the Environmental Impact Statement (EIS) and Feasibility Study (FS). As a part of the MWMP, all Site contact water runoff will be directed towards the north settling pond for treatment prior to discharge during operating conditions. Under Post-Closure (PC) conditions the Site stormwater runoff will be directed towards the open pit, allowing the pit to fill over the span of approximately 13.1 years (GHD, 2021a). Once the pit has been filled, Site runoff will overflow into the Killag River naturally.

The Water Balance Analysis indicated that the Killag River is expected to see a 2.2% and 1.1% increase in annual runoff volume under End-of-Mine (EOM) and PC conditions. The Water Balance Analysis looks at the Killag River contributing drainage as a whole including overall baseflow reduction. This memo will look at the potential localized impact to baseflow on a smaller scale, focusing on baseflow reduction within Cameron Flowage due to drawdown from the open pit.. The impacts to baseflow presented in this memo do not change the predicted increase in annual runoff volume predicted in the Water Balance Analysis. This technical memo will assess the potential impacts to the baseflow of Cameron Flowage on a local scale, the potential impacts during the period of time that the pit is being filled, and how those potential impacts will be mitigated.

2. Baseflow Assessment – Operating Conditions

During operating conditions, the open pit will be excavated to an approximate bottom elevation of -45 metres above sea level (masl), which is below the water surface elevation of Killag River/Cameron Flowage. The typical water surface elevation of the Killag River/Cameron Flowage (as measured at nearby monitoring stations) ranges from approximately 128 masl to 124 masl depending on the time of year. As such, some groundwater that would naturally discharge to Cameron Flowage as baseflow will be intercepted by the open

pit. Adjacent to the open pit, the groundwater flow direction may switch from being towards Cameron Flowage, to flowing away from Cameron Flowage towards the open pit. Therefore, there is potential for water from Cameron Flowage to migrate through the subsurface and discharge to the open pit, thereby reducing baseflow to the Killag River.

To predict the potential reduction in baseflow to Cameron Flowage, the groundwater flow model (hydrogeologic model) developed for the Site (GHD, 2021b) was applied to simulate the open pit and predict the potential change in baseflow between baseline conditions, and EOM and PC. Through the application of the hydrogeologic model, it is estimated that at EOM Cameron Flowage will experience a reduction in baseflow from baseline conditions of between 38% and 42% for dry and wet conditions, respectively (GHD, 2021b). The total baseflow to the Killag River up to the Killag River Downstream Assessment Point (Downstream Assessment Point is indicated on Figure 4-4 of the Water Balance Analysis (GHD, 2021a)) is expected to decrease between 1.2% and 1.4% for dry and wet conditions respectively. As per the GHD Water Balance Analysis, baseflow contribution throughout the Killag River watershed composes roughly 24% of total streamflow in the Killag River on an average annual basis (GHD, 2021a). Given that the baseflow contribution from Cameron Flowage is a relatively small portion of the total baseflow in the Killag River, the minor impact of baseflow reduction in Cameron Flowage is small relative to the total baseflow in the Killag River, and the impacts of baseflow reduction on total streamflow are found to be minimal. The total streamflow within the Killag River is still expected to increase by 2.2% during EOM conditions due to an increase in the drainage area contributing to the Killag. The Killag River downstream of Cameron Flowage is expected to see a 2% decrease in baseflow due to mine development.

Groundwater discharge (i.e., intercepted baseflow) to the open pit will be pumped to the north settling pond for treatment and storage prior to discharge. The north settling pond will discharge via an open channel, back into Cameron Flowage. The flow path for water pumped from the open pit can be seen on Figure 2-1. To select the discharge location presented on Figure 2.1, the predicted distribution of baseflow reduction along Cameron Flowage was assessed to identify spatial extent along Cameron Flowage where the majority of baseflow reduction is predicted to occur. As shown on Figure 2.2, Cameron Flowage was subdivided into 6 reaches. The simulated baseflow reduction to each reach was calculated to identify the reaches within Cameron Flowage where the majority of simulated baseflow reduction occurs. Table 2.1 presents the simulate baseflow reduction by reach, expressed as a percentage of the total simulated baseflow reduction within Cameron Flowage.

Table 2.1 Simulated Baseflow Reduction Along Cameron Flowage by Reach

Reach	CF-1	CF-2	CF-3	CF-4	CF-5	CF-6	Total
Baseline Baseflow (m^3/d)	-55.57	-34.87	-54.62	-76.15	-146.12	-382.01	-749.34
EOM Baseflow (m^3/d)	-54.86	-32.93	-39.23	-14.99	19.25	-322.95	-445.73
Baseflow Reduction	-0.70	-1.94	-15.39	-61.16	-165.36	-59.06	-303.61
Percent of Total Baseflow Reduction Within Reach	0.23%	0.64%	5.07%	20.14%	54.47%	19.45%	100.00%

As shown in Table 2.1, over 99 percent of the simulate baseflow reduction occurs in reaches CF-3, CF-4, CF-5, and CF-6 at EOM. Reaches CF-1 and CF-2 are predicted to contain under 1 percent of the total baseflow reduction in Cameron Flowage at EOM. Therefore, a CF-3, CF-4, CF-5, and CF-6 are identified as

the Cameron Flowage Groundwater Influence zone, in which the majority of baseflow reduction within Cameron Flowage is predicted to occur.

As shown on Figure 2.1, the discharge point from the north settling pond falls was selected to correspond to the upstream limit of the Cameron Flowage Groundwater Influence Zone, coinciding with the upstream extent of reach CF-3. By discharging water pumped from the open pit upstream of the Cameron Flowage Groundwater Influence Zone any potential reduction in total flow due to a reduction in baseflow is mitigated because groundwater that discharges to the open pit is re-routed and discharged back into Cameron Flowage upstream of where the majority of baseflow reduction is predicted to occur.

Given that any groundwater intercepted by the open pit will be discharged back into Cameron Flowage upstream of where the majority of predicted baseflow reduction occurs, it is not anticipated that the predicted 38% to 42% decrease in baseflow will result in any appreciable difference in total flow within Cameron Flowage.

3. Baseflow Assessment – Post Closure Conditions

3.1 Pit Filling Conditions

Under PC conditions, the surface water runoff from the Site is to be directed towards the open pit in order to fill the pit over the span of approximately 13.1 years (GHD, 2021a). The pit is expected to be filled to an elevation of 127 masl at which point the pit will overflow into Cameron Flowage. Once the pit has been filled Cameron Flowage is still expected to see a 20% to 24% decrease in baseflow from existing conditions (GHD, 2021b). The anticipated baseflow reduction during this time of pit filling can be assumed to gradually transition from the predicted decrease of 38%-42% during operating conditions to the 20-24% decrease in baseflow predicted under PC conditions. During this time Site runoff will be directed towards the pit in order to allow the pit to fill, resulting in decreased discharge to Cameron Flowage. The 20-24% reduction in baseflow to Cameron Flowage results in a decrease of total baseflow between 0.6% and 0.8% for dry and wet conditions respectively. Given the minor impact of baseflow reduction in Cameron Flowage on total baseflow in the Killag River, the impacts of baseflow reduction on total streamflow are found to be minimal. Despite the reduction in baseflow to Cameron Flowage, the total streamflow within the Killag River is still expected to increase by 1.1% during PC conditions due to the increase in drainage area contribution to the Killag. The Killag River downstream of Cameron Flowage is expected to see a 2% decrease in baseflow due to mine development.

The baseflow from existing conditions is expected to decrease 41% under base case operating conditions from 749 m^3/day to 446 m^3/day (a decrease of 303 m^3/day). In order to mitigate potential impacts to Cameron Flowage the north settling pond will not be decommissioned until the pit has been filled. The pond will be kept full (maximum storage volume of 48,438 m^3) so that during the summer months (when surface runoff decreases and baseflow is a larger proportion of the total flow in Cameron Flowage) the total flow in Cameron Flowage can be supplemented using water from the north settling pond. The north settling pond, with a maximum storage volume of 48,438 m^3, would be able to supplement the Cameron Flowage baseflow by 303 m^3/day for 159 days, a sufficient length of time to ensure the total flow in Cameron Flowage during the summer months is maintained to baseline conditions while the pit is being filled.

To reduce the impacts that the pit filling will have on the total flow in Cameron Flowage the north settling pond will be brought to full capacity prior to the summer months and will be discharged as necessary to maintain flow within Cameron Flowage. The north settling pond will discharge to Cameron Flowage at a rate similar to the predicted loss of baseflow (303 m^3/day) in order to supplement the total flow for the months of July, August and September, the months which experience the least amount of predicted runoff as per the GHD Water Balance Assessment (GHD, 2021a). All water discharged from the north settling pond during this time will be regulatory water quality objectives outlined in the GHD Predictive Water Quality Assessment (GHD, 2021c).

3.2 Pit at Capacity Conditions

Once the pit has been filled Cameron Flowage is still expected to see a 20% to 24% decrease in baseflow from baseline conditions. This decrease in baseflow is expected to occur as the proposed pit lake elevation is below the baseline groundwater elevation within the proposed pit lake footprint. As such, the hydraulic gradient from the pit to Cameron Flowage is predicted to decrease from baseline conditions to PC conditions. The decreased hydraulic gradient will result in a reduction in groundwater discharge to Cameron Flowage. The decreased baseflow to Cameron Flowage under PC conditions is mitigated by the surface water discharge point of the pit lake and the predicted increase in runoff to the Killag River of 1.1% as per the Water Balance Analysis (GHD, 2021a), due to an increase in the drainage area contributing to the Killag River. The pit lake discharge point is located approximately 200 m from the furthest downstream point in the Cameron Flowage Groundwater Influence Zone, as show on Figure 2.1.

3.3 Baseflow Reduction Mitigation Options

Baseflow to Cameron Flowage is predicted to permanently decrease by 20 to 24% during PC conditions, once the pit lake has reached an elevation of 127m. A mitigation strategy to reduce the potential baseflow reduction would be to raise the water surface elevation of the pit lake to 130 masl and discharge the runoff via a discharge channel on the west side of the pit lake, through the pre-existing north settling pond discharge channel. The increase in water surface elevation would re-instate the existing positive groundwater gradient towards Cameron Flowage from the pit lake. Additionally, by discharging on the west side of the pit lake, surface water will be discharged upstream of where the majority of any remaining baseflow reduction would occur.

4. Conclusions

GHD has performed an assessment of the impacts of baseflow reduction on the total flow in Cameron Flowage for three (3) conditions: operating conditions, pit filling conditions and pit at capacity conditions. The predicted reduction in baseflow under operating conditions is mitigated by the flow path of the intercepted groundwater. Groundwater that discharges into the open pit will be pumped to the north settling pond before discharging back into Cameron Flowage. The impact that the baseflow reduction during operation conditions will have on the total flow in the Killag River is expected to be mitigated by this circular flow path.

The baseflow reduction under pit filling conditions is to be mitigated by continuing operation of the north settling pond while the pit is being filled with water. All Site surface water will be directed first towards the

north settling pond with an overflow leading to the pit. The north settling pond will be maintained at full capacity with the purpose of providing surface water discharge to Cameron Flowage during the months of July, August and September. This flow augmentation will mitigate the impacts that a reduction in baseflow would have on the total flow in Cameron Flowage during July, August, and September.

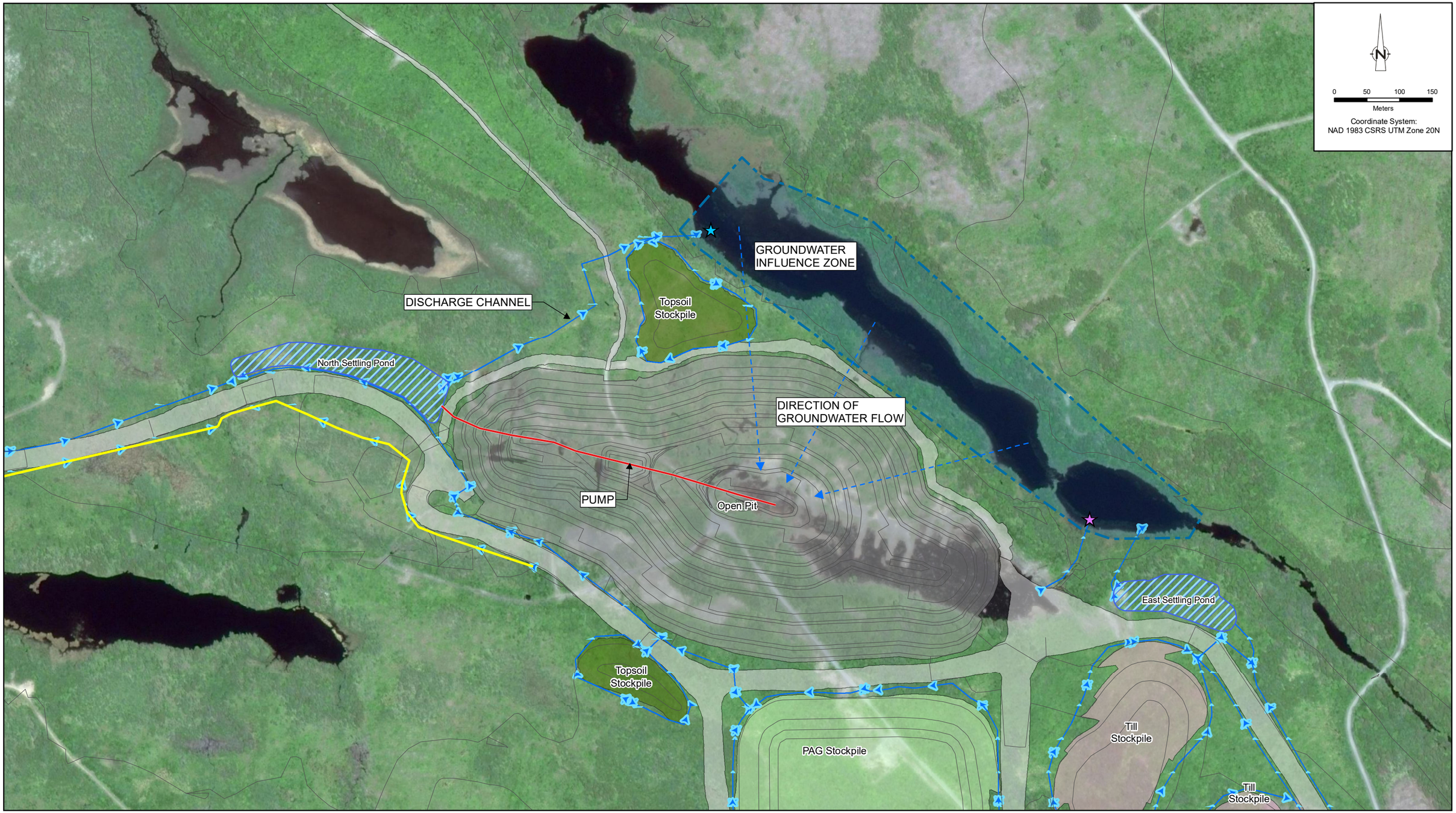
Once the pit has been filled Cameron Flowage is still anticipated to see a decrease in baseflow due to a reduction in hydraulic gradient. The reduced baseflow in Cameron Flowage will be mitigated by the discharge from the pit lake. While the discharge point of the pit lake occurs near the downstream end of Cameron Flowage, the overall runoff to the Killag River is expected to increase by 1.1% (GHD, 2021a), resulting in an increase in total flow in the Killag River, despite the reduction in baseflow. An additional mitigation strategy includes raising the pit lake elevation to 130 masl and discharging on the west side of the pit lake. This would reduce the potential baseflow reduction to Cameron Flowage while discharging surface water upstream of where the majority of any remaining baseflow reduction would occur.

5. References

GHD (2021a). Water Balance Analysis, Beaver Dam Mine Site, Marinette, Nova Scotia

GHD (2021b). Hydrogeologic Modelling Report, Beaver Dam Mine Site, Marinette, Nova Scotia

GHD (2021c). Predictive Water Quality Assessment, Beaver Dam Mine Site, Marinette, Nova Scotia



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Legend

- SWM Ditches
- Clean Water Ditch
- Pumping Path
- Groundwater Influence Zone
- Direction of Groundwater Flow
- Elevation Contour
- EOM Discharge Point
- PC Discharge Point
- Settling Pond
- Open Pit
- PAG Stockpile
- Road
- Topsoil Stockpile
- Till Stockpile

ATLANTIC MINING NOVA SCOTIA
BEAVER DAM MINE
MINE WATER MANAGEMENT PLAN
BASEFLOW MITIGATION ASSESSMENT

CAMERON FLOWAGE BASEFLOW MITIGATION

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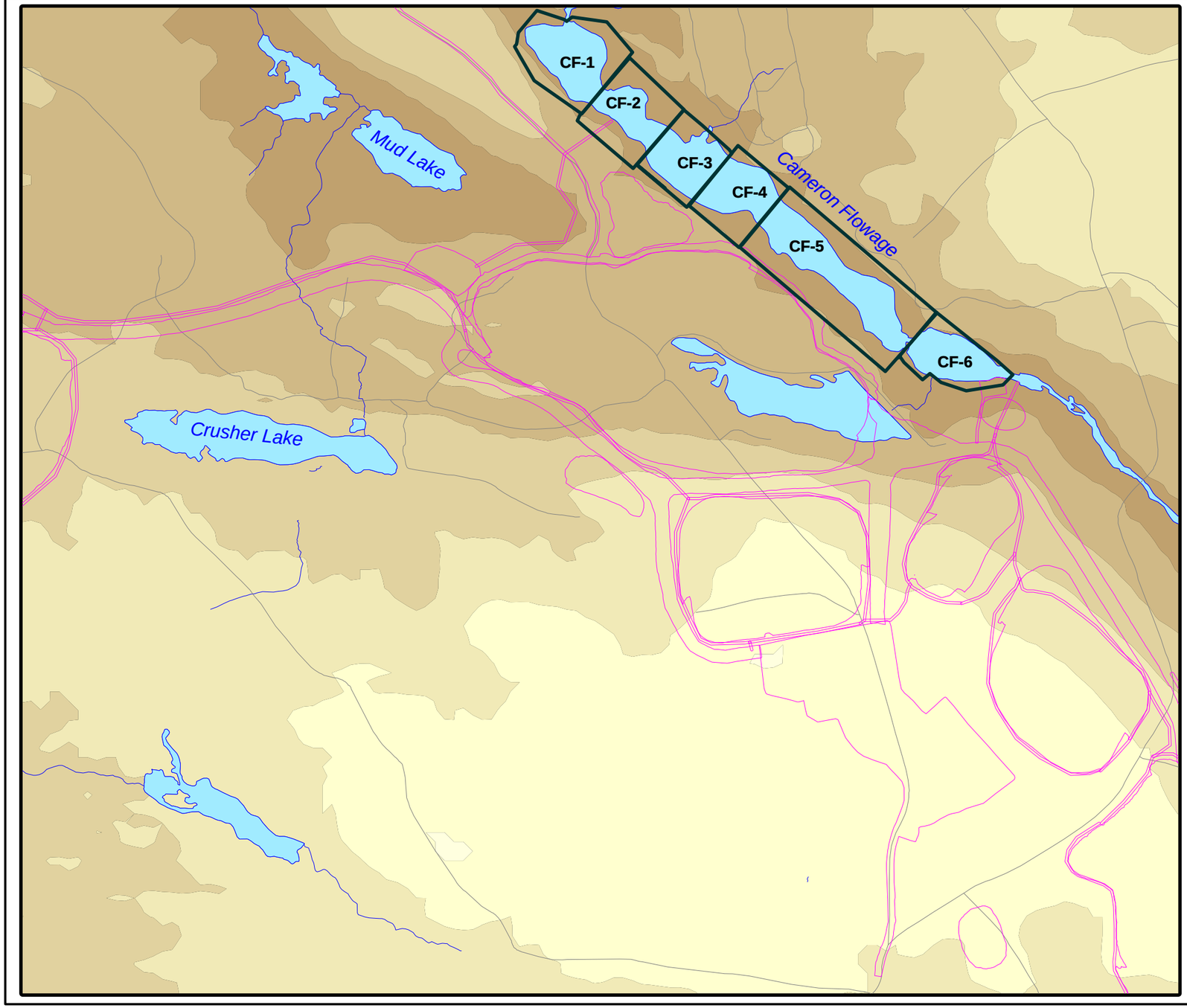
Feb 12, 2021

FIGURE 2.1

GIS File: Q:\GIS\PROJECTS\88000s\88664\Layouts\MEMO005\088664-50(MEMO005)GIS-WA001.mxd



LEGEND

- SURFACE WATER BODY
- MINE FEATURES
- ROAD
- CAMERON FLOWAGE BASEFLOW ASSEMENT REACH

GROUND SURFACE ELEVATION (m AMSL)

0 20 40 60 80 100 120 140 160 180 200

0 80 160 240 m

N

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BEAVER DAM MINE

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CAMERON FLOWAGE BASEFLOW ASSESSMENT REACHES

FIGURE 2.2

HEG file: Z:\HEG\088664\MOD\F50\WC-CameronFlowage-MB\Figure 2.2 - CF-BF-Reaches.srf

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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