GENERATIONPGM

January 14, 2022

Via E-Mail

Joint Review Panel
Impact Assessment Agency of Canada
160 Elgin Street, 22nd Floor
Ottawa, ON K1A 0H3

Attention: Debra Sikora
Panel Chair, Marathon Palladium Project

Dear Ms. Sikora:

Re: Generation PGM ("GenPGM") Marathon Palladium Project ("Project") Additional Fisheries Offset and Water Quality Modelling Information

Please see attached additional fisheries offset and water quality modelling information as referenced in the Joint Review Panel's December 7, 2021 Notice of Sufficiency of Information (CIAR# 955) and Generation PGM's December 30, 2021 letter (CIAR# 970).

Yours truly,

GENERATION PGM INC.

<Original signed by>

Jeremy Dart
Environmental Manager

Encl.

Fisheries Act, Paragraph 35(2)(b) Authorization, Offset Plan and MDMER Schedule 2 Fish Habitat Compensation Plan (Draft)

Marathon PGM-Copper Project
Generation PGM Inc.

Project #OMEMA2008Z

First Canadian Place, 100 King Street West, Suite 7010
P.O. Box 70, Toronto, ON M5X 1B1

January 2022

Fisheries Act, Paragraph 35(2)(b) Authorization, Offset Plan and MDMER Schedule 2 Fish Habitat Compensation Plan (Draft)
Marathon PGM-Copper Project

Marathon, Ontario
Project #OMEMA2008Z

Prepared for:

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14 January 2022

REVISION HISTORY

Revision No.	Revision Date	Purpose of Revision
0	January 2022	Issued for DFO and Indigenous community review.

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1.0 DESCRIPTION OF PROPOSED WORK, UNDERTAKING OR ACTIVITY

1.1 Purpose

The Marathon PGM-Copper Project (Project) is a proposed new open pit mining and milling operation for copper and platinum group metals with supporting infrastructure. The Project, owned by Generation PGM Inc. (GenPGM), is located approximately 300 kilometres (km) east and 400 km northwest (by highway) of Thunder Bay and Sault Ste. Marie, respectively (Figure 1-1).

The purpose of the Project is to extract ore by open pit mining and process the ore (crushed, ground, concentrated) at an on-site processing facility. Final concentrates containing copper and platinum group metals will be transported off-site via existing roadways and/or rail to a smelter and refinery for subsequent metal extraction and separation. Iron sulfide magnetite and vanadium concentrates may also be produced, depending upon the results of further metallurgical testing and market conditions at that time. Process solids and mine rock will be deposited and stored on site in purposefully-built storage areas.

The ore deposit will be developed in a responsible manner, which respects Indigenous communities that have been actively engaged during the development of this draft Plan, resource users, regional stakeholders, and environmental protection best practices. The deposit provides an opportunity for GenPGM to provide a reasonable rate of return on investment to shareholders and bring benefits to the local and regional economy.

The Project will positively affect employment and skills development, including within the region itself, through the creation of employment opportunities. There is also the potential to increase local and regional revenue and business profits, from which future investments can be made in social services, community infrastructure, business development, training and employment.

GenPGM has strong relationships with local Indigenous communities and will establish productive local partnerships that contribute to achieving development goals identified by the community, to address local priorities and concerns and to have communities derive benefits from the Project.

The Project is being assessed in accordance with the *Canadian Environmental Assessment Act* (CEAA, 2012) and Ontario's *Environmental Assessment Act* (EA Act) through a Joint Review Panel (the Panel) pursuant to the *Canada-Ontario Agreement on Environmental Assessment Cooperation* (2004).

1.2 Permitting Background

Stillwater Canada Inc. (Stillwater), the original Proponent of the Project, had prepared and submitted an Environmental Impact Statement (EIS) and supporting documents in 2012 to assess the potential effects of the Project. Following a review of this information and subsequent responses to information requests, the Panel (in 2013) determined that sufficient information was available to proceed to a public hearing. However, prior to the hearing, the process was put on hold by Stillwater and ultimately postponed in 2014. Since 2014, the Project has been acquired by GenPGM and the Panel review process to assess the potential effects of the Project has resumed.

This draft Fish Habitat Offset and Compensation Plan (FHOCP) addresses regulatory requirements under the *Fisheries Act* associated with the development of GenPGM's proposed Project. Offsets and compensation will be required in relation to both *Fisheries Act* (or Act) subsections 35(2) and Section 27.1 of the Metal and Diamond Mining Effluent Regulations (MDMER). Potential fish habitat offset and compensation opportunities are described, and the opportunities recommended by GenPGM to address Project impacts are made. This draft FHOCP is presented in consideration of and consistent with the requirements of the modernized *Fisheries Act* which came into force on 28 August 2019 and is also consistent with the MDMER as developed under Section 36 of the *Fisheries Act* and as amended in 2018.

1.3 Associated Infrastructure

The proposed site layout is provided on Figure 1-2. The site layout places the required mine-related facilities near the open pits to the extent practical, and on GenPGM lands (surface and/or mineral rights) within the Project boundary. The site plan may be refined further as a result of ongoing consultation activities and engineering studies.

The mine key components and/or activities associated with the Project include:

- Open pits (North, Central and South);
- Ore handling;
- Process Plant;
- Concentrate handling, storage, and transport;
- Mine Rock management;
- Processed solids management;
- Water supply;
- Water management;
- Water discharge and treatment plants;
- Pipelines;
- Site road network and distribution;
- Explosives storage and production;
- 115 kV Transmission line;
- Aggregate supply; and
- Waste management.

Key maintenance, administration and on-site support facilities include:

- Fuel farm;
- Truck shop and warehouse;
- Aggregate plant;
- Bulk reagent storage and hazmat building;
- Assay lab;
- Administration and services building;
- Propane storage area; and
- Concentrate storage building.

In addition to the components listed above, the Project will include additional temporary facilities and activities associated with construction and decommissioning of the Project including the development of temporary stockpiles, laydown areas, access roads, water management, temporary flow isolation, environmental control measures (e.g., silt fencing, cofferdam, berms), temporary facilities and creek crossings, where required.

The Project design minimizes encroachment on fish habitat where reasonably possible and opportunities to avoid and mitigate impacts will continue to be evaluated and implemented. However, unavoidable impacts to fish and fish habitat will occur because of the proposed Project development. Given the high relief and steep topography within the Marathon region, location of the ore body and the presence of numerous headwater lakes and small watercourses in the area, avoidance of fish habitat is not feasible.

Many of the impacts will be considered Harmful Alteration, Disruption or Destruction (HADD) of waterbodies requiring listing on Schedule 2 of the MDMER that will need offsetting or compensation consistent with *Fisheries Act* regulations and policies. The Project will meet the requirements of the *Fisheries Act* where fish bearing water courses are overprinted or otherwise potentially impacted by proposed mine related infrastructure through the development and implementation of this Fish Habitat Offset and Compensation Plan (the Plan) as approved by Fisheries and Oceans Canada (DFO).

1.4 Stakeholder Consultation and Engagement

Consultation and engagement activities throughout the preparation of this draft Plan built on the identified impacts and potential offsetting and compensation opportunities outlined in the conceptual offset strategy and compensation plan submitted as part of the EIS Addendum (Ecometrix 2021).

Consultation activities are summarized in Appendix A (Table A.1) and include engagement with local resource users, Indigenous communities, provincial and federal agencies. Confirmation of the initial quantification of predicted impacts was sought and refined based on feedback and increased conservativism regarding indirect fish habitat impacts associated with reduction in surface water flow.

Potential fisheries habitat enhancement opportunities were solicited from stakeholders and Indigenous communities through direct conversations, committee meetings and newspaper publications. Several additional alternatives were added to the draft Plan based on direct feedback from local resource users, Indigenous communities, and regulators.

Community-led initiatives were also suggested and have been included in this draft Plan for consideration as both habitat improvement projects and complementary measures, including research and education projects (Section 8.1.1).

In addition to the Joint Review Panel report submission, this draft Plan has been provided directly to Indigenous communities for review and comment. Feedback from both provincial regulators and federal agencies as well as local and Indigenous communities will be incorporated into the final Plan and considered in the preparation of required fisheries permit applications.

1.5 Guidance Documents

The assessment of impacts to fish and development of offsetting / compensation measures and the preparation of this draft Plan were determined using guidance provided in the documents listed in Table 1-1. These documents include federal and provincial guidance.

1.6 Phases and Schedule

The Project will consist of three distinct phases, namely a construction phase of approximately 18 to 24 months, an operations phase of approximately 12.7 years, and a decommissioning and closure phase of approximately 2 years. These phases are briefly described below and the timing of works specifically associated with impacting or offsetting fish and fish habitat are listed in Table 1-2, with reference to the years of project development.

The post-closure phase will occur following substantial completion of all on-site decommissioning activities. This will consist primarily of follow-up and monitoring programs and the subsequent stabilization of existing environmental conditions for an anticipated duration of up to 45 years.

1.6.1 Construction Phase

Construction would begin once the EA processes are complete and initial approvals are received. The timeframe to complete the construction of the surface infrastructure to start mining and processing activities is approximately 18 to 24 months. The site preparation would include site clearing, grading and excavation to permit the subsequent construction activities consisting of the building of the physical infrastructure and structures necessary to bring the Project in to production. This would include almost all infrastructure development such as the main site footprint, the mine access road and transmission line, and as such would be the period where most fisheries impacts are expected to occur. To allow flexibility in the presented schedule, the construction phase is shown as years -2 to -1.5 in Table 1-2, with the operations phase beginning as year 1.

1.6.2 Operations Phase

The operations phase is anticipated to last 12.7 years and will include the commissioning of the plant site, and operation of the mine including advancing the open pits, use of the PSMF, development of ore stockpiles and release of treated effluent discharge to Hare Lake. Progressive reclamation is also expected to occur during this time as practical, as well as some of the proposed restoration and enhancements.

1.6.3 Decommissioning / Closure Phase

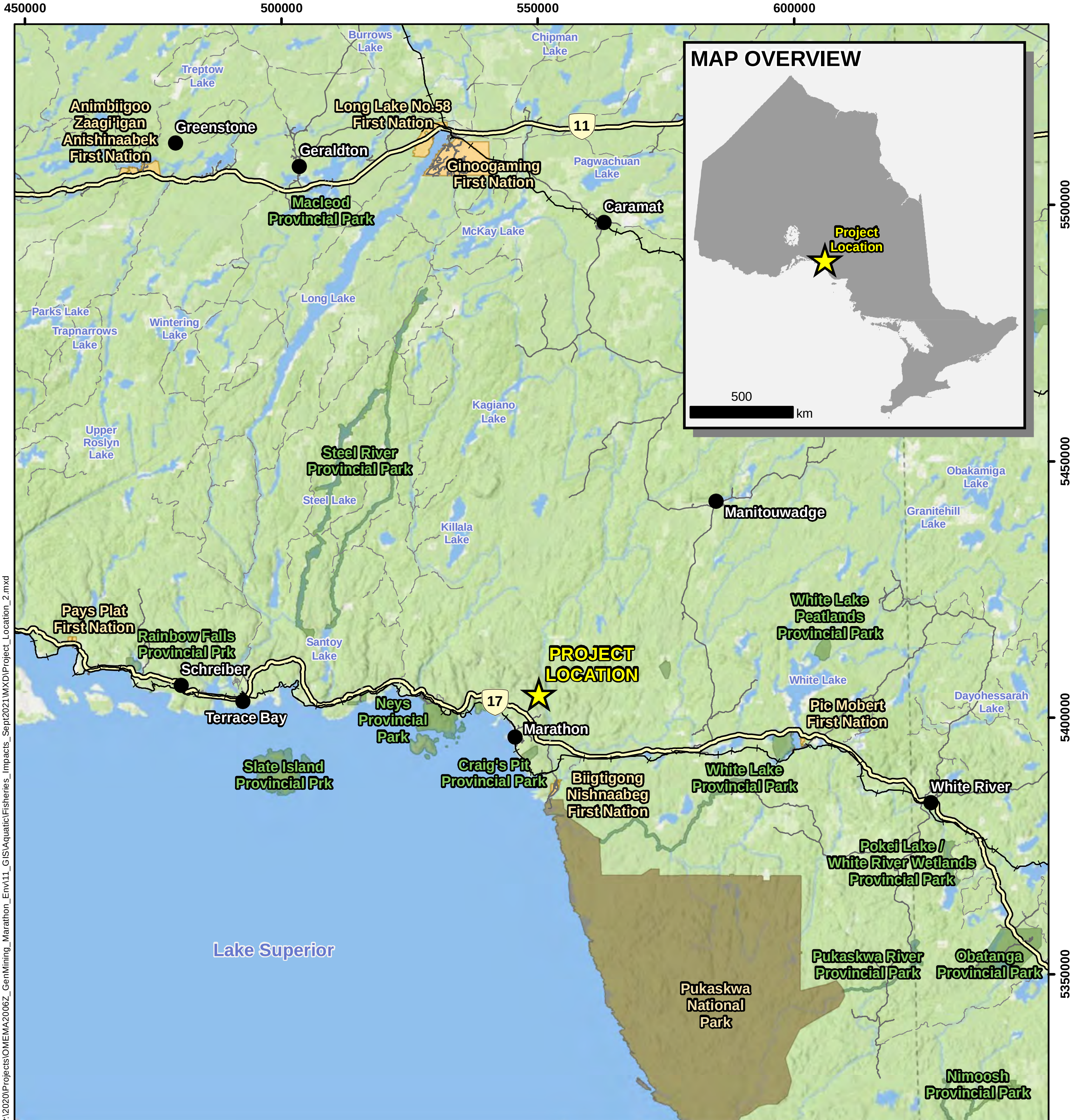
The decommissioning / closure phase is anticipated to extend 2 years with the post-closure phase including monitoring components that extend longer. Activities to be completed during the active decommissioning / closure phase, if not completed progressively during operation as appropriate, are anticipated to include removal of remaining infrastructure and restoration of disturbed areas. It is during this period that reconnection of surface water drainage features with downstream watercourses will occur.

Table 1-1: Guidance Documents for Impacts Determination and Offsetting

Document / Guidance	Purpose / Use
Schedule 1 of Authorizations Concerning Fish and Fish Habitat Protection Regulations: SOR/2019-286. 2019 Government of Canada. https://laws-lois.justice.gc.ca/eng/regulations/SOR-2019-286/page-2.html#h-1194586	Schedule 1 describes the information and documents to be provided in the offset plan and application documents for Fisheries Authorizations.
Fish and Fish Habitat Protection Policy Statement August 2019. Fisheries and Oceans Canada https://www.dfo-mpo.gc.ca/pnw-ppe/policy-politique-eng.html	Used to ensure compliance and consistency with DFO in the application of fish habitat protection provisions of the *Fisheries Act*.
Standards and codes of practice, Fisheries and Oceans Canada https://www.dfo-mpo.gc.ca/pnw-ppe/practice-practique-eng.html	Used to guide the planning and construction of works near water to avoid and mitigate harmful effects to fish and fish habitat.
Policy for Applying Measures to Offset Adverse Effects on Fish and Fish Habitat Under the *Fisheries Act*, December 2019, Fisheries and Oceans Canada https://www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/policies-politiques-eng.html	Provides guidance on undertaking effective measures to offset death of fish and the harmful alteration, disruption or destruction of fish habitat, consistent with the fish and fish habitat protection provisions of Canada's *Fisheries Act*. Includes guiding principles.
Pathways of Effects, Fisheries and Oceans Canada https://www.dfo-mpo.gc.ca/pnw-ppe/pathways-sequences/index-eng.html	Diagrams for common land based and in-water activities that show cause-effect relationships that are known to exist; and the mechanisms by which stressors ultimately lead to effects in the aquatic environment.

Table 1-2: Conceptual Schedule of Project Work, Undertaking or Activity and Offsets

Works or Offset Component affecting Fish Habitat	Impact or Offset	Mine Operations Commence Year 1	
		Early Start (year)	Late Completion (year)
Road crossings, Process Plant site, Aggregate Site (Subwatersheds 101, 102 and 103)	Impact	-2	1
Processed Solids Management Facility and Overburden Stockpiles (Subwatershed 106)	Impact	-2	1
Central and South Pits (Subwatershed 102)	Impact	-2	1
North Pit (Subwatersheds 103 and 108)	Impact	-2	1
Mine Rock Storage Area, Run of Mine Stockpile, and Overburden Stockpile (Subwatersheds 102 and 103)	Impact	-2	1
Water Management Pond and Stormwater Management Pond (Subwatersheds 102 and 106)	Impact	-2	1
Colonizing Fishless Lakes (Subwatersheds 101, 102, 103 and 105)	Offset	-2	1
Shipyard Road Habitat Creation and Enhancement (offsite)	Offset	-1	1
Camp 19 Road Habitat Enhancements (Subwatershed 101)	Offset	-2	-1
Lake 8 Habitat Enhancement and Increased Community Diversity (Subwatershed 102)	Offset	-2	1



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LEGEND

- Project Location
- City / Town
- First Nation
- Railway
- Highway
- Local / Secondary Road
- Resource Road
- National Park
- Provincial Park

0 10 20 40 60 80 100 Kilometres

NOTES:
- Topographic information extracted from ESRI online basemaps and Land Information Ontario (NDMNRF).

Datum: NAD83
Projection: UTM Zone 16N

N S E W

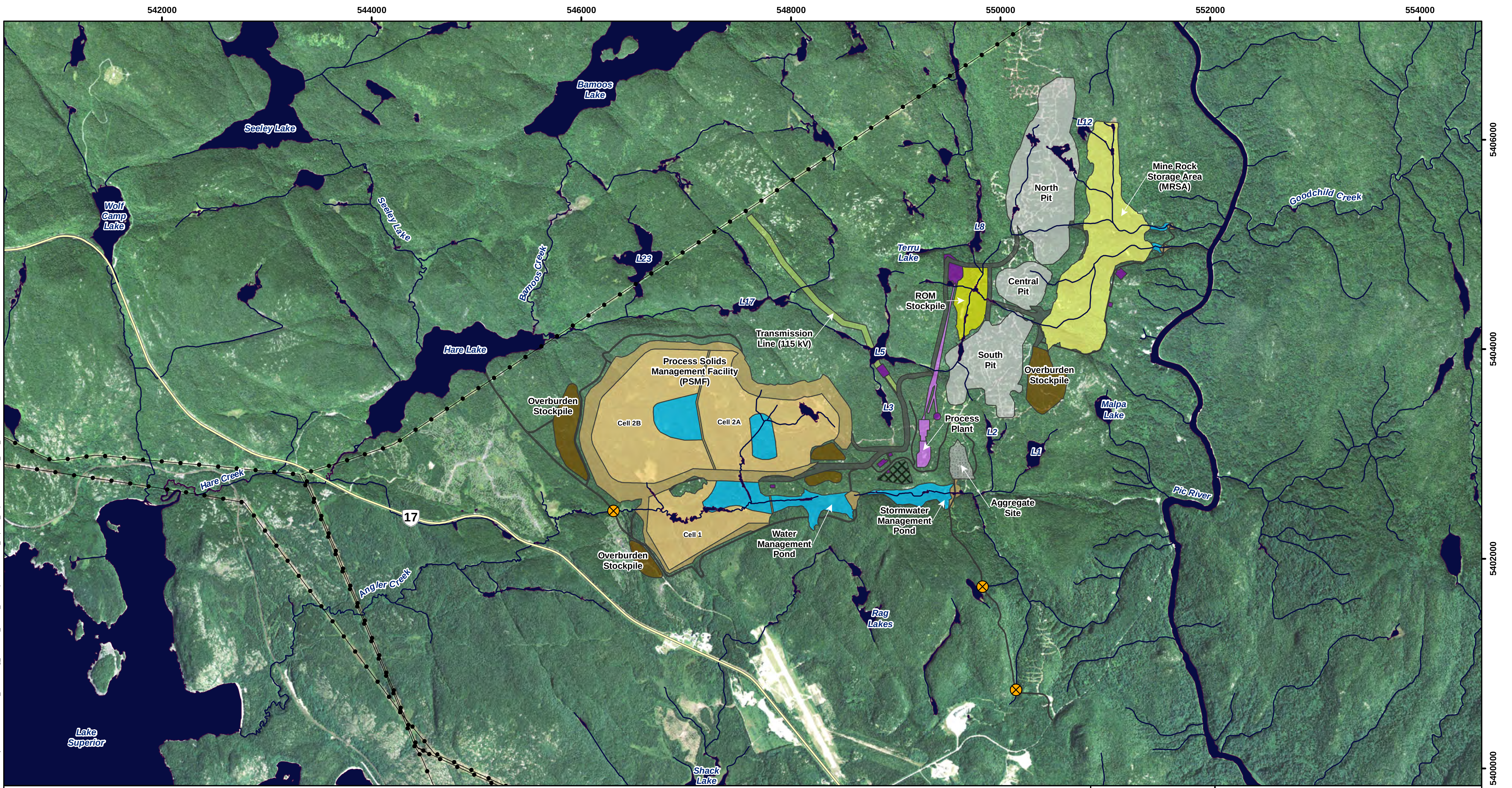
GENERATION MINING

wood.

MARATHON PALLADIUM PROJECT

Project Location

PROJECT N°: OMEMA2006Z	**FIGURE: 1-1**
SCALE: 1:1,000,000	DATE: January 2022



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LEGEND

- Existing Transmission Line
- Existing Highway
- Watercourse
- Waterbody

Proposed Mine Features

- Open Pit
- Mine Rock Storage Area (MRSA)
- ROM Stockpile
- Soil/Overburden Stockpile
- Pond
- Process Solids Management Facility (PSMF)
- Dam
- Building
- Process Plant Area
- Road
- Laydown Area
- Aggregate Site
- Corridor
- Watercourse Crossing

0 1 2 4 6 8 Kilometres

NOTES:
- Aerial imagery extracted from AgMaps, NDMNRF.
- Topographic data extracted from LIO, NDMNRF.
- Anticipated fisheries impacts and site watersheds provided by Ecometrix.

Datum: NAD83
Projection: UTM Zone 16N

N E S W

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MARATHON PALLADIUM PROJECT

Site Plan

PROJECT N^{o}: OMEMA2006Z

FIGURE: 1-2

SCALE: 1:34,000

DATE: January 2022

2.0 PROJECT CONTACT INFORMATION

Proponent:

Name and Address of Owner	**Authorized Contact Person**
Project Office Address: Generation PGM Inc. 90 Peninsula Rd., P.O. Box 1508 Marathon ON Canada P0T 2E0	Registered Office | Attention to: Mr. Drew Anwyll, Chief Operating Officer First Canadian Place, 100 King Street West, Suite 7010 P.O. Box 70, Toronto, ON Canada M5X 1B1 <contact information removed>

Mr. Anwyll is an authorized representative for the Proponent and will be the signing authority for the Fisheries Authorization Application, on behalf of the Proponent.

3.0 LOCATION OF PROPOSED PROJECT

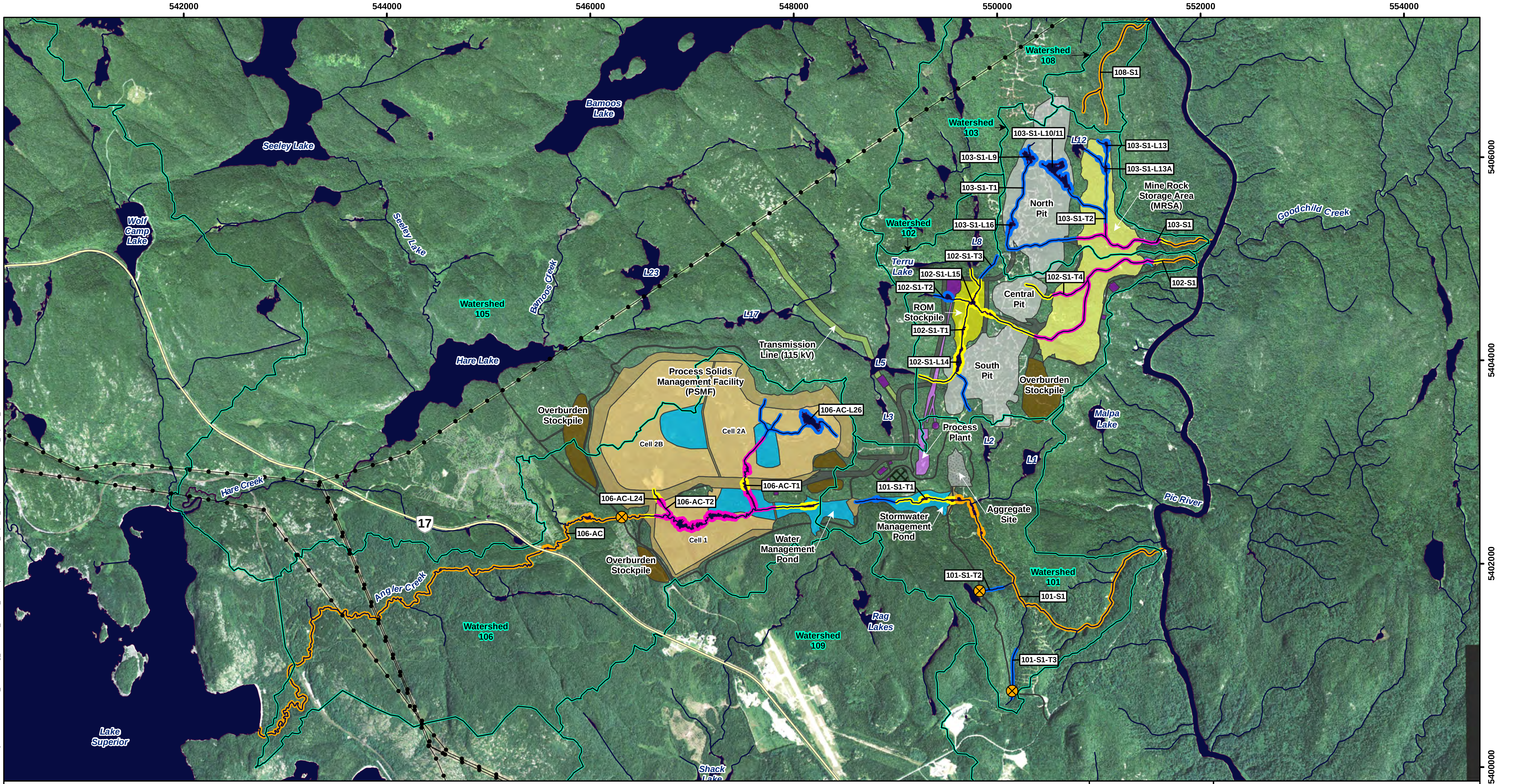
The Project is located approximately 300 kilometres (km) east and 400 km northwest (by highway) of Thunder Bay and Sault St. Marie, respectively (Figure 1-1).

The Universal Transverse Mercator (UTM) coordinates for the approximate centre of the Project footprint are Easting 550,197 and Northing 5,403,595 mE (NAD 83 Zone 16). The Project site is roughly bounded by Highway 17 and the Marathon Airport to the south, the Pic River and Camp 19 Road to the east, Hare Lake to the west, and Bamoos Lake to the north. Access is currently gained through Camp 19 Road.

There are several waterbodies (lakes, small ponds and creeks) affected by the Project where HADD to fish and fish habitat would occur through direct overprinting of fish habitat, as well as indirect impacts associated with flow reduction due to removal or redirection of headwater sources that require approval through a Section 35 *Fisheries Act* authorization. Additionally, locations where the deposition of mine waste into fish habitat will require these natural waterbodies to be listed on Schedule 2 of the MDMER. These waterbody locations, the type of impacts (direct/indirect) and relevant approval legislation are shown on Figure 3-1. The centroid coordinates of each waterbody and watercourse are provided in Table 3-1. There are also several waterbodies and watercourse segments that are fishless and consequently do not require compensation or offsetting. Additional descriptions of the baseline studies and anticipated Project impacts to fish and fish habitat are provided in Sections 4 and 5, respectively.

Table 3-1: Coordinates of Waterbodies Affected by the Project

Subwatershed	Segment ID (as per Figure 3-1)	Watercourse / Waterbody	Approximate Waterbody Centroid	
			UTM Easting	UTM Northing
101	101-S1	Stream 1 Mainstem	550,498	5,401,500
	101-S1-T1	Stream 1 Tributary 1	549,355	5,402,638
	101-S1-T2	Stream 1 Tributary 2	549,930	5,401,738
	101-S1-T3	Stream 1 Tributary 3	550,155	5,400,907
102	102-S1	Stream 1 Mainstem	550,916	5,404,832
	102-S1-L14	Stream 1 Lake 14	549,627	5,403,985
	102-S1-L15	Stream 1 Lake 15	549,759	5,404,564
	102-S1-T1	Stream 1 Tributary 1	549,685	5,404,362
	102-S1-T2	Stream 1 Tributary 2	549,588	5,404,600
	102-S1-T3	Stream 1 Tributary 3	549,833	5,404,774
	102-S1-T4	Stream 1 Tributary 4	550,690	5,404,640
103	103-S1	Stream 1 Mainstem	551,557	5,405,155
	103-S1-L10/11	Stream 1 Lakes 10/11	550,564	5,405,873
	103-S1-L13	Stream 1 Lake 13	551,072	5,406,123
	103-S1-L13a	Stream 1 Lake 13a	551,068	5,405,891
	103-S1-L16	Stream 1 Lake 16	550,143	5,405,336
	103-S1-L9	Stream 1 Lake 9	550,313	5,405,999
	103-S1-T1	Stream 1 Tributary 1	550,204	5,405,565
	103-S1-T2	Stream 1 Tributary 2	551,068	5,405,337
106	106-AC	Angler Creek	545,273	5,401,969
	106-AC-L24	Angler Creek Lake 24	546,681	5,402,623
	106-AC-L26	Angler Creek Lake 26	548,153	5,403,414
	106-AC-T1	Angler Creek Tributary 1	547,521	5,402,854
	106-AC-T2	Angler Creek Tributary 2	546,721	5,402,565
108	108-S1	Stream 1	551,156	5,406,990



LEGEND

- Site Watersheds
- Existing Transmission Line
- Existing Highway
- Watercourse
- Waterbody
- Anticipated Schedule 2 Listing
- Anticipated Section 35 Authorization (Direct Impact)
- Anticipated Section 35 Authorization (Flow Reduction)
- Non Fish Bearing Water

Proposed Mine Features

- Open Pit
- Mine Rock Storage Area (MRSA)
- ROM Stockpile
- Soil/Overburden Stockpile
- Pond
- Process Solids Management Facility (PSMF)
- Dam
- Building
- Process Plant Area
- Road
- Laydown Area
- Aggregate Site
- Corridor
- Watercourse Crossing

NOTES:
- Aerial imagery extracted from AgMaps, NDMNRF.
- Topographic data extracted from LIO, NDMNRF.
- Anticipated fisheries impacts and site watersheds provided by Ecometrix.

Datum: NAD83
Projection: UTM Zone 16N

0 1 2 4 6 8 Kilometres

GENERATION MINING | wood.

MARATHON PALLADIUM PROJECT

Anticipated Fisheries Impacts

PROJECT N°: OMEMA2006Z | **FIGURE: 3-1**

SCALE: 1:35,000 | DATE: January 2022

4.0 BACKGROUND AND ENVIRONMENTAL SETTING

The Project site is in an area characterized by white birch and balsam fir dominated mixed wood forest. The terrain is moderate to steep, with frequent bedrock outcrops and prominent east to west oriented valleys. The climate of this area is typical of northern areas within the Canadian Shield, with long winters and short, warm summers.

Fisheries and fish habitat studies have been undertaken at the Project site and surrounding environment since 2006 and include multiple years and multiple seasons of investigation. The objective of the sampling programs was to sample all lakes in the Project area including representative upper, midsection, and lower reaches of each of the applicable subwatersheds. This standard practice was employed to provide a realistic representation of fish presence/absence, species composition and general abundance for the waterbodies in the area. Drastic stream gradient changes, morphology and seasonal flow regimes have created permanent and semi-permanent barriers to fish movement within the area. Repeated baseline sampling has confirmed a number of fishless stream reaches and waterbodies within the Project footprint. Deduction of fish presence/absence was considered reasonable where sampling downstream of a barrier produced fish captures yet sampling upstream of the barrier did not.

The current and existing data is sufficient to accurately define species presence and relative abundance by waterbody, as well as habitat conditions to support this plan and future monitoring. Additional detailed fisheries investigations, summaries and analysis of the baseline data are available in the following Project documents:

- Ecometrix Incorporated. 2012. Marathon PGM-Cu Project Site – Aquatic Resources Baseline Report. July 2012.
- Ecometrix Incorporated. 2020. Marathon Palladium Project – Aquatic Environment Baseline Report Update. November 2020.
- Ecometrix Incorporated. 2021. Marathon Palladium Project Environmental Impact Statement Addendum; Appendix D6 Fish and Fish Habitat Offsetting Plan Update. Preliminary Proposed Fish Habitat Offset Strategy and Compensation Plan for the Marathon Palladium Project. March 2021.
- Generation PGM. 2021. IR5-13 Fish Habitat Characterization. November 2021.
- Generation PGM. 2021. IR5-14 Potential Effects to Fish. November 2021.

The baseline fish community and fish habitat data collection has been thorough and provides a comprehensive, informative baseline condition on which to determine watercourse sensitivities and offsetting / compensation measures. A summary of the fish species presence by subwatershed and waterbody or watercourse is provided in Table 4-1, with productivity metrics (catch-per-unit-effort (CPUE)) data from fish habitats predicted to be affected by the Project provided in Table 4-2.

Table 4-1: Fish Species Present in Local Waterbodies

Subwatershed	Segment ID	Species Richness	Brook Stickleback	Brook Trout	Chinook Salmon	Coho Salmon	Fathead Minnow	Finescale Dace	Johnny Darter	Lake Chub	Longnose Dace	Mottled Sculpin	Northern Pearl Dace	Northern Pike	Northern Redbelly Dace	Rainbow Trout	Slimy Sculpin	Trout-perch	White Sucker
101	101-S1	10	X	X	X		X	X			X		X		X	X	X		
	101-S1-T1	4		X_i				X_i					X_i		X_i				
	101-S1-T2	4		X_i				X_i					X_i		X_i				
	101-S1-T3	5		X				X					X_i		X	X			
102	102-S1	12	X	X	X			X		X	X	X		X		X	X	X	X
	102-S1-L14	2	X							X									
	102-S1-L15	3	X					X_i		X_i									
	102-S1-T1	3	X_i					X_i		X_i									
	102-S1-T2	3	X_i					X_i		X_i									
	102-S1-T3	3	X_i					X_i		X_i									
	102-S1-T4	3	X_i					X_i		X_i									
103	103-S1	6		X					X		X	X				X	X		
	103-S1-L10/11	0																	
	103-S1-L13	0																	
	103-S1-L13a	0																	
	103-S1-L16	0																	
	103-S1-L9	0																	
	103-S1-T1	6		X_i					X_i		X_i	X_i				X_i	X_i		
	103-S1-T2	6		X_i					X_i		X_i	X_i				X_i	X_i		
106	106-AC	5	X			X					X	X				X			
	106-AC-L24	0																	
	106-AC-L26	0																	
	106-AC-T1	1	X																
	106-AC-T2	1	X_i																
108	108-S1	0																	

Notes:
(Xi) Species inferred based on adjacent waterbodies and habitat type.
Grey segment IDs indicate fishless waterbodies and have been included in this table for consistency with other tables presented in the Plan.

Table 4-2: Fish Productivity Metrics (CPUE) for Local Waterbodies Affected by Project

Subwatershed	Stream / Waterbody	Electrofishing	Minnow Trap	Nordic Net
101	101-S1	0.02 (0.002 - 0.64)	0.003	—
102	102-S1	—	0.03 (0.01 - 0.05)	—
	102-S1-L14	—	0.75 (0 - 2.14)	—
	102-S1-L15	—	0.38 (0.06 - 0.90)	—
103	103-S1	0.02 (0.004 - 0.03)	—	—
106	106-AC	0.05 (0.02 - 0.11)	0.02	0.01
	106-AC-T1	0.03	—	—

Notes:

Catch per unit effort (CPUE) expressed as the number of fish caught per electrofishing second, or minnow trap / net hour.
Average CPUE values are shown, with the minimum and maximum values by gear type presented in brackets (as available).
Baseline data presented for the affected waterbodies include the 2006 to 2020 fish community sampling data (GenPGM 2021a).

5.0 PROPOSED WORKS, UNDERTAKING OR ACTIVITY LIKELY TO AFFECT FISH AND FISH HABITAT

Descriptions of the Project components and their interactions with fish and fish habitat are summarized below, with the areas of impact shown on Figure 3-1. The physical footprint and in-water works associated with the Project have the potential to directly and indirectly impact waterbodies frequented by fish through activities such as infilling and excavation (i.e., displacement of waterbodies). Indirect habitat impacts are also considered in this draft Plan, such as flow alterations to headwater habitats, adjacent waterbodies and downstream watercourses; or impacts from construction methods, such as land clearing (sedimentation) or blasting (particularly considering the moderate to high relief and steep topography of the Project site).

The potential impacts discussed by major Project components (e.g., PSMF, open pits, plant site, access road) along with avoidance and mitigation measures to avoid HADD are presented in this draft Plan. Residual predicted HADD and waterbodies that will require listing to Schedule 2 of the MDMER are summarized in Section 6 (Table 6-1).

5.1 Process Solids Management Facility

5.1.1 Direct Effects

The PSMF is located southwest of the open pits and will consist of two storage cells (Cell 1 and Cell 2) and the separate Water Management Pond (see Section 5.4). Most of the PSMF footprint is within subwatershed 106 that will directly overprint the headwater portions of Angler Creek, including some ponded habitat, as well as reaches of non-fish bearing water. The Plan currently assumes that most of the PSMF footprint will be treated as a mineral waste, and as such the overprinted waterbodies will require listing on Schedule 2 of the MDMER. The dams however are classified as Section 35 impacts and in either case, the waterbodies and habitats overprinted by the PSMF will be permanently lost in their entirety.

5.1.2 Indirect Effects

The stream and pond habitat downstream of the PSMF will be altered by changes in flow due to a reduction in drainage area. This primarily includes the Angler Creek mainstem (106-AC), as shown on Figure 3-1. A conservative approach has been taken in this draft Plan to reflect uncertainties with potential impacts and possible changes to the PSMF during detailed design. Accordingly, the entire Angler Creek area downstream of the PSMF has been quantified as a HADD, as a worst-case basis. Subsequent revisions of this draft Plan may refine this approach based on future consultation, review comments and design considerations.

5.1.3 Avoidance and Mitigation

GenPGM site planning efforts to date have included the design of a small overall footprint for the mine including the PSMF. The preferred location was selected after careful assessment of environmental, technical, and financial considerations which included understanding the overprinting of fish frequented waterbodies. Although the PSMF has been designed to make efficient use of space, the nature of the impact (direct overprinting) does not allow for any additional mitigation for the overprinted waterbodies.

The seepage collection basins and associated ditching around the PSMF will collect seepage and runoff from the facility to protect the downstream Angler Creek mainstem and other nearby waterbodies (e.g., Lake 3, Lake 5, Hare Lake) from construction impacts (i.e., suspended solids). Standard measures and best management practices will be implemented as per Section 7. Efforts to relocate fish from the overprinted waterbodies will be made prior to infilling and will be required for the proposed compensation and offsetting measures (Section 8). No blasting is currently expected at the PSMF location, but if minor incidental blasting is required during construction, measures will be taken to comply with federal blasting guidelines (Wright and Hopky 1998) and as per Section 7.

5.2 Open Pits

5.2.1 Direct Effects

Three open pits are required to extract ore for onsite processing. The pits will be excavated by blasting using a site mixed emulsion (SME) explosive. An ammonium-nitrate fuel oil (ANFO) explosive may also be used. Blasted ore and mine rock will be handled in the pits by mining shovels and large wheel loaders in combination with high-capacity haul trucks. Smaller capacity haul trucks may also be used to support the main fleet. Run of mine ore will be hauled from the open pits to the Crusher, located west of the central pit (Figure 3-1)

The pits are expected to be developed in a sequenced manner. The conceptual plan for pit development is to mine the North Pit throughout the life of the project with mining of the Central and South Pits to occur at various times to supplement ore production from the North Pit. The mining plan will serve to optimize the economics of the Project, as well as provide the opportunity to blend various ore types, which will enhance the operation of the Process Plant. By the end of Year 6, the South Pit will be mined out and will be available for storage of mine rock and Type 2 material.

The direct effects to fish habitat of open pit development are relatively minor since the pits are not overprinting a lot of fish habitat. The North Pit is overprinting several fishless lakes, but no fish bearing waters are directly impacted by this pit. The Central Pit will overprint the headwater segment of subwatershed 102 stream 1, tributary 4 (102-S1-T4; Figure 3-1). The South Pit will also overprint headwater segments of subwatershed 102 stream 1 and Lake 14 (102-S1 and 102-S1-L14, respectively; Figure 3-1).

5.2.2 Indirect Effects

<u>Dewatering</u>

Indirect effects from dewatering the open pits will contribute to changes in groundwater and surface water contribution to other local lakes and waterbodies. Modeling of groundwater and surface water reductions to local surface waters has been completed (Stantec 2021). This Plan has assumed indirect effects related to flow reductions are assumed to be 100% of the affected areas as shown on Figure 3-1.

<u>Blasting</u>

The open pits will be developed using heavy equipment and explosives. Blast patterns and charges per delay will vary according to the rock type, conditions and proximity to adjacent lakes. Potential blasting effects to fish and fish habitat associated with the current Project are considered mitigatable as per below.

5.2.3 Avoidance and Mitigation

<u>Location and Avoidance</u>

The location of the ore body and the resulting open pits are fixed and cannot be relocated.

<u>Blasting</u>

Blasting residues have the potential to harm fish if not properly managed. This will be mitigated through collection of water from the mine and fish habitat area operations and the use of onsite water management facilities prior to discharge to the environment.

The detonation of explosives near waterbodies can produce post-detonation shock waves which result in a pressure deficit referred to as overpressure that can cause impacts in fish (Wright and Hopky 1998). An overpressure in excess of 100 kilopascal (kPa) can result in effects in fish including damage to the swim bladder and potential rupture and hemorrhage to the kidney, liver, spleen and sinus venous. Vibrations can also harm fish eggs and larvae, and a limit of a peak particle velocity no greater than 13 $mm \cdot s^{-1}$ is allowed in a spawning bed during the period of egg incubation. The overpressure and vibration limits specified in DFO's *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998) are shown in Table 5-1.

A site-specific blasting assessment will be completed for the Project to calculate the allowable explosive loading per delay based on the closest distance to the nearest waterbodies. Charge per delay values will be used by the Project team to develop a blasting mitigation plan that meets the DFO criteria in Table 5-1, or alternate values derived in consultation with DFO.

Fish Relocation / Depletion

A comprehensive fish relocation / depletion program is proposed to minimize the unintentional death of fish associated with development of the Project. Although fish removals have become a common mitigation measure for projects impacting waterbodies, each Project requires individual consideration as to the best methods and preferred objectives.

The portions of waterbodies within the Project footprint have primarily small-bodied forage fish species that are typically well-suited to realize successful capture and relocation. Fish relocation from directly impacted waterbodies are proposed within this draft Plan as a compensation and offsetting measure to colonize fishless lakes in the Project area (Section 8.1.2).

5.3 Plant Site and Stockpiles

5.3.1 Direct Effects

The plant site and run of mine (ROM) stockpile are located south and west of the Central and South pits (Figure 3-1). The process plant infrastructure will overprint a small headwater segment of subwatershed 102 stream 1 tributary 1 (102-S1-T1; Figure 3-1), as well as a fishless segment of subwatershed 102 stream 1 tributary 2 (102-S1-T2; Figure 3-1). The ROM stockpile will overprint two lakes and portion of the headwater stream within subwatershed 102.

The overburden stockpiles are located east of the South Pit and around the PSMF and will not overprint or impact fish habitat. The Mine Rock Storage Area (MRSA) is positioned east of the North and Central pits, overprinting the middle reaches of streams and tributaries within subwatersheds 102 and 103 (Figure 3-1). Some of this habitat is not fish bearing; however, the Schedule 2 impacts are shown on Figure 3-1.

5.3.2 Indirect Effects

Changes in flow due to a combination of drainage area reduction and possible changes in groundwater contribution will have indirect impacts to subwatershed 102 and 103 drainage features that report to the Pic River, as shown on Figure 3-1. These drainage feature segments are fish bearing and the entire stream segments have been included within the HADD accounting as a worst-case basis (Table 6-1).

5.3.3 Avoidance and Mitigation

The plant site and stockpile locations were selected to avoid waterbodies to the extent practical given the limitations of local site topography (moderate to high relief, steep cliffs) and orientation of the ore body with multiple pits. Ditching around the plant site and stockpiles will collect runoff and seepage from the facilities and direct it to the water management system (Section 5.4). To protect the adjacent waterbodies from construction impacts (i.e., suspended solids), standard measures and best management practices will be implemented as per Section 7.

5.4 Water Management Ponds

5.4.1 Direct Effects

The Water Management Pond (WMP) will receive excess water (e.g., contact water and precipitation) from the site and will be operated as the primary contact WMP for the site (i.e., contact water from Open Pits, MRSA, and Stormwater Management (SWM) Pond), providing the process water source for the Process Plant. During operations, water will be reclaimed from the WMP to the Process Plant on a continuous basis. The recycling of water from the WMP to the Process Plant has been maximized to limit the need for additional fresh water from other sources. Overflow from the WMP can be managed within Cell 1 of the PSMF to provide additional operational flexibility. Excess water will be transferred from the WMP to a water treatment plant (WTP), treated as required, and discharged to Hare Lake. The WMP will directly overprint a headwater segment of the Subwatershed 106 Angler Creek mainstem (106-AC; Figure 3-1).

Runoff from the Process Plant area, Truckshop / Warehouse area, Laydown area and the Aggregate Plant area will be collected in the SWM Pond. Water collected in the SWM Pond will be routed to the WMP or directly to the WTP via the water transfer pipelines. The SMW Pond will also provide tertiary containment for the Process Plant area and associated pipelines (i.e., process solids and reclaim water pipelines) and Fuel Farm, ensuring that Subwatershed 101 and the Pic River will be protected in the case of an unplanned event. The SWM Pond will directly overprint a segment of the Subwatershed 101 stream 1 tributary 1 watercourse (101-S1-T1; Figure 3-1).

5.4.2 Indirect Effects

Changes in flow due to a combination of drainage area reduction will result in the impacts to the Subwatershed 101 stream 1 mainstem and Subwatershed 106 Angler Creek mainstem for the SWM Pond and WMP, respectively. Accordingly, the entire area of the impacted channels downstream of the SWM Pond and WMP/PSMF have been quantified as HADD as a worst-case basis. Subsequent revisions of this draft Plan may refine this approach based on future consultation, review comments and design considerations.

5.4.3 Avoidance and Mitigation

The WMP and SWM Pond locations were selected to utilize natural topography as possible and avoid waterbodies to the extent practical given the limitations of site topography and location of the PSMF. Seepage collection basins will be used to capture and manage water from these facilities. To protect the adjacent waterbodies from construction impacts (i.e., suspended solids) standard measures and best management practices will be implemented as per Section 7.

5.5 Road Crossings and Pipelines

Road access to the mine site will be provided along Camp 19 Road from an existing intersection at Highway 17, opposite Peninsula Road. A security building and gate will be located at the entrance to the mine site, immediately north of the Subwatershed 101 crossing. Since the original EIS (2012), upgrades to Camp 19 Road and its intersection with Highway 17 were completed. Additional upgrades may be necessary to accommodate mine-related traffic, which will include brushing, installation/upgrades to culverts, and construction of an appropriate gravel roadbed.

A new section of road will be developed that links the Camp 19 Road to the mine site, which follows a revised alignment from the one proposed in the original EIS (2012). This new road section runs north, off the Camp 19 Road about 2.2 km from Highway 17. The road corridor is anticipated to be 30 m wide and the roadbed material will consist of Type 1 mine rock that has been crushed and screened to appropriate sizes using portable on-site crushing and screening equipment.

An access road extending from the mine site to Hare Lake to support the effluent discharge will also be needed. The currently proposed alignments result in three potential crossings along the site access road, including one at Angler Creek along the access route to Hare Lake.

5.5.1 Avoidance and Mitigation

Road and pipeline routes have been aligned to avoid water crossings where feasible. Further alignments may be considered and evaluated to balance aquatic impacts with sensitive terrestrial impacts. Road crossings will use standard mitigation measures and best management practices (such as structure sizing, embedment and construction methods) to mitigate impacts. For example, culvert design, installation and maintenance will follow and conform to appropriate DFO and NDMNRF operational statements, guidance, and protocols.

5.6 Transmission Line

A new 2.2 km 115 kilovolt (kV), overhead transmission line is proposed to tie the Project into the existing Terrace bay-Manitouwadge transmission line (M2W Line; Figure 3-1. The new line will run from the existing transmission corridor to a transformer substation located north of the Process Plant between the South Pit and PSMF. The proposed transmission line route has been established to minimize overall length as well as reduced environmental effects.

The transmission line is expected to be comprised primarily of single, wooden pole structures, established within a 30 m wide right of way. Additional cleared right of way width may be required at turning points, or where pole anchors are needed, such as in poor ground conditions. The transmission line is expected to be constructed primarily in the winter from temporary winter roads, avoiding sensitive periods for wildlife as much as practical. Establishment of a permanent road within the right of way is not proposed at this time. Work including vegetation clearing may also occur during the late summer and fall on higher ground / in areas of good accessibility

Transmission line water crossings will all be clear span with wooden poles located above the high-water mark to avoid in-water structures and avoid HADD. Vegetation maintenance within the right of way will restrict vegetation heights, but vegetation cover is expected to remain adequate to prevent long term ground erosion and sedimentation to waterbodies.

The transmission line and access road represent a small and localized interaction with the waterbodies, and no permanent change to banks or beds of the waterbodies. Although minor changes to riparian vegetation may occur, the small extent relative to the overall length of the channels or waterbody is not considered likely to impact habitat quality such as temperature, cover, nutrients or food supply to an extent that would be harmful to resident fish. Accordingly, transmission line effects have not been included as predicted HADD in Section 6.

5.6.1 Avoidance and Mitigation

The location and routing of the transmission line was selected based on a review of effects to the both the biophysical environments and the human environment, as well as cost effectiveness and technical considerations. The transmission line construction is proposed to be completed outside of the open water wetted area at all times.

Installation will be largely completed in the winter over frozen ground, minimizing risk or soil disturbance and mobilizations. Vegetation will be cleared within the right of way and work areas, but not grubbed. The construction access road is expected to be a winter road with ice crossings or structural crossings (i.e., temporary bridges) if required. To the extent possible, the "Interim code of practice: temporary stream crossings" (DFO Code of Practices: Date modified: 2020-07-02) will be used for the temporary access road crossings.

Table 5-1: DFO Blasting Near Canadian Fisheries Water Limits

Assessment Type	Assessment Metric	Limit
Water-overpressure	Peak Pressure (P_{peak})	≤ 100 kPa
Vibration [1]	Peak Particle Velocity (PPV)	≤ 13 mm/s

Note:

The vibration limit applies with a maximum PPV level of 13 mm/s in a spawning bed during the period of egg incubation.

6.0 RESIDUAL HADD AND WATERBODIES TO BE LISTED TO MDMER SCHEDULE 2

The assessment of potential impacts associated with the proposed Project activities (Section 5) shows residual impacts to fish and fish habitat exist and are quantified in Table 6-1. The residual impacts from the indirect and direct impacts to fish and fish habitat including the locations of Schedule 2 waterbodies and HADD delineated as impact segments are shown on Figure 3-1. The current combined residual HADD and impacts to waterbodies frequented by fish associated with the Project requiring offsetting or compensation has been calculated as 12.33 ha (Table 6-1).

Direct overprinting causing habitat loss (i.e., infilling or excavation) of waterbodies represent most of the predicted residual impacts to fish and fish habitat. The predicted changes in surface water flows resulting from alterations to small creeks or headwater lakes represent indirect impacts from the Project. Direct habitat loss is quantified as 100% of the area overprinted regardless of whether it will be restored during a subsequent Project phase; however, indirect impacts such as flow reductions to creeks and small drainages were also assumed to be quantified as 100% of the habitat as a worst-case conservative assumption. As such, all direct and indirect impacts to fish and fish habitat have been considered HADD. This conservative approach shows a worst-case scenario, while additional mitigation measures and design options can be considered during the draft Plan review process and EA.

As noted previously, the baseline study results have shown a number of headwater watercourses and waterbodies do not support fish at any time of the year. As such, these waterbodies and watercourses are not included in the impact accounting and do not require compensation or offsetting.

Table 6-1: Summary of Predicted Fish Habitat Impacts

Subwatershed	Segment ID (as per Figure 3-1)	Watercourse / Waterbody	Section 35		Schedule 2	Non-Fish Bearing	Total Area
			Direct Impact	Flow Reduction			
101	101-S1	Stream 1 Mainstem	—	13,044	—	—	13,044
	101-S1-T1	Stream 1 Tributary 1	3,264	1,103	753	—	5,120
	101-S1-T2	Stream 1 Tributary 2	—	—	—	538	538
	101-S1-T3	Stream 1 Tributary 3	—	—	—	497	497
102	102-S1	Stream 1 Mainstem	3,024	1,094	4,122	—	8,240
	102-S1-L14	Stream 1 Lake 14	7,030	—	—	—	7,030
	102-S1-L15	Stream 1 Lake 15	2,586	—	—	—	2,586
	102-S1-T1	Stream 1 Tributary 1	2,930	—	—	331	3,261
	102-S1-T2	Stream 1 Tributary 2	146	—	—	2,474	2,620
	102-S1-T3	Stream 1 Tributary 3	672	—	—	224	895
	102-S1-T4	Stream 1 Tributary 4	337	—	402	—	740
103	103-S1	Stream 1 Mainstem	358	1,571	2,136	—	4,066
	103-S1-L10/11	Stream 1 Lakes 10/11	20,142	—	—	—	20,142
	103-S1-L13	Stream 1 Lake 13	—	—	1,652	—	1,652
	103-S1-L13a	Stream 1 Lake 13a	—	—	1,726	—	1,726
	103-S1-L16	Stream 1 Lake 16	—	—	—	3,164	3,164
	103-S1-L9	Stream 1 Lake 9	—	—	—	6,990	6,990
	103-S1-T1	Stream 1 Tributary 1	—	—	440	2,097	2,537
	103-S1-T2	Stream 1 Tributary 2	—	—	318	3,020	3,338
106	106-AC	Angler Creek	2,783	25,013	18,434	—	46,230
	106-AC-L24	Angler Creek Lake 24	780	—	344	—	1,123
	106-AC-L26	Angler Creek Lake 26	—	—	—	13,413	13,413
	106-AC-T1	Angler Creek Tributary 1	1,466	—	4,654	1,508	7,628
	106-AC-T2	Angler Creek Tributary 2	86	—	184	—	270
108	108-S1	Stream 1	—	743	—	—	743
		Total Square Meters	**45,605**	**42,568**	**35,166**	**34,255**	**157,593**
		Total Hectares	**4.56**	**4.25**	**3.52**	**3.43**	**15.76**
		Total Predicted Impacts to Fish and Fish Habitat	**12.33 ha**				

Notes:

Table values expressed as square metres unless otherwise noted.

Type I mine rock will be used for mining infrastructure and does not constitute mine waste being deposited into fish bearing water, therefore are subject to *Fisheries Act* Section 35 permitting.

Type II mine rock is considered mine waste and receiving waterbodies and watercourses are subject to the MDMER Schedule 2 permitting.

7.0 MEASURES AND STANDARDS TO AVOID OR MITIGATE DEATH OF FISH OR HADD TO FISH HABITAT

7.1 Measures, Standards and Contingencies

The Marathon project has unique topography that needs to be considered in the mitigation. A combination of site-specific mitigation measures as defined in permits, approvals or EA commitments will be used to avoid or mitigate additional HADD to fish habitat during implementation of the plan, along with best management practices and DFO codes of practice where applicable and appropriate. Measures and standards would include but not be limited to:

- Construction water management;
- Erosion and sedimentation controls; and
- Timing windows to protect sensitive life cycle periods.

These measures are to be implemented for construction of the Project facilities and during the implementation of offset and compensation measures.

Where possible the offset and compensation measures would be implemented concurrently with major Project impacts as shown in the conceptual Project development schedule (Table 1-2). This approach would allow for the initial development and stabilization of the works to be achieved, and benefits from the measures to be realized by adjacent fish communities and the remote compensation measures at the same time that fisheries impacts occur from the Project.

A list of typical measures, standards, codes and contingency measures that may be implemented during the Project to avoid or mitigate impacts to fish habitat as applicable to each circumstance, are shown in Table 7-1.

The measures, standards, codes and contingencies listed in Table 7-1 will be implemented and/or ready for use prior to the start of the works and maintained in a functional or prepared state until completion of the works specified in the plan as appropriate.

7.2 Monitoring and Reporting of Avoidance and Mitigation Measures

To ensure that the measures and standards described are implemented as proposed, Project environmental monitors (or designates) will monitor construction and implementation of this plan. Monitoring will be reported to DFO in as-constructed reports provided within 12 months of the works being completed. The as-constructed monitoring will require multiple reports to reflect some of the measures being constucted at closure.

Documentation will be maintained to demonstrate effective implementation and function of the avoidance and mitigation measures, with summaries provided in the as-constructed report(s). These records are proposed to include:

- A photographic record using consistent vantage points, and inspection reports will be kept to document measures and standards employed, and their observed effectiveness to limit HADD;
- Regular environmental monitoring inspections will be made of in-water activities during construction to ensure mitigation measures such as water management and erosion and sedimentation controls are in place, functional and maintained appropriately; and
- A record of all fish removal efforts carried out with the numbers of fish removed and relocation locations (consistent with permit conditions), specifically related to the colonization of fishless lakes as proposed in Section 8.1.2.

A detailed record will be made of any contingency measures that were implemented to prevent impacts greater than those predicted by this Plan if mitigation measures did not function as described, as well as the effectiveness of the contingency measures. A summary of any contingency measures will be provided in the as-constructed report.

7.3 Seasonal Construction Constraints

The waterbodies associated with the Project development activities reflect both coolwater and coldwater fish communities. Consistent with measures to protect fish and fish habitat, the timing of in-water works should avoid restricted periods to protect fish, including their eggs, juveniles, spawning adults and/or the organisms upon which they feed (DFO 2017).

In-water works are to be avoided during the timing constraints of any given year as per the *In-water Work Timing Window Guidelines* (MNR 2013); and the *Ontario Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat* (DFO 2017). Once the initial isolation of specific areas is complete, fish are removed and the risk of impacting downstream habitats is removed, this timing window would no longer apply. In the event that an exemption to the specified timing window is necessary, a request for alternate work periods will be made to the NDMNRF and copied to DFO.

Table 7-1: Measures and Standards, Success Criteria and Contingency Measures

Measure or Standard	Success Criteria	Contingency
Sediment and erosion control measures associated with the work will be in place prior to substantial ground disturbance and throughout the duration of construction.	No visible sediment entering natural waterbodies as a result of ground disturbance.	Stop the work that is resulting in sediment release until effective controls are implemented. Maintain supply of erosion and sediment control supplies on site to repair, replace or supplement control measures as needed.
DFO *codes of practi*ce for applicable works, activities and undertakings.	Follow *Codes of Practice* where a detailed site-specific assessments / review of works, activities and undertakings have not been completed. Apply measures to protect fish and fish habitat.	Assess applicability of codes and use alternate site-specific mitigation measures or conduct detailed assessment / review of works, activities and undertakings.
Observe timing constraints for in-water work.	No in-water work during constraint period.	Exemption from timing period may be requested from NDMNRF and copied to DFO.
Minimize duration of in-water work to the extent practicable.	Work continues in continuous and efficient manner to completion.	Monitor contractor's effort and implement additional site planning as needed. Ensure materials are available to complete the construction continuously as needed.
Undertake in-water activities in isolation of open or flowing water to avoid introducing sediment into the watercourse.	Work areas are effectively isolated from open or flowing water. Follow DFO *Code of Practice* or other equivalent review and assessment.	Stop works that are not isolated from open or flowing water. Isolate work area, remove fish from work area before continuing works. Maintain a sufficient supply of pumps and materials on site to isolate flows.
Stabilize shoreline or banks disturbed by any activity associated with the works.	Shorelines are mostly stable and not eroding.	Grade bank to stable slope if necessary. Use temporary or permanent bank stabilization material to stabilize banks.
Remove fish from areas where waterbodies are to be abandoned or isolated from the active creek channel due to the works.	Minimize dead or stranded fish within the work areas.	If stranded or distressed fish are observed in the work area, stop work causing distress, assess the activity and continue fish removal if necessary.
Screen or use other deterrents at any pump intakes to prevent entrainment or impingement of fish as per DFO *Code of Practice* or equivalent review / assessment.	No fish entrained or impinged at pump intakes.	If fish are entrained or impinged, implement corrective action by, either repairing or supplementing the exclusion measure in place.
Ensure that machinery arrives on site in a clean condition and is maintained free of fluid leaks.	Machinery arrives on site in clean condition. Measures are in place to mitigate spread of invasive species.	Have an area or location on site to clean equipment to a suitable condition on arrival or as required.
Wash, refuel and service machinery and store fuel and other materials for the machinery in such a way as to prevent any deleterious substances from entering the water.	No deleterious substances entering waterbodies.	Follow site response plan that is to be implemented immediately in the event of a sediment release or spill of a deleterious substance and keep an emergency spill kit on site.

8.0 MEASURES TO OFFSET AND COMPENSATE FOR RESIDUAL HADD AND SCHEDULE 2 WATERBODIES

8.1 Description of Offsetting and Compensation Measures

This section of the draft Plan describes the currently proposed offset and compensation measures to be implemented as part of the Project. Recognizing that this is a draft Plan which will undergo further review and consultation during the permitting process, it is expected that proposed measures may be modified, expanded upon, substituted or removed to reflect the comments received from Indigenous communities, local resource users and regulators.

Early engagement with Indigenous communities including Biigtigong Nishnaabeg (BN), Pays Plat First Nation (PPFN), Ginoogaming First Nation (GFN), Michipicoten First Nation, Jackfish Métis, Red Sky Métis Independent Nation and the Métis Nation of Ontario, as well as DFO, MECP, NDMNRF, IAAC, ECCC and other parties (e.g., North Shore Steelhead Association) have contributed to this draft Plan. Consultation activities are summarized in Appendix A. An initial list of community focussed measures has been included in this draft Plan for further discussion during the review period (see Section 8.1.1).

Despite the avoidance and mitigation measures proposed as part of the Project (Section 5), there will be a loss of fish habitat. The Project team has prepared an offsetting and compensation strategy that attempts to balance the anticipated needs and expectations of the regulatory fisheries approvals process and recognize that there are limited opportunities for fish habitat restoration within the immediate Project area due to the local terrain and nature of the existing fish habitats.

The proposed fish habitat offset and compensation strategy for the estimated 12.33 ha of impacted waterbodies (Section 6) is focused on colonizing local fishless waterbodies and habitat enhancements at locations within the Project site, as well as habitat creation and enhancement at a remote site in Thunder Bay, Ontario. Community focused measures are also noted within this draft Plan as provided by Indigenous communities during the early engagement.

This strategy will realize near-term benefits from the offsets concurrent with the impacts to fish and fish habitat during Project development. A number of other candidate offsetting and compensation opportunities were considered, some of which have considerable time lag between the impact to fish and fish habitat and some of the benefits from the offsets being realized. Longer lag times can increase uncertainty of success due to the potential for mine plans and closure plans to change over time. There is also a cumulative loss of fish productivity over the lag time that may require increased offsetting ratios to balance the difference. An explanation of the ranking matrix values is provided in Table 8-1, and the comprehensive matrix of candidate offsetting and compensation options considered for this draft Plan is provided in Table 8-2. The proposed options that are currently being carried forward in this draft Plan, and are subject to change during the review process, are presented in Table 8-3.

The currently proposed base case offset and compensation measures to be implemented for the Project include the following, with the estimated quantities for each of these measures provided in Table 8-3:

- Colonizing seven (7) fishless lakes (L1, L2, L3, L12, L22, Malpa Lake and Terru Lake) with the fish salvaged from within the habitat directly impacted by project development to establish functioning communities that can contribute to downstream fisheries.
- Create fish habitat at a former paper mill site in Thunder Bay by improving coastal wetland function within the Lake Superior Area of Concern (AOC) and provide nursery and/or rearing habitat for Coaster Brook Trout.

- Camp 19 road crossing replacement and habitat enhancements to remove the barrier near the Pic River and improve fish passage, specifically for salmonids.
- Lake 8 habitat complexity improvements and increasing fish community diversity to support the downstream fishery, as this waterbody will be maintained as a refugia for fish prior to reconnecting the Subwatershed 102 watercourse during the mine closure phase.

8.1.1 Community Focused Measures

GenPGM solicited ideas from local and Indigenous communities with respect to potential fisheries offsets and compensation measures that could be considered for the Project. GenPGM is facilitating further collaboration in consideration of community focused measures; however, the draft Plan does not account for anticipated gains associated with community focused measures in the balance of impacts and benefits to allow for continued flexibility with these initiatives. The draft Plan is considered to have sufficient compensatory measures proposed to effectively offset the calculated fish and fish habitat impacts from the Project.

Examples of community focused measures suggested by Indigenous communities during early engagement include the following and will be refined further during the draft Plan review process, prior to finalizing the Plan for DFO approval:

- Supporting BN with an expansion of their existing small-scale Book Trout hatchery program. The NDMNRF currently provide Brook Trout eggs to the program, which allow students the opportunity to learn about and observe egg development. BN is seeking approval through the NDMNRF to stock local area lakes and have included lake assessments to evaluate suitability of candidate stocking lakes as part of the expanded program.
- Supporting BN with development and implementation of an Aquatic Monitoring Program (AMP) focused on monitoring potential impacts to aquatic systems from the Project. The proposed workplan includes the development of a framework for long-term monitoring within BN's traditional territory and will ultimately form the basis of a community-based BN AMP.
- Support PPFN and Lakehead University with Walleye population structure and spawning habitat use assessments within Black Bay, Lake Superior. These studies would contribute to the existing research studies being conducted within the Black Bay AOC.

8.1.2 Colonizing Fishless Lakes

A number of lakes within the project area were shown to be fishless during the baseline studies. Barriers to fish passage, primarily associated with steep gradients (>10%) and narrow headwater channels with instream obstacle (i.e., boulders, have prevented fish from colonizing these waterbodies. Given the existing barrier to fish movement, and the fact that the waterbodies have not colonized with fish to date, it is considered unlikely that the lakes would naturally colonize with fish in the near future. The baseline data were reviewed to confirm that total water depths and habitat features are suitable to support year-round fish communities, and seven (7) lakes have been proposed in this draft Plan (Figure 8-1). In total, a combined area of approximately 13.26 ha is accredited to the proposed colonization of fishless lakes, quantified as:

- 3.23 ha Lake 1;
- 1.34 ha Lake 2;
- 2.02 ha Lake 3;
- 1.34 ha Lake 12;

- 1.38 ha Lake 22;
- 3.28 ha Malpa Lake; and
- 0.67 ha Terru Lake.

This offset measure will realize near-term net benefits to local fisheries. Candidate species for colonization will match those species found downstream and emulate the fish communities of the impacted waterbodies. It is expected that adult and early life stage fish will pass downstream (emigrate), thereby contributing to downstream fish assemblages and productivity of the overall fishery through supply of forage fish to upper trophic level species. These lakes will also provide a source of baitfish for harvesting and will replace the lost habitat currently used for baitfish harvest.

8.1.3 Shipyard Road Habitat Creation and Enhancement

The property located at 550 Shipyard Road, Thunder Bay, Ontario is the former Superior Fine Papers Inc. (SFP) mill site. SFP plans to restore a portion of the property located north of Shipyard Road to a natural state for long-term contributions to biodiversity and public enjoyment (Figure 8-2). SFP has been working with Lakehead University to collect baseline data and have developed preliminary concepts for improving and creating fish habitat features on site. These include improved function of the coastal wetland, habitat enhancement of site drainages using natural channel design principles that have groundwater contributions and were anecdotally known to support Coaster Brook Trout (commonly referred to as "Coasters" that reside mainly year-round in Lake Superior but rely on nearshore habitat for spawning and early life stages. The creation of complex aquatic habitat on site will support fish with added features to support other aquatic and avian fauna (e.g., turtles, snakes, birds). GenPGM proposes to assume the cost, planning, approval, implementation and monitoring of this measure with agreement from the owner. SFP is not otherwise required to rehabilitate this portion of the former mill site and as such the voluntary habitat creation area would be appropriate for inclusion to this Plan. SFP intends for the new habitat areas to be accessible to the public and is exploring options to transfer the land to a Public Trust thereby ensuring long-term public access and conservation protection status. In total, the estimated fish habitat enhancement opportunity would represent 4 ha accredited to the offsetting and compensation balance.

8.1.4 Camp 19 Road Crossing Replacement and Habitat Enhancement

The baseline aquatic studies identified the culvert beneath the existing access road crossing near the outlet of Subwatershed 101, Stream 1 to the Pic River as a barrier to fish passage (Figure 8-1). This structure presents an impassable barrier to upstream fish passage, except during very high flow conditions. As a result, habitat in this stream is underutilized and provides limited spawning and nursery habitat for migratory salmonids due to the restricted access from the Pic River. Removal of this barrier would increase the productive capacity of Stream 1 within Subwatershed 101, as it would permit more regular upstream movement of migrating salmonids from the Pic River. Replacement of the perched culvert would allow unrestricted access for fish from the Pic River, which would be accomplished by lowering the culvert and creating a series of step pools to allow fish passage in low flow conditions. Additional habitat enhancements within the stream would also be considered in conjunction with the culvert enhancement to enhance productivity, though candidate sites for such works would need to be confirmed. For example, the creation of a gravel bed in the area near the proposed step pools could provide spawning habitat for Steelhead when stream flows are relatively high. It has been estimated that this option has the potential to provide new access to approximately 1.5 km (approximately 0.75 ha) of functional habitat upstream from the confluence of the Pic River to the bedrock cascade falls barrier.

8.1.5 Lake 8 Habitat Enhancements and Increasing Community Diversity

Lake 8 is located west of the North Pit and directly north of the ROM Stockpile, outside of the proposed site impacts (Figure 8-1). The baseline aquatic study results characterize Lake 8 as a long, narrow, shallow lake (maximum depth of 2.3 m), with substrate composed primarily of muck and some exposed bedrock, minor amounts of boulder, cobble and gravel (Ecometrix 2012). Fish community surveys identified Brook Stickleback are the only species inhabiting the lake (in low abundance), and the limited connectivity to downstream habitats have prevented other species from colonizing the lake. This waterbody will not be impacted during the Project construction and operation phases and would function as a refugia for the resident fish prior to reconnecting the Subwatershed 102 watercourses during the mine closure phase. Fish habitat enhancements are proposed that may include excavation of deeper pools, placement of in-water structures (e.g., boulder clusters and root wads), as well as the introduction of other fish species that will be salvaged from impact waterbodies to improve species diversity. Increasing habitat complexity and species richness would allow the habitat to become stable and established during mine life and ultimately contribute to the downstream fishery once Lake 8 is reconnected to the Subwatershed 102 watercourses. The estimated fish habitat enhancement opportunity would represent 2.2 ha accredited to the offsetting and compensation balance.

8.2 Monitoring the Implementation and Effectiveness of the Measures

Implementation and effectiveness of the offset and compensation measures will be determined by confirming that measures have been constructed as per the approved plans and are functioning as intended using the criteria outlined in Table 8-4. A combination of onsite monitors, and qualified designates as required will be used to document compliance with the approved plans.

The monitoring results will be documented in an as-constructed report(s) and in performance monitoring reports submitted to DFO according to an approved schedule. The as-constructed report(s) will be prepared for any of the physical habitat construction / in-water works (e.g., new fish habitat created, enhancement features) and will be due within 12 months of completing the compensation measures.

Performance monitoring reports will be due on or before March 31 following each year of monitoring. It is proposed that monitoring be based on the individual offsetting and compensation measures as described in Table 8-4.

If the results of the monitoring indicate that the measures are not completed on time and/or are not functioning according to the Plan, written notice will be given to DFO, and contingency measures will be implemented (Table 8-5) with additional monitoring as required.

8.3 Cost Estimate and Letter of Credit or Equivalent Financial Guarantee

As per SOR/2019-286 Paragraph 2(1)(b) and MDMER Paragraph 27.1(4) the proponent is required to provide irrevocable letters of credit; or an equivalent financial guarantee issued by a recognized Canadian financial institution to cover the costs of implementing the approved offsetting and compensation plan.

DFO may draw upon funds of the letters of credit or other financial guarantee provided to cover the cost of implementing the offsetting and compensation measures including the associated monitoring and reporting measures included in this plan, in the event that the Proponent fails to implement the Plan or components of the Plan.

This draft Plan is intended to undergo review and consultation which may result in modifications and changes to the proposed offset measures and areas. As such the values of the financial guarantee will be determined with DFO and submitted under separate cover or in the revised Plan with the final application documents, and prior to Schedule 2 listing, respectively.

Table 8-1: Definition of Categories for Candidate Offsetting and Compensation Options

Overall Rank	Alternative	Simplicity of concept and pre-design information needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use	Habitat Area Gain		Construction Implementation and Required Controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
						Portion of Constructed or Restored Habitat Credited to Offset Balance	Percent of Total Offset Amount Required						
Rank is order of feasibility and priority (1 being the highest or most preferred alternative)	Description of alternative, representing the type of alternative (i.e., channel realignment, new lake basin, existing habitat enhancement).	Simplicity ranking, with 1 being the least simple and 6 being the simplest. Lower rankings will require more extensive field programming and time to obtain necessary pre-design information. Very Low to Low (1-2) Moderate (3) Moderate to Good (4- 5) Very Good (6)	Monitoring success simplicity ranking, with 1 being the least simple and 6 being the simplest. Effort required to establish certainty of project success through monitoring. Very Low to Low (1-2) Moderate (3) Moderate to Good (4- 5) Very Good (6)	Relevance to facilitation of project site development. High relevance (e.g., 6) means the alternative also facilitates/supports site infrastructure development. Very Low to Low (1-2) Moderate (3) Moderate to Good (4- 5) Very Good (6)	Brief description of existing land use and proposed offsetting alternative feasibility / compatibility with this land use type. Very Low to Low (1-2) Moderate (3) Moderate to Good (4- 5) Very Good (6) Proposed offset alternative relevance to the existing land use, habitat type or fishery. High compatibility (e.g., 6) means the alternative is highly compatible with existing land use. Very Low to Low (1-2) Moderate (3) Moderate to Good (4- 5) Very Good (6)	The proportion of the total area required to be compensated that the specific alternative can provide. New habitats receive high values (100%= very high) while habitat enhancement only receive partial credit. Very Low to Low (1-2) Moderate (3) Moderate to Good (4-5) Very Good (6)	The percent of the total area required to be compensated that the specific alternative can provide. Higher values are awarded to larger alternatives. Very Low to Low (1-2) = <1 ha Moderate (3) = 1 to 4 ha Moderate to Good (4- 5) = >4 to 10 ha Very Good (6) = >10 ha	Level of controls and implementation required during the specific alternative construction to prevent additional environmental damage. Higher values are awarded where fewer controls are needed. Very Low to Low (1-2) Moderate (3) Moderate to Good (4-5) Very Good (6)	Feasibility of constructing the specific alternative, including access to the offset location and terrain type. High certainty (e.g., 6) means the constructability is highly certain. Lower values are awarded where increase controls are needed (e.g., land clearing to provide access, difficulty with terrain for access). Very Low to Low (1-2) = land clearing, difficult terrain Moderate (3) Moderate to Good (4-5) Very Good (6) = Access exists	Certainty that GenPGM will have tenure of the lands proposed to be included in the specific offsetting alternative. High certainty (e.g., 6) means the lands are under control of GenPGM. Very Low (1) = Private Owner Low to Moderate (2-3) = Non-Resource Provincial Agency (e.g., MTO) Moderate to Good (4-5) = MNDNMRF / Federal Crown Land Very Good (6) = Gen PGM owned.	Cost of the specific offset alternative relative to other proposed alternatives within the matrix. High relative cost (e.g., 1) means the cost is higher than other alternatives. Very Low to Low (1-2) Moderate (3) Moderate to Good (4-5) Very Good (6)	How well the specific offset alternative aligns with the interests of First Nations, other stakeholder groups and provincial management objectives. Higher values are awarded to alternatives with high alignment. Very Low to Low (1-2) Moderate (3) Moderate to Good (4-5) Very Good (6)	Cumulative score of the specific offset alternative.

Table 8-2: Candidate Fish Habitat Offset and Compensation Options Matrix

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
1	Colonizing Fishless Lakes (L1, L2, L3, L12, L22, Malpa Lake, and Terru Lake)	Proponent	Very Good (6) Measure improves existing habitat diversity and baseline habitat data are available to predict success. Requires agreement with Province to relocate forage fish.	Very Good (6) Baseline data available to show fishless lakes.	Good (5) Not directly required to facilitate project site development, close proximity to project impacts.	Land Use Very Good (6) Increase net fish habitat. Ecological Relevance Very Good (6) Stocking of new fish habitat, previously isolated by natural barriers.	Very Good (6) 100% of the waterbodies should be credited to the compensation.	Very Good (6) Large total area available (11.92 ha)	Very Good (6) No construction required, using existing waterbodies.	Good (5) Access to some locations may require improvement beyond general site development.	Very Good (6) Property under control of Proponent	Very Good (6) Habitat is available, transfer of salvage fish is required.	Moderate (3) Alignment with fisheries management objectives to be determined.	67
2	Camp 19 Road Crossing Replacement and Habitat Enhancement	Proponent	Very Good (6) Common practice. Basic fisheries and engineering values needed from baseline condition to replicate habitat. Most information is available or readily obtainable.	Very Good (6) Monitoring is simple and relies on comparison to baseline values.	Very Good (6) Water crossing modification already required to support site development.	Land Use Very Good (6) Existing Road, not proposing a new water crossing location. Ecological Relevance Very Good (6) Restoring passage to upstream habitat.	Good (5) Assumes significant portion of the newly available upstream habitat would be credited.	Low (2) Assume 1.5 km length x 5 m width = approx. 0.75 ha	Good (5) Crossing upgrade works and impact mitigation via BMPs are well understood.	Very Good (6) Good access to area already exists.	Very Good (6) Property under control of Proponent	Moderate to Good (4) Cost per culvert crossing with small in-water footprint. Low (2) Cost per clear span structure.	Very Good (6) Option is in immediate project areas as per preferences of DFO and other stakeholders. Sportfish potential.	64
3	Lake 8 habitat improvement	Proponent	Good (5) Measure improves existing species diversity and baseline habitat data are available to predict success. Requires agreement with Province to relocate forage fish.	Moderate to Good (4) Monitoring is simple and relies on baseline reference values. Longer term monitoring may be required to confirm function.	Moderate (3) Not directly required to facilitate project site development, but enhancement of Lake 8 will improve local area species diversity and contribute to downstream fishery.	Land Use Very Good (6) Existing Lake habitat. Ecological Relevance Good (6) Options to improve limitations and support increased coldwater species diversity (Lake Trout, Cisco).	Very Good (6) 100% of the waterbody should be credited to the compensation.	Moderate (4) Total area available (2.2 ha)	Very Good (6) No construction required, using existing waterbodies.	Very Good (6) Access to location will be gained through site development.	Very Good (6) Property under control of Proponent	Very Good (6) Habitat is available, transfer of salvage fish is required.	Moderate (3) Alignment with fisheries management objectives to be determined.	61

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain: Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Habitat Area Gain: Percent of Total Compensation Amount Required	Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
4	Stream 6 (Angler Creek) Subwatershed Enhancements [1]	Proponent	Moderate to Good (4) Re-establishment of stream channels are common practice. Basic Fisheries and engineering values needed from baseline condition to replicate habitat. Hydrology and geotechnical assessment needed to better predict flow condition of new channel.	Good (5) Monitoring is understood and relies on baseline reference values for comparison. Longer term monitoring may be needed for salmonid success criteria.	Very Good (6) Facilities are required to facilitate project site development, enhanced closure planning to gain fish habitat near project impacts.	Land Use Very Good (6) Watercourse features will already be fragmented; therefore, returning to a natural state. Ecological Relevance Very Good (6) Creation of new habitat and increase habitat complexity within immediate the project area.	Good (5) The channel area would be new and credited in full. However, there is uncertainty on how much drainage will report to the headwater (reclaimed Water Management Pond)	Moderate (3) Assume total area = 2.0 ha	Good (5) New channel can be constructed in isolation prior to closure. New channel construction is relatively common and predictable.	Very Good (6)	Very Good (6) Property under control of Proponent	Moderate (3) Watercourse enhancement is Moderate.	Low (2) Reclamation of former mine waste areas. Time lag between impacts and offset.	57
5	Subwatershed 101, Stream 1 Enhancements [1]	Proponent	Very Good (6) Naturalization of Water Management and Stormwater Management ponds on site.	Very Good (6) Monitoring is simple and relies on comparison to baseline reference values. Relatively short duration 3-5 years. Similar habitat should have similar fish values.	Low (2) Not required to facilitate project site development.	Land Use Good (5) Replace aquatic habitat overprinted by project. Ecological Relevance Very Good (6) Opportunity to replace lost habitat through creation of new habitat with enhancement features to increase net productivity.	Very Good (6) 100% of newly created habitat should be credited to the compensation.	Very Good (6) Large total area available, assumes approximately = 10.4 ha	Good (5)	Moderate (3) Potential for mine design changes and life of mine extension that could impact enhancement schedule.	Very Good (6) Property under control of Proponent	Moderate (3) Waterbody enhancement is Moderate.	Low (2) Reclamation of former mine waste areas. Time lag between impacts and offset.	57
6	Shipyard Road, Thunder Bay – Habitat restoration	Lake Superior AOC RAP / Lakehead University	Very Good (6) Improvement and creation of new fish habitat.	Very Good (6) Monitoring is simple as this is newly created habitat.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Net increase of new fish habitat. Ecological Relevance Very Good (6) Creation of new habitat and support coastal wetland development within Lake Superior north shore.	Very Good (6) Assumes 100% of newly created habitat and high proportion of habitat enhancements for existing fish habitat.	Good (5) Assume 4 ha	Moderate to Good (4) In water works required to create habitat enhancement features. Construction BMPs available to mitigate impacts.	Moderate to Good (4) Good access to site.	Moderate (3) Property under control of others; however, owner planning to transfer ownership for long-term conservation status.	Moderate (3) Waterbody enhancement is Moderate.	Good (5) Private land owner objective aligns with coastal wetland regional objectives.	56

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
7	Fish Passage Improvement in Camp 14 Creek (barrier removal and habitat enhancement)	Proponent	Moderate to Good (4) Common practice. Basic fisheries and channel engineering values needed from comparable baseline condition to replicate habitat.	Low (2) Limited baseline data for measuring success within newly accessible reaches.	Very Good (6) Water crossing modification already required to support site development.	Land Use Very Good (6) Existing stream habitat. Ecological Relevance Very Good (6) Increase access to spawning habitat for existing Lake Superior fish.	Good (5) Assumes 100% of newly accessible stream reaches.	Moderate (3) Assume 1.5 km length x 3 m width = 0.45 ha	Good (5) Crossing upgrade works and impact mitigation via BMPs are well understood.	Very Good (6) Good access to area already exists at Hwy. 627 crossing.	Moderate (3) Property under control of Province.	Moderate to Good (4) Cost per crossing with small in-water footprint.	Good (5) Option is in immediate project areas as per preferences of DFO and other stakeholders. Sportfish potential.	55
8	Stream 2 and 3 Subwatersheds Enhancements [1]	Proponent	Moderate to Good (4) Re-establishment of stream channels are common practice. Basic Fisheries and engineering values needed from baseline condition to replicate habitat. Hydrology and geotechnical assessment needed to better predict flow condition of new channel.	Good (5) Monitoring is understood and relies on baseline reference values for comparison. Longer term monitoring may be needed for salmonid success criteria.	Low (2) Not required to facilitate project site development.	Land Use Very Good (6) Increase fish habitat. Ecological Relevance Very Good (6) Creation of new habitat.	Good (5) The channel area would be new and credited in full. However, there is uncertainty on how much drainage will report to the headwater (reclaimed Water Management Pond)	Low (2) Assume total area = 0.2 ha	Good (5) Channel enhancement construction is relatively common and predictable.	Moderate (3) Potential for mine design changes and life of mine extension that could impact enhancement schedule.	Very Good (6) Property under control of Proponent	Moderate (3) Waterbody enhancement is Moderate.	Low (2) Reclamation of former mine waste areas. Time lag between impacts and offset.	49

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
9	Fish Passage Improvement and Habitat Enhancement in Hare Creek	Proponent	Moderate to Good (4) Common practice. Basic fisheries and channel engineering values needed from comparable baseline condition to replicate habitat.	Low (2) Limited baseline data for measuring success within newly accessible reaches.	Moderate (3) Not directly required to facilitate project site development, but close proximity to impacts helps mitigate loss of upstream habitat.	Land Use Very Good (6) Existing stream habitat. Ecological Relevance Very Good (6) Increase access to spawning habitat for existing Lake Superior fish.	Good (5) Assumes significant portion of the newly available upstream habitat would be credited.	Moderate (3) Assume access to newly accessible stream habitat = 1.8 ha	Moderate (3) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Very Low (1) Construction access / laydown areas could be severely limited due to steep ravine/valley features.	Very Good (6) Property under control of Proponent	Low (2) Drilling and blasting likely required to remove barrier within remote reaches.	Good (5) Option is in immediate project areas as per preferences of DFO and other stakeholders. Sportfish potential.	46
10	Current River, Thunder Bay - Improve Fish Passage (Barrier #2 - Fish Ladder)	North Shore Steelhead Association	Moderate (3) Fish ladder design and function is well understood; however, site-specific design will be needed.	Very Low (1) Limited baseline data for measuring success.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Increase access to spawning habitat. Ecological Relevance Very Good (6) Restore historic spawning habitat for lake species; Rainbow Trout and Brook Trout.	Good (5) Assumes 100% of newly accessible stream reaches.	Very Good (6) Assume 1% habitat upstream of Dam = 55 ha	Moderate to Good (4) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Moderate to Good (4) Access assumed via landowner (City of Thunder Bay) with support of NSSA.	Very Low (1) Property under control of others.	Low (2) Drilling and blasting likely required to remove barrier.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local association and Province.	44

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
11	Waboosekon Dam - barrier removal (fish ladder)	Ginoogaming FN	Moderate (3) Fish ladder design and function is well understood; however, site-specific design will be needed.	Very Low (1) Limited baseline data for measuring success.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Assume dam is required to maintain lake level; however, ladder installation will not impact current use/function. Ecological Relevance Very Good (6) Reconnect fragmented habitat for Pic River fish community.	Very Good (6) 100% of newly accessible Waboosekon Lake should be credited to the compensation.	Very Good (6) Large total area available (Approx. 175 ha)	Moderate to Good (4) In water works required. Construction BMPs available to mitigate impacts.	Moderated (3) Access assumed via landowner (Province).	Very Low (1) Property under control of others.	Low (2) Drilling and blasting likely required to construct ladder.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local FN.	44
12	Pic River barrier removal (Assume High Falls is the barrier)	Ginoogaming FN	Moderate (3) Fish ladder design and function is well understood; however, site-specific design will be needed.	Very Low (1) Limited baseline data for measuring success.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Assume dam is required to help manage flood conditions downstream; however, ladder installation will not impact current use/function. Ecological Relevance Very Good (6) Reconnect fragmented habitat for Pic River fish community.	Very Good (6) 100% of newly accessible Pic River between High Falls and Waboosekon Lake Dam should be credited to the compensation.	Very Good (6) Large total area available (Approx. 31 ha)	Moderate to Good (4) In water works required. Construction BMPs available to mitigate impacts.	Moderated (3) Access assumed via landowner (Province).	Very Low (1) Property under control of others.	Low (2) Drilling and blasting likely required to construct ladder.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local FN. Alignment with fisheries management objectives to be determined.	44
13	McKay Lake outlet dam barrier removal (fish ladder)	Ginoogaming FN	Moderate (3) Fish ladder design and function is well understood; however, site-specific design will be needed.	Very Low (1) Limited baseline data for measuring success.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Assume dam is required to maintain lake level; however, ladder installation will not impact current use/function. Ecological Relevance Very Good (6) Reconnect fragmented habitat for Pic River and McKay Lake fish community.	Very Good (6) 100% of newly accessible McKay Lake habitat upstream of the Dam should be credited to the compensation.	Very Good (6) Large total area available (Approx. 3,132 ha)	Moderate to Good (4) In water works required. Construction BMPs available to mitigate impacts.	Moderated (3) Access assumed via landowner (Province).	Very Low (1) Property under control of others.	Low (2) Drilling and blasting likely required to construct ladder.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local FN. Alignment with fisheries management objectives to be determined.	44

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
14	Fish Passage Improvement and Habitat Enhancement in Angler Creek	Proponent	Moderate to Good (4) Common practice. Basic fisheries and channel engineering values needed from comparable baseline condition to replicate habitat.	Low (2) Limited baseline data for measuring success within newly accessible reaches.	Moderate (3) Not directly required to facilitate project site development, but close proximity to impacts helps mitigate loss of upstream habitat.	Land Use Very Good (6) Existing stream habitat. Ecological Relevance Very Good (6) Increase access to spawning habitat for existing Lake Superior fish.	Good (5) Assumes significant portion of the newly available upstream habitat would be credited.	Low (2) Assume access to newly accessible stream habitat = 0.16 ha	Moderate (3) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Very Low (1) Construction access / laydown areas could be severely limited due to steep ravine/valley features.	Good (5) Property mostly under control of Proponent or Crown	Very Low (1) Drilling and blasting likely required to remove barrier within remote reaches.	Good (5) Option is in immediate project areas as per preferences of DFO and other stakeholders. Sportfish potential.	43
15	Habitat enhancement in Hare Lake	Proponent	Low (2) Habitat limitations need to be identified. Current population of Yellow Perch with Northern Pike may impact success of habitat enhancements for coldwater species.	Low (2) Monitoring requires ability to detect difference between existing population and future values. More data are needed to quantify baseline.	Low (2) Not directly required to facilitate project site development.	Land Use Very Good (6) Existing lake habitat. Ecological Relevance Good (6) Options to improve limitations and support increased coldwater species diversity (Lake Trout, Cisco).	Low (2) Assume 2% of Lake area	Moderate (3) Profundal habitat enhancement = 1.1 ha	Moderate to Good (4) In water works required to create habitat enhancement features. Construction BMPs available to mitigate impacts.	Moderate to Good (4) Good access to site. Enhancement activities likely based on barge access.	Very Good (6) Property under control of Proponent	Moderate (3) Waterbody enhancement is Moderate.	Low (2) Option is near project as per preferences of DFO and other stakeholders. Some concern may be raised due to effluent receiver and water quality.	42
16	Current River, Thunder Bay - Improve Fish Passage (Barrier #1 - Natural Falls/Cascade feature)	North Shore Steelhead Association	Moderate to Good (4) Common practice. Basic fisheries and engineering values needed from comparable baseline condition to replicate habitat.	Very Low (1) Limited baseline data for measuring success.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Increase access to spawning habitat. Ecological Relevance Very Good (6) Restore historic spawning habitat for lake species; Rainbow Trout and Brook Trout.	Good (5) Assumes significant portion of the newly available upstream habitat would be credited.	Moderate (3) Assume access to new habitat upstream of Cumberland St. to Dam = Approx. 1.1 ha	Moderate to Good (4) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Moderate to Good (4) Access assumed via landowner (City of Thunder Bay) with support of NSSA.	Very Low (1) Property under control of others.	Low (2) Drilling and blasting likely required to remove barrier.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local association and Province.	42

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
17	Marathon - Mink Creek barrier removal for salmonids	Marathon Resident	Moderate (3) Fish ladder design and function is well understood; however, site-specific design will be needed.	Very Low (1) Limited baseline data for measuring success.	Good (5) Not directly required to facilitate project site development, close proximity to project impacts.	Land Use Very Good (6) Existing stream habitat, increase access to spawning habitat for existing lake fish. Ecological Relevance Very Good (6) Provide access to more habitat and include enhancement features.	Good (5) Assumes 100% of enhancement features and stream reach is credited.	Low (2) Assume three (3) barriers include the Mink Creek Falls and fish ladder construction would provide upstream access total credit for 1 km length x 9 m width = 0.9 ha total	Moderate to Good (4) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Moderate (3) Access assumed via landowner (Province) with support of Township of Marathon.	Very Low (1) Property under control of others.	Low (2) Drilling and blasting likely required to remove barrier.	Moderate (3) Alignment with fisheries management objectives to be determined. Need to consider sea lamprey control obligations in design.	41
18	Fish passage enhancements: lower tributaries of Lake Superior	Natural Resources and Forestry	Low (2) Site access unknown, few details of existing barriers.	Very Low (1) Limited baseline data for measuring success.	Moderate (3) Not directly required to facilitate project site development, some locations far from project impacts to habitat.	Land Use Very Good (6) Increase access to spawning habitat. Ecological Relevance Very Good (6) Restore historic spawning habitat.	Very Good (6) Assumes 100% of newly accessible stream reaches.	Low (2) Assume 4 locations (300 m length x 3.5 m width). 0.1 ha credit each = 0.4 ha total	Moderate to Good (4) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Low (2) Access currently unknown.	Very Low (1) Property under control of others.	Moderate (3) Cost per location may vary with small in-water footprint.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local Communities and Province.	40
19	Kakabeka Falls area - stream rehabilitation	Private Land Owner	Low (2) Site access unknown, photos provided from land owner but habitat limitations unknown.	Very Low (1) Limited baseline data for measuring success.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Existing stream habitat. Ecological Relevance Very Good (6) Enhance habitat within the local area.	Good (5) Assumes 100% of enhancement features and stream reach is credited.	Low (2) Assume 1 stream reach (300 m length x 3.5 m width) for total credit = 0.1 ha total	Moderate to Good (4) In water works required to create habitat enhancement features. Construction BMPs available to mitigate impacts.	Moderate (3) Access currently unknown; however, landowner promoted opportunity and assume feasible.	Very Low (1) Property under control of others.	Moderate (3) Cost per enhancement location may vary with small in-water footprint.	Moderate to Good (5) Private land owner objective to improve fish habitat.	40

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
20	Long Lake; Lake Sturgeon re-introduction	Ginoogaming FN	Low (2) Stocking program requires understanding of existing conditions to support stocking calculations and confidence of success.	Very Low (1) Limited baseline data for measuring existing conditions and Lake Sturgeon are long lived (many years of monitoring needed).	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Existing fish habitat available. Ecological Relevance Very Low (1) High amount of study required to validate this option implies poor certainty of ecological success.	Low (2) Assume 2% of Long Lake area.	Very Good (6) Large total area available (est. >10 ha)	Moderate (3) No construction required, using existing lake. Sourcing fish stock, target stocking values and timing availability unknown.	Good (5) Access to lake is available; however, proposed stocking location(s) unknown.	Very Low (1) Property under control of others.	Very Good (6) Habitat is available, transfer of salvage fish is required.	Moderate (3) Works are further removed from site and area of impact. Works have interest of local FN. Alignment with fisheries management objectives to be determined.	38
21	Mazukama Creek, Nipigon – barrier removal	North Shore Steelhead Association	Low (2) Site access unknown, few details of existing barrier.	Very Low (1) Limited baseline data for measuring success.	Low (2) Not directly required to facilitate project site development, far from project impacts to habitat.	Land Use Very Good (6) Increase access to spawning habitat. Ecological Relevance Very Good (6) Restore historic spawning habitat.	Good (5) Assumes 100% of newly accessible stream reaches.	Low (2) Assumes 300 m length x 5 m width = 0.15 ha	Moderate to Good (4) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Low (2) Access currently unknown.	Very Low (1) Property under control of others.	Low (2) Waterbody enhancement is Moderate; however, further information needed to confirm scope of work.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local association and Province.	37

Overall Rank	Alternative	Alternative Promoter	Simplicity of Concept and Pre-design Information Needs	Monitoring Simplicity and Success Certainty	Operational Relevance	Compatibility with Existing Land Use and Ecological Relevance	Habitat Area Gain		Construction Implementation and required controls	Construction Certainty	Land Tenure Certainty	Relative Cost per Type of Compensation / Offset Measure	Stakeholder Interest (Aligns with Interests of Several Groups, Increases Diversity of Fish Community)	Cumulative Score (Highest is Most Preferred)
							Portion of Constructed or Restored Habitat Credited to Compensation / Offset Balance	Percent of Total Compensation Amount Required						
22	St. Marys River AOC, Sault St. Marie – Whitefish Island Habitat Restoration	Lake Superior AOC RAP /	Moderate (3) Measures improve existing habitat and require detailed existing habitat values to compare to predicted values. Option has been prepared to concept level by Remedial action group (Federal and FN). Requires planning and agreements with multiple groups.	Moderate (3) Post construction comparison must demonstrate that channel improvements have transferred to increased productivity. May require higher effort and duration to clearly demonstrate success.	Very Low (1) Not required to facilitate project site development and further removed from site.	Land Use Very Good (6) Existing channel / aquatic habitat. Ecological Relevance Very Low (1) High amount of study required to validate this option implies poor certainty of ecological success.	Moderate (3) The habitat is existing and only partial credit for improvement will be given.	Moderate (3) Waterbody approx. 7 ha	Moderate to Good (4) In water works required to remove barriers and create habitat enhancement features. Construction BMPs available to mitigate impacts.	Moderate (3) Good access to general site. Work area will require barge access and or temporary working platforms in the bay area.	Very Low (1) Property under control of others.	Moderate (3) Cost per unit of bay enhancement is uncertain but complexity of work and access will be more than traditional material management.	Moderate to Good (4) Works are further removed from site and area of impact. Works have interest of local association and Province.	35

Note:

1 Grey cells indicate compensation and offsetting opportunities that are available during the Closure Phase and would experience a substantial time lag between impacts and benefits.

Table 8-3: Summary of Fish Habitat Offset and Compensation Measures

Proposed Offset / Compensation Measure	Type of Offset Measure [1]	Approximate Area of Offset Measure (ha) or Area Equivalent	Project Phase of Implementation and/or Duration
Colonizing Fishless Lakes	Habitat restoration and enhancement	13.25	Construction
Shipyard Road Fish Habitat Creation and Enhancement	Habitat restoration and enhancement	4.0	Construction
Camp 19 Road Crossing Replacement and Habitat Enhancement	Habitat restoration and enhancement	0.75	Construction
Lake 8 Habitat Enhancements and Increasing Community Diversity	Habitat restoration and enhancement	2.2	Construction
Community Focused Measures	Habitat restoration and/or research support	To be determined Maximum 10% of Offset	Ongoing
Total Area of New or Restored Fish Habitat		**20.21**	

Note:

GenPGM has included the above measures to offset and compensate for the anticipated Project impacts to fish and fish habitat; however, GenPGM is also committed to working with the Indigenous Nations to support community focused measures which may be included within the complimentary measures of the Plan (see Section 8.1.1).

Table 8-4: Criteria and Timing to Assess Implementation and Effectiveness Success

Attribute	Success Criteria	Date (post construction / restoration)
Physical construction of offset measures (new or restored habitat)	• [1,2] As-constructed survey demonstrates that measures are constructed as per the approved plans. • Separate as-constructed survey reports will be necessary to account for time separation between measures (i.e., post construction and post closure).	Within 12 months
Physical function of offset measures (new or restored habitat)	• Water levels, water depth, flow paths and connectivity are consistent with those specified in the design and facilitate conditions for fish passage. • [1] Aerial extent of works as per the plans (habitat quantity consistent with design).	Within 12 months
Stability of structures (new or restored habitat)	• [3] Constructed habitat features remain in place (rock and vegetation structures in place. • Banks and habitat features are stable and not eroding (greater than 90% of features are considered stable). • Riparian vegetation cover and plantings achieve 90% coverage of area.	Years 1, 3, and 5
Species presence (new or restored habitat)	• A comparison will be made between the newly constructed or restored on site habitat and the baseline data for the same or adjacent waterbodies. The comparison will use the existing baseline data as well as data collected during the fish removal efforts during construction to better define the fish communities. • In each location, species richness success criteria is achieved at 80% of the target community (i.e., 8 out of 10 species). It is expected that even at 80% species matching, the new habitat will represent a functional fish community. In the cases where a sportfish community was expected to develop based on baseline occurrence, presence of the sport fish will be part of the success criteria.	Years 1, 3, and 5
Full life cycle usage (new or restored habitat)	• Multiple year classes including young of the year fish are present in the offset feature.	Years 1, 3, and 5
Fish abundance (new or restored habitat)	• Average CPUE / abundance consistent with baseline values. (electrofishing, minnow traps, seine nets, gill nets). • Average abundance values within the offset habitats will be within 25% of the chosen critical effect size [4]	Years 1, 3, and 5
Strategic Colonization of Fishless Lakes	• Species abundance maintained consistent with baseline values.	Years 1, 3, and 5

Notes:

1 Localized field fits may be required during construction with consideration of on site specific existing conditions. It is proposed that the habitats be constructed to a tolerance of +/- 10% for area. This would equal +/- 0.1 ha (100 m^2) per 1 ha (10,000 m^2).

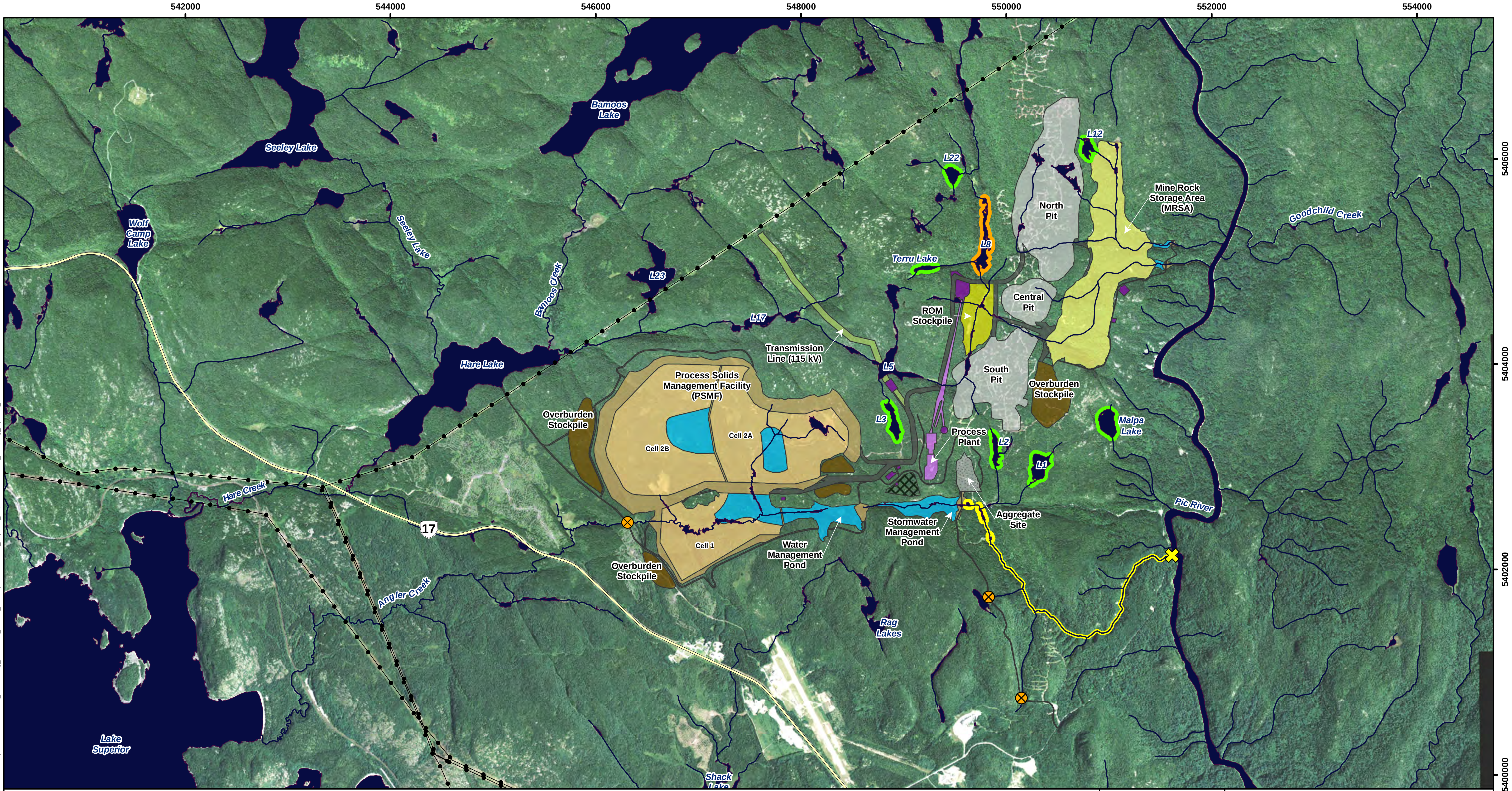
2 Presence of 98% or greater of enhancement structures (i.e,, boulder clusters / tree piles) at initial construction as shown in as-constructed records.

3 70% or greater functionality based on percent of structure available to fish use.

4 Critical effect size (CES) is a threshold above which an effect may be indicative of meeting a prescribed success criteria. A critical effect size of 25% is proposed based on the *Metal Mining Technical Guidance Document for Environmental Effects Monitoring* (ECCC 2012) which states "*An extensive literature review has shown that CESs that have been defined in other programs are often consistent with a CES of around 25% or 2 SDs [standard deviations] for many biological or ecological monitoring variables. This value appears to be reasonable for use in a wide variety of monitoring programs and with a wide variety of variables (Munkittrick et al. 2009).*"

Table 8-5: Contingency Measures for Implementation Success

Attribute	Mode of Failure	Contingency
Physical construction of offset measures	• Habitat not constructed as per plan. • Water area, depths and or habitat structures not in place or present as per the plans.	• Engineer / biologist to assess failure and recommend corrective actions. • Proponent to take required corrective action.
Physical function of offset measures	• Conditions do not provide for fish passage or targeted life stage purpose (i.e. spawning).	• Engineer / biologist to assess cause of failure and recommend corrective actions. • Proponent to take required corrective action.
	• Water level not consistent with those specified in plans.	• Adjust grades of structures to alter water levels. • Excavate pools to specified depths. • Add more substrate or regrade substrates.
Stability of structures	• Constructed habitat features (wood, rock and vegetation structures) missing or not functional.	• Repair or replace structures.
	• Banks not stable (less than 90% of banks are considered stable).	• Assess cause and areas of instability. • Add permanent erosion control (rock, vegetation) in areas of erosion. • Re-grade habitat.
	• Riparian vegetation cover less than 90% coverage of area.	• Apply seed and replacement plantings where required. • Substitute species, and/or use soil amendments if conditions require.
Species presence	• Less than 80% of baseline species of fish are present in the offset measure.	• Use monitoring data to assess limiting factors for other species. • Supplement limiting factors through additional works or assess habitat use by other species.
Life cycle usage	• Absence of expected year classes.	• Use monitoring data to assess limiting factors for spawning or overwintering. • Supplement limiting factors through additional planting, structure placement or excavation.
Fish abundance	• Overall CPUE / abundance metric does not meet targets.	• Use monitoring data to assess limiting factors for abundance. • Supplement limiting factors through additional planting, structure or excavation. • Consider longer term monitoring program if trend shows increasing abundance.
Strategic Colonizing of Fishless Lakes	• A specific colonization plan will be developed in cooperation with indigenous communities and regulators as part of the final offsetting plan.	• To be specified in the fishless lakes colonization plan.



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LEGEND

- Camp 19 Road Habitat Enhancement
- Newly Accessible Fish Habitat
- Lake 8 Habitat Enhancement
- Fish Colonization Lakes
- Existing Transmission Line
- Existing Highway
- Watercourse
- Waterbody

Proposed Mine Features

- Open Pit
- Mine Rock Storage Area (MRSA)
- ROM Stockpile
- Soil/Overburden Stockpile
- Pond
- Process Solids Management Facility (PSMF)
- Dam
- Building
- Process Plant Area
- Road
- Laydown Area
- Aggregate Site
- Corridor
- Watercourse Crossing

NOTES:
- Aerial imagery extracted from AgMaps, NDMNRF.
- Topographic data extracted from LIO, NDMNRF.
- Anticipated fisheries impacts and site watersheds provided by Ecometrix.

Datum: NAD83
Projection: UTM Zone 16N

N W E S

0 1 2 4 6 8 Kilometres

GENERATION MINING

wood.

MARATHON PALLADIUM PROJECT

Local Fish Habitat Compensation and Offsetting

PROJECT N°: OMEMA2006Z

FIGURE: 8-1

SCALE: 1:35,000

DATE: January 2022

S:\Gis\Projects\OMEMA\OMEMA2006Z_MSS\ArcGIS\Fig 8-2 Shipyard Road Habitat Enhancement.mxd

LEGEND

- Beaver Dam Impoundment
- Coastal Wetland
- Existing Wetland Outlet
- Storm Sewer
- Proposed Mine Site Location
- Shipyard Road Site Location

Habitat Enhancement Features

1 Create restored stream and floodplain habitat
2 Improve floodplain access
3 Improve terrestrial habitat complexity within existing wetland
4 Improve aquatic habitat complexity within the existing wetland
5 Improve fish habitat within the constructed wetland
6 Stabilize the wetland outlet
7 Establish a recreational trail
8 Improve amphibian and wetland migratory bird habitat
9 Improve water quality and terrestrial habitat

0 0.03 0.06 0.12 0.18 0.24 0.3 Kilometres

NOTES:
- Information taken from Stantec, July 23, 2021 550 Shipyard Road, Thunder Bay, Ontario, Habitat Enhancement Feasibility Study
- Service Layer Credits: © 2021 Microsoft Corporation © 2021 Maxar ©CNES (2021) Distribution Airbus DS

Datum: NAD83
Projection: UTM Zone 16N

N W E S

GENERATION MINING

wood.

MARATHON PALLADIUM PROJECT

Shipyard Road Habitat Enhancement

PROJECT N^{o}:OMEMA2006	**FIGURE: 8-2**
SCALE: 1:4,000	DATE: January 2022

9.0 FISHERIES OFFSET ACCOUNTING AND BALANCING

A calculated area of 12.33 ha will be impacted by the development of the Project and its associated facilities. The currently proposed offsetting and compensation measures in this draft Plan could result in the development, restoration or enhancement of approximately 20.21 ha of habitat as shown in (Table 9-1), resulting in a loss to gain ratio of approximately 1.6:1. It is recognized that this document is a draft of the offset and compensation plan, and that revisions to the selected measures and quantities may be required in subsequent versions based on consultation and comments received. However, the Plan in its current state provides a descriptive account of predicted impacts (HADD and waters to be listed on Schedule 2 of the MDMER) and viable measures to be implemented to offset the impacts.

Table 9-1: Offset Area Accounting and Balance Summary

Description	Initial Impact Area (ha)	Calculated Offset / Compensation Area (ha)
Combined Project impacts as per Table 6-1	-12.33	
Colonizing Fishless Lakes		13.26
Shipyard Road Fish Habitat Creation and Enhancement		4.0
Camp 19 Road Crossing Replacement and Habitat Enhancement		0.75
Lake 8 Habitat Enhancements and Increasing Community Diversity		2.2
Summary	-12.33	20.21
Net Difference		7.88
Net Ratio		1.6 : 1

10.0 REFERENCES

Ecometrix Incorporated (Ecometrix). 2012. Marathon PGM-Cu Project Site – Aquatic Resources Baseline Report. 09-1630. July 2012.

Ecometrix Incorporated (Ecometrix). 2020. Marathon Palladium Project – Aquatic Baseline Report Update. 20-2722. November 2020.

Ecometrix Incorporated (Ecometrix). 2021. Marathon Palladium Project Environmental Impact Statement Addendum Appendix D6: Fish and Fish Habitat Offsetting Plan Update. 20-2722. March 2021.

Generation PGM Inc. (GenPGM). 2021a. IR5-13 Fish Habitat Characterization. Response to the Joint Review Panel's Request for Information #5 Received August 20, 2021.

Generation PGM Inc. (GenPGM). 2021b. IR5-14 Potential Effects to Fish. Response to the Joint Review Panel's Request for Information #5 Received August 20, 2021.

Stantec Consulting Ltd. (Stantec). 2021. Marathon Palladium Project Environmental Impact Statement Addendum Appendix D4: Hydrogeology Updated Effects Assessment Report. March 2021.

Appendix A

Record of Indigenous Community, Regulator and Other Agency Engagement

Table A.1: Record of indigenous Community, Regulator and Other Agency Engagement

Date	Committee	Communities Present	Regulators Present	Points of Discussion
May 12, 2021	Regional	Red Sky Métis Independent Nation Jackfish Métis Métis Nation of Ontario Michipicoten First Nation Town of Marathon	None	Does baseline mercury info exist including fish tissue? MNO asks for species list of fish that will be impacted (sent by email May 14) Discussion about sediment dredge vs core sampling for mercury Asked about loss of individual fish/fish mortality. Will stocking be considered? Request suggestions for community-based fisheries compensation projects
September 8, 2021	Regional	Ginoogaming First Nation Jackfish Métis Red Sky Métis Independent Nation Town of Marathon	None	Provided summary of baseline studies, potential impacts and draft compensation measures. Ginoogaming stated interest in participating in fish studies being conducted on site.
September 21, 2021	Biigtigong Nishnaabeg	Biigtigong Nishnaabeg	None	Hare Lake used to have trout and Cisco present, there has been a change of species from cold species to cool population. Fisheries habitat work should include a focus group of local harvesters. Stream 6 (Anglers) and salmonoid population are important, concerned about flow impacts. Sturdy Cove must be protected. Suggest monitoring Stream 6/Anglers Creek during operations to ensure no loss of productivity

Date	Committee	Communities Present	Regulators Present	Points of Discussion
				and allow for adaptive management. *Not currently part of the EEM or Country Foods plan*
September 24, 2021	Government	None	DFO NDMNRF	MNRF suggested potential habitat compensation opportunities: • Cavers Creek • Selim Creek • West gravel pit Recommends focus on Brook Trout as species of interest
September 28, 2021	Local	Rod and Gun Club	None	Solicit information and ideas around potential fish offset and local habitat enhancement projects.
October 13, 2021	Regional	Ginoogaming First Nation Jackfish Métis Michipicoten First Nation Red Sky Métis Independent Nation Métis Nation of Ontario	DFO	Lamprey should be considered as a risk to connecting Lake Superior with inland lakes. Brook trout and water quality are key community concerns. Community hatchery for sturgeon and walleye are potential fisheries opportunities.
November 5, 2021	Pays Plat First Nation	Pays Plat First Nation	None	Request suggestions for community-based fisheries compensation projects Concern about low water levels and Project impacts to flow States that changes to beaver population can impact fish
November 23, 2021	RAP (Remedial Action Plan)	None	ECCC NDMNRF MECP	Discussion of community-supported fisheries compensation opportunities: • St Mary's River • Current River • Shipyard Road

Date	Committee	Communities Present	Regulators Present	Points of Discussion
				• Credit River Rapids • Mazukama Creek
November 30, 2021	Ginoogaming First Nation	Ginoogaming First Nation	None	Community proposes offset measures: Wabuskam dam removal Removal of structure a headwaters @McKay Lake Efforts to re-introduce Sturgeon at Long Lake where spawning beds were destroyed in WWII
December 6, 2021	Pays Plat First Nation	Pays Plat First Nation Lakehead University	None	Existing proposal to conduct telemetry monitoring and density studies in Black Bay Includes acoustic deployment for population estimates Community member participation could be included in the project design
December 7, 2021	Biigtigong Nishnaabeg	Biigtigong Nishnaabeg	None	Lake sturgeon research project is complete, muskie research project remains active Propose community led aquatic monitoring program (AMP) Interested in community participation in fish salvage and relocation work
December 7, 2021	Government	None	DFO	Presentation of proposed offset measures DFO raises concern around flow loss calculations and requests follow up meeting with hydrology team (complete Dec 17)
January 7, 2022	Local	Wilderness North Lakehead University	None	Provided more detail on proposed Shipyard Road habitat creation and enhancement project

Water Quality Modelling

Rationale:

On July 30, 2021, the Panel requested that GenPGM provide the inputs necessary to run its MineMod water quality model. In response to the Panels' IR 4-6, GenPGM indicated that key inputs that form the basis of the water quality model are comprised of both the hydrologic inputs and those associated with the geochemical inputs. GenPGM stated that key input parameters are described in the Updated Water Quality Assessment (Appendix D11 of the EIS Addendum [Vol 2]), specifically Sections 2.5, 3.0, and 5.0. Section 1.5 of the EIS Guidelines require all data and models to be documented such that the analyses are transparent and reproducible. Appendix D11 does not appear to contain all inputs to allow participants to reproduce the outputs of the water quality model.

Information Request:

1. *In order to support the Joint Review Panel and others to participate effectively at the public hearing, GenPGM is required to provide the inputs for the MineMod water quality model by January 14, 2022.*

GenPGM Response:

Further information, as requested by the Joint Review Panel, is provided in Attachment A.

List of Attachments

Attachment A: Marathon Palladium Project: MineMod™ Theory Manual

ATTACHMENT A: MARATHON PALLADIUM PROJECT: MINEMOD™ THEORY MANUAL

MARATHON PALLADIUM PROJECT: MINEMOD™ THEORY MANUAL

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Ref. 20-2722
14 January 2022

MARATHON PALLADIUM PROJECT: MINEMOD™ THEORY MANUAL

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Project Principal and Reviewer

EXECUTIVE SUMMARY

The following report provides a description of the theoretical basis for the water quality model, MineMod™, used to generate water quality predictions for the Marathon Palladium Project. This document is intended to give technical reviewers sufficient information on the inputs and workings of the model to reproduce and check calculations to verify the results. The quantitative approach to the assessment of potential surface water quality effects uses numerical modelling to predict water quality that includes the concentrations of individual water quality constituents, in water courses and water bodies that receive Project related waters.

This report is to be used to aid in the understanding of the underlying water quality model and is broken down into the following sections:

- General Model Theory: outlines the theory behind each of the individual components that generate the mine site, component assumptions, and governing equations;
- Water Balance, Geochemistry, and Loading Rates;
- Description of the numerical method that solves the resulting water quality model; and;
- Example Pathway Calculation: provides a steady-state calculation averaged over a two-year period of a selected pathway.

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LIST OF FIGURES

1.0 Introduction

Generation PGM Inc. (GenPGM) proposes to develop the Marathon Palladium Project (the "Project"), which is a platinum group metals (PGM) and copper (Cu) open pit mine and milling operation near the Town of Marathon, Ontario. The Project is being assessed in accordance with the Canadian Environmental Assessment Act (2012) and Ontario's Environmental Assessment Act (EA Act) through a Joint Review Panel (the Panel) pursuant to the Canada-Ontario Agreement on Environmental Assessment Cooperation (2004).

Ecometrix Incorporated (Ecometrix) was retained by GenPGM to provide an updated water quality assessment for the Project. The intent of this report is to describe the theory underlying the geochemical modelling software known as MineMod™, as it relates to the created site-wide loadings model for the Project site and to the water quality assessment described in Ecometrix (2021; CIAR Ref#727-45). In addition, this document is intended to give technical reviewers sufficient information on the inputs and workings of the model to reproduce and check calculations to verify the results.

As well as providing the underlying theory for the mass balance equations, descriptions of the water balance, chemical loadings and numerical methods that construct and solve the model, this report also includes a sample pathway calculation in Section 7.0. The sample calculation is a steady-state calculation of the implemented MineMod™ model described in the Marathon Palladium Project – Water Quality Assessment (Ecometrix, 2021; CIAR Ref#727-45). This pathway analysis is used to demonstrate the input and outputs of different components of the model using a steady-state calculation of a selected flow pathway using site wide averages over a given 2-year period. This steady-state calculation gives an approximation of water quality throughout the mine site and estimates the water quality of effluent being discharged to the surrounding environment. It is important to note that the steady-state calculation of the 2-year period is not representative of the entire life cycle of the Project site and is only presented below for demonstration purposes. For more information on water quality predictions, see Ecometrix (2021; CIAR Ref#727-45).

2.0 MineMod™ Framework

MineMod™ is an *object-oriented* graphic software program that specializes in simulating the entire lifecycle of a mine site. Unlike more traditional scientific applications, which often create large simulation blocks of hand-crafted code for specific model descriptions, MineMod™ utilizes component modelling to create a versatile tool that can be easily and rapidly adapted to capture different mining processes and scenarios.

One of the largest benefits of component modelling is that each of the components are self contained units, meaning that they can be developed and tested individually before being integrated into the modelling software. Another added benefit of component modelling is that it allows for complex systems, such as mine sites, to be broken down into more manageable building blocks, as opposed to directly modelling the entire system. Not only does this make the modelling process more efficient, but it allows the user to easily and effectively gain insight into how each of the components affect the model output.

In MineMod™, the user can create a mine site model by manipulating and linking together a variety of defined mining components, such as process solids management facilities, pumping pipes, mine rock piles, open pits and process facilities to name a few. These components are what allow the user to track the water quality throughout the mine site and help to determine the overall impact that mining operations will have on the surrounding environment. Figure 2-1 illustrates the major components for the Project site.

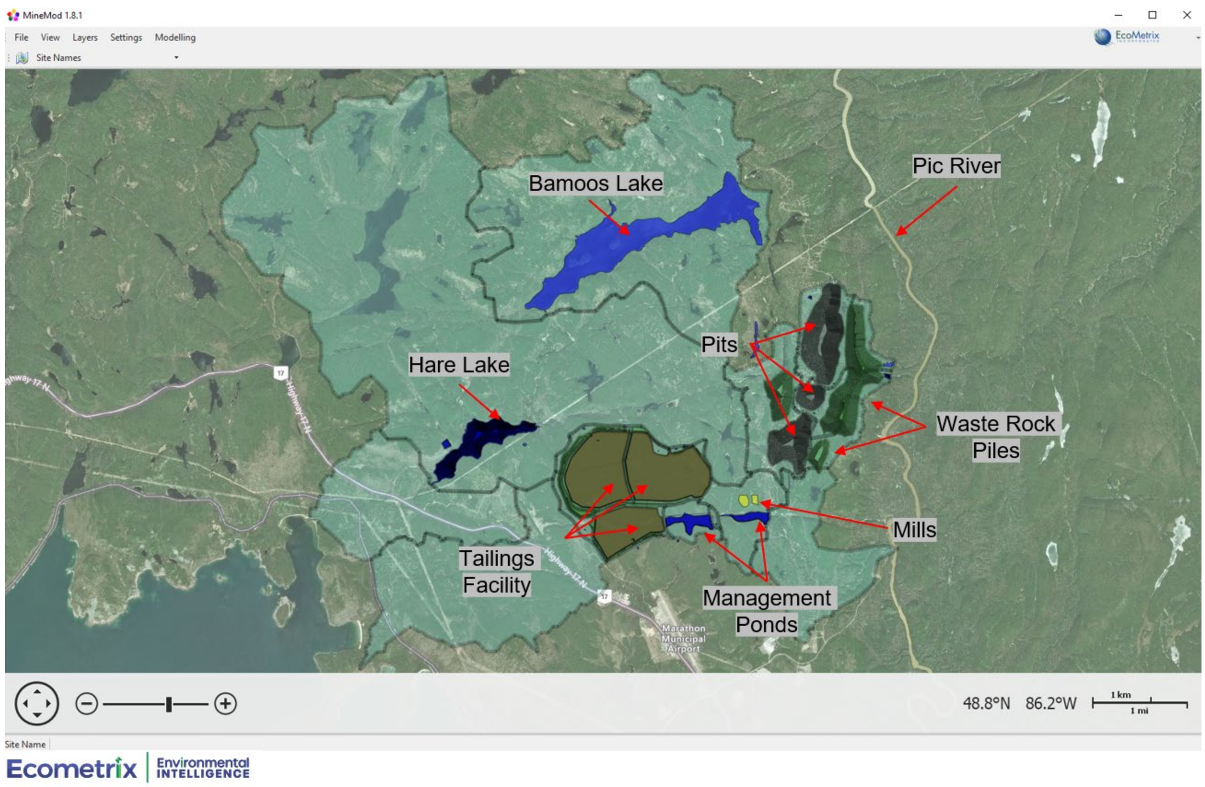

Figure 2-1: MineMod™ configuration of the Project site.

Figure 2-2 demonstrates a typical user-input interface for a pit component. By selecting each of the input boxes, the user can characterize that component, either directly within the MineMod™ interface or the user can import data directly to that component. This allows the user to specify key characteristics, such as flow rates, precipitation, evaporation, mass loadings, etc., of each component to accurately simulate the mine site.

After the mine site is fully characterized, the model is run and each of the model components generates an output file, which can be viewed directly within the MineMod™ interface, by selecting the green highlighted output boxes (Figure 2-2), or exported as a spreadsheet. Not only does MineMod™ allow the user to specify the time length of the simulation, but it also allows the user to select the frequency of the output data measurements. The model outputs detail the water quality within that feature over the duration of the simulation.

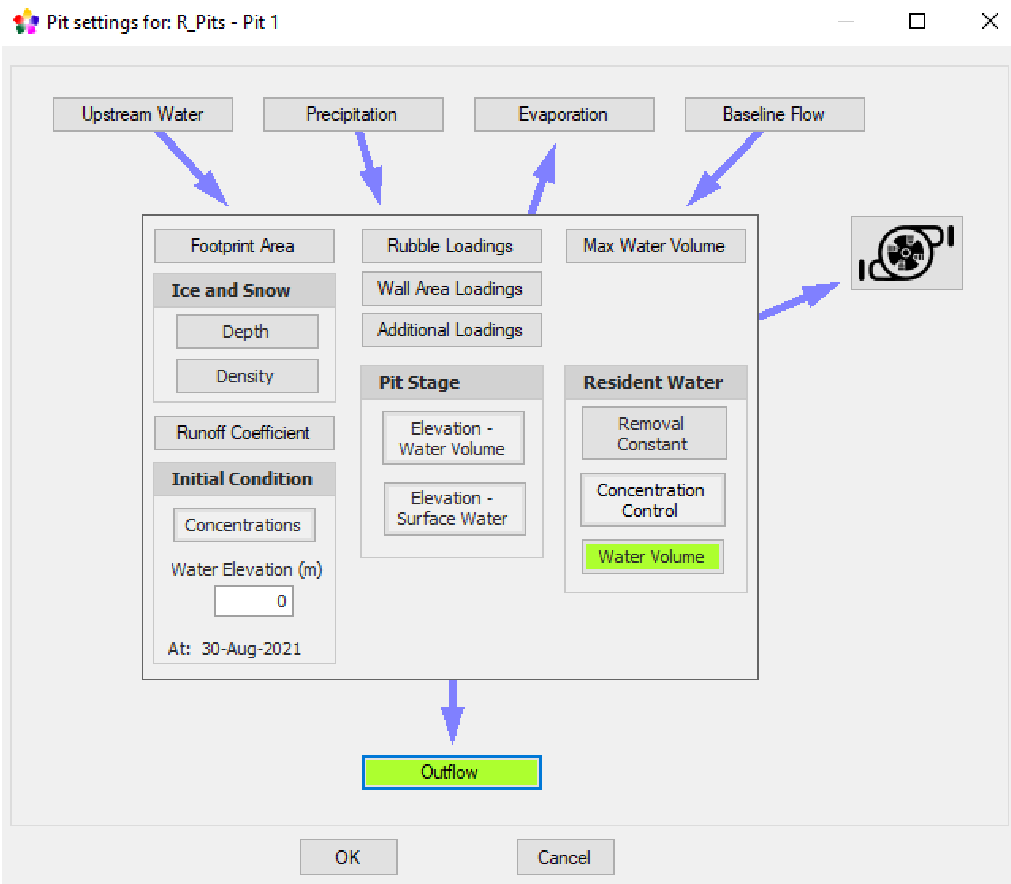

Figure 2-2: Sample Input Prompt for a Pit Component.

On a mine site, water flows from mine feature to mine feature. In MineMod™, each mine feature is represented by a model component and the model components can be connected to each other to model the flow of water on the site. The collection of the interconnected model components forms the mine site model, which can be used to predict water quality at any individual feature of the site.

Each MineMod™ component can store, create, remove, partition, or alter the water that it interacts with, altering site hydrology or water quality. The subsequent sections of this report describe the different model components that can be used to construct the overall mine site model.

The mine site in Marathon is modelled using a combination of multiple components. The components included in the model are pits, ponds, process solids management facilities, drainage areas, mine rock piles, process facilities, creeks and pipes, and pumping pipes.

3.1 Open Pit

3.1.1 Description

The pit model is constructed by balancing inflows/outflows of water along with constituent concentrations. The model accounts for background surface runoff, precipitation, evaporation, inflow from and outflow to other existing MineMod™ components, tracks the change in volume of water and change in constituent concentrations within the pit. With respect to geochemistry, the model accounts for chemical loadings from the pit walls and rubble inside the pit. A conceptual schematic of an open pit mine, both during operation and post closure is presented in Figure 3-3.

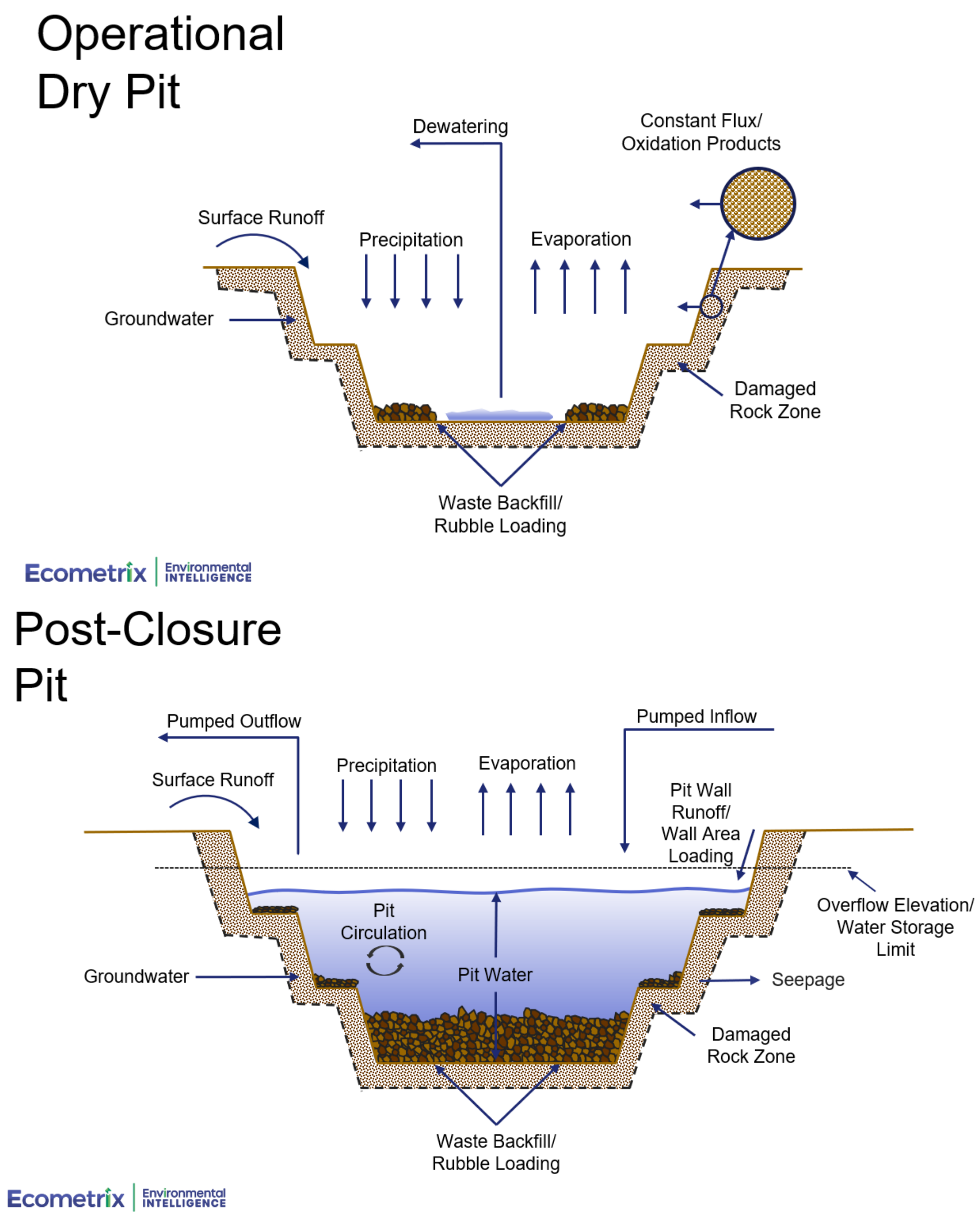

Figure 3-3: Conceptual Model of the Pit Component.

3.1.2 Assumptions

- Water balance is calculated as a balance between surface runoff, precipitation, evaporation, baseline flow, and local inflow/outflows from other components.
- The model has the capacity for first-order decay and production of constituents, as well as a user-specified mass loading rate to the pit.
- Mass of constituent is calculated as a balance between surface runoff loading, mine discharge loadings, local inflow and outflow loadings, decay and production within the pit, as well as generic user-defined mass loading events.
- The water-filled closed pit is assumed to be well-mixed at all times, meaning there are no horizontal or vertical concentration gradients.
- The water elevation in the pit can fluctuate over time.

3.1.3 Governing Equations

The pit water balance can be represented as a balance between incoming and outgoing flow, which may vary over time and may depend on mine operations, seasonal precipitation, and background water sources, such as streams and seasonal snow melt. The volume of water within the pit is calculated by balancing local sources and sinks. Sources of water for the pit include inflow from other upstream mine components (US), inflow from local surface runoff (SR), pumped flow from other mine components, baseline flow (B) to the pit from the surroundings and local precipitation (P). Outflows from the pit include overflow of the pit (OF), pumped withdrawals from the pit (PO), and evaporation (E). Accounting for each of these different processes, the water balance for the pit is described by

$$\frac{dV}{dt} = Q_{US} + Q_{SR} + Q_{PI} + Q_B - Q_{OF} - Q_{PO} + (P - E) \cdot i \cdot A$$ **Equation (1)**

where

V	= volume of water in pit (m^3)
t	= time (s)
Q_{US}	= inflow from upstream feature (m^3/s)
Q_{SR}	= inflow from local surface runoff (m^3/s)
Q_{PI}	= pumped flow from other features to pit (m^3/s)
Q_B	= user-specified baseflow (m^3/s)
Q_{OF}	= outflow, overflow from the pit (m^3/s)
Q_{PO}	= outflow, pumped withdrawals from the pit (m^3/s)
P	= precipitation (m/s)
E	= evaporation (m/s)
i	= runoff coefficient (unitless)
A	= surface area of the pit (m^2)

This equation can be simplified and re-written by combining all inflows and outflows as

$$\frac{dV}{dt} = \sum Q_{IN} - \sum Q_{OUT} + (P - E) \cdot i \cdot A$$ **Equation (2)**

where

$$\sum Q_{IN} = Q_{US} + Q_{SR} + Q_{PI} + Q_B$$ **Equation (3)**

$$\sum Q_{OUT} = Q_{OF} + Q_{PO}$$ **Equation (4)**

The change in mass of a target constituent within the pit is constructed by balancing incoming and outflowing mass. Incoming mass constituent can enter the pit from upstream mine components (US), local surface runoff (SR), pumped flow from other mine components (PI), and from baseline flow (B). Outflowing mass leaves the pit during pumped withdrawals from the pit (PO) during operations or pit overflow events (OF) after closure and water filling has occurred. The mass balance also accounts for decay (λ) of constituents following a first-order reaction, as well as a user-specified mass loading (L) within the pit. Accounting for all processes, the mass balance of a constituent within the pit is represented by

$$\frac{dM}{dt} = \frac{d(V \cdot C)}{dt} = \sum (Q_{IN} \cdot C_{IN}) - \sum Q_{OUT} \cdot C - \lambda \cdot V \cdot C + L$$ **Equation (5)**

$$\sum Q_{IN} \cdot C_{IN} = Q_{US} \cdot C_{US} + Q_{SR} \cdot C_{SR} + Q_{PI} \cdot C_{PI} + Q_B \cdot C_B$$ **Equation (6)**

$$\sum Q_{OUT} \cdot C = (Q_{OF} + Q_{PO}) \cdot C$$ **Equation (7)**

where

M	= mass of constituent in pit (kg)
C	= concentration in pit (kg/m^3)
C_{US}	= concentration from upstream feature (kg/m^3)
C_{SR}	= concentration from surface runoff (kg/m^3)
C_{PI}	= concentration from pumped low feature (kg/m^3)
C_B	= concentration in baseflow (kg/m^3)
C_{IN}	= concentration of inflow source (kg/m^3)
i	= runoff coefficient (unitless)
λ	= linear decay coefficient (s^{-1})
L	= user-specified mass loading of pit (kg/s)

Simplifying and rearranging, we obtain the chemical balance as

$$\frac{dC}{dt} = \frac{1}{V} \sum (Q_{IN} \cdot C_{IN}) - \left(\frac{1}{V} \frac{dV}{dt} + \frac{1}{V} \sum Q_{OUT} + \lambda \right) \cdot C + \frac{L}{V}$$ **Equation (8)**

3.2 Ponds

3.2.1 Description

The pond component represents an open body of water with different source inputs and outflow. The water body has a fixed water volume and acts as a mixing vessel for incoming constituents. The pond model is constructed by balancing inflows/outflows of water along with constituent concentrations. The model accounts for background surface runoff, precipitation, evaporation, inflow from and outflow to other existing mine components, and tracks the change in constituent concentrations within the pond. A conceptual model for the pond component is presented in Figure 3-4.

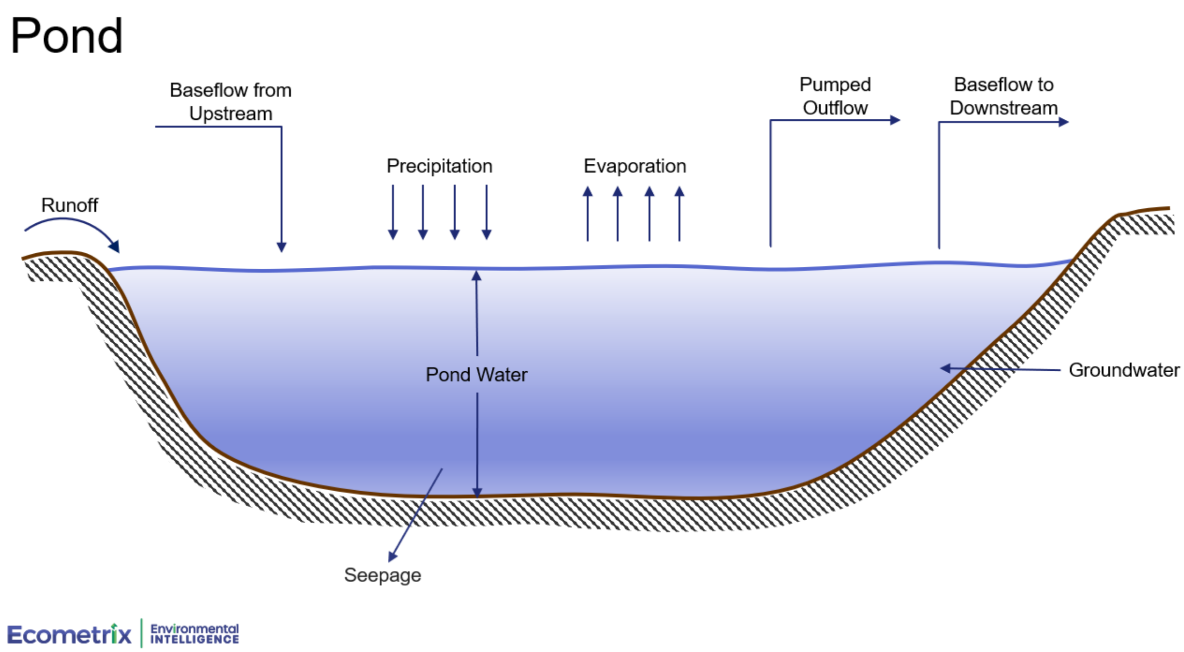

Figure 3-4: Conceptual Model of the Pond Component.

3.2.2 Assumptions

- The pond is assumed to be well-mixed at all times, meaning there are no horizontal or vertical concentration gradients.
- Water balance is calculated as a balance between surface runoff, precipitation, evaporation, and local inflow/outflows.
- The volume of the pond remains constant, i.e., change in volume with respect to time is zero.
- The model has the capacity for first-order decay and production of constituents, as well as user-specified mass loading of the pond.

- Mass of constituent is calculated as a balance between surface runoff loading, loadings from mine components, local inflow and outflow loadings, decay and production within the pond, as well as generic user-defined mass loading events.

3.2.3 Governing Equations

The pond water balance can be represented as a balance between incoming and outgoing flow, which each may vary over time and may depend on mine operations, seasonal precipitation, and background water sources, such as streams and seasonal snow melt. The volume of water within the pond remains constant and is calculated by balancing local sources and sinks. Sources of water for the pond include inflow from other upstream mine components (US), inflow from local surface runoff (SR), pumped flow from other mine components, baseline flow (B) to the pond from the surroundings and local precipitation (P). Outflows from the pond include overflow of the pond (OF), pumped withdrawals from the pond (PO), and evaporation (E). Accounting for each of these different processes and features, the water balance for the pond is described by

$$\frac{dV}{dt} = 0 = Q_{US} + Q_{PI} + Q_B - Q_{OF} + (P - E) \cdot A \qquad \textbf{Equation (9)}$$

where

V	= volume of water in pond (m^3)
t	= time (s)
Q_{US}	= inflow from upstream feature (m^3/s)
Q_{PI}	= pumped flow from other features to pond (m^3/s)
Q_B	= user-specified baseflow (m^3/s)
Q_{OF}	= outflow, overflow from the pond (m^3/s)
P	= precipitation (m/s)
E	= evaporation (m/s)
A	= surface area of the pond (m^2)

This equation can be simplified and re-written by combining all inflows and outflows as

$$\frac{dV}{dt} = 0 = \sum Q_{IN} - \sum Q_{OUT} + (P - E) \cdot A \qquad \textbf{Equation (10)}$$

where

$$\sum Q_{IN} = Q_{US} + Q_{PI} + Q_B \qquad \textbf{Equation (11)}$$

$$\sum Q_{OUT} = Q_{OF} \qquad \textbf{Equation (12)}$$

The change in mass of a target constituent within the pond is constructed by balancing incoming and outflowing mass. Incoming mass constituent can enter the pond from upstream mine features

(US), local surface runoff (SR), pumped flow from other mine features (PI), and from baseline flow (B). Outflowing mass leaves the pond during pond overflow events (OF) or during pumped withdrawals from the pond (PO). The mass balance also accounts for decay (λ) of constituents following a linear reaction, as well as a user-specified mass loading (L) within the pond. Accounting for all processes, the mass balance of a constituent within the pond is represented by

$$\frac{dM}{dt} = V\frac{dC}{dt} = \sum Q_{IN} \cdot C_{IN} - \sum Q_{OUT} \cdot C - \lambda \cdot V \cdot C + L$$ **Equation (13)**

$$\sum Q_{IN} \cdot C_{IN} = Q_{US} \cdot C_{US} + Q_{PI} \cdot C_{PI} + Q_B \cdot C_B$$ **Equation (14)**

$$\sum Q_{OUT} \cdot C = Q_{OF} \cdot C$$ **Equation (15)**

where

M	= mass of constituent in pond (kg)
C	= concentration in pond (kg/m^3)
C_{US}	= concentration from upstream feature (kg/m^3)
C_{PI}	= concentration from influent pumped water (kg/m^3)
C_B	= concentration in baseflow (kg/m^3)
C_{IN}	= concentration of inflow source (kg/m^3)
λ	= linear decay coefficient (s^{-1})
L	= user-specified mass loading of pond (kg/s)

If reactions do not occur, then the equation simplifies to

$$\frac{dM}{dt} = V\frac{dC}{dt} = \sum Q_{IN} \cdot C_{IN} - \sum Q_{OUT} \cdot C + L$$ **Equation (16)**

3.3 Process Solids Management Facility

3.3.1 Description

The process solids management facility (PSMF) feature calculates the water quality of a process solids management facility that has variable water elevation as well as process solids volumes. The PSMF model is constructed by balancing inflows/outflows of water along with constituent concentrations. The model accounts for background surface runoff, precipitation, evaporation, inflow from and outflow to other existing mine components. Since PSMFs often have a managed maximum volume, there is the option for the user to specify a pumping rate when the pond volume exceeds a defined threshold. Additionally, it incorporates potential geochemical loadings from the tailings beach which are carried into the PSMF pond as well as loadings from the underwater interface between the submerged tailings and the pond. A conceptual model of the PSMF is presented in Figure 3-5.

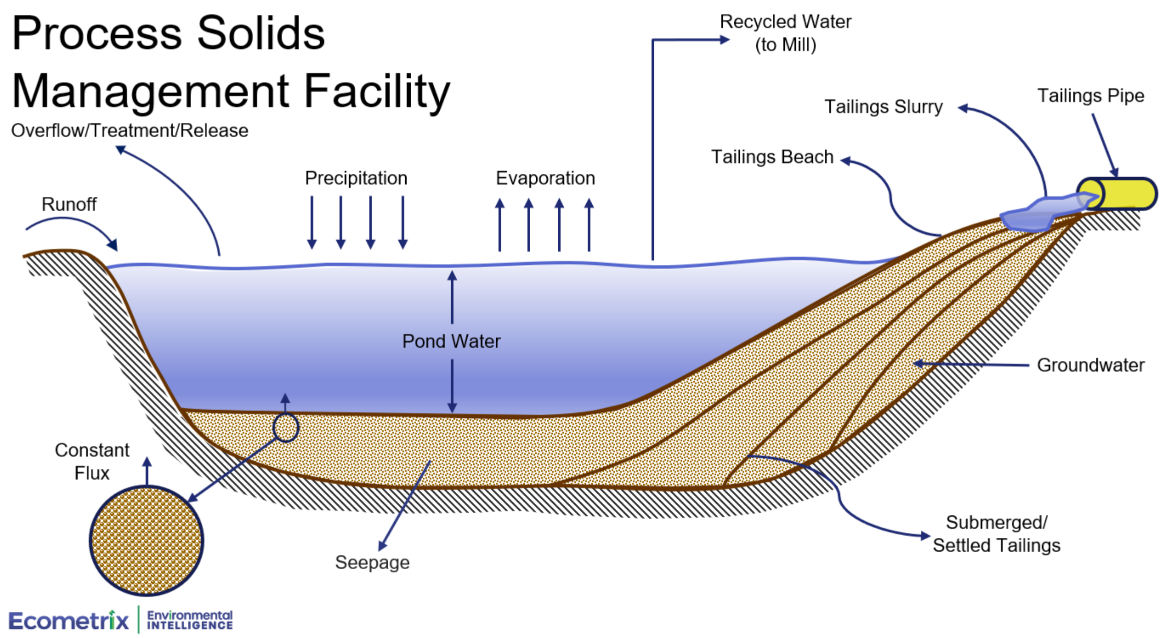

Figure 3-5: Conceptual Model of the PSMF Component.

3.3.2 Assumptions

- The PSMF pond is assumed to be well mixed at all times, implying no horizontal or vertical concentration gradients.
- Water balance is calculated as a mass balance between surface runoff, precipitation, evaporation, and local inflows/outflows, this includes both surrounding surface runoff and surface runoff from a tailings beach.
- The water elevation in the PSMF fluctuates over time as tailings are added to the facility.

3.3.3 Governing Equations

The flow from the tailings beach to the PSMF is calculated using local precipitation and characteristics of the tailings beach including tailings beach evaporation, tailings beach area, and a tailings beach runoff coefficient. The tailings beach flow is calculated as

$$Q_{beach} = (P - E_{beach}) \cdot A_{beach} \cdot i$$ **Equation (17)**

where

Q_{beach}	= beach surface runoff (m^3/s)
P	= precipitation (m/s)
E_{beach}	= beach evaporation (m/s)
A_{beach}	= area of the tailings beach (m^2)
i	= runoff coefficient of the tailings beach (unitless)

The PSMF water balance can be represented as a balance between incoming and outgoing flow, which each may vary over time and may depend on mine operations, seasonal precipitation, and background water sources, such as streams and seasonal snow melt. The volume of water within the PSMF is calculated by balancing local sources and sinks. Sources of water for the PSMF include inflow from other upstream mine components (US), inflow from local surface runoff (SR), pumped flow from other mine components, and local precipitation (P). Outflows from the PSMF include overflow of the PSMF (OF), pumped withdrawals from the PSMF (PO), and evaporation (E). An additional water balance terms comes from the calculated from of the tailings beach. Accounting for each of these different processes and features, the water balance for the PSMF is described by

$$\frac{dV}{dt} = Q_{US} + Q_{SR} + Q_{PI} - Q_{OF} - Q_{PO} + (P - E) \cdot A + Q_{beach}$$ **Equation (18)**

where

V	= volume of water in the PSMF (m^3)
t	= time (s)
Q_{US}	= inflow from upstream feature (m^3/s)
Q_{SR}	= inflow from local surface runoff (m^3/s)
Q_{PI}	= pumped flow from other features to pond(m^3/s)
Q_{OF}	= outflow, overflow from the pond (m^3/s)
Q_{PO}	= outflow, pumped withdrawals from the pond (m^3/s)
P	= precipitation into the PSMF (m/s)
E	= evaporation from the PSMF (m/s)
A	= surface area of the PSMF (m^2)

This equation can be simplified and re-written by combining all inflows and outflows as

$$\frac{dV}{dt} = \sum Q_{IN} - \sum Q_{OUT} + (P - E) \cdot A + (P - E_{beach}) \cdot A_{beach} \cdot i$$ **Equation (19)**

where

$$\sum Q_{IN} = Q_{US} + Q_{SR} + Q_{PI}$$ **Equation (20)**

$$\sum Q_{OUT} = Q_{OF} + Q_{PO}$$ **Equation (21)**

The change in mass of a target constituent within the PSMF is constructed by balancing incoming and outflowing mass. Incoming mass constituent can enter the PSMF from upstream mine components (US), local surface runoff (SR), pumped flow from other mine components (PI), and from baseline flow (B). Outflowing mass leaves the PSMF during pond overflow events (OF) or during pumped withdrawals from the pond (PO). The mass balance also accounts for beach surface runoff loadings (BL) and underwater loadings (UL). Accounting for all processes, the mass balance of a constituent within the pond is represented by

$$\frac{dM}{dt} = \frac{d(V \cdot C)}{dt} = \sum (Q_{IN} \cdot C_{IN}) - \sum Q_{OUT} \cdot C + BL + UL$$ **Equation (22)**

$$\sum Q_{IN} \cdot C_{IN} = Q_{US} \cdot C_{US} + Q_{SR} \cdot C_{SR} + Q_{PI} \cdot C_{PI} + C_{beach} \cdot Q_{beach}$$ **Equation (23)**

$$\sum Q_{OUT} \cdot C = (Q_{OF} + Q_{PO}) \cdot C$$ **Equation (24)**

where

M	= mass of constituent in PSMF (kg)
C	= concentration in pond (kg/m^3)
C_{US}	= concentration from upstream feature (kg/m^3)
C_{SR}	= concentration from surface runoff (kg/m^3)
C_{PI}	= concentration from pumped low feature (kg/m^3)
C_{beach}	= concentration of beach constituent (kg/m^3)
C_{IN}	= concentration of inflow source (kg/m^3)
BL	= mass loading of the tailings beach (kg/s)
UL	= mass loading of the underwater tailings (kg/s)

Simplifying and rearranging, we have the chemical balance given by

$$\frac{dC}{dt} = \frac{1}{V}\sum (Q_{IN} \cdot C_{IN}) - \left(\frac{1}{V}\frac{dV}{dt} + \frac{1}{V}\sum Q_{OUT}\right) \cdot C + \frac{BL + UL}{V}$$ **Equation (25)**

3.4 Drainage Area

3.4.1 Description

A drainage area is a generalized area within the mine site that generates surface runoff during rainfall and snow-melt events and transports it towards other features located within the drainage area.

3.4.2 Assumptions

- Drainage area can contain other components if other component centroids are inside the drainage area boundary.
- A drainage area will collect water from mine rock piles and process solids and send it to a containing pit or pond.

3.4.3 Governing Equations

The flow to the drainage area from local surface runoff is calculated using local precipitation and characteristics of the drainage area evaporation, area, and drainage area runoff coefficient. The background surface runoff (SR) to the drainage area is calculated as

$$Q_{SR} = (P - E) \cdot A \cdot i$$ **Equation (26)**

where

Q_{SR}	= surface runoff flow (m^3/s)
P	= precipitation (m/s)
E	= evaporation (m/s)
A	= area of the drainage area (m^2)
i	= runoff coefficient of the drainage (unitless)

Water flow through the drainage area can be represented as a balance between incoming and outgoing flow as

$$Q_{DA} = Q_{SR} + \sum Q_{US}$$ **Equation (27)**

where

Q_{DA}	= total flow to the drainage area (m^3/s)
Q_{US}	= inflow to drainage area from upstream features (m^3/s)

The mass balance for constituents dissolved in the drainage incorporates upstream concentrations (US), surface runoff concentrations (SR), and the potential for mass loading (L). The mass balance for the drainage area is given as

$$\frac{dM}{dt} = V \cdot \frac{dC}{dt} = Q_{SR} \cdot C_{SR} + \sum Q_{US} \cdot C_{US} + L$$ **Equation (28)**

where

M	= mass of constituent in creek (kg)
C	= concentration in drainage area (kg/m^3)
C_{US}	= concentration from upstream feature (kg/m^3)
C_{SR}	= concentration from surface runoff (kg/m^3)
L	= user-specified mass loading of drainage area (kg/s)

3.5 Mine Rock Storage Area (MRSA)

3.5.1 Description

Precipitation that lands on a mine rock pile either evaporates, runs of the surface, infiltrates and exits the mine rock pile as seepage, or infiltrates the rock pile and enters the groundwater below the rock pile. Water that leaves a mine rock pile can carry some of the mine rock material to downstream water bodies, potentially posing an environmental challenge.

MineMod™ models mine rock piles by tracking water movement according to these different pathways (Figure 3-6). Precipitation that lands on the mine rock pile is split into evaporation, runoff, and infiltration. Runoff water receives chemical loadings from the surface layer and exits mine rock pile as surface outflow, carrying the loadings with it. Similarly, water that infiltrates into the mine rock pile carries chemical loadings from the bulk stock pile. However, the infiltrated water is further divided between the mine rock seepage and infiltration to groundwater.

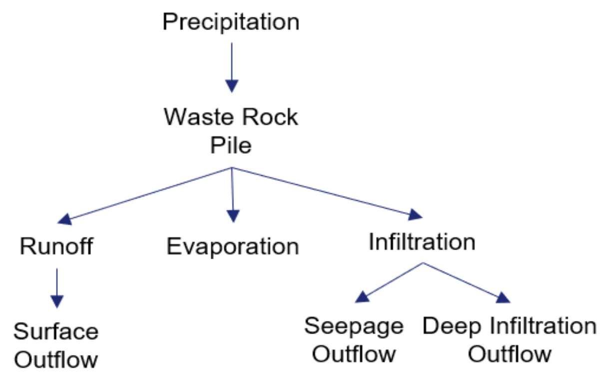

Figure 3-6: Water paths within a Mine Rock Pile.

Water percolating through the mine rock in the MRSA can interact with the rock and chemical reactions can lead to leching of chemical constituents into the water. Some of the important reactions that affect water quality include oxygen and water. A conceptual model for a mine rock pile is presented in Figure 3-7. Estimations of the chemical reactions and their rate are typically measured in the laboratory in Humidity Cell Tests for planned mines or in Field Test cells for operating mines. The results from those tests are used as a basis for estimating loading rates and concentrations in full scale MRSA. The scales of the tests are accounted for in estimating rates of reactions in a mine rock pile. The scales of the tests are shown comparatively to the MRSA in Figure 3-7.

Water percolating though the pile can become chemically saturated with select chemical constituents while in the mine rock pile. To account for this, MineMod™ presents the opportunity to implement a concentration-control on the different streams of water in the mine rock pile, meaning a maximum concentration can be imposed for modelling.

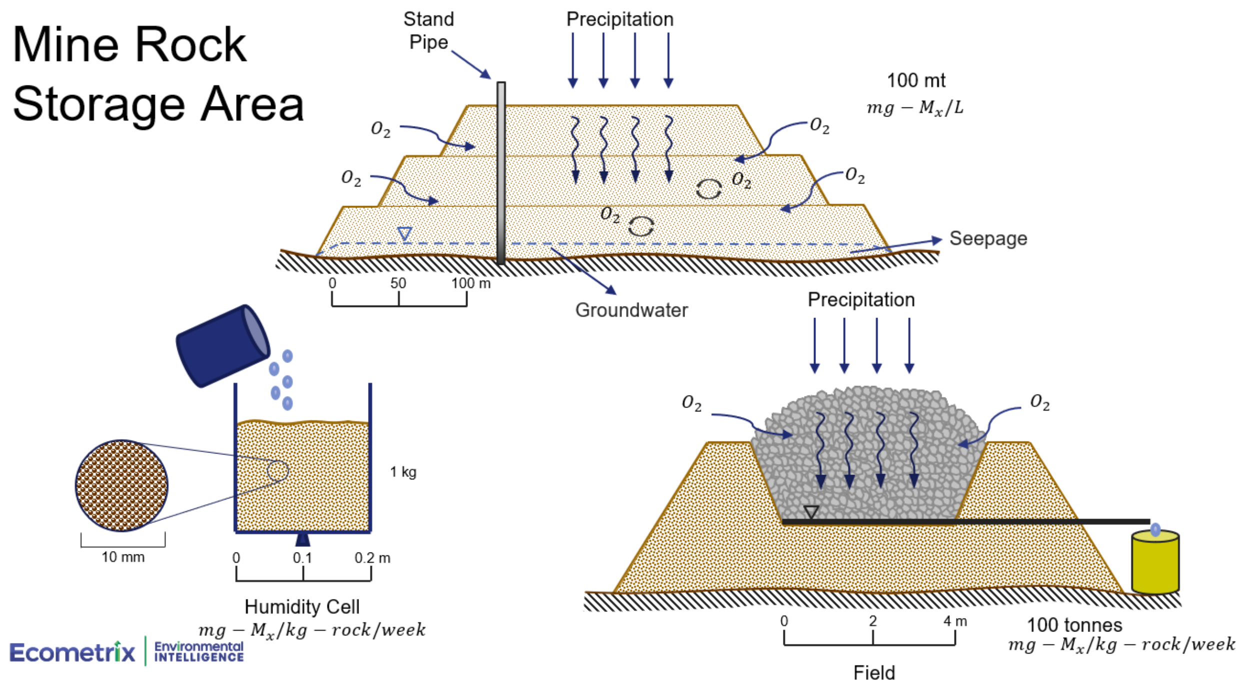

Figure 3-7: Conceptual Model of a Mine Rock Pile Component.

3.5.2 Assumptions

- Water enters the mine rock pile from the surface.
- Water flow is broken into three compartments (surface, seepage, groundwater) depending on the rock that it interacts with (see Figure 3-6).
- Concentrations are calculated from chemical loading rates within the mine rock pile.
- Outflow is calculated for the base of the mine rock pile.

3.5.3 Governing Equations

The flow of water at the surface of the mine rock pile is calculated by balancing precipitation and evaporation over the area of the rock pile. The flow of water at the surface of the rock pile is calculated as

$$Q_{WR} = \frac{dV}{dt} = (P - E) \cdot A$$ **Equation (29)**

where

Q_{WR}	= surface water flow of mine rock pile (m^3/s)
V	= surface volume of water (m^3)
P	= precipitation (m/s)
E	= evaporation (m/s)
A	= area of the mine rock pile (m^2)

This volume of water is distributed through the mine rock pile as surface runoff (SR) , seepage (S), and groundwater (GW) following

$$Q_{WR} = Q_{SR} + Q_S + Q_{GW}$$ **Equation (30)**

$$Q_{SR} = Q_{WR} \cdot \alpha_{SR}$$ **Equation (31)**

$$Q_S = Q_{WR} \cdot (1 - \alpha_{SR}) \cdot (1 - \alpha_{GW})$$ **Equation (32)**

$$Q_{GW} = Q_{WR} \cdot (1 - \alpha_{SR}) \cdot \alpha_{GW}$$ **Equation (33)**

where

Q_{WR}	= volumetric flow of water interacting with the mine rock pile (m^3/s)
Q_{SR}	= surface outflow from mine rock pile (m^3/s)
Q_S	= seepage outflow from mine rock pile (m^3/s)
Q_{GW}	= groundwater outflow from mine rock pile (m^3/s)
α_{SR}	= fraction of water in mine rock as surface runoff (unitless)
α_{GW}	= fraction of water in mine rock as groundwater (unitless)

The concentration of a constituent in the outflowing water from the mine rock pile is calculated directly from the mine rock that it encounters. There are separate chemical loading rates from the surface layer (SL) of mine rock and mine rock in the bulk layer (BL). Therefore, we have that the concentration of constituent in each outflowing water type (surface runoff, seepage, groundwater) is calculated as

$$C_{SR} = \frac{M_{WRSL} \cdot L_{WRSL}}{Q_{SR}}$$ **Equation (34)**

$$C_S = \frac{M_{WRBL} \cdot L_{WRBL}}{Q_S}$$ **Equation (35)**

$$C_{GW} = \frac{M_{WRGW} \cdot L_{WRGW}}{Q_{GW}}$$ **Equation (36)**

where

C_{SR}	= concentration in surface outflow from mine rock pile (kg/m^3)
C_S	= concentration in seepage outflow from mine rock pile (kg/m^3)
C_{GW}	= concentration in groundwater outflow from mine rock pile (kg/m^3)
M_{WRSL}	= mass of mine rock in surface layer (kg)
M_{WRBL}	= mass of mine rock in bulk layer (kg)
L_{WRSL}	= mass flux from mine rock in surface layer (kg/kg/s)
L_{WRBL}	= mass flux from mine rock in bulk layer (kg/kg/s)

3.6 Process Facility

3.6.1 Description

Process Facilities are mills and water treatment plants that extract elements out of the processing flows.

3.6.2 Assumptions

- Process facility alters the concentrations in process water.
- Process facility does not store water.
- Process facility has two states for each constituent, (1) Treatment and (2) non- Treatment.
- When the inlet concentration is above the user-specified start concentration for a constituent, the facility alters the concentration. When the inlet concentration is below the user-specified stop concentration for a constituent, the facility does not alter the input concentration.
- When the process facility is altering a constituent concentration, the constituent's outlet concentration is equal to the user-specified "target concentration." When the process facility is not altering a constituent, the outlet concentration is the same as the inlet concentration.

3.6.3 Governing Equations

The process facility contains no water storage capacity, meaning the outflow rate of a process facility is equal to its intake.

$$Q_{OUT} = \sum Q_{US} \qquad \textbf{Equation (37)}$$

where

Q_{OUT}	= outflow of water from a process facility (m^3/s)
Q_{US}	= inflow to process facility from upstream features (m^3/s)

When the process facility is not altering the source water, there is no change in concentration of the constituent, i.e., water flows directly through the process facility. When the facility is altering concentration in water, the concentration of constituent is changed to a user-specified effluent concentration.

The process facility begins altering a constituent when the influent water exceeds a user-specified "start concentration" and ends when the influent concentration decreases below the user-specified "stop concentration."

3.7 Creeks and Pipes

3.7.1 Description

Creeks and pipes connect water components and guide water flow between components.

3.7.2 Assumptions

- The creek carries water from upstream features and releases it downstream.
- The creek incorporates the mixture of baseflow into the creek and has the potential of a user-defined mass loading event during transport.
- No reactions take place within the creek.
- The creek is fully mixed by the outlet.

3.7.3 Governing Equations

The water balance for the creek is straightforward in that the total flow out of the creek at the downstream end is equal to the baseline flow (B) and the sum of the inflow from all other upstream (US) features. Therefore, as the water balance for the creek is represented by

$$\frac{dV}{dt} = 0 = Q_B + \sum Q_{US} - Q_{OUT}$$ **Equation (38)**

where

V	= volume of the creek (m^3)
Q_B	= baseline flow of the creek (m^3/s)
Q_{US}	= inflow to creek from upstream features (m^3/s)
Q_{OUT}	= outflow of water from a creek (m^3/s)

The water balance for the creek can be simplified and represented as

$$Q_{OUT} = Q_B + \sum Q_{US}$$ **Equation (39)**

which states that the outflow from the creek is equal to the sum of the inflows.

The mass balance for constituents dissolved in the stream incorporates upstream concentrations (US), concentrations in the baseline flow (B), and the potential for mass loading (L) throughout the creek. The mass balance for the creek is given as

$$\frac{dM}{dt} = V \cdot \frac{dC}{dt} = Q_B \cdot C_B + \sum Q_{US} \cdot C_{US} + L$$ **Equation (40)**

where

M	= mass of constituent in creek (kg)
C	= concentration in creek (kg/m^3)
C_{US}	= concentration from upstream feature (kg/m^3)
C_B	= concentration in baseflow (kg/m^3)
L	= user-specified mass loading of creek (kg/s)

3.8 Pumping Pipe

3.8.1 Description

Pumping pipes connect water components and guides water flow between features. While the creeks and pipes feature passively accept water from upstream components, pumping pipes actively pull water from upstream features and move it downstream.

3.8.2 Assumptions

- The pumping pipe pumps water from an upstream feature and releases it downstream.
- The pumping pipe incorporates the mixture of baseflow into the creek and has the potential of a user-defined mass loading event during transport.
- No reactions take place within the pumping pipe.

3.8.3 Governing Equations

The water balance for the pumping pipe is straightforward in that the total flow out of the pumping pipe at the downstream end is equal to the pumped flow from the upstream (US) component.

$$\frac{dV}{dt} = 0 = Q_B + \sum Q_{US} - Q_{OUT}$$ **Equation (41)**

where

V	= volume of water in pumping pipe (m^3)
Q_B	= baseline flow of pumping pipe (m^3/s)
Q_{US}	= inflow to pipe from upstream features (m^3/s)
Q_{OUT}	= outflow of water from pumping pipe (m^3/s)

The water balance for the pumping pipe can be simplified and represented as

$$Q_{OUT} = Q_B + \sum Q_{US}$$ **Equation (42)**

which states that the outflow from the pumping pipe is equal to the pumped flow from the upstream source.

The mass balance for constituents dissolved in the pumping pipe is based only on upstream

$$\frac{dM}{dt} = V \cdot \frac{dC}{dt} = Q_B \cdot C_B + \sum Q_{US} \cdot C_{US} + L$$ **Equation (43)**

where

M	= mass of constituent in the pumping pipe (kg)
C	= concentration in the pumping pipe (kg/m^3)
C_{US}	= concentration from the upstream feature (kg/m^3)
C_B	= concentration in baseflow (kg/m^3)
L	= user-specified mass loading of the pumping pipe (kg/s)

3.9 Additional Model Component Features

3.9.1 Ice and Snow

An ice and snow feature is available as an input in the following components: Pit, Pond, PSMF, MRSF and Drainage Area. This feature allows the user to specify the conversion of open water, for example in a pit, pond, or PSMF, water will be removed from the water cap (as a sink) and converted to ice with a user-defined thickness and density and can be affected by surrounding weather conditions, i.e., precipitation. In features such as a mine rock pile and drainage area, formation of ice and snow occurs due to surrounding weather conditions. As ice and snow begins to dissipate, water is released back to the underlying component as a source. An underlying assumption of the ice and snow feature is that all ice and snow is formed/dissipates instantaneously and consists only of pure water, i.e., water that contains no particulate matter or dissolved constituents and therefore only affects the water balance.

3.9.2 Concentration Control

The concentration control feature is available as a user-constraint for the release of water from specific components including Pit, MRSF (surface outflow, seepage outflow, deep infiltration outflow), PSMF, and Process Facility. This feature allows mine operators to intervene and treat water before it is discharged from that component. The concentration control is a dynamic control that can be set to become active when the concentration of a constituent exceeds a threshold value. When the concentration control feature is active, it overrides the mass balance of a defined constituent and alters the concentration of that constituent to a user-defined value.

3.9.3 Outflow Fractions

The outflow fractions feature is available for all model components. This feature allows the user to specify the distribution/fraction of water that is leaving a feature and entering a downstream feature. The default MineMod™ outflow fraction is calculated as an equal fraction depending on the number of downstream features. This feature allows the user to more precisely determine the flow path of water on a mine site.

4.0 Site Water Balance

Knight Piésold (2021; CIAR Ref#727-39) has developed an updated site water balance for the Project. The water balance was prepared using the GoldSim software package (GoldSim Technology Group LLC, 2019) and includes all Project phases. A stochastic analysis was completed to consider normal, wet, and dry conditions. The water balance report describes the water management strategy, analysis assumptions, methodology, and results of the water balance analysis in detail. Within the context of the development of the water quality model and associated water quality predictions, the site water balance is overlain on the natural hydrological system in the study area and ultimately provides estimates of the quantities of water that will be moving around the site as well as those released from the site to the environment.

The MineModTM model for the project incorporated the site water balance from Knight Piésold. The base case water quality model corresponded to the physical descriptions of mine infrastructure as described in Table 2 of Knight Piesold (2021; CIAR Ref #727-39) and the 50th percentile conditions as shown in Tables 3, 4, 5 and 6 of Knight and Piesold (2021; CIAR Ref #727-39). For reference, the aforementioned tables are provided in Appendix A of this report. For a complete description of the site water balance see Ecometrix (2021; CIAR Ref#727-45) and Knight Piésold (2021; CIAR Ref #727-39).

4.1 Local Hydrology

Local baseline hydrologic conditions that were used to develop the base case WQ model were provided by Stantec (2020; CIAR Ref # 722-5) in the updated baseline hydrology report, with specific reference to Table 6.5 that describes local subwatershed areas and Table 6.8 that shows the equations that represent the relationships between mean monthly flow and catchment area size. For reference the aforementioned tables are reproduced in Appendix A of this report. Flow data for the Pic River are represented by monitoring data for Water Survey of Canada Station 02BB003 located approximately 3.4 km from the Project site. Physical and limnological information for Hare Lake has been presented in several documents (e.g., Ecometrix, 2020; CIAR Ref #722-4), and key base case model inputs were summarized in the updated water quality assessment (Ecometrix, 2021; CIAR Ref#727-45) as reproduced here: *Hare Lake is northwest of the site and discharges to Hare Creek at the western end, which outlets to Lake Superior approximately 3 km downstream at Port Munroe. The surface area of the lake is ~57 ha, total lake volume is approximately 8.5 M m^3 and maximum and average depths are 30 m and 15 m. Lake retention time, based on annual average flows, is in the order of 6 to 7 months.*

In addition, the base case WQ model integrates changes in baseline hydrological conditions that will result due alterations in subwatershed areas that reflect project site development and then project site restoration at closure. The project-related changes to baseline hydrological conditions are described by Stantec (2021; CIAR Ref # 727-37), specifically referencing Table 6.4 of that report. For reference the aforementioned table is reproduced in Appendix B of this report.

5.0 Geochemistry and Loading Rates

Kinetic test cell results for mine rock and process solids and the submerged column tests for the high sulphur materials formed the basis of the loading rates used to populate different components of the model. The loading rates associated with each mine component are summarized below. For full details related geochemical prediction methods and loading rates, see Section 2.5 and Appendix A of the Marathon Palladium Project – Water Quality Assessment Update (Ecometrix, 2021; CIAR Ref#727-45). Relevant input information associated with geochemistry and loading rates are reproduced in Appendix C of this report for clarity.

5.1 Loading Rates for Mine Rock

The results from humidity cell tests containing mine rock were utilized in the development of loading rates for mine rock that will be placed in mine rock stockpiles, exposed on pit walls and as rubble remaining on the pit benches.

The average values were selected to represent the loading rates for most constituents for the individual mine rock types as summarized in (Ecometrix, 2021; CIAR Ref#727-45) Appendix A. Loading rates remain unchanged from those presented in the original EIS documentation, with the exception of the temperature scaling factor. The original laboratory rates applied a temperature correction factor of 0.17 to represent field conditions, whereas the rates presented herein applied a more conservative scaling factor for temperature of 0.3 as recommended in MEND (2006).

5.2 Loading Rates for Low Sulphur Process Solids

Loading rates for low sulphur constituents were estimated from the steady state unit rates observed for the humidity cell tests. The steady state loading rates were generally represented by the average humidity cell loading rates from week 44 to the end of the test at week 52. The results for most of the constituents are represented by concentrations in the leachate that are below analytical detection limits and therefore the estimated loading rates will represent conservative maximum values and will require careful interpretation when the effects of seepage on the local watershed drainage are considered. The loading rates are summarized in Ecometrix (2021; CIAR Ref#727-45): Appendix A.

5.3 Loading Rates for Submerged Process Solids

5.3.1 Submerged High Sulphur Process Solids

The loading rates were estimated from mass balance calculation for the overlying water including mass associated with samples collected for chemical analysis. The mass release from high sulphur process solids was calculated weekly to provide estimates of loading rates in mg/wk and then divided by the surface area of the solids to provide flux values in units of $mg/m^2/wk$. Some of these loadings rates were subject to adjustments including those for aluminum and iron that will be controlled by solubility constraints at the pH value of the overlying water. The loading rates are summarized in Ecometrix (2021; CIAR Ref#727-45): Appendix A.

5.3.1.1.1 Submerged Bulk Process Solids

The loading rates (mg/wk) were estimated from mass balance calculations that included mass associated with samples collected for analysis to quantify weekly release rates. The loading rates were then converted to flux values (mg/m^2/wk) by dividing by the surface area of the submerged process solids. The results are summarized in Ecometrix (2021; CIAR Ref#727-45): Appendix A.

5.3.2 Loading Rates for Pit Walls and Rubble on Pit Benches

The pit walls and rubble on the pit benches will contribute loadings of constituents to the pit water during operations. These loadings were estimated to allow an assessment of pit water quality.

The loadings from the pit walls and from the rubble on the benches were estimated with the following assumptions;

- the pit development schedule was a function of excavated rock to calculate pit wall heights and bench areas,
- the loadings from walls were based on the exposed wall areas by year and were surface area controlled,
- the benches were assumed to be an average of 25 m wide and were a function of the open pit area, in plain view,
- the loadings from the benches assumed that rubble was 0.1 m thick and uniformly distributed, and,
- the loading rate from rubble was estimated from humidity cell results for low sulphur mine rock.

The loading rates of constituents estimated from humidity cell results are expressed in terms of mass of rock tested with units of mg/kg/wk.

The loading rates for rubble on the pit benches was estimated from humidity cell results with no correction for particle size or surface area. This means that the loading rates for rubble were assumed to be much greater than those for rock in the low sulphur stockpile.

All loading rates for pit walls and benches are summarized in Ecometrix (2021; CIAR Ref#727-45): Appendix A.

5.4 Quality of Seepage from the PSMF

The quality of seepage water will be a function of the initial process water in the process solids in the short to intermediate period, and a function of leaching of the surficial process solids and infiltration rates in the longer term. The pore water in the process solids at the end of the operation will slowly migrate downward to the natural ground and will migrate laterally to appear as seepage near the toes of the PSMF dams.

6.0 Method of Calculation

The model used to predict water quality throughout the Project site is constructed as a mass balance by accounting for various geochemical processes. As a result, the model is formulated as a system of differential equations, which are solved numerically using a standard finite difference method.

A finite difference method is a solution technique for solving differential equations that is described by a type of problem known as an initial value problems. The initial value problem consists of a differential equation (or a system of differential equations) along with initial evaluation points. An initial evaluation point is the starting point for the numerical solution and the solution to the equations emanate from this point. A standard initial value problem for a single ordinary differential equation is given below

$$\frac{dy}{dt} = f(t,y) \qquad a \le t \le b \qquad \textbf{Equation (44)}$$

subject to an initial condition $y(a) = \alpha$.

In the context of the Project model, each state variable (y) represents the mass of a given constituent and each forcing function (f) contains the various processes that affect the mass of the constituent (depending on the type of model component described in Section 3.0 above).

The general idea behind numerical solutions of differential equations is not to obtain a continuous approximation of the solution $y(t)$, but to instead generate approximations to the solution at various grid points over a given interval $[a, b]$.

The finite difference method solves Equation (44) by discretizing the time span into discrete points and uses information related to the derivative of the differential equation to determine how the solution behaves at the next time point. This process is analogous to substituting the time derivative of the differential equation using a forward difference approximation. At a given grid point, t_n, the derivative approximation is given by

$$\frac{y(t_n) - y(t_{n-1})}{\Delta t} = f\big(t_{n-1}, y(t_{n-1})\big) \qquad \textbf{Equation (45)}$$

Rearranging gives the solution to the differential equation at the next time step as

$$y(t_n) = y(t_{n-1}) + \Delta t \cdot f\big(t_{n-1}, y(t_{n-1})\big) \qquad \textbf{Equation (46)}$$

where the N uniform grid locations are given by $t_i = a + i \cdot \Delta t$, for $i = 1,2,3, \dots, N$ and $\Delta t = (b - a)/N$ so that the interval $[a, b]$ is split into evenly spaced segments. A visual representation of a single calculation of the finite difference method is given in Figure 6-8.

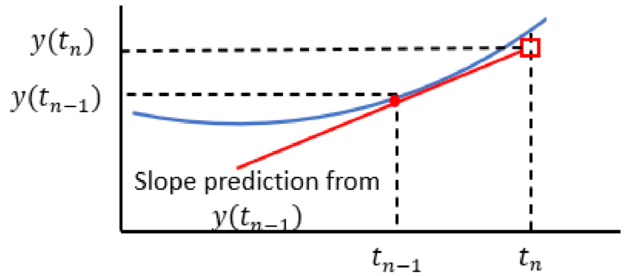

Figure 6-8: Visual representation of the slope prediction using a standard finite difference method.

7.0 Example Pathway Calculation

The intent of the example pathway calculation described in this section is to demonstrate the input and outputs of a selected pathway over a 2-year period. It is important to note that the pathway calculation is a steady-state calculation of the Project site, meaning that water flows and mass loading rates remain constant over the time period of interest, and as such, any water quality results given are considered to be approximations of the full site-wide model implemented in MineMod™. For more information on water quality predictions, see (Ecometrix, 2021; CIAR Ref#727-45).

7.1 Description of Pathway

Due to the complexity of the Project site, a sample pathway was selected to demonstrate how different aspects of each component are accounted for in the model. Below is a steady-state calculation of the model over a two-year time span (2025 - 2026). The pathway outlined in Figure 7-9 was selected to account for as many different components and features as possible.

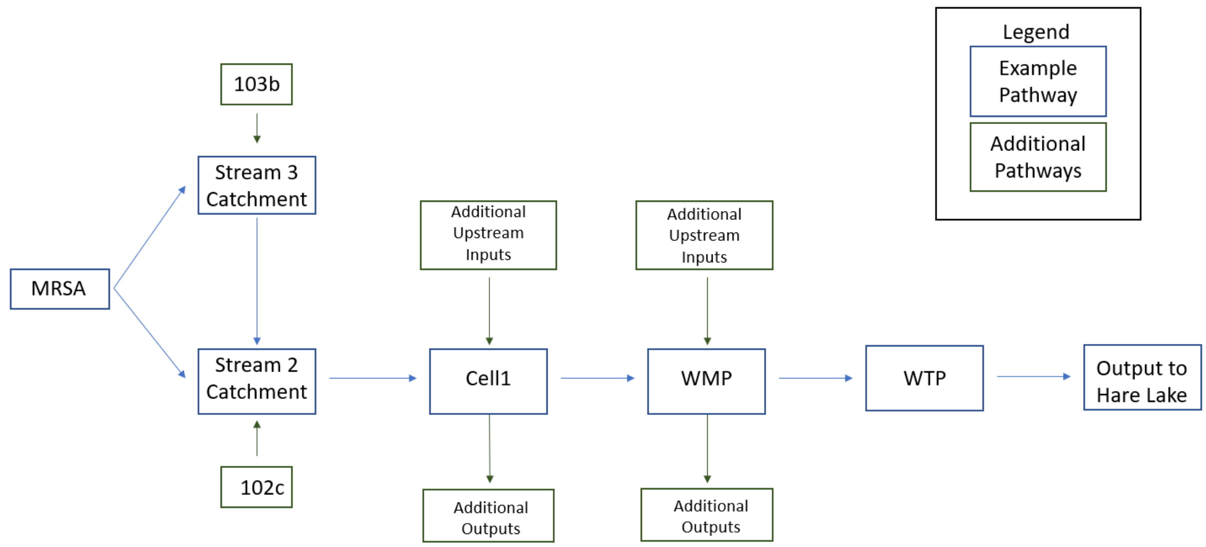

Figure 7-9: Sample Pathway Flow Chart.

Note here that the demonstration flow path is denoted by the boxes outlined in blue and additional model input/outputs are shown in the green boxes. These additional input/outputs must be considered in the overall mass balance to accurately reflect water quality and COPC concentrations. For the purpose of this demonstration only, the additional input/outputs are calculated using MineMod™ and are averaged across the years 2025 – 2026, it is important to note that all averaged concentrations were calculated for average flow rates.

In this example the flow of water follows a linear path with no re-circulation. This allows the evaluation of the model to begin at the highest upstream point (MRSA) and move towards the lowest downstream point (Hare Lake). Note that Stream 2 and Stream 3 Catchment Areas both receive water from the MRSA; however, Stream 3 Catchment Area is also an input for Stream 2 Catchment Area. For this reason, the order of calculation is as follows:

MRSA→Stream 3 Catchment Basin→Stream 2 Catchment Area→Cell 1→WMP→WTP→Hare Lake

For each of the components in the example pathway, steady-state equations based on the component type, averaged inputs (units given for MineMod™ and standard SI-units) for years 2025 -2026 and averaged additional pathway inputs are presented. The pathway calculations were completed for two chemical constituents of potential concern (COPC); with arsenic representing a trace constituent and magnesium representing a major ion in mine water systems.

For a full characterization of source terms for each component types, see Table 5-1 of the Marathon Palladium Project Updated Water Quality Assessment (Ecometrix, 2021; CIAR Ref#727-45).

7.2 Pathway Calculation

7.2.1 Mine Rock Storage Area

The MRSA is modelled as a mine rock pile. This means that water from precipitation is split into 3 categories, runoff, evaporation, and infiltration. Infiltrated water is again subdivided as seepage or deep infiltration. During the period of 2025 - 2026, it was assumed that there was no surface runoff or evaporation. Furthermore, infiltrated water only existed as seepage. Table 7-1 contains the two-year averaged parameters for the MRSA.

Table 7-1: 2025 – 2026 Average Input Parameters for the MRSA.

MRSA					
		Input Units		Standard Units	
Parameter	**Symbol**	**Unit**	**Value**	**SI-Units**	**Value**
Precipitation	P	mm/d	2.00	m/s	2.32E-07
Area	A	m^2	515095.9	m^2	5.15E+05
Runoff coefficient	i	-	0	-	0.00E+00
Infiltration coefficient	α_{SR}	-	0.32	-	3.20E-01
Bulk Rock Mass	M_{MRSA}	kg	3.58E+10	kg	3.58E+10
As (Loading)	L_{As}	mg/kg/wk	3.77E-06	1/s	6.23E-18
Mg (Loading)	L_{Mg}	mg/kg/wk	1.26E-03	1/s	2.08E-15

Applying Equation (30) to Equation (33) and noting that $Q_{SR} = Q_s = 0$, the outflow of water from the MRSA can be calculated as

$$Q_{MRSA} = Q_s = P \cdot A \cdot (1 - \alpha_{SR})$$ **Equation (47)**

Applying Equation (34) to Equation (36) and noting $C_{SR} = C_s = 0$, the outflow concentration of arsenic and magnesium are given by

$$C_{As} = \frac{P \cdot A \cdot M_{MRSA} \cdot L_{As}}{Q_S}$$ **Equation (48)**

$$C_{Mg} = \frac{P \cdot A \cdot M_{MRSA} \cdot L_{Mg}}{Q_S}$$ **Equation (49)**

7.2.2 Stream 3

Water and COPCs are transported from the MRSA to the Stream 3 Catch Basin via Stream 3. There is no change to the water balance or COPC concentration during the transport process of runoff from the catchment area.

7.2.3 Stream 3 Catchment Basin

Stream 3 Catch Basin receives a fraction of the water that exits the MRSA via Stream 3. Additional inputs into the Stream 3 Catchment Area include the underlying drainage area (103b).

Stream 3 Catch Basin is modelled as a pond because the water is captured and pumped out to keep the drainage water within the operation. Precipitation and evaporation were accounted for in the underlying watershed and the contribution of precipitation is added via Drainage Basin 103b. All other averaged parameters for the Stream 3 Catchment area are given in Table 7-2.

Table 7-2: 2025 – 2026 Average Input Parameters for the Stream 3 Catchment Area

Stream 3 Catchment Basin					
		Input Units		Standard Units	
Parameter	**Symbol**	**Unit**	**Value**	**SI-Units**	**Value**
MRSA Outflow Fraction to Stream 3	γ_{S3}	-	0.189	-	0.189
Other Inputs (103b)					
Flow	Q_{Other}^{S3}	L/s	8.05	m^3/s	0.008
As Concentration in 103b runoff	C_{Other}^{As}	mg/L	0	kg/m^3	0
Mg Concentration in 103b runoff	C_{Other}^{Mg}	mg/L	0	kg/m^3	0

Applying Equation (10) to Equation (12), the water balance for the Stream 3 Catchment Basin is calculated as

$$Q_{S3} = \gamma_{S3} \cdot Q_{MRSA} + Q_{Other}^{S3} \qquad \textbf{Equation (50)}$$

Applying Equation (13) - Equation (15), the concentration of arsenic and magnesium is calculated as

$$C_{S3}^{As} = \frac{\gamma_{S3} \cdot Q_{MRSA} \cdot C_{MRSA}^{As} + Q_{Other}^{S3} \cdot C_{Other}^{As}}{Q_{S3}} \qquad \textbf{Equation (51)}$$

$$C_{S3}^{Mg} = \frac{\gamma_{S3} \cdot Q_{MRSA} \cdot C_{MRSA}^{Mg} + Q_{Other}^{S3} \cdot C_{Other}^{Mg}}{Q_{S3}} \qquad \textbf{Equation (52)}$$

7.2.4 Stream 2

Water and COPCs are transported from the MRSA to Stream 2 Catchment Area via Stream 2. There is no change to the water balance or COPC concentrations during the transport process of runoff from the catchment area.

7.2.5 Stream 2 Catchment Basin

Stream 2 Catch Basin receives a fraction of the water that exits the MRSA via Stream 2 and all outflow water from Stream 2 Catchment Basin. Additional inputs into the Stream 2 Catchment Basin include the underlying drainage area (102c).

The Stream 2 Catch Basin is modelled hydraulicly similar to a pit rather than a pond so that water levels and volumes can change in the containment area as water accumulate and is pumped back to the operation. Similar to Stream 3, it was assumed that precipitation and evaporation was accounted for in the underlying watershed and the contribution of precipitation is added via

Drainage Basin 102c. All other averaged parameters for the Stream 2 Catchment Basin are given in Table 7-3.

Table 7-3: 2025 – 2026 Average Input Parameters for the Stream 2 Catchment Basin

Stream 2 Catchment Basin					
		Input Units		Standard Units	
Parameter	**Symbol**	**Unit**	**Value**	**SI-Units**	**Value**
MRSA Outflow Fraction to Stream 2	γ_{S2}	-	0.811	-	0.811
Other Inputs (102c)					
Flow	Q_{Other}^{S2}	L/s	9.61	m^3/s	9.61E-03
As Concentration in flow to Stream 2	C_{Other}^{As}	mg/L	1.07E-03	kg/m^3	1.07E-06
Mg Concentration in flow to Stream 2	C_{Other}^{Mg}	mg/L	0.11	kg/m^3	1.12E-04

Applying the steady-state versions of Equation (2), the outflow of water from the Stream 2 Catchment Area is calculated as

$$Q_{S2} = \gamma_{S3} \cdot Q_{MRSA} + Q_{Other}^{S2} + Q_{S3}$$ **Equation (53)**

Applying the steady-state version of Equation (5), the outflow concentration of arsenic and magnesium is calculated as

$$C_{S2}^{As} = \frac{\gamma_{S2} \cdot Q_{MRSA} \cdot C_{MRSA}^{As} + Q_{S3} \cdot C_{S3}^{As} + Q_{Other}^{S2} \cdot C_{Other}^{As}}{Q_{S2}}$$ **Equation (54)**

$$C_{S2}^{Mg} = \frac{\gamma_{S2} \cdot Q_{MRSA} \cdot C_{MRSA}^{Mg} + Q_{S3} \cdot C_{S3}^{Mg} + Q_{Other}^{S2} \cdot C_{Other}^{Mg}}{Q_{S2}}$$ **Equation (55)**

7.2.6 Stream 2 to Cell 1

Water and COPCs are transported from the Stream 2 Catch Basin to Cell 1 via a pumping pipe. There is no change to the water balance or COPC concentrations during the transport process.

7.2.7 Cell 1

Cell 1 is a process solids management facility and is modelled as a PSMF as described previously in this document. The PSMF incorporates both a tailings beach where surface water contributes to mass loadings and a PSMF pond that holds receiving waters and has underwater area loadings. Additional inputs to Cell 1 include transfer of water from other process solids management facilities, seepage, dewatering of open pits, and collections from ponds. The average of these inputs are calculated separately and are presented in Table 7-4.

Table 7-4: 2025 – 2026 Average Input Parameters for Cell 1

Cell 1					
		Input Units		Standard Units	
Parameter	**Symbol**	**Unit**	**Value**	**SI-Units**	**Value**
Precipitation	P	mm/d	2.00	m/s	2.32E-07
Pond Evaporation	E	mm/d	1.55	m/s	1.80E-07
Beach Area	A_{beach}	m^2	414901.4	m^2	414901.4
Beach Runoff coefficient	i	-	0.9	-	0.9
Mass of Process Solids	M_{solids}	kg	6.31E+08	kg	6.31E+08
As (Loading)	L_{beach}^{As}	mg/kg/wk	2.15E-05	1/s	3.55E-17
Mg (Loading)	L_{beach}^{Mg}	mg/kg/wk	0.248	1/s	4.10E-13
Pond Area	A_{pond}	m^2	73217.9	m2	73217.9
As (Loading)	$L_{underwater}^{As}$	mg/m^2/wk	0.00112	kg/m^2/s	1.85E-15
Mg (Loading)	$L_{underwater}^{Mg}$	mg/m^2/wk	22.8	kg/m^2/s	3.77E-11
Outflow rate	Q_D	L/s	294.41	m^3/s	0.29441
Volume to start outflow	V	L	1.35E+09	m^3	1.35E+06
Flow to voids (entrained)	Q_{void}	L/s	96	m^3/s	0.096
Seepage flow	$Q_{seepage}$	L/s	3.855	m^3/s	3.86E-03
Other Inputs					
Flow	Q_{Other}^{Cell1}	L/s	442.24	m^3/s	0.44
As Concentration	C_{Other}^{As}	mg/L	4.00E-03	kg/m^3	4.00E-06
Mg Concentration	C_{Other}^{Mg}	mg/L	2.81	kg/m^3	2.81E-03

Applying the steady-state versions of Equation (19) to Equation (21), the water balance for Cell 1 is calculated as

$$Q_{Cell1} = Q_{S2} + (P - E) \cdot A_{pond} + (P - E_{beach}) \cdot A_{beach} \cdot i + Q_{Other}^{Cell1} - Q_{void} - Q_{seepage}$$ **Equation (56)**

Applying the steady-state version of Equation (22), the outflow concentration of arsenic and magnesium is calculated as

$$C_{Cell1}^{As} = \frac{Q_{S2} \cdot C_{S2}^{As} + Q_{Other}^{Cell1} \cdot C_{Other}^{As} + M_{solids} \cdot L_{beach}^{As} + A_{pond} \cdot L_{Underwater}^{As}}{Q_{Cell1}}$$ **Equation (57)**

$$C_{Cell1}^{Mg} = \frac{Q_{S2} \cdot C_{S2}^{Mg} + Q_{Other}^{Cell1} \cdot C_{Other}^{Mg} + M_{solids} \cdot L_{beach}^{Mg} + A_{pond} \cdot L_{Underwater}^{Mg}}{Q_{Cell1}}$$ **Equation (58)**

7.2.8 Cell 1 to WMP

Water and COPCs are transported from Cell 1 to the Water Management Pond (WMP) via Cell 1 to WMP creek. There is no change to the water balance or COPC concentrations during the transport process.

7.2.9 Water Management Pond

The WMP receives runoff from the PSMF, receives dewatering flows from the pits, is the source of water for the mill, and is the point of discharge from the site. The WMP is modelled hydraulically as a PSMF component but does not have any internal source loadings. Average parameter values for the two-year span (2025 – 2026), as well as average additional inputs are given in Table 7-5.

Table 7-5: 2025 – 2026 Average Input Parameters for the Water Management Pond

WMP					
		Input Units		Standard Units	
Parameter	**Symbol**	**Unit**	**Value**	**SI-Units**	**Value**
Precipitation	P	mm/d	2.00	m/s	2.32E-07
Pond Evaporation	E	mm/d	1.55	m/s	1.80E-07
Pond Area	A_{pond}	m^2	289781.9	m^2	289781.9
Outflow rate	Q_D	L/s	0	m^3/s	0
Volume to start outflow	V	L	1.35E+09	m^3	1.35E+06
Seepage flow	$Q_{seepage}$	L/s	1.4	m^3/s	0.0014
Other Inputs					
Flow	Q_{Other}^{WMP}	L/s	302.42	m^3/s	0.30
As Concentration	C_{Other}^{As}	mg/L	1.95E-03	kg/m^3	1.95E-06
Mg Concentration	C_{Other}^{Mg}	mg/L	2.53	kg/m^3	2.53E-03

Applying the steady-state versions of Equation (19) to Equation (21), the water balance for Cell 1 is calculated as

$$Q_{WMP} = Q_{Cell1} + (P - E) \cdot A_{pond} + Q_{Other}^{WMP} - Q_{seepage}$$ **Equation (59)**

Applying the steady-state version Equation (22), the outflow concentration of arsenic and magnesium is calculated as

$$C_{WMP}^{As} = \frac{Q_{Cell1} \cdot C_{Cell1}^{As} + Q_{Other}^{WMP} \cdot C_{Other}^{As}}{Q_{WMP}}$$ **Equation (60)**

$$C_{WMP}^{Mg} = \frac{Q_{Cell1} \cdot C_{Cell1}^{Mg} + Q_{Other}^{WMP} \cdot C_{Other}^{Mg}}{Q_{WMP}}$$ **Equation (61)**

7.2.10 Water Treatment Plant/Hare Lake

After water leaves the water management pond it passes through a Water Treatment Plant before being released into Hare Lake. If at this point the water does not meet regulatory guidelines for water quality, it may be treated. However, if the water does not require treatment, it is released into Hare Lake at the same quality level as the effluent from the Water Management Pond. For this sample calculation, we assume no treatment is required. Therefore, the final water quality of effluent being released into Hare Lake is the same as the effluent water quality from the Water Management Pond.

7.3 Steady-State Results

After applying the steady-state flow and chemical equations presented in Section 7.2, the quality of discharge water from the WMP is calculated and compared to the average values calculated from MineMod™. The results are illustrated in Table 7-6.

Table 7-6: Comparison of Effluent Discharge Water Quality to Hare Lake

	As (mg/L)	Mg (mg/L)
Steady-State Calculation	3.42E-03	3.06
MineMod™ (2-yr average)	2.57E-03	3.62
Precent Difference	28%	17%

8.0 References

Ecometrix Incorporated (Ecometrix). 2020. Marathon Palladium Project – Updated Baseline Conditions Aquatic Environment. CIAR Ref #722-4.

Ecometrix Incorporated (Ecometrix). 2021. Environmental Impact Statement Addendum Appendix D3: Marathon Palladium Project Water Quality Assessment Update. CIAR Ref #727-45.

Knight Piesold. 2021. Marathon Palladium Project mine and mill site water balance. CIAR Ref #727-39.

Mine Environment Neutral Drainage (MEND). 2006. Update on cold temperature effects of geochemical weathering. MEND Report 1.61.1. October 2006.

Stantec Consulting Ltd. 2020. Marathon Palladium Project Updated Baseline Conditions Hydrology. CIAR Ref # 722-5.

Stantec Consulting Ltd. 2021. Environmental Impact Statement Addendum Appendix D3: Surface Water Hydrology Updated Effects Assessment Report. CIAR Ref # 727-37.

Appendix A Water Balance Information

The following tables are reproduced from Knight Piesold (2021; Marathon Palladium Project mine and mill site water balance. CIAR Ref #727-39), as referenced in this report.

TABLE 2

GENERATION MINING
MARATHON PALLADIUM PROJECT

SITE WATER BALANCE SUMMARY
CRITERIA

Print Mar/03/21 11:22:08

Criteria	Units	Value	Basis
General			
Annual Rainfall	mm	818	Stantec 2020 Draft Hydromet Report
Annual Evaporation	mm	518	Stantec 2020 Draft Hydromet Report
Runoff Coefficients			
Undisturbed	%	20 to 100	Varies Seasonally
Pond	%	100	Typical Value
Open Pit	%	100	Groundwater inflow expected
PS Beach	%	75 to 100	Varies Seasonally
Road, Rockfill, and ROM stockpile	%	50 to 100	Varies Seasonally
Maximum Ice Thickness	mm	1000	Varies Seasonally
Process Solids Management Facility			
Catchment Area			
Cell 1	ha	87.6	KP AutoCAD takeoff
Cell 2A	ha	134.8	KP AutoCAD takeoff
Cell 2B	ha	117.7	KP AutoCAD takeoff
WMP	ha	47.7	KP AutoCAD takeoff
Seepage Collection Basins	ha	29.4	KP AutoCAD takeoff - Includes Basins 1 to 10
Storage			
Cell 1	Million m^3	18.1	KP
Cell 2A	Million m^3	28.7	KP, Excludes Type II Waste Rock
Cell 2B	Million m^3	35.9	KP, Excludes Type II Waste Rock
WMP	Million m^3	1.4	KP
Total Process Solids Produced	Mtonnes	117.7	Gmining 03DEC2020
Average Throughput	dtpa	9,200,000	Gmining 03DEC2020
	dtpd	25,205	Gmining 03DEC2020
Type 1 Process Solids			
Throughput	dtpd	21,425	85% of Process Solids
Slurry % Solids by mass	%	55%	Ausenco 21 OCT 2020 PFDs
Water With Slurry	m^3/day	17,529	Calculated
Settled Density	dt/m^3	1.6	KP Estimate based on 2013 Lab Testing
Specific Gravity	n/a	3.08	2013 SGS Testing (NB12-00238)
Type 2 Process Solids			
Throughput	dtpd	3,781	15% of Process Solids
Slurry % Solids by mass	%mass	22%	Ausenco 21 OCT 2020 PFDs
Water With Slurry	m^3/day	13,405	Calculated
Settled Density	dt/m^3	1.1	KP Estimate based on 2013 Lab Testing
Specific Gravity	n/a	3.20	2013 SGS Testing (NB12-00409)
Freeboard			
Cell 1	m	2	KP Estimate, allows for flow over Spillway/Swale and Wave Run-up
Cell 2A	m	2	KP Estimate, allows for flow over Spillway/Swale and Wave Run-up
Cell 2B	m	2	KP Estimate, allows for flow over Spillway/Swale and Wave Run-up
WMP	m	2	KP Estimate, allows for flow over Spillway/Swale and Wave Run-up
Initial Construction Dates			
WMP	Year	-2	KP
Cell 1	Year	-1	KP
Cell 2A	Year	-1	KP
Cell 2B	Year	3	KP
Bedrock Seepage			
From WMP to 101	m^3/day	122	Stantec Email - 10DEC2020
From Cell 1 to 106	m^3/day	335	Stantec Email - 03NOV2020
From Cell 2B to 105	m^3/day	158	Stantec Email - 03NOV2020
Process Plant			
Total Water Requirement	m^3/day	30,935	Based on Process Solids Throughput
Reclaim Water	m^3/day	25,367	82% of total, based on Ausenco 21 OCT 2020 PFDs
Fresh Water	m^3/day	4,640	15% of total, based on Ausenco 21 OCT 2020 PFDs
Water With Ore	m^3/day	928	3% of total, based on Ausenco 21 OCT 2020 PFDs
Storm Water Management Pond (SWMP)			
Catchment Area	ha	129	KP AutoCAD takeoff
Total Water Storage	m^3	650,000	KP Estimate based on Gmining Road Alignment
Target Normal Operating Level	m^3	0	Target empty operating conditions
Mine Rock Storage Area			
Catchment Area			
Stream 2 Catch Basin	ha	111	KP AutoCAD Takeoff - Includes east and west side of MRSA
Stream 3 Catch Basin	ha	71	KP AutoCAD Takeoff - Includes east and west side of MRSA
Storage			
Stream 2 Catch Basin	m^3	97,500	Temporary containment of 1 in 25 year 24 rainfall event
Stream 3 Catch Basin	m^3	62,000	Temporary containment of 1 in 25 year 24 rainfall event
Open Pit			
Catchment Areas			
L-6	ha	56.7	KP AutoCAD Takeoff
Collection Pond 1	ha	0.0	Negligible, accounted for in other areas
South Pit	ha	201.3	KP AutoCAD Takeoff
Central Pit	ha	28.1	KP AutoCAD Takeoff
North Pit	ha	114.5	KP AutoCAD Takeoff
Groundwater Inflow			
South Pit	m^3/day	328 to 457	Stantec 2020 draft estimate
Central Pit	m^3/day	181	Stantec 2020 draft estimate
North Pit	m^3/day	294 to 509	Stantec 2020 draft estimate

I:\1\01\00448\09\A\Correspondence\NB20-00916 - Water Balance Summary\Final\[Table 1 and 2_MGP.xlsx]Table 2

TABLE 3

GENERATION MINING
MARATHON PALLADIUM PROJECT

SITE WATER BALANCE SUMMARY
ANNUAL BALANCE - PROCESS SOLIDS MANAGEMENT FACILITY - 50TH PERCENTILE RESULTS

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PROCESS SOLIDS MANAGEMENT FACILITY (CELL 1, 2A, AND 2B)

				INPUTS					OUTPUTS							
	MINE YEAR	MODEL YEAR	CALENDAR YEAR	RUNOFF & PRECIPITATION (m^3/year)	WATER WITH SLURRY (m^3/year)	TRANSFER FROM COLLECTION POND 1 (m^3/year)	TRANSFER FROM CATCH BASIN 2	SEEPAGE PUMPBACK SYSTEM (m^3/year)	WATER ENTRAINED IN VOIDS (m^3/year)	BEDROCK SEEPAGE TO SUB-WATERSHED 105 (m^3/year)	BEDROCK SEEPAGE TO SUB-WATERSHED 106 (m^3/year)	EMBANKMENT SEEPAGE (m^3/year)	EVAPORATION (m^3/year)	TRANSFER TO WMP (m^3/year)	TO SUB-WATERSHED 106 (m^3/year)	END OF YEAR STORAGE (m^3/year)
PRE PRODUCTION	-4	1	2020													
	-3	2	2021													
	-2	3	2022	0	0	218,099	107,682	0	0	0	0	0	0	325,781	0	0
	-1	4	2023	233,379	247,040	958,028	446,321	93,427	84,312	0	102,452	29,795	4,118	857,520	0	900,000
OPERATIONS	1	5	2024	715,217	6,054,762	1,793,809	757,216	240,161	2,066,419	0	122,289	39,480	41,178	7,110,900	0	1,081,029
	2	6	2025	738,024	11,176,408	1,976,138	781,941	246,721	3,815,059	2,723	122,289	47,203	65,239	10,862,800	0	1,084,936
	3	7	2026	1,216,592	11,290,910	2,069,424	791,617	478,705	3,798,496	52,236	122,289	192,349	87,218	11,068,200	0	1,611,398
	4	8	2027	1,355,766	11,290,909	2,151,949	796,580	492,600	3,155,240	58,826	122,289	206,246	132,843	11,348,000	0	2,677,740
	5	9	2028	1,443,022	11,290,909	2,261,947	808,304	494,408	3,155,240	58,826	122,289	206,246	155,890	11,832,800	0	3,447,739
	6	10	2029	1,523,411	11,290,909	2,338,264	808,254	492,831	3,155,240	58,826	122,289	206,246	179,372	12,333,600	0	3,845,935
	7	11	2030	1,600,359	11,290,909	1,264,112	817,180	492,826	3,155,240	58,826	122,289	206,246	190,989	11,048,400	0	4,523,331
	8	12	2031	1,677,233	11,290,909	1,293,703	821,109	492,600	3,155,240	58,826	122,289	206,246	219,342	11,223,600	0	5,115,342
	9	13	2032	1,765,413	11,290,909	1,940,570	820,457	491,739	3,155,240	58,826	122,289	206,246	240,792	11,400,800	0	6,242,237
	10	14	2033	1,833,618	11,290,909	2,452,712	815,407	490,003	3,155,240	58,826	122,289	206,246	261,116	11,998,800	0	7,324,369
	11	15	2034	1,921,491	6,398,182	1,118,847	821,267	492,476	2,331,945	58,826	122,289	206,246	280,342	10,793,300	0	4,285,684
	12	16	2035	2,108,218	6,398,182	1,122,866	813,908	490,002	2,331,945	58,826	122,289	206,246	333,328	9,913,726	0	2,254,500
	13	17	2036	2,147,020	6,398,182	1,134,468	820,579	491,823	2,331,945	58,826	122,289	206,246	341,230	10,172,800	0	16,036
	14	18	2037	2,153,106	945,371	1,134,522	4,434	490,003	344,559	58,826	122,289	206,246	344,386	3,589,277	0	79,889
CLOSURE	15	19	2038	2,151,974	0	0	0	489,556	0	41,018	133,791	206,246	344,077	1,922,408	0	73,879
	16	20	2039	2,152,351	0	0	0	489,219	0	41,018	133,791	206,246	343,939	1,955,498	0	34,959
	17	21	2040	2,163,524	0	0	0	487,351	0	41,018	129,752	205,329	344,026	1,916,267	0	48,440
	18	22	2041	2,164,972	0	0	0	490,452	0	41,018	124,715	204,208	344,085	1,897,072	0	92,766
	19	23	2042	2,164,640	0	0	0	36,079	0	41,018	122,517	202,901	343,799	0	1,500,000	83,250
	20	24	2043	2,151,695	0	0	0	0	0	40,588	110,138	196,702	343,136	0	1,401,091	83,250
	21	25	2044	2,163,118	0	0	0	0	0	41,018	101,099	196,572	343,076	0	1,480,353	83,250
	22	26	2045	2,151,639	0	0	0	0	0	41,018	100,733	196,491	343,032	0	1,470,585	83,250
	23	27	2046	2,151,851	0	0	0	0	0	41,018	100,733	196,485	343,027	0	1,470,588	83,250
	24	28	2047	2,166,831	0	0	0	0	0	41,018	100,733	196,491	343,005	0	1,485,584	83,250

WATER MANAGEMENT POND (WMP)

				INPUTS				OUTPUTS							
	MINE YEAR	MODEL YEAR	CALENDAR YEAR	RUNOFF & PRECIPITATION (m^3/year)	SEEPAGE PUMPBACK SYSTEM (m^3/year)	WATER TRANSFER FROM CELL 1 (m^3/year)	WATER TRANSFER FROM SWMP (m^3/year)	EVAPORATION (m^3/year)	BEDROCK SEEPAGE TO SUB-WATERSHED 101 (m^3/year)	EMBANKMENT SEEPAGE (m^3/year)	TRANSFER TO CENTRAL PIT (m^3/year)	RECLAIM TO MILL (m^3/year)	EXCESS WATER DISCHARGE TO HARE LAKE (m^3/year)	TO SUB-WATERSHED 101 (m^3/year)	END OF YEAR STORAGE (m^3)
PRE PRODUCTION	-4	1	2020												
	-3	2	2021												
	-2	3	2022	78,428	0	325,781	171,455	41,815	44,581	2,129	0	0	0	0	487,159
	-1	4	2023	298,550	6,719	857,520	78,353	100,145	44,581	2,129	0	239,829	0	0	1,341,836
OPERATIONS	1	5	2024	332,307	10,202	7,110,900	341,092	175,073	44,581	2,129	0	5,873,119	1,716,000	0	1,333,455
	2	6	2025	280,949	10,091	10,862,800	475,179	150,864	44,581	2,129	0	10,843,060	622,500	0	1,307,360
	3	7	2026	244,457	10,092	11,068,200	475,727	123,851	44,581	2,129	0	10,952,160	672,000	0	1,319,115
	4	8	2027	257,285	10,092	11,348,000	449,434	153,516	44,581	2,129	0	10,952,160	912,000	0	1,327,540
	5	9	2028	294,426	10,202	11,832,800	458,795	187,110	44,581	2,129	0	10,952,160	1,407,000	0	1,306,783
	6	10	2029	336,734	10,091	12,333,600	441,276	260,660	44,581	2,129	0	10,952,160	1,902,000	0	1,306,934
	7	11	2030	283,120	10,092	11,048,400	508,975	124,033	44,581	2,129	0	10,952,160	696,000	0	1,326,818
	8	12	2031	371,073	10,092	11,223,600	474,531	129,610	44,581	2,129	0	10,952,160	679,000	0	1,306,434
	9	13	2032	268,123	10,112	11,400,800	451,071	144,359	44,581	2,129	0	10,952,160	974,250	0	1,327,061
	10	14	2033	325,994	10,028	11,998,800	441,174	254,465	44,581	2,129	0	10,952,160	1,524,000	0	1,333,722
	11	15	2034	283,415	10,028	10,793,300	511,595	180,366	44,581	2,129	0	10,952,160	720,000	0	1,040,804
	12	16	2035	210,993	10,027	9,913,726	476,039	52,247	44,581	2,129	0	10,952,160	0	0	608,472
	13	17	2036	206,902	10,127	10,172,800	479,262	43,392	44,581	2,129	0	10,952,160	0	0	443,331
	14	18	2037	209,735	10,127	3,589,277	448,670	37,463	44,581	2,129	2,185,200	1,818,251	0	0	821,516
CLOSURE	15	19	2038	206,028	10,127	1,922,408	447,267	36,491	44,305	2,129	2,629,800	0	0	0	705,441
	16	20	2039	223,971	10,127	1,955,498	448,400	36,198	44,305	2,129	2,629,800	0	0	0	637,003
	17	21	2040	216,573	10,127	1,916,267	444,867	36,547	44,305	2,129	2,629,800	0	0	0	520,076
	18	22	2041	220,035	10,127	1,897,072	452,316	36,433	44,305	2,129	2,629,800	0	0	0	395,759
	19	23	2042	220,061	10,127	0	476,033	36,216	44,305	2,129	834,059	0	0	193,291	0
	20	24	2043	221,508										221,508	0
	21	25	2044	218,228										218,228	0
	22	26	2045	209,549										209,549	0
	23	27	2046	205,170										205,170	0
	24	28	2047	207,740										207,740	0

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NOTES:
1. VALUES PROVIDED REPRESENT 50[TH] PERCENTILE PRECIPITATION CONDITIONS.
2. CELLS HIGHLIGHTED IN GREY REPRESENT WATER THAT IS NOT COLLECTED AS PART OF THE SITE WATER MANAGEMENT STRATEGY.

TABLE 4

GENERATION MINING
MARATHON PALLADIUM PROJECT

SITE WATER BALANCE SUMMARY
ANNUAL BALANCE - OPEN PITS - 50TH PERCENTILE RESULTS

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	MINE YEAR	MODEL YEAR	CALENDAR YEAR	NORTH PIT – INPUTS: RUNOFF & PRECIPITATION (m³/year)	NORTH PIT – INPUTS: OVERFLOW FROM CENTRAL PIT (m³/year)	NORTH PIT – INPUTS: GROUNDWATER INFLOW (m³/year)	NORTH PIT – OUTPUTS: TRANSFER TO COLLECTION POND 1 (m³/year)	NORTH PIT – OUTPUTS: OVERFLOW TO SUB-WATERSHED 103 (m³/year)	CENTRAL PIT – INPUTS: RUNOFF & PRECIPITATION (m³/year)	CENTRAL PIT – INPUTS: WATER WITH PROCESS SOLIDS SLURRY (m³/year)	CENTRAL PIT – INPUTS: TRANSFER FROM STREAM 2 CATCHMENT BASIN (m³/year)	CENTRAL PIT – INPUTS: TRANSFER FROM WMP (m³/year)	CENTRAL PIT – INPUTS: OVERFLOW FROM SOUTH PIT (m³/year)	CENTRAL PIT – INPUTS: INFLOW FROM L-8 (m³/year)	CENTRAL PIT – INPUTS: GROUNDWATER INFLOW (m³/year)
PRE PRODUCTION	-4	1	2020	445,583	0	0		445,583	101,427	0	0	0	0	0	0
	-3	2	2021	433,934	0	0		433,934	96,775	0	0	0	0	0	0
	-2	3	2022	449,285	0	0	22,464	426,821	99,769	0	0	0	0	0	0
	-1	4	2023	475,859	0	0	95,132	380,527	112,825	0	0	0	0	0	0
OPERATIONS	1	5	2024	545,862	0	6,341	552,203	0	122,803	0	0	0	0	0	1,544
	2	6	2025	584,750	0	28,253	613,003	0	133,222	0	0	0	0	0	4,639
	3	7	2026	584,764	0	50,880	635,644	0	157,566	0	0	0	0	0	7,735
	4	8	2027	606,702	0	73,507	680,209	0	160,773	0	0	0	0	0	10,030
	5	9	2028	652,705	0	96,134	748,839	0	169,899	0	0	0	0	0	13,926
	6	10	2029	694,025	0	112,049	806,074	0	169,046	0	0	0	0	0	17,021
	7	11	2030	738,192	0	121,214	859,406	0	166,798	0	0	0	0	0	20,117
	8	12	2031	755,371	0	130,379	885,750	0	168,949	0	0	0	0	0	23,212
	9	13	2032	759,530	0	137,519	897,049	0	170,326	0	0	0	0	0	26,308
	10	14	2033	755,880	0	142,621	898,501	0	169,529	0	0	0	0	0	29,403
	11	15	2034	756,200	0	147,724	903,924	0	169,332	4,892,727	0	0	1,146,007	0	32,498
	12	16	2035	755,127	0	152,827	907,954	0	169,412	4,892,727	0	0	1,141,280	0	35,594
	13	17	2036	760,269	0	157,929	918,198	0	169,342	4,892,727	0	0	1,144,663	0	38,689
	14	18	2037	758,559	0	163,032	919,591	0	169,304	724,250	0	0	1,140,236	0	41,785
CLOSURE	15	19	2038	755,441	4,644,931	168,134	0	0	170,403	0	815,270	2,629,800	995,910	214,923	18,615
	16	20	2039	755,432	4,644,178	173,237	0	0	170,401	0	813,969	2,629,800	996,481	214,912	18,615
	17	21	2040	760,394	4,658,097	175,795	0	0	171,529	0	820,175	2,629,800	999,708	216,270	18,615
	18	22	2041	758,559	4,658,971	175,795	0	0	170,869	0	821,858	2,629,800	1,000,443	215,788	18,615
	19	23	2042	758,943	2,022,981	175,795	0	0	170,952	0	178,855	438,300	1,000,468	215,791	18,615
	20	24	2043	758,556	1,400,677	175,795	0	0	170,869	0	0	0	996,481	214,912	18,615
	21	25	2044	760,459	1,413,223	175,795	0	0	171,738	0	0	0	1,005,588	217,282	18,615
	22	26	2045	758,559	1,400,129	175,795	0	0	170,869	0	0	0	995,914	214,931	18,615
	23	27	2046	758,553	1,400,118	175,795	0	0	170,868	0	0	0	995,910	214,923	18,615
	24	28	2047	758,945	1,405,831	175,795	0	0	170,952	0	0	0	1,000,472	215,792	18,615

MINE YEAR	MODEL YEAR	CALENDAR YEAR	CENTRAL PIT – OUTPUTS: TRANSFER TO COLLECTION POND 1 (m³/year)	CENTRAL PIT – OUTPUTS: OVERFLOW TO NORTH PIT (m³/year)	CENTRAL PIT – OUTPUTS: WATER ENTRAINED IN VOIDS (m³/year)	SOUTH PIT – INPUTS: RUNOFF & PRECIPITATION (m³/year)	SOUTH PIT – INPUTS: ROM STOCKPILE RUNOFF (m³/year)	SOUTH PIT – INPUTS: GROUNDWATER INFLOW (m³/year)	SOUTH PIT – OUTPUTS: OVERFLOW TO CENTRAL PIT (m³/year)	SOUTH PIT – OUTPUTS: TRANSFER TO COLLECTION POND 1 (m³/year)	SOUTH PIT – BALANCE	L-8 POND – INPUTS: RUNOFF & PRECIPITATION (m³/year)	L-8 POND – OUTPUTS: OUTFLOW TO CENTER PIT (m³/year)	L-8 POND – OUTPUTS: TRANSFER TO COLLECTION POND 1 (m³/year)	COLLECTION POND 1 – INPUTS: INFLOW FROM OPEN PITS AND L-8 (m³/year)	COLLECTION POND 1 – OUTPUTS: TRANSFER TO PSMF (m³/year)
-4	1	2020		0	0	582,592	0	0	0		582,592	220,701	0		0	
-3	2	2021		0	0	547,884	0	0	0		547,884	214,931	0		0	
-2	3	2022	24,584	0	0	603,289	20,248	0	0	171,070	452,467	214,923	0	0	218,099	218,099
-1	4	2023	99,655	0	0	710,595	63,656	0	0	774,241	0	214,685	0	0	958,028	958,028
1	5	2024	124,147	0	0	793,414	87,810	19,083	0	900,307	0	217,282	0	217,282	1,793,939	1,793,939
2	6	2025	137,861	0	0	836,439	88,010	85,029	0	1,009,478	0	215,788	0	215,788	1,976,128	1,976,128
3	7	2026	165,301	0	0	837,542	88,012	127,134	0	1,052,688	0	215,791	0	215,791	2,089,424	2,089,424
4	8	2027	179,803	0	0	843,782	89,460	143,103	0	1,076,345	0	215,792	0	215,792	2,151,949	2,151,949
5	9	2028	183,825	0	0	859,759	93,169	159,073	0	1,112,001	0	217,282	0	217,282	2,261,947	2,261,947
6	10	2029	186,089	0	0	866,867	95,923	165,745	0	1,128,335	0	215,788	0	215,788	2,336,264	2,336,264
7	11	2030	186,915	0	0	878,129	99,154	163,067	0	0	1,140,350	215,791	0	215,791	1,264,112	1,264,112
8	12	2031	192,181	0	0	885,192	100,936	160,390	0	0	1,146,518	215,792	0	215,792	1,293,703	1,293,703
9	13	2032	196,634	0	0	885,543	100,704	157,712	0	630,827	513,132	216,060	0	216,060	1,940,570	1,940,570
10	14	2033	198,932	0	0	884,997	100,317	155,034	0	1,140,348	0	214,931	0	214,931	2,452,712	2,452,712
11	15	2034	0	0	823,295	892,715	100,935	152,357	1,146,007		0	214,923	0	214,923	1,118,847	1,118,847
12	16	2035	0	0	823,295	891,300	100,281	149,679	1,141,280		0	214,912	0	214,912	1,122,866	1,122,866
13	17	2036	0	0	823,295	896,957	100,704	147,002	1,144,663		0	216,270	0	216,270	1,134,468	1,134,468
14	18	2037	0	0	121,847	895,597	100,317	144,324	1,140,236		0	214,931	0	214,931	1,134,522	1,134,522
15	19	2038	0	4,644,921	0	895,594	100,318	0	995,910	0	0	214,923	214,923	0	0	0
16	20	2039	0	4,644,178	0	896,200	100,281	0	996,481	0	0	214,912	214,912	0	0	0
17	21	2040	0	4,658,097	0	899,004	100,704	0	999,708	0	0	216,270	216,270	0	0	0
18	22	2041	0	4,658,971	0	899,510	100,933	0	1,000,443	0	0	215,788	215,788	0	0	0
19	23	2042	0	2,022,981	0	899,530	100,935	0	1,000,468	0	0	215,791	215,791	0	0	0
20	24	2043	0	1,400,677	0	896,200	100,281	0	996,481	0	0	214,912	214,912	0	0	0
21	25	2044	0	1,413,223	0	904,134	101,454	0	1,005,588	0	0	217,282	217,282	0	0	0
22	26	2045	0	1,400,129	0	895,597	100,317	0	995,914	0	0	214,931	214,931	0	0	0
23	27	2046	0	1,400,118	0	895,594	100,318	0	995,910	0	0	214,923	214,923	0	0	0
24	28	2047	0	1,405,831	0	899,536	100,936	0	1,000,472	0	0	215,792	215,792	0	0	0

I:\1661004.07\09\A\Correspondence\NB20-00916 - Water Balance Summary\Final\[Summary Tables and Figures Rev 0.xlsx]Table 4 OpenPits

NOTES:
1. VALUES PROVIDED REPRESENT THE 50th PERCENTILE PRECIPITATION CONDITIONS.
2. CELLS HIGHLIGHTED IN GREY REPRESENT WATER THAT IS NOT COLLECTED AS PART OF THE SITE WATER MANAGEMENT STRATEGY.

TABLE 5

GENERATION MINING
MARATHON PALLADIUM PROJECT

SITE WATER BALANCE SUMMARY
ANNUAL BALANCE - MINE ROCK STORAGE AREA - 50TH PERCENTILE RESULTS

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	MINE YEAR	MODEL YEAR	CALENDAR YEAR	STREAM 3 CATCH BASIN				STREAM 2 CATCH BASIN					
				INPUTS	OUTPUTS			INPUTS		OUTPUTS			
				RUNOFF & PRECIPITATION (m^3/year)	EVAPORATION (m^3/year)	WATER TRANSFER TO STREAM 2 CATCH BASIN (m^3/year)	TO PIC RIVER VIA SUB-WATERSHED 103 (m^3/year)	RUNOFF & PRECIPITATION (m^3/year)	WATER TRANSFER FROM STREAM 3 CATCH BASIN (m^3/year)	EVAPORATION (m^3/year)	STREAM 2 CATCH BASIN TO PSMF (m^3/year)	STREAM 2 CATCH BASIN TO CENTRAL PIT	TO PIC RIVER VIA SUB-WATERSHED 102 (m^3/year)
PRE PRODUCTION	-4	1	2020	275,769	0	0	275,769	431,517	0	0	0	0	431,517
	-3	2	2021	268,559	0	0	268,559	420,236	0	0	0	0	420,236
	-2	3	2022	269,064	18	0	269,046	430,727	0	29	107,682	0	323,045
	-1	4	2023	269,649	18	0	269,631	446,321	0	31	446,321	0	0
OPERATIONS	1	5	2024	274,502	25	274,477	0	482,763	274,477	46	757,216	0	0
	2	6	2025	279,249	22	279,234	0	488,762	279,234	45	781,941	0	0
	3	7	2026	288,193	22	288,178	0	493,949	288,178	48	791,617	0	0
	4	8	2027	296,651	24	296,635	0	499,014	296,635	50	796,560	0	0
	5	9	2028	307,138	33	307,116	0	504,088	307,116	58	808,304	0	0
	6	10	2029	309,394	27	309,358	0	503,496	309,358	49	808,254	0	0
	7	11	2030	313,167	29	313,130	0	505,754	313,130	49	817,180	0	0
	8	12	2031	314,427	32	314,395	0	506,766	314,395	52	821,109	0	0
	9	13	2032	316,239	36	316,201	0	503,890	316,201	57	820,457	0	0
	10	14	2033	314,418	33	314,384	0	500,813	314,384	53	815,407	0	0
	11	15	2034	314,693	30	314,655	0	506,926	314,655	49	821,267	0	0
	12	16	2035	314,074	30	314,036	0	499,930	314,036	49	813,908	0	0
	13	17	2036	316,239	36	316,201	0	504,012	316,201	57	820,579	0	0
	14	18	2037	314,418	31	314,384	0	500,924	314,384	50	4,434	0	0
CLOSURE	15	19	2038	314,425	30	314,393	0	500,926	314,393	49	0	815,270	0
	16	20	2039	314,074	30	314,036	0	499,981	314,036	49	0	813,969	0
	17	21	2040	316,239	36	316,201	0	504,031	316,201	57	0	820,175	0
	18	22	2041	314,692	33	314,653	0	507,058	314,653	53	0	821,658	0
	19	23	2042	314,693	33	314,655	0	514,030	314,655	53	0	178,855	649,777
	20	24	2043	314,074			314,074	505,009					505,009
	21	25	2044	316,239			316,239	516,863					516,863
	22	26	2045	314,456			314,456	505,965					505,965
	23	27	2046	314,459			314,459	505,967					505,967
	24	28	2047	314,427			314,427	514,036					514,036

I:\1\01\00446\09\A\Correspondence\NB20-00916 - Water Balance Summary\Final\[Summary Tables and Figures Rev 0.xlsx]Table 5 MRSA

NOTES:

1. VALUES PROVIDED REPRESENT THE 50TH PERCENTILE PRECIPITATION CONDITIONS.
2. CELLS HIGHLIGHTED IN GREY REPRESENT WATER THAT IS NOT COLLECTED AS PART OF THE SITE WATER MANAGEMENT STRATEGY.

TABLE 6

GENERATION MINING
MARATHON PALLADIUM PROJECT

SITE WATER BALANCE SUMMARY
ANNUAL BALANCE - STORMWATER MANAGEMENT POND AND PROCESS PLANT - 50TH PERCENTILE RESULTS

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	MINE YEAR	MODEL YEAR	CALENDAR YEAR	STORMWATER MANAGEMENT POND					PROCESS PLANT					
				INPUTS	OUTPUTS				INPUTS		OUTPUTS			
				RUNOFF & PRECIPITATION (m³/year)	EMBANKMENT SEEPAGE (m³/year)	EVAPORATION (m³/year)	WATER TRANSFER TO WMP (m³/year)	TO SUB-WATERSHED 101 (m³/year)	RECLAIM FROM WMP (m³/year)	WATER WITH ORE (m³/year)	WATER IN SLURRY TO CELL 1 (m³/year)	WATER IN SLURRY TO CELL 2A (m³/year)	WATER IN SLURRY TO CELL 2B (m³/year)	WATER IN SLURRY TO CENTRAL PIT (m³/year)
PRE PRODUCTION	-4	1	2020											
	-3	2	2021											
	-2	3	2022	172,340	886	0	171,456							
	-1	4	2023	480,716	1,608	0	480,716	0	239,629	7,411	139,989	107,051	0	0
OPERATIONS	1	5	2024	481,823	1,608	658	341,088	0	5,873,119	181,643	3,431,032	2,623,730	0	0
	2	6	2025	479,767	1,608	6,312	475,176	0	10,843,060	335,352	6,334,431	4,843,977	0	0
	3	7	2026	478,604	1,608	3,780	475,728	0	10,952,180	338,727	5,894,561	4,892,727	503,622	0
	4	8	2027	479,933	1,608	4,848	449,436	0	10,952,180	338,727	0	4,892,727	6,398,182	0
	5	9	2028	485,463	1,692	7,008	456,792	0	10,952,180	338,727	0	4,892,727	6,398,182	0
	6	10	2029	485,671	1,728	13,452	441,276	0	10,952,180	338,727	0	7,132,091	4,158,818	0
	7	11	2030	480,819	1,620	4,692	508,980	0	10,952,180	338,727	0	7,132,091	4,158,818	0
	8	12	2031	479,252	1,608	4,944	474,528	0	10,952,180	338,727	0	7,132,091	4,158,818	0
	9	13	2032	482,426	1,620	5,760	451,068	0	10,952,180	338,727	0	7,132,091	4,158,818	0
	10	14	2033	482,777	1,692	15,888	441,168	0	10,952,180	338,727	0	7,132,091	4,158,818	0
	11	15	2034	478,967	1,608	6,036	511,596	0	10,952,180	338,727	0	2,239,364	4,158,818	4,892,725
	12	16	2035	478,187	1,608	743	476,040	0	10,952,180	338,727	0	2,239,364	4,158,818	4,892,725
	13	17	2036	481,174	1,608	588	479,268	0	10,952,180	338,727	0	2,239,364	4,158,818	4,892,725
	14	18	2037	478,174	1,608	550	448,668	0	1,618,251	28,361	0	330,880	614,491	701,241
CLOSURE	15	19	2038	478,185	1,608	748	447,288	0						
	16	20	2039	478,188	1,608	743	446,400	0						
	17	21	2040	481,175	1,608	803	444,888	0						
	18	22	2041	478,241	1,608	749	452,316	0						
	19	23	2042	478,223	1,608	748	476,028	0						
	20	24	2043	478,188				478,188						
	21	25	2044	481,454				481,454						
	22	26	2045	478,241				478,241						
	23	27	2046	478,223				478,223						
	24	28	2047	478,199				478,199						

I:\1101\00446\09\A\Correspondence\NB20-00916 - Water Balance Summary\Final\[Summary Tables and Figures Rev 0.xlsx]Table 6 SWMP & Mill

NOTES:

1. VALUES PROVIDED REPRESENT THE 50TH PERCENTILE PRECIPITATION CONDITIONS.
2. CELLS HIGHLIGHTED IN GREY REPRESENT WATER THAT IS NOT COLLECTED AS PART OF THE SITE WATER MANAGEMENT STRATEGY.

Appendix B Local Hydrological Information

The following tables are reproduced from Stantec (2020; Marathon Palladium Project Updated Baseline Conditions Hydrology. CIAR Ref # 722-5) and Stantec (2021; Environmental Impact Statement Addendum Appendix D3: Surface Water Hydrology Updated Effects Assessment Report. CIAR Ref # 727-37) as referenced in this report.

Table 6.5: Local Watersheds Within SSA

Watershed ID	Area (km2)	Mean Slope (%)	Area of Waterbodies (%)	Land Cover
101	4.538	17.307	3%	Deciduous Trees (38.1%)
102	3.495	20.918	4%	Mixed Trees (35.4%)
103	1.867	13.27	4%	Deciduous Trees (45.0%)
104	3.457	18.733	4%	Deciduous Trees (52.1%)
105	47.826	17.846	11%	Mixed Trees (45.1%)
106	10.523	11.025	3%	Mixed Trees (39.8%)
107	0.501	18.811	0%	Deciduous Trees (45.3%)
108	0.567	22.153	0%	Deciduous Trees (34.8%)
109	12.037	6.795	9%	Coniferous Trees (30.8%)
110	0.133	12.242	0%	Deciduous Trees (60.7%)
111	0.121	19.041	0%	Deciduous Trees (76.5%)
112	0.109	23.742	0%	Deciduous Trees (83.5%)
113	0.240	17.75	0%	Deciduous Trees (82.3%)
114	1.344	20.16	2%	Deciduous Trees (43.1%)
115	0.311	15.515	0%	Deciduous Trees (54.8%)
116	2.935	12.431	0%	Deciduous Trees (50.3%)
117	0.261	13.575	0%	Deciduous Trees (72.5%)

In comparison to the Calder (2012a) watersheds (Table 2.3), watershed 103 has an area 13% smaller than originally presented and watershed 108 has an area 7% greater. The remaining identified 6 watersheds (101, 102, 104 through 107) are reasonably consistent in area.

Source: Stantec (2020; Marathon Palladium Project Updated Baseline Conditions Hydrology. CIAR Ref # 722-5)

Table 6.8: Regional Station Relationship Between Mean Monthly Flows and Catchment Area

Month	Mean Monthly Flow Regression Equation	R^2
January	$Q_{JanuaryMean}=0.0028x^{1.0569}$	0.9854
February	$Q_{FebruaryMean}=0.0022x^{1.0439}$	0.9879
March	$Q_{MarchMean}=0.0078x^{0.9011}$	0.9694
April	$Q_{AprilMean}=0.0433x^{0.8945}$	0.9872
May	$Q_{MayMean}=0.0573x^{0.9395}$	0.9940
June	$Q_{JuneMean}=0.0138x^{1.0265}$	0.9925
July	$Q_{JulyMean}=0.0077x^{1.0368}$	0.9944
August	$Q_{AugustMean}=0.0047x^{1.0285}$	0.9930
September	$Q_{SeptemberMean}=0.0135x^{0.9235}$	0.9823
October	$Q_{OctoberMean}=0.0323x^{0.8896}$	0.9909
November	$Q_{NovemberMean}=0.0221x^{0.9285}$	0.9968
December	$Q_{DecemberMean}=0.0074x^{1.0063}$	0.9892

Source: Stantec (2020; Marathon Palladium Project Updated Baseline Conditions Hydrology. CIAR Ref # 722-5)

Table 6.4: Changes in Hydrology Through Project Mine Phases

Watershed ID	Watershed Location	Catchment Area (km^2)					Mean Annual Flow (m^3/s)					Largest Change in MAF (%)
		Baseline	Construction	Operation	Closure	Post-Closure	Baseline	Construction	Operation	Closure	Post-Closure	
101	S1 Watershed	4.54	2.99	2.99	4.78	4.78	0.074	**0.050**	0.057	0.080	0.080	-33%
102	Terru Lake Watershed	3.50	0.07	0.07	1.18	1.18	0.058	**0.001**	0.002	0.020/0.002	0.020	-98%
103	S4 Watershed	1.87	0.07	0.07	4.20	4.20	0.032	**0.001**	0.002	0.009/0.002	0.056	-96%
104	Claw Lake Watershed	3.46	3.41	3.41	3.41	3.41	0.057	0.056	0.059	**0.060**	**0.060**	5%
105	Hare Lake Watershed	47.83	58.39	58.39	47.18	47.18	0.691	0.676	**0.774**	0.683	0.683	12%
106	Angler Creek Watershed	10.52	6.54	6.54	10.15	10.15	0.164	**0.105**	0.110	0.157/0.110	0.157	-36%
107	Watershed East of Claw Lake	0.50	0.50	0.50	0.50	0.50	0.009	**0.009**	**0.009**	**0.009**	**0.009**	-1%
108	Watershed South of Claw Lake	0.57	0.54	0.54	0.56	0.56	0.010	0.010	0.010	**0.009**	**0.009**	-8%
109	Shack Lake Watershed	12.04	12.27	12.27	12.35	12.35	0.187	0.190	0.195	**0.196**	**0.196**	5%
110	S25 Watershed	0.13	0.13	0.13	0.13	0.13	0.003	0.003	0.003	**0.003**	**0.003**	5%
111	Watershed east of Terru Lake	0.12	0.12	0.12	0.12	0.12	0.002	0.002	0.002	**0.003**	**0.003**	6%
112	Watershed east of Terru Lake	0.11	0.11	0.11	0.11	0.11	0.002	0.002	0.003	**0.003**	**0.003**	58%
113	S24 Watershed	0.24	0.24	0.24	0.24	0.24	0.005	0.005	0.005	**0.005**	**0.005**	5%
114	Malpa Lake Watershed	1.34	1.34	1.34	1.34	1.34	0.023	0.023	0.024	**0.024**	**0.024**	4%
115	Watershed South of Malpa Lake	0.31	0.31	0.31	0.31	0.31	0.006	0.006	**0.006**	**0.006**	**0.006**	1%
116	Watershed South of S1	2.94	2.94	2.94	2.94	2.94	0.049	0.049	**0.049**	**0.049**	**0.049**	1%
117	Watershed North of S6	0.26	0.26	0.26	0.26	0.26	0.005	0.005	0.005	**0.005**	**0.005**	4%

NOTES:
1. Bolded numbers indicate the Project phase with the largest change in mean annual flows compared to baseline conditions.
2. Highlighted red cells indicate the change in MAF is above the threshold for an assessment
3. Underlined number indicates flow is for scenario 2 as described in Section 6.3.2

Source: Stantec (2021; Environmental Impact Statement Addendum Appendix D3: Surface Water Hydrology Updated Effects Assessment Report. CIAR Ref # 727-37)

Appendix C Geochemical Investigations Supporting Information

The following information is reproduced from Ecometrix (2021; Environmental Impact Statement Addendum Appendix D3: Marathon Palladium Project Water Quality Assessment Update. CIAR Ref #727-45) as referenced in this report.

Table A.1: Conceptual Pit, MRSA and Overburden Stockpile Development during Operations Phase

Year		Date	Mine Rock								Overburden
			kg of Material								
			Rubble - North Pit	Rubble - South Pit	Rubble - Centre Pit	East Waste Dump (NPAG)	South Pit Inpit Dumping (NPAG + PAG)	South Pit Dump Extension (NPAG)	PSMF Cell 2 (PAG)	Center Pit Inpit Dumping (PAG)	Ovb Dump (OVB)
0	2022	01-Jan-22	606,106	420,814	-	-	-	-	-	-	51,657,590
1	2023	01-Jan-23	1,653,475	6,941,688	967,498	10,817	-	-	-	-	675,368,707
2	2024	01-Jan-24	19,738,107	6,941,688	967,498	9,367,737,966	-	-	1,285,195,654	-	1,489,763,717
3	2025	01-Jan-25	42,363,920	11,749,569	967,498	26,200,917,917	-	-	7,648,355,975	-	1,747,822,808
4	2026	01-Jan-26	48,616,791	32,593,564	967,498	45,489,219,694	-	-	12,033,947,205	-	2,191,682,800
5	2027	01-Jan-27	50,549,657	60,551,257	967,498	65,643,319,939	-	-	18,325,850,209	-	2,371,902,442
6	2028	01-Jan-28	68,096,710	72,679,828	967,498	87,716,927,722	-	-	19,545,009,169	-	2,575,068,934
7	2029	01-Jan-29	99,234,708	72,679,828	967,498	113,890,737,582	3,600,536,857	-	19,545,009,169	-	2,663,209,990
8	2030	01-Jan-30	112,361,921	72,679,828	16,901,055	131,342,764,800	5,534,589,716	-	19,545,009,169	-	3,031,060,631
9	2031	01-Jan-31	144,581,602	72,679,828	16,901,055	131,342,764,800	34,757,880,275	-	19,545,009,169	-	3,701,109,744
10	2032	01-Jan-32	166,459,674	72,679,828	25,921,686	131,342,764,800	54,150,300,175	-	19,545,009,169	-	3,732,202,966
11	2033	01-Jan-33	195,501,405	72,679,828	27,240,969	131,342,764,800	73,342,584,000	11,168,729,693	19,545,009,169	-	3,732,202,966
12	2034	01-Jan-34	217,622,025	72,679,828	27,240,969	131,342,764,800	73,342,584,000	15,750,653,327	19,545,009,169	7,049,374,107	3,732,202,966
13	2035	01-Jan-35	228,045,877	72,679,828	27,240,969	131,342,764,800	73,342,584,000	16,027,276,256	19,545,009,169	13,790,063,193	3,732,202,966
14	2036	01-Jan-36	230,009,348	72,679,828	27,240,969	131,342,764,800	73,342,584,000	16,234,246,028	19,545,009,169	15,546,564,736	3,732,202,966
15	2037	01-Jan-37	230,255,866	72,679,828	27,240,969	131,342,764,800	73,342,584,000	16,236,052,200	19,545,009,169	15,791,276,132	3,732,202,966
16	2038	01-Jan-38	230,255,866	72,679,828	27,240,969	131,342,764,800	73,342,584,000	16,236,052,200	19,545,009,169	15,791,276,132	3,732,202,966
17	2039	01-Jan-39	230,255,866	72,679,828	27,240,969	131,342,764,800	73,342,584,000	16,236,052,200	19,545,009,169	15,791,276,132	3,732,202,966
18	2040	01-Jan-40	230,255,866	72,679,828	27,240,969	131,342,764,800	73,342,584,000	16,236,052,200	19,545,009,169	15,791,276,132	3,732,202,966

Table A.2: Conceptual PSMF and Run of Mine Stockpile Development during Operations Phase

Year		Date	Type 1 PSMF Construction Rock						Type 2 PSMF Construction Rock		Run of Mine Ore	
			kg of Material									
			Water Management Pond - West Embankment	**Water Management Pond** - East Embankment	**Cell 1** - West Embankment	**Cell 2A** - S, E, N Embankments	**Cell 2A-2B Divider Portion in 2033 is TYPE 1 ROCK**	**Cell 2B** - W Embankment	**Cell 2A** - S, E, N Embankments	**Cell 2A-2B Divider TYPE 2 ROCK**	**Ore at Stockpile**	**Mill Throughput**
0	*2022*	*01-Jan-22*	612,720,000	788,400,000	-	-	-	-	-	-	-	-
1	*2023*	*01-Jan-23*	612,720,000	788,400,000	1,247,280,000	3,700,800,000	-	-	240,960,000	-	1,616,396,569	201,558,936
2	*2024*	*01-Jan-24*	612,720,000	788,400,000	2,812,560,000	3,700,800,000	-	-	240,960,000	1,285,440,000	2,598,255,487	4,933,509,960
3	*2025*	*01-Jan-25*	612,720,000	788,400,000	6,713,280,000	8,800,800,000	-	-	240,960,000	7,568,880,000	6,056,227,360	9,108,333,000
4	*2026*	*01-Jan-26*	612,720,000	788,400,000	6,713,280,000	8,800,800,000	-	3,132,480,000	240,960,000	12,429,360,000	9,759,368,577	9,200,000,000
5	*2027*	*01-Jan-27*	612,720,000	788,400,000	6,713,280,000	9,349,200,000	-	5,886,000,000	240,960,000	19,034,400,000	10,668,804,189	9,200,000,000
6	*2028*	*01-Jan-28*	612,720,000	788,400,000	6,713,280,000	9,349,200,000	-	11,704,080,000	240,960,000	21,166,320,000	11,475,560,339	9,200,000,000
7	*2029*	*01-Jan-29*	612,720,000	788,400,000	6,713,280,000	10,813,680,000	-	11,704,080,000	240,960,000	21,644,640,000	11,695,671,848	9,200,000,000
8	*2030*	*01-Jan-30*	612,720,000	788,400,000	6,713,280,000	10,813,680,000	-	20,124,240,000	240,960,000	22,871,040,000	12,633,790,453	9,200,000,000
9	*2031*	*01-Jan-31*	612,720,000	788,400,000	6,713,280,000	13,439,760,000	-	20,124,240,000	240,960,000	25,946,640,000	11,213,956,800	9,200,000,000
10	*2032*	*01-Jan-32*	612,720,000	788,400,000	6,713,280,000	13,439,760,000	-	31,494,960,000	240,960,000	27,513,120,000	11,076,789,080	9,200,000,000
11	*2033*	*01-Jan-33*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	31,494,960,000	240,960,000	30,588,240,000	6,764,115,237	9,200,000,000
12	*2034*	*01-Jan-34*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	31,494,960,000	240,960,000	30,588,240,000	4,761,424,296	9,200,000,000
13	*2035*	*01-Jan-35*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	43,812,720,000	240,960,000	30,588,240,000	3,881,764,170	9,200,000,000
14	*2036*	*01-Jan-36*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	43,812,720,000	240,960,000	30,588,240,000	908,857,800	9,200,000,000
15	*2037*	*01-Jan-37*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	43,812,720,000	240,960,000	30,588,240,000	0	2,257,252,603
16	*2038*	*01-Jan-38*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	43,812,720,000	240,960,000	30,588,240,000	0	-
17	*2039*	*01-Jan-39*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	43,812,720,000	240,960,000	30,588,240,000	0	-
18	*2040*	*01-Jan-40*	612,720,000	788,400,000	6,713,280,000	16,640,400,000	1,903,200,000	43,812,720,000	240,960,000	30,588,240,000	0	-

Table A.3: Summary of Mine Rock Loading Rates

Chemical Constituent	Type 1 Mine Rock Field Rate[1] (mg/kg/wk)	Type 2 Mine Rock Field Rate[1] (mg/kg/wk)	Rubble Field Rate[2] (mg/kg/wk)	Pit Walls Field Rate[3] (mg/m2/wk)	Run of Mine Ore Field Rate[1] (mg/kg/wk)
Aluminum[3]	0.13	0.02	0.13	0.13	0.02
Antimony	7.22E-07	7.17E-07	7.22E-05	6.28E-06	6.39E-07
Arsenic	3.77E-06	8.54E-06	3.77E-04	3.28E-05	1.31E-06
Boron	1.07E-06	2.86E-06	1.07E-04	9.35E-06	2.01E-06
Cadmium	9.78E-09	3.02E-08	9.78E-07	8.51E-08	5.81E-08
Chromium	1.43E-06	1.35E-06	1.43E-04	1.24E-05	1.33E-06
Cobalt	2.58E-07	4.90E-06	2.58E-05	2.24E-06	3.37E-06
Copper	1.79E-06	1.36E-05	1.79E-04	1.56E-05	2.89E-05
Iron[3]	0.004	0.004	0.004	0.004	0.004
Lead	1.00E-07	1.00E-07	1.00E-05	8.71E-07	1.84E-07
Manganese	2.41E-05	7.21E-05	2.41E-03	2.10E-04	9.54E-05
Molybdenum	8.39E-07	4.17E-07	8.39E-05	7.29E-06	3.35E-07
Nickel	7.07E-07	1.75E-05	7.07E-05	6.15E-06	1.29E-05
Selenium	1.39E-06	1.40E-06	1.39E-04	1.21E-05	1.33E-06
Silver	1.48E-08	5.00E-08	1.48E-06	1.29E-07	7.97E-08
Thallium	2.20E-08	1.17E-07	2.20E-06	1.91E-07	2.44E-07
Uranium	4.12E-07	7.37E-07	4.12E-05	3.58E-06	4.31E-07
Vanadium	2.82E-06	6.56E-07	2.82E-04	2.45E-05	2.09E-07
Zinc	2.86E-06	4.23E-06	2.86E-04	2.49E-05	4.00E-06
Sulphate	4.19E-03	1.86E-02	4.19E-01	3.64E-02	6.29E-02

Notes:

1 - Adjusted for surface area (particle size) and temperature.

2 - Based on Type 1 unit rates, adjusted for temperature.

3 - Converted from Type 1 unit rates (mg/kg/wk) to surface area rates ($mg/m^2/wk$).

4 - Dependant on geochemical characteristics of solubility and pH control. Constant concentration in mg/L.

Table A.4: Summary of Nitrogen Loadings Associated with Mine Roc

Year	Ammonia N Released	Nitrate N Released
	mg/kg/wk	mg/kg/wk
2022	5.53E-04	4.37E-03
2023	1.01E-03	8.02E-03
2024	1.20E-03	9.52E-03
2025	1.01E-03	8.00E-03
2026	9.75E-04	7.71E-03
2027	9.96E-04	7.88E-03
2028	9.66E-04	7.64E-03
2029	9.43E-04	7.46E-03
2030	8.96E-04	7.08E-03
2031	8.36E-04	6.61E-03
2032	7.93E-04	6.27E-03
2033	7.43E-04	5.88E-03
2034	7.37E-04	5.83E-03
2035	6.93E-04	5.48E-03
2036	6.55E-04	5.18E-03
2037	6.00E-04	4.75E-03
2038	5.45E-04	4.31E-03
2039	4.95E-04	3.91E-03
2040	4.49E-04	3.55E-03
2041	4.08E-04	3.22E-03
2042	3.70E-04	2.93E-03
2043	3.36E-04	2.66E-03
2044	3.05E-04	2.41E-03
2045	2.77E-04	2.19E-03
2046	2.51E-04	1.99E-03
2047	2.28E-04	1.80E-03
2048	2.07E-04	1.64E-03
2049	1.88E-04	1.49E-03
2050	1.71E-04	1.35E-03
2051	1.55E-04	1.23E-03
2052	1.41E-04	1.11E-03
2053	1.28E-04	1.01E-03
2054	1.16E-04	9.17E-04
2055	1.05E-04	8.33E-04
2056	9.56E-05	7.56E-04
2057	8.67E-05	6.86E-04
2058	7.87E-05	6.23E-04
2059	7.15E-05	5.65E-04
2060	6.49E-05	5.13E-04
2061	5.89E-05	4.66E-04
2062	5.35E-05	4.23E-04
2063	4.86E-05	3.84E-04
2064	4.41E-05	3.49E-04
2065	4.00E-05	3.16E-04
2066	3.63E-05	2.87E-04
2067	3.30E-05	2.61E-04
2068	2.99E-05	2.37E-04
2069	2.72E-05	2.15E-04
2070	2.47E-05	1.95E-04
2071	2.24E-05	1.77E-04
2072	2.03E-05	1.61E-04
2073	1.85E-05	1.46E-04
2074	1.68E-05	1.33E-04
2075	1.52E-05	1.20E-04
2076	1.38E-05	1.09E-04
2077	1.25E-05	9.91E-05
2078	1.14E-05	9.00E-05
2079	1.03E-05	8.17E-05
2080	9.38E-06	7.42E-05
2081	8.51E-06	6.73E-05
2082	7.73E-06	6.11E-05
2083	7.02E-06	5.55E-05
2084	6.37E-06	5.04E-05
2085	5.78E-06	4.57E-05

Notes:

1 - Estimated basec on an expected 0.27 g N/g emulsion. The expected explosives use was based on the mine rock production schedule.

2 - Relative proportions of N-species are based on Ferguson & Leask, 1988. "The Export of Nutrients from Surface Coal Mines."

3 - Release rate estimated using Brenda L.Bailey, Lianna J.D.Smith, David W.Blowes, Carol J.Ptacek, Leslie Smith, David Segod (2013). The Diavik Waste Rock Project: Persistence of contaminants from blasting agents in waste rock effluent. Applied Geochemistry (36), pp 256-270.

Table A.5: Process Solids Loadings Rates

Parameter	Process Solids Beach Loading Rates		Submerged Process Solids Loading Rates
	Laboratory Rate (mg/kg/wk)	Field Rate[1] (mg/kg/wk)	Laboratory Rate & Field Rate[2] (mg/m2/wk)
Aluminum	0.12	0.020	0.14
Antimony	0.00010	0.000017	0.0010
Arsenic	0.00013	0.000021	0.0011
Boron	0.0099	0.0017	1.3
Cadmium	0.0000099	0.0000017	0.000080
Chromium	0.00014	0.000024	0.0035
Cobalt	0.00010	0.000018	0.00093
Copper	0.00053	0.000090	0.0055
Iron	0.030	0.0051	0.10
Lead	0.000051	0.0000086	0.00041
Manganese	0.0013	0.00023	0
Molybdenum	0.00024	0.000041	0.18
Nickel	0.00056	0.000094	0.0091
Selenium	0.00027	0.000045	0.0024
Silver	0.0000099	0.0000017	0.00010
Thallium	0.000099	0.000017	0.0010
Uranium	0.000099	0.000017	0.0026
Vanadium	0.0010	0.00018	0.010
Zinc	0.0033	0.00056	0.031
Sulphate	11	1.9	404
Phosphorus	0.050	0.0085	3.1

Notes:

1. Process Solids Beach field loading rates apply an adjustment factor for temperature of 0.17.
2. Submerged Process Solids loading rates do not apply adjustment factors for field conditions.

Table A.6: Loadings Rates Associated with the Process Plant

Parameter	Type 1 Process Solids Mill Water (mg/L)	Type 2 Process Solids Mill Water (mg/L)
Aluminum	0.087	0.858
Antimony	--	--
Arsenic	0.0006	0.0067
Boron	0.046	0.041
Cadmium	0.000033	0.000012
Chromium	0.00012	0.00191
Cobalt	0.00006	0.000069
Copper	0.0005	0.0028
Iron	0.076	0.034
Lead	0.00002	0.00001
Manganese	0.00989	0.00069
Molybdenum	0.0284	0.0158
Nickel	0.003	0.0016
Selenium	0.00057	0.00205
Silver	0.00005	0.00005
Thallium	0.000005	0.000005
Uranium	0.000154	0.000026
Vanadium	0.0011	0.0787
Zinc	0.002	0.002
Sulphate	30	21
Phosphorus	0.535	1.39

Note:
N-species concentrations vary per year. See Table A.7

Table A.7: Loadings Rates Associated with the Process Plant – N-species

Year	Constituent		
	Ammonia-N	Nitrate-N	Nitrite-N
2020	0.00	0.00	0.00
2021	0.00	0.00	0.00
2022	0.00	0.00	0.00
2023	0.41	3.28	0.08
2024	0.41	3.23	0.07
2025	0.41	3.23	0.07
2026	0.41	3.23	0.07
2027	0.41	3.23	0.07
2028	0.41	3.23	0.07
2029	0.41	3.23	0.07
2030	0.41	3.23	0.07
2031	0.41	3.23	0.07
2032	0.41	3.23	0.07
2033	0.41	3.23	0.07
2034	0.41	3.23	0.07
2035	0.41	3.23	0.07
2036	0.41	3.23	0.07
2037	0.67	5.32	0.12
2038	0.00	0.00	0.00
2039+	0.00	0.00	0.00

Notes:
Concentrations calculated assuming 4.55 g of N-residual per tonne of ore. Residual is approximately 11% as ammonia, 87% as nitrate, and 2% as nitrite.