APPENDIX 29-21. AQUATIC EFFECTS MONITORING PROGRAM (AEMP) DESIGN PLAN

Aquatic Effects Monitoring Program Design Plan

Meliadine Mine

Version 3_NWB

Prepared for:

Agnico Eagle Mines Limited
Meliadine Division
Rankin Inlet, Nunavut X0C 0G0

February 7, 2025

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ᐊᐅᓚᑦᑎᔨᓂᙶᖅᑐᑦ ᓇᐃᓈᖅᓯᔪᑦ

ᑎᑎᖅᑲᐅᑎᒥᑦ ᑎᑎᕋᖅᓯᒪᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᑦᑑᓂᐊᕐᓂᖓ ᐃᒪᕐᒥᑦᑐᓂᑦ ᖃᓄᐃᙵᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᑕᓯᕐᔪᐊᕐᒥᑦ ᐅᔭᖅᑕᓇᐊᕐᒧᑦ, 25 ᑭᓶᒥᑖᓗᐊᓂᒃ ᐅᐊᖕᓇᖕᒍᓃᑦᑐᖅ ᑲᖏᖅᖠᓂᖅ, ᑰᓇᕗᑦ. ᐃᒪᕐᒦᑦᑐᓂᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᐋᖅᑭᒃᑕᐅᓯᒪᔪᑦ ᖃᐅᔨᓴᕐᓂᐊᕐᓗᒋᑦ ᐊᒻᒪᓗ ᓇᓗᓇᐃᕐᓗᒋᑦ ᐅᔭᖅᑕᓇᐊᖅ ᐊᐅᓐᕿᒪᑦ ᐸᕐᓇᐅᑕᐅᓯᒪᓂᖓᑐᑦ ᐊᒻᒪᓗ ᐊᖏᔪᒥᒃ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᖃᙱᓪᓗᓂᑦ ᐃᒪᕐᒦᑦᑐᑦ ᐊᕙᑎᖕᒐᓂᑦ. ᐃᒪᕐᒦᑦᑐᓂᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᐱᙳᖅᑎᑕᐅᓚᐅᖅᑐᖅ ᐅᖃᖅᑎᒋᑉᓗᒋᑦ ᓄᓇᓖᑦ, ᐱᖃᖅᑕᐅᔪᑦ, ᐊᒻᒪᓗ ᒪᓕᒐᓕᕆᓂᕐᒧᑦ ᐱᔪᓐᓇᖅᑎᑦᑎᔩᑦ ᐊᒻᒪᓗ ᐱᔭᕆᐊᖃᖅᑐᑦ ᒪᓕᒃᓗᒋᑦ ᓄᓇᕗᒻᒥ ᐃᒪᓕᕆᔨᒃᑯᑦ Type A ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯᖓᑦ (2AM-MEL1631) ᐊᒻᒪᓗ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᐱᓕᕆᐊᕐᒧᑦ ᓇᓗᓇᐃᒃᑯᑕᖓᑦ (ᓈᓴᐅᑎ 006).

ᐃᒪᕐᒥᑦᑐᓂᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᒪᕈᑉᐸᓗᑎᒃ ᐊᑉᓯᒪᔪᑦ ᖃᐅᔨᓴᐃᓃᑦ: ᑕᓯᕐᔪᐊᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐊᒻᒪᓗ ᐊᓯᖏᓐᓂᑦ ᑕᓯᕐᓂᑦ ᖃᐅᔨᓴᐃᓂᖅ. ᑕᓯᕐᔪᐊᖅ ᑭᖑᓪᓕᖅᐹᒃᑯᑦ ᑯᕕᑎᑦᑎᕙᐅᓂᖠᓕᖅᑐᖅ ᖀᖕᒐᓂᑦ ᐊᒃᑐᖅᑕᐅᓯᒪᔪᖅ ᐃᒪᖅ ᑲᑎᑕᐅᔪᖅ ᐅᔾᔨᕐᑕᕆᐊᕐᒥᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᕙᐅᓗᐊᖅᑐᒥᑦ ᐃᒪᕐᒦᑦᑐᓂᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ (AEMP). ᐃᓚᒋᔭᐅᔪᑦ ᑕᓯᕐᔪᐊᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐃᓚᐅᔪᑦ ᑯᕙᓂᐅᔪᑦ ᐊᒻᒪᓗ ᖀᖕᒐᓂᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖕᒐᓂᒃ ᖃᐅᔨᓴᐃᒃᑖᕐᓂᖅ, ᐆᒪᔪᕋᓛᓄᑦ ᐃᓚᒋᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ, ᑭᖑᕋᓗᖕᓂᑦ ᐊᒻᒪᓗ ᐊᓗᐊᓄᐊᖅᑐᑦ ᖃᓄᐃᓕᐅᕐᓂᖕᒋᓐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ, ᐊᒻᒪᓗ ᐃᒃᑲᓗᐃᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖕᒋᓐᓂᒃ ᐊᒻᒪᓗ ᓂᕿᖕᒋᓐᓂᑦ ᖃᓄᐃᓕᐅᕐᓂᖕᒋᓐᓄᑦ ᖃᐅᔨᓴᐃᓃᑦ (ᑲᑭᓚᓴᐃᑦ ᐊᒻᒪᓗ ᐃᓘᕋᐃᑦ. ᑭᖑᕋᓗᐃᑦ ᐊᒻᒪᓗ ᐃᖃᓗᖕᓂᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖕᒋᓐᓂᒃ ᖃᐅᔨᓴᐃᓚᐅᖅᑐᑦ ᐊᑐᖅᓱᒋᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐱᔭᐅᔭᕆᐊᖐᑦ ᒪᓕᒃᓱᒍ ᑎᑎᖅᑲᖅ 5 (ᐊᕙᑎᒥᒃ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᓴᐃᓂᖅ) ᓴᕕᖕᓂᑦ ᐊᒻᒪᓗ ᓯᑎᔪᑦ ᐅᔭᖅᑲᓂᒃ ᐅᔭᕋᒃᑕᖅᑕᐅᔪᓂᒃ ᑯᕕᔪᓄᑦ ᒪᓕᒐᖁᑦ (MDMER). ᐊᔪᕐᓇᙱᒃᑳᖕᒐᑦ ᐃᒪᕐᒥᑦᑐᓂᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᐊᑉᐱᕆᓕᖅᑎᑕᐅᓯᒪᔪᖅ ᐊᕙᑎᒥᒃ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᒃᑖᕐᓂᕐᒧᑦ ᑐᕌᖕᒐᔪᒧᑦ (EEM) ᐊᑐᕈᖕᓃᖅᑎᓐᓂᐊᖏᓗᒍ.

ᑕᓯᕐᓂᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐋᖅᑭᒃᑕᐅᓚᐅᖅᑐᖅ ᖃᐅᔨᓴᕐᓂᐊᕐᓗᒋᑦ ᐊᓯᐊᒍᕐᓂᐅᔪᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖕᒐᓄᑦ ᐱᔪᓂᒃ ᐊᓯᐊᒍᖅᑎᓇᓂᕐᓄᑦ ᐃᒪᖃᕐᓂᐅᔪᓂᑦ ᐊᒻᒪᓗ ᐱᒋᐊᕐᕕᐅᖏᑦᑐᓂᒃ ᑯᕕᑎᑦᑎᓂᕐᓄᑦ ᓯᕐᓗ ᐳᔪᖃᑖᒃ ᐊᒻᒪᓗ ᐊᓂᖅᓵᖅᑐᖅᑕᑉᑎᖕᓄᑦ ᐊᓂᐊᔪᑦ. ᐱᖕᒋᓱᑦ ᑕᓲᑦ ᐃᓚᐅᑎᑕᐅᓚᐅᖅᑐᑦ ᑕᓯᕐᓂᑦ ᖃᐅᔨᓴᐃᕆᐊᕐᒪᑕ. ᑕᖅᓯ A8, ᑕᖅᓯ B7, ᐊᒻᒪᓗ ᑕᖅᓯ D7.

3-ᒋᔭᖓ ᐃᒪᕐᒦᑦᑐᓂᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᖃᓄᐃᑦᑑᓂᐊᕐᓂᖓᓄᑦ ᐸᕐᓇᐅᑎ ᐱᓕᕆᐊᖑᓚᐅᖅᑐᖅ ᐃᑲᔪᕐᓂᐊᕐᓗᓂ 2024-ᒧᑦ ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯᒥᒃ ᐋᖅᑭᒋᐊᖅᓯᓂᕐᒧᑦ ᑐᒃᓯᕋᐅᓯᐅᖅᑕᐅᔪᒧᑦ ᓄᓇᕗᒻᒥᑦ ᐃᒪᓕᕆᔨᒃᑯᓄᑦ ᐊᒃᓃᒃᑯᑦ ᐅᔭᕋᒃᑕᕈᖕᓇᕐᓂᐊᕐᓗᑎᒃ ᐱᑕᓕᖕᓂᑦ ᓈᒻᒪᒋᔭᐅᓯᒪᔪᖅ ᐱᓕᕆᐊᕐᒧᑦ ᓇᓗᓇᐃᒃᑯᑕᖅ 006-ᒥᑦ. ᐱᔾᔪᑎᒋᒃᑯᓄᑦ ᕿᒥᕐᕈᔭᐅᓚᐅᖅᑐᖅ 3-ᒋᔭᐅᔪᖅ ᐃᒪᕐᒦᑦᑐᓂᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᖃᓄᐃᑦᑑᓂᐊᕐᓂᖓᓄᑦ ᐸᕐᓇᐅᑎ ᑐᓂᔭᐅᓚᐅᖅᑐᖅ ᑕᖅᕿᓇᖅᓯᐊᖅ 2024-ᒥᑦ. ᒪᓕᒃᓱᒋᑦ ᐅᖃᐅᓯᐅᔪᑦ, ᒪᕈᖕᓂᒃ ᐋᖅᑭᒋᐊᖅᓯᓚᐅᖅᑐᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᑦᑑᓂᐊᖅᑐᒧᑦ:

- ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖕᖓᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ ᑕᓯᕐᓂᑦ ᐱᔭᐅᓯᒪᓂᐊᖅᑐᖅ ᐃᒪᕐᑏᑦᑐᓂᑦ ᖃᓄᐃᖕᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᖃᓄᐃᑦᑑᓂᐊᕐᓂᖕᖓᓄᑦ ᐸᕐᓇᐅᑎᒥᑦ ᓅᙱᖕᖔᕐᓗᒍ ᖃᐅᔨᓴᐃᓂᖅ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖕᖓᓄᑦ ᐊᒻᒪᓗ ᑯᕕᔪᒥᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒥᑦ (ᑎᑎᖅᖃᒧᑦ ᐃᓚᓕᐅᑎᓯᒪᔪᖅ D ᐃᒪᕐᒥᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐸᕐᓇᐅᑎᒥᑦ). ᑕᖅᓯ A8 ᐲᖅᑕᐅᓂᐊᖅᑐᖅ ᖃᐅᔨᓴᐃᓂᕐᒥᑦ ᐊᒃᓃᑯᒃᑯᑦ ᐱᐊᓂᒍᒪᖕᒪᓕᑦ ᐃᖃᓗᖕᓂᑦ ᐱᖃᑦᑕᕐᓂᖕᖏᓐᓂᑦ ᐊᐅᔭᖕᖓᓂᑦ 2025-ᒥᑦ ᐃᒪᐃᔭᖅᑕᐅᖅᖄᖅᑎᓐᓇᒍ ᑕᓯᖅ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᓕᐅᕐᓂᐊᕐᓗᑎᒃ ᖃᓂᑕᖕᖓᓂᑦ ᑕᖅᓯ A8. ᑕᓯᖅ (E3) ᐃᓇᖕᒌᓂᐊᖅᑐᖅ ᑕᖅᓯ A8-ᒥᑦ ᑕᓯᕐᓂᑦ ᖃᐅᔨᓴᖅᑕᐅᔪᓂᑦ ᐱᒋᐊᕐᓗᑎᒃ 2025-ᒥᑦ.
- ᑲᑭᓚᓴᐃᑦ ᐊᒻᒪᓗ ᐃᓲᕋᐃᑦ ᐋᓐᓂᐊᖃᖅᑕᐃᓕᒪᓂᖕᖏᓐᓂᒃ ᖃᐅᔨᓴᐃᓃᑦ ᐱᖕᖓᓱᖕᖓᓐᓂᑦ ᐊᕙᑎᒥᒃ ᖃᓄᐃᖕᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᖃᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖕᖓᔪᒧᑦ (EEM) ᐊᑐᓕᓚᐅᖅᑐᑦ ᐃᒪᕐᑏᑦᑐᓂᑦ ᖃᓄᐃᖕᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ (AEMP).

ᒥᑭᑦᑐᓂᒃ ᐋᖅᑭᒃᓯᐃᓚᐅᖅᑐᑦ ᐃᒪᕐᑏᑦᑐᓂᑦ ᖃᓄᐃᖕᖓᓕᖅᑎᑦᑎᓂᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᖅ (AEMP) ᖃᓄᐃᑦᑑᓂᐊᕐᓂᖕᖓᓄᑦ ᐸᕐᓇᐅᑎᒧᑦ ᐱᓕᕆᐊᖑᓂᐊᕐᓗᑎᒃ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᑦ ᐱᔭᐅᓚᐅᖅᑐᑦ ᐊᔾᔨᒌᙱᑦᑐᓂᑦ ᐱᔾᔪᔾᔨᐅᔪᓂᒃ ᕿᒥᕐᕈᑎᓪᓗᒋᑦ 2-ᒋᔭᐅᔪᒥᑦ (ᑕᖅᕿᓇᕐᔪᐊᖅ 2023) ᐊᒻᒪᓗ 3-ᒋᔭᐅᔪᖅ (ᑕᖅᕿᓇᕐᔪᐊᖅ 2024).

EXECUTIVE SUMMARY

This document outlines the study design for the Aquatic Effects Monitoring Program (AEMP) for the Meliadine Mine, located approximately 25 km north of Rankin Inlet, Nunavut. The AEMP is designed to assess and verify that the Mine is operating as planned and not causing adverse effects on the aquatic environment. The AEMP was developed in consultation with the local communities, stakeholders, and regulatory authorities and is required under the Nunavut Water Board (NWB) Type A Water Licence (2AM-MEL1631) and the Nunavut Impact Review Board (NIRB) Project Certificate (No. 006).

The AEMP consists of two separate studies: the Meliadine Lake study and the Peninsula Lakes study. Meliadine Lake is the final discharge point for surface contact water collected at the Mine and the primary study area for the AEMP. The core components of the Meliadine Lake study include effluent and surface water quality monitoring, a phytoplankton study, benthic invertebrate community and sediment chemistry monitoring, and a fish health and tissue chemistry monitoring program (Threespine Stickleback and Lake Trout). The benthic invertebrate community and fish health studies were based on monitoring required under Schedule 5 (Environmental Effects Monitoring) of the Metal and Diamond Mining Effluent Regulations (MDMER). Where possible, the AEMP has been harmonized with the EEM program to avoid redundancy.

The Peninsula Lakes study was designed to monitor changes in water quality caused by physical alteration of watersheds and non-point source discharges such as dust and aerial emissions. Three lakes were included in the initial Peninsula Lakes study: Lake A8, Lake B7, and Lake D7.

Version 3 of the AEMP Design Plan was prepared to support the 2024 Water Licence Amendment application to the NWB to allow Agnico Eagle to mine deposits that were approved in Project Certificate No. 006. The agencies reviewed Version 3 of the AEMP Design Plan that was submitted in January 2024. Based on their comments, two revisions were made to the study design:

- Water quality monitoring for the Peninsula Lakes will be retained in the AEMP Design Plan rather than moving this study to the Water Quality and Flow Monitoring Plan (Appendix D in the Water Management Plan). Lake A8 will be removed from the study because Agnico Eagle plans on completing a fish salvage program in summer of 2025 before dewatering the lake to facilitate pit development in the Lake A8 area. Lake E3 will replace Lake A8 in the Peninsula Lakes study starting in 2025.
- The Threespine Stickleback and Lake Trout fish health studies for the Cycle 3 Environmental Effects Monitoring Program (EEM) were adopted for the AEMP.

Minor edits to the AEMP Design Plan were made to address comments that were received from various agencies in their review of Version 2 (January 2023) and Version 3 (January 2024).

REVISION HISTORY

Version	Date	Notes
0	April 2015	Final preliminary design for submission with the Water Licence application.
1	June 2016	Prepared by Golder Associates based on principles and objectives outlined in the Conceptual AEMP Design Plan. Version 1 includes commitments made with respect to submissions received during the Technical and Public Hearing process for the Meliadine Type A Water Licence Application and based on the terms and conditions of the Type A Water Licence.
2	April 2022	Incorporated findings from the annual AEMP completed from 2016 to 2020, including the results of the Amendment No. 1 monitoring program in 2020.
2_NWB	January 2023	Submitted as part of the Type A Water Licence Amendment application for the Meliadine Extension. Comments received from regulators regarding the April 2022 Draft for Discussion. Responses to comments received from regulators are provided in **Appendix C**.
3_NWB	January 2024	Submitted with the application to amend the Type A Water Licence to allow Agnico Eagle to develop previously-approved deposits. Two updates were made to the AEMP Design Plan: (1) Incorporate the water quality monitoring program for Lake D7, and any lakes selected in the future for monitoring non-point source discharges from mining activities, into the Water Quality and Flow Monitoring Plan (Appendix D of the Water Management Plan). (2) Complete the 2024 fish health studies according the proposed study design for the Cycle 3 Environmental Effects Monitoring Program.
	January 2025	This version of the AEMP Design Plan addressed the following comments from the agencies (**Appendix D**): (1) Peninsula Lakes were retained in the AEMP except Lake A8, which is scheduled to be fished-out and dewatered in 2025. Lake E3 added to the Peninsula Lakes study to assess potential effects of the Mine. (2) Adopted the fish population study that was implemented for the Cycle 3 EEM program (3) Incorporate the Federal Environmental Water Quality Guidelines (FEQGs) for cobalt, copper, strontium, and vanadian. Note, FEQGs have been incorporated into the AEMP, as they come available, since 2019. (4) Agnico Eagle will continue comparing Meliadine Lake's water quality to predictions in the FEIS.

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GLOSSARY

Term	Definition
Aquatic Effects Monitoring Program	A monitoring program to evaluate the effect of mining activities and mitigation on the aquatic environment.
AEMP Design Plan	The "how to manual" that describes the details of the AEMP.
Assemblage	An association of interacting populations of organisms in a given waterbody.
Bathymetry	The measurement of underwater depth.
Benthic invertebrates	Aquatic animals without backbones (e.g., insects, worms, snails, clams, crustaceans) that live on/in the bottom substrate of a waterbody.
Canadian drinking water quality guidelines (CDWQG)	Health Canada guidelines used to evaluate the suitability of water for human consumption.
Canadian water quality guideline for the protection of freshwater aquatic life (FWAL)	Guidelines established by the Canadian Council of Ministers of the Environment to protect aquatic life in Canadian surface waters.
Critical effect size	A threshold above which an effect may be indicative of a higher risk to the environment.
Chlorophyll-a	A photosynthetic pigment found in plants, responsible for the conversion of inorganic carbon and water into organic carbon. The concentration of chlorophyll *a* is often used as an indicator of algal biomass.
Community	The groups of organisms living together in the same area, usually interacting or depending on each other for existence.
Effluent	The out-flow water discharged from a treatment plant. For purposes of this document, effluent is the water that is discharged from the water treatment plant to Meliadine Lake.
Ekman grab	A sampling apparatus used to collect a discrete sample of lake bottom sediment.
Exposure area	An area that receives direct discharge from mining operations.
Freshet	A large increase in water flow down a river or estuary, typically resulting from snowmelt during spring.

Term	Definition
General and Aquatic Effects Monitoring	Commonly included in a Nunavut Water Licence specifying what is to be monitored according to a schedule[1]. It covers all types of monitoring (i.e., geotechnical, lake levels, etc.). This monitoring is subject to compliance assessment to confirm sampling was carried out using established protocols, included QA/QC provisions, and addresses identified issues. General monitoring is subject to change as directed by an Inspector, or by the Licensee, subject to approval by the Water Board.
Inuit Qaujimajatuqangit (IQ)	Specific Inuit traditional knowledge. This is the guiding principles of Inuit social values including respect of others, relationships, development of skills, working together, caring, inclusiveness, community service, decision making through consensus, innovation, and respect and care for the land, animals, and the environment.
Interim Sediment Quality Guideline (ISQG)	In reference to the Canadian sediment quality guidelines, the concentration above which adverse effects may occur, and below which they are not expected to occur.
Metalloid	A class of chemical elements intermediate in properties between metals and non-metals; e.g., arsenic and boron.
Metals	A class of chemical elements that are good conductors of electricity and heat, and have the capacity to form positive ions in solution; e.g., aluminum, copper, iron, and zinc.
Mine Water	A general term to refer to water that is managed as a result of mining operations. It primarily refers to the contact water (i.e., water that has come into contact with any part of mining operations) and must be controlled and managed to reduce or eliminate effects to the environment.
Nutrients	Substances (elements or compounds) such as nitrogen or phosphorus, which are necessary for the growth and development of plants and animals.
Parameter	A particular physical, chemical, or biological property that is being measured.
pH	The negative logarithm of the concentration of the hydronium ion (H+). The pH is a measure of the acidity or alkalinity of an aqueous solution, expressed on a scale from 0 to 14, where 7 is neutral, values below 7 are acidic, and values over 7 are alkaline.
Phytoplankton	Small, free-floating algae that are suspended in the water column.

[1] Referred to in NWT and old NWB licences as the Surveillance Network Program.

Term	Definition
Probable Effects Level (PEL)	Canadian sediment quality guideline for the protection of freshwater quality life representing the concentration above which adverse effects may but will not always occur.
Receptor	Entity that may be adversely affected by contact with or by exposure to a contaminant of concern.
Reference area	An area that is reasonably similar in terms of monitored components and features to the exposure area, though not necessarily identical, but has no potential to be affected by the mine.
Regulated Monitoring	Monitoring specified in licences or regulations, including stations to be monitored, and discharge limits that must be achieved to maintain compliance with an authorization (i.e., Water Licence) or regulation (i.e., Metal and Diamond Mining Effluent Regulations). Enforcement action may be taken if discharge limits are exceeded for a parameter.
Secchi Depth	A parameter used to determine the clarity of surface waters. The measurement is made with a Secchi disk, a black and white disk that is lowered into the water and the depth is recorded at which it is no longer visible. Higher Secchi depth readings indicate clearer water that allows sunlight to penetrate to a greater depth. Lower readings indicate turbid water that can reduce the penetration of sunlight. Limited light penetration can be a factor in diminished aquatic plant growth beneath the surface, thus reducing the biological re-aeration at greater depths.
Total suspended solids (TSS)	A measurement of the concentration of particulate matter found in water.
Verification Monitoring	Monitoring carried out for operational and management purposes by Agnico Eagle. This type of monitoring provides data for decision making and builds confidence in the success of processes being used. There is no obligation to report verification monitoring results, although some monitoring locations are mentioned in environmental management plans (i.e., sampling to verify soil remediation in the landfarm).
Water Column	The water in any waterbody from the surface down to the substrate.
Zooplankton	Small, sometimes microscopic animals that live suspended in the water column.

ABBREVIATIONS AND ACRONYMS

Abbreviation	Term
AEMP	Aquatic Effects Monitoring Program
Agnico Eagle	Agnico Eagle Mines Limited
ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
BA	Before-After study design
CALA	Canadian Association for Laboratory Accreditation Inc.
CCME	Canadian Council of Ministers of the Environment
CES	Critical effect size
CI	Control-Impact
CIRNAC	Crown-Indigenous Relations and Northern Affairs Canada
CP	Containment ponds
DL	Detection limit
DO	Dissolved oxygen
DQO	Data quality objective
ECCC	Environment and Climate Change Canada
EEM	Environmental Effects Monitoring
EWTP	Effluent Water Treatment Plant
FEIS	Final Environmental Impact Statement
FEQG	Federal Environmental Quality Guideline
GCDWQ	Guidelines for Canadian Drinking Water Quality
GN	Government of Nunavut
GSI	Gonadosomatic index
IC25	Effluent concentration that causes a 25% inhibitory effect in the sublethal endpoint being measured
ISQG	Interim Sediment Quality Guideline
IQ	Inuit Qaujimajatuqangit
IR	Information request
KivIA	Kivalliq Inuit Association
LC50	Median lethal concentration
$\log_{10}$	Logarithm base 10
LSI	Liver somatic Index
MDMER	Metal and Diamond Mining Effluent Regulations

Abbreviation	Term
Mine	Meliadine Mine
MTG	Major taxonomic group
NIRB	Nunavut Impact Review Board
nMDS	Nonmetric multidimensional scaling
NWB	Nunavut Water Board
PEL	Probable Effect Level
QA	Quality assurance
QC	Quality control
RCA	Reference condition approach
SD	Standard deviation
SSWQO	Site-specific water quality objectives
TDS	Total dissolved solids
TOC	Total organic carbon
TP	Total phosphorus
TSF	Tailings storage facility
TSS	total suspended solids
UTM	Universal Transverse Mercator
WAD	weak acid dissociable
WRSF	Waste rock storage facility

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This report has been prepared by Azimuth Consulting Group Inc. (Azimuth), for the use of Agnico Eagle Mines Limited (Agnico Eagle), who has been party to the development of the scope of work for this project and understands its limitations. The extent to which previous investigations were relied on is detailed in the report.

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In addition, the conclusions and recommendations of this report are based upon applicable legislation existing at the time the report was drafted. Changes to legislation, such as an alteration in acceptable limits of contamination, may alter conclusions and recommendations.

This report is time-sensitive and pertains to a specific site and a specific scope of work. It is not applicable to any other site, development or remediation other than that to which it specifically refers. Any change in the site, remediation or proposed development may necessitate a supplementary investigation and assessment.

1 INTRODUCTION

1.1 Objectives

This document describes the study design for the Aquatic Effects Monitoring Program (AEMP) at Agnico Eagle's Meliadine Mine (the Mine). The AEMP is the integrated monitoring program that considers activities that take place at the Mine, and the potential effects these activities may have on the aquatic environment. The AEMP has three main objectives:

- Determine the short- and long-term effects of the Mine on aquatic receiving environments,
- Evaluate the accuracy of predictions made in the Final Environmental Impact Statement (FEIS),
- Provide a Response Framework (**Section 6**) with mechanisms to ensure that environmental monitoring results trigger timely and appropriate actions to mitigate potential impacts on aquatic receiving environments.

Other objectives include incorporating Inuit Qaujimajatuqangit (IQ) into the study design (**Section 1.4**) and providing a basis for engagement and to solicit feedback on updates presented in this document.

1.2 Background and Overview of the AEMP

The AEMP was developed in two stages. First, a Conceptual AEMP was prepared for the Final Environmental Impact Statement (FEIS; Appendix SD 7-3, Agnico Eagle, 2014). The Conceptual AEMP defined the principles and objectives of the AEMP as required by the Nunavut Impact Review Board (NIRB) during their review of the application in 2014:

The Proponent shall develop an Aquatic Effects Monitoring Plan to provide information on monitoring, to address mitigation measures to be implemented to protect and minimize the impacts on aquatic system from any and all project activities occurring in or near and watercourses during construction, operation, temporary closure, final closure (decommission & reclamation), post-closure phases.

Secondly, a workshop was held in Edmonton in November 2014 to elicit feedback on the AEMP and discuss details of the study design. The stakeholders at the meeting included Environment Canada, Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC; formerly AANDC), and the Rankin Inlet Hunters and Trappers Organization. The attendees agreed that the AEMP should consist of two distinct monitoring programs: one for Meliadine Lake and one for the Peninsula Lakes. Minutes from the meeting in November 2014 are included as Appendix A in Version 1 of the AEMP Design Plan (Golder, 2016). Of the two studies, Meliadine Lake is more comprehensive because it is the receiving environment for treated surface contact water from the Mine. The agencies agreed that the AEMP study should be designed to fulfill monitoring requirements listed in the Metal and Diamond Mining

Effluent Regulations (MDMER). The agencies also agreed that the study design for the Peninsula Lakes could be limited to water quality monitoring.

Meliadine Lake Study

The Meliadine Lake study was designed around the core monitoring requirements of the federal Environmental Effects Monitoring program (EEM). Supplemental components were included in the AEMP to fulfill the additional conditions and requirements of the Water Licence and to monitor for potential mine-related effects to the aquatic environment. The Meliadine Lake study includes the following components:

- Effluent and surface water quality (**Section 4.2**),
- Phytoplankton community (**Section 4.3**),
- Benthic invertebrate community (**Section 4.4**),
- Sediment quality (**Section 4.5**),
- Fish health (small-bodied and large-bodied species; **Section 4.6**), and
- Fish tissue chemistry (**Section 4.7**).

Peninsula Lakes Study

The Peninsula Lakes study was included in the AEMP to monitor potential effects of aerial emissions and physical alteration of the watersheds on small lakes located close to the Mine. The small lakes and ponds on the peninsula do not receive direct effluent discharges; therefore, the stakeholders agreed that water quality monitoring on a regular basis was adequate for the Peninsula Lakes study. Three lakes were included in the Peninsula Lakes study (Lake A8, Lake B7, and Lake D7) based on their proximity to the Mine.

Agnico Eagle plans on developing the Wesmeg and Pump deposits in 2025 and 2026, which requires Lake A8 to be fished out and dewatered in 2025. As such, Lake A8 has been removed from the Peninsula Lakes study design. Lake B7 will eventually be converted into a containment pond to store saline water from the underground mine. For now, Lake B7 is retained in the Peninsula Lakes study design. No construction or mining activities are planned for the area adjacent to Lake D7 (located west and south of Lake B7). Lakes that are potential candidates to replace Lakes A8 and B7 are discussed in **Section 1.5**.

Key Questions

Key questions were developed in Version 1 of the AEMP Design Plan to focus the methods, data analyses, and approach used to interpret the monitoring results. The key questions for each study are provided in **Table 1-1** by component and have largely remained the same as the original study design.

Table 1-1. Key Questions for the Aquatic Effects Monitoring Program.

Component	Key Questions
Meliadine Lake	
Water Quality	Are concentrations of key parameters in effluent less than limits specified in the Water Licence?
	Has water quality in the exposure areas changed over time, relative to reference/baseline areas?
	Is water quality consistent with predictions in the FEIS and below guidelines to protect aquatic life and human health?
Phytoplankton Community	Is the phytoplankton community affected by potential mine-related changes in water quality in Meliadine Lake?
Benthic Invertebrate Community	Is the benthic invertebrate community affected by potential mine-related changes in water and sediment quality in Meliadine Lake?
Fish Health	Is fish health affected by changes in water and sediment quality in Meliadine Lake?
Fish Tissue Chemistry	Are tissue metal concentrations in fish from Meliadine Lake increasing due to mining activities?
	Are tissue metal concentrations in fish from Meliadine Lake increasing relative to reference areas or baseline?
Peninsula Lakes	
Water Quality	Is water quality consistent with predictions in the FEIS and below guidelines to protect aquatic life and human health?
	Has water quality changed over time relative to baseline conditions?

1.3 Applicable Regulations

The AEMP complies with existing regulations and follows available guidelines provided by the federal government and the Government of Nunavut. Applicable regulations and guidelines are:

- Fisheries Act (Government of Canada, 1985), including the MDMER (Government of Canada, 2002),
- Nunavut Environmental Protection Act (Government of Northwest Territories, 1988),
- Nunavut Land Claim Agreement Act (Government of Canada, 1993).

1.4 Incorporation of Traditional Knowledge/Inuit Qaujimajatuqangit

Inuit Qaujimajatuqangit (IQ) is the most successful and oldest monitoring practice in Nunavut, where the resource users do the observing or monitoring. The information collected can contribute to mine design and monitoring in a meaningful way. Agnico Eagle is committed to including IQ and accounting for public concerns stemming from IQ, where practical, in the design of management and monitoring plans for the Mine.

Through the public consultation process for the Meliadine FEIS and the Traditional Use Study (FEIS, Volume 9), Meliadine Lake was identified as an important drinking water source, including use for making tea, by local residents (Agnico Eagle, 2014b). Domestic fishing is an important part of the Inuit way of life, and most of the waterbodies in the study area are fished for Lake Trout and Arctic Char. Therefore, the fish health program incorporated Lake Trout as the large-bodied fish species. Based on IQ and community consultation, the importance of clean water and the health of fish and birds was emphasized by the Elders and other people in the communities who rely on these resources for traditional use.

Agnico Eagle will continue to engage with communities and Inuit organizations as the Mine proceeds through operations and closure. In addition, feedback will be sought on how to report the results to the local communities in a relevant and meaningful way. This consultation and engagement may lead to the inclusion of additional IQ in future updates to the AEMP.

1.5 Updates to the AEMP in Version 3

The AEMP Design Plan was updated in January 2024 (Version 3) to support the Water Licence Amendment Application so that Agnico Eagle can develop deposits that were included in the2014 Final Environmental Impact Statement and already approved under NIRB Project Certificate No.006. Those deposits include Pump, F-Zone, Wesmeg, and Discovery. Two modifications to the study design were proposed in the January 2024 update that was submitted to the NWB: (1) moving the Peninsula Lakes water quality monitoring program under the Water Quality and Flow Monitoring Plan (Appendix D in the Water Management Plan) and (2) adopted the Cycle 3 EEM fish population study as the fish health assessment for the AEMP.

The amended Water Licence was issued in by the NWB on October 25 2024, and approved by the Minister of Northern Affairs on November 22, 2024. Through the Water Licence Amendment process, Environment and Climate Change Canada (ECCC) agreed with harmonizing the fish population studies for the AEMP and EEM. However, the agency did not agree with removing the Peninsula Lakes study from the AEMP. Instead, ECCC recommended replacing Lake A8 and Lake B7 when they are dewatered with new locations to monitor changes in water quality caused by non-point source discharges.

The most suitable replacement for Lake A8 is Lake E3 (MEL-15) located northwest of the Emulsion Plant. Lake E3 is a good candidate for three reasons: (1) at 57 ha, it is one of the larger lakes in proximity to the Mine that will not be altered for the next phase of mining activity, (2) its location northwest of Lake B7 can provide insight on the spatial extent of non-point source impacts from the Mine, and water samples have been collected annually during the open water season since July 2018 as per the Water Licence (monitoring station MEL-15).

The most suitable replacement for Lake B7 is Lake A1, a relatively small lake (16 ha) located downgradient from the F-Zone deposit and upstream from Meliadine Lake. Unlike Lake E3, there is a sparse dataset for Lake A1; only two sampling events were collected during the baseline period in 1994 and 2011 (Agnico Eagle, 2014). However, water quality predictions were developed for Lake A1 for operations, closure, and post-closure.

2 MINE OVERVIEW

2.1 Mine Site Location and Layout

The Meliadine Mine (Mine) is in the Kivalliq District of Nunavut near the western shore of Hudson Bay (**Figure 2-1**). The nearest community is Rankin Inlet, located approximately 25 km south of the Mine on the Kudlulik Peninsula. The Mine is located within the Meliadine Lake watershed within the Wilson Water Management Area (Nunavut Water Regulations Schedule 4).

The Mine consists of the following facilities that were assessed in the Approved Project (2014 FEIS) and included in the Type A Water Licence (2AM-MEL1631): the power plant, mill, Tiriganiaq underground mine, open pit mining of Tiriganiaq, Wesmeg, Pump, F-Zone and Discovery deposits, camp, ore stockpiles, waste rock storage facilities , the tailings storage facility (TSF), landfill, incinerator, landfarm, emulsion plant, a potable water and sewage collection and treatment system, contact and saline treatment system, water intake, diffuser, quarries and borrow pits, water management infrastructure (e.g., saline and contact water collection ponds, channels, dikes, berms, jetties, pump systems and pipelines, and culverts), the All-Weather-Access-Road (AWAR) and bypass road, and access roads.

The layout of the Mine as of 2024 is shown in **Figure 2-2**.

2.2 Mining Operations

The Mine started commercial gold production in 2019 with mining of the Tiriganiaq deposit. Underground and open pit methods have been used to develop the Tiriganiaq deposit. In addition to Tiriganiaq, Project Certificate No. 006 and amended (2024) Water Licence granted Agnico Eagle approval to mine F-Zone, Pump, Wesmeg, and Discovery deposits. The additional deposits will extend the life of the Mine to 2031.

The extent of the Mine at the end of operations in 2031 is shown in **Figure 2-3**.

2.3 Waste Rock and Tailings Management

There are three types of mine waste associated with the development of the deposits: waste rock, tailings, and overburden material. Overburden refers to the soil and till that needs to be removed prior to developing the open pits. Waste rock refers to the fragment rock with no economic value that is initially removed during development of the open pit and underground workings. Tailings are the residual waste left over after the ore is processed in the mill.

Waste rock and overburden are co-managed within the Mine Waste Management Plan. The majority of the waste rock is stored in designated waste rock and overburden storage facilities (WRSFs). WRSF1 is located north of Tiriganiaq Pit 1 and WRSF3 located between Tiriganiaq Pit 2 and the Exploration Camp (**Figure 2-2**). WRSF6 is scheduled to start in early 2025 (**Figure 2-3**). Waste rock from the underground mine is either stored in the WRSFs or brought back underground for storage within backfill. Additional WRSFs are planned to manage waste rock from open-pit mining F-Zone (WRSF7) and Discovery (WRSF9).

Geochemical testing indicates that the waste rock and overburden from the Tiriganiaq area is not acid generating, nor metal leaching (Golder 2020). Therefore, waste rock is not expected to contribute to acidic conditions or leach metals into surface contact water. Waste rock from the Discovery deposit contains rock with potential for acid generation (PAG), or potential to leach metals and will require a thermal cover to reduce potential impacts on the environment.

The mill uses a conventional gold circuit comprising crushing, grinding, gravity separation and cyanide leaching with a carbon-in-leach circuit, followed by cyanide destruction and filtration of the tailings. The final solids content of the tailings is approximately 85% by weight, with a consistency of “damp, sandy silt” (Agnico Eagle, 2020). Tailings are either sent to the TSF (“dry stacking”) or used as backfill, underground. None of the water used in the milling circuit is discharged to Meliadine Lake.

2.4 Water Management

The objective of the Water Management Plan is to minimize potential impacts to the quantity and quality of surface water from operations at the Mine. The two main sources of water that require management are: (1) surface contact water (i.e., precipitation and runoff that occurs within the footprint of the Mine) and (2) saline contact groundwater from underground mining operations. An overview of surface contact water collection, treatment, storage, and disposal is provided below based on the Water Management Plan in place for the Mine.

2.4.1 Collection, Storage, and Treatment of Surface Contact Water

The strategy for managing surface contact water is to intercept water that comes in contact with mine infrastructure and direct it towards containment ponds (CPs) through a network of dikes, channels, and culverts. Water from these peripheral CPs is ultimately pumped to CP1. Other sources of water to CP1 include direct runoff from the CP1 catchment and treated wastewater from the Sewage Treatment Plant. Water management for the CPs involves drawing down the water levels prior to the ponds freezing over in the winter. This strategy ensures there is reserve capacity to store runoff collected during freshet.

Surface contact water in CP1 is discharged to Meliadine Lake after treatment at the Effluent Water Treatment Plant (EWTP). The purpose of the EWTP is to reduce total suspended solids (TSS) to below 15 mg/L.

2.4.2 Effluent Discharge to Meliadine Lake

The Mine is authorized to discharge surface contact water to Meliadine Lake under the Type A Amended Water Licence 2AM-MEL1631 (NWB, 2024). Discharge occurs during the summer months (mid-June through September) through the permanent diffuser that was installed in August 2017 (located at N 6,989,147.41 and E 542,797.91). The diffuser is approximately 30 m in length, 40 cm in diameter, and sits 2 m above the lake bed in approximately 11 m of water. Effluent is released through 10 x 5 cm diameter ports spaced evenly every 3 m along the length of the diffuser (Tetra Tech, 2018).

MEL-14 is the compliance station for effluent chemistry and toxicity testing specified under MDMER and the Water Licence. MEL-13 is the first receiving environment station in Meliadine Lake and is located where effluent enters Meliadine Lake at the permanent diffuser. Water samples are collected monthly at MEL-13 and reference station MEL-03-01 when the Mine is discharging effluent to comply with MDMER and Water Licence reporting.

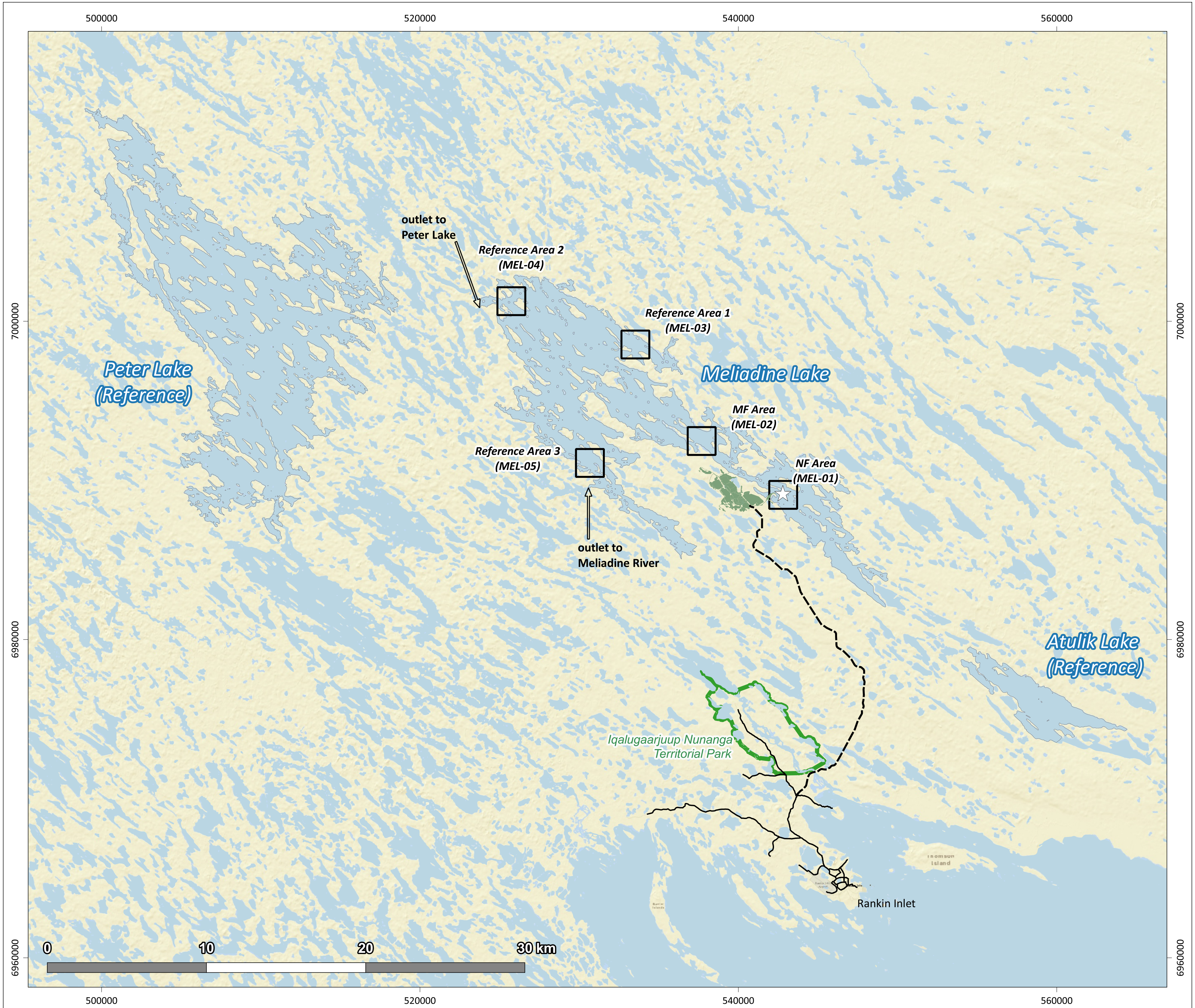
Figure 2-1
Study Area for the Meliadine AEMP

AEMP Design Plan (Verison 3)

AZIMUTH

Date:	February 3, 2025
Datum:	NAD 83 UTM Zone 15N
Scale:	1:310,000
Software:	QGIS version 3.22.11-Białowieża
Produced by:	E. Franz

REFERENCES:
1. Basemap imagery from ESRI
2. Mine Plan provided by Agnico Eagle
3. Roads and waterbodies from NRC



Legend
- All weather access road
- Meliadine Mine
- Diffuser / MEL-13
- Study Area Lakes

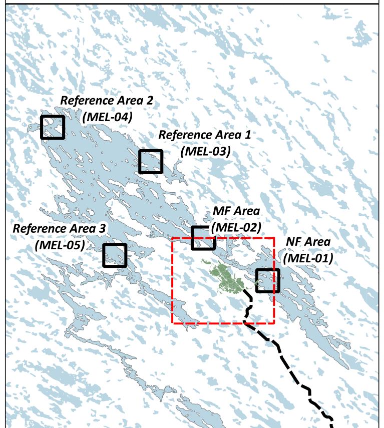
Figure 2-2
Meliadine Mine (2024)

AEMP Design Plan (Verison 3)

AZIMUTH

Date:	February 3, 2025
Datum:	NAD 83 UTM Zone 15N
Scale:	1:35,000
Software:	QGIS version 3.22.11-Białowieża
Produced by:	E. Franz

REFERENCES:
1. Basemap imagery from ESRI
   Maxar (Vivid) imagery captured on July 28, 2024
2. Mine Plan provided by Agnico Eagle
3. Roads and waterbodies from NRC



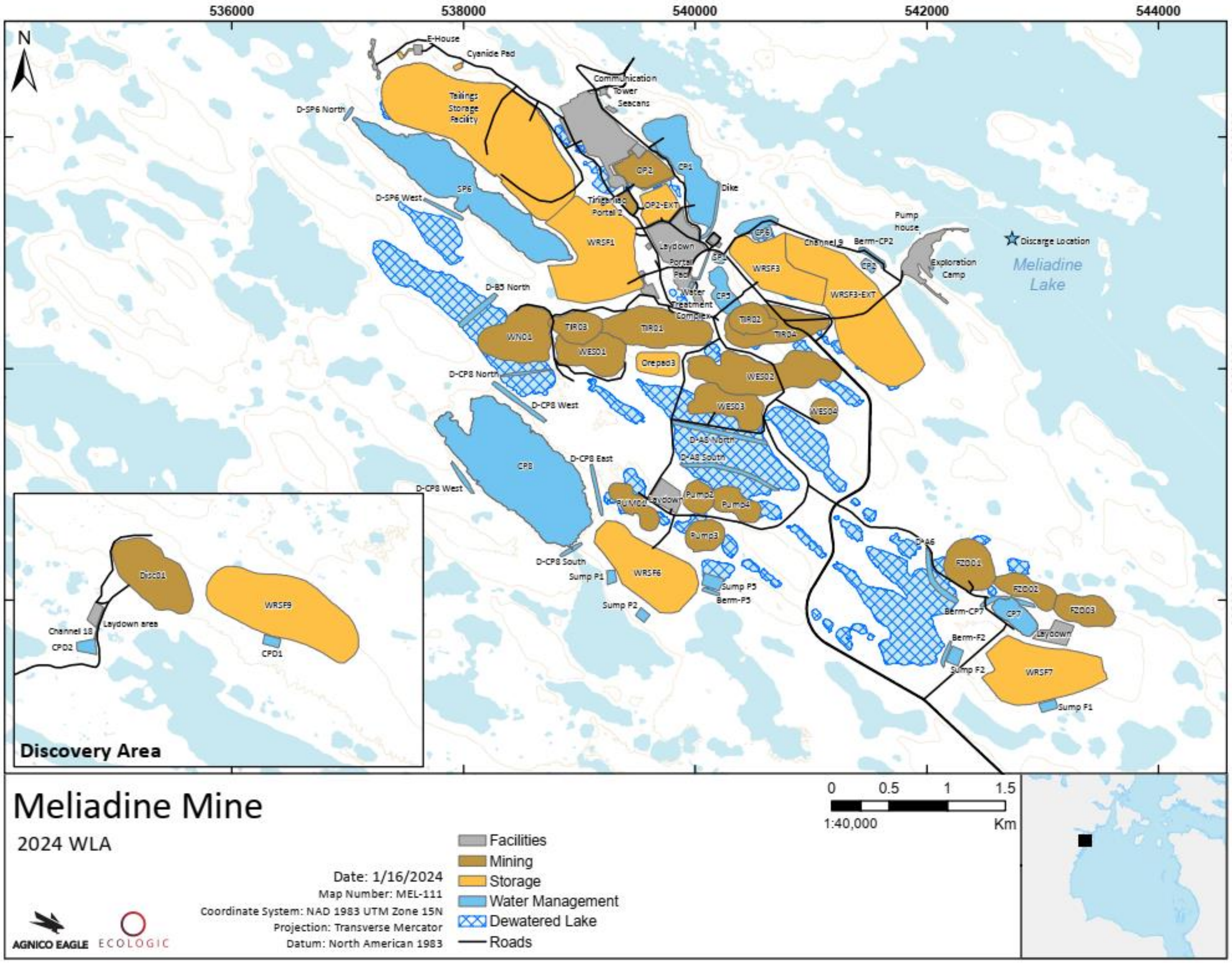
Legend

All weather access road

CP1 Diffuser

AEMP Water Quality Station

Figure 2-3. Meliadine Mine (2031)



3 CONCEPTUAL SITE MODEL

3.1 Introduction

Conceptual site models are used extensively in ecological risk assessments to describe key relationships between natural processes (i.e., natural stressors), human activities (i.e., project-related stressors), and the plants and animals that utilize habitats in the vicinity of the study area (i.e., human and ecological receptors). Conceptual site models are also important for designing an effective AEMP (INAC, 2009). A conceptual site model was developed in Version 1 of the AEMP Design Plan to visualize site characteristics and provide a clear understanding of potential adverse effects of the Mine on aquatic receiving environments. Potential adverse effects from the Mine were broadly defined as either toxicological or nutrient-related:

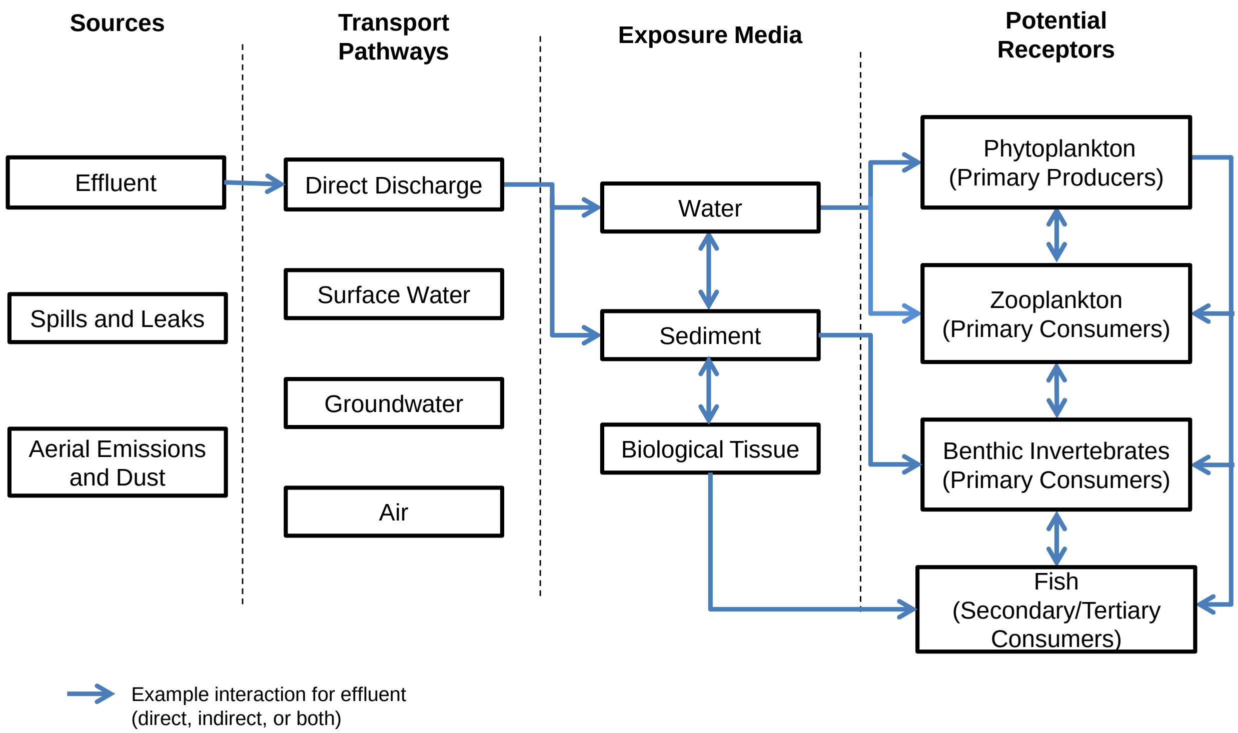
- Toxicological Impairment Hypothesis: Toxicity to aquatic organisms may occur either directly or indirectly due to the release of substances of toxicological concern. Direct interactions involve direct influences on a receptor. For example, direct toxicity to fish due to an elevated concentration of an ion or a metal represents a direct pathway. Indirect toxicological effects to fish may occur if lower trophic level communities are impacted.
- Nutrient Enrichment Hypothesis: Increased productivity may occur due to the release of nutrients (primarily phosphorus and nitrogen) in effluent. Nutrient enrichment would manifest as increased primary productivity, which can contribute to higher rates of decomposition, in turn reducing dissolved oxygen concentration and the capacity of a waterbody to support aquatic life (i.e., invertebrates and fish).

The following information was integrated into the conceptual site model in Version 1 of the AEMP Design Plan:

- The overall mine plan and major activities during construction, operation, and closure,
- Contaminants of potential concern for the aquatic receiving environment (Volume 10 of the 2014 FEIS),
- The ecology of the aquatic ecosystem in the AEMP study area (Volume 7 of the 2014 FEIS), and
- Predictions in the 2014 FEIS.

The conceptual site model focuses on environmental variables related to commitments made by Agnico Eagle and conditions stipulated during the environmental permitting process. A simple box-style conceptual site model that illustrates the stressor specific pathway for effluent discharge to Meliadine Lake is shown in **Figure 3-1**. This type of generic conceptual site model is an effective way of showing the relevant sources, stressors, transport pathways, exposure media, routes of exposure, and receptors of concern.

Figure 3-1. Conceptual Site Model for Effluent Discharge to Meliadine Lake.



3.2 Receptors of Concern and Aquatic Interactions

A receptor of concern is any organism, population, community, habitat or ecosystem that is potentially exposed to a stressor. The level of biological organization varies depending on the receptor. Phytoplankton and aquatic invertebrate are typically identified at the community level, whereas fish are usually defined at the population level (e.g., fish population). In aquatic monitoring programs, it is common to select a 'surrogate' species to represent other species that may be difficult to assess (e.g., difficult to catch). For example, Threespine Stickleback are the surrogate species used to monitor effects to all small-bodied fish species in Meliadine Lake.

The term 'receptors of concern' is generally equivalent to the term 'valued ecosystem components' used in the 2014 FEIS. The following valued ecosystem components that are relevant to the AEMP were included in the ecological risk assessment: plankton (phytoplankton and zooplankton[1]), benthic invertebrates, and fish (refer to Table 10.1-1 in the 2014 FEIS).

[1] Zooplankton was not integrated into the Meliadine Lake AEMP due to high variability in the zooplankton dataset (Golder 2018).

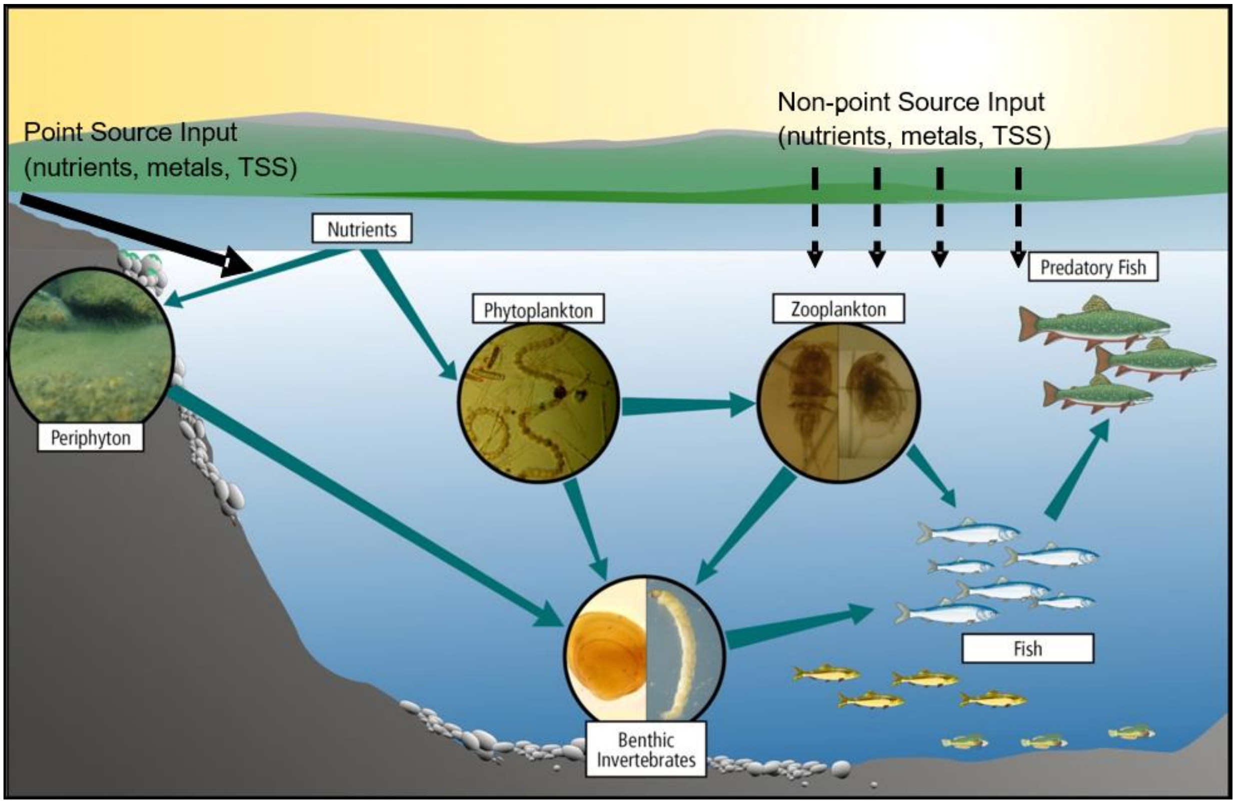
- Phytoplankton and periphyton form the base of the aquatic food web. Algal species use nutrients and carbon sources (i.e., internal recycling and renewed external sources) for growth, and are food for aquatic invertebrates. The structure and biomass of the phytoplankton and periphyton communities can change due to effluent released by a mine (e.g., increased growth from nutrient enrichment, or decreased growth from direct toxicity). Changes in the phytoplankton community can affect the zooplankton and benthic invertebrate communities.
- Benthic Invertebrates play a vital role in nutrient cycling and the breakdown of detritus in the aquatic environment. They are also an important food source for small forage fish and juvenile predatory fish species. Benthic invertebrates are well-suited to monitoring changes in the environment because they are often abundant, easy to collect, and sensitive to change, showing early responses to environmental stress (Reynoldson and Metcalfe-Smith, 1992; Resh and Rosenberg, 1993). In the context of the Meliadine AEMP, the main stressor(s) of concern are nutrients and metals in effluent. The pattern of change for mild nutrient enrichment would typically be an increase in the abundance and number of benthic invertebrate taxa (taxon richness), whereas elevated concentrations of metals in water or sediment could lead to the loss of sensitive taxa and lower abundance (Environment Canada, 2012).
- Fish were selected as a valued ecosystem components because domestic fishing is an important part of Inuit life. Several fish species occur in the region. Lake Trout (*Salvelinus namaycush*), Arctic Char (*Salvelinus alpinus*), and Arctic Grayling (*Thymallus arcticus*) are important species for subsistence use; Lake Trout and Arctic Grayling are important recreational species. Small forage species such as Threespine Stickleback (*Gasterosteus aculeatus*) and Slimy Sculpin (*Cottus cognatus*) provide food for larger, predatory species.

3.3 Stressors and Transport Pathways

In the context of the AEMP, stressors are chemical or physical agents that have the potential to cause adverse effects to the receiving environment. Transport pathways determine how stressors will move from source(s) to the aquatic environment where they may affect aquatic receptors. The most obvious transport pathway for the aquatic receiving environment is surface water, but other pathways such as groundwater and air (e.g., erosion or dust) are also relevant. Most stressors in aquatic environments are initially present in the water column. However, once in the water column, stressors may partition among water, sediment, and tissues depending on their characteristics.

The primary pathways identified in the FEIS with the potential to affect water and sediment quality in Meliadine Lake were (1) discharge of treated effluent, (2) alteration of watershed, and (3) deposition of dust and metals from air emissions (**Figure 3-2**). The key pathways considered in the Peninsula Lakes study that could cause changes in the aquatic ecosystem include watershed alteration due to dewatering, diversion of natural drainage paths, construction of new drainage channels, and/or water balance changes, and release of air emissions. These activities, alone or in combination during construction and operations, could potentially cause a change in water and sediment quality, as well as affect aquatic habitats and lower trophic levels, the abundance and distribution of fish, and the continued use of fish by traditional users.

Figure 3-2. Conceptual representation of interactions between stressors and receptors in an aquatic Ecosystem



3.4 Assessment Endpoints and Measurement Endpoints

Assessment and measurement endpoints are terms commonly used in environmental assessments to describe the valued component to be protected and the indicators used to measure potential effects. Assessment endpoints identify what is to be protected (e.g., healthy fish populations) and measurement endpoints are the quantifiable metrics used to measure potential effects. The assessment endpoints for the AEMP were selected based on the following valued components identified in the FEIS:

- Water is safe for human and wildlife consumption,
- Fish are safe to eat for human and wildlife consumption, and

- The ecological function of the aquatic ecosystem is maintained (e.g., there is adequate food for fish, and fish are able to survive, grow, and reproduce).

Assessment and measurement endpoints currently included in the AEMP Design Plan are listed in **Table 3-1**. The assessment and measurement endpoints are considered as part of the Response Framework (**Section 6**) and in the integration of results in the AEMP report (**Section 7**).

Table 3-1. Assessment and Measurement Endpoints in the AEMP

Assessment Endpoint (attribute to protect)	Measurement Endpoints
Water and sediment quality support a healthy aquatic ecosystem	Effluent quality, surface water quality, sediment chemistry Acute and chronic toxicity tests using standardized aquatic test species
Maintenance of a health phytoplankton community compared to baseline conditions and/or reference communities	Phytoplankton biomass, density, and taxa richness Chlorophyll-a concentrations (supporting metric)
Benthic invertebrate communities are characteristic of an oligotrophic subarctic lake	Measurement endpoints for the AEMP are aligned with requirements under EEM. Primary effect endpoints under EEM include: Total benthic invertebrate density, taxa richness, Simpson's evenness index, and Bray-Curtis dissimilarity index. The following supporting endpoints are used to help interpret the results: Simpson's diversity index, major taxa density, relative proportion of major taxa, and taxon presence/absence.
Self-sustaining and healthy fish populations compared to baseline and/or reference area populations	Measurement endpoints for the AEMP are aligned with requirements under EEM. Endpoints typically considered in fish population studies for EEM programs include: Survival, age, condition, weight-at-age, relative fish gonad size, and relative liver size.
Continued opportunity for use of surface water and fisheries for traditional and non-traditional human use	Surface water quality Fish tissue metal concentrations that are consistent with baseline/reference conditions

4 MELIADINE LAKE STUDY

4.1 Overview

4.1.1 Environmental Setting

Meliadine Lake

Meliadine Lake is one of the larger lakes in the region with a surface area of approximately 107 km^2 and a maximum length of 31 km (SE to NW). The morphology of the lake is characterized by a highly convoluted shoreline, numerous islands, and shallow reefs (**Figure 4-1**). More than one third of Meliadine Lake volume is contributed by lake areas that are less than 2 m in depth, which indicates a considerable reduction in lake volume and overwintering potential during winter (Golder, 2019). Maximum ice thickness is about 2 m and occurs in March/April, increasing the concentration of some ions, such as chloride, in the water near the ice-water interface. This occurs due to cryo-concentration, where ice formation excludes certain ions and increases their concentration in the water column (Wetzel, 2001). This phenomenon is well documented at reference lakes and exposure areas sampled in the winter as part of the Core Receiving Environment Monitoring Program (CREMP) for the Meadowbank Mine (Azimuth, 2019).

Meliadine Lake has three connected, yet distinct basins based on its morphology.

- The **east basin** is 2,212 ha and contributes approximately 21% to the entire area of Meliadine Lake. It is separated from the rest of the lake by a shallow and narrow area (up to 2.3 m deep, 100 to 300 m wide, and 800 m long) that features numerous rocky islands and reefs. The east basin may be isolated from the west basin during the winter months, preventing fish passage (Agnico Eagle, 2014).
- The **northwest basin** is the largest basin in Meliadine Lake. At approximately 7,100 ha, this area is approximately 68% of the surface area of the entire Lake.
- The **southwest basin** is 1,135 ha and contributes approximately 11% to the entire lake area. The SE end of the south basin near the outlet to the Meliadine River is generally shallow (less than 4 m deep).

Baseline water quality in Meliadine Lake was typical of northern latitude lakes, with low concentrations of total dissolved solids (TDS), hardness, alkalinity, specific conductivity, nutrients, and metals. Slight differences in water quality were evident among the different basins, with higher specific conductivity and higher concentrations of major cations, chloride, sulphate, and some metals (e.g., total arsenic, barium, cobalt, copper, nickel, silicon, and strontium) concentrations in the near-field area (MEL-01) compared to the mid-field (MEL-02) and reference areas (MEL-03, -04, and -05). The inherent difference among basins is important to consider when assessing mining versus natural changes in water quality as well as other AEMP monitoring components.

Lakebed substrate in Meliadine Lake is characterized by coarse materials in the shallow areas close to shore. Transition areas, consisting of fine organic materials interspersed among cobble and courser substrates are common throughout most of the lake. Substrates within deeper areas of the lake are composed primarily of fine particulate organic material and silt (Golder, 2014). Under baseline conditions, concentrations of arsenic, chromium, and copper were above generic sediment quality guidelines in some areas. MEL-01 had the highest concentrations of metals in sediment, even after sediment chemistry was normalized to fine sediment content before analysis (Golder, 2018). Higher concentrations of these metals are indicative of the more mineralized area around the east basin compared to MEL-02 and the reference areas.

Regional Reference Lakes (Peter Lake and Atulik Lake)

Peter Lake and Atulik Lake were chosen as external reference areas for the Lake Trout population studies for the Cycle 2 and Cycle 3 EEM. The summary below was prepared for the Cycle 3 EEM study design (Azimuth and Portt, 2024).

Peter Lake is one of the larger lakes in the region, covering an area of 154.4 km^2 (Meliadine Lake = 107.7 km^2). Peter Lake is located within the same watershed as Meliadine Lake. There is a weak (secondary) connection between Peter Lake and Meliadine Lake; water flows from Meliadine Lake, through a series of small lakes, into Peter Lake. Peter Lake eventually drains into Hudson Bay via the Diana River (**Figure 2-1**).

Peter Lake and Meliadine Lake have similar morphology with a highly convoluted shoreline and a number of islands. Baseline data for Peter Lake includes water chemistry, sediment chemistry, phytoplankton community and benthic invertebrate community samples. There are no bathymetry data for Peter Lake, but limnology profiles completed in 1998 indicate there are areas at least 18 m deep.

Atulik Lake (surface area = 17.6 km^2) is situated within a separate watershed from Meliadine Lake and Peter Lake. Surface water flows through a series of small lakes before draining into Hudson Bay. The only baseline data for Atulik Lake is water chemistry. No sediment chemistry or benthic invertebrate community sampling was completed in Atulik Lake for the Environmental Assessment. A reconnaissance small-bodied fish sampling program was completed in 2013 to determine if Atulik Lake could serve as a reference area for future small-bodied fish monitoring programs, but no fish were captured (trap netting was the only method used).

One water sample and a limnology profile were taken at Peter Lake and Atulik Lake in the vicinity of where gillnets were set to collect Lake Trout during the Cycle 2 EEM program in August 2021. The two reference lakes differed in their water quality characteristics. Atulik Lake had a lower pH (6.5) compared to Peter Lake which was circumneutral (7.0). Atulik Lake also had noticeably higher conductivity (79 µS/cm) compared to Peter Lake (50 µS/cm). As expected, there was no evidence of stratification in temperature, pH, dissolved oxygen, or specific conductivity. Dissolved oxygen was fully-saturated.

Atulik Lake, which is located closer to Hudson's Bay, had higher conductivity, hardness, and higher concentrations of major ions such as chloride, sodium, magnesium, and potassium compared to Peter Lake. Nutrient concentrations were typical of low productivity lakes in the regions. Total phosphorus was 0.004 mg/L, at the lower end of the range of oligotrophic conditions (CCME, 2004). Metals concentrations were uniformly low in both lakes and there were no exceedances of the CCME water quality guidelines.

4.1.2 Study Areas

The location of each monitoring area in Meliadine Lake is shown in **Figure 4-1**. Station depths and coordinates are provided in **Table 4-1**.

The Meliadine Lake study areas were selected based on the spatial extent of effects predicted in the FEIS, concerns raised through the FEIS process about potential far downstream effects, and requirements under the federal MDMER EEM program. Predictions for the Mine (as reported in the FEIS) were that water quality concentrations at the edge of the mixing zone would not exceed Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the protection of freshwater aquatic life (CCME, 1999), or Canadian Drinking Water Quality Guidelines (GCDWQ; Health Canada, 2020). However, reviewers of the FEIS were concerned about potential far-field changes in Meliadine Lake and potential changes as far downstream as Peter Lake. To address their concerns, monitoring areas were established throughout Meliadine Lake to detect mine-related changes and define the spatial and temporal extent of those changes. The study design includes two exposure areas (near-field [MEL-01], mid-field [MEL-02]) and three reference areas to provide spatial context when interpreting potential changes within and between years.

- MEL-01 is located in the east basin around the diffuser. Changes in water quality and effects to the biological communities caused by discharge of effluent to Meliadine Lake would be expected to occur at MEL-01 first.
- MEL-02 is located approximately 6 km downstream from MEL-01 past the narrows that separates the east and northwest basins. Monitoring data from MEL-02 helps define the spatial extent of potential changes observed at MEL-01.

- Three internal reference areas are included in the study design to provide insights into regional trends that would be expected to influence all sampling areas. Reference Area 1 (MEL-03) is located in a bay in the northwest basin[2] of Meliadine Lake. Reference Area 2 (MEL-04) is located in northwest area of the lake near the outlet to Peter Lake. Reference Area 3 (MEL-05) is located in the southwest basin near the outlet to Meliadine River.

The frequency of sampling by area and monitoring component is presented in **Table 4-2**.

Reference Area Considerations

Nearby reference lake(s) with similar morphology, fish assemblage, and accessibility that meets health and safety needs, were not identified during the baseline period when data was collected to support the FEIS. Furthermore, sending field crews to far off locations to collect biological data is a high-risk activity. To reduce the health and safety risks but still meet the regulatory needs of the AEMP, reference areas within Meliadine Lake were established for monitoring changes in water quality, sediment quality, phytoplankton communities, benthic invertebrate communities, and small-bodied fish. Internal reference areas are still considered suitable for these components of the AEMP based on the following considerations:

- The quantity of effluent is small relative to the volume of Meliadine Lake. Bathymetry surveys were completed in the east and south basins, and the volume of water in each domain is estimated at 98,851,000 m^3 and 48,429,000 m^3, respectively. The largest volume of water discharged from CP1 to Meliadine Lake was 1 mM in 2020.
- The distance between the diffuser, the three reference areas, and the lake outlets are as follows:
    - Reference Area 1 (MEL-03) – 16 km
    - Reference Area 2 (MEL-04) – 19 km
    - Reference Area 3 (MEL-05) – 21 km
    - Outlet to Peter Lake (MEL-04) – 20 km
    - Outlet to the Meliadine River (MEL-05) – 48 km
    - Due to the seasonal discharge to Meliadine Lake, the conservatism in the site water balance and water quality discharge model, the size of Meliadine Lake (107 km^2 in surface area), the distance between the diffuser and Reference Areas, and the natural mixing processes in Meliadine Lake, in-lake reference areas are still suitable for the AEMP.

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[2] Use of east, west and south basins for Meliadine Lake as per Golder (2019).

- Concentrations at the edge of the mixing zone (100 m from the diffuser) are consistently less than water quality guidelines to protect aquatic life and human health (Azimuth, 2023).
- Phytoplankton and benthic invertebrates are relatively sessile. Therefore, internal reference areas are suitable for assessing mining-related impacts.
- Some of the species observed in Meliadine Lake do not co-occur in neighboring lakes in sufficient numbers to support the AEMP. This was particularly evident for small-bodied fish, which are sampled in the AEMP and EEM program (**Table 4-3**). Threespine Stickleback (*Gasterosteus aculeatus*) was the dominant small-bodied species at Meliadine Lake, but they were not captured at any of the reference lakes that were sampled during the baseline period.

Unlike small-bodied fish species, large-bodied species such as Lake Trout have larger home ranges, making it difficult to accurately assess effluent-related effects. Radiotelemetry data collected during the baseline period indicated that Lake Trout migrate extensively within Meliadine Lake and as far downstream as the Meliadine River (Golder, 2012).

The Lake Trout study design in Version 1 of the AEMP Design Plan followed a before-after study approach. However, this method is not ideal for large-bodied fish programs because it cannot effectively distinguish between mining-related impacts and natural variability in fish populations caused by factors such as climate change, predation, or long-term ecological shifts. Recognizing these limitations, the Lake Trout study for the Cycle 2 EEM study adopted a multiple-control impact study design that incorporated Peter Lake and Atulik Lake as external references. The same study design was repeated for the Cycle 3 EEM in August 2024.

4.1.3 Monitoring Components

The scope of the Meliadine Lake study includes monitoring water, sediment, phytoplankton, benthic invertebrates, fish health, and fish tissue chemistry (**Table 4-2**). Water, phytoplankton, sediment, and benthic invertebrate samples are co-located at each station except for MEL-04 where only surface water and phytoplankton sampling is conducted.

Sediment at MEL-01 is predominantly silt and clay in the vicinity of the diffuser. The MF and reference area stations were established in areas with similar depth (8.5 m ± 1.5 m) and similar habitat to avoid the confounding effect of habitat differences when assessing differences in the benthic invertebrate communities among the exposure and reference areas. Sediment and benthic invertebrate samples are preferentially collected at the same location as water and phytoplankton. However, stations will be relocated if the sediment substrate is predominantly sand or if it is difficult to obtain an acceptable sample. A few of the sediment and benthic invertebrate sampling stations were realigned during the August 2021 field program to areas that had higher silt and clay content compared to stations that were sampled in 2018.

Sampling locations for the small-bodied fish program in the exposure area (MEL-01) and reference areas (MEL-03 and MEL-04) are selected in suitable shoreline habitats for Threespine Stickleback. Similarly, Lake Trout are collected from MEL-01 near the diffuser, recognizing that they migrate throughout Meliadine Lake and are therefore only transiently exposed to effluent. Gillnets are set in similar habitats in the reference lakes to ensure comparability.