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REPORT

MELIADINE GOLD PROJECT, NUNAVUT

Aquatic Effects Monitoring Program (AEMP) Design Plan 6513-REP-03

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Golder Associates

ᓇᐃᓈᖅᓯᒪᔪᖅ

ᑕᓯᕐᔪᐊᕐᒥᑦ ᒨᓗᒧᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᓕᕆᕙᓪᓚᐊᔪᑦ (ᐱᓕᕆᐊᖅ), ᑭᕙᓪᓕᕐᖁᖅ ᓄᓇᕗᒻᒥᑦ ᖃᓂᑕᖕᒐᓂᑦ ᐱᖓᖕᓇᖅᐸᓯᖕᒐᓂᑦ ᑕᓯᐅᔭᕐᔪᐊᑉ ᓯᒃᔭᖕᒐᓂᑦ, ᐅᑭᐅᖅᑕᖅᑐᖕᒐᓂᑦ ᑲᓇᑕᐅᑉ, 25 ᑭᓛᒥᑕᓪᓗᐊᓂᒃ ᐅᐊᖕᓇᖕᒐᓂᑦ ᐅᖕᒐᓯᒃᑎᒋᔪᖅ ᑲᖏᖅᖠᓂᕐᒥᑦ. ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒧᑦ ᐸᕐᓇᐅᑎ ᐅᒃᑯᐃᖕᒐᔪᒥᑦ ᓄᓇᒥᑦ ᐊᒪᓗ ᓄᓇᐅᑉ ᐃᓗᐊᓂᑦ ᐅᔭᕋᖕᓂᐊᕐᓂᕐᑲᕈᒪᔪᖅ ᑎᓇᒐᓂᐊᖅ-ᒥᑦ.

ᐃᒪᕐᒧᑦ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᒋᐊᕐᑲᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖕᒐᔪᖅ (AEMP) ᐱᔭᕆᐊᕐᑲᖅᑎᑕᐅᔪᖅ Type A ᐃᒪᕐᒧᑦ ᓚᐃᓴᓐᓯᐅᑉ ᑐᓂᔭᐅᓂᐊᖅᑐᖅ ᓄᓇᕗᒻᒥ ᐃᒪᓕᕆᔨᒃᑯᖏᓐᓄᑦ (NWB). AEMP ᐋᕐᑭᐅᒪᔪᖅ ᐸᕐᓇᐅᑎ ᐱᓕᕆᐊᒧᑦ ᓴᖅᑭᑕᐅᓚᐅᖅᑐᖅ ᐅᕐᑲᕐᑎᕐᑲᑦᑕᐅᑎᓂᒃᑯᑦ ᓄᓇᓕᖕᒥᐅᓂᒃ, ᐱᕐᑲᖅᑲᑕᐅᔪᓂᒃ, ᐊᒪᓗ ᒪᓕᒐᓂᒃ ᑲᒪᔨᐅᔪᓂᒃ. ᑲᑎᑎᓯᒪᔪᖅ ᖃᐅᔨᒋᐊᕐᑲᑦᑕᕐᓂᕐᒧᑦ ᑐᕌᖕᒐᔪᖅ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᒪᓗ ᐊᔾᔨᖅᑲᓕᖅᑎᓯᒪᐸᓗᓂ ᐊᕙᑎᒥᒃ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᐅᔨᒋᐊᕐᑲᑦᑕᕐᓂᕐᒧᑦ (EEM) ᐱᔭᕆᐊᓕᖕᓄᑦ ᓴᕕᖕᓂᑦ ᐅᔭᕋᖕᓂᐊᖅᑐᓕᕆᓂᖅ ᐊᒃᑕᑰᖅᑕᐅᔪᓄᑦ ᒪᓕᒐᐃᑦ (MMER).

ᐃᓂᐅᓂᐊᖅᑑᑉ ᖃᓄᐃᖕᒐᓂᐊᕐᓂᖕᒐ

ᐃᓂᐅᓂᐊᖅᑑᑉ ᖃᓄᐃᖕᒐᓂᐊᕐᓂᖕᒐ ᑕᑯᒃᓴᐅᔪᖅ ᐅᖃᐅᓯᖅᑲᖅᓗᓂ ᐱᓕᕆᖃᑎᒌᖕᓂᖕᒋᑦ ᐅᔭᕋᖕᓂᐊᖅᑐᓕᕆᓂᐅᑉ, ᐊᒃᑐᖅᑕᐅᓯᒪᔪᑦ ᐊᕝᖁᑎᒋᔭᐅᔪᑦ (ᐃᒪᖅ, ᑕᓯᐅᑉ ᐊᓗᐊᓃᑦ, ᑑᒪᔪᐃᑦ), ᐊᒪᓗ ᐃᒃᐱᒋᓂᖃᖅᑐᑦ (phytoplankton, zooplankton, benthic invertebrates, ᐊᒪᓗ ᐃᖃᓗᐃᑦ). ᑯᕕᓃᑦ, ᐃᖕᖓᖅᑐᑦ, ᓯᓚᒧᐊᖅᐸᓪᓚᐊᔪᑦ, ᐊᒪᓗ ᐳᔪᖃᑖᑦ ᐊᒃᑐᖅᓯᓂᖃᕈᓐᓇᖅᑐᑦ ᐃᒃᐱᒋᓂᖃᖅᑐᓂᒃ, ᑭᓯᐊᓂ ᐅᔭᕋᖕᓂᐊᖅᑐᓕᕆᓂᕐᒥᙵᖅᑐᓗᐊᑦ ᐊᒃᑐᖅᓯᓂᖃᕈᓐᓇᖅᑐᖅ ᐃᒃᐱᒋᓂᖃᖅᑐᓂᒃ. ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᓴᑯᑕᐅᔪᑦ ᐱᐅᖏᑦᑐᑦ ᐱᐅᖏᑦᑐᖅᑕᖃᓕᖅᑎᑦᑎᔪᖕᓇᖅᑐᑦ (ᓰᕐᓗ ᐱᐅᖏᑦᑐ ᓴᕕᖕᓂᑦ) ᐅᕙᓘᓃᑦ ᑎᒥᒧᑦ ᓂᕐᑭᒋᔭᐅᔪᓂᒃ ᐱᐅᓯᒋᐊᖅᑎᑦᑎᑲᓐᓂᕐᓗᓂ (ᐊᖏᒡᓕᒋᐊᖅᓯᓗᓂ ᐱᕙᓪᓕᐊᓂᖅ ᑎᒥᒧᑦ ᓂᕐᑭᒋᔭᐅᔪᓂᒃ); AEMP ᐋᕐᑭᒃᑕᐅᓚᐅᖅᑐᖅ ᐃᓱᒪᒋᔭᖃᕐᓗᓂ ᑕᒪᐃᓂᒃ ᐊᒃᑐᖅᓯᓂᖃᖅᑐᓂᒃ. ᐊᑐᕐᓂᖅ ᐃᓂᐅᓂᐊᖅᑑᑉ ᖃᓄᐃᖕᒐᓂᐊᕐᓂᖕᒐᓂᒃ ᑐᓂᓯᔪᖅ ᐱᕙᓪᓚᐊᓂᕐᒥᒃ ᐊᒪᓗ ᐱᐅᓯᒋᐊᖅᑎᑦᑎᓂᕐᒥᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᖃᓄᐃᖕᒐᓂᐊᕐᓂᖕᒐᓂᒃ, ᐊᒪᓗ ᑐᑭᓕᐅᕆᓂᕐᒧᑦ ᖃᓄᐃᖕᒐᓂᐅᔪᓂᒃ.

ᖃᐅᔨᓴᐃᓂᖅ ᖃᓄᐃᖕᒐᓂᐊᕐᓂᖕᒐᓄᑦ

ᒪᕐᕈᒃ ᐅᔾᔨᕐᓇᖅᑑᒃ ᑐᕋᖕᒐᔪᓕᐊᖑᔪᒪᔪᑦ AEMP-ᒧᑦ: ᑕᓯᕐᔪᐊᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐊᒪᓗ ᑕᓯᕐᓂᑦ ᖃᐅᔨᓴᐃᓂᖅ ᖃᓄᐃᑑᓂᐊᕐᓂᖕᒐ ᐊᑐᖅᓗᓂ ᐱᓕᕆᐊᑉ ᖃᓄᐃᑑᓂᐊᕐᓂᖕᒐᓄᑦ, ᐃᓄᐃᑦ ᖃᐅᔨᒪᔭᑐᖅᑲᖏᓐᓂᒃ (IQ), ᐅᖅᑲᖅᑎᖅᑲᑦᑕᐅᑎᓂᒃᑯᑦ, ᐊᒪᓗ ᒪᓕᒐᑎᒍᑦ ᐱᔭᕆᐊᖅᑲᕐᓂᒃᑯᑦ. IQ ᐊᒪᓗ ᓄᓇᓕᖕᒥᑦ ᐅᖅᑲᖅᑎᖅᑲᑦᑕᐅᑎᓂᒃᑯᑦ, ᐱᒻᒪᕆᐅᒋᔭᐅᔪᖅ ᓴᓗᒪᔪᒥᒃ ᐃᒪᖅᑲᕐᓂᖅ ᐊᒪᓗ ᐋᓐᓂᐊᖅᑲᖅᑕᐃᓕᒪᓂᖕᒋᑦ ᐃᖃᓗᐃᑦ ᑎᖕᒥᐊᓪᓗ ᐅᖃᐅᓯᐅᓚᐅᖅᑐᖅ ᐃᓐᓇᑎᔭᐅᔪᓄᑦ ᐊᓯᖕᒋᓐᓄᓪᓗ ᐃᓄᖕᓄᑦ ᓄᓇᓕᖕᓂᑦ ᑕᒪᒃᑯᓂᙶᑦ ᐊᑐᖅᑲᑦᑕᖅᑐᓄᑦ ᐱᖅᑯᓯᖕᒋᑦᑎᒍᑦ. ᐃᓐᓇᑎᔭᐅᔪᑦ ᐃᓱᒡᓕᓅᑎᖕᒥᖕᓂᒃ ᖃᐅᔨᑎᑦᑎᓚᐅᖅᑐᑦ ᐊᖏᔪᒥᒃ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᖅᑲᕈᓐᓇᕐᓂᖕᒐ ᐱᓕᕆᐊᖅ ᐃᒥᖅᑕᐅᖅᑲᑦᑕᖅᑐᒧᑦ ᐊᒪᓗ ᐃᖃᓗᖕᓄᑦ ᑕᓯᕐᔪᐊᓗᒃᑖᒧᑦ. ᑕᐅᑐᒃᓗᒍ ᖃᐅᔨᓴᐃᓂᐅᑉ ᖃᓄᐃᖕᒐᓂᖕᒐ ᐊᒪᓗ ᖃᐅᔨᓴᐃᓂᖅ ᖃᓄᐃᖕᒐᓂᐅᔪᓂᒃ ᐊᕐᕋᒍᑕᓖᑦ ᖃᐅᔨᒋᐊᕐᑲᑦᑕᕐᓂᕐᒧᑦ ᐅᓂᑉᑲᓂᑦ, ᐊᐱᖅᑯᑕᐅᓗᐊᖅᑐᑦ ᐊᑐᖅᑕᐅᓚᐅᖅᑐᑦ ᐊᑐᓂ ᖃᐅᔨᒋᐊᕐᑲᑦᑕᕐᓂᕐᒧᑦ ᐃᓚᒋᔭᐅᔪᓄᑦ ᐊᑐᓂ ᒪᕐᕈᖕᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᓄᑦ.

ᑕᓯᕐᔪᐊᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᖅ ᐋᕐᑭᒃᑕᐅᓚᐅᖅᑐᖅ EEM-ᒧᑦ ᐱᔭᕆᐊᖅᑲᕐᓂᒃᑯᑦ (ᓲᕐᓗ, ᖃᐸᓯᐅᓂᖕᒋᑦ ᐃᓂᒋᔭᐅᔪᑦ ᐊᑕᐅᓯᕐᒧᑦ, ᐆᒃᑐᕋᐃᓂᐅᑉ ᐊᖏᓂᖕᒐ, ᐆᒃᑐᕋᐃᓃᑦ ᐃᓱᖕᒋᑦ ᐊᒪᓗ ᑕᒻᒃᑯᓈᓐᖓ ᐊᒃᑐᐊᔪᑦ), ᑕᓯᕐᔪᐊᖅ ᐱᓂᐊᕐᓂᖕᒐᓄᑦ ᐱᐅᖏᑦᑐᒥᒃ ᑯᕕᔪᒥᑦ. ᐃᓚᒋᔭᐅᓗᐊᖅᑐᖅ ᑕᓯᕐᔪᐊᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖕᒐ, ᑕᓯᐅᑉ ᐊᓗᐊᓃᑦ ᖃᓄᐃᓂᖕᒋᑦ, ᐆᒪᔪᕋᓛᑦ, ᐊᒪᓗ ᐃᖃᓗᐃᑦ. ᑐᕌᒐᐅᔪᑦ ᐆᒪᔪᕋᓛᓂᒃ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐃᓚᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒥᒃ ᐆᒪᔪᕋᓛᓂᒃ ᖃᐅᔨᒋᐊᕐᑲᑦᑕᕐᓂᖅ. ᑕᓯᕐᔪᐊᕐᒥᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ, ᐱᖓᓱᐃᑦ ᑕᓯᕐᖁᑦ ᐅᖃᐅᓯᐅᔪᑦ ᐃᓚᐅᕙᓗᑎᒃ ᖃᓄᐃᖕᒐᓂᐅᔪᒥᑦ. ᑕᓯᕐᖁᓂᒃ ᐅᖃᐅᓯᐅᔪᑦ ᓂᕈᐊᖅᑕᐅᓚᐅᖅᑐᑦ, ᐊᔾᔨᐅᖏᓐᓂᖏᓐᓄᑦ ᒥᑭᑦᑐᑦ ᐃᖃᓗᐃᑦ ᑲᑎᕐᒪᔪᑦ ᑕᐃᒪᐅᓂᖏᓐᓄᑦ ᑕᓯᕐᔪᐊᕐᒥᑦ ᐊᓯᖏᓐᓂᐅᖕᒐᓂᑦ ᑕᓯᕐᓂᑦ ᑭᕙᓪᓕᕐᒥᑦ, ᐊᒪᓗ ᖃᓄᐃᖕᒐᓕᖅᑎᑦᑎᓂᐅᔪᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᓇᔭᖕᒐᓂᒃ ᓂᕆᐅᒋᔭᐅᔪᖅ ᖃᓂᑦᑐᒦᓐᓂᐊᕐᓂᖕᒐᓄᑦ; ᑕᒪᓇ ᐊᑐᕈᖕᓇᖅᑎᑦᑎᔪᖅ ᐅᖃᐅᓯᐅᔪᓂᒃ ᐃᓚᖕᒋᓐᓂᒃ ᐅᖕᒐᓯᒃᑐᒥᑦ ᑰᒃᑐᓂᑦ ᓯᐊᒪᒃᑎᑦᑎᔪᒥᑦ.

ᐊᓯᖏᑦ ᑕᓱᑦ ᐱᐅᖏᑦᑐᓂᒃ ᑯᕕᔪᓂᒃ ᐱᔾᔾᖏᑦᑐᑦ, ᖃᐅᔨᓴᐃᓂᖅ ᐋᕿᑦᑕᐅᓚᐅᕐᒪᑦ ᖃᐅᔨᓂᕐᒧᑦ ᑕᐃᑲᙵᖏᑦᑐᓂᒃ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᕐᓂᒃ (ᓲᕐᓗ, ᓯᓚᒧᐊᖅᑐᓂᒃ ᐊᒻᒪ ᐊᓯᐊᕐᔪᖅᑎᑦᑎᔪᓂᒃ ᐃᒪᕐᑲᖅᑐᓂᒃ). ᐃᓚᒋᔭᐅᓗᐊᖅᑐᖅ ᐊᓯᖏᓐᓂᒃ ᑕᓯᕐᓄᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ. ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓ ᖃᐅᔨᒋᐊᖅᑕᐅᖃᑦᑕᐃᓐᓇᕐᓂᐊᖅᑐᖅ, ᐆᒪᓂᖃᕐᓂᒃᑯᑦ ᐅᕙᓘᓅᑦ ᐊᓯᐅᒍᑦ ᖃᐅᔨᓴᐃᓂᒃᑯᑦ (ᓲᕐᓗ, ᑐᕌᒐᓇᔭᐅᔪᑦ ᖃᐅᔨᓴᐃᓃᑦ) ᐃᓚᔭᐅᓗᑎᒃ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖓᓄᑦ ᖃᓄᐃᖓᓂᐅᔪᑦ ᐅᔭᕋᖕᓂᐊᕐᕕᖕᒥᙵᖅᑐᒥᒃ ᐊᓯᐊᕐᔪᕐᓂᖅᑲᖅᐸᑕ.

ᐅᐸᓗᐊᓂᕐᔫᖕᒐᔪᖅ

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ᐅᓂᒃᑳᕐᓂᖅ

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EXECUTIVE SUMMARY

The Meliadine Gold Mine Project (Project) is located in the Kivalliq District of Nunavut near the western shore of Hudson Bay, in Northern Canada, approximately 25 kilometres (km) north of Rankin Inlet. The mine plan proposes open pit and underground mining of Tiriganiaq.

An Aquatic Effects Monitoring Program (AEMP) is a requirement of the Type A Water Licence to be issued by the Nunavut Water Board (NWB). The AEMP design plan for the Project was developed through consultation with communities, stakeholders, and regulatory authorities. It is an integrated monitoring program study design and is harmonized with the Environmental Effects Monitoring (EEM) requirement of the Metal Mining Effluent Regulations (MMER).

Conceptual Site Model

The conceptual site model is a visual illustration describing the interactions of mine activities, exposure pathways (water, sediment, biological tissue), and receptors of potential concern (phytoplankton, zooplankton, benthic invertebrates, and fish). Spills, leaks, aerial emissions, and dust deposition can potentially affect the receptors, but release of mine effluent is the primary activity that could affect the biological receptors. Effects from effluent release could result in toxicological impairment (e.g., toxicity due to metals) or nutrient enrichment (increased productivity due to nutrients); the AEMP was designed to consider both lines of chemical stressors. The use of a conceptual site model provides the basis for developing and refining the study design, and for interpretation of results.

Study Design

Two distinct programs are proposed for the AEMP: the Meliadine Lake study and the Peninsula Lakes study with the design dictated by Project design, Inuit Qaujimajatuqangit (IQ), consultation, and regulatory requirements. 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. Elders have expressed concerns regarding potential adverse effects due to the project on drinkability of water and fish populations in waterbodies in the entire Meliadine watershed. To focus the study design and analysis of results in the annual monitoring reports, key questions were developed for each monitoring component in each of the two studies.

The Meliadine Lake study was designed around the key aspects of EEM requirements (e.g., number of stations per area, sample sizes, measurement endpoints and supporting variables), as Meliadine Lake will receive direct effluent discharge. The core components of the Meliadine Lake study are water quality, sediment quality, benthic invertebrate communities, and fish. A targeted plankton study is also included to investigate the potential for plankton monitoring. For the Meliadine Lake study, up to three within-lake reference areas are included in the design. Within-lake reference areas were chosen, because a different small bodied fish assemblage was found in Meliadine Lake compared to other lakes in the region, and effects on water quality are expected to be localized; this allows use of reference areas at some distance downstream from the diffuser.

The Peninsula Lakes will not receive direct effluent discharges, thus the study was designed to detect potential indirect effects (i.e., aerial deposition and physical alteration of watersheds). The core component of the Peninsula Lakes study is water quality. Water quality will be monitored on a regular basis, with biological or other studies (i.e., targeted studies) added if the water quality results suggest mine-related changes have occurred.

Response Framework

The Response Framework is a systematic approach for responding to AEMP results and provides input into mitigation and adaptive management. For this version of the Response Framework, Low Action Levels were developed for all monitoring components. If a Low Action Level is exceeded, a response or action will be initiated, and Medium and High Action Levels will be developed. The type of response taken after reaching an Action Level will depend on the type and magnitude of effect observed.

Reporting

Reporting requirements of the AEMP and EEM will be harmonized where possible. A comprehensive report will be submitted to the NWB annually (schedule to be determined), and to Environment Canada on the EEM reporting schedule.

REVISION HISTORY

Version	Date	Notes/Revisions
0	April 2015	Final preliminary design for submission with the Water Licence application

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APPENDICES

APPENDIX A
Meliadine AEMP Workshop Meeting Minutes

GLOSSARY

Term	Definition
Aquatic Effects Monitoring Program	A monitoring program designed to evaluate the effect of mining activities and mitigation on the aquatic environment.
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 Water Quality Guideline (CWQG) for the Protection of Aquatic Life	Guidelines established by the Canadian Council of Ministers of the Environment to protect aquatic life (i.e., fish, aquatic plants, and benthic invertebrates) in Canadian surface waters.
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.
Drinking Water Quality Guidelines (DWQG)	Health Canada guidelines used to evaluate the suitability of water for human consumption.
Effluent	The out-flow water or wastewater from a water processing system or device, or the final water which is 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 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.
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)	This is considered as 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 (CCME 2001), 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.

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

Term	Definition
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.
Probable Effects Level (PEL)	Canadian sediment quality guideline for the protection of freshwater quality life (CCME 2001), 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 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

AANDC	Aboriginal Affairs and Northern Development Canada
AEMP	Aquatic Effects Monitoring Program
Agnico Eagle	Agnico Eagle Mines Limited
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
AWAR	All-weather Access Road
BCI	Bray-Curtis Index
CALA	Canadian Association for Laboratory Accreditation Inc.
CCME	Canadian Council of Ministers of the Environment
CFIA	Canadian Food Inspection Agency
CI	Control-Impact
cm	Centimetre
CP	Contact Pond
CRM	Certified Reference Standard
CREMP	Core Receiving Environment Monitoring Program
CSQG	Canadian Sediment Quality Guidelines
CWQG	Canadian Water Quality Guidelines
DEIS	Draft Environmental Impact Statement
DO	Dissolved Oxygen
DWQG	Drinking Water Quality Guidelines
EC	Environment Canada
EEM	Environmental Effects Monitoring
FEIS	Final Environmental Impact Statement
GF	Glass Fibre
GSI	Gonadosomatic Index
KIA	Kivalliq Inuit Association
IM	Immature
IQ	Inuit Qaujimajatuqangit
k	Condition Factor
L	Litre
LSI	Liversomatic Index
MA	Maturing
µg	Microgram
mg	Milligram
mL	Millilitre
MMER	Metal Mining Effluent Regulations
µS	MicroSiemens
NAD 83	North American Datum 1983
NIRB	Nunavut Impact Review Board

NLCA	Nunavut Land Claims Agreement
NMDS	Nonmetric Multidimensional Scaling
NWT	North West Territories
NWB	Nunavut Water Board
PEL	Probable Effect Level
Project	Meliadine Gold Project
QA	Quality Assurance
QC	Quality Control
RB	Reabsorbing
RP	Ripe
RS	Resting
SEI	Simpson's Evenness Index
SD	Seasonal Development
SP	Spent
SR	Studentized Residuals
TBD	To Be Determined
TSF	Tailings Storage Facility
TSS	Total Suspended Solids
UTM	Universal Transverse Mercator
UN	Unknown
WRSF	Waste Rock Storage Facility

1.0 INTRODUCTION

1.1 Background

The Meliadine Gold Mine Project (Project) is located in the Kivalliq District of Nunavut near the western shore of Hudson Bay, in Northern Canada (Figure 1-1). The nearest community is Rankin Inlet (coordinates: 62°48'35''N; 092°05'58''W), located at approximately 25 kilometres (km) south of the Tiriganiaq deposit (coordinates: 63°01'03''N, 92°12'03''W). The Project is located within the Meliadine Lake watershed of the Wilson Water Management Area (Nunavut Water Regulations Schedule 4). Rankin Inlet is an Inuit hamlet on the Kudlulik Peninsula located between Chesterfield Inlet and Arviat. It is the regional center and the largest community of the Kivalliq region, and the second most populated community in Nunavut after the capital of Iqaluit.

The mine plan proposes open pit and underground mining methods for the development of the Tiriganiaq gold deposit, with two open pits (Tiriganiaq Pit 1 and Tiriganiaq Pit 2) and one underground mine. The proposed mine will produce approximately 12.1 million tonnes (Mt) of ore, 31.8 Mt of waste rock, 7.4 Mt of overburden waste, and 12.1 Mt of tailings. There are four phases to the development of Tiriganiaq: just over 4 years construction (Q4 Year -5 to Year -1), 8 years mine operation (Year 1 to Year 8), 3 years closure (Year 9 to Year 11), and post-closure (Year 11 forwards).

More details on the life of the mine and water management are provided in Section 2.0.

A conceptual Aquatic Effects Monitoring Program (AEMP) description was prepared for the Project. The AEMP is a requirement of the Type A Water Licence and has been designed to function as an integrated monitoring program, which considers pathways to potential effects of the Project on the aquatic environment. Changes in surface water quality, sediment quality, lower trophic communities, fish habitat, and fish health due to release of mine water, physical alteration of watersheds, and air emissions during construction, operations, and closure are considered in the AEMP.

The AEMP was designed as a defensible and comprehensive program, and was developed through consultation with communities, stakeholders, and regulatory authorities, and includes incorporation of Inuit Qaujimajatuqangit (IQ), plus scientific knowledge of aquatic ecosystems. Traditional Knowledge is generally defined as a cumulative body of knowledge, practice, and beliefs, while IQ is generally defined as traditional knowledge specific to the Inuit way of life and encompasses the guiding principles of Inuit social values.

The AEMP is structured as a comprehensive monitoring plan, which incorporates various aquatic components and provides integration, where possible, in terms of stations sampled, sample matrix, and sample analysis. It is proposed that the scheduling and reporting requirements for the AEMP and the Metal Mining Effluent Regulations (MMER) Environmental Effects Monitoring (EEM) components be harmonized within the AEMP annual report. The core studies considered within the AEMP design plan are as follows:

- Meliadine Lake AEMP and EEM program required under the MMER (hereafter referred to as the Meliadine Lake study);
- Peninsula Lakes study; and
- targeted studies (i.e., studies of short duration with focussed objectives).

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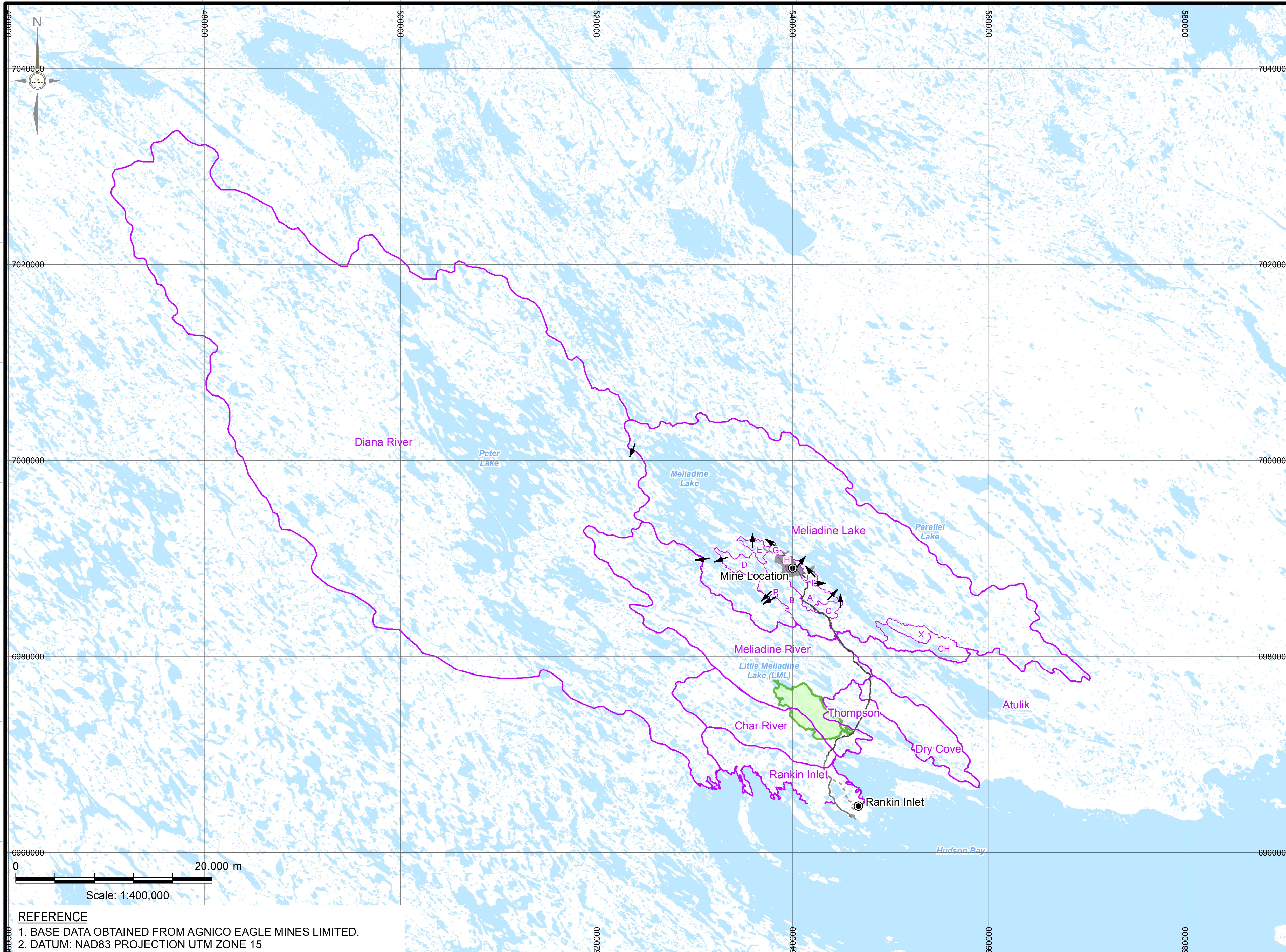

REFERENCE

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

LEGEND

- DIRECTION OF FLOW AT WATERSHED OUTLET
- ALL-WEATHER ACCESS ROAD (AWAR)
- ROAD - NEW
- ROAD - EXISTING
- MINE FOOTPRINT
- WATERSHED BOUNDARY
- TERRITORIAL PARK
- WATERCOURSE
- WATERBODY

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FIGURE 1–1 STUDY AREA FOR THE MELIADINE AQUATIC EFFECTS MONITORING PROGRAM

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The Project will be supported by several monitoring programs and management plans. A sample of some of the programs and linkages among them are illustrated in Figure 1-2. For example, the proposed regulated monitoring station for the water management plan is the final effluent sampling station from the water treatment plant. Samples collected at this location will be used to characterize effluent quality and quantity; results will be presented in the AEMP and used to provide context for AEMP results for Meliadine Lake. Snow sampling for potential contaminants of concern will be conducted under the air quality monitoring program, but results (when relevant) will be summarized in the AEMP to further interpret results.

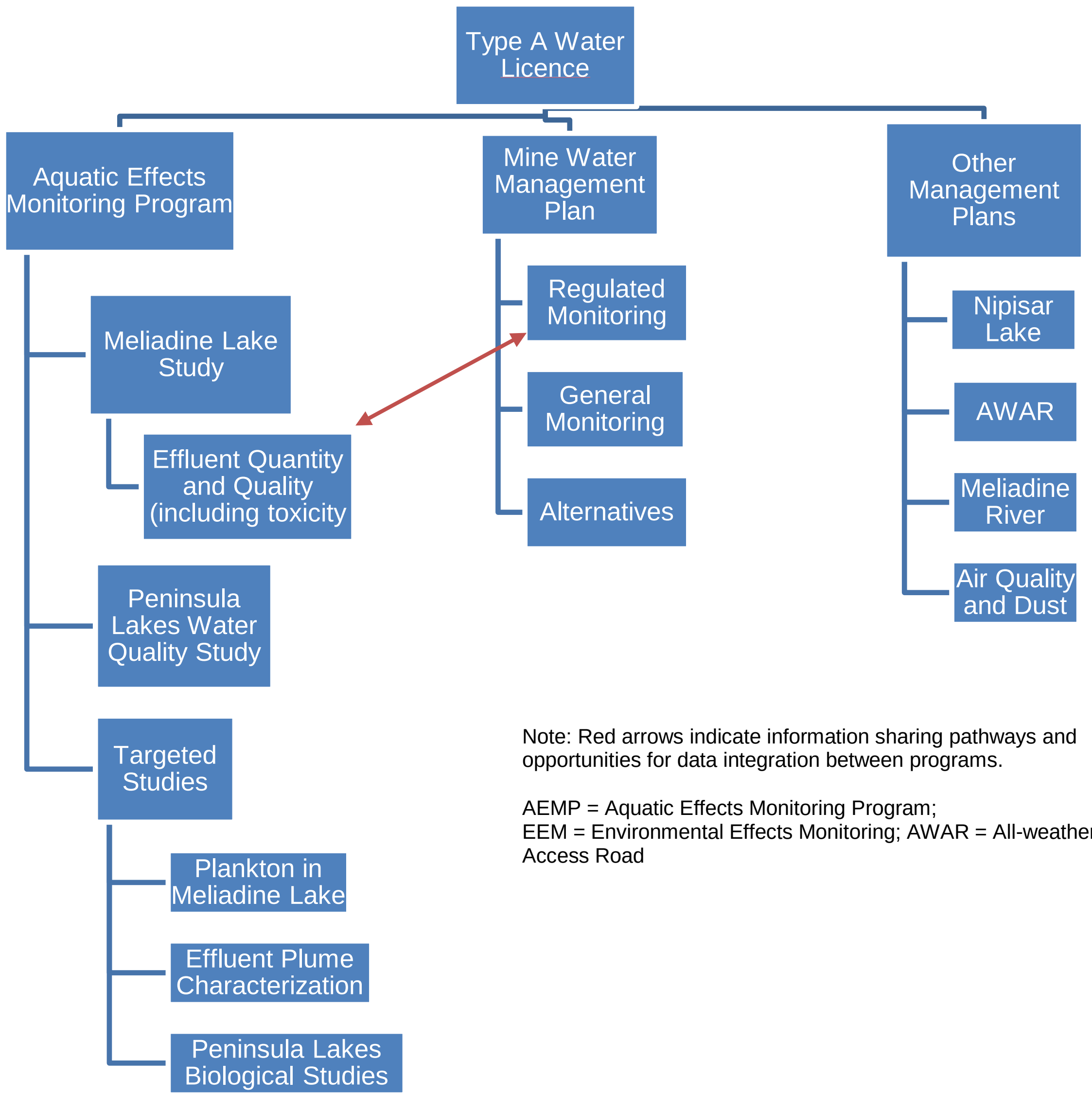


Figure 1-2: Examples of Monitoring Programs for the Project that fall under the Water Licence

1.2 Commitments

The Project recently underwent an environmental assessment with the Nunavut Impact Review Board (NIRB). In the NIRB decision report (NIRB 2014), a series of recommendations and conditions were listed. In addition, during the Final Environmental Impact Statement (FEIS) process, Agnico Eagle Mines Limited (Agnico Eagle) committed to a series of recommendations raised by various interveners. A summary of the NIRB recommendations and conditions, and commitments made by Agnico Eagle to interveners during the regulatory process, which are directly relevant to the AEMP, are provided in Table 1-1.

Table 1-1: Recommendations, Conditions, and Commitments Related to the Aquatic Effects Monitoring Program

Commitment Number and Source	Recommendation / Condition / Commitment Details	Reference within Document
NIRB Decision Report (NIRB 2014) Condition 30	The Proponent shall update its AEMP to include, at a minimum: a. Provide details for additional reference lakes to be included within its sampling and monitoring programs; b. Updates to include sedimentation within relevant monitoring programs; and c. Results from additional testing for mercury in fish tissue, and include test results in updated baseline data.	a. Sections 4.2 and 5 b. not included in this Plan c. Sections 5.5 and 7.3.4
FEIS KIA-IR-06	Agnico Eagle will engage the Inuit to ensure their assessment of whether the “Opportunity for traditional and non traditional use” has been impaired.	Approach outlined in Section 4.4
FEIS KIA-IR-11	Agnico Eagle will monitor water quality in the receiving environment to enable the identification of trends and additional adaptive management strategies, if required, including potential sediment and erosion control.	Sections 5.1 and 6
FEIS KIA-IR-22	The KIA are concerned about dissolved oxygen concentrations during vulnerable times of the year (i.e., low flow or under-ice). They recommended modelling of under-ice dissolved oxygen in the mixing zone. Agnico Eagle commits to monitoring under-ice dissolved oxygen concentrations in the mixing zone of Meliadine Lake.	Section 5.1
FEIS KIA-IR-29	Agnico Eagle will conduct a survey to collect fish tissue chemistry to provide a recent baseline dataset.	Sections 5.5 and 7.3.4
FEIS KIA-IR-NEW-08	KIA are concerned that water quality downstream in Peter Lake (downstream of the northwest outlet of Meliadine Lake) could be impacted, and have recommended a monitoring location in the Diana River watershed. Agnico Eagle has committed to monitoring water quality in Meliadine Lake near the northwest outlet as an early warning to potential far downstream effects.	Sections 4.2 and 5.1
FEIS KIA-IR-NEW-09	For the purposes of future water quality monitoring programs, the term "differing from baseline" will be defined through calculations of normal range.	Section 8

Table 1-1: Recommendations, Conditions, and Commitments Related to the Aquatic Effects Monitoring Program (continued)

Commitment Number and Source	Recommendation / Condition / Commitment Details	Reference within Document
FEIS KIA-IR-NEW-11	Agnico Eagle will assess the impact of project activities in part through the changes observed in the benthic macroinvertebrate community composition and density.	Sections 5.2 and 7.3.1
FEIS KIA-IR-NEW-12	Agnico Eagle has committed to analyzing tissue from fish in Meliadine Lake and select peninsula lakes.	Sections 5.5 and 7.3.4
FEIS GN-1	Agnico Eagle has committed to monitoring water quality during different seasons of the year including under-ice and early spring. Sampling of snowpack and snowmelt runoff are not currently included in the AEMP design.	Section 5.1

AEMP = Aquatic Effects Monitoring Program; NIRB = Nunavut Impact Review Board; FEIS = final environmental impact statement; KIA = Kivalliq Inuit Association; GN = Government of Nunavut; IR = information request.

1.3 Objectives and Scope

The overall objective of the AEMP is to assess potential mine-related effects on the aquatic ecosystem and to meet regulatory requirements outlined in the Type A Water Licence and MMER, while also meeting commitments made during the environmental permitting process (i.e., NIRB certificate). A single design plan that meets the needs of all the regulatory bodies has been developed to avoid duplication of sampling and reporting efforts.

Planning and development of the AEMP considered lessons learned from the Meadowbank Mine, MMER requirements (Government of Canada 2012; EC 2012), and the AEMP design guidance document developed for the Northwest Territories (AANDC 2009).

The objectives of the AEMP for the Project are as follows:

- determine the short- and long-term effects of the Project on the aquatic receiving environment;
- evaluate the accuracy of predictions made in the FEIS, including the final significance statements regarding impact to the aquatic ecosystem;
- assess the efficacy of planned mitigation incorporated into the Project design; and
- collect data required to identify the need for potential additional mitigation of Project effects within a management response framework.

Additional objectives of this AEMP design plan document are to:

- provide a framework for incorporation of IQ; and
- provide a basis to engage in and solicit feedback on the design plan.

The core components of the AEMP are water quality, sediment quality, benthic invertebrate community, and fish health and tissue chemistry. Additional supporting information includes regional air temperature data. Plankton community monitoring is proposed as a targeted study to evaluate its utility as a monitoring tool in the Project area.

The focus of the current AEMP design is on the early phases of the Project (i.e., construction to early operations), but the design also considers later phases of the Project (i.e., late operations to closure), and potential development of other deposits. The proposed components, stations, parameters, frequency, and overall design are appropriate for construction through closure, and as data are collected during the life of the Project, the frequency of monitoring may change.

2.0 MINE OVERVIEW

2.1 Mines Phases

The AEMP has been designed to encompass all phases of mine development. Understanding the schedule for mine development is required to understand the AEMP design plan. Mine development activities will occur in four phases: pre-development, construction, operation, and closure, with additional monitoring and mitigation continuing into post-closure.

Pre-development is defined as any construction activities (as defined below) but specific to activities allowed under the provision of the Nunavut Land Claims Agreement Article 13, Section 13.5.5 or the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*. This phase will commence after receipt of the Project Certificate from the Nunavut Impact Review Board, the (new or amended) Type B Water Licence from the NWB, and the land use permit from the Kivalliq Inuit Association.

Construction is defined as any activities undertaken for the purposes of establishing or constructing components, infrastructure, and facilities required for development of a mine. Full mine site construction will commence following receipt of a Type A Water Licence from the NWB and Land Use Permit from the Kivalliq Inuit Association. Construction (including pre-development activity) will take a little over four years from Year -5 to Year -1.

Operations is defined as the period that the Process Plant is operating and producing a commodity (i.e., gold). During the mine start-up, this will include a 3 month commissioning period planned for October to December (i.e., Q4) of Year -1.

Closure (Abandonment, Reclamation and Closure) and Post-Closure is defined as an Operator ceasing operations at a facility without the intent of resuming mining activities. The expectation will be that the site will be reclaimed and post-closure monitoring will continue until it can be demonstrated that the mine site is both chemically and physically stable.

2.2 Water Management Plan

Key to establishing an effective and practical AEMP program is understanding overall water management objectives, strategies, and infrastructure associated with the mine development. Details on the water management for the Project are provided in the Water Management Plan; a summary of the Water Management Plan is provided below.

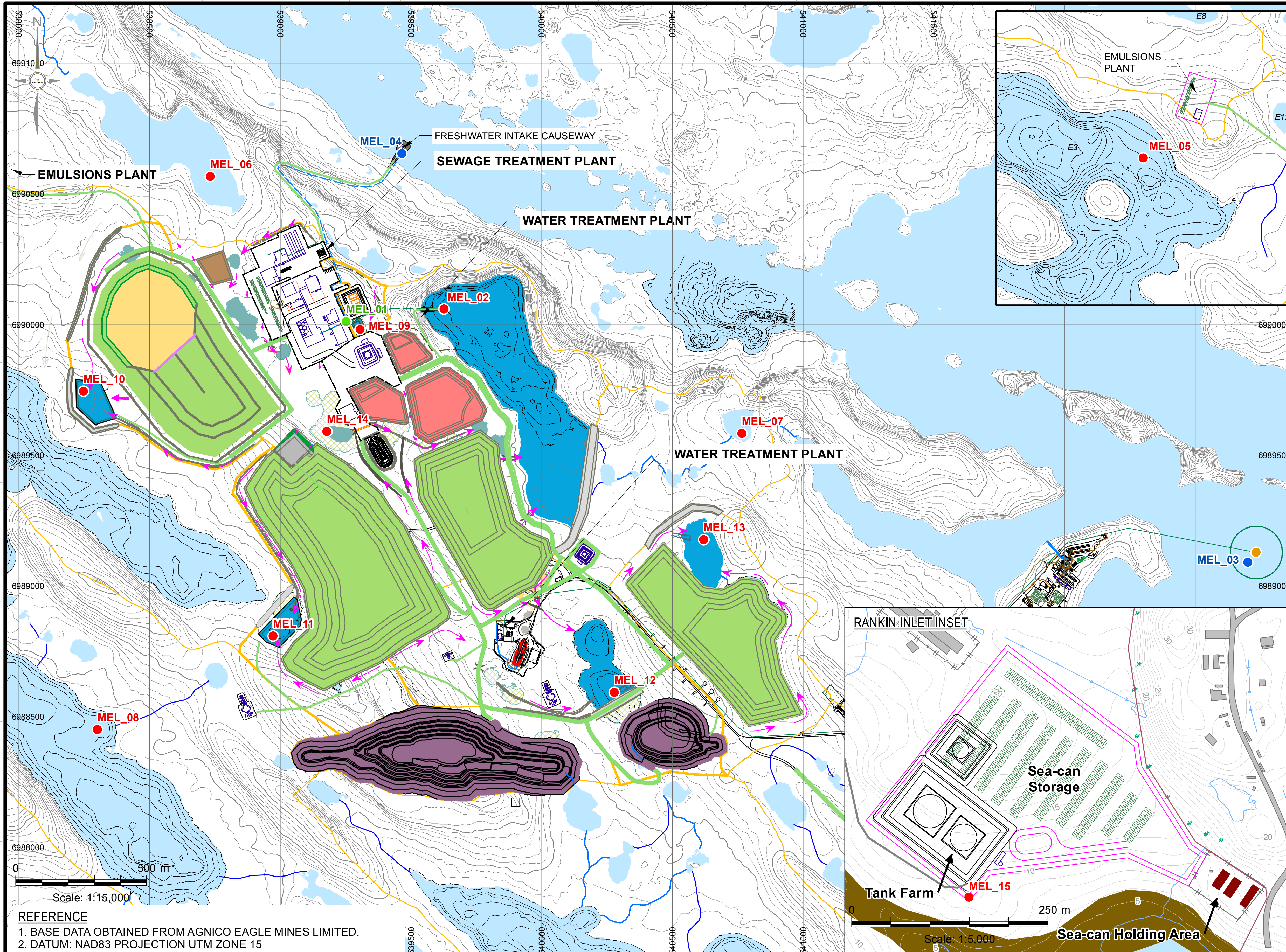
The water management objectives for the Project are to minimize potential impacts to the quantity and quality of surface water at the site. The strategy involves the following:

- minimize the amount of contact water for management, monitoring, and treatment (if required) to the extent practical;
- divert non-contact water from undisturbed lands away from the Project site infrastructure to the extent practical; and
- limit fresh water make-up quantities to the extent practical.

To achieve the objectives and strategy for mine water management for the Project, main components of the water management infrastructure associated with mine development (illustrated on Figure 2-1), is as follows:

- six water collection ponds (CP1 to CP6);
- five water retention dikes (D-CP1, D-CP3, D-DCP4, D-CP5, and D-CP6);
- three water diversion/collection berms (Berm1 to Berm3), eight water collection channels (Channel1 to Channel8), and six water passage culverts (Culvert1 to Culvert6) to convey and control contact water within the proposed mine site;
- a freshwater pumping station and intake causeway on Meliadine Lake;
- a sewage treatment plant;
- network of surface pumps and pipelines;
- potable water treatment plant; and
- a water treatment plant to treat contact water prior to release to Meliadine Lake through a discharge diffuser.

In addition to water quality monitoring that will occur in the receiving environment (AEMP), there will also be monitoring on the proposed mine site. Proposed mine water monitoring sites are provided on Figure 2-1; more details on the locations, sampling frequency, and sample parameters are included in the Water Management Plan and the Environmental Management and Protection Plan. The key station that links the mine site water monitoring and the AEMP water monitoring is the regulated monitoring station in the water treatment plant after treatment but before release to Meliadine Lake.



REFERENCE
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2. DATUM: NAD83 PROJECTION UTM ZONE 15

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LEGEND
- CATCHMENT BOUNDARY
- SERVICE ROAD
- HAUL ROAD
- NON CONTACT WATERBODY
- CONTACT WATERBODY
- WATER COLLECTION POND
- DRAINED POND AREA
- OPEN PIT
- OVERBURDEN
- WASTE ROCK
- ORE
- TAILINGS
- INDUSTRIAL SITE PAD
- CONTACT WATER FLOW DIRECTION
- STREAM
- DIFFUSER LOCATION
- GENERAL AQUATIC MONITORING LOCATION
- REGULATED MONITORING LOCATION
- VERIFICATION MONITORING LOCATION

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FIGURE 2-1 MELIADINE MINE DURING OPERATIONS

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2.3 Schedule of Activities

Full details on activities and schedule for the mine phases are provided in the Mine Plan; however, a high level summary with linkages to AEMP planning and design are provided in Table 2-1.

Table 2-1: Summary of Mine Development Activity and Water Management Activities

Phase, Mine Year	Mine Development Activity	Water Management Activity
Pre-development Mine Year -5	■ Initiate construction of the industrial pad. ■ Develop ore stockpiles	■ Dewatering top 0.5 to 1.0 m of fresh water in Pond H17.
Construction Mine Years -4 to -1	■ General site preparation. ■ Construct infrastructure related to rock handling, mill processing, and tailings and water management. ■ Construct diversion infrastructure and control ponds. ■ Start mining, milling and deposition of tailings (October of year -1). ■ Placement of waste to WRSFs.	■ Collect and store local contact water from initial ore stockpiles and overburden pile in the WRSFs ■ Begin operation of water collection ponds. ■ Start to treat sewage water and pump the treated sewage water from sewage treatment plant to CP1 ■ Dewater Pond A54. ■ Install culverts under haul roads. ■ Start supply freshwater. ■ Start release of treated water to Meliadine Lake through the diffuser.
Operations Mine Years 1 to 8	■ Operation of contact ponds. ■ Mining and milling. ■ Deposition of tailings to TSF. ■ Operational management of WRSFs, ore stockpiles and TSF.	■ Release of treated water to Meliadine Lake through the diffuser. ■ Dewatering of ponds, as needed.
Closure Mine Years 9 to 12	■ Start of closure and decommissioning. ■ Removal and demolition of most infrastructure on site. ■ Active reclamation and rehabilitation.	■ Active filling of open pit by pumping water from Meliadine Lake. ■ Continue to collect the contact water and pump to the contact water treatment plant for treatment.
Post-closure Mine Years 13+5 (2032+)	■ Post closure monitoring.	■ Decommissioning of the water management system when water quality meets direct discharge criteria.

TSF = tailings storage facility; WRSFs = waste rock storage facilities; AWAR = all-weather access road; CP = collection pond.

3.0 CONCEPTUAL SITE MODEL

3.1 Introduction

The conceptual site model is an illustrative approach to describing the interactions of stressors associated with proposed mine activities, exposure pathways, and receptors of potential concern. The intent of the model is to assist in communicating the functions of, and interactions between, ecological components of the study area and potential effects of mine activities. The conceptual site model currently considers the following:

- the Project Description, including major activities during construction, operation, and closure;
- knowledge of aquatic ecology and the specific aquatic ecosystems in the AEMP study area; and
- predictions of the FEIS.

The conceptual model considers those environmental variables related to commitments made by Agnico Eagle and conditions stipulated during the environmental permitting process. In addition, the conceptual site model will be updated to reflect input received during the water licencing phase, as appropriate.

3.2 Aquatic Interactions

Aquatic interactions include biological responses to the physico-chemical conditions in lakes and sediments, as well as biota-biota interactions (Figure 3-1). Phytoplankton use nutrients and carbon sources (i.e., internal recycling and renewed external sources) for growth, and are food for benthic invertebrates and zooplankton. Phytoplankton community structure can change due to effluent released by a mine (e.g., increased growth from nutrient enrichment, or decreased growth from direct toxicity). Zooplankton feed directly on phytoplankton, whereas benthic invertebrates feed on decaying organic material that settles to the bottom of waterbodies. Changes in the phytoplankton community can affect the zooplankton and benthic invertebrate communities. Small fish and young fish feed on zooplankton and benthic invertebrates, and larger, predatory fish feed on smaller fish. Species such as Cisco (*Coregonus artedi*), Lake Trout (*Salvelinus namaycush*), and Arctic Char (*Salvelinus alpinus*) occupy top trophic positions in Meliadine Lake. In the Peninsula Lakes, the same species are present, but species assemblages vary among lakes.

Changes in phytoplankton, zooplankton, and benthic invertebrate densities or species composition can affect the fish community in waterbodies. The broad categories of biological receptors of the aquatic ecosystem for the Project are as follows:

- Primary producers: phytoplankton and periphyton;
- Primary consumers: zooplankton and benthic invertebrates; and
- Secondary/tertiary consumers: fish.

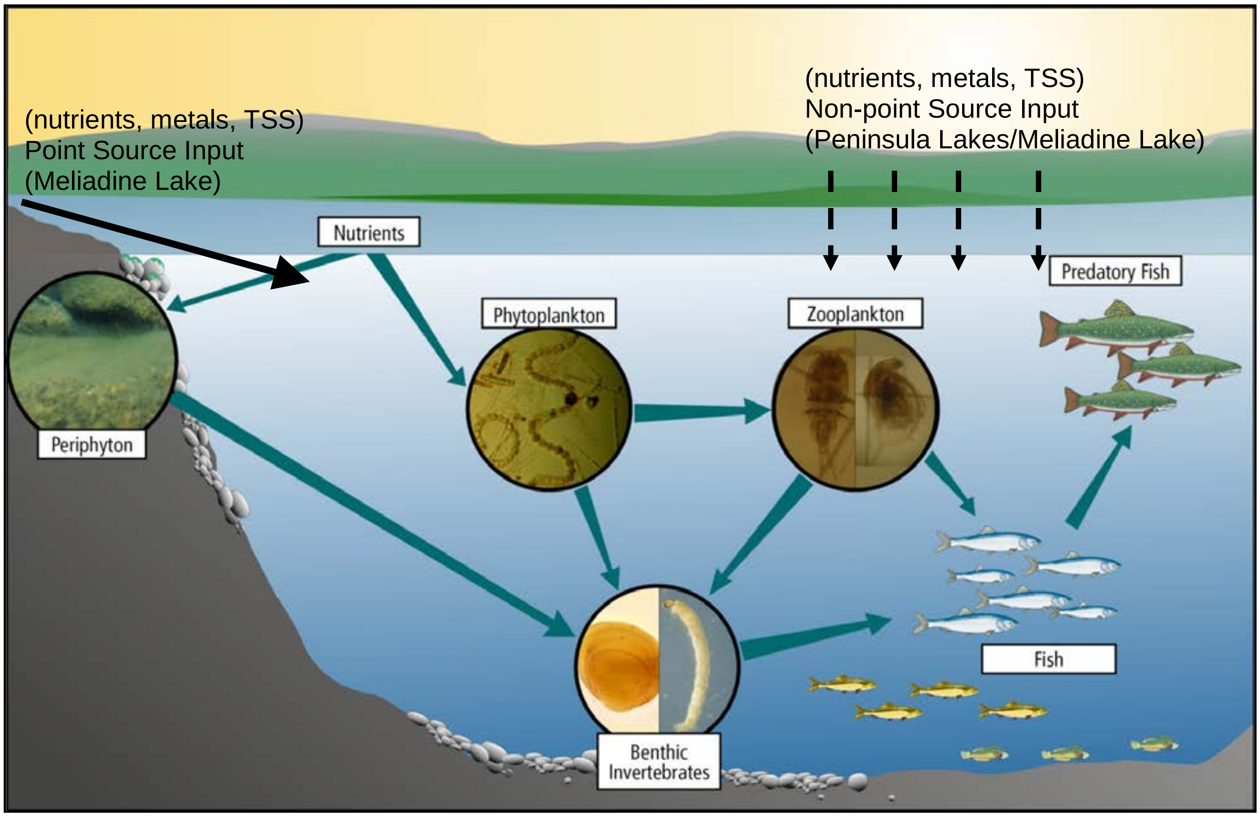

Figure 3-1: Interactions in an Aquatic Ecosystem

TSS = total suspended solids

3.3 Stressors of Concern

The sources of potential stressors of concern, with corresponding transport pathways, exposure media, and biological receptors are illustrated in Figure 3-2. The main sources of the stressors are effluent, spills and leaks, and aerial emissions and dust. For purposes of this conceptual figure, effluent includes all mine activities involved in the generation and management of effluent. These stressors are transported to the aquatic environment through direct discharge, surface water, groundwater, and air.

An example of a stressor specific pathway from the release of effluent is illustrated in Figure 3-2 as the blue line. This is conceptual and not necessarily representative of all constituents. In the example, treated effluent is released directly to Meliadine Lake. The effluent may change the water, sediment, or biological tissue (directly or indirectly), which in turn may influence the biological receptors of concern either directly, indirectly, or both. Direct interactions involve direct influences on a receptor. For example, direct toxicity to fish as a result of elevated concentration of an ion or a metal represents a direct pathway. Indirect interactions often include several levels of receptors. For example, discharge of mine-affected water may elevate nutrient concentrations and primary productivity, which in turn may reduce dissolved oxygen concentration and the capacity of a waterbody to support aquatic life (i.e., invertebrates and fish).

The specific chemical stressors of concern will be identified through the monitoring program such that the conceptual site model can be updated and refined to reflect specific stressor chemicals and at a minimum the main pathways to potential effects on the aquatic ecosystem, and how they interact with the potential receptors.

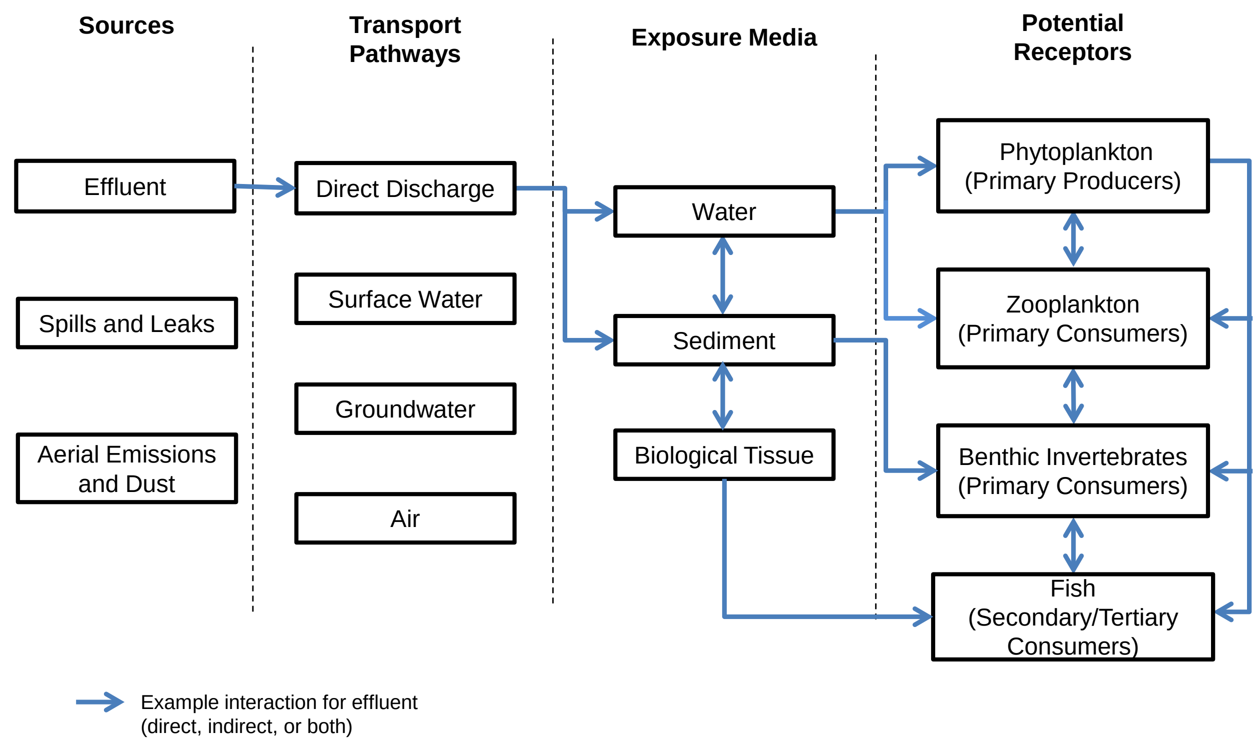

Figure 3-2: Meliadine Lake Study Conceptual Site Model with Exposure Pathways

Changes to water quality from the Project were predicted to be negligible to low, local in extent, and medium-term (for Meliadine Lake) to permanent (for some peninsula watersheds and drainage paths) in duration (Agnico Eagle 2014a). The Project was not predicted to adversely impact the continued opportunity for traditional and non-traditional use of fish in the study area, nor the health of aquatic life, or the quality of water for human consumption. To evaluate these predictions, the key pathways considered in the Meliadine Lake study conceptual site model that could cause changes in the aquatic ecosystem include the release of treated effluent (illustrated in Figure 3-2) and release of air emissions (acidifying emissions, dust, and associated metals). The key pathways considered in the Peninsula Lakes study that could cause changes in the aquatic ecosystem include the alteration of watersheds (including dewatering, diverting natural drainage paths, constructing new drainage channels, and changing the water balance) and release of air emissions. All of these activities, alone or in combination, during construction and operations may cause a change in water quality and sediment quality, and affect aquatic habitat (including benthic invertebrates), the abundance and distribution of fish, and the continued use of fish by traditional users.

Therefore, stressors considered in the AEMP and associated pathways to receptors include the following:

- metals that could lead to direct toxicity in fish and other aquatic organisms; and

- nutrients that could lead to increased productivity, reduced concentrations of dissolved oxygen, and change in aquatic ecosystem structure.

3.4 Impact Hypotheses, Assessment Endpoints, Measurement Endpoints

To investigate the effect of the mine on the aquatic ecosystem, the stressors and pathways to biological receptors are summarized in two impact hypotheses:

- *Toxicological Impairment Hypothesis*: Toxicity to aquatic organisms may occur due to the release of substances of toxicological concern (primarily metals).
- *Nutrient Enrichment Hypothesis*: Increased productivity may occur due to the release of nutrients (primarily phosphorus and nitrogen).

Assessment and measurement endpoints are terms commonly used in environmental assessments to describe the valued component to be protected (e.g., water quality) and the indicators used to measure potential effects to them (e.g., water chemistry), respectively. This terminology is adopted for the AEMP, where the assessment and measurement endpoints are used to focus the study design components through the collection of appropriate data to address the impact hypotheses. The assessment and measurement endpoints are considered annually as part of the Response Framework (Section 8) and in the integration of results in the AEMP report (Section 9).

Assessment endpoints identify what is to be protected (e.g., a healthy and sustainable aquatic ecosystem). The assessment endpoints for the AEMP (Table 3-1) are based on the valued components identified in the FEIS, and consider the effect predictions made in the FEIS. Measurement endpoints are quantifiable measures of specific constituents or biological components (e.g., concentrations of water quality constituents or benthic invertebrate community variables). Measurement endpoints are assessed using field studies, and are considered within the AEMP through the study design details of the water and sediment quality, benthic invertebrate community, and fish components.

Table 3-1: Assessment and Measurement Endpoints Associated with the Aquatic Effects Monitoring Program

Aquatic Component	Assessment Endpoint	Measurement Endpoint	Supporting Evidence
Water Quality	Suitability of water to support an aquatic ecosystem	Concentrations of metals in: • effluent discharge; • surface water; and • sediments	• Concentrations of toxicity-modifying parameters (e.g., pH, hardness) • Sediment chemistry
		Concentrations of nutrients in: • effluent discharge; • surface water; and • sediments	• Concentrations of other parameters (e.g., chlorophyll *a*)
		Chronic toxicity response of an algal and invertebrate species	• Water chemistry • Sediment chemistry
Sediment Quality		Concentrations of nutrients and metals in: • surficial sediments	• Water chemistry • Sediment particle size and total organic carbon
Benthic Invertebrate Community	Maintenance of benthic invertebrate communities characteristic of an oligotrophic subarctic lake	Total invertebrate density and densities of dominant invertebrate groups	• Water chemistry • Sediment chemistry • Physical habitat characteristics
		Taxonomic richness	
		Benthic community composition	
		Benthic community similarity between exposure and reference areas	
Fish Health	Maintenance of fish health	Reproduction (energy use)	• Site characterization • Water chemistry • Sediment chemistry • Benthic invertebrate community • Target species abundance (catch per unit effort) • Fish tissue chemistry
		Condition (energy storage)	
		Survival (age)	
Fish Tissue	Maintenance of fish tissue metal concentrations that do not pose a risk to wildlife or human health (exceed consumption guidelines or natural variability, whichever is greater)	Large-bodied fish tissue chemistry (Hg)	• Water chemistry • Sediment chemistry • Small-bodied fish tissue chemistry

4.0 AQUATIC EFFECTS MONITORING PROGRAM OVERVIEW

4.1 Overview

A key objective of the AEMP is to monitor potential mine-related effects to the aquatic environment within a design that meets the conditions of the NIRB report, commitments from the FEIS, conditions and requirements of the Water Licence, and requirements of metal mining EEM. The AEMP for the Project has been designed around the key aspects of EEM requirements, with supplemental components included to fulfill the anticipated additional conditions and requirements of the Water Licence. The core components of the AEMP are proposed as follows:

- water quality;
- sediment quality;
- benthic invertebrate community; and
- fish (i.e., fish health and fish tissue chemistry).

Two distinct programs are proposed within the AEMP, the Meliadine Lake study and the Peninsula Lakes study.

As per the Metal Mining Technical Guidance for EEM (EC 2012), biological studies are only required where there is a point source discharge of effluent. For this reason, the Meliadine Lake study is built around the EEM program requirements and is considered the core of the AEMP. The Peninsula Lakes will not receive effluent and thus do not require an EEM biological program. The design for the Peninsula Lakes study is developed with consideration of adaptive management and response planning, using water quality as the early-warning indicator of potential biological effects. If water quality data suggest that the Project has affected the Peninsula Lakes beyond FEIS predictions, a supplemental biological program will be designed and implemented through the AEMP Response Framework. During consultation with Environment Canada, Aboriginal Affairs and Northern Development Canada, and the Rankin Inlet Hunters and Trappers Organization (see meeting minutes in Appendix A), there was support for the approach of an AEMP with two distinct programs. There was also support for an EEM based program in Meliadine Lake and a water quality only program in the Peninsula Lakes.

The AEMP design will integrate IQ (Section 4.5) where available (e.g., when finalizing sampling locations, and developing culturally appropriate sampling methods for data collection).

4.2 Key Questions

Key questions are proposed for each core component as a way to focus the study methods, data analyses, and interpretation. The key questions for each study, by component, are provided in Table 4-1.

Table 4-1: Key Questions for the Meliadine Aquatic Effects Monitoring Program

Study[(a)]	Component	Key Questions
Meliadine Lake	Water Quality	Are concentrations of key parameters in effluent less than Water Licence limits?
		Are concentrations of key parameters in Meliadine Lake consistent with FEIS predictions and less than AEMP Action Levels[(b)]?
		Are concentrations in the exposure area increasing over time relative to the reference areas?
	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	Are concentrations of key parameters in the Peninsula Lakes consistent with FEIS predictions and less than AEMP Action Levels[(c)]?
		Are concentrations of key parameters in the Peninsula Lakes increasing over time relative to baseline or reference conditions?

(a) At the November 2014 workshop, there was general agreement on the two study types for the Meliadine AEMP (Appendix A).

(b) Action Levels still to be developed but will be based around normal range (i.e., quantitative estimates of background variability) and benchmarks (aquatic life and drinking water guidelines).

(c) Action Levels for water quality in the peninsula lakes still be developed but will be different than the Action Levels for Meliadine Lake and will be based around normal range for the peninsula lakes and benchmarks (aquatic life and drinking water quality guidelines).

4.3 Meliadine Lake Study Overview

The AEMP study area for the Meliadine Lake study was 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 MMER EEM requirements. The predictions for the Project as reported in the FEIS were that water quality concentrations at the edge of the mixing zone would not exceed CCME Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life (CCME 1999), or Canadian Drinking Water Quality Guidelines (DWQG; Health Canada 2012). Reviewers of the FEIS were concerned about potential far-field changes in Meliadine Lake and potential changes as far downstream as Peter Lake. To verify the prediction from the FEIS, to address concerns about extent of potential changes, and to meet EEM requirements, Meliadine Lake will be monitored in the near-field exposure area, a mid-field exposure area, and three downstream reference areas. Two reference areas will be located near the two lake outlets. In addition, Little Meliadine Lake which is downstream of the southwest Meliadine Lake outlet, Meliadine River downstream of the All-weather Access Road (AWAR), and Nipisar Lake, drinking water source for Rankin Inlet, were all identified as areas of concern for the local community. Monitoring of these lakes and river do not necessarily meet the needs of the AEMP and are thus not included in this document. However, monitoring of these waterbodies is important to Agnico Eagle, and they have been included in other plans, such as the Roads Management Plan, Cultural and Heritage Resources Protection Plan (Agnico Eagle 2014b), and the Community Involvement Plan (Agnico Eagle 2014c).

Reference areas within Meliadine Lake were selected, rather than separate reference lakes, for the following reasons:

- The quantity of effluent to be released is small (maximum annual water volume of 729,000 cubic metres during operations; Water Management Plan) relative to the volume of Meliadine Lake (east and south basins estimated at 98,851,000 cubic metres and 48,429,000 cubic metres, respectively).
- Concentrations at the edge of the mixing zone (100 metres [m] from the diffuser) were predicted to be at or less than CWQG for the protection of aquatic life and DWQG (FEIS, Volume 7).
- The effluent discharge point is approximately 20 km from the outlet in the northwest basin (secondary outlet) and 48 km from the outlet in the southwest basin (main outlet).
- The target small-bodied fish species for the AEMP is Threespine Stickleback, based on presence and abundance, and this species is not found in any other regional lake studied to date (Section 4.2.1).
- A nearby reference lake(s), with a similar large size and fish assemblage, with good accessibility that meets health and safety needs, has not been identified.

In summary, a near-field exposure area, a mid-field exposure area, and three reference areas are proposed within Meliadine Lake (Figure 4-1). Each core component is proposing to sample three to five of these different areas for the Meliadine Lake study.

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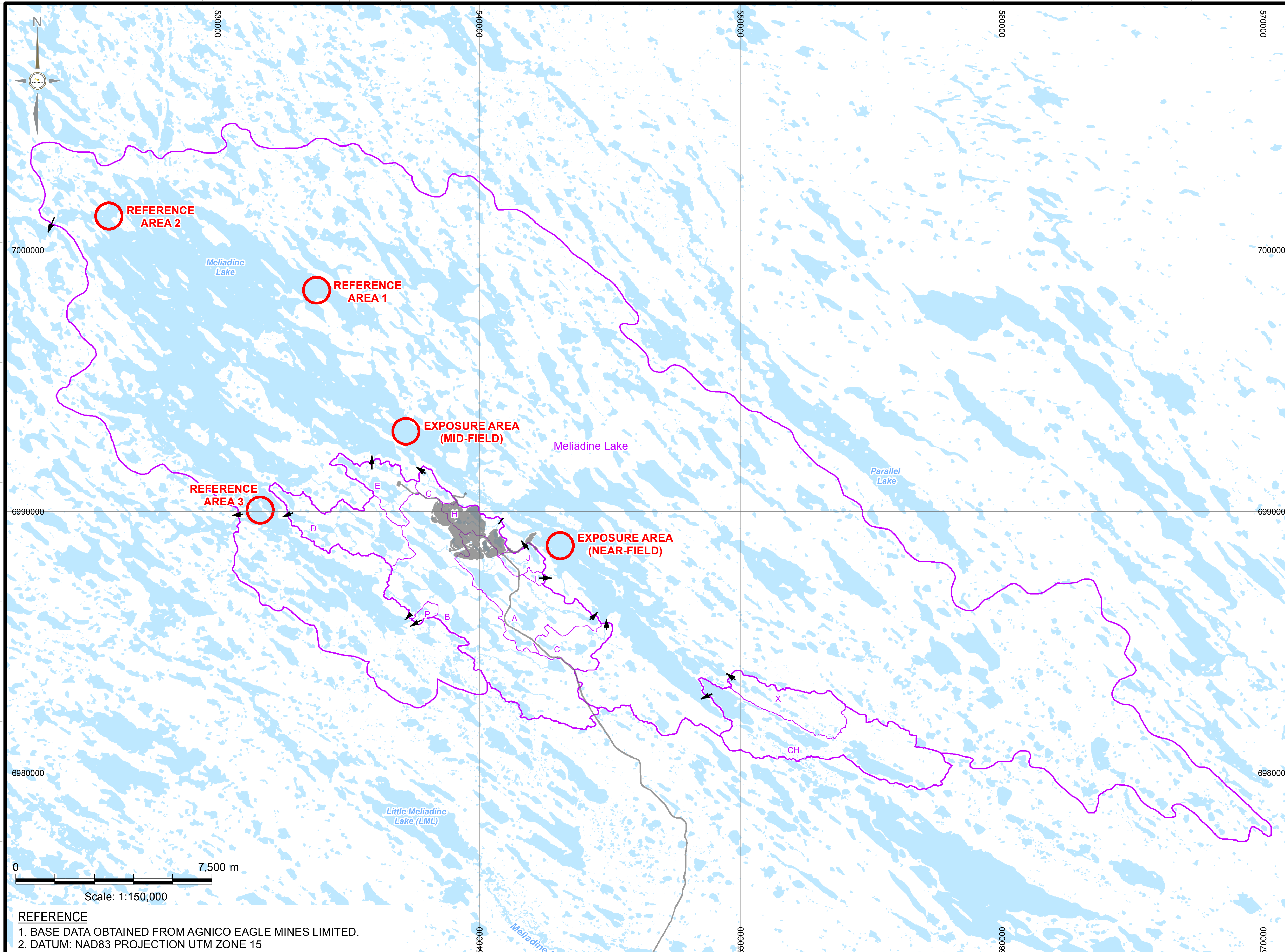

REFERENCE
1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

LEGEND
- DIRECTION OF FLOW AT WATERSHED OUTLET
- MINE FOOTPRINT
- WATERSHED BOUNDARY
- WATERCOURSE
- WATERBODY

AGNICO EAGLE

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APPROUVÉ PAR APPROVED BY	DRW		24-03-2015
No. PROJET PROJECT NO.	1405283		
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AGNICO EAGLE – MELIADINE DIVISION
FIGURE 4-1 MELIADINE LAKE SAMPLING AREAS

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4.3.1 Rationale for Study Design Approach

Reference areas were selected within Meliadine Lake, rather than in separate reference lakes, based on consideration of available fish community data, Project design, and health and safety. This section provides background information on fish community characteristics relevant to selecting reference areas and the rationale for within-lake reference areas.

Several fisheries assessments have been conducted in Meliadine Lake since 1997 using multiple gear types including angling, backpack electrofishing, fyke nets, gill nets, and minnow traps. In Meliadine Lake, 10,018 fish, representing eight different species, were collected during the fisheries surveys conducted in 1997, 1998, 1999, 2000, and 2013. During these surveys, Threespine Stickleback (*Gasterosteus aculeatus*, 62.3 percent [%]) were most abundant, followed by Cisco (25.0%), Arctic Char (4.7%), Lake Trout (4.6%), Arctic Grayling (*Thymallus arcticus*, 2.0%), Round Whitefish (*Prosopium cylindraceum*, 1.1%), Burbot (*Lota lota*, 0.2%), and Slimy Sculpin (*Cottus cognatus*, 0.04%). Threespine Stickleback is proposed as a sentinel species for the AEMP due to their small size, early age-of-maturity, small home-range size, and high abundance in Meliadine Lake.

Fisheries assessments have been conducted at several nearby lakes in an effort to identify suitable reference lakes for the AEMP. The lakes investigated to date have included Atulik Lake (2013), Chickenhead Lake (2008), Control Lake (2011), Little Meliadine Lake (1997, 1998, 1999, 2000), and Parallel Lake (1998, 2013) (Table 4-2). Some of the species observed in Meliadine Lake do not co-occur in neighboring lakes in sufficient numbers to support the AEMP, and this is particularly problematic with respect to small-bodied fishes. Threespine Stickleback, which dominated catches in Meliadine Lake, were not observed at any of the potential reference lakes sampled. Although several large-bodied species (i.e., Arctic Char, Arctic Grayling, Burbot, Cisco, Lake Trout, and Round Whitefish) were captured in both Meliadine Lake and the potential reference lakes, species assemblages were often different than Meliadine Lake. Little Meliadine Lake had the most similar large-bodied fish species assemblage to Meliadine Lake, although most species were collected in lower numbers.

Based on the information collected to date on fish assemblages, an adequate regional reference lake does not exist for the AEMP, particularly for the small-bodied fish surveys. In addition, sending field crews to far off locations to collect biological data is a high risk activity for a mine. To reduce the health and safety risk, but still meet the regulatory needs of the study, reference areas as close to the mine as possible are a preferred alternative. As such, the current AEMP design plan proposes to sample distant (i.e., >10 km away from the effluent discharge location) areas of Meliadine Lake as reference areas, in regions or bays of the lake that are expected to remain largely hydrologically isolated from any influence of the effluent (additional supporting rationale for this recommendation is provided in Section 4.3.2).

Table 4-2: Number of Fish Captured in Meliadine Lake and Potential Reference Lakes (1997 to 2013) Using Various Capture Methods

Lake	Meliadine Lake	Potential Reference Lakes				
		Atulik Lake[(a)]	Chickenhead Lake	Control Lake	Little Meliadine Lake	Parallel Lake
Large-bodied Fish						
Arctic Char	473	0	0	0	30	0
Arctic Grayling	199	0	12	2	83	0
Burbot	19	0	1	1	1	0
Cisco	2,503	0	0	0	27	6
Lake Trout	463	0	17	16	83	38
Lake Whitefish	0	0	0	0	0	1
Round Whitefish	114	0	0	42	91	19
Small-bodied Fish						
Ninespine Stickleback	0	0	0	38	18	0
Threespine Stickleback	6,243	0	0	0	0	0
Slimy Sculpin	4	0	0	1	7	0

(a) Combined data sources include Golder 2012a, 2012b, Azimuth 2013.

4.3.2 Sampling Design Overview

The water, sediment, and benthic invertebrate community core programs, plus the targeted plankton study, have been designed so that the various components will be collected at the same sampling stations within each sampling area in Meliadine Lake. Sampling areas for fish will be determined based on habitat suitability within the study areas. Overlap between the sampling locations for the water, benthic invertebrate community, and sediment components, and the plankton targeted study, will provide the following benefits:

- reduction of sampling effort, time, and overall program redundancy;
- provision of supporting environmental information to aid in the interpretation of the biological results; and
- ease of referring to sampling stations in both verbal and written communications.

Adequate replication within each area is necessary to provide sufficient statistical power to detect differences among sampling areas. In each sampling area of Meliadine Lake, five stations are proposed to be consistent with Metal Mining Technical Guidance for EEM (EC 2012).

Water depth can be a confounding factor for benthic invertebrates, and thus it is important to standardize water depths among stations. Based on results of previous studies, a target water depth of 8 to 10 m is proposed.

The overall conceptual study design for water quality, sediment quality, benthic invertebrates, and plankton is provided in Table 4-3. Station coordinates are to be determined during the first year of the program (expected 2015). Additional details on the specific components, sampling locations, frequency, and measurement endpoints are provided in Section 5.0.

Table 4-3: Proposed Aquatic Effects Monitoring Program Study Design for Water Quality, Plankton, Sediment Quality, and Benthic Invertebrates in Meliadine Lake

Area	Core (or Target Study)	Number of Stations per Area	No. of Samples per Station	Parameters[a]	Sample Type	Collection Frequency within Program	Program Frequency
Exposure Area (near-field and mid-field)	Water Quality[b]	5	1	major ions, nutrients, metals	composite; from specific depth	once during under-ice; monthly during discharge period[e]	annual
		5	1	chlorophyll *a*	composite; from specific depth or depth-integrated	monthly during discharge period[e]	
	Benthic Invertebrates	5	5	benthic invertebrate taxonomy	composite from 5 grabs	once per year[f]	annual to every 3 years
	Sediment Quality[b]	5	5	particle size, total organic carbon, nutrients, metals	composite grab	once per year[f]	annual to every 3 years
	Plankton[c]	5	1	phytoplankton taxonomy	composite; depth-integrated	monthly during open-water period[e]	annual for 2 years
		5	1	zooplankton taxonomy	composite; vertical tow of water column		
Reference Area 1 (northeast bay)	Water Quality	5	1	major ions, nutrients, metals	composite; from specific depth	monthly during open-water period[e]	annual
		5	1	chlorophyll *a*	composite; from specific depth or depth-integrated		
	Benthic Invertebrates	5	5	benthic invertebrate taxonomy	composite from 5 grabs	once per year[f]	annual to every 3 years
	Sediment Quality	5	5	particle size, total organic carbon, nutrients, metals	composite grab	once per year[f]	annual to every 3 years
	Plankton[c]	5	1	phytoplankton taxonomy	composite; depth-integrated	monthly during open-water period[e]	annual for 2 years
		5	1	zooplankton taxonomy	composite; vertical tow of water column		

Table 4-3: Proposed Aquatic Effects Monitoring Program Study Design for Water Quality, Plankton, Sediment Quality, and Benthic Invertebrates in Meliadine Lake (continued)

Area	Core (or Target Study)	Number of Stations per Area	No. of Samples per Station	Parameters[a]	Sample Type	Collection Frequency within Program	Program Frequency
Reference Area 2 (northwest bay) and Reference Area 3 (southwest bay)	Water Quality	5	1	major ions, nutrients, metals	composite; from specific depth	once per year[f]	annual
		5	1	chlorophyll *a*	composite; from specific depth or depth-integrated	once per year[f]	annual
	Benthic Invertebrates[d]	5	5	benthic invertebrate taxonomy	composite from 5 grabs	as required	as required
	Sediment Quality[d]	5	5	particle size, total organic carbon, nutrients, metals	composite grab	as required	as required
	Plankton[c, d]	5	1	phytoplankton taxonomy	composite; depth-integrated	as required	as required
		5	1	zooplankton taxonomy	composite; vertical tow of water column	as required	as required

[a] Detailed information on parameters or endpoint metrics can be found in Sections 5.1 (water quality), Section 5.2 (benthic invertebrates), Section 5.3 (sediment quality), and Section 7.1 (plankton community).

[b] At least one of these stations will also be a general station at the edge of the mixing zone.

[c] Two-year targeted study.

[d] Sampled to collect baseline data; further sampling will depend on triggering by water quality results.

[e] Discharge period still to be confirmed, but likely between June and September.

[f] Sampled once in the late open-water period (August or September).

Samples will be collected from the exposure and reference areas of Meliadine Lake to meet requirements of the Water Licence, the FEIS commitments, and the MMER program requirements. A summary of the alignment between the requirements (Water Licence and MMER) by core study components are provided in Table 4-4.

Table 4-4: Meliadine Lake Study Design – Alignment between Water Licence and Metal Mining Effluent Regulations

Component	Description	Meliadine Lake	Frequency	Component Required by	
				Water Licence	MMER
Water Quality	Physical and chemical characteristics of surface waters	near-field, mid-field, and reference areas	Every year; multiple times per year	Yes	Yes
Effluent Characterization	Characterization of end-of-pipe effluent quality	not applicable	Every year; multiple times per year	Yes	Yes
Effluent Plume Characterization[(a)]	Distribution of the effluent plume and percent effluent concentration in Meliadine Lake	exposure area	Once	No	Yes
Sediment Quality[(b)]	Physical and chemical characteristics of bottom sediments	near-field, mid-field, and reference areas	Initially every year (pre-operations), then moving to EEM schedule	Yes	Yes
Benthic Invertebrate Community	Structure and composition of the benthic invertebrate assemblage	near-field, mid-field, and reference areas	Initially every year (pre-operations), then moving to EEM schedule	Yes	Yes
Fish Health	Lethal and non-lethal fish health survey of two fish species	near-field area and reference areas	Pre-operations (once), then moving to EEM schedule	Yes	Yes
Fish Tissue	Assessment of mercury (large-bodied fish) and other metals (small-bodied fish) in fish tissue	near-field and reference areas	Pre-operations (once), then moving to EEM schedule	Yes	Yes

(a) not a core component but a related study with results required for both EEM and AEMP.

(b) supporting component for EEM but core component for AEMP.

EEM = Environmental Effects Monitoring; MMER = Metal Mining Effluent Regulations

4.4 Peninsula Lakes Study Overview

The sampling design for the Peninsula Lakes is based on the predicted effects of the Project to water quality and aquatic biota. The Project has the potential to influence the small Peninsula Lakes through deposition of aerial emissions and alteration of watersheds (i.e., changes to natural drainage paths or hydrologic balance). These changes were predicted to be local and to not extend to Meliadine Lake.

The general study design concept is to complete a baseline program to fill data gaps and monitor water quality through construction and operations as part of the AEMP. Additional monitoring components would be added through the AEMP response Framework (Section 8), if water quality results suggest mine-related changes have occurred. A biological study design will be developed prior to construction such that pre-development (i.e., baseline) biological data can be collected, for use in future monitoring and, if necessary, in response planning.

4.4.1 Rationale for Study Design Approach

The Peninsula Lakes will be subject to non-point source discharges (e.g., aerial emissions) and potentially erosion and sedimentation from alteration of natural drainages. Other changes to water quality in the Peninsula Lakes may be related to changes in the hydrologic balance as a result of the proposed mine footprint. The FEIS concluded that as a result of implementation of environmental design features to control erosion and air emissions, potential effects from this pathway are expected to be negligible to low. Also, monitoring results from other mines indicate that contributions of dustfall to water quality constituent concentrations are negligible (Rescan 2012). A similar outcome is expected for the Project, as indicated by the predictions of negligible to low effects in the FEIS; this prediction will be verified through air quality monitoring (Air Quality Monitoring Plan in Agnico Eagle 2014d), and water quality monitoring under the AEMP.

The general framework for the Peninsula Lakes study is as follows:

- design a baseline program for AEMP monitoring components (water quality, sediment quality, benthic invertebrates, and fish);
- set Low Action Levels for water quality once additional baseline data have been collected (e.g., based on normal range of variability, CWQG for the protection of aquatic life, and DWQG);
- monitor water quality as part of the AEMP; and
- revisit and adjust monitoring design as part of the AEMP Response Framework (e.g., implement more detailed studies if the Low Action Level is reached for water quality).

4.4.2 Sampling Design Overview

The Peninsula Lakes study will evaluate indirect effects from the Project, such as alteration of natural watersheds and potential effects from dust deposition. Headwater lakes (Lake A8, Lake B7, Lake D7) in three peninsula watersheds will be sampled to collect additional baseline data for AEMP monitoring components (i.e., water quality, sediment quality, benthic invertebrates, plankton, and fish) (Figure 4-2). These data will help to determine normal ranges in the selected lakes. The selected peninsula lakes include two lakes close to the proposed mine footprint that were previously fished by the Inuit (Lakes B7 and D7) during winter (pers. comm. Wesley from Rankin Inlet HTO).

Additional baseline data will be collected in 2015 to 2016. More details on the specific components, sampling locations, frequency, and measurement endpoints are provided in Sections 6.0 and 7.0. The AEMP study design for peninsula lakes is focussed on water quality to address Water Licence requirements (Table 4-5), but sediment and biological studies will be considered under the AEMP Response Framework, if water quality results indicate mine-related changes are occurring.

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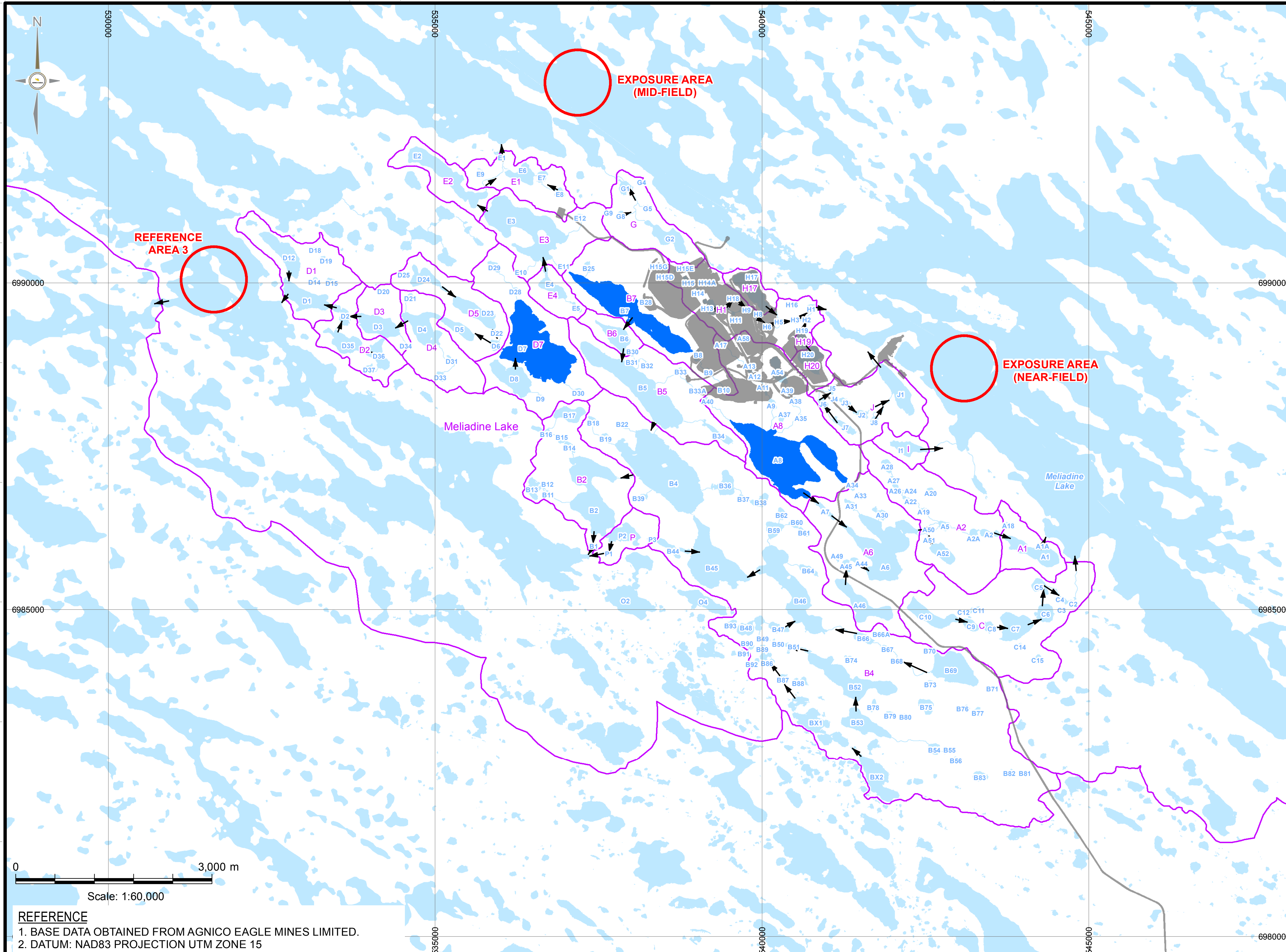

LEGEND

- DIRECTION OF FLOW
- MINE FOOTPRINT
- SUB-WATERSHED BOUNDARY
- WATERCOURSE
- PROPOSED PENINSULA AEMP LAKES
- WATERBODY

REFERENCE

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

AGNICO EAGLE

Golder Associates

TITRE / TITLE	# DWG
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REVISIONS

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VÉRIFIÉ PAR CHECKED BY	LY		24-03-2015
APPROUVÉ PAR APPROVED BY	DRW		24-03-2015
No. PROJET PROJECT NO.	1405283		
DATE	–		

TITRE / TITLE

AGNICO EAGLE – MELIADINE DIVISION
FIGURE 4–2 PENINSULA LAKES SAMPLING AREAS

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Table 4-5: Peninsula Lakes Study Design for Water Licence Requirements

Component	Description	Lake	Frequency	Water Licence Requirement?
Water Quality	Physical and chemical characteristics of surface waters, including aquatic habitat	Lakes A8, B7, and D7	Every year; at least two times per year	Yes

4.5 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. Information collected can contribute to mine design and monitoring. Agnico Eagle is committed to including IQ and public concerns stemming from IQ, where practical, in the design of management and monitoring plans for the Project. Agnico Eagle will continue active engagement with communities and Inuit organizations as the Project proceeds through permitting, and if approved, construction, operations and closure. This consultation and engagement should lead to further inclusion of IQ, as it becomes available, in updates to the design and implementation of environmental programs. Section 1.5 of the Main Application Document summarizes IQ and public concerns. A list of public concerns can be found in the Public Engagement and Consultation Baseline Report, submitted in support of this Type A Water Licence Application.

The AEMP will continue to integrate IQ into the design where possible. To capture IQ into the study design, and future data analysis and reporting of information, consultation is ongoing with the Rankin Inlet Hunters and Trappers Organization and community groups (e.g., through the DEIS and FEIS, at the 7 November 2013 meeting in Ranking Inlet, and the 6 November 2014 meeting in Edmonton). A community consultation workshop will be held in 2015, when the AEMP design will be presented and feedback on sensitive areas, receptors, and sampling frequency will be discussed. In addition, feedback will be sought on the reporting of results to the local communities so that it is of relevance and meaning to them. For example, reporting to the communities might involve copies of reports and maps, plus presentations and plain language interpretation of the results.

The AEMP considers IQ, including traditional ecological knowledge, traditional land use, and public concerns regarding Project effects on traditional resources and traditional land use sites. Through the public consultation process for the 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 2014). 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. Elders have expressed concerns regarding potential adverse effects due to the project on drinkability of water and fish populations in waterbodies in the entire Meliadine watershed. Therefore two distinct programs are proposed for the AEMP: the Meliadine Lake study and the Peninsula Lakes. In addition, a framework for responding to changes has been identified to allow Agnico Eagle to respond quickly and early to any unexpected changes in Meliadine Lake or the Peninsula Lakes.

5.0 MELIADINE LAKE

5.1 Water Quality

5.1.1 Objectives

The proposed water quality monitoring program has been designed in accordance with the anticipated requirements of the NWB Type A Water Licence and the MMER (Government of Canada 2012).The primary objectives of the water quality component of the Meliadine Lake study, including effluent characterization, are as follows:

- Characterize and interpret water quality within Meliadine Lake for the purpose of identifying Project-related effects and meeting Part 1, Section 7 of the MMER requirements (Government of Canada 2012);
- Characterize effluent quantity and quality to meet Part 1, Section 4 of the MMER requirements (Government of Canada 2012) and to aid interpretation of effects in the receiving environment;
- Verify and update FEIS predictions (Agnico Eagle 2014);
- Assess the efficacy of impact mitigation strategies proposed in this plan and the Environmental Management and Protection Plan to minimize the water quality effects of the mine;
- Recommend appropriate changes to the water quality component of the AEMP for future years; and
- Provide data to inform adaptive management intended to reduce or eliminate Mine-related effects to water quality in Meliadine Lake.

5.1.2 Study Design and Schedule

Water sample collection in Meliadine Lake will be aligned, where possible, with the collection of plankton samples (i.e., collected at the same time and at the same stations; the targeted plankton study is described in Section 7.1), and with collection of benthic invertebrate and sediment samples (i.e., collected at the same stations but not necessarily at the same time) as described in Sections 5.2 and 5.3, respectively. In addition, effluent samples for full characterization will be collected on the same day, and for the same parameters, as water quality samples in the near-field area. The general design for water quality is to collect samples from five stations in each of five areas in Meliadine Lake (i.e., near-field area, mid-field area, and three reference areas) (Figure 4-1). Each station (exact coordinates to be determined) will be established in water of a target water depth of 8 to 10 m. Standardization of the total water depth is important for interpreting results of the benthic invertebrate study (Section 5.2). To use data generated by all study components for overall ecological interpretation, a standardized sampling design (including target water depth) is required.

The water quality program will be conducted annually with samples collected at specific times during the year. Samples will be collected at the near-field and mid-field stations once during ice cover period (i.e., April) and three times during the open-water period (i.e., July to September; Table 5-1). At the stations in three reference areas, samples will be collected three times during the open-water period (i.e., July, August, September). The timing for the open-water sample collection will coincide with the schedule of effluent discharge and MMER EEM requirements.

Effluent quality will be collected and characterized according to MMER requirements (Government of Canada 2012). Samples for effluent characterization will be collected in the water treatment plant, at the regulated monitoring station, at the last point of control. The effluent characterization field program will include weekly monitoring of water flow and field measurements (pH and temperature), and collections of effluent water quality samples on a weekly to quarterly basis depending upon the test parameters (Table 5-1). More details on effluent sampling can be found in the Water Management Plan.

Table 5-1: Meliadine Lake Water Quality Study Design Details

Location	Component	Number of Stations	Number of Samples per Station per Event	Parameter[a]	Program Frequency	Collection Frequency within Program
Water Treatment Plant (end of pipe regulated monitoring station)[b]	Effluent Characterization	1	1	flow	annual	whenever samples are collected
				field measurements		weekly
				conventional parameters (e.g., pH, hardness) and major ions (e.g., chloride)		weekly to monthly during discharge
				nutrients (e.g., ammonia, total phosphorus)		monthly during discharge
				metals (e.g., aluminum, lead)		weekly to monthly during discharge
				toxicity (acute and sub-lethal)		two to four times per
Near-Field	Receiving Water Quality	5	1	field measurements, conventional parameters, major ions, nutrients, metals, organics, chlorophyll *a*	annual	four times per year[c]
Mid-Field		5	1			
Reference Area 1	Receiving Water Quality	5	1		annual	three times per year[d]
Reference Area 2		5	1			
Reference Area 3		5	1			

[a] Detailed parameter list in Water Management Plan for effluent characterization parameters and Table 5-2 for receiving water quality parameters.

[b] More details in the Water Management Plan.

[c] Samples collected once during under-ice period (April) and three times during the open-water period (July, August, September).

[d] Samples collected three times during the open-water period (July, August, September).

5.1.3 Field Methods

5.1.3.1 Collection of Field Data

In Meliadine Lake, in situ physico-chemical measurements of specific conductivity, dissolved oxygen (DO; concentration and percent saturation), pH, and water temperature will be taken at each water quality station, during each field program, using a water quality multimeter (e.g., YSI 6-Series Multimeter). Total depth of the water column will be measured by using a boat-mounted sonar unit or a sounding line. A cable of sufficient length for use in Meliadine Lake (i.e., 20 m) will be used with the multimeter to collect water quality profile measurements at the surface (0.1 m), 0.5 m below the surface, and every 1 m thereafter throughout the water column and ending at 1 m above the sediments. Secchi depth will be measured during open-water conditions to provide a visual measure of water clarity. During winter programs, ice thickness will be measured at each station using an ice-thickness gauge before sampling and total water depth will be measured with a sounding line. Additional information that will be recorded in the field includes station coordinates, date and time of sample collection, sample collection depth, weather, photographs, equipment malfunctions, helicopter hours, wildlife activity, and any observed hazards.

At the regulated monitoring end-of-pipe station, in situ measurements of specific conductivity, pH, and water temperature will be taken every time an effluent sample is collected. Rate of flow (m^3/day) will also be recorded whenever a sample is collected. Additional supporting information that will be collected will include photographs (if anything unusual is noticed), description of equipment malfunctions, and any observed hazards.

Detailed field data sheets for the receiving environment stations and the end-of-pipe station will be developed to aid the collection of consistent information.

5.1.3.2 Sample Collection

On Meliadine Lake, water samples will be collected for detailed chemical analysis with a Kemmerer, or equivalent, sampler. The station coordinates will be determined during the supplemental baseline program. At all stations, samples will be collected from the depth of maximum conductivity, or mid-depth, if no conductivity gradient is present. Samples will be processed as required (e.g., filtered and/or preserved) and added to laboratory supplied bottles.

During the under-ice period, a gasoline-powered ice auger will be used to drill a hole in the ice, and the Kemmerer sampler will be lowered through the hole into the water column to collect water samples. Water from the Kemmerer sampler will be transferred into holding vessels; sampling bottles will be filled and samples will be processed once back at the mine. Using this procedure will help reduce complications associated with attempting to fill several small bottles in very low temperatures, and reduce the chances of contamination in the field.

At the water treatment plant, at a yet to be confirmed location, samples will be collected for detailed chemical analysis. The location in the plant will be in an area where water can still be diverted to a holding area, if necessary (e.g., if water quality samples fail specific tests, concentrations above the limits for deleterious substances set out in the MMER document).

Quality control samples (duplicate and blanks) will be collected at a quantity of 10% of all samples collected, and will be collected at random stations for the receiving environment program, and for the effluent characterization program.

5.1.3.3 Sample Handling

Sample bottles will be provided by an accredited analytical laboratory (e.g., ALS Environmental, Maxxam Analytics) and samples will be processed (i.e., filtered and/or preserved as required, and refrigerated) according to the instructions provided by the laboratory. Water samples requiring filtration will be filtered through a 0.45 micrometre Millipore filter before being preserved with laboratory-provided preservative. Water samples will be kept refrigerated before shipping and ice-packs will be added to the coolers. Samples will be shipped to the analytical laboratory as soon as feasible after sample collection and processing.

5.1.4 Data Analysis and Interpretation

5.1.4.1 Effluent Characterization

Analysis and interpretation of final effluent quality data will focus on answering the following key question:

- Are concentrations of key parameters in effluent less than Water Licence limits?

To understand potential effects of effluent loads to Meliadine Lake, treated effluent results will be reviewed as follows:

- concentrations will be compared to Water Licence limits and MMER limits for deleterious substances;
- concentrations will be compared to FEIS predictions;
- dilution factors will be determined;
- results of acute toxicity tests will be evaluated for toxicity response; and
- results of chronic toxicity will be evaluated for growth and developmental effects with interpretations supported by effluent characterization results.

Parameters to include in the effluent characterization program are provided in the Water Management Plan.

Final effluent quality data will be analyzed to understand temporal trends in discharge quantity and quality, and to compare individual and monthly results to Water Licence limits. Results (concentrations and loads) will be plotted to allow direct visual comparisons to limits and evaluation of changes over time. Effluent loads to Meliadine Lake will be calculated using the following equation (Government of Canada 2012):

$$ML = C \times V / 1,000$$

where,

ML = Monthly Load

C = Monthly mean concentration

V = Total monthly volume of effluent, measured at the regulated monitoring station

The need for quarterly or annual loading will be determined once the effluent discharge schedule has been confirmed.

Results of toxicity tests on final effluent will be reviewed for trends and/or concentration-response relationships, if relevant. Thresholds such as 25% (for a chronic test) or 50% (for a chronic or acute test) can be used to evaluate an adverse effect.

A diffuser will be installed to maximize potential mixing of effluent in the near-field area of Meliadine Lake. The dilution factors achieved by the diffuser will be calculated by comparing concentrations in the final effluent to concentrations in the mixing zone using the following equation:

$$DF = (C_e - C_b)/(C_d - C_b)$$

where,

DF = Dilution factor

C_e = Flow-weighted average concentration of constituent in final effluent

C_b = Background concentration of constituent in the lake

C_d = Concentration of constituent in the mixing zone at the AEMP stations

5.1.4.2 Meliadine Lake Receiving Water Quality

Analysis and interpretation of Meliadine Lake water quality data will focus on answering the following key questions:

- Are concentrations of key parameters in Meliadine Lake consistent with FEIS predictions and less than AEMP Action Levels?
- Are concentrations in the exposure area increasing over time relative to the reference areas?

Water quality results from all Meliadine Lake stations will be evaluated, and concentrations will be compared to CCME acute and chronic guidelines for the protection of aquatic life (CWQGs; CCME 1999), Health Canada DWQGs (Health Canada 2012), and baseline conditions[1]. The list of parameters to monitor are provided in Table 5-2; these align with the Group 2 and field parameters provided in the Quality Assurance and Quality Control Plan and the Environmental Management and Protection Plan. Currently there are no site-specific water quality objectives for Meliadine Lake; if site-specific water quality objectives are developed in the future, they will be included as part of future screening of results.

Table 5-2: List of Water Quality Parameters

Group	Parameters
2	**Conventional Parameters**: bicarbonate alkalinity, chloride, carbonate alkalinity, turbidity, conductivity, hardness, calcium, potassium, magnesium, sodium, sulphate, pH, total alkalinity, total dissolved solids (TDS), total suspended solids (TSS), total cyanide, free cyanide, and weak acid dissociable (WAD) cyanide. **Nutrients**: ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, ortho-phosphate, total phosphorus, total organic carbon, dissolved organic carbon, and reactive silica. **Total and dissolved metals**: aluminum, antimony, arsenic, barium, beryllium, boron cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc.
Field	Field pH, specific conductivity, dissolved oxygen, and temperature, Secchi depth (open-water), total depth, ice thickness (winter)

Note: These align with "Group 2" and "Field" as presented in the Environmental Monitoring and Protection Plan and the Quality Assurance and Quality Control Plan).

[1] The parameters included for Meliadine are the same as the proposed Meadowbank Group 2 water quality parameters plus field measurements

Results will be analyzed to determine if water quality parameters are increasing over time, if concentrations are above guidelines (if concentrations were not above guidelines during baseline), and if there are differences between the exposure area (near-field and mid-field areas) and the reference areas.

Methods to assess temporal trends in water quality in Meliadine Lake include the following:

- Comparing parameter concentrations (i.e., individual samples and the mean or median) in study areas with FEIS predictions, CCME guidelines, and Health Canada drinking water guidelines;
- Using a statistical test to identify trends for selected parameters at selected stations;
  - data will be reviewed to determine which stations may be good candidates to include in trend analysis;
  - it is anticipated that the stations near the diffuser (i.e., near-field exposure) may be suitable for evaluating temporal trends;
  - data will be reviewed to determine the key parameters to include in trend analysis; and
- Reviewing vertical profiles in the study lakes over time;
  - vertical profiles for parameters, such as dissolved oxygen, temperature, and conductivity, collected at all of the lake stations will be plotted over time to evaluate potential trends.

Spatial patterns or differences between the exposure areas (i.e., near-field and mid-field) and pooled reference areas will also be investigated using appropriate statistical tests.

5.1.5 Quality Assurance and Quality Control

An overall quality assurance and quality control (QA/QC) has been developed for the Mine (QA/QC Plan). This section provides a high-level overview of QA/QC; more details will be developed for future versions of the AEMP design plan.

Quality assurance and quality control practices determine data integrity and are relevant to sample collection through to data analysis and reporting. Quality assurance (QA) encompasses management and technical practices designed at the outset to confirm that the data generated are of consistent, acceptable quality. Quality control (QC) is an aspect of QA and includes the procedures used to measure and evaluate data quality, and the corrective actions to be taken when data quality objectives are not met.

5.1.5.1 Quality Assurance

5.1.5.1.1 Field

Samples will be collected by qualified field staff trained to be proficient in standardized field sampling procedures, data recording, and equipment operations applicable to water quality sampling. Fieldwork will be completed according to approved specific work instructions and established technical procedures. Specific work instructions are standardized forms that describe exact sampling locations and provide specific sampling instructions, equipment needs and calibration requirements, sample labelling protocols, shipping protocols, and laboratory contacts.

One crew member will be response for managing the sample documentation process so that:

- required samples are collected or reasons are documented as to why a sample was not collected;

- chain-of-custody and analytical request forms are filled out appropriately; and
- established labelling and documentation procedures are followed.

5.1.5.1.2 Laboratory

One member of the team will act as a laboratory liaison to confirm that an accredited laboratory is used (accredited by the Canadian Association for Laboratory Accreditation Inc. [CALA]), samples are received, and that specific analyses are completed. Under CALA's accreditation program, performance evaluation assessments are conducted for laboratory procedures, methods, and internal QC.

5.1.5.1.3 Office

Office-related QA includes using appropriately trained personnel for each task, senior review of work, standardized data handling/summary tools, filing of original data, and establishment of a data management system (e.g., database).

5.1.5.2 Quality Control

5.1.5.2.1 Field

The field QC program will involve the collection and analysis of field blanks and duplicate samples, which are defined as follows:

- **Field blanks** consist of de-ionized water provided by the analytical laboratory, which is exposed to the sampling environment at the sample site and handled in the same manner as the surface water samples collected during the field program (e.g., preserved, filtered). Field blanks are used to detect potential sample contamination during sample collection, handling, shipping, and analysis.
- **Duplicate samples** are additional samples collected at the same time and location as surface water samples collected during a field program, using the same sampling methods. They are used to check within-site variation (percent difference of 20 percent or less between duplicates), and the precision of field sampling methods and laboratory analysis.

Quality control sample collection will occur at a rate of 10% of total samples collected for a program. Quality control samples will be analyzed for the same suite of parameters as the test samples and will be submitted blind to the laboratory.

5.1.5.2.2 Laboratory

Upon receipt of data from the laboratory, there are various QC steps to complete to confirm that data of acceptable quality have been received. Sample steps may include the following:

- verification that all samples were analyzed;
- verification that parameters requested were analyzed and to the required detection limits;
- verification and acceptance of results (e.g., checked any unusual results in follow-up discussion with the laboratory);
- logic checks on total dissolved solids and conductivity, hardness and alkalinity, total and dissolved phosphorus, total and dissolved carbon, and total and dissolved metals;

- review of blanks for evidence of contamination; and
- review of duplicate samples for unacceptable variation.

5.1.5.2.3 Office

Aspects of the office QC may include the following:

- cross-checking laboratory raw data files with data stored in a database;
- creating backup files before each major data manipulation; and
- verifying the accuracy of calculations.

5.2 Benthic Invertebrate Community

5.2.1 Objectives

The primary objective of this component is to determine whether treated Mine effluent has potential short or long-term effects on benthic invertebrate communities due to changes in water or sediment quality in Meliadine Lake. Specific monitoring objectives are as follows:

- compare benthic invertebrate communities in near-field and mid-field areas within Meliadine Lake relative to within-lake reference areas, based on benthic invertebrate effect endpoints (e.g., invertebrate density, taxonomic richness, evenness, and similarity to reference communities);
- verify predictions made in the FEIS relating to benthic invertebrate communities;
- meet the requirements of Part 2, Schedule 9 (d) of the MMER regulations (Government of Canada 2012);
- monitor the effectiveness of proposed mitigation; and
- provide data to inform adaptive management intended to reduce or eliminate Mine-related effects to benthic invertebrate communities in Meliadine Lake.

5.2.2 Study Design and Schedule

The study design for monitoring benthic invertebrates considers the following:

- requirements of MMER/EEM;
- alignment with other components when possible; and
- sampling effort consistent with other comparable monitoring programs in Nunavut and the NWT, with sampling effort sufficient to provide appropriate statistical power for monitoring mine-related effects.

The preliminary study design under consideration is a control-impact AEMP design with monitoring in five study areas in Meliadine Lake consistent with the control-impact design recommended by Metal Mining Technical Guidance for EEM (EC 2012). Specifically, a near-field area, a mid-field area and three within-lake reference areas would be monitored. The proposed study design is intended to facilitate the characterization of spatial and temporal variation in benthic invertebrate communities, as part of an AEMP designed to fulfil both EEM/MMER and AEMP requirements.

Annual sampling is proposed for two years prior to mine operations to compile a pre-operational dataset suitable for inclusion in a hybrid AEMP/EEM program. Sampling will be scheduled to occur in late summer (potentially August) consistent with previous sampling in Meliadine Lake and other benthic monitoring programs in Nunavut. After two consecutive years of pre-operational sampling the frequency of benthic invertebrate sampling will be reviewed.

Reporting after one year of data collection at near-field, mid-field, and reference area stations will be focused towards evaluating the study design and data collection methods, with respect to optimizing the sampling program to achieve the objectives described in Section 5.2.1. Reporting after two years of data collection at these stations will be primarily focused towards characterizing baseline conditions to support operational monitoring, in terms of spatial and temporal variability and the relationship between benthic invertebrate metrics and habitat variables.

5.2.3 Methods

5.2.3.1 Field

5.2.3.1.1 Sampling Locations and Frequency

Benthic invertebrate sampling in Meliadine Lake will be undertaken in five study areas; three potential within-lake reference areas, one mid-field area, and one near-field area. For a given year, five replicate stations will be sampled within each area (total of 25 stations) with one composite sample taken at each station. Annual sampling during late summer/fall (potentially in August) is proposed.

5.2.3.1.2 Sampling Methods

Benthic invertebrate samples will be collected within a standard water depth range (8 to 10 m) and comparable substrate types will be sampled. Samples will be collected using a standard Ekman grab from a boat anchored at each sampling station. One composite sample comprising five individual grabs will be taken at each station. Discrete grab samples will be collected at one station per study area and processed separately to assess within station variability. Grab samples will be sieved through a 500-µm mesh screen and material retained in the mesh will be placed into a single pre-labelled container, thus creating a single composite sample consisting of five grabs for each station. Samples will be preserved in 10% neutral buffered formalin.

Sediment grab samples will also be collected at each benthic invertebrate sampling station for analysis of sediment chemistry (e.g., metals, nutrients, and carbon content) and particle size distribution as described in Section 5.3. The following supporting data will be collected at each benthic invertebrate sampling station:

- station location as UTMs, including UTM zone, using NAD 83;
- water depth;
- weather conditions;
- habitat description (e.g., water clarity and colour) and field water quality measurements (e.g., pH, dissolved oxygen, water temperature, conductivity) prior to disturbing the sediments;
- bottom sediment-related information (texture, colour, odour, particle size distribution at lake stations analyzed in the laboratory; visually-assessed substrate composition at stream stations); and
- benthic sample-related information (sampler used, sieve mesh size, sampler fullness, preservative).

5.2.3.2 Laboratory

Benthic invertebrate samples will be shipped to a qualified taxonomist for processing, enumeration and identification to the lowest taxonomic level. The taxonomist still has to be confirmed but only taxonomists that are certified via the Society for Freshwater Science Taxonomic Certification Program, as recommended by EC (2012), will be considered. The samples will be processed according to standard methods described in the Metal Mining Technical Guidance for EEM (EC 2012).

Samples will be processed according to EC (2012) guidance and subsequent updates, if any. At the present time, the process is generally as follows. Invertebrates retained on a 500-µm sieve will be identified to the lowest practical taxonomic level, typically genus, using recognized taxonomic keys. Organisms that cannot be identified to the desired level, such as immature or damaged specimens, will be reported as a separate category at the lowest taxonomic level possible, typically family. Organisms that require detailed microscopic examination for identification, such as midges (Chironomidae) and aquatic worms (Oligochaeta), will be mounted on microscope slides using an appropriate mounting medium. All rare or less common taxa will be slide-mounted for identification.

5.2.4 Data Analysis and Interpretation

5.2.4.1 General Approach

Benthic invertebrate data will be interpreted to answer the program objectives (Section 5.2.1) and the following key question:

- Is the benthic invertebrate community affected by potential mine-related changes in water and sediment quality in Meliadine Lake?

Benthic invertebrate effect endpoints (i.e., metrics such as invertebrate density, densities of dominant invertebrates, taxonomic richness, evenness, and similarity to reference communities) will be evaluated, using both statistical (quantitative) and visual (qualitative) methods, to determine whether changes in the benthic invertebrate community have occurred. A subset of these benthic invertebrate metrics are recommended in the Metal Mining Technical Guidance for EEM (EC 2012). Appropriate statistical analyses will be conducted to evaluate potential differences in benthic community structure between the near-field area, mid-field area, and the three within-lake reference areas.

If changes in the benthic invertebrate community are observed, an evaluation of the statistical and visual results will be used to determine whether the change in the benthic community is within FEIS predictions. This evaluation will be based on the magnitude of change observed and consider whether results from multiple evaluation methods indicate a change. The results of data analyses will be further interpreted in light of results of other monitoring components, such as changes in water and sediment quality.

5.2.4.2 Benthic Invertebrate Community Metrics

As recommended by EC (2012) and consistent with AEMP programs for other northern mines, the following benthic community metrics will be calculated as a component of the data analysis.

- Total invertebrate density (as organisms per m^2);
- Taxonomic richness as total richness (number of unique taxa per station).

- Simpson's Evenness Index (SEI): this evenness index incorporates density as well as taxonomic richness. Index values range from 0 to 1; values closer to 1 indicate that the distribution of organisms among taxa is more even compared to stations with values closer to 0.
- Bray-Curtis Index (BCI); this metric is currently recommended by the EEM program for MMER to provide a measure of changes in the structure of effluent exposed benthic invertebrate communities compared to the structure of benthic invertebrate communities from reference areas (EC 2012). The metric will be calculated as required by EEM guidance and upcoming updates.
- Relative invertebrate abundance by major taxonomic group as a percentage of total abundance.
- Densities of dominant taxa: defined as those taxa accounting for more than 5% of the total invertebrates across all stations.

Descriptive statistics including the arithmetic mean, median, minimum, maximum, standard deviation, and standard error will be calculated for the above metrics, excluding relative invertebrate abundance according to major taxonomic group. For evaluation of community composition by major taxa metric, area means will be calculated and plotted as stacked bar graphs to assess changes in benthic community composition over time.

5.2.4.3 Statistical Analysis

The approach to data analysis will be designed to address the key question for benthic invertebrates and to be consistent with MMER technical guidance provided by EC (2012) and will consider both univariate (e.g., analysis of variance [ANOVA]) and multivariate statistical analysis techniques (e.g., nonmetric multidimensional scaling [NMDS[2]]). Relationships between habitat variables and the benthic invertebrate metrics will be evaluated using tools such as calculating Spearman rank correlation coefficients and examining scatter plots. Habitat variables that are significantly correlated with summary variables would be considered in the subsequent statistical analyses as potential covariates.

Once sufficient data are available from multiple years of sampling, time series plots will be generated for relevant metrics with comparisons to critical effect sizes (e.g., two standard deviations or a percentage of the reference area mean). Consideration may also be given to developing normal ranges for the mean of each summary variable using reference area or baseline data to characterize natural variability. Trends over time may also be evaluated using time series plots of mean values of each variable and compared to the normal range using graphical methods.

5.2.5 Quality Assurance/Quality Control

The QA/QC procedures employed in the collection, processing, and analysis of benthic invertebrate samples and supporting information will be consistent with the Metal Mining Technical Guidance for EEM (EC 2012). For benthic invertebrate samples, this will include an assessment of sample sorting efficiency and an assessment of subsampling procedures, if subsampling is required. Invertebrate sample sorting efficiency will be verified by an individual other than the original sorter by performing spot-checks on debris remaining after sorting. Ten percent

[2] NMDS is a nonparametric ordination method that allows for the reduction of a data set consisting of a large number of taxa to typically two or three new dimensions referred to as ordination axes (Clarke 1993). The analysis is based on a station-by-station distance matrix and provides a visual representation of ecological distances among stations. A station-by-station Bray-Curtis distance matrix will be generated from the biomass data and used as the input for the ordination. The number of dimensions selected for the ordination will be determined by using a configuration that has a reasonably low stress level (less than 0.2).

of the samples will be re-sorted. The data quality objective is a minimum removal of 90% of the total number of organisms in a sample. If more than 10% of the total number of organisms removed from the sample is found in the debris, then all samples will be re-sorted by an individual other than the original sorter. In addition, if an entire taxonomic group is inadvertently omitted by the sorter, then all samples will be re-sorted by an individual other than the original sorter.

The QA/QC procedures will be applied during the benthic invertebrate monitoring program to verify that the data collected are of acceptable quality. The QA/QC procedures include, but may not be limited to, the following.

- Review of electronically entered data for data entry errors and appropriate corrections made by a second person. Validation of unusually high or low results on a case-by-case basis. Retention of invalidated data in appendix tables, but flags appended to the data indicating that the sample was considered unreliable or the results were designated as not correct due to an internal review of the data.
- Quality checks of supporting data entered from field data sheets by a second person.
- Spot checks of calculations performed during the data summary and analysis stage for potential errors by a second person.
- Review of tables containing both summary data and statistical results by a second person.

5.3 Sediment Quality

5.3.1 Objectives

The objective of the sediment quality component is to determine whether treated Mine effluent has an effect on sediment quality and to provide supporting information to the benthic invertebrate component. The specific objectives are as follows:

- verify predictions made in the FEIS in relation to sediment quality in Meliadine Lake;
- characterize sediment quality;
- collect supporting data for the benthic invertebrate and water quality components to aid in interpretation of results (as per Part 2, Schedule 16 (a) (iii) of the MMER regulations [Government of Canada 2012]); and
- provide data to inform adaptive management intended to reduce or eliminate Mine-related effects to sediment quality in Meliadine Lake.

5.3.2 Study Design and Schedule

The sediment quality study design has been developed to provide complementary and supporting information to the benthic invertebrate program. Thus, samples will be collected at the same time and from the same locations identified for the benthic invertebrate community component (Section 5-.2). Samples will be collected from five areas within Meliadine Lake (Section 4.3 and Table 4-3): the near-field and mid-field exposure areas, and three reference area. From each area, five samples will be collected.

Annual sampling is proposed for a minimum of two years prior to mine operations to compile a pre-operational dataset suitable for inclusion in an integrated AEMP and EEM program. Sampling will be scheduled to occur annually in late summer (potentially August) consistent with previous sampling in Meliadine Lake and other benthic monitoring programs in Nunavut. After two consecutive years of pre-operational sampling, the sediment sampling frequency will be reviewed but it will always be conducted along with the benthic invertebrate study component.

5.3.3 Field Methods

Sediment samples for detailed chemical analysis (detailed below and in Section 5.3.4) will be collected with a coring device (e.g., Tech-Ops Corer); supporting environmental variables including station coordinates, water depth, and water column profile measurements (e.g., temperature and DO) will be recorded.

From each station, ten cores will be collected for analysis of particle size, total organic carbon, nutrients, and metals (Table 5-3). The upper 5 centimetres (cm) of five of the cores will be extruded and sub-sampled for particle size, and the upper 1 to 2 cm of the remaining five cores will be subsampled for total organic carbon, nutrient, and metals analysis. Each set of five sub-samples will be combined into a single composite representative of the station and placed into containers provided by an accredited analytical laboratory (e.g., ALS Environmental, Maxxam Analytics). Ice-packs will be added to the coolers to keep the samples as cool as possible during shipping, and samples will be shipped to the analytical laboratory as soon as possible after sample collection and processing.

Field duplicate samples, accounting for 10% of all samples collected, will be collected at randomly selected stations. . Quality control samples will be analyzed for the same suite of parameters as the test samples, and will be submitted blind to the laboratory.

5.3.4 Data Analysis and Interpretation

Analysis and interpretation of Meliadine Lake sediment quality data will focus on answering the following key questions:

- Are concentrations of sediment quality parameters in Meliadine Lake less than benchmarks (Table 5-3)?
- Are concentrations in the exposure area increasing over time relative to the reference areas?

To understand the potential effects of effluent loads to Meliadine Lake, sediment samples will be analyzed for the parameters summarized in Table 5-3 with results for each sample compared to Canadian Sediment Quality Guidelines (CSQGs; CCME 2001) and baseline data.

Results will be screened to determine if concentrations are above guidelines (i.e., if concentrations were not already above guidelines during baseline), and evaluated for differences between the exposure and reference areas.

Table 5-3: Sediment Quality Parameters

Group	Parameters
Particle Size and Carbon Content	sand, silt, clay, total organic carbon
Metals	aluminum, antimony, arsenic, beryllium, boron cadmium, chromium, copper, iron, lead, mercury, molybdenum, nickel, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc

Sediment quality data will be summarized by area in terms of minimum, median, mean, maximum concentration, and standard deviation for each parameter. Individual sample results and summary statistics will be compared to sediment quality benchmarks. The current set of benchmarks are based on CSQGs, but future benchmarks could also include baseline statistics (e.g., median or 95th percentile) once additional data have been collected. Results will be analyzed to determine if sediment quality parameters are increasing over time, if concentrations are above guidelines (if concentrations were not above guidelines during baseline), and if there are differences between the near-field and mid-field areas compared to the reference areas.

5.3.5 Quality Assurance/Quality Control

An overall QA/QC has been developed for the Mine (QA/QC Plan). This section provides a high-level overview of QA/QC but more details will be developed for future versions of the AEMP design plan.

Quality assurance and quality control practices determine data integrity and are relevant to all aspects of a study, from sample collection to data analysis and reporting. Quality assurance encompasses management and technical practices designed to confirm that the data generated are of consistent high quality. Quality control is an aspect of QA and includes the procedures used to measure and evaluate data quality, and the corrective actions to be taken when data quality objectives are not met.

5.3.5.1 Quality Assurance

5.3.5.1.1 Field

Samples will be collected by qualified field staff who are trained to be proficient in standardized field sampling procedures, data recording, and equipment operations applicable to sediment quality sampling. Fieldwork will be completed according to approved specific work instructions and established technical procedures. Specific work instructions are documents that describe exact sampling locations and provide specific sampling instructions, equipment needs and calibration requirements, sample labelling protocols, shipping protocols, and laboratory contacts.

One crew member will be responsible for managing the sample documentation process so that:

- all required samples are collected or reasons are documented as to why a sample was not collected;
- chain-of-custody and analytical request forms are complete and correct; and
- proper labelling and documentation procedures are followed.

5.3.5.1.2 Laboratory

One member of the team will act as a laboratory liaison to confirm that an accredited laboratory is used (accredited by the CALA), samples are received, and that specific analyses are completed. Under CALA's accreditation program, performance evaluation assessments are conducted for laboratory procedures, methods, and internal QC.

5.3.5.1.3 Office

Office-related QA includes using appropriately trained personnel for each task, senior review of work, standardized data manipulation/summary tools, filing of original data, screening of laboratory data (e.g., correct analytical methods used, correct detection limits used), and establishment of a data management system (e.g., database).

5.3.5.2 Quality Control

5.3.5.2.1 Field

A field QC program for sediment quality involves the collection and analysis of duplicate samples. Duplicate samples are additional samples collected at the same time and location as sediment samples collected during a field program, using the same sampling methods. They are used to check within-site variation, and the precision of field sampling methods and laboratory analysis.

It is standard to set the QC sample collection to 10 percent of total samples collected for a program. Quality control samples will be analyzed for the same suite of parameters as the test samples, and will be submitted blind to the laboratory.

5.3.5.2.2 Laboratory

Upon receipt of data from the laboratory, there are various QC steps to complete to confirm that data of acceptable quality have been received. Sample steps can include the following:

- verification that all samples were analyzed;
- verification that all parameters were analyzed and to the required detection limits;
- verification and acceptance of results;
- logic checks on total dissolved solids and conductivity, hardness and alkalinity, total and dissolved phosphorus, total and dissolved carbon, and total and dissolved metals;
- review of blanks for evidence of contamination; and
- review of duplicate samples for unacceptable variation.

5.3.5.2.3 Office

Aspects of the office QC can include the following:

- cross-checking laboratory raw data files with data stored in a database;
- creating backup files before each major data manipulation; and
- verifying the accuracy of calculations.

5.4 Fish Health

5.4.1 Objectives

The objectives of the fish health component are as follows:

- determine whether Project effluent has an effect on the growth, reproduction, survival, or condition of fish in Meliadine Lake;
- verify predictions made in the FEIS pertaining to fish health;
- meet the requirements of Part 2, Schedule 9 (b) of the MMER regulations (Government of Canada 2012);
- recommend appropriate changes to the fish health program for future years; and

- provide data to inform adaptive management intended to reduce or eliminate Mine-related effects to fish health in Meliadine Lake.

5.4.2 Study Design and Schedule

Fish health assessments will be conducted every three years using a population-level approach focused on indicators of energy storage, energy use, and survival. The fish health assessment will involve two lethal surveys: a small-bodied and a large-bodied survey. It is anticipated the small-bodied survey will target Threespine Stickleback (*Gasterosteus aculeatus*) as a sentinel species; fish will be collected in the near-field exposure area, and two reference areas, in the Northwest and Northeast basins of Meliadine Lake (Figure 4-1). The large-bodied survey will use a Control-Impact (CI) design and target Lake Trout (*Salvelinus namaycush*) as a sentinel species; fish will be collected at Meliadine Lake before and after the Project initiates effluent discharge, with data compared to samples collected during the pre-operational phase. Sentinel species were selected based upon historical data for the study lakes and considered relative abundance and catch-per-unit-effort (Section 4.3.1). The rationale for the design of the fish health component of the AEMP is based on guidance from the Metal Mining Technical Guidance for EEM (EC 2012).

5.4.2.1 Sample Size

The sample sizes for the fish health survey will consider the Metal Mining Technical Guidance for EEM minimum sample size of 20 male, 20 female and 20 juvenile fish (EC 2012), as well as the data quality and interpretation needs of the AEMP[3]. For Threespine Stickleback, juvenile and adult fish (i.e., both male and female) will be collected. Adult male and female Lake Trout will also be collected. Required sample sizes to achieve sufficient statistical power (e.g., 80%) will be reassessed following baseline data collection, once estimates of variability in fish health endpoints in Meliadine Lake are available.

5.4.2.2 Timing

The timing of the fish health assessment is dependent on the reproductive strategy of the sentinel species, and should target individuals when they are accessible and undergoing gonadal recrudescence (i.e., undergoing gonad development in preparation for the next spawning event) (Barrett and Munkittrick 2010).

Spawning of Threespine Stickleback is temperature dependent, generally occurring between May and July in the northern portion of their range (i.e., Alaska), when water temperatures rise between 10°C and 22°C (McPhail and Lindsey 1970, McPhail 1970). Due to the late timing of ice-off in northern lakes (i.e., early July), safe access to pre-spawning fish is not possible, as they spawn under ice or during ice-off when safe access for fish collection is not possible. Therefore, optimal sampling for Threespine Stickleback would occur in late August and early September, as the fish will have begun early gonad development for the next years' spawning efforts, providing sufficient gonad development to yield useful reproductive endpoint information for the fish health survey.

Spawning is also temperature dependent for Lake Trout, occurring as water temperatures decline to between 8 and 11°C (Coad et al. 1995). At Meliadine Lake, it is anticipated this temperature threshold is reached between late August and early September (Golder 2012a, Table 7-10).

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3 The sample sizes for small-bodied fish will meet the minimum recommended sample sizes for lethal fish surveys when there is insufficient data to calculate sample size *a priori* (EC 2012)

Therefore, the study design proposes to target Threespine Stickleback at the optimal time for gonadal development during the open-water period, while concurrently targeting Lake Trout, with the understanding that the timing of the Lake Trout collections may not be optimally timed for reproductive endpoints (i.e., four to six weeks prior to the spawning season [Barrett and Munkittrick 2010]). Prioritization of small-bodied fish reproductive endpoints over large-bodied fish reproductive endpoints is considered valid due to the high variability in Lake Trout reproductive endpoints typically measured in other studies in the north (e.g., De Beers 2010), which is believed to be due to discontinuous annual spawning cycles among individuals in the Lake Trout population (also known as “skip spawning”).

Fish sampling programs are contingent upon application and receipt of applicable scientific collection permits from Fisheries and Oceans Canada (e.g., licence to fish for scientific purposes, animal use permit).

5.4.3 Field Methods

The field methods being considered include techniques suitable for lake shore and open water habitats and are based on those used successfully in previous northern AEMP programs. For small-bodied fish collections, the proposed gear types include minnow traps, fyke nets, and electrofishing. For large-bodied fish collections, the proposed gear types include gill netting and angling. For each day of fishing the following information will be recorded:

- time (in hours) for each fishing effort for each gear type;
- gear specific parameters (e.g., settings for electrofisher);
- water depth of each gear-type set;
- GPS coordinates of each fishing effort;
- substrate type (e.g., mud, sand, gravel, cobble) at each fishing location;
- water quality field measurements (e.g., DO, water temperature, pH, conductivity, and turbidity), one time daily in each lake basin;
- weather (air temperature and wind velocity and direction, taken from the on-site weather station);
- number of each fishing effort (an effort identification number);
- number and species of fish captured; and
- photographs of representative habitat types and fish species captured.

All non-target fish species captured will be enumerated and measured for length and weight and released live when possible.

A representative photograph of each species captured will be taken. Wet gloves will be used during fish handling to reduce stress on the fish mucosal layer. If a specimen cannot be readily identified in the field, a specimen will be collected and brought to the office for identification. The total number of fish captured and released will be recorded so as to track fish numbers relative to limits specified in scientific collection permits.

5.4.3.1 Fish Health Parameters

All individuals of the sentinel species captured during the lethal surveys will undergo an external and internal examination. Features of the fish that do not appear normal (e.g., wounds, tumours, parasites, fin fraying, gill parasites or lesions) will be reported in detail, and if necessary, submitted for further analysis (i.e., histopathology). Where possible, information on maturity, sex, and overall health will be recorded and this information will be verified during the internal examination. External examinations will be conducted following the recommendations outlined in Chapter 3 of the Metal Mining Technical Guidance for EEM (EC 2012). Photographs will be taken of any fish with abnormal features.

Following the external examination, the fish will be sacrificed by a sharp blow to the back of the head and cervical dislocation (i.e., cutting the spinal cord immediately behind the head) followed immediately[4] by an internal examination. The biological variables collected from lethally sampled fish will be:

- fork length (± 1 mm);
- total length (± 1 mm);
- total body weight (± 0.001 g);
- presence of physical abnormalities (e.g., tumours, lesions, parasites);
- internal pathology (e.g., liver and kidney colour, fat content);
- parasite weight (if present; ± 0.001 g);
- sex;
- liver weight (± 0.001 g);
- gonad weight (± 0.001 g);
- photograph of gonad;
- state of reproductive development (i.e., maturity stage, as outlined in Table 5-4); identified visually for large-bodied fish and using gonadal histology for small-bodied fish; and
- carcass weight (± 0.001 g).

Tissue samples will be collected during the internal health assessment and labelled with a unique fish identification number for further analyses, as follows:

- gonads will be preserved for histology to determine reproductive state (Table 5-4) (small-bodied fish only);
- ovary/egg subsample weight will be collected for fecundity estimates (adult females only);

[4] Processing of live fish is necessary to observe internal pathology, as organs are perfused while the heart is still beating immediately after sacrificing the fish (i.e., blood is still flowing). In this way, organ colour can be observed and health implications can be accurately assessed, whereas mortalities or previously dead fish pathology do not represent accurate observations of fish health endpoints, nor do they provided accurate organ weights for comparison to live-sampled fish , due to tissue degradation processes that begin immediately upon death in non-frozen tissues. Only live fish will be assessed in the fish health survey.

- carcasses will be retained from small-bodied fish (adults only) and a muscle filet and liver tissue from large-bodied fish will be retained for tissue metals analysis (see Section 5.5); and
- otoliths and/or fin rays will be archived for aging analyses (each fish).

Table 5-4: Proposed Gonad Maturity Categories to be used in the Fish Health Survey based on Histological Examination of Gonads

Life Stage	Maturity Stage	Definition
1	Unknown (UN)	External examination only, or unable to determine following internal examination.
2	Immature (IM)	Fish has never spawned and will not spawn in the coming season; testes/ovaries transparent, very small and close under the vertebral column, determination of sex may be difficult.
3	Maturing (MA)	Fish has not spawned before, but will spawn in the coming season; gonads developed primarily in the anterior body cavity.
4	Seasonal Development (SD)	Sexually mature, has spawned before, gonads developing for coming season.
5	Ripe (RP)	Roe/milt extruded with slight pressure on belly.
6	Spent (SP)	Spawning completed, reabsorption of residual ovarian tissue not yet completed.
7	Reabsorbing (RB)	Sexually mature, was developed for the current season but did not spawn; interrupted spawning effort; eggs become atretic (small, hard, and white).
8	Resting (RS)	Sexually mature, has spawned before; gonads not developing for the coming season; alternate year spawner.

Internal condition (i.e., tissue colour and pathology) will be observed and recorded immediately following the opening of the body cavity. Liver weight will be recorded. During excision of the liver, the gall bladder will be observed and percent fullness will be estimated visually and recorded.

Gonads will be weighed together to yield a total gonad weight. Photographs will be taken of representative normal gonads, as well as of any abnormalities. For males, the total gonad will be placed in a labelled vial and preserved in 10% buffered formalin for histology. For females, one lobe will be processed for histology, while the second lobe will be processed for fecundity estimation by preserving in 10% buffered formalin. Subsample weights and lobe (left or right) for each respective analysis will be recorded. Fecundity will be estimated by counting developing eggs contained within the ovary lobe or a subsample of the ovary lobe using a dissecting microscope, and adjusting to the ovary and sample (i.e., lobe or subsample) weight. Egg size will be estimated by measuring the diameter of 30 eggs per fish with a micrometer under a dissecting scope. Representative photographs of the ovary lobe and eggs will be taken through the microscope for each sample during fecundity/egg size analyses.

Appropriate aging structures (e.g., sagittal otolith pairs, fin rays) will be collected and archived. Ageing structures will be wrapped in wax paper, placed into envelopes, and labelled with the unique fish identification number. Aging categories will be assigned annually via examination of length-frequency distributions.

Carcass weight (i.e., body without liver, gonads, stomach, intestines, and aging structure) will be measured and recorded for each fish and the carcasses will be submitted for tissue chemistry analyses (see Section 5.5.3).

5.4.4 Data Analysis and Interpretation

Analysis and interpretation of fish health will focus on answering the following key question:

- Is fish health affected by changes in water and sediment quality in Meliadine Lake?

Data will be analyzed to determine whether fish health has been affected by changes in water and sediment quality in Meliadine Lake, and whether changes observed in fish health are greater than those predicted in the FEIS. Lethal fish health surveys using Threespine Stickleback and Lake Trout will measure fish health endpoints related to survival (e.g., age), growth (e.g., size at age), reproduction (e.g., relative gonad size, relative fecundity), and condition (e.g., condition, relative liver size) taking into consideration sex, state of maturity and parasite presence/absence. For Threespine Stickleback, comparisons will be made between the exposure area near the Project effluent discharge, and reference areas in the Northwest and Northeast basins of Meliadine Lake, while for Lake Trout, samples collected before and after the pre-operational phase will be compared.

5.4.4.1 Catch Data Summary

Catch-per-unit-effort provides an estimate of abundance by standardizing catch data according to fishing effort. For all fish captured during the health survey, catch-per-unit-effort will be calculated and summarized by area and sampling method to document the amount of effort expended to collect the required number of fish. Total numbers of fish collected and processed as part of the lethal fish health surveys will be summarized by area and presented in summary tables.

5.4.4.2 Descriptive Statistics

Common fish indices that describe relationships between body metrics will be calculated as follows:

$$k = \left(\frac{carcass\ weight}{fork\ length^3}\right) * F; \qquad \text{Equation 1}$$

$$GSI = \frac{gonad\ weight}{carcass\ weight} * 100 \qquad \text{Equation 2}$$

$$LSI = \frac{liver\ weight}{carcass\ weight} * 100 \qquad \text{Equation 3}$$

where:

K = condition factor
GSI = gonadosomatic index
LSI = liver somatic index
F = scaling factor of 100 to 1000
all weight measurements are in grams (g) and length is in millimeters (mm)

Carcass weight is the measured body weight following removal of the liver, gonad, viscera, and aging structures, as well as parasites (if large parasites such as tapeworms are present). Carcass weight will be used in the calculations of GSI and LSI because of possible differences in organ weight among sampling areas. In some instances, carcass weight may be replaced with adjusted body weight in the above equations for supporting analyses. Adjusted body weight is the total body weight minus parasite weight (if parasites are present).

Descriptive statistics (i.e., sample size, mean, standard deviation, standard error, minimum, and maximum) will be calculated for mature fish and summarized for all quantitative fish health endpoints and indices. The incidences of abnormalities and parasites will be quantified for each area.

5.4.4.3 Analysis for Lethal Surveys

The objective of the fish health survey is to determine whether Project effluent has a significant effect on the growth, reproduction, survival, and/or condition of fish in Meliadine Lake relative to fish populations at the reference areas and/or pre-operational phase. The following endpoints will be analysed:

- survival (e.g., age);
- energy use (e.g., size-at-age; relative gonad size; fecundity); and
- energy storage (e.g., condition; relative liver size).

Survival is a measure of the difference in the mean age of all fish (separated by species and sex) between the exposure and reference areas. A healthy population should exhibit variability in age.

Energy Use is a measure of the ability of the fish population to utilize resources in their environment to grow and reproduce. It is also an indicator as to whether a population is growing and reproducing normally and successfully.

Energy Storage is a measure of the energy reserves of the fish population. Condition and relative liver size provide valuable information on food quality and availability to the fish population. A healthy fish will demonstrate a greater body weight to length ratio and have a liver weight that is proportional to its body size. Stressors from the environment, whether they are natural or anthropogenic, can affect the condition of a fish population and alter the relative liver size (e.g., enlarged liver as a result of contaminant depuration processes or increased lipid processing as a result of eutrophication).

Fish health endpoints related to the above responses will be statistically compared either between the exposure and reference areas, or before and after pre-operational phase, to identify whether an effect has occurred on the fish population at Meliadine Lake as per the Metal Mining Technical Guidance for EEM (EC 2012). An "effect" is defined as a statistically significant difference in effect indicators measured between an area exposed to effluent and a reference area (EC 2012). Fish health response effect indicators, endpoints, dependent variables and covariates (as appropriate), and statistical procedures that are applicable to the fish health component of the AEMP are provided in Table 5-5. Fish data will be divided by sex, state of maturity (i.e., male and female fish will be analyzed separately, and immature fish will not be included), and presence or absence of parasites. This is necessary due to different energetic requirements associated with reproduction, which result in differences in growth patterns and subsequent differences in growth rate, body weight, gonad size, and liver size (EC 2012). Parasitism will also be considered due to the influence some parasites, especially tapeworms (e.g., *Schistocephalus*) can have on nutrient uptake and, therefore, energy availability for reproduction and growth.

Once data are separated based on sex and state-of-maturity and, if applicable, parasitism status, data will be $\log_{10}$ transformed, if necessary, to achieve normality and homogeneity of variance prior to conducting the statistical analyses. The data will be tested for normality and homogeneity of variance and screened for potential outliers by visual examination of box and whisker plots and linear regression plots prior to proceeding with statistical analyses.

Studentized residuals (SR) from the linear regression analyses will be used as an additional data screening tool. Observations that are more than three standard deviations (i.e., SR>|3|) from the mean will be checked and validity confirmed; data points will only be removed if warranted. Outliers that are removed will be identified, the reasons for removal (e.g., transcription error, analytical error) will be described, and the screening will be re-run (i.e., box plots, linear regression). If there is no obvious reason for the presence of the outlier, the ANOVA and analysis of covariance (ANCOVA) will be conducted with and without the outlier, per the Metal Mining Technical Guidance for EEM (EC 2012). Statistical analyses, including screening, will be conducted using appropriate statistical software (e.g., SYSTAT 13.1 [Systat Software, San Jose, CA]).

Table 5-5: Statistical Procedures Used to Identify Differences in Endpoints Between Exposure and Reference Areas or Pre-operational Conditions

Effect Indicator	Endpoint	Dependent Variable (Y)	Covariate (X)	Statistical Procedure
Survival	Age	n/a	n/a	ANOVA
Growth (Energy Use)	Size at age	Adjusted body weight	Age	ANCOVA
		Length	Age	ANCOVA
	Length-frequency distribution	n/a	n/a	K-S test
	Body weight	n/a	n/a	ANOVA
	Length	n/a	n/a	ANOVA
Reproduction (Energy Use)	Relative gonad size	Gonad weight	Carcass weight	ANCOVA
		Gonad weight	Length	ANCOVA
	Relative fecundity	# eggs/female	Adjusted body weight	ANCOVA
		# eggs/female	Length	ANCOVA
		# eggs/female	Age	ANCOVA
Condition (Energy Storage)	Condition	Adjusted body weight	Length	ANCOVA
		Carcass weight	Length	ANCOVA
	Relative egg size	Mean egg weight	Adjusted body weight	ANCOVA
		Mean egg weight	Carcass weight	ANCOVA
		Mean egg weight	Age	ANCOVA
	Relative liver size	Liver weight	Length	ANCOVA
		Liver weight	Carcass weight	ANCOVA

n/a = not applicable; ANOVA = Analysis of Variance; K-S test = 2-sample Kolmogorov-Smirnov test; ANCOVA = Analysis of Covariance; Adjusted body weight = total body weight minus parasite weight (if parasites present); Carcass weight = measured carcass weight after removal of liver, gonads, stomach, intestines, and aging structures.

The ANOVA will be used to test whether there is a statistical difference between the exposure area and respective reference areas in fish age, total body weight, carcass weight, and length for each sex (Table 5-5). For each analysis, the level of significance (P) for the test statistic will be reported. If a statistical difference is detected, direction and magnitude of effect will be calculated. Direction provides an indication of whether the exposure area means are larger or smaller than the reference means. Magnitude is the percent difference between two areas, and will be calculated by comparing the means between the exposure and reference areas (Equation 4):

$$Magnitude = \left(\frac{exposure\ mean - reference\ mean}{reference\ mean}\right) * 100 \qquad \text{Equation 4}$$

A general linear model followed by ANCOVA will be used to assess endpoints, including size-at-age, condition (adjusted body weight against length), liver size, gonad size, and fecundity. Testing for homogeneity of slopes between the dependent variable and covariate for fish in each lake (i.e., test for significant covariate interaction) is done with a general linear model. In cases where a significant interaction between areas and covariate is found, but the difference in the R^2 value between the full regression model and the reduced regression model is less than 0.02, ANCOVA will proceed as per Barrett et al. (2010). If the difference in the R^2 value is greater than 0.02, ANCOVA will not be conducted and an ANOVA will be performed on the dependent variable. Magnitude will be calculated by comparing the least squares mean (LSM) between the exposure and reference areas (Equation 5):

$$Magnitude = \left(\frac{exposure\ LSM - reference\ LSM}{reference\ LSM}\right) * 100 \qquad \text{Equation 5}$$

Where the general linear model produces no significant interaction between areas and the covariate (i.e., homogeneity of slopes is not violated), but there is no significant regression with the covariate, ANOVA analysis will be completed on the dependent variable following the procedure outlined above. In cases where the general linear model produces no significant interaction between areas and the covariate, and there is a significant regression relationship with the covariate, ANCOVA will be performed. If the results of the ANCOVA indicate significant differences between the exposure and reference areas, hypothesis testing will be performed to determine which areas are different from each other (i.e., pair-wise comparisons will be performed by hypothesis testing). At the study design stage, the probability of a Type 1 error (α) is set to the same level (i.e., 0.1) as a Type II error (β) because the probability of missing an important effect is deemed to be as important as the probability of finding an effect when none exists (EC 2012). Power analysis will be performed on ANOVA and ANCOVA analyses to determine whether there was sufficient power to detect differences in the population. In any case where there is deemed to be low power, the required number of samples to achieve sufficient power (e.g., 0.80) will be calculated.

5.4.4.4 Fish Health Relative to Normal Range

Fish health parameters from the exposure area will be compared to pre-operational and regional reference data to determine whether there have been changes in fish health in the exposure area relative to normal range (i.e., natural variability). It is anticipated the normal range will be calculated as a 95% prediction interval for the mean (Barrett et al. In Review), which considers available pre-operational and reference area data.

5.4.4.5 Environmental Effects Monitoring Specified Analysis

If a statistically significant difference in an endpoint[5] is observed between reference and exposure areas, or before and after the pre-operational phase in a BACI design, an effect on fish health is considered to have occurred, as defined under the Metal Mining Technical Guidance for EEM (EC 2012). If similar effects are

[5] EEM specific endpoints for fish health include weight-at-age, relative fish gonad size, relative liver size, condition and age.

observed in two consecutive surveys, they are considered to have been confirmed and the Project will be required to determine the magnitude and geographic extent of the effects, as well as perform an Investigation Of Cause. The level of effort required will be based on the magnitude of confirmed effects relative to the critical effect size for that endpoint (Table 5-6), with effects exceeding the CESs considered to be of higher risk to the environment, requiring greater effort to characterize (EC 2012).

If the results of two consecutive biological monitoring studies show no effects on fish health, fish tissue and benthic invertebrate community structure (i.e., all three components together not showing effects), the Project has not affected fish in the receiving environment and the Project may reduce its biological monitoring effort, with respect to the EEM program, from every 36 months to every 72 months.

Table 5-6: Critical Effect Sizes for the metal Mining Environmental Effects Monitoring Program

Fish Effect Endpoint	Critical Effect Size[(a)]
Weight-at-age	±25%
Relative fish gonad size	±25%
Relative liver size	±25%
Condition	±10%
Age	±25%

[(a)] Differences in fish population effect endpoints are expressed as percentage (%) of reference mean.

5.4.5 Quality Assurance and Quality Control

The QA/QC procedures are designed such that field sampling, laboratory analyses, data entry, data analyses, and report preparation produce technically sound and scientifically defensible results. As part of routine QA/QC for field operations, equipment (e.g., water quality meters, weigh scales) will be calibrated and samples will be collected by experienced personnel and will be labelled, preserved, and shipped according to standard protocols. Specific work instructions outlining each field task in detail will be provided to the field personnel by the task manager and reviewed prior to the start of the field program. Field notes will be recorded in waterproof field books and on pre-printed waterproof field data sheets in either pencil or indelible ink. Data sheets and all sample labels will be checked at the end of each field day for completeness and accuracy. Chain-of-custody forms will be used to track the shipment of all samples. Ten percent of the histology data will be randomly selected and re-analyzed by an independent histopathologist. If aging structures are submitted for analysis, 10% of the prepared sections will be re-aged by an independent fish ageing specialist. If there is a discrepancy greater than 10% between the specialist's results and the initial results, all samples will be re-analyzed. For every ten fecundity samples, one sample will be recounted by a second person. If the re-count of the sample is within 10% of the initial count, the initial count will be regarded as acceptable and no re-count of the remaining samples will be required. If the re-count is not within 10% of the initial count, the initial count will be regarded as unacceptable and the remaining nine samples will be re-counted. The QA/QC procedure will be repeated until re-counts are within 10% of the previous count.

The QA/QC for data entry involves checking a minimum of 10% of the data for data entry errors, transcription errors, and invalid data. This checking will be done by an independent person from the person who entered the data. If an error is found, every datum will be checked. Statistical results will be independently reviewed by a senior statistician. Tables containing both summary data and statistical results will be reviewed and values verified by a second person.

5.5 Fish Tissue Chemistry

5.5.1 Objectives

The objectives of the fish tissue chemistry component are as follows:

- determine whether Project effluent has an effect on metal concentrations in fish tissue in Meliadine Lake, including whether fish tissue chemistry has been altered in such a way as to limit fish use by humans;
- verify predictions made in the FEIS pertaining to fish tissue metal concentrations;
- meet the requirements of Part 2, Schedule 9 (c) of the MMER regulations (Government of Canada 2012);
- aid in the interpretation of the fish health study;
- recommend appropriate changes to the fish tissue chemistry program for future years; and
- provide data to inform adaptive management intended to reduce or eliminate Mine-related effects to fish tissue chemistry in Meliadine Lake.

5.5.2 Study Design and Schedule

Fish tissue chemistry will be analyzed from Threespine Stickleback carcasses and Lake Trout muscle, liver, and kidney tissues collected during the fish health survey. As such, timing of sampling will follow the late August and early September fish health survey described in Section 5.4.2.2. Threespine Stickleback will be sampled to provide an early indicator of potential changes in fish tissue chemistry at Meliadine Lake, and Lake Trout will be used to document concentrations in species of fish likely to be eaten by people (i.e., community members). Tissue chemistry data will be collected from these species every three years in accordance with the Metal Mining Technical Guidance for EEM (EC 2012).

5.5.3 Field Methods

Fish tissue samples will be collected from Threespine Stickleback and Lake Trout captured during the fish health survey (field collection methods are outlined in Section 5.4.3). Threespine Stickleback carcasses will be retained from lethally sampled fish. Subsamples of muscle, liver and kidney tissue will be collected from lethally sampled Lake Trout. Field tools will be cleaned with 5% nitric acid between dissections to minimize the potential for cross contamination between samples, or disposable and new tools will be used for each fish (e.g., scalpels). Tissue samples will be weighted, wrapped in plastic, and labelled with the appropriate fish identification number number. If small-bodied fish carcasses or large-bodied tissue samples of sufficient size are not available to meet the minimum sample weight (i.e., 5 g ww), then samples from no more than four fish of similar size and the same sex (i.e., male only and female only) will be composited. Tissues will be submitted to an appropriate laboratory for analyses of mercury, metals and major ions listed in Table 5-7.

Table 5-7: Proposed parameters to be Analyzed in Tissue Samples for the Meliadine Aquatic Effects Monitoring Program with Expected Achievable Detection Limits

Parameter	Detection Level (µg/g ww)	Parameter	Detection Level (µg/g ww)
% Moisture	0.1	Manganese	0.01
Aluminum	0.4	Mercury	0.001
Antimony	0.002	Molybdenum	0.004
Arsenic	0.004	Nickel	0.04
Barium	0.01	Phosphorus	2.0
Beryllium	0.002	Potassium	4.0
Bismuth	0.002	Rubidium	0.01
Boron	0.2	Selenium	0.01
Cadmium	0.001	Silver	0.001
Calcium	4.0	Sodium	4.0
Cesium	0.001	Strontium	0.01
Chromium	0.01	Tellurium	0.004
Cobalt	0.004	Thallium	0.0004
Copper	0.02	Tin	0.02
Iron	0.6	Uranium	0.0004
Lead	0.004	Vanadium	0.02
Lithium	0.1	Zinc	0.1
Magnesium	0.4	Zirconium	0.04

µg/g ww = micrograms per gram wet weight.

5.5.4 Data Analysis and Interpretation

Analysis and interpretation of fish tissue chemistry will focus on answering the following key questions:

- 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?

Prior to summarizing and performing statistical analyses on the fish tissue chemistry data, values below the limit of detection, or non-detects, will be reviewed. Where data are below the laboratory detection limit, values will be set to one-half the detection limit to calculate summary statistics (i.e., the mean, standard deviation, standard error, maximum, and minimum values) and perform pairwise comparisons between the exposure and reference areas (Table 5-8). If results for one parameter are all below the detection limit, no mean will be calculated, and the result will be reported as "not-detected". Metal concentrations will be then be compared to Canadian Food Inspection Agency guidelines (CFIA 2009).

Table 5-8: Statistical Procedures Used in the Analysis of Fish Tissue for Identifying Differences between Reference and Exposure Areas

Metal	Dependent Variable (Y)	Covariate (X)	Statistical Procedure
Cesium[a], Thallium[a]	cesium, thallium	Length, weight or age[c]	ANOVA or ANCOVA[a]
Mercury[b], Selenium[b]	mercury, selenium	Length, weight or age[c]	ANCOVA
Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Phosphorus, Potassium, Rubidium, Silver, Sodium, Strontium, Tellurium, Tin, Uranium, Vanadium, Zinc, Zirconium	n/a	n/a	ANOVA

[a] Cesium and thallium can bioaccumulate in higher trophic level organisms, particularly in piscivorous fish species. Analysis for these metals will be standardized to fish size for statistical testing; if significant regression relationships do not exist between either cesium or thallium concentration and body size, analyses will proceed by ANOVA.

[b] Mercury and selenium can biomagnify (i.e., accumulate to a greater degree in higher trophic level organisms); therefore, these metals will be standardized to fish size for statistical testing.

[c] The best covariate will be used in the statistical analysis, as determined by regressing tissue cesium, mercury, selenium or thallium concentration against each potential covariate (i.e., length, weight or age). The covariate with the strongest regression relationship (i.e., smallest *P*-value) will be used as the covariate for the ANCOVA.

5.5.4.1 Tissue Chemistry Relative to Normal Range

Where tissue concentrations in Threespine Stickleback (carcass) and Lake Trout (muscle, liver, and kidney) are above the limit of detection in more than 50% of the samples, tissue metal concentrations from the exposure area will be compared to pre-operational and regional reference data to determine whether there have been changes in fish tissue concentration in the exposure area relative to normal range (i.e., natural variability). It is anticipated the normal range will be calculated as a 95% prediction interval for the mean (Barrett et al. In Review), which considers all available pre-operational and reference area data.

However, if the measured concentration of a metal in fish tissue samples is below the limit of detection from pre-operational analyses (i.e., analytical detection limits have improved and metals are detectable at levels that were not measurable during the pre-operational baseline studies), then statistical tests cannot be performed and limited, qualitative inferences will be made regarding temporal trends for that metal in fish tissue relative to the pre-operational phase.

5.5.4.2 Environmental Effects Monitoring

As defined under Metal Mining Technical Guidance for EEM (EC 2012), if concentrations of total mercury in fish tissue are statistically greater at the exposure area compared to reference areas, or before and after the pre-operational phase in a BACI design, and exceed 0.5 micrograms per gram (µg/g) wet weight, an effect on fish health is considered to have occurred. If similar effects are observed in two consecutive surveys, they are considered to have been confirmed and the Project will be required to determine the magnitude and geographic extent of the effects, as well as perform an Investigation of Cause. Further details on this process are provided in Section 5.4.4.4.

5.5.5 Quality Assurance and Quality Control

Duplicate tissue samples from large-bodied fish collected in the study areas will be submitted opportunistically (e.g., 10% of total samples will be submitted as field duplicates). Inter-laboratory comparisons will be done with large-bodied fish with a subset of samples going to two laboratories to compare results.

The analytical laboratory with analyze a series of sample blanks, spikes, and laboratory duplicates, and Certified Reference Standards (CRMs) will be run in parallel with the tissue chemistry samples. The results of these internal QA/QC processes will be reported with the laboratory data and any deviations from acceptable data quality objectives will be reported. If acceptable limits are exceeded, samples will be re-assessed and, if necessary and possible, re-analyzed.

Laboratory data will be screened in a manner similar to the water quality data (Section 5.1.5). A review of the data entry will involve checking a minimum of 10% of the data for completeness, data entry errors, transcription errors, and invalid data. This checking will be done by a second, independent individual. If an error is found, all data will undergo a zero tolerance (i.e., every datum checked) QA check. All statistical results will be independently reviewed by a second, competent statistician. Tables containing both summary data and statistical results will be reviewed and values verified by a second, independent individual.

6.0 PENINSULA LAKES

6.1 Water Quality

6.1.1 Objectives

Water quality monitoring will form a core component of the Peninsula Lakes study. Biological studies (Section 7.3) will be included in future monitoring cycles if results of the water quality program indicate that the small lakes on the peninsula may be affected by mining activities. Water quality triggers to initiate future biological studies are still to be determined. The Peninsula Lakes will not receive direct discharge from the mine, and are therefore not required to be monitored under MMER. The primary objectives of the water quality component for the Peninsula Lakes study are as follows:

- characterize and interpret water quality in the selected monitoring lakes for purposes of identifying Project related effects;
- verify and update the FEIS predictions;
- assess efficacy of impact mitigation strategies to minimize the water quality effects of the mine; and
- provide data to inform management intended to reduce or eliminate Mine-related effects to water quality in the Peninsula Lakes.

6.1.2 Study Design and Schedule

The general design for water quality monitoring is to select up to three representative stations in each lake that can be sampled on a regular basis. The lakes will be sampled for water, benthic invertebrates (Section 7.3.1), sediment (Section 7.3.2), plankton (Section 7.3.3), and fish (Section 7.3.4) during the pre-operational period to collect additional data. Only the water quality program will be continued as a core study, while the biological studies will resume if triggered by water quality results through the AEMP Response Framework.

The proposed lakes for this program are one from each of watershed A (Lake A8), watershed B (Lake B7), and watershed D (Lake D7) (Figure 4-2). Samples are proposed to be collected twice during the open-water period.

6.1.3 Field Methods

At each water quality station, during each field program, field data and water samples for laboratory analysis will be collected, and samples will be analyzed for the same set of parameters identified in the Meliadine Lake study (Table 5-2). Collection of field data will include physico-chemical measurements of the water column profile (pH, temperature, dissolved oxygen, and conductivity) and recording of incidental information such as station coordinates, total water depth, sample collection depth, Secchi depth, photographs, equipment malfunctions, helicopter hours, wildlife activity, hazards, and issues. Water samples for laboratory analysis will be collected with a Kemmerer (or similar) sampler from a pre-determined depth (e.g., surface, mid-depth, depth of maximum conductivity, bottom). Standardized field data sheets will be developed.

6.1.4 Data Analysis and Interpretation

Analysis and interpretation of the Peninsula Lakes water quality data will focus on answering the following key questions:

- Are concentrations of key parameters in the Peninsula Lakes consistent with FEIS predictions and less than AEMP Action Levels?
- Are concentrations of key parameters in the Peninsula Lakes increasing over time relative to baseline or reference conditions?

Water quality results will be evaluated, and concentrations will be compared to CWQG (CCME 1999) and DWQG (Health Canada 2012) (Table 5-2), and baseline conditions for the peninsula lakes. From this review, appropriate water quality benchmarks and triggers will be developed.

Results will be analyzed to determine if water quality parameters are increasing over time, and if concentrations are above guidelines (if concentrations were not above guidelines during baseline).

6.1.5 Quality Assurance and Quality Control

QA/QC procedures will be consistent with those described for water quality monitoring in Meliadine Lake (Section 5.1.5).

7.0 TARGETED STUDIES

Targeted studies are not part of the core AEMP program; rather, they are special studies that are designed for short periods of time. Some of these studies will provide pre-operations data to support future adaptive management.

7.1 Plankton in Meliadine Lake

Plankton are small, usually microscopic organisms that live suspended in the open water. Phytoplankton are the open water, algal component (i.e., non-vascular, photosynthetic plants) of plankton that rely on nutrients and carbon sources in the lake water for growth. Zooplankton are small, sometimes microscopic, animals that float, drift, or swim weakly in the water column and feed on phytoplankton. Phytoplankton and zooplankton are primary and secondary producers, respectively, and form the base of the food-web in most lake ecosystems.

Phytoplankton and zooplankton community metrics can be useful indicators of environmental change because of their rapid response to changes in nutrients or other substances. However, the inherent variability within the plankton community poses a challenge and can limit their usefulness as a monitoring tool. Plankton abundance, biomass, and taxonomic composition vary vertically and horizontally within the open water; therefore, estimates are sensitive to the number of stations, samples, and the depth of the water column sampled (Findlay and Kling 2001; Paterson 2002). Seasonal succession within the plankton community and natural year-to-year variation also contribute to the inherent variability of these communities (Wetzel 2001; Paterson 2002). Plankton monitoring is proposed as a two-year targeted study, rather than as a main component of the AEMP, until it can be determined if plankton will be a useful monitoring tool for the Project. Similar to the approach proposed for the core components of the AEMP, the plankton targeted study will consist of sampling within Meliadine Lake, as described below.

7.1.1 Objectives

The main objectives of the two-year plankton study in Meliadine Lake are to:

- collect additional information related to the current status, in terms of abundance, biomass, and composition, of the phytoplankton and zooplankton assemblages in Meliadine Lake;
- characterize seasonal patterns in plankton biomass and community composition;
- assess the strength of the relationship between chlorophyll *a* concentrations and phytoplankton biomass; and
- evaluate use of plankton communities as a long-term monitoring tool.

7.1.2 Study Design and Schedule

The plankton program will be carried out as a targeted study with annual monitoring over two years to provide baseline information on natural seasonal patterns, inter-annual variability and spatial differences within Meliadine Lake.

Five stations will be sampled within each of the five sampling areas of Meliadine Lake. The stations and areas to be sampled in Meliadine Lake will be harmonized with the core components of the AEMP (Figure 4-1; Table 5-1). Sampling will occur monthly during the open-water period (July, August, and September) to capture temporal changes in the plankton community. Plankton samples will be collected at the same time as water quality samples are collected by the water quality component. Depth-integrated water samples will also be collected at these locations for analysis of chlorophyll *a* and nutrient concentrations.

Sampling effort will be consistent with other programs, as appropriate (e.g., Meadowbank, Snap Lake, NICO, Diavik). The plankton targeted study will help to determine plankton metrics that could be included as part of the long-term monitoring program.

7.1.3 Field Methods

Plankton sampling will be carried out during the open-water period in Meliadine Lake (i.e., July, August, and September) at the same time and location as the detailed water quality program (Section 5.1). Community composition samples for phytoplankton and zooplankton, as well as concentrations of chlorophyll *a* and nutrients (e.g., total nitrogen, total phosphorus, orthophosphate, and silicate) will be collected at five sampling stations in each area of Meliadine Lake.

At each sampling station, Secchi depth, maximum depth, and limnology profiles will be measured prior to the collection of the plankton samples (Section 5.1 for details). Maximum water depth is required to determine the sampling depth for zooplankton.

The order of sampling will be: total depth (via a depth sounder), Secchi depth, water column profile measurements with a water quality multimeter, samples for detailed water quality analysis (Section 5.1), a depth integrated sample for phytoplankton, and then a full water column haul for zooplankton.

Phytoplankton

One phytoplankton sample will be collected at each station for a total of 25 phytoplankton samples per sampling event from Meliadine Lake. A Kemmerer water sampler (or similar) will be used to collect one composite phytoplankton sample from within the euphotic zone (i.e., approximate depth to which 1% of incident light penetrates); this zone will be estimated as twice the Secchi depth. Water samples will be collected at 2-m intervals within the euphotic zone. For example, if the euphotic zone is 6 m, water will be collected at the surface (0 m), 2 m, 4 m, and 6 m. The grab samples of water from each depth will be combined into a large bucket to create a composite sample. Sub-samples of the composite water sample will be collected for phytoplankton taxonomy, chlorophyll *a*, and nutrients.

Pre-labelled, prepared phytoplankton collection bottles will then be filled with the composite water from the bucket. The phytoplankton bottles will be prepared by placing 2.5 millilitre (mL) of acidified Lugol's solution in the 250-mL amber bottles prior to sample collection. Samples will be stored in the dark, either refrigerated or at ambient temperatures. Samples will be submitted to a laboratory and identified to the lowest taxonomic level.

Chlorophyll and Nutrients

The remaining water in the bucket from the composite Kemmerer grab samples will be used for the chlorophyll *a* and nutrient samples. A 2-L amber bottle will be filled with composite water. The collected water sample will be filtered onto 47-mm Glass Fibre type C Filter (GF/C) using a glass filter tower and vacuum pump. The chlorophyll filtration will be done under low light conditions in the laboratory. A sufficient volume of water must be filtered to discolour the filter, approximately 500 mL per filter. For each sample, three chlorophyll filters will be prepared.

Once the filtering is complete, the filter will be taken off the tower, folded in half and put into a pre-labelled Petri dish. The volume filtered will be recorded on the data sheet as well as the sample label. Samples will then be wrapped in aluminum foil, to prevent light penetration, and frozen.

Sample bottles for nutrients analysis will be provided by an accredited analytical laboratory and samples will be processed (e.g., preserved as required and refrigerated) according to the instructions provided by the laboratory. Water samples will be kept refrigerated before shipping and ice-packs will be added to the coolers to keep the samples as cool as possible during shipping. Samples will be shipped to the analytical laboratory as soon as possible after sample collection and processing.

Zooplankton

A single zooplankton sample will be collected at each station for a total of 25 samples per sampling event from Meliadine Lake. Zooplankton samples will be collected using the vertical tow method, with the bottom of the net being lowered approximately 1 m above the bottom substrate (i.e., 1 m should be subtracted from the maximum depth); this depth will be recorded as the depth for the zooplankton vertical tow. A Wisconsin-style plankton net (63-µm mesh) with a detachable cod end and a flow meter will be used to collect zooplankton samples. The flow meter will be zeroed by turning the propeller blades prior to the net being deployed to the required depth. The plankton net will be pulled to the surface at an approximate rate of 0.5 metres per second. Once the plankton net is out of the water, it will be rinsed down by splashing lake water on the outside of the net to transfer any zooplankton clinging to the plankton net walls into the plankton bucket. The plankton bucket will be removed and the sample transferred into a 250-mL clear Nalgene® sample bottle. The plankton bucket will be washed to remove all organisms. The final sample will be concentrated so that it fills no more than half of the sample bottle (i.e., 125 mL or less in the 250-mL collection bottles). The flow meter reading will be recorded on the field datasheet.

Once the zooplankton sample has been collected, one half of an Alka-Seltzer tablet will be added to the container and allowed to dissolve (1 to 2 minutes). This is to prevent the zooplankton from being shocked and contorted by the preservative and to facilitate taxonomic identification and length determination. The zooplankton samples will then be preserved by filling the bottle (up to 125 mL) with 4% buffered formalin solution and the lid secured. Samples will be submitted to a laboratory and identified to the lowest taxonomic level.

7.1.4 Data Analysis and Interpretation

Analysis of the two-year targeted study of plankton communities will aim to address the following key questions:

- What are the current concentrations of chlorophyll *a* and what do these concentrations indicate about the trophic status and algal biomass of Meliadine Lake in the reference and exposure areas? Is there a link between chlorophyll *a* concentrations and phytoplankton biomass in these locations?
- What is the current status, in terms of abundance, biomass, and composition, of the plankton communities in Meliadine Lake?
- Are the plankton metrics useful to be carried forward into the AEMP for Meliadine Lake, and if so, which plankton metrics would be most useful?

Temporal trends in chlorophyll *a* concentrations will be examined and concentrations will be compared to trophic classification schemes for lakes (Carlson 1977; Wetzel 2001; CCME 2004) (Table 7-1). The trophic status will be evaluated by examining the depth integrated nutrient data, chlorophyll *a*, and water transparency (Secchi depth) data. Trophic classifications will be based on the *Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems* (EC 2004) and Carlson's Trophic State Index (Carlson 1977).

Table 7-1: Trophic Status Classification

Parameter	Unit	Source	Ultra-oligotrophic	Oligotrophic	Mesotrophic	Meso-eutrophic	Eutrophic	Hyper-eutrophic
Total Phosphorus	mg/L	Vollenweider 1970	-	0.003 to 0.018	0.011 to 0.096	-	0.016 to 0.386	-
		Carlson 1977	-	0.0 to 0.012	0.012 to 0.024	-	0.024 to 0.096	0.096 to 0.384+
		CCME 2004	<0.004	0.004 to 0.01	0.01 to 0.02	0.02 to 0.035	0.035 to 0.1	>0.1
Chlorophyll *a*	µg/L	Vollenweider 1970	-	0.3 to 4.5	3.0 to 11.0	-	3.0 to 78.0	-
		Carlson 1977	-	0 to 2.6	2.6 to 20	-	20 to 56	56 to 155+
Secchi Depth	m	Vollenweider 1970	-	5.4 to 28.3	1.5 to 8.1	-	0.8 to 7.0	-
		Carlson 1977	-	>8.0 to 4	4 to 2	-	2 to 0.5	0.5 to <0.25

mg/L = milligrams per litre; µg/L = micrograms per litre; m = metre; - = no data

Plankton abundance and biomass data will be divided into groups based on taxonomic results. Phytoplankton groups will be cyanobacteria, chlorophytes, chrysophytes, cryptophytes, dinoflagellates, diatoms, and others (when necessary). Zooplankton groups will be cladocerans, calanoid copepods, cyclopoid copepods, rotifers, and others (when necessary). The relative proportion accounted for by each group, based on both abundance and biomass, will be calculated separately for each station and for each sampling event to evaluate temporal and spatial variability in community structure. Annual qualitative comparisons will also be used to compare between exposure and reference areas within Meliadine Lake. Information collected as part of the water quality component, such as maximum water depth, Secchi depth, limnology profiles (i.e., specific conductivity, DO, water temperature, and pH), and nutrient concentrations will be incorporated into the plankton component, as required. Nonparametric correlations, such as Spearman rank order correlations, will be used to assess potential habitat-related variation, where appropriate.

More detailed comparisons will be made following three years of data acquisition and will employ temporal and spatial trend analyses in the form of multivariate statistical analyses such as NMDS, as appropriate. NMDS will be run on the plankton biomass data set to summarize the community and evaluate potential differences in community structure over space and time in Meliadine Lake. Ordination results will be presented as two-dimensional scatter-plots of the sampling station-year combinations in ordination space.

7.1.5 Quality Assurance/Quality Control

The QA/QC procedures will be applied during all aspects of the plankton component to verify that the data collected are of acceptable quality. Data entered electronically will be reviewed for data entry errors and appropriate corrections will be made.

Ten percent of both the phytoplankton and zooplankton samples will be re-counted by the taxonomist to verify internal counting efficiency. Samples will be reanalyzed if 10% or more of the samples were counted incorrectly.

The inherent variability associated with the plankton samples prevents the establishment of a QC threshold value. For the purposes of the plankton QC, the proportion of each major group will be calculated and the occurrence of dominant species will be used to assess consistency between the field samples and duplicate samples analyzed. In addition, the Bray-Curtis index and relative percent difference will be used to assess the overall similarity between the field and duplicate samples. Due to high variability in species occurrence, these comparisons will be made at the major group level for both abundance and biomass, not the species level. The Bray-Curtis index only allows for comparison between entire samples, while the relative percent difference compares differences in abundance and biomass of each major group between each pair of duplicate samples.

The data will be reviewed for unusually high or low values (i.e., greater or less than 10 times typical lake values), which would suggest erroneous results. Unusually high or low results will be validated on a case-by-case basis. All invalidated data will be retained in the appendix tables, but a flag will be appended to the data indicating that the sample was considered unreliable or the results were designated as not correct due to an internal review of the data.

7.2 Effluent Plume Characterization

The FEIS predicted mixing behaviour of mine effluent in the exposure area of Meliadine Lake; the preliminary predictions will be updated with a plume characterization study as a requirement under MMER. A plume characterization study is used to predict mixing of effluent in the area around the diffuser to determine the distance from the diffuser where 1% effluent concentration will be approached. The plume characterization study will be desktop based and then validated in the field once effluent release has started. A plume characterization study is not required every year and, therefore, is proposed as a special study. The results of the study will be used to confirm and/or refine appropriate sampling areas and to use in the future for comparison to monitoring data.

7.3 Peninsula Lakes

Biological and sediment quality monitoring in the Peninsula Lakes is proposed as a targeted study because of uncertainty around the most appropriate monitoring tool for these lakes given the Project design and footprint. The study design included in this section is for collection of additional baseline data in 2015 to 2016. A similar design could be followed if results of water quality monitoring trigger biological monitoring through the AEMP Response Framework.

7.3.1 Benthic Invertebrates

7.3.1.1 Objectives

The objective of this component is to assess Project-related effects on the benthic invertebrate community in the Peninsula Lake receiving environments if a water quality benchmark or trigger (still to be defined) is reached as a result of the Project, or there is the potential for negative changes to aquatic life. In the event that a water quality trigger is reached, monitoring data would also be used to verify predictions made in the FEIS relating to benthic invertebrate communities.

7.3.1.2 Study Design and Schedule

The preliminary study design under consideration involves pre-operational monitoring of three waterbodies downstream of the proposed mine (lake B7, A8, D7). Annual sampling is proposed for two years prior to mine operations to compile a pre-operational dataset suitable for inclusion in an AEMP program. The data collected would serve to characterize spatial and temporal variability in these lakes and to characterize invertebrate communities using the methods that would be employed during future monitoring of benthic invertebrates (if triggered within the AEMP).

7.3.1.3 Methods

7.3.1.3.1 Field

Sampling Locations and Frequency

Three replicate stations will be sampled within each of the three proposed lakes (total of 9 stations) with one composite sample taken at each station. To minimize the potential influence of confounding factors on the ability to detect mine-related spatial or temporal changes, efforts will be made to sample within a standardized depth range, sample consistent substrate types, and record in situ field water quality and other relevant information at each station sampled.

Sampling will be scheduled to occur annually in late summer (potentially in August) consistent with previous sampling in the Peninsula Lakes and will be coordinated with concurrent sampling on Meliadine Lake. The location of benthic invertebrate sampling stations in the Peninsula Lakes will be harmonized with water and sediment quality monitoring in these lakes.

Sampling Methods

Benthic invertebrate samples will be collected within a standardized water depth range and comparable substrate types will be sampled. Samples will be collected using a standard Ekman grab from a boat anchored at each sampling station. One composite sample comprising five individual grabs will be taken at each replicate station within a given study area. Grab samples will be sieved through a 500-µm mesh and material retained in the mesh will be placed into a single pre-labelled container, thus creating a single composite sample consisting of five Ekman grabs for each station. Each composite sample will be preserved in 10% neutral buffered formalin. Discrete grab samples will be collected at one station per lake and processed separately to assess within station variability. Benthic invertebrate samples will be submitted to a qualified taxonomist for processing, enumeration and identification to the lowest taxonomic level. The samples will be processed according to MMER technical guidance provided by EC (2012).

Sediment grab samples will also be collected at each benthic invertebrate sampling station for analysis of sediment chemistry (e.g., metals, nutrients, and carbon content) and particle size distribution as described in Section 5.3. The following supporting data will be collected at each benthic invertebrate sampling station:

- actual station location as UTMs, including UTM zone using NAD 83;
- water depth;
- weather conditions;
- habitat description (e.g., water clarity and colour) and field water quality measurements (e.g., pH, dissolved oxygen, water temperature, conductivity) prior to disturbing the sediments;
- bottom sediment-related information (texture, colour, odour, particle size distribution at lake stations analyzed in the laboratory; visually-assessed substrate composition at stream stations); and
- benthic sample-related information (sampler used, sieve mesh size, sampler fullness, preservative).

7.3.1.3.2 Laboratory

Laboratory methods will follow the methods described for benthic invertebrate monitoring in Meliadine Lake (Section 5.2.3.2).

7.3.1.4 Data Analysis and Interpretation

Benthic invertebrate effect endpoints (i.e., metrics such as invertebrate density, densities of dominant invertebrates, taxonomic richness, evenness, and similarity to reference communities) will be calculated and summarized to provide baseline data for potential comparisons if benthic invertebrate monitoring in the Peninsula Lakes is triggered in the future. The approach will be similar to that described for benthic invertebrate monitoring in Meliadine Lake (Section 5.2.4).

7.3.1.5 Quality Assurance/Quality Control

The QA/QC procedures will be consistent with those described for benthic invertebrate monitoring in Meliadine Lake (Section 5.2.5).

7.3.2 Sediment Quality

7.3.2.1 Objectives

The objective of this component is to assess Project-related effects on sediment quality in the Peninsula Lake receiving environments if a water quality benchmark or trigger (still to be defined) is reached as a result of the Project, or there is the potential for negative changes to aquatic life. If the sediment quality monitoring program in the Peninsula Lakes is triggered, the monitoring program would be designed to verify predictions make in the FEIS and to monitor the effectiveness of mitigation.

A field program will be conducted to collect sediment quality data from the selected Peninsula Lakes before operations, and thus to provide additional baseline data to use in future monitoring programs (if required).

7.3.2.2 Study Design

As with the Meliadine Lake sediment component, the sediment quality program for the Peninsula Lakes has been developed to provide complementary and supporting information to the benthic invertebrate program. Thus, samples will be collected at the same time and from the same locations identified for the benthic invertebrate component (Section 7.3.1).

Annual sampling is proposed for a minimum of two years prior to mine operations to compile a pre-operational dataset. Sampling will be scheduled to occur annually in late summer (potentially August) consistent with other benthic monitoring programs in Nunavut. After two consecutive years of pre-operational sampling, the sediment sampling frequency will be reviewed but it will still be conducted concurrently with the benthic invertebrate study component.

7.3.2.3 Field Methods

Sediment samples for detailed chemical analysis (same as described in Section 5.3.4 and Table 5-3) will be collected with a coring device (e.g., Tech-Ops Corer); supporting environmental variables including station coordinates, water depth, and water column profile measurements (e.g., temperature and DO) will be collected.

From each station, ten cores will be collected for analysis of particle size, total organic carbon, nutrients, and metals (Table 5-3). The upper 5 cm of five of the cores will be extruded and sub-sampled for particle size, while the upper 1 to 2 cm of the remaining five cores will be subsampled for total organic carbon, nutrient, and metals analysis. Each set of five sub-samples will be combined into a single composite representative of the station and placed into containers provided by an accredited analytical laboratory (e.g., ALS Environmental, Maxxam

Analytics). Ice-packs will be added to the coolers to keep the samples as cool as possible during shipping, and samples will be shipped to the analytical laboratory as soon as possible after sample collection and processing.

Field duplicate samples accounting for 10% of all samples collected will be collected at randomly selected stations.

7.3.2.4 Data Analysis and Interpretation

Results will be analyzed to determine if concentrations are above guidelines (if concentrations were not above guidelines during baseline), and if there are differences among lakes. Sediment quality data will be summarized by lake in terms of minimum, median, mean, maximum and standard deviation for each parameter. Individual sample results and summary statistics will be compared to sediment quality benchmarks (Table 5-3). The current set of benchmarks are based on CSQGs, but future benchmarks could also include baseline statistics (e.g., median or 95th percentile) once additional data have been collected.

7.3.2.5 Quality Assurance/Quality Control

Quality assurance/quality control procedures will be consistent with those described for sediment quality monitoring in Meliadine Lake (Section 5.3.5).

7.3.3 Plankton

7.3.3.1 Objectives

The first objective of this component is to evaluate the use of plankton communities as a long-term monitoring tool for the Peninsula Lakes. If plankton is identified as a useful tool, if a water quality benchmark or trigger (still to be defined) is reached as a result of the Project, and if there is the potential for negative changes to aquatic life, a plankton monitoring program could be triggered. The monitoring results would also be used to verify predictions made in the FEIS relating to plankton communities.

7.3.3.2 Study Design and Schedule

Two years of sampling are proposed in three Peninsula Lakes to provide baseline information on natural seasonal patterns and among-year variability in these lakes. Sampling will occur twice during the open-water period (July to September) to capture temporal changes in the plankton community. Plankton samples will be collected at the same time as water quality samples are collected for the water quality component. Depth integrated water samples will also be collected at these locations for analysis of chlorophyll *a* and nutrient concentrations.

Three stations are proposed to be sampled in each of lakes A8, B7, and D7. Sampling stations in the Peninsula Lakes will be harmonized with the core components of the AEMP (Figure 4-2).

Sampling effort will be consistent with other programs as appropriate (e.g., Meadowbank, Snap Lake, NICO, Diavik). The plankton targeted study for the Peninsula Lakes will help to better characterize plankton communities under baseline conditions.

7.3.3.3 Field Methods

Field sampling methods will follow the methods described for Meliadine Lake (Section 7.1.3).

7.3.3.4 Data Analysis/Interpretation

Data will be analyzed using the approach described for Meliadine Lake (Section 7.1.4).

7.3.3.5 Quality Assurance/Quality Control

QA/QC procedures will follow the approach described for Meliadine Lake (Section 7.1.5).

7.3.4 Fish

7.3.4.1 Objectives

The objective of this component is to assess Project-related effects on fish health and fish tissue chemistry in the Peninsula Lake receiving environments if a water quality benchmark or trigger (still to be defined) is reached as a result of the Project. Should fish health or fish tissue chemistry monitoring in the Peninsula Lakes be triggered during operations, then the monitoring program would be designed to verify predictions made in the FEIS relating to fish health and fish tissue chemistry and monitor the effectiveness of any proposed mitigation.

7.3.4.2 Study Design and Schedule

If a water quality trigger is reached, and if warranted, a fish health and fish tissue chemistry monitoring program will be considered. As an example, a site specific small-bodied fish health survey, targeting, for example, Ninespine Stickleback (*Pungitius pungitius*), from representative peninsula lakes may be proposed, dependent on species presence/absence in the peninsula lakes (Agnico Eagle 2014). Fish health and tissue chemistry endpoints will reflect those used in the Meliadine Lake Study (Sections 5.4.3 and 5.5.3), and may be adjusted to address specific water quality concerns.

7.3.4.3 Field Methods

Field methods for fish health and fish tissue chemistry monitoring are outlined in Sections 5.4.3 and 5.5.3 respectively. Briefly, fish will be captured using a variety of gear types, sacrificed and immediately processed to document and collect fish health endpoints detailed in Section 5.4.3.1. Select tissues will be retained for tissue chemistry analysis. Sample sizes and timing will reflect variation in measured endpoints as well as the reproductive cycle of the sentinel species selected.

7.3.4.4 Data Analysis and Interpretation

Interpretation of fish health and tissue chemistry data will consider if changes exceed the range of natural variability relative to selected reference sites. Appropriate statistical analyses will be completed to evaluate potential differences between data sets following appropriate screening of data related to reproductive and trophic status, maturity, and parasite presence/absence (see Sections 5.4.4 and 5.5.4 for further details on the analysis of fish health and tissue chemistry data respectively). Monitored endpoints will be specific and appropriate to the water quality issues of concern.

If a statistically significant difference in one or more fish tissue metal concentrations occurs relative to the normal range, in a direction and magnitude indicative of impairment to fish health, an effect may have occurred, and further investigation may be required.

7.3.4.5 Quality Assurance/Quality Control

QA/QC procedures will be consistent with those described for fish monitoring in Meliadine Lake (Sections 5.5.4 and 5.5.5).

8.0 AQUATIC MONITORING RESPONSE FRAMEWORK

The AEMP Response Framework links monitoring results to management actions, with the purpose of maintaining the assessment endpoints within acceptable ranges. It is a systematic approach for evaluating AEMP results and responding appropriately, such that potential unexpected effects are identified and mitigation is undertaken to reduce or reverse them, thereby preventing the occurrence of a significant adverse effect. This is accomplished by continually evaluating monitoring data and implementing follow-up actions (e.g., confirmation, further study, mitigation) at pre-defined levels of change in measurement endpoints (i.e., Action Levels).

The Response Framework described in this section provides information for adaptive management by the Mine. Adaptive management itself occurs outside of the AEMP and is documented in the Environmental Management and Protection Plan.

The Response Framework was developed with guidance from the *Draft Guidelines for Adaptive Management – a Response Framework for Aquatic Effects Monitoring* (WLWB 2010) and through experience gained with the Meadowbank Gold Mine Management Response Plan (Azimuth 2012a,b). At Meadowbank, the core receiving environment monitoring program (CREMP; analogous to the Meliadine AEMP) is one of many monitoring programs that feed into the overall management response for the Mine. Through this and subsequent iterations of the AEMP design plan document, the Action Levels and management responses will be further developed or amended.

8.1 Terminology

For purposes of this Response Framework, the following terms are used: effect, normal range, benchmark, Action Level, and Significance Threshold.

Effect – An effect is a change that follows an event. It is not inherently positive or negative. For a change to be deemed an effect there must be a link between the measured change and a cause for the change. In the case of this AEMP, there must be a link between mining activities at the proposed mine site and a change in the measurement endpoints defined in this document.

Normal Range – The normal range is used to represent the range of natural variability in a sampling area or waterbody. For a water quality parameter, it may be defined as a 95% prediction interval of the whole-lake mean concentration, calculated based on available baseline data. Each AEMP component may estimate the normal range differently. The fish component may use regional baseline data to calculate the normal range, while the water quality and benthic invertebrate components may use baseline data from a specific lake or lake basin to calculate the normal range.

Benchmark – This is a generic term to refer to a standard that is used for screening of monitoring results. Benchmarks may be generic aquatic life guidelines (e.g., CCME guidelines), generic drinking water guidelines, or site-specific water quality guidelines. Benchmarks are set at a level to be protective of aquatic life or drinking water, and are below the Significance Threshold. For the Meadowbank CREMP (Azimuth 2012b), the term *Threshold* is used to define license limits, regulatory guidelines, or other benchmarks, and is analogous to the term *Benchmark* used in this document.

Action Level – Action Levels (Low, Moderate, and High) are pre-defined levels of environmental change that trigger follow-up actions referred to as management responses (Table 8-1). Action Levels may be linked to exceedances of normal ranges or benchmarks, or to results of statistical tests, or a combination of these. For example exceedance of the normal range and approaching a benchmark by a water quality parameter in the near-field exposure area may be defined as the Low Action Level. A change that falls within the normal range of variability for the study area would not trigger an Action Level. For the Meadowbank CREMP (Azimuth 2012b), the term *Trigger Level* is analogous to *Action Level*.

The AEMP response planning guidance document (WLWB 2010) recommends setting Moderate and High Action Levels as part of the response planning once a Low Action Level is exceeded. Following the guidance document, Low Action Levels will be proposed for the Project once sufficient data are available to characterize the normal range; Moderate and High Action Levels will not be initially proposed.

Action Levels are developed through analysis of baseline data to estimate normal ranges, or by selecting applicable benchmarks and statistical tests. For the Meliadine Lake study, Low Action Levels will be developed for each monitoring component and each impact hypothesis (i.e., toxicological impairment and nutrient enrichment; Section 3.4). For the Peninsula Lakes study, Low Action Levels will be developed for water quality only. For both Meliadine Lake and the Peninsula Lakes, Low Action Levels will be developed following the collection of additional baseline data, which are required to estimate normal ranges.

For the Meadowbank Response Framework in the CREMP, there is one Trigger Level and one Threshold. Results are evaluated as below the Trigger Level, above the Trigger Level, or above the Threshold. Similar to the way Action Levels are used in this AEMP, results for each endpoint (e.g., concentration of an individual nutrient or metal constituent in the water) feed into the management response. Under both approaches, responses may consist of no action, continue monitoring for a trend, or active follow-up with detailed quantitative assessment. Results from the Meadowbank CREMP feed into the larger Management Response Plan for the Mine (Azimuth 2012a). The Mine Management Actions can include characterization of the magnitude of the detected change, assessment of risks, identification of cause, or mitigation to reduce the magnitude of effect.

Additional information on Action Levels is provided in Section 8.4.

Significance Threshold – The Significance Threshold, for the purposes of an AEMP Response Framework, is a magnitude of change that would result in significant adverse effects. It is a clear statement of environmental change that must never be reached. The AEMP Response Framework is designed to prevent reaching the significance threshold for all assessment endpoints.

In the FEIS, the effect of the Project on water quality and fish were evaluated for significance. It was determined that the Project will not have a significant adverse effect on the continued opportunity for traditional and non-traditional use of fish, on health of aquatic life, or on human health.

Additional information on Significance Thresholds is provided in Section 8.3.

8.2 Approach

The Response Framework for the Meliadine AEMP will have three Action Levels consistent with regulatory guidance (WLWB 2010): Low, Moderate and High. Initially, the Low Action Level will be developed for each monitoring component. Action Levels will be developed through the use of baseline data, regulatory guidelines, and monitoring data.

Levels of change that fall within the normal range of variability for a sampling area or lake (typically referred to as a negligible effect) would not trigger the Low Action Level (Figure 8-1). There is increasing level of concern, and need for response, as the Low, Moderate and High Action Levels are exceeded. After an Action Level has been reached (for one or multiple AEMP components), a response action or management response will be initiated. The purpose of the response will be to reverse the effect, decrease its magnitude, or prevent a further increase in its magnitude. The type of management response taken after reaching an Action Level will depend on the type and magnitude of effect observed, and cannot be defined a priori. Examples of management responses are provided in Table 8-1. These examples are similar to the management response actions developed for the Meadowbank Mine (Azimuth 2012a).

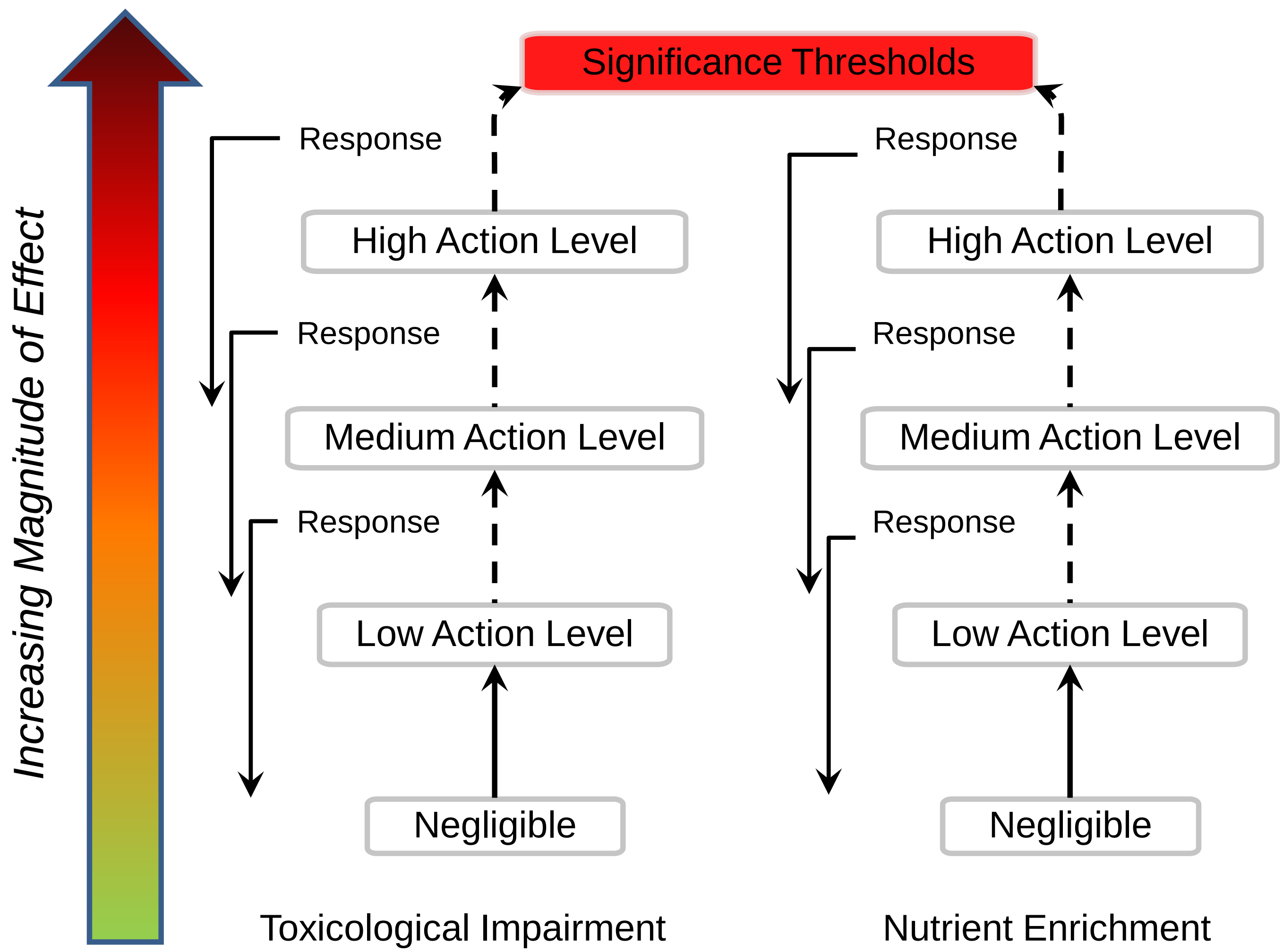

Figure 8-1: Overview of the Aquatic Effects Monitoring Program Response Framework

Table 8-1: Examples of Action Levels and Responses

Action Level	Example of Action Level to Support Impact Hypothesis "Toxicological Impairment"	Example of Action Level Response[f]
Negligible[a,b]	• e.g., no difference between reference and exposure areas or from baseline conditions; values of measurements endpoints within normal ranges	• (none required)
Low[c]	• e.g., difference between reference and exposure areas, or from baseline conditions, but below an applicable benchmark • e.g., increasing trend toward conditions outside of baseline or normal range, or toward a benchmark	• AEMP best practices • Confirm Low Action Level trigger • Compare to FEIS predictions • Prepare a response plan • Investigate further to identify contributing factors from the Mine • Examine ecological relevance • Identify potential mitigation options • Increase monitoring • Re-evaluate benchmark and revise if necessary • Set Moderate and High Action Levels
Moderate[d]	• e.g., significant difference between reference and exposure areas, or from baseline conditions, and benchmark exceeded • e.g., consistently increasing trend approaching benchmark exceedance	• AEMP best practices • Notify Board • Confirm Moderate Action Level trigger • Compare to FEIS predictions • Prepare a response plan • Investigate further to identify contributing factors from the Mine • Examine ecological relevance and implications • Implement mitigation and examine effectiveness of mitigation • Update monitoring design
High	• e.g., benchmarks consistently exceeded, or effect is above predictions but below the Significance Threshold[e]	• AEMP best practices • Notify Board • Confirm High Action Level trigger • Compare to FEIS predictions • Prepare a response plan • Identify and implement improved mitigation to reverse trend • Remediate

Note: AEMP Best Practices: evaluate causation/linkage to the proposed Mine, examine trends, predict trends where appropriate, examine linkage between exposure, toxicity, and field biological responses, examine ecological significance, confirm that benchmarks are appropriate and revise if warranted.

[a] Not an Action Level, but is listed to provide an indication of the estimated magnitude of background variation..

[b] Analogous to a magnitude rating of "0" (no exceedances of triggers or thresholds, or no apparent changes from baseline) in the Meadowbank CREMP (Azimuth 2012b).

[c] Analogous to a magnitude rating of "1" (early warning triggers exceeded, or change from baseline warranting concern) in the Meadowbank CREMP (Azimuth 2012b).

[d] Analogous to a magnitude rating of "2" (threshold exceeded, or change from baseline exceeding magnitude of concern) in the Meadowbank CREMP (Azimuth 2012b).

[e] Significance Threshold is defined as the point at which an environmental change would be considered significantly adverse. The adaptive management actions are used to prevent a Significance Threshold from being reached.

[f] Action level responses are aligned with options developed for the Meadowbank Mine (Azimuth 2012a).

For the Project, Action Levels will be developed for each monitoring component and each impact hypothesis (i.e., toxicological impairment and nutrient enrichment) following the collection of additional baseline data.

8.3 Significance Thresholds

Significance Thresholds are centred on key values to protect, rather than the numeric values set as Action Levels. The Significance Thresholds span all monitoring components and both impact hypotheses, and are considered the "no-go" condition for the Mine. The proposed Significance Thresholds are focused on key "values" that are to be protected, which include the following:

- water is safe to drink – water is safe for human and wildlife consumption;
- fish are safe to eat – fish are safe for human and wildlife consumption; and
- the ecological function is maintained – there is adequate food for fish, and fish are able to survive, grow, and reproduce.

Based on these values, Significance Thresholds proposed for the AEMP are as follows:

- Water is not drinkable (human health and/or wildlife risk):
  - Safety of water for consumption will be considered through a human health and/or wildlife risk assessment for drinking water; it is expected a formal human health and/or ecological risk assessments would be initiated if a Moderate or High Action Level was exceeded.
- Fish are not safe for consumption (human health and/or wildlife risk):
  - Safety of fish for consumption will be considered through the use of risk assessment tools with consideration of measured fish tissue parameters. The significance threshold is not considered exceeded if one fish sample is above Canadian Food Inspection Agency guidelines, which exist for only three metals: mercury, lead, and arsenic (CFIA 2009). This is because the potential for toxicity is based on a sufficient dose (i.e., consumption of more than one fish). Further, concentrations of mercury in the region are already above the commercial food inspection guidelines in some large piscivorous fish; this is largely due to local geology and/or atmospheric deposition and is unrelated to the operation of the Mine.
- Ecological Function is not maintained:
  - Inadequate food for fish, or
  - Fish are unable to survive, grow, or reproduce, or
  - Sustained absence of a fish species.
  - Significance thresholds are not defined for water quality, sediment quality, and fish tissue chemistry as they relate to ecological function. Action levels are defined for these components in Section 8.4. These endpoints provide early warning indication of potential adverse effects to plankton and benthos (which are food for fish), to fish health, and to the maintenance of ecological function.

8.4 Action Levels

8.4.1 Toxicological Impairment Hypothesis

The Mine has the potential to result in toxicological impairment and thus the proposed Low Action Levels (Table 8-2) are designed to provide time to respond before significant adverse effects occur. The Action Levels for each component to address the toxicological impairment hypothesis will be selected on the basis of the following:

- Benchmarks
  - Water quality benchmarks (still to be confirmed) for evaluation of aquatic effects will be based on a combination of CCME aquatic life guidelines for water quality parameters selected as measurement endpoints for the AEMP (Table 3-1) and baseline data (if guidelines are not available). If necessary, guidelines from other jurisdictions (e.g., United States Environmental Protection Agency) may be considered when selecting benchmarks.
  - It is necessary to have a good understanding of the natural variability of baseline conditions, such that an appropriate benchmark can be selected, and an appropriate percentile of a benchmark can be selected as a Low Action Level. For parameters with CCME aquatic life guidelines, benchmarks will likely be set at the guidelines. For parameters without guidelines, the normal range will likely be used to set the Low Action Level. Benchmarks will be selected once additional baseline data are collected (scheduled for 2015).
  - Drinking water quality guidelines will also be used to evaluate water quality results. The benchmarks for evaluating drinking water quality will be based on the Health Canada guidelines.
- Normal range
  - The normal range will be used for many measurement endpoints and will be based on baseline data collected using the AEMP study design. The normal range may be calculated differently by component or parameter, but is anticipated to be defined as the 95% prediction interval of the whole-lake mean based on pre-operations data, reference area data, or both, for concentrations of water and sediment quality parameters and biological variables (e.g., benthic invertebrate density and taxonomic richness).

Table 8-2: Proposed Action Levels for Toxicological Impairment

Action Level[a]	Water Quality			Benthic Community	Fish Health	
	End of Pipe	Aquatic Life	Human Consumption		Aquatic Life	Human Consumption
Low	Persistent sublethal toxic effects on test organisms other than fish in end-of-pipe samples **AND** No sublethal toxic effects on fish in end-of-pipe samples	Concentration in near-field area greater than normal range, supported by temporal trend **AND** Concentration exceeds a defined percentage of AEMP benchmark[b,c] **AND** Divergence of trends in concentrations compared to reference areas	Drinking water parameters in near-field area above a defined percentage of a benchmark[b] (Health Canada human health or aesthetic drinking water quality guideline)	Decline in near-field area below the normal range in total density, richness, or densities of dominant taxa **AND** Divergence of trends in total density, richness, or densities of dominant taxa compared to reference areas	Statistically significant differences in fish health endpoints[d] or fish tissue chemistry that are beyond the normal range **AND** Changes is in direction and magnitude that are indicative of impairment of fish health	Metals in edible fish tissue above normal range
Moderate	TBD[e]	TBD[e]	TBD[e]	TBD[e]	TBD[e]	TBD[e]
High	TBD[e]	TBD[e]	TBD[e]	TBD[e]	TBD[e]	TBD[e]

Note: Normal range is to be developed for key variables assessed by each monitoring component.

(a) Only Low Action Levels are developed initially; Moderate and High Action Levels will be developed if the Low Action Level is reached, consistent with regulatory guidance (WLWB 2010).

(b) Benchmark and percentage of benchmark used in the AEMP to be set once supplemental baseline data are collected.

(c) For Meadowbank (Azimuth 2012b, 2014), Triggers analogous to the Low Action Level are the maximum of the value halfway between the median baseline value and the guideline (Threshold), or the 95th percentile of the baseline.

(d) Key fish health endpoints are condition, relative gonad size, and relative liver size.

(e) TBD – to be determined if a Low Action Level is reached.

8.4.2 Nutrient Enrichment Hypothesis

The proposed mine will have the potential to result in nutrient enrichment through the treated effluent discharge to Meliadine Lake. The proposed Low Action Levels (Table 8-3) are designed to provide time to respond before significant adverse changes occur. The Action Levels to address the nutrient enrichment hypothesis will be selected on the basis of benchmarks, normal ranges and statistically significant differences.

Table 8-3: Proposed Action Levels for Nutrient Enrichment

Action Level[a]	Water Quality	Benthic Community	Fish Health
Low	Concentrations of nutrients in the near-field area above the normal range, supported by temporal trends **AND** Concentration exceeds a defined percentage of AEMP benchmark[b,c] **AND** Divergence of trends in comparison to reference areas	Increases above normal range in total density, richness, or densities of dominant taxa **AND** Divergence of trends in total density, richness, or densities of dominant taxa compared to reference areas	Statistically significant differences in fish health endpoints[d] or fish tissue chemistry that are beyond normal range **AND** Change is in direction, and of magnitude, that is indicative of an impairment to fish health
Moderate	TBD[e]	TBD[e]	TBD[e]
High	TBD[e]	TBD[e]	TBD[e]

Note: Normal range is to be developed for key variables assessed by each monitoring component.

[a] Only Low Action Levels are developed initially; Moderate and High Action Levels will be developed if the Low Action Level is reached, consistent with regulatory guidance (WLWB 2010).

[b] Benchmark and percentage of benchmark used in the AEMP to be set once supplemental baseline data are collected.

[c] For Meadowbank (Azimuth 2012b, 2014), Triggers analogous to the Low Action Levels are the maximum of the value halfway between the median baseline value and the guideline (Threshold), or the 95th percentile of the baseline.

[d] Key fish health endpoints are: condition, relative gonad size, and relative liver size.

[e] TBD – to be determined if a Low Action Level is reached.

9.0 REPORTING

The reporting requirements for the AEMP and the EEM components of the MMER will be harmonized where possible. It is anticipated that having one report that meets the needs of both agencies will be the most efficient and technically useful. By harmonizing the schedules for the AEMP and EEM components, numerous efficiencies will be created during field programs, and data analysis and interpretation. Harmonization of monitoring components enables the most effective integration of all available data for interpretation.

The reporting approach, including the reporting schedule for AEMP annual reports and anticipated report organization, will be described in later versions of the AEMP design plan.

As part of the annual report, results for each component will be synthesized in an integrated manner to evaluate the overall direction of change to the aquatic ecosystem. A qualitative rating system, similar to the one used for Meadowbank (Azimuth 2014) will be applied to rank the results of each component. The objective of the synthesis will be to:

- integrate AEMP findings from all components;
- determine the strength of support for each impact hypothesis and effects at the ecosystem; and
- support decision making for management responses.

A comprehensive report will be provided to the Nunavut Water Board (NWB; as per anticipated Type-A Water Licence requirements for the Project) on an annual basis and to Environment Canada (as per the MMER requirements) on the EEM reporting schedule. These reports will be available on the public registry for regulator and stakeholder review and input. Reports filed with EC will be reviewed by a Technical Advisory Panel to satisfy the biological components of the MMER EEM program. Data on fish and lower trophic level monitoring will be entered to a federal government website for integration into a national dataset on biological monitoring at metal mines (EC 2012).

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Report Signature Page

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APPENDIX A

Meliadine AEMP Workshop Meeting Minutes

MELIADINE GOLD PROJECT
AEMP WORKSHOP MEETING MINUTES

ISSUE DATE:	January 16, 2015	**REFERENCE No.**	Doc 480-1405283 Ver. B
LOCATION AND TIME:	Golder Associates, 16820 - 107 Ave, Edmonton	Meeting Date:	November 6, 2014
DISTRIBUTION:	Attendees and File		
PREPARED BY:	Rainie Sharpe/Colleen Prather	**REVIEWED BY:**	Lasha Young

ATTENDEES:
AEM: Ryan Vanengen
AANDC: Ian Parsons, Amjad Tariq
EC: Anne Wilson, Lindsey Wilson, Paula Siwik
Rankin HTO: Wesley
Golder: Rainie Sharpe, Colleen Prather

REGRETS:
AEM: Stephane Robert
AANDC: Murray Ball, James Neary
HESL: Neil Hutchinson
KIA: Luis Manzo

AEM (Agnico Eagle Mines Ltd.), Golder (Golder Associates Ltd.), EC (Environment Canada), AANDC (Aboriginal Affairs and Northern Development Canada), KIA (Kivalliq Inuit Association), Rankin HTO (Rankin Hunters and Trappers Organization)

EMAIL: Colleen_Prather@golder.com

MELIADINE GOLD PROJECT – AEMP WORKSHOP MEETING MINUTES

Topic	Action
1. Introductions • Round table introductions • Anticipating approval will come in December for feasibility of the Project • AEM hopes to submit Type A Water Licence immediately following Board approval, which would result in a submission target of 2015 Quarter 1 • Intention of this meeting is to get the feedback on the Aquatic Effects Monitoring Plan (AEMP) design concepts	
2. Meeting Objectives and Meeting Format • Reviewed agenda and approach to meeting – all in favour of meeting objectives and format	
3. Introduction to the Meliadine AEMP • Reviewed map of the Project and discussed the details regarding the discharge location • Discussed terminology associated with the Meliadine AEMP versus others in Nunavut	

Topic	Action

• Question asked of 'what is the benchmark relative to' in regards to the terms Action Level and Significance Threshold?
    ▪ Any Canadian Council of Ministers of the Environment (CCME) or Site-specific Water Quality Objectves (SSWQO) would be considered a benchmark for water quality (WQ) for example, and these benchmarks will be considered as part of the action level triggers
• Reviewed lessons learned from the Meadowbank project
    ▪ AEM is currently operating at Meadowbank located 70 km north of Baker Lake (Meliadine 30 km north of Rankin Inlet)
    ▪ 60km NW of Meadowbank is "armaruq" (sounds like armouruk – means wolf) – preliminary exploration site, starting to develop plans for permitting here
    ▪ Meadowbank largely surrounded by large lakes, they have dyked open pits that were previously lake bed
    ▪ What hasn't worked at Meadowbank?
        o Had intended in harmonizing AEMP and EEM but the reporting is still pretty independent. Some of this is logistical in that the consultant does the AEMP, but not EEM sampling
    ▪ What are the challenges at Meadowbank?
        o The mechanism for EEM reporting means the timing for AEMP reporting and EEM doesn't work together. MMER 10 year review right now, so the mechanism for change to make it harmonize better is now
        o Annual effluent water quality is due end of March, annual EEM reporting is July 1 (on a 3 year cycle), and the Water Licence is due March 31 (annually)
        o EC – if went out in first year of 3 year cycle, instead of second year of the cycle, then you could report at any point in that cycle and things could line-up better. Most mines go out in the second year.
    ▪ What's worked or not worked relating to redundancy on the ground?
        o Health and Safety at Meadowbank with regard to getting to 16 km distance Reference Lakes. There is a desire to design something more accessible.
        o MAC has put internal reference lakes on the table
    ▪ EKATI design started with BACI and moved to a regression approach, which at that time reduced some of their sample collection (maybe likely before that) but haven't followed if getting the same information now. They have 15 years of operational data (Rescan is the consultant for EKATI)	

4. Meliadine AEMP Preliminary Design
• Reviewed flow chart in Type A Water Licence
    ▪ Comment made from AANDC regarding Nipisar Lake. Rankin Inlet is going through an amendment process for the drinking water source, to have a secondary source as Char River or Lower Landing Lake (First Landing Lake)
    ▪ Question on where does the MMER compliance monitoring live?
        o AEM sees MMER compliance monitoring falling under the "effluent quantity and quality" but will also fall under the "regulated monitoring" under the Water Management Plan
• Reviewed Objectives for Preliminary Design
    ▪ AEM should consider leaving a window open that links AEMP and EEM before officially triggered into the MMER. It might be too late for harmonizing well if EEM isn't considered until after AEMP is designed	

Topic	Action
▪ Context of pulling out the AEMP stations from the Water Licence so they don't need ministerial approval to adjust; not implying that we're going to separate them, but on the ground one sample is collected and taken to use for both ▪ Question was posed if AEM was anticipating to redo models in mine operations to be sure to keep on track (re: confirming or evaluating predictions made in the FEIS)? o It is the expectation that yes; AEM will be tracking during operations, as it is in the mines best interest. ▪ For incorporation of TK/IQ – Rankin HTO noted that there have been areas that people are using but no one area in particular as the whole lake is valued ▪ Plankton is included under "Target Studies". A clarification was made that plankton also includes zooplankton and phytoplankton • Conceptual Site Model ▪ Aquatic ecosystem is in the current state due to natural features and natural inputs of total suspended solids, nutrients, and metals. With the addition of loadings from the mine, the aquatic ecosystem could shift slightly ▪ The purpose of the AEMP will be to monitor these linkages and attempt to identify early if negative or potentially adverse changes are occurring or have the potential to occur ▪ The single arrow for the Point Source input represents the single effluent discharge point. It will be constant in location and constant in loading (within engineered design limits) ▪ The multiple arrows for the Non-Point Source Input are meant to imply varied potential sources and inconsistent in location and loading • Stressors and Impact Hypotheses ▪ Chemical and physical stressors can change the aquatic ecosystem interactions ▪ To examine the effect of stressors on the aquatic environment, hypotheses, assessment endpoints, measurement endpoints, and key questions are proposed and will be reviewed. ▪ Physical stressors have been removed for now since we don't have a physical stressor related hypothesis ▪ Discussion of both Assessment and Measurement Endpoints ▪ Question asked if there is ever a cross-over with fish tissue for the health of fish not just the consumption risk? o Yes there is, fish health survey considers fish tissue chemistry as supporting information • Reviewed map of Meliadine Lake for the AEMP Preliminary Design ▪ The edge of the mixing zone is 100 m out from the diffuser ▪ Comment made that the southwest reference area could potentially be a far field area and not a reference area, because of the air shed impacts o Other mines are demonstrating that dustfall will not be an issue that far out • Meliadine Lake Reference Areas ▪ Threespine Stickleback is a target for small-bodied fish. A suggestion was made to send a Threespine Stickleback specimen to the University for confirmation that they are not Fivespine that have lost their spines ▪ Comment made that Diavik is seeing elevated TDS levels in their midfield areas, which seems like a long way	

Topic	Action
▪ To note, AEM only discharging during open water season; MMER still requires up to 4 times a year not and not less than 1 month apart. This MMER requirement is not adjustable. However if you're only discharging for 3 months, then 3 sampling events, 60 days, 2 sampling events. Sampling only required during discharge period. ▪ Question asked on what period will AEM be discharging? o Expected mid-July to mid-October • Discussion on Components and Target Studies table ▪ Additional clarity was required on the table (slide 28 and 29) o Question asked if the sampling frequency was the same in the Peninsula Lakes and in Meliadine Lake? Discussion in response about not necessarily requiring the same effort in the Peninsula Lakes given there is not a direct source discharge in the Peninsula Lakes and thus not subject to MMER. o Discussion about fish species and timing of collections – spring spawning species can't be collected prespawn in the north because of late ice-off and safety issues, so tend to sample in the fall for spring spawners to get the fish in early gonadal development (which will continue under ice over the winter) • Meliadine Lake ▪ Is chlorophyll *a* being examined o Yes it is ▪ The water intake structure is located in the middle between the exposure area and the mid-field area ▪ Is AEM proposing receiving water quality objectives as part of the water licence? o Additional question of when will AEM have effluent plume monitoring available. AEM has to think about loadings and monitoring in the discharge area, tend to have monitoring in the area of the diffuser. Sediment and water quality in the area of the diffuser – we're thinking about five stations in the area of the diffuser for water and sediment quality ▪ Question asked if the baseline data straddles 5 to 10m depth for benthic invertebrate community (BIC)? o Discussion around the fact that BIC tends to change within that depth range, community changes at 5 to 10 m, somewhere in that range it shifts • Meliadine Lake – Water Quality ▪ Does AEM have a sense about lake stratification, that would determine water sampling depths and seasonal? o Typically see weakly stratified, variable between years. If stratified would sample from top and bottom, but if it's mixed would take one sample ▪ To align with the water quality program, effluent will be collected on the same schedule for the same parameters ▪ The schedule for effluent is broken down more to align with MMER requirements ▪ AEM is also proposing to do under ice sampling in the exposure area. Targeting April as a sampling period ▪ It was noted that Ekati did exactly what was noted in last bullet in slide 35 "Once sufficient temporal data, investigate trends over time and compare trends between areas (i.e., slope)"	**Paula** going to look into ability to pick-up AEMP design document and submit as EEM design

Topic	Action
• Meliadine Lake – Benthic Invertebrates ▪ Discussion took place regarding analytical methods for particle size and the amount of sediment needed (0 to 1.5 kg?) ▪ It was confirmed there is an openness to using cores for metal analysis ▪ Two years of pre-operational data, would it make sense to do annual during construction and pre-operation to avoid the gap? ▪ There will always be the requirement to submit the first study design to EC within 12 months* of triggering into the MMER, o **or 24 months, if biological monitoring studies that determine if effluent was causing an effect were completed before the mine becomes subject to the MMER regulations and these results are submitted to the authorization office, along with a report, not later than 12 months after the day on which the mine becomes subject to the MMER* ▪ Question asked if reference lakes and pooling for analysis or not? o Tend to test for statistical differences – if none, you can pool, if not, pairwise comparison of individual lakes • Meliadine Lake – Sediment Quality ▪ Question was asked if power analysis going into things is being considered? o It will be considered; however can't yet be done • Meliadine Lake – Fish ▪ Very much like the intention of lethal and a non-lethal program for small bodied fish to get lots of data to accurately ID age groups; still requires 2nd lethal monitoring species though, could be a non-lethal Lake Trout (large bodied) program, as this would then only miss the liver endpoints o Could use incidental Lake Trout mortalities for liver endpoint? 100-400 target sample size for he non-lethal survey ▪ Comment made that typically viscera chemistry for analysis would be supported ▪ Question asked if AEM has enough data for power analysis at this point in time? o Studies will take place in 2015 to collect data to support the AEMP design, the scope of which is not certain yet • Peninsula Lakes – Water Quality ▪ What species of fish are here? There are a variety of species among the Peninsula Lakes, some have Threespine Stickleback, some do not. Summary table is available in the FEIS. ▪ Question asked of how connected are all these lakes? o They are very ephemerally (i.e., seasonally, typically in the spring) connected ▪ Will there be dustfall monitoring in the areas of the Peninsula Lakes that are to be monitored? What will AEM do with this data? o These results will be reported within the respective management plan ▪ How is this data going to inform adaptive management on the ground? o Information sharing pathways will be in place between relevant management and monitoring plans to enable adapative management and sharing of information during annual reporting efforts ▪ Comment was made that Regulators haven't seen this type of monitoring of water quality at other mines, in the Peninsula Lakes	**Paula** to respect the TAP process, so will communicate with them about the peninsula lakes studies

Topic	Action
o Sometimes you see changes in the fauna due to micronutrient changes, the fauna respond to something that was previously limiting o Might want to have two different kinds of lakes, so rather than compare them, but have a shallow or a deep lake • Target Studies ▪ Question asked if it is possible that effluent would be less than 1% at 250 m, if so, don't require fish. If this is the case, can move fish to every five years for fish populations and traditional endpoints ▪ Question asked what is AEM going to use a tracer? o Typically, conductivity is a good tracer. Believe that Diavik uses barium as a tracer, so will look if there is something particularly unique in their effluent quality • Target Studies – Peninsula Lake Biota ▪ Discussion ensued around the real need for the Peninsula Lakes program o All agree on collecting pre-operations data, but could potentially switch away from the annual snapshot and do an "as needed" approach (e.g., shoreline grab sample) o Consensus that the Peninsula Lakes AEMP does exist, with water quality and targeted studies for biota. Study lakes will be proposed in water licence application, and then iterative process to make sure the right ones have been identified ▪ Lake D7 and A8 are both traditionally used to collect small little Lake Trout and Lake Whitefish; control lake not traditionally used (comment made by Wesley during the meeting) ▪ An overlay would be very useful re. where the infrastructure is relative to the peninsula o Time was spent looking at maps and FEIS predictions for various peninsula lakes ▪ Those lakes that will be present at the end of the mine, perhaps they are worth looking at more closely… but the formal AEMP likely more a targeted study ▪ Good idea to pull it all together for the peninsula lakes not in the AEMP report, but in the management annual report	
5. AEMP Response Framework • Discussion about when to define low action levels, when will there be sufficient amount of data to understand variability • Action Levels ▪ Meadowbank example for water quality action level ▪ Or develop benchmarks for each parameter (for some this is pre-operations statistic, for others this might be aquatic life guideline) ▪ Discussion regarding harmonization of EEM "effect" = a low action level trigger… risk of triggering all the time for stat differences that aren't biologically meaningful o Suggest at minimum an additional "and" statement for normal range to be included, and a comparison to critical effect sizes as per MMER EEM guidance (e.g., 10% for condition, 25% for other fish health endpoints, plus or minus 2 standard deviations for benthic invertebrates) ▪ EC's (Anne) expectation for programs to run annually until things stabilized during operations, and annual programs for construction and early operations. This applies to water, sediment, BIC, but not fish – then move to tri-annual as of trigger into MMER	

Topic	Action
o Point being need to fully characterize the variability – AEM is committing to pre-operational collections, but we're submitting a plan that currently doesn't have a lot of the data to understand variability at this time ▪ Discussion of required data to be at least two years of baseline (predisturbance), then also collect data during construction. Any disturbance could affect water quality. Once past construction, there will be a gap. Experience has been the stakeholders want to see real data. o AEM open to water quality and BIC perhaps plankton, but reluctance to commit to BIC every year. Every other mine is doing that, but is it useful? ▪ What was it that triggered Meadowbank? o Because of water and TSS (even though it was below the limits). Mines have been triggered in this way during construction, but this one was a surprise. i) have to meet definition of mine and mine underdevelopment (shifts during construction); ii) >50m^3 discharge per day, and iii) have deleterious substances – having these at detectable levels, not even at limits (schedule 4) ▪ Question asked if water boards would be able to assign dates for reporting up until point of discharge, then shuffle with the hard lined MMER schedule? o Unsure	
6. Review of NIRB final hearing report and key items from the EIS stage (i.e., commitments) • Discussion on Little Meliadine Lake • Chemical loading in the snow pack • Note two sections in the NIRB decision document related to AEMP – both hydrology and freshwater aquatic environment	
7. Recap of Meeting • High level general agreement on AEMP Design within Meliadine Lake, approach being similar as Meadowbank but will be driven by data collected • Consensus on the approach for Peninsula Lakes • Lakes D7 and A8 need monitoring because they were traditionally used • Possibility on the table that the reference location near the farthest outlet may become a far field station	**Golder** to provide high level meeting minutes

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