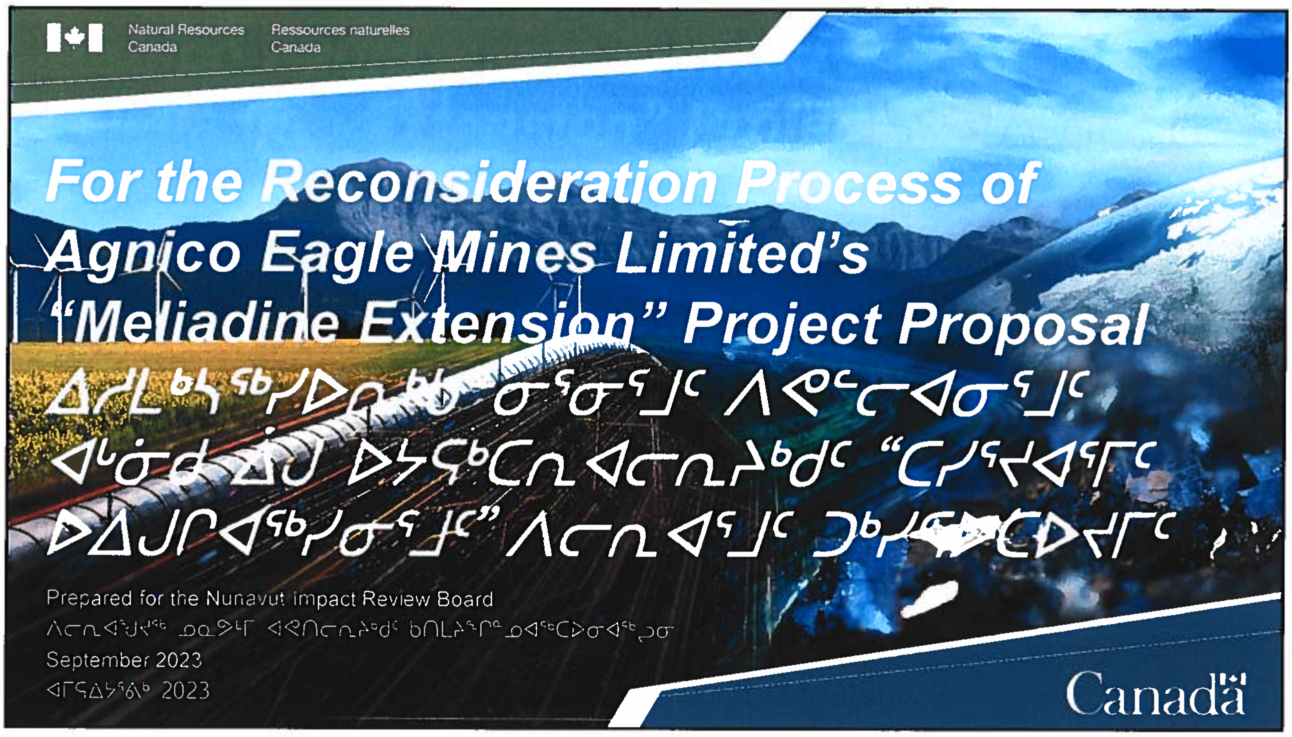
NUNAVUT IMPACT REVIEW BOARD
Date: September 15, 2023
Exhibit No.: 28



Natural Resources Canada / Ressources naturelles Canada

# For the Reconsideration Process of Agnico Eagle Mines Limited's "Meliadine Extension" Project Proposal

# ᐃᓱᒪᒃᓴᖅᓯᐅᕆᓂᒃᑯ ᓂᕐᓂᕐᒧᑦ ᐱᕙᓪᓕᐊᓂᕐᒧᑦ ᐊᒃᓃᖁ ᐄᒍ ᐅᔭᕋᒃᑕᕆ ᐊᓕᓇᐳᒃᑯᑦ "ᑕᓯᕐᔪᐊᕐᒥᑦ ᐅᐃᒍᕆᐊᖅᓯᓂᕐᒧᑦ" ᐱᓕᕆᐊᕐᒧᑦ ᑐᒃᓯᕋᐅᑕᐅᔪᒥᑦ

Prepared for the Nunavut impact Review Board
ᐱᓕᕆᐊᕐᔪᐊᖅ ᓄᓇᕗᒻᒥ ᐊᕙᑎᓕᕆᔨᒃᑯᑦ ᑲᑎᒪᔨᖏᓐᓄ ᓄᐊᑦᑕᐅᓂᐊᖅᑐᓂ
September 2023
ᐊᒥᕋᐃᔭᕐᕕᒃ 2023

Canada

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# Outline

- Mandate
- Relevant Acts and Scope of Review
- Technical Review and Recommendations
  - Groundwater Quantity
  - Permafrost
  - Mine Waste Management

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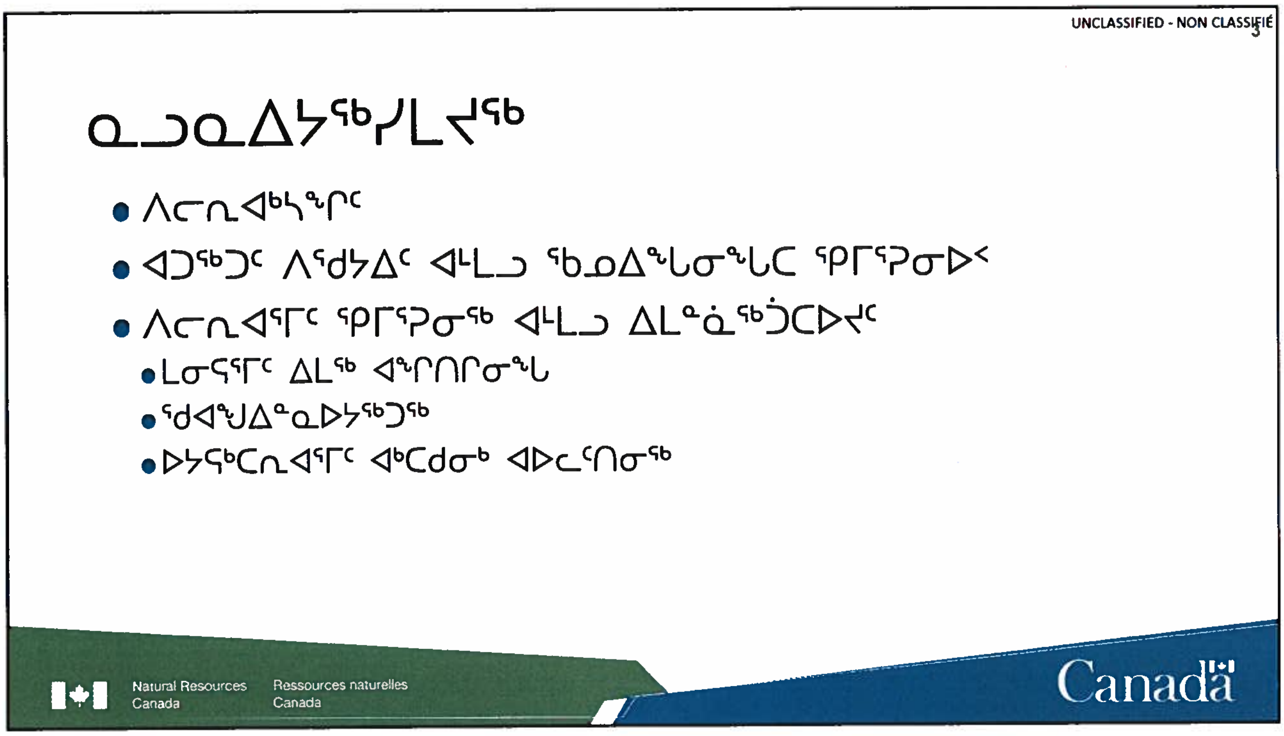

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## ᓄᓗᓇᐃᔭᖅᓯᒪᔪᖅ

- ᐱᓕᕆᐊᒃᓴᖏᑦ
- ᐊᑐᖅᑐᑦ ᐱᕐᑯᔭᐃᑦ ᐊᒻᒪᓗ ᖃᓄᐃᖕᒐᓂᖕᒐᑕ ᕿᒥᕐᕈᓂᐅᑉ
- ᐱᓕᕆᐊᕐᒥᑦ ᕿᒥᕐᕈᓂᖅ ᐊᒻᒪᓗ ᐃᒪᓐᓈᖅᑑᑕᐅᔪᑦ
  - ᒪᓂᕋᕐᒥᑦ ᐃᒪᖅ ᐊᖏᑎᒋᓂᖓ
  - ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᖅ
  - ᐅᔭᕋᒃᑕᓇᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᕐᑎᓂᖅ

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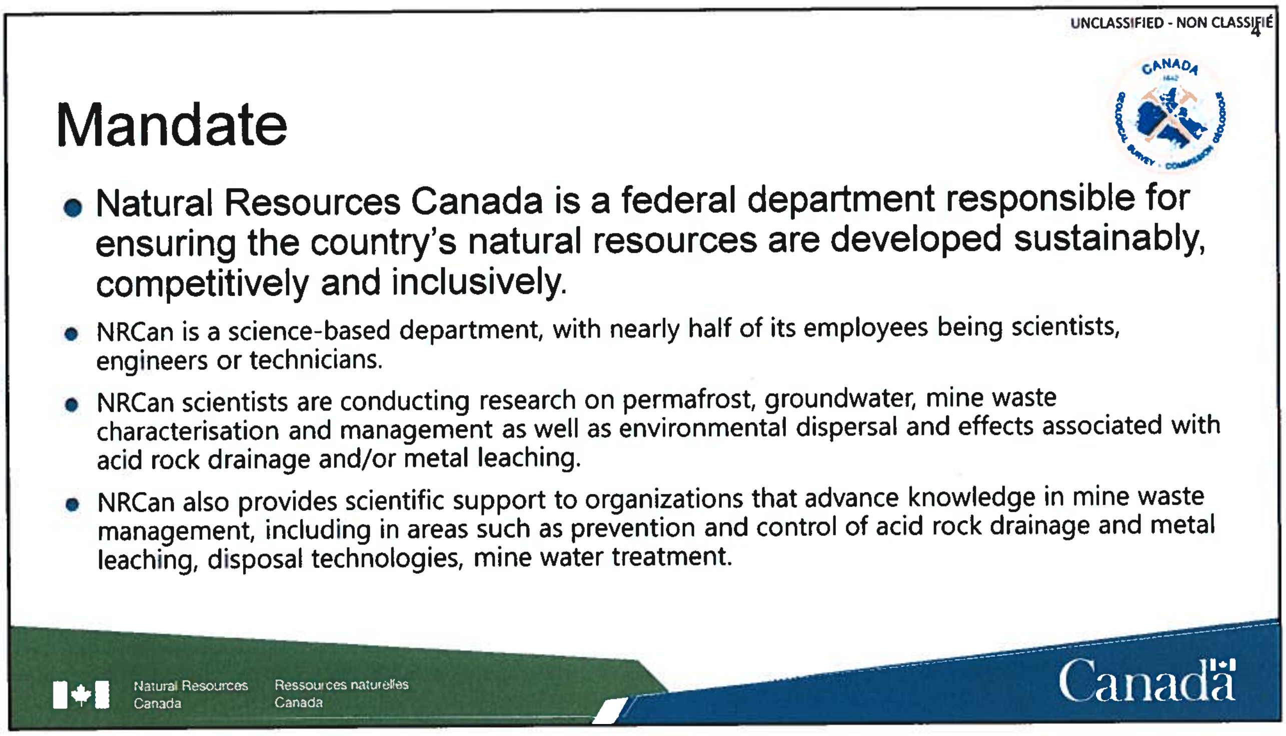

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## Mandate

- Natural Resources Canada is a federal department responsible for ensuring the country's natural resources are developed sustainably, competitively and inclusively.
- NRCan is a science-based department, with nearly half of its employees being scientists, engineers or technicians.
- NRCan scientists are conducting research on permafrost, groundwater, mine waste characterisation and management as well as environmental dispersal and effects associated with acid rock drainage and/or metal leaching.
- NRCan also provides scientific support to organizations that advance knowledge in mine waste management, including in areas such as prevention and control of acid rock drainage and metal leaching, disposal technologies, mine water treatment.

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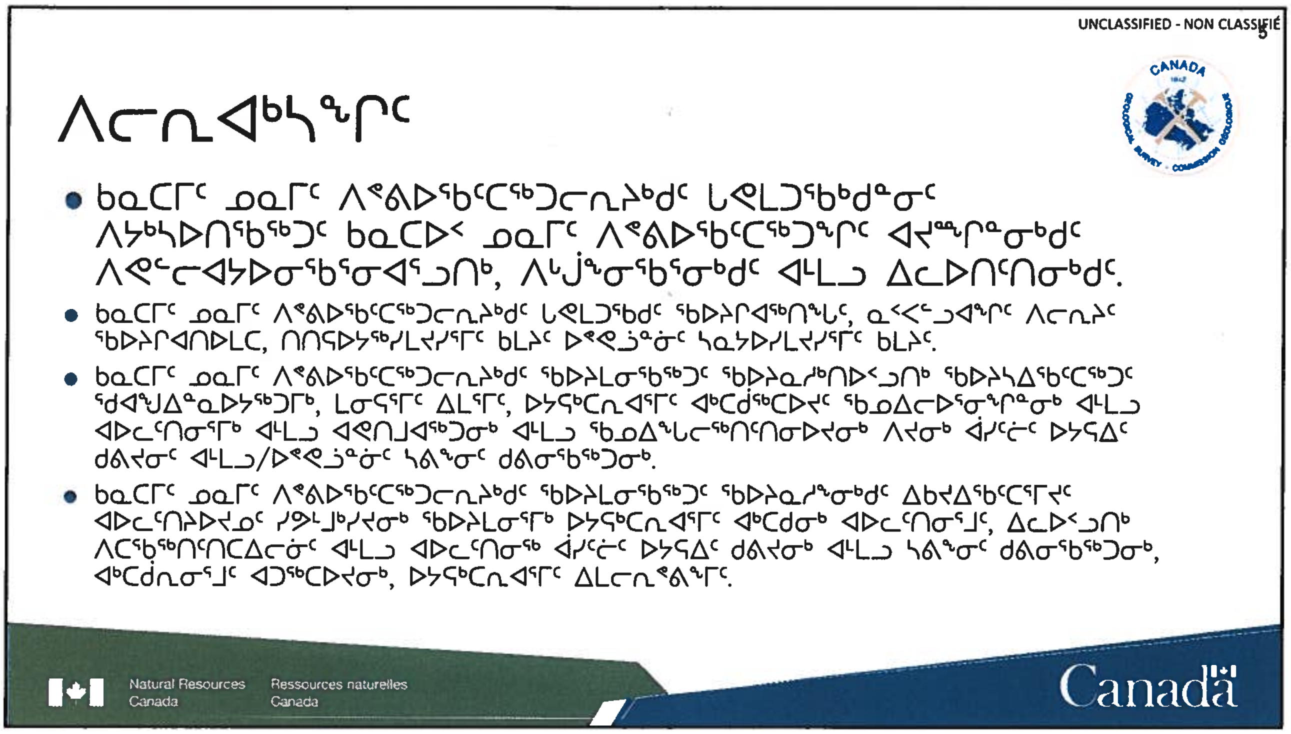
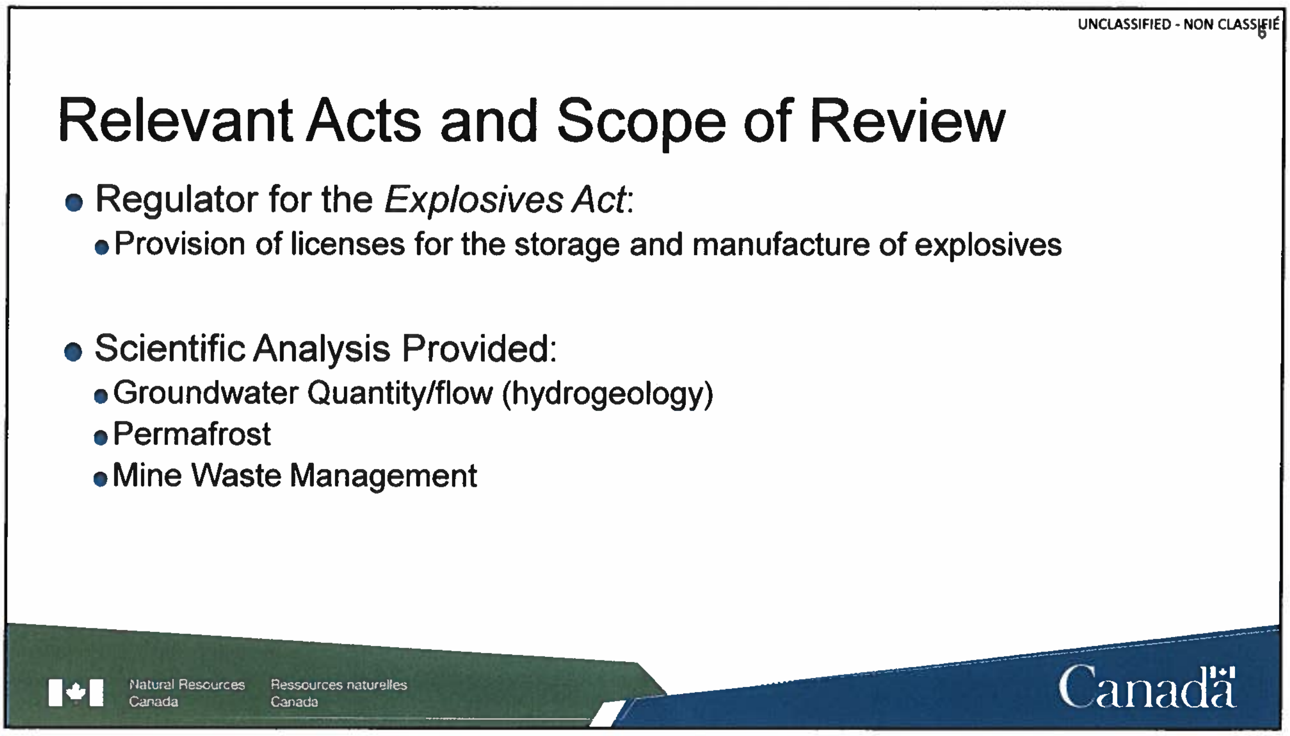


## ᐱᓕᕆᐊᒃᓴᖏᑦ

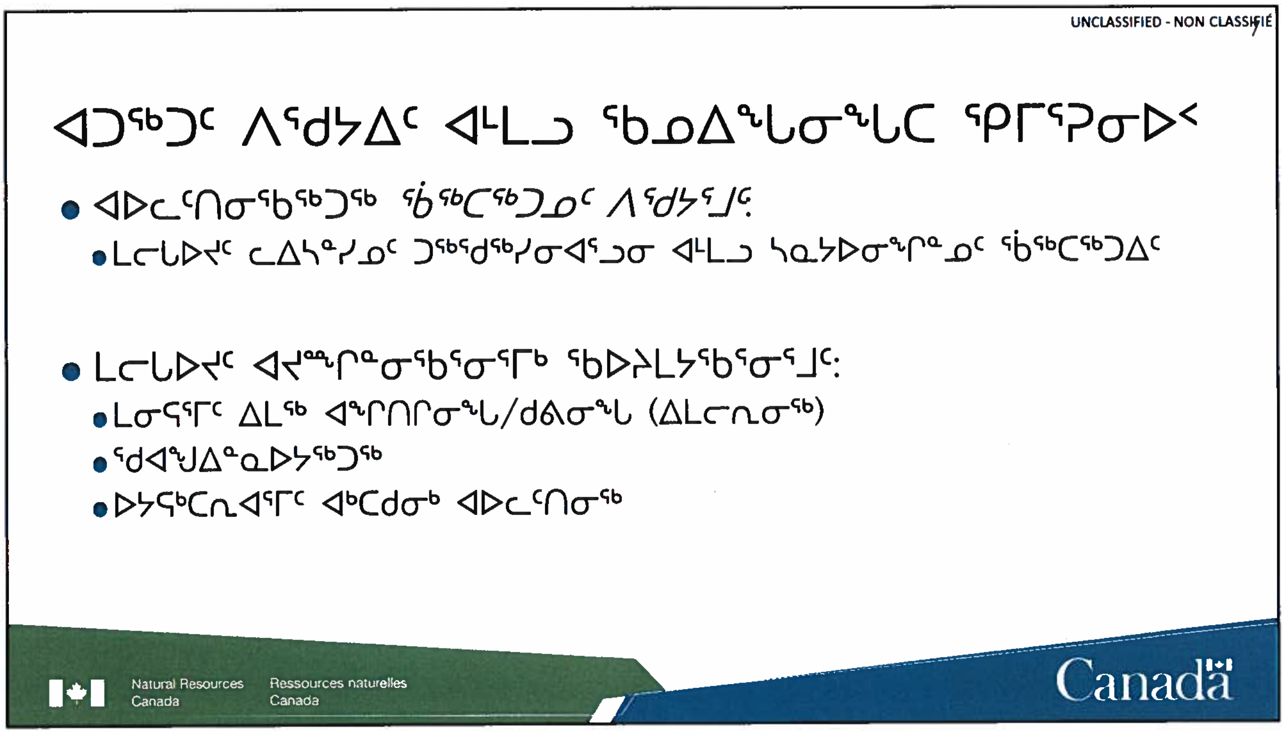
- ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᕝᕕᐅᖃᑦᑕᖅᑐᓕᕆᔨᒃᑯᑦ ᒐᕙᒪᑐᖃᒃᑯᓐᓂᑦ ᐱᔭᒃᓴᐅᑎᖃᖅᑐᑦ ᑲᓇᑕᐅᑉ ᓄᓇᒥᑦ ᐱᕝᕕᐅᖃᑦᑕᖅᑐᖏᑦ ᐊᔪᙱᓐᓂᒃᑯᑦ ᐱᕙᓪᓕᐊᔭᐅᓂᖃᕐᓂᐊᕐᑐᑎᒃ, ᐱᒡᒨᖕᓂᖃᕐᓂᒃᑯᑦ ᐊᒻᒪᓗ ᐃᓚᐅᑎᑦᑎᓂᒃᑯᑦ.
- ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᕝᕕᐅᖃᑦᑕᖅᑐᓕᕆᔨᒃᑯᑦ ᒐᕙᒪᑐᖃᑯᑦ ᖃᐅᔨᒋᐊᖅᑎᖓᑦ, ᓇᑉᐸᓪᓗᐊᖏᑦ ᐱᓕᕆᔩᑦ ᖃᐅᔨᒋᐊᑎᐅᒪᑕ, ᑎᑎᕐᐅᔭᖅᓯᒪᔪᓯᕐᒥᑦ ᑲᒪᔩᑦ ᐅᕝᕙᓘᓐᓃᑦ ᓴᓇᔭᐅᓯᒪᔪᓯᕐᒥᑦ ᑲᒪᔩᑦ.
- ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᕝᕕᐅᖃᑦᑕᖅᑐᓕᕆᔨᒃᑯᑦ ᖃᐅᔨᒪᓂᖃᖅᑐᑦ ᖃᐅᔨᓇᓱᒃᑎᐅᑉᓗᑎᒃ ᖃᐅᔨᓴᐃᖃᑦᑕᖅᑐᑦ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᒥᒃ, ᒪᓂᕋᕐᒥᑦ ᐃᒪᕐᒥᑦ, ᐅᔭᕋᒃᑕᓇᐊᕐᒥᑦ ᐊᒃᑕᑰᖅᑕᐅᔪᑦ ᖃᓄᐃᓕᐅᕐᓂᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᕐᒥᒃ ᐊᒻᒪᓗ ᐊᕙᑎᒧᐊᖅᑐᓂᒃ ᐊᒻᒪᓗ ᖃᓄᐃᖓᓕᖅᑎᑦᑎᓂᐅᔪᓂᒃ ᐱᔪᓂᒃ ᐋᓯᑦᓖᑦ ᐅᔭᕋᐃᑦ ᑯᕕᔪᓂᑦ ᐊᒻᒪᓗ/ᐅᕝᕙᓘᓐᓃᑦ ᓴᕕᖕᓂᑦ ᑯᕕᓂᖃᖅᑐᓂᒃ.
- ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᕝᕕᐅᖃᑦᑕᖅᑐᓕᕆᔨᒃᑯᑦ ᖃᐅᔨᒪᓂᖃᖅᑐᑦ ᖃᐅᔨᓇᓱᖕᓂᒃᑯᑦ ᐃᑲᔪᐃᖃᑦᑕᕐᒥᔪᑦ ᐊᐅᓚᑦᑎᔨᐅᔪᓄᑦ ᓯᕗᒻᒧᒃᓯᔪᓂᒃ ᖃᐅᔨᒪᓂᕐᒥᒃ ᐅᔭᕋᒃᑕᓇᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ, ᐃᓚᐅᑉᓗᑎᒃ ᐱᑕᖃᖅᑎᑦᑎᑕᐃᓕᓃᑦ ᐊᒻᒪᓗ ᐊᐅᓚᑦᑎᓂᖅ ᐋᓯᑦᓖᑦ ᐅᔭᕋᐃᑦ ᑯᕕᔪᓂᒃ ᐊᒻᒪᓗ ᓴᕕᖕᓂᑦ ᑯᕕᓂᖃᖅᑐᓂᒃ, ᐊᒃᑕᑰᓇᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᓂᒃ, ᐅᔭᕋᒃᑕᓇᐊᕐᒥᑦ ᐃᒪᓕᕆᕝᕕᖏᑦ.



## Relevant Acts and Scope of Review

- Regulator for the *Explosives Act*:
  - Provision of licenses for the storage and manufacture of explosives

- Scientific Analysis Provided:
  - Groundwater Quantity/flow (hydrogeology)
  - Permafrost
  - Mine Waste Management



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## ᐊᑐᖅᑐᑦ ᐱᕐᑯᓯᐃᑦ ᐊᒻᒪᓗ ᖃᓄᐃᖕᒐᓂᖕᒐᑕ ᕿᒥᕐᕈᓂᐅᑉ

- ᐊᐅᓚᑦᑎᓂᖅᑲᖅᑐᖅ ᖄᖅᑕᖅᑐᓄᑦ ᐱᕐᑯᓯᕐᒧᑦ:
  - ᒪᓕᒐᐅᔪᑦ ᓚᐃᓴᓐᓯᓄᑦ ᑐᖅᑯᖅᓯᓂᐊᕐᓗᓂ ᐊᒻᒪᓗ ᓴᓇᔭᐅᓂᖕᒋᓐᓄᑦ ᖄᖅᑕᖅᑐᐃᑦ

- ᒪᓕᒐᐅᔪᑦ ᐊᔪᙱᓐᓂᖅᑲᕐᓂᕐᒥᒃ ᖃᐅᔨᒪᔭᖅᑲᕐᓂᕐᒧᑦ:
  - ᒪᓂᕿᕐᒥᑦ ᐃᒪᖅ ᐊᖏᑎᒋᓂᖓ/ᑯᕕᓂᖓ (ᐃᒪᓕᕆᓂᖅ)
  - ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᖅ
  - ᐅᔭᖅᑕᓇᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᑦᑎᓂᖅ

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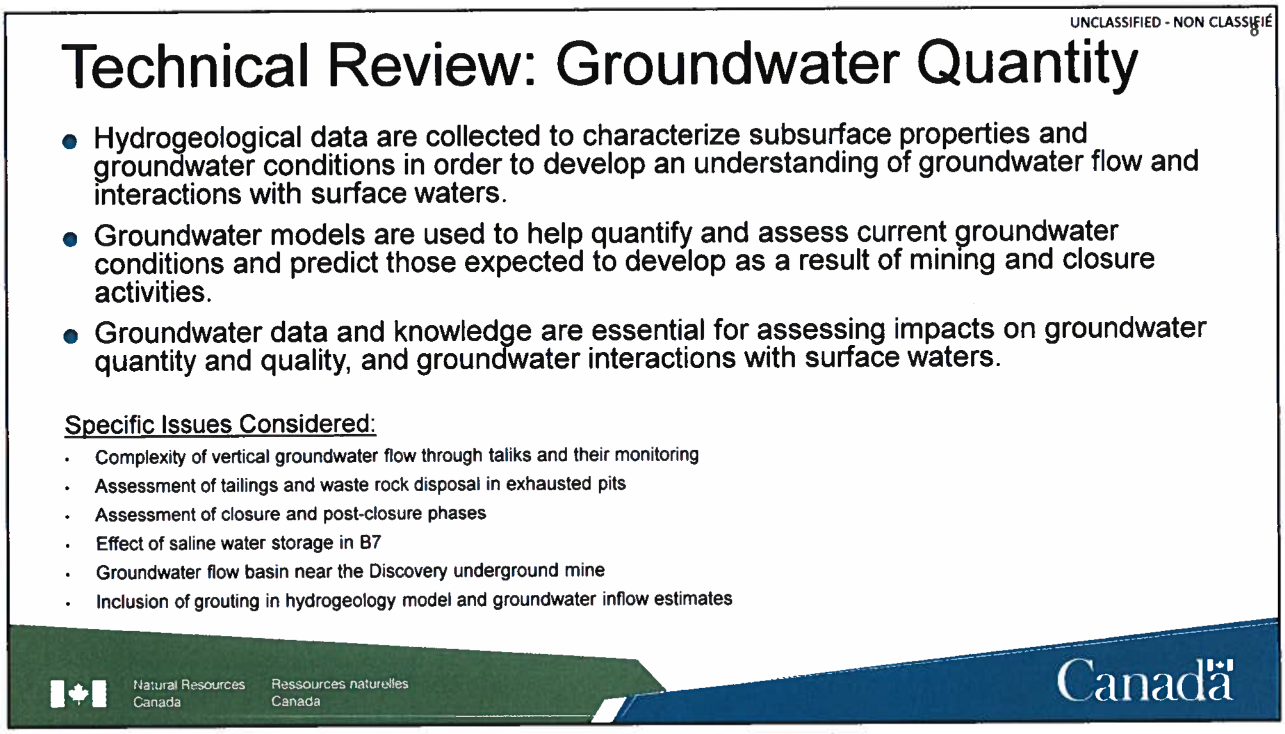

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## Technical Review: Groundwater Quantity

- Hydrogeological data are collected to characterize subsurface properties and groundwater conditions in order to develop an understanding of groundwater flow and interactions with surface waters.
- Groundwater models are used to help quantify and assess current groundwater conditions and predict those expected to develop as a result of mining and closure activities.
- Groundwater data and knowledge are essential for assessing impacts on groundwater quantity and quality, and groundwater interactions with surface waters.

Specific Issues Considered:

- Complexity of vertical groundwater flow through taliks and their monitoring
- Assessment of tailings and waste rock disposal in exhausted pits
- Assessment of closure and post-closure phases
- Effect of saline water storage in B7
- Groundwater flow basin near the Discovery underground mine
- Inclusion of grouting in hydrogeology model and groundwater inflow estimates

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# ᐱᓕᕆᐊᕐᒥᑦ ᕿᒥᕐᕈᓂᖅ: ᒪᓂᕋᕐᒥᑦ ᐃᒪᖅ ᐊᖏᑎᒋᓂᖓ

- ᐃᒪᓕᕆᓂᕐᒧᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᑲᑎᑕᐅᖃᑦᑕᖅᑐᑦ ᖃᓄᐃᓐᓂᖏᓐᓅᕐᓂᐊᕐᓗᒋᑦ ᐃᒪᐅᑉ ᐃᓗᐊᓃᑦᑐᑦ ᐊᒻᒪᓗ ᒪᓂᕋᕐᒥᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖏᓐᓄᑦ ᑐᑭᓯᐅᓕᕈᒪᑉᓗᒋᑦ ᒪᓂᕋᕐᒥᑦ ᐃᒪᖅ ᑯᕕᓂᖓ ᐊᒻᒪᓗ ᖃᓄᐃᓕᐅᕈᑎᓂᖏᑦ ᖄᖓᓃᑦᑐᑦ ᐃᒪᕐᒧᑦ.
- ᒪᓂᕋᕐᒥᑦ ᐃᒪᕐᒧᑦ ᐋᖅᑭᐅᒪᔪᖅ ᐊᑐᖅᑕᐅᖃᑦᑕᖅᑐᖅ ᐊᒥᓱᙳᓇᐊᖅᑎᓐᓂᐊᕐᓗᒋᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᕐᓗᒋᑦ ᒫᓇᐅᔪᖅ ᒪᓂᕋᕐᒥᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᕆᔭᖕᒥᑦ ᐊᒻᒪᓗ ᓇᓚᐅᑦᑖᕐᓗᒋᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᐋᖅᑭᒃᓱᓂᐊᕐᓗᓂ ᖃᓄᐃᖕᒪᓂᐅᔪᓂᒃ ᐅᔭᖅᑕᓕᐊᓕᕆᓂᕐᒥᑦ ᐱᔪᑦ ᐊᒻᒪᓗ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕈᑕᐅᔪᓂᑦ.
- ᒪᓂᕋᕐᒥᑦ ᐃᒪᕐᒧᑦ ᓈᓴᐅᑏᑦ/ᑎᑎᖅᑲᐃᑦ ᐊᒻᒪᓗ ᖃᐅᔨᒪᓂᕆᔭᐅᔪᑦ ᐱᒻᒪᕆᐅᔪᑦ ᖃᐅᔨᓴᐃᓂᕐᒧᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᓂᒃ ᒪᓂᕋᕐᒥᑦ ᐃᒪᐅᑉ ᐊᖏᑎᒋᓂᖓᓂᑦ ᐊᒻᒪᓗ ᖃᓄᐃᓐᓂᖓᓂᑦ, ᐊᒻᒪᓗ ᒪᓂᕋᕐᒥᑦ ᐃᒪᐃᑦ ᖃᓄᐃᓕᐅᕈᑎᓂᖏᑦ ᖄᖓᓃᑦᑐᑦ ᐃᒪᕐᓂᑦ.

<u></u>

**ᐃᔾᔪᑕᐅᔪᑦ ᐃᓱᒪᒃᓴᖅᓯᐅᕈᑎᒋᔭᐅᔪᑦ:**

- ᐊᖏᑎᒋᓂᖓ ᖁᒻᒧᙵᔪᖅ ᒪᓂᕋᕐᒥᑦ ᐃᒪᐅᑉ ᐃᓗᐊᓂᑦ ᑯᕕᓂᖓ ᐅᑭᐅᓗᒃᑖᖅ ᐃᒪᐅᕐᒥᓐᓇᖅᑐᓂᑦ ᐊᒻᒪᓗ ᖃᐅᔨᓴᖅᑕᐅᓂᖏᑦ
- ᖃᐅᔨᓴᐃᓂᖅ ᕿᒪᒃᑎᑦᑐᓄᑦ ᐊᒻᒪᓗ ᐊᒃᑕᑰᖅᑕᐅᔪᖅ ᐅᔭᖅᑲᐃᑦ ᐃᓕᔭᐅᓂᖏᑦ ᐃᓗᓃᕈᑎᓯᒪᔪᓂᑦ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᓂᑦ
- ᖃᐅᔨᓴᐃᓂᖅ ᐅᒃᑯᐊᖅᐸᓪᓕᐊᓂᕐᒥᑦ ᐊᒻᒪᓗ ᐅᒃᑯᐊᖅᓯᒪᓕᖅᑎᓪᓗᒍ
- ᖃᓄᐃᖕᒪᓕᖅᑎᑦᑎᓂᖅ ᑕᕆᐅᑕᒃ ᐃᒪᖅ ᑐᖅᑯᖅᑕᐅᓯᒪᓂᖓᓄᑦ B7-ᒥᑦ
- ᒪᓂᕋᕐᒥᑦ ᐃᒪᖅ ᑯᕕᕝᕕᐅᔪᖅ ᖃᓂᑕᖓᓂᑦ ᑎᒃᑲᕗᕆᒥᑦ ᓄᓇᐅᑉ ᐃᓗᐊᓂᑦ ᐅᔭᖅᑕᓕᐊᒥᑦ
- ᐃᓚᐅᑎᑕᐅᓂᖓ ᐃᓗᓪᓕᖅᑐᐃᓂᖅ ᐃᒪᓕᕆᓂᕐᒧᑦ ᐋᖅᑭᐅᒪᔪᒥᑦ ᐊᒻᒪᓗ ᒪᓂᕋᕐᒥᑦ ᐃᒪᖅ ᐃᓗᐊᓄᑦ ᑯᕕᓂᐅᔪᓂᒃ ᓇᓚᐅᑦᑖᕆᓃᑦ

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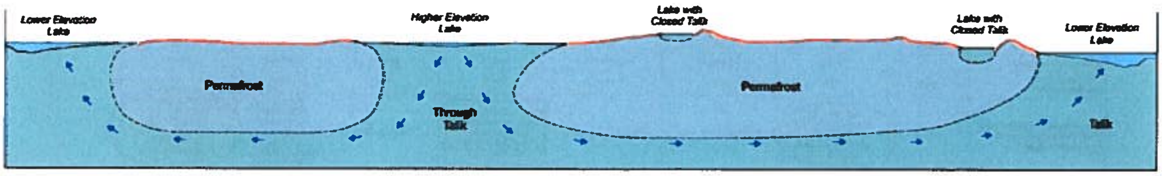
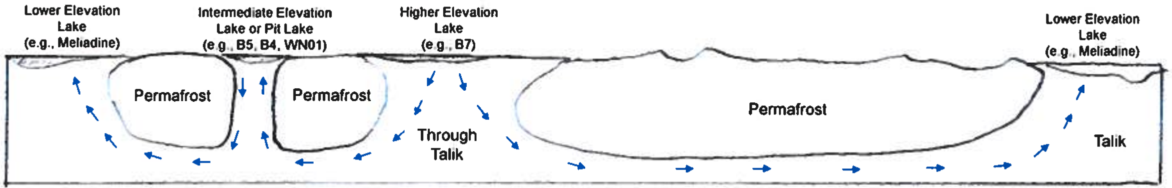
# Conceptual permafrost and groundwater flow model



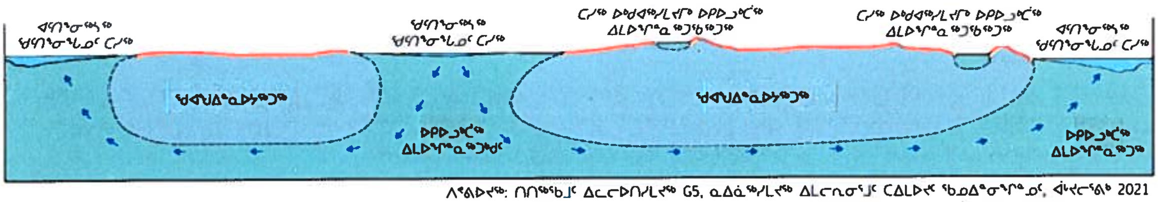
Source: Appendix G5, Summary of Hydrogeology Existing Conditions, Dec 2021



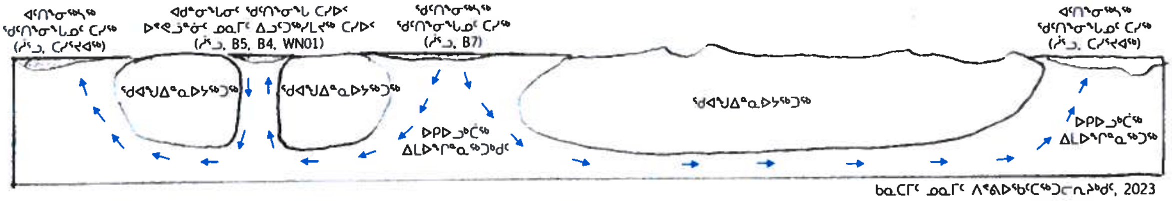
NRCan, 2023

- Intermediate elevation lakes with through talik can receive groundwater flow from upslope lakes *and/or* provide groundwater flow to downslope lakes, with implications for in-pit disposal

## ᑕᐅᑐᒐᐅᓯᖅ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᖅ ᐊᒻᒪᓗ ᒪᓂᕋᕐᒥᑦ ᐃᒪᕐᒥᑦ ᑯᕕᔪᒧᑦ ᐋᖅᑭᐅᒪᔪᖅ



ᐱᕙᐅᔪᖅ: ᑎᑎᖅᑲᒧᑦ ᐃᓚᓕᐅᑎᓯᒪᔪᖅ G5, ᓇᐃᓈᖅᓯᒪᔪᖅ ᐃᒪᓕᕆᓂᕐᒧᑦ ᑕᐃᒪᐅᔪᑦ ᖃᓄᐃᓐᓂᖓᓐᓄᑦ, ᐋᒡᒌᓯ 2021



ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᕙᐅᖅᑲᑦᑕᖅᑐᓕᕆᔨᒃᑯᑦ, 2023

- ᐊᑯᓐᓂᖓᓂᑦ ᖁᑦᑎᖕᓂᖓ ᑕᓲᑦ ᐅᑭᐅᓗᒃᑖᖅ ᐃᒪᐅᖏᓐᓇᖅᑐᒃᑯᑦ ᒪᓂᕋᕐᒥᑦ ᐃᒪᕐᒥᑦ ᑯᕕᔪᒥᑦ ᐱᔭᖕᓇᖅᑐᑦ ᖁᒻᒧᑦ ᐅᕕᖓᓂᖅᑲᖅᑐᓂᑦ ᑕᓯᕐᓂᑦ ᐊᒻᒪᓗ/ᐅᕐᕈᓘᓐᓃᑦ ᒪᓂᕋᕐᒥᑦ ᐃᒪᕐᒥᑦ ᑯᕕᔪᖅᑲᓗᓂ ᑕᐅᓄᖓᖓᔪᖅ ᐅᕕᖓᓂᖅᑲᖅᑐᑦ ᑕᓯᕐᓄᑦ, ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᓄᐊᕐᓂᖅᑲᖅᓗᑎᒃ

## Seepage from/to in-filled pits/pit lakes

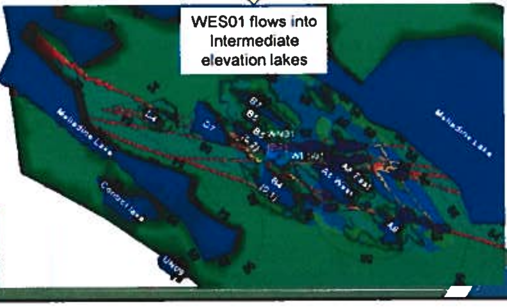
Table 2: Predict Contact Seepage Discharge from In-filled Pits to Downgradient Surface Water Lakes and Pit Lakes

| Value | Unit | WES01 | WES04 | WES08 | WN01 | PUM01 | PUM03 | DISC |
|---|---|---|---|---|---|---|---|---|
| Pit Bottom Elevation | m asl | -10 | 30 | -45 | -65 | 25 | -5 | -75 |
| Backfill Material(a) | - | Tailings | Tailings | Tailings | Tailings | Tailings | Tailings | Waste Rock |
| Backfill Elevation(a) | m asl | 50 | 54 | 47 | 44 | 47 | 49 | 16 |
| Underlying Underground | - | present | not present | not present | present | present | present | present |
| Post-closure Pit Lake Elevation(a) | m asl | 62.5 | 63 | 63.6 | 58.3 | 58.7 | 60.3 | 67 |
| Receptor and Predicted Contact Water Flux using Numerical Groundwater Model | m³/day | Lake B4 – 0.1<br>Pit Lake WN01 – 0.7<br>Lake B5 – 0.2<br>(total contact water seepage – 1) | Meliadine Lake – 0.2 | Meliadine Lake – 4.1 | No Pit Lake Discharge<br>Groundwater discharges to Pit Lake<br>Total Discharge to Pit Lake – 93.7 | Lake B4 – 0.02 | No Pit Lake Discharge<br>Groundwater discharges to Pit Lake<br>Total Discharge to Pit Lake – 2.0 | Meliadine Lake – 0.6<br>Lake UN1 – 0.8<br>Lake CH1 – 1.0<br>Lake CH5 – 0.4<br>Lake UND – 0.03<br>(total contact water seepage 2.8) |
| Travel time (first arrival of contact water seepage) Using Numerical Groundwater Model(b) | Years | Lake B4 – 450<br>Lake WN01 – 70<br>Lake B5 – 70 | Meliadine Lake – >1000 | Meliadine Lake – 275 | not applicable | Lake B4 – 850 | not applicable | Meliadine Lake – >1000<br>Lake UN1 – >1000<br>Lake CH1 – >1000<br>Lake CH5 – >1000<br>Lake UND – >1000 |

a) From Lorax 2022

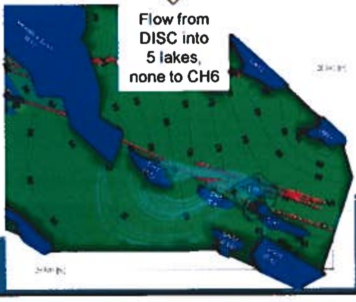
b) Travel times do not include time to develop open talik conditions below the pits. Actual travels times may be faster than predicted as a result of how the faults are incorporated in the model (see Section 3.8)

Source: WSP Technical Memo, Reference no. 22524250-972-TM-Rev1-6000, May 05, 2023



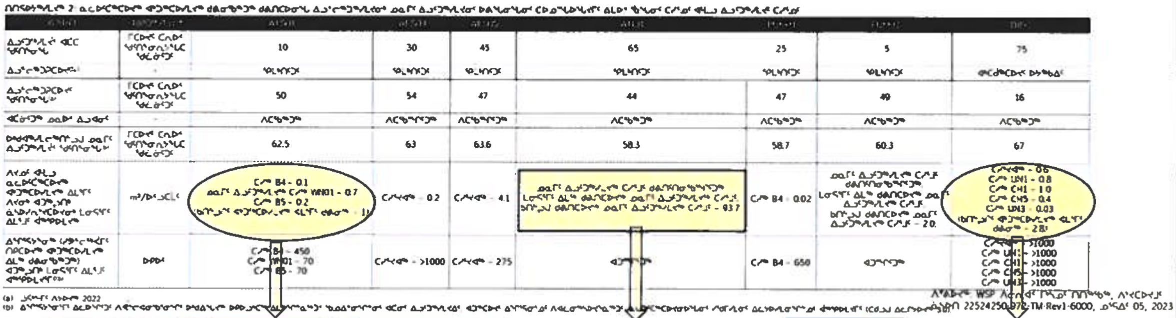
WES01 flows into Intermediate elevation lakes

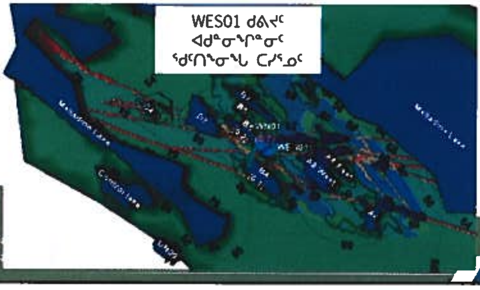
Flow into Pit Lake WN01, an in-filled pit with an intermediate elevation



Flow from DISC into 5 lakes, none to CH6

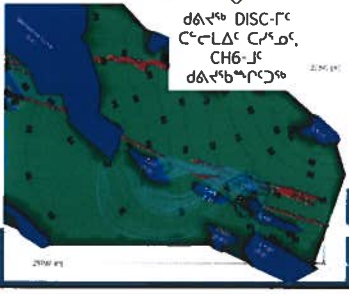
# ᑯᐱᓂᖅᑲᖅᑐᖅ ᓄᓇᒥᑦ ᐃᒧᑦᑐᖅᓯᒪᔪᑦ ᐃᒧᓪᓕᖅᑐᖅᓯᒪᔪᓂᑦ/ᓄᑦ ᓄᓇᒥᑦ ᐃᒧᑦᑐᖅᓯᒪᔪᓄᑦ/ᓂᑦ





WES01 ᑯᐱᔪᑦ
ᐊᑯᓐᓂᖏᓐᓂᑦ
ᖁᑦᑎᓐᓂᖓ ᑕᓯᕐᓄᑦ

ᑯᐱᔪᖅ ᓄᓇᒥᑦ
ᐃᒧᑦᑐᖅᓯᒪᔪᖅ WN01-ᒧᑦ,
ᐃᒧᓪᓕᖅᓯᒪᔪᖅ ᓄᓇᒥᑦ
ᐃᒧᑦᑐᖅᓯᒪᔪᖅ
ᐊᑯᓐᓂᖓᓂᑦ
ᖁᑦᑎᒃᓯᓯᒪᓪᓗᓂ



ᑯᐱᔪᖅ DISC-ᒥᑦ
ᑕᓪᓕᒪᐃᑦ ᑕᓯᕐᓄᑦ,
CH6-ᒧᑦ
ᑯᐱᔪᖃᙱᑦᑐᖅ

# Technical Review: Permafrost

- Knowledge of permafrost is required to minimize the impacts of the project on the environment, and the impacts of the environment on the project.
- Knowledge of distribution of permafrost and unfrozen ground (talik) is essential for determining groundwater flow pathways.

Specific Issues Considered:

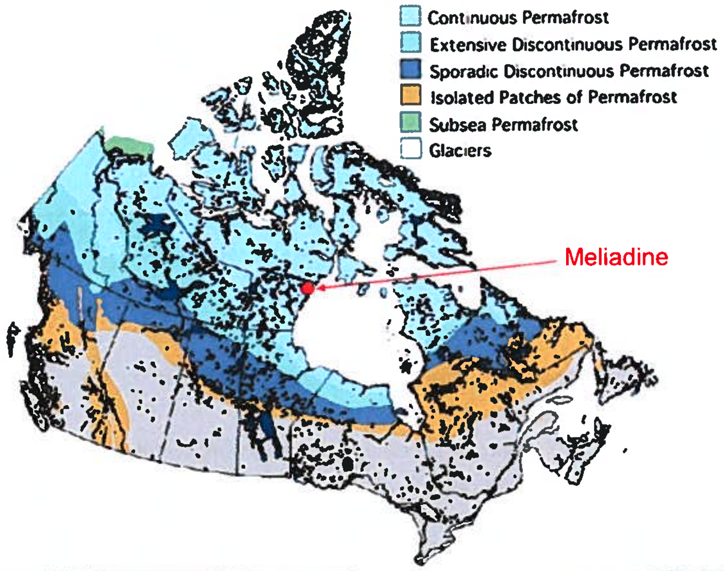
- Thermal modelling- To support design of Mine Waste Storage Facilities
- Ground thermal regime in the project area
- AEM response to Commitment 19 (Thermal modelling of temporary water storage in pits)
- AEM response to Commitment 42 (In-pit deposition alternative and disposal study)

# ᐱᓕᕆᐊᕐᒥᑦ ᕿᒥᕐᕈᓂᖅ: ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᖅ

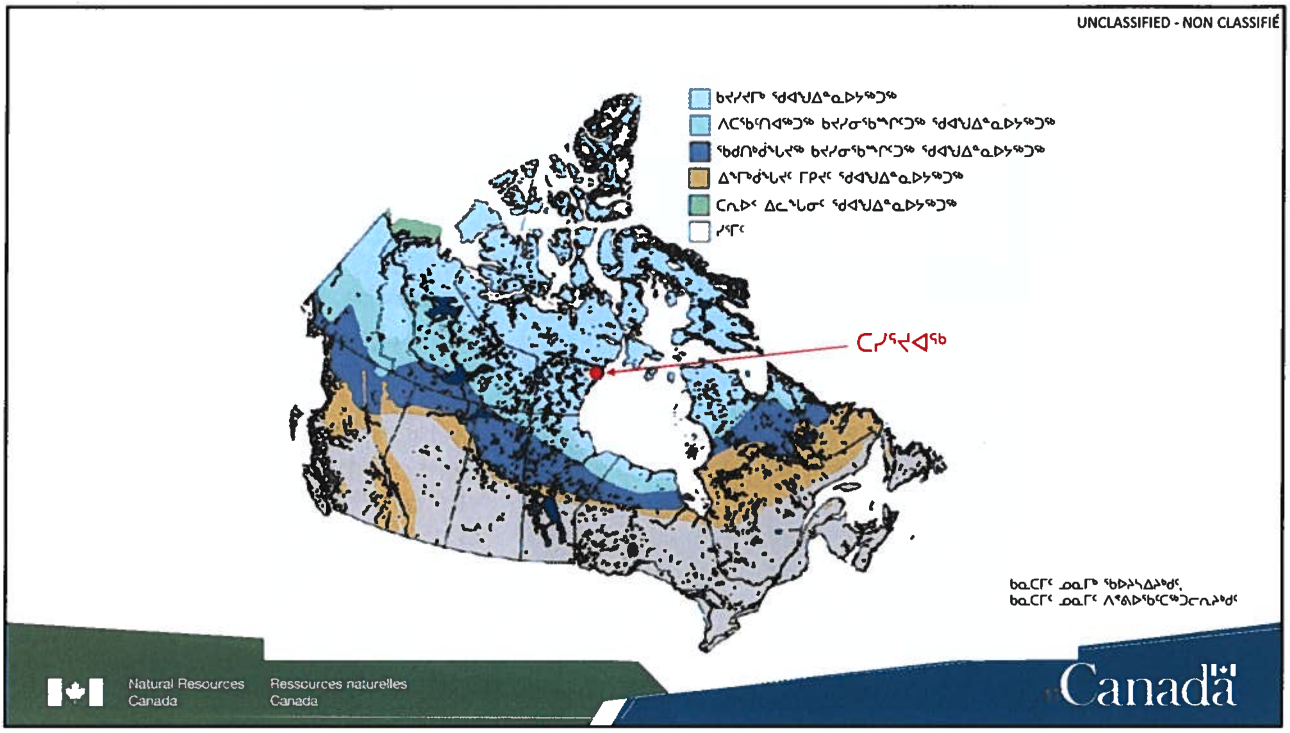
- ᖃᐅᔨᒪᓂᖅᑲᓇᐊᖅᑲᖅᓇᖅᑐᖅ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᒥᒃ ᒥᑭᓛᒃᑰᖅᑎᓐᓂᐊᕐᓗᒋᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᐱᓕᕆᐊᕐᒥᑦ ᐱᔪᑦ ᐊᕙᑎᒧᑦ, ᐊᒻᒪᓗ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᐊᕙᑎᒥᑦ ᐱᔪᑦ ᐱᓕᕆᐊᕐᒧᑦ.
- ᖃᐅᔨᒪᓂᕆᔭᐅᔪᖅ ᓇᒦᓐᓂᖏᓐᓄᑦ ᖁᐊᖑᐃᓐᓇᐅᔭᖅᑐᑦ ᐊᒻᒪᓗ ᖁᐊᖅᓯᒪᙱᑦᑐᑦ ᒪᓂᕋᖅ (ᐅᑭᐅᓗᒃᑖᖅ ᐃᒪᐅᖏᓐᓇᖅᑐᖅ) ᐱᒻᒪᕆᐅᔪᖅ ᖃᐅᔨᓂᐊᕐᓗᓂ ᒪᓂᕋᕐᒥᑦ ᐃᒪᐅᑉ ᑯᕕᓂᖏᓐᓄᑦ ᐊᑉᖁᑎᖏᑦ.

ᐱᔾᔪᑕᐅᔪᑦ ᐃᓱᒪᒃᓴᖅᓯᐅᕈᑎᒋᔭᐅᔪᑦ:

- ᐆᓇᖅᑎᑦᑎᓂᕐᒧᑦ ᐋᖅᑭᐅᒪᔪᖅ – ᐃᑲᔪᕐᓂᐊᕐᓗᓂ ᐋᖅᑭᒃᑕᐅᓂᖏᑦ ᐅᔭᕋᒃᑕᓇᐅᕐᒥᑦ ᐊᒃᑰᖅᑕᐅᔪᓄᑦ ᑐᖅᖁᖅᓯᓯᒪᖕᕖᑦ
- ᒪᓂᕋᕐᒥᑦ ᐆᓇᖅᑎᑦᑎᓂᕐᒧᑦ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᐱᓕᕆᐊᖅᑲᖅᕕᐅᔪᒥᑦ
- ᐊᒡᓃᑯᒃᑯᑦ ᑭᐅᔪᑦ ᐱᓂᐊᕐᓂᕆᔭᐅᔪᖅ 19-ᒧᑦ (ᐆᓇᖅᑎᑦᑎᓂᕐᒧᑦ ᐋᖅᑭᐅᒪᔪᖅ ᐃᒪᕐᒥᒃ ᑐᖅᖁᖅᓯᓯᒪᖕᕕᐅᓕᐅᐱᓪᓕᒃᑐᒧᑦ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᓂᑦ)
- ᐊᒡᓃᑯᒃᑯᑦ ᑭᐅᔪᑦ ᐱᓂᐊᕐᓂᕆᔭᐅᔪᖅ 42-ᒧᑦ (ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒥᑦ ᐃᓕᔭᐅᓂᖕᒥᑦ ᐊᓯᐊᒍᖕᒑᖅ ᐊᒻᒪᓗ ᐃᓕᔭᐅᔪᓂᒃ ᖃᐅᔨᓴᐃᓂᖅ)

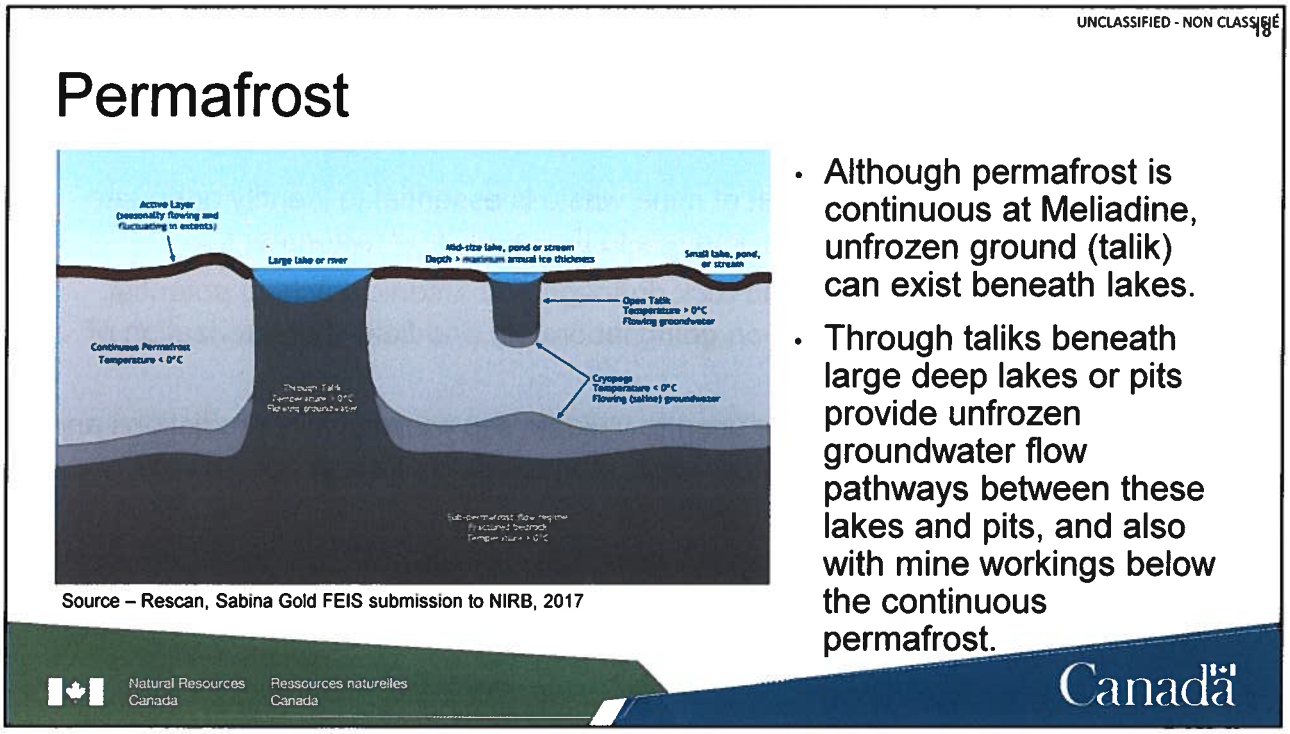


Geologic Survey of Canada, NRCan



UNCLASSIFIED - NON CLASSIFIÉ

ᑲᓇᑕᒥᑦ ᓄᓇᒥᒃ ᖃᐅᔨᓴᐃᔨᒃᑯᑦ,
ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᖕᕕᐅᖅᑲᑦᑕᖅᑐᓕᕆᔨᒃᑯᑦ

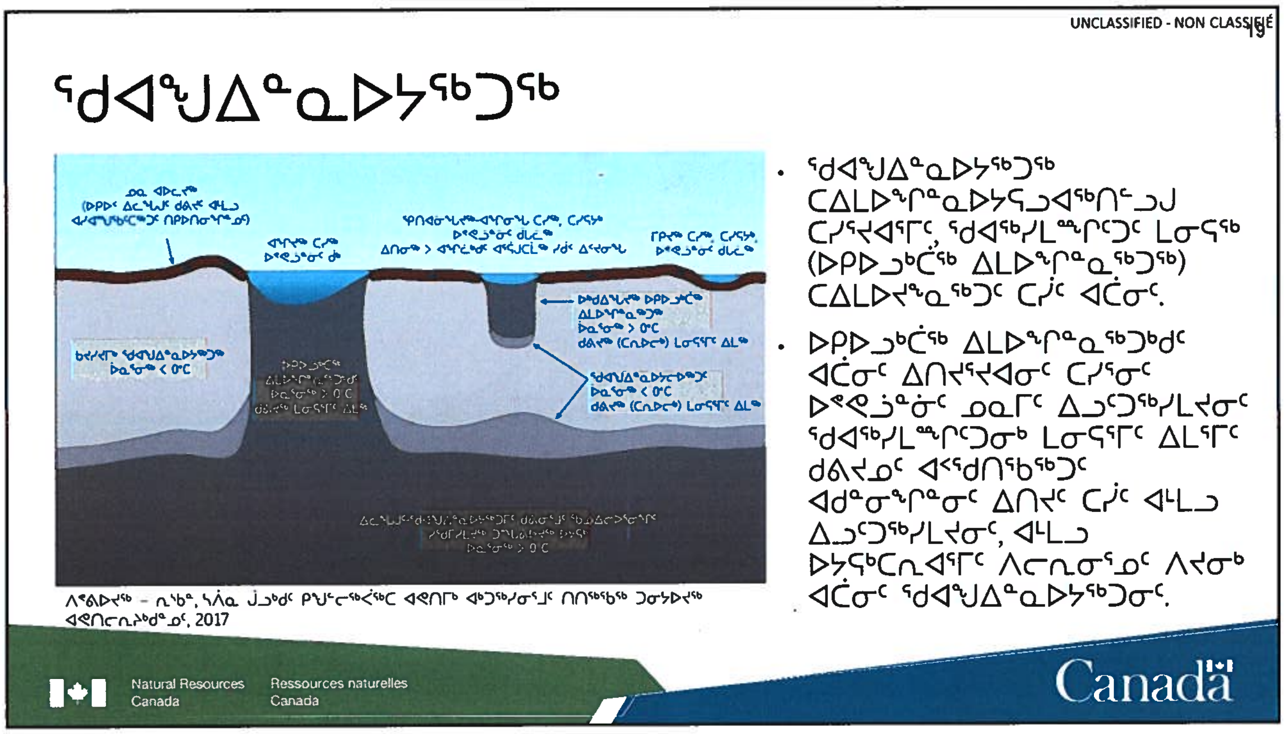


UNCLASSIFIED - NON CLASSIFIÉ

# Permafrost

Source – Rescan, Sabina Gold FEIS submission to NIRB, 2017

- Although permafrost is continuous at Meliadine, unfrozen ground (talik) can exist beneath lakes.
- Through taliks beneath large deep lakes or pits provide unfrozen groundwater flow pathways between these lakes and pits, and also with mine workings below the continuous permafrost.



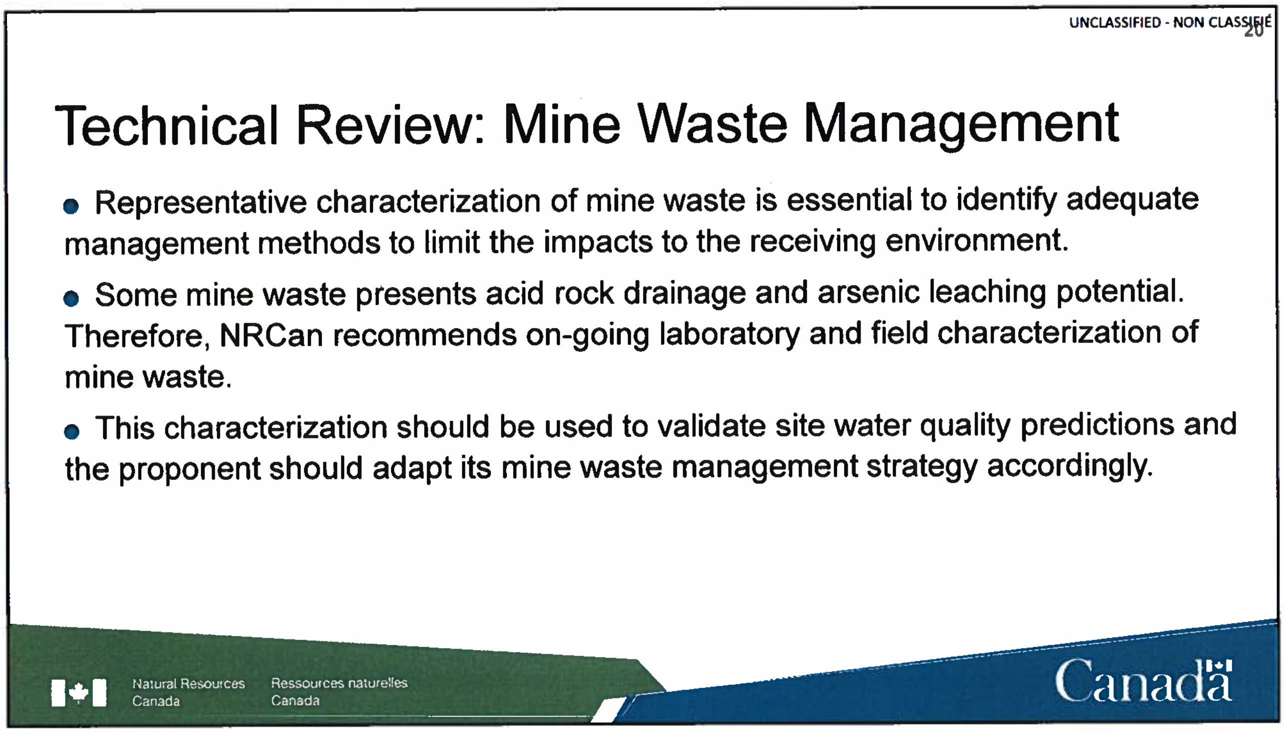
## ᖁᐊᖑᐃᓐᓇᐅᔪᖅᑐᖅ

ᐱᕝᕕᐅᔪᖅ – ᓇᖅᑲᓐ, ᓴᐲᓇ ᒨᓗᒃᑯᑦ ᑭᒡᒍᓕᖅᐸᖅᑕ ᐊᕙᑎᒥᒃ ᐊᒃᑐᖅᓯᓂᕐᒧᑦ ᑎᑎᖅᑲᖅ ᑐᓂᔭᐅᔪᖅ ᐊᕙᑎᓕᕆᔨᒃᑯᓐᓄᑦ, 2017

- ᖁᐊᖑᐃᓐᓇᐅᔪᖅᑐᖅ ᑕᐃᒪᐅᕐᒋᓐᓇᐅᔪᕋᓗᐊᖅᑎᓪᓗᒍ ᑕᓯᕐᔪᐊᕐᒥᑦ, ᖁᐊᖅᓯᒪᙱᑦᑐᑦ ᒪᓂᕋᖅ (ᐅᑭᐅᓗᒃᑖᖅ ᐃᒪᐅᕐᒋᓐᓇᖅᑐᖅ) ᑕᐃᒪᐅᔪᕐᓇᖅᑐᑦ ᑕᓯᑦ ᐊᑖᓂᑦ.
- ᐅᑭᐅᓗᒃᑖᖅ ᐃᒪᐅᕐᒋᓐᓇᖅᑐᒃᑯᑦ ᐊᑖᓂᑦ ᐃᑎᔪᕐᔪᐊᓂᑦ ᑕᓯᕐᓂᑦ ᐅᕙᓘᓐᓃᑦ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᓂᑦ ᖁᐊᖅᓯᒪᙱᑦᑐᓂᒃ ᒪᓂᕋᕐᒥᑦ ᐃᒪᕐᒥᑦ ᑯᕕᔪᓄᑦ ᐊᑉᕐᑯᑎᖅᑲᖅᑐᑦ ᐊᑯᓐᓂᕐᒋᓐᓂᑦ ᐃᑎᔪᑦ ᑕᓯᑦ ᐊᒻᒪᓗ ᐃᓗᑦᑐᖅᓯᒪᔪᓂᑦ, ᐊᒻᒪᓗ ᐅᔭᕋᒃᑕᕆᐊᕐᒥᑦ ᐱᓕᕆᓂᕐᓄᑦ ᐱᔪᓂᒃ ᐊᑖᓂᑦ ᖁᐊᖑᐃᓐᓇᐅᔪᖅᑐᓂᑦ.

Natural Resources Canada
Ressources naturelles Canada

Canada



## Technical Review: Mine Waste Management

- Representative characterization of mine waste is essential to identify adequate management methods to limit the impacts to the receiving environment.
- Some mine waste presents acid rock drainage and arsenic leaching potential. Therefore, NRCan recommends on-going laboratory and field characterization of mine waste.
- This characterization should be used to validate site water quality predictions and the proponent should adapt its mine waste management strategy accordingly.

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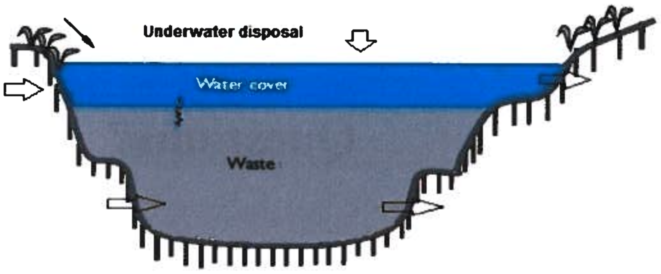
Canada

# ᐱᓕᕆᐊᕐᒥᑦ ᕿᒥᕐᕈᓂᖅ: ᐅᔭᖃᒃᑕᕆᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᑦᑎᓂᖅ

- ᐱᔪᓂᒃ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᓄᑦ ᐅᔭᖃᒃᑕᕆᐊᕐᒥᑦ ᐊᒃᑕᑰᖅᑕᐅᔪᓂᒃ ᐱᔪᓂᒃ ᐱᒻᒪᕆᐅᔪᖅ ᖃᐅᔨᓂᐊᕐᓗᓂ ᓈᒻᒪᒃᑐᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᑐᖅᑕᐅᔪᓂᒃ ᑭᒡᓕᖃᖅᑎᓐᓂᐊᕐᓗᒋᑦ ᐊᒃᑐᖅᓯᓂᐅᔪᑦ ᐊᕙᑎᒧᑦ.
- ᐃᓚᖏᑦ ᐅᔭᖃᒃᑕᕆᐊᕐᒥᑦ ᐊᒃᑕᑯᐃᑦ ᐋᓯᑦᓚᖕᓂᒃ ᐅᔭᖃᓂᑦ ᑯᕕᓂᖃᖅᑐᑦ ᐊᒻᒪᓗ ᐋᓯᓂᒃᒥᑦ ᑯᕕᔪᖃᕈᓐᓇᖅᑐᓂᒃ. ᑕᐃᒪᓐᓇᒎᑦ, ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᕝᕙᐅᖅᑲᑦᑕᖅᑐᓕᕆᔾᑯᑦ ᖃᐃᔾᔭᐃᕝᕙᑎᒍᑦ ᖃᐅᔾᔭᖅᑕᐅᖏᓐᓇᖁᔨᔪᑦ ᐊᒻᒪᓗ ᐱᓕᕆᕝᕙᐅᔪᓂᑦ ᖃᓄᐃᓕᐅᕐᓂᖏᓐᓂᒃ ᐅᔭᖃᒃᑕᕆᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᒃ.
- ᖃᓄᐃᓕᐅᕐᓂᖏᑦ ᐊᑐᖅᑕᐅᔭᕆᐊᓖᑦ ᓇᓗᓇᐃᕐᓂᐊᕐᓗᒋᑦ ᐃᓂᐅᔪᒥᑦ ᐃᒪᐅᑉ ᖃᓄᐃᓐᓂᖓᓄᑦ ᓇᓚᐅᑦᑖᖅᑕᐅᔪᑦ ᐊᒻᒪᓗ ᐱᓕᕆᐊᓕᒃ ᐊᑐᖅᑕᐅᑎᑦᑐᒍ ᐅᔭᖃᒃᑕᕆᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᖃᓄᖅᑑᕈᑎᖓᑦ.

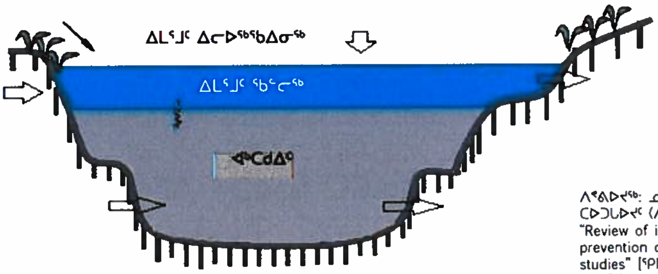
# Mine Waste Management: In-pit Disposal



- In-pit disposal under the water table reduces/eliminates:
  - acid rock drainage and metal leaching;
  - groundwater contamination if appropriately designed; and
  - maintenance of above ground dam structures.
- NRCan recommends that acid rock drainage and arsenic leaching mine waste be placed in exhausted open pits to the extent practicable as recommended by MEND 2.36.1 and 2.36.1b

Source: Pit disposal concept (adapted from MEND report 2.36.1 "Review of in-pit disposal practices for the prevention of acid mine drainage – Case studies".) from Subaqueous in-pit disposal - Mine Closure (gtk.fi)

# ᐅᔾᕋᒃᑕᕆᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᒃ ᐊᐅᓚᑦᑎᓂᖅ: ᓄᓇᐅᑉ ᐃᓗᐊᓄᑦ ᐃᓕᐅᖅᑳᐃᓂᖅ



ᐱᕙᐅᔪᖅ: ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒥᑦ ᐃᓕᐅᖅᑳᐃᓂᕐᒧᑦ ᑕᐅᑐᒐᐅᔪᑦ (ᐱᔭᐅᔪᖅ MEND ᐅᓂᒃᑳᖅ 2.36.1-ᒥᑦ "Review of in-pit disposal practices for the prevention of acid mine drainage – Case studies" [ᕿᒥᕐᕈᔭᐅᓂᖓ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒧᐊᖅᓯᖅᑲᑦᑕᕐᓂᕐᓄᑦ ᐋᓯᑦ ᐅᔾᕋᒃᑕᕆᐊᕐᒥᑦ ᑯᕕᑎᑦᑎᑦᑕᐃᓕᓂᕐᒧᑦ – ᐱᓯᒪᔪᒥᒃ ᖃᐅᔨᓴᐃᓃᑦ]) ᐅᕙᙵᑦ Subaqueous in-pit disposal – Mine Closure [ᓴᙱᓂᕐᑲᙱᑦᑐᖅ ᓄᓇᒥᑦ ᐃᓗᑦᑐᖅᓯᒪᔪᒧᐊᖅᑐᑦ – ᐅᔾᕋᒃᑕᕆᐊᖅ ᐅᒃᑯᐊᖅᑎᕐᓗᒍ] (gtk.fi)

- ᓄᓇᐅᑉ ᐃᓗᐊᓄᑦ ᐃᓕᐅᖅᑳᐃᓂᖅ ᐃᒪᐅᑉ ᐃᓗᐊᓄᑦ ᒥᒃᓯᒥᐊᖅᓯᖅᑲᑦᑕᖅᑐᖅ/ᐱᑦᑲᕈᓐᓂᖅᑎᑦᑎᖅᑲᑦᑕᖅᑐᖅ:
  - ᐋᓯᑦᓵᑦ ᐅᔾᕋᓂᑦ ᑯᕕᑎᑦᑎᓂᖅ ᐊᒻᒪᓗ ᓴᕕᖕᒥᑦ ᑯᕕᔪᖅ;
  - ᒪᓂᕋᕐᒥᑦ ᐃᒪᖅ ᐱᐅᙱᑦᑐᓕᒃ ᓈᒻᒪᒃᑐᒃᑯᑦ ᐋᖅᑭᒃᓯᖅᑕᐅᓯᒪᒃᐸᑦ; ᐊᒻᒪᓗ
  - ᐱᓕᕆᐊᖑᖅᑲᑦᑕᕐᓂᖏᑦ ᖁᓛᓃᑦᑐᑦ ᒪᓂᕋᕐᒥᑦ ᐊᐅᓚᓄᑦ ᐋᖅᑭᒃᓯᒪᔪᑦ.
- ᑲᓇᑕᒥᑦ ᓄᓇᒥᑦ ᐱᓇᓱᐊᖅᑲᑦᑕᖅᑐᑎᓐᓂᒃᑯᑦ ᐋᓯᑦᓵᑦ ᐅᔾᕋᓂᑦ ᑯᕕᑎᑦᑎᓂᖅ ᐊᒻᒪᓗ ᐋᓯᓂᒃᒥᑦ ᑯᕕᓂᖅ ᐅᔾᕋᒃᑕᕆᐊᕐᒥᑦ ᐊᒃᑕᑯᓂᑦ ᐃᓕᔭᐅᖅᑯᔮᔪᑦ ᓄᓇᒥᑦ ᓄᖑᑎᖅᓯᒪᔪᑦ ᐅᒃᑯᐃᖓᔪᓄᑦ ᐊᔪᙱᓐᓂᓕᒫᒃᑯᑦ ᐱᖅᑯᔭᐅᓯᒪᓂᖓᑐᑦ MEND 2.36.1-ᒥᑦ ᐊᒻᒪᓗ 2.36.1b-ᒥᑦ

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# Questions?

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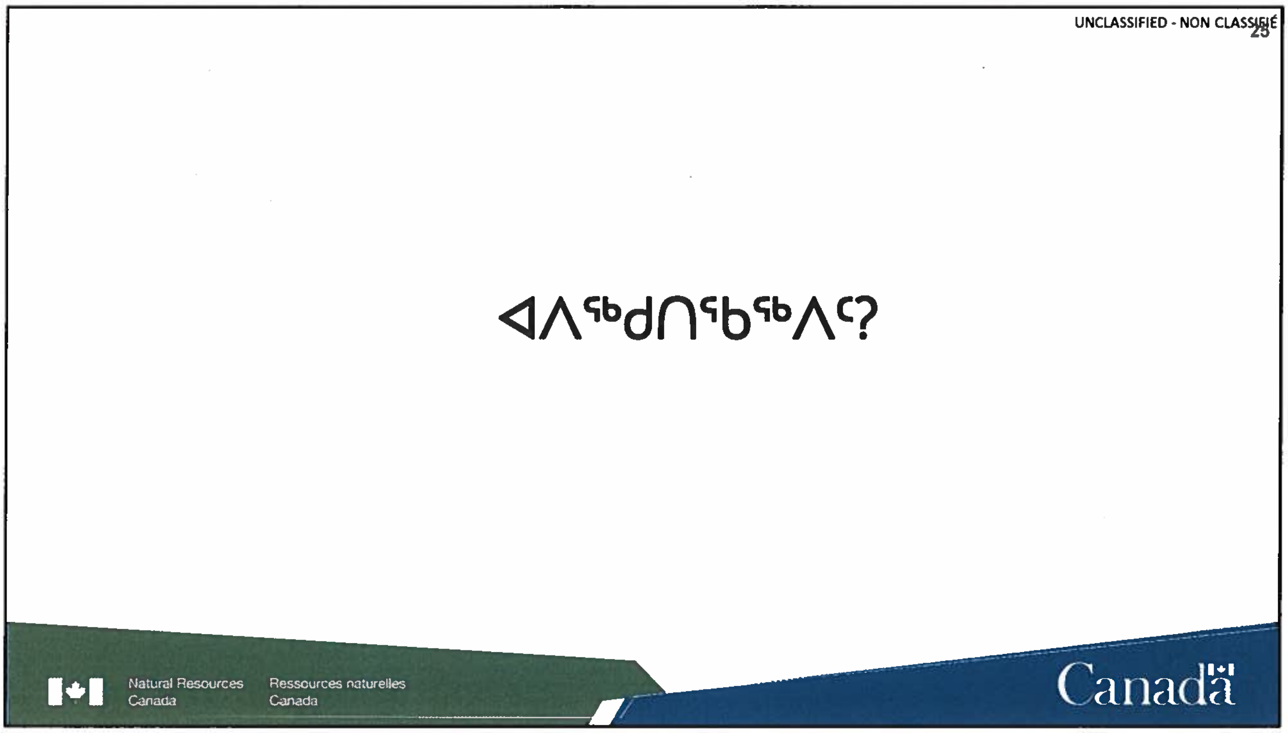

UNCLASSIFIED - NON CLASSIFIÉ

## ᐊᐱᖅᑯᑎᖃᖅᐱᑦ?