Boring into groundwater impact predictions of hardrock mines in Canada

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htrod	Inction

Methods

of Canada's usable

freshwater is shallow (within

150m) groundwater

LANA

Results

of rural Canadians rely solely

on groundwater for water

supply

Discussion

75% 80% 97%

of potable water in the Yukon comes from groundwater

Pores filled

with water

2

Infiltration

Water in aquifer

Bedrock

Diagram: <u>Adriana Vargas, 2025</u>





Victoria Gold's Eagle mine site groundwater highly contaminated, Yukon government says

Blair McBride - The Northern Miner | August 9, 2024 | 4:18 pm News Canada Gold



Results

Calgary

The Canadian Critical Minera

FROM EXPLORATION TO Powering the Green and Di Canada and the World

Carney pledges faster project reviews to make Canada 'energy superpower'

Liberals' single-window assessment office idea similar to Poilievre Conservative promise

Jason Markusoff · CBC News · Posted: Apr 09, 2025 6:50 PM ADT | Last Updated: April 9





https://www.canada.ca/en/campaign/critical-minerals-in-canada/canadian-critical-minerals-strategy.html

Canada's federated system:

- Federal government
- Provincial governments (10)
- Territorial governments (3)

Federal IA regimes apply to:

- CEAA 2012: metal mines with an ore production capacity of 3,000+ tonnes/day (600+ for gold or rare earth elements).
- IAA 2019: metal mines with an ore production capacity of
 5,000+ tonnes/day (2,500+ for rare earth elements).





We investigated hardrock mines...

- Temporal boundaries of groundwater impact predictions;
 Dotails of groundwater monitoring place
- 2. Details of groundwater monitoring plans;
- How climate change was accounted for;
 Accessibility of information for groundwater impact predictions.



> Methods

Results





Canadian Environmental Assessment Act, 2012

Hardrock mines (16)



Gold-Silver (2)





🔂 Iron (1)

Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, NRCan, Parks Canada, Esri, USGS

ENVIRONMENTAL ASSESSMENT FOR THE MARATHON PGM-Cu **PROJECT AT MARATHON, ONTARIO** IDM MINING STILLWATER CANADA INC. Red Mountain Underground Gold MARATHON PGM-Cu PROJECT Project - Mine Area Hydrogeology SUPPORTING INFORMATION **DOCUMENT No. 14 -BASELINE REPORT -**Prepared for HYDROGEOLOGY -**IDM** Mining MARATHON PGM-Cu PROJECT

Projet R

PROJET : 171-14416-00

Projet Rose Lithium-Tantale / Rose Lithium-Tantalum Project

MISE À JOUR DE L'ÉTUDE D'IMPACT SUR L'ENVIRONNEMENT / UPDATE OF THE ENVIRONMENTAL IMPACT STATEMENT





Out of 16 mines assessed under CEAA 2012...

Methods

Introduction

15 used field data to estimate hydraulic conductivity and gradients

Results

Discussion

• 6 performed particle tracking studies to estimate residence time



Out of 16 mines assessed under CEAA 2012...

Results

6 proposed a post-closure groundwater monitoring program
0 explained how post-closure monitoring would be funded

"Post-closure groundwater monitoring will continue until the effluent discharge and groundwater quality criteria **demonstrate compliance for a continuous period of five years** ..." - 2013

Methods

"Monitoring of groundwater quality will be **discontinued once it has been demonstrated that the objectives of closure have been met**." - 2017

Discussion

Out of 16 mines assessed under CEAA 2012...

5 predicted contaminant exceedances of water quality guidelines

Results

Opredicted how long contaminant exceedances would last

Н

Hvdrogen

Ion (Acid)

• O performed a quantitative analysis of climate change influences

$FeS_2 + O_2 + H_2O \Rightarrow Fe(OH)_3 + SO_4 + H^+$



Introduction

Pyrite Oxygen Water



Methods

Iron (III) Hydroxide

Cu Pd Cd Cr As CN-

"Extreme precipitation has the potential to cause flooding and erosion in the project's water drainage system ... **drought** could reduce water levels and deplete groundwater quantity ... **it is likely that [the project] will experience residual effects from climate change** ... but potential adverse effects have been considered through project design and planning." - 2020

Discussion

Introduction	> Methods	Results	> Discussion
<u>St-Pierre, 2024</u>			Statement of the local division of the local
			and a publication

Discussion & Recommendations

Introduction

St-Pierre, 2024

Methods

Key findings: when modelling was done for groundwater impact predictions...

- temporal boundaries were highly variable
 post-closure monitoring was rarely planned
 contaminant exceedances were solder
- contaminant exceedances were seldom discussed, and
- climate change was not accounted for.



Eskay Creek Revitalization Project

Chapter 14 Groundwater Effects Assessment



The **Tahltan Nation** outlined an approach to the proponent of *"back casting and forecasting across:*

- one to three generations (short-term); and
- four to seven generations (long-term)

to provide a perspective that reflects the Tahltan Continuum of **ancient, contemporary and future knowledge and practices, as grounded in Tahltan's past, present, and future interconnection to the land**" (p. 18).

Skeena Resources 2025

Recommendations

Robust long-term field **monitoring programs** should be detailed in all groundwater assessments, including:

- Temporal and spatial scope;
- Parameters to be evaluated;
- Monitoring costs, and how those costs will be funded



Living Lakes 2019

Recommendations

Regulators should offer guidance to proponents to: provide quantitative groundwater impact predictions that include climate change scenarios, clearly rationalized methods, and minimum time scales (e.g., 150 years or 7 Generations). **Proponents** should focus on: consistency, clarity, and accessibility of provided EIS and technical studies to better facilitate informed review and decision-making.



Let's continue the conversation!

Message me your questions or comments in the IAIA25 app.





#iaia25

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Miglani, S., Collison, B. R., James, P., & Westwood, A. R. (in review). Boring into groundwater impact predictions of hardrock mines in Canada reveals inadequate clarity, timelines, and monitoring plans to inform decision-making. *Environmental Impact Assessment Review*, EIR-D-25-00562.

Introduction

Met<u>hods</u>



Modelling Software

MODFLOW (13)

FEFLOW (3)

VS.

none of the projects provided rationale for choice of software.

Waterloo Hydrogeologic

Introduction

Methods



Cooke, C. A., Emmerton, C. A., & Drevnick, P. E. (2024). Legacy coal mining impacts downstream ecosystems for decades in the Canadian Rockies. *Environmental Pollution*, 344, 123328.

Key finding: hardrock mines may influence groundwater over timeframes far **longer** than those currently assessed.

 When particle tracking was done (38% of projects), the estimated residence time **exceeded** the temporal horizon of groundwater impact forecasts.



Bozan, C., Wallis, I., Cook, P. G., & Dogramaci, S. (2022). Groundwater-level recovery following closure of open-pit mines. *Hydrogeology Journal*, 30(6), 1819–1832.