

MEMO

Appendix H.4.C.4

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Date: May 20, 2026

File No.: 22-402

Subject: **Georgian Bay (Ontario) Pumped Storage Hydropower Project
Summary of DND Meaford Munitions and Contamination Monitoring Reports
As Summarized using Google NotebookLM Artificial Intelligence (AI)**

Google NotebookLM AI has been utilized to provide a ‘closed query’ summary of the following DND Meaford Munitions and Contamination Monitoring Reports as described below.

The Evaluation of Soil Contamination by Explosive and Metals at Meaford DND by Defence R & D Canada - Valcartier (May 2009); the Stantec 2020 Groundwater Monitoring and Sampling Report for DND (Mar 30, 2021); the Stantec 2021 Groundwater Monitoring and Sampling Report (Mar 22, 2022); the Arcadis Groundwater Monitoring and Sampling Report (Mar 2023); the Meaford DND Munitions Monitoring Plan, Part B - Annual Results Report (Mar 2024) and the Meaford DND Munitions Monitoring Plan, Part B - Annual Results Report (Aug 2025).

Note: ‘Deep’ wells refer to groundwater monitoring wells screened not deeper than 10-20 m.

May 20, 2026 5:00 pm version AI results.

Overview of sources (6 Reports)

This **2023 Annual Results Report** document outlines the environmental monitoring efforts at the **4 Canadian Division Training Centre (CDTC) Meaford** in Ontario. Prepared by the **Environmental Sciences Group** for the **Department of National Defence**, the report evaluates the impact of **munitions constituents**, such as metals and propellants, released during military training. The primary focus is a **groundwater monitoring plan** designed to ensure compliance with **federal and provincial environmental regulations**. Key objectives include preventing the **transboundary migration** of contaminants and protecting **local aquatic life** and fisheries. The results are compared against established **reference values** and site-specific guidelines to identify potential ecological or health risks. Ultimately, the report provides **technical data and recommendations** to maintain the sustainable use of the training ranges.

1. **Please provide a summary for current contamination of groundwater and soils at depths less than 25 m below ground, including parameter range.**

Based on the provided documents, the current contamination of groundwater and soils at the 4th Canadian Division Training Centre (4CDTC) Meaford, focusing on depths less than 25 m below ground surface (m BGS), is characterized by various exceedances of federal and provincial quality guidelines. The environmental monitoring categorizes groundwater into a **shallow zone (typically 10–12 m BGS)** and a **deep zone (starting below 12 m BGS)**. Soil studies have also examined depths up to 30 m in specific training ranges.

Groundwater Contamination (< 25 m BGS)

Groundwater contamination involves general chemistry parameters, dissolved metals, and trace organic compounds. While many parameters are within background levels, several consistently exceed applicable criteria such as the Federal Interim Groundwater Quality Guidelines (FIGQG) and Ontario Site Condition Standards (SCS).

General Chemistry and Anions

Exceedances in both shallow and deep aquifers frequently include chloride, fluoride, nitrate, and sulphate.

- **Nitrite:** Exceedances are primarily found in the **shallow aquifer** only.
- **Sulphate:** Widely reported, with some concentrations significantly elevated near specialized areas like the 7th Line.
- **Ranges (Representative):**
 - **Chloride:** Up to 10,104 mg/L.
 - **Fluoride:** 0.8 – 5.2 mg/L.
 - **Nitrite-N:** Up to 0.8 mg N/L.
 - **Sulphate:** 331 – 2,147 mg/L.

Dissolved Metals

Monitoring has identified several metals exceeding irrigation and aquatic life guidelines. Notably, exceedances for **aluminum, arsenic, and zinc** are typically restricted to the **shallow aquifer**, while **sodium and strontium** exceedances are more characteristic of the **deep aquifer**.

- **Boron:** One of the most frequent exceedances, particularly in shallow wells.
- **Iron and Manganese:** Common exceedances across both shallow and deep wells.
- **Ranges (Representative):**
 - **Aluminum:** < 4.9 – 3,729 µg/L.
 - **Arsenic:** < 1.0 – 27.8 µg/L.
 - **Boron:** 20 – 16,232 µg/L.
 - **Iron:** < 100 – 14,600 µg/L.

- **Manganese:** < 2.0 – 630 µg/L (reported values); guidelines/tolerance limits up to 14,881 µg/L.
- **Sodium:** 200 – 3,598,500 µg/L.
- **Zinc:** < 5.0 – 400 µg/L.

Organic Contaminants

- **Petroleum Hydrocarbons (PHCs) and BTEX:** Detections are generally low. Benzene concentrations are mostly non-detect, though some historical exceedances of PHC fraction F3 were noted. Total Xylenes have been reported up to 18 µg/L.
- **Energetics and Perchlorate:** Generally non-detect or present at very low concentrations (< 0.5 µg/L) in groundwater, despite being a focus of monitoring in impact areas.
- **PFAS:** Monitoring at the Garrison Landfill area has detected total PFAS ranging from **0.002 to 0.060 µg/L**.

Soil Contamination (< 25 m BGS)

Soil contamination is primarily linked to specific military training activities, such as small arms firing and grenade ranges. Studies analyze discrete depth intervals (e.g., 0–5 m, 10–15 m, 20–25 m).

Metals in Soil

Soil quality is generally described as "excellent," though heavy metals are elevated in specific ranges.

- **Zinc:** Found at concentrations of **988 to 2,140 mg/kg**, which is 2.7 to 6 times higher than the CCME industrial threshold criteria.
- **Lead:** Highly elevated in small arms ranges, reaching up to **6,000 mg/kg** at the Alpha range.
- **Other Metals:** Chromium, lead, magnesium, nickel, titanium, and barium have been found at concentrations exceeding background mean levels + 2 standard deviations.

Energetics and PAHs in Soil

- **Energetics:** Low levels of nitroglycerine (NG) and dinitrotoluenes (DNTs) are present in specific ranges.
 - **Nitroglycerine:** 6.65 – 7.07 ppm.
 - **2,4-DNT:** 4.62 – 5.31 ppm.
 - **2,6-DNT:** ~0.2 ppm.
- **Polycyclic Aromatic Hydrocarbons (PAHs):** Found in the Skeet Range soils.
 - **Benzo(a)pyrene:** 0.02 – 2.00 ppm.
 - **Chrysene:** 0.03 – 1.4 ppm.

2. Which contaminants are the result of military live fire ordnance or toxic military disposal?

Based on the provided documents, contaminants resulting from military live-fire ordnance and military disposal activities are collectively referred to as **Munitions Constituents (MC)**. These primarily include energetic materials (explosives), propellants, and heavy metals.

Energetic Materials and Propellants

These compounds are dispersed through live firing, air bombing, and the destruction of obsolete ammunition via **open burning and open detonation (OB/OD)**.

- **Nitroglycerine (NG):** A propellant residue found at high concentrations near the firing positions of anti-tank weapons (like the 84-mm Carl Gustav), small arms, and mortars.
- **2,4-Dinitrotoluene (2,4-DNT):** A propellant residue found near firing positions, often embedded in nitrocellulose fibers. It is ejected from the muzzles of artillery guns and can also result from the open burning of propellants.
- **TNT (2,4,6-Trinitrotoluene):** A primary high explosive found in impact areas and demolition ranges, often resulting from cratering practice or the detonation of live ammunition.
- **RDX and HMX:** High explosives used in various weapons and demolition blocks (C-4). **HMX** is often found as an impurity of RDX in demolition ranges following "blow in place" (BIP) operations for unexploded ordnance.
- **Perchlorate:** Associated with anti-tank firing points, impact areas, and the use of **pyrotechnics** such as flares, smoke grenades, and simulators.
- **Other Energetics:** Tetryl (found in older munitions), as well as metabolites and impurities like **2-ADNT, 4-ADNT, and nitrobenzene**.

Heavy Metals

Live firing of munitions spreads significant quantities of metals across training ranges, particularly in impact areas.

- **Lead:** Found at high concentrations across all small arms ranges.
- **Antimony, Copper, and Zinc:** Frequently identified as contaminants of potential concern at small arms ranges.
- **Selenium:** Identified at high concentrations specifically at tank firing positions in the Cambrai range.
- **Thorium-232:** Associated with anti-tank weapon impact areas.
- **Other Metals:** Cadmium, iron, magnesium, aluminum, and titanium are also linked to various range activities and ammunition types.

Other Related Contaminants

- **Polycyclic Aromatic Hydrocarbons (PAHs):** These were identified at the **Skeet Range**, likely resulting from the composition of the targets or launcher materials.
- **CS Riot Gas:** Historically used and tracked as part of munitions expenditures.

- **Per- and polyfluoroalkyl substances (PFAS):** While not from live fire, these are linked to toxic military training activities, specifically **Aircraft Rescue Fire Fighter Training** using Aqueous Film Forming Foam (AFFF).

3. **Please provide a summary for current contamination of groundwater at monitoring wells within and adjacent to the Project Designated Construction Zone including, GW231, GW058, GW068, GW030, GW114, GW070, GW113, GW052, GW229, GW046, GW142, GW143, GW124, GW141, GW043, GW044 and GW134, including parameter range wells and at depths less than 25 m below ground.**

Current groundwater contamination at monitoring wells within and adjacent to the Project Designated Construction Zone is primarily characterized by exceedances of federal and provincial guidelines for **dissolved metals, general chemistry parameters (anions), and specific inorganic elements**. These wells typically monitor the "Deep Aquifer," defined as depths below 12 m, though almost all are within the requested depth of less than 25 m below ground.

Summary by Monitoring Well

The following summary details the contaminants and exceedances reported for the specific wells requested:

- **GW231 (Deep):** Consistently reports exceedances for **Boron (9.32 mg/L), Sodium (2,930 mg/L), Strontium (36.1 mg/L), Iron (3.51 mg/L)**, Aluminum (0.265 mg/L), Lithium (2.72 mg/L), Manganese (0.532 mg/L), Chloride, and Sulphate (768 mg/L).
- **GW113 (Deep):** High levels of **Sodium (2,400 mg/L), Boron (9.14 mg/L), Strontium (42.8 mg/L)**, Barium (3.01 mg/L), Iron (1.58 mg/L), Manganese (0.541 mg/L), Lithium (2.16 mg/L), and Chloride.
- **GW114 (Deep):** Significant exceedances of **Sodium (1,660 mg/L), Boron (9.57 mg/L), Strontium (27.1 mg/L)**, Iron (1.62 mg/L), Manganese (0.258 mg/L), and Lithium (1.67 mg/L). It is one of the few wells reporting **Nitrite-N exceedances (0.735 mg/L)**.
- **GW030 / GW232 (Deep):** The original GW030 reported exceedances of Boron, Iron, Manganese, Sodium, and Strontium. Its replacement, GW232, reported even higher concentrations of these parameters, including **Sulphate at 1,110 mg/L**.
- **GW124 (Deep):** Key exceedances include **Boron (6.8 mg/L), Sodium (620 mg/L)**, Iron (0.94 mg/L), Manganese (0.58 mg/L), Strontium, Silver, and Zinc.
- **GW142 & GW143 (Deep):** Located near the Garrison Landfill, these wells report exceedances for **Boron (up to 8.6 mg/L)**, Manganese, Iron, Chloride, and Fluoride. GW142 reports **Sulphate at 855 mg/L**.
- **GW058 (Deep):** Exceedances for **Manganese, Boron**, Barium, Zinc, Selenium, and Sulphate (129.5 mg/L).
- **GW070 (Shallow/Deep):** Exceedances for Manganese, Iron, Barium, Boron, Lithium, Sodium, Strontium, Chloride, and Fluoride.

- **Other Designated Wells:**

- **GW068:** Manganese, Zinc, and Nitrite.
- **GW052:** Boron, Calcium, Uranium, and Chloride.
- **GW046:** Antimony, Boron, and Zinc.
- **GW229:** Boron.
- **GW141:** Boron and Manganese.
- **GW043:** Copper, Boron, Barium, and Iron.
- **GW044:** Boron, Manganese, Strontium, and Sulphate.
- **GW134:** Boron (5.78 mg/L), Iron (0.319 mg/L), Lithium, and Fluoride.

Representative Parameter Ranges (< 25 m Depth)

Concentrations vary significantly across the site, but representative ranges for primary contaminants in these wells include:

Parameter	Concentration Range (µg/L unless noted)	Reference
Boron	20 – 16,232	
Sodium	200 – 3,598,500	
Chloride	Up to 10,104 mg/L	
Sulphate	129 – 2,147 mg/L	[49, prev task]
Iron	< 100 – 14,600	
Manganese	< 2.0 – 630 (Measures up to 14,881 TL)	
Strontium	Up to 31,000	
Nitrite-N	Up to 0.735 mg N/L	
Arsenic	< 1.0 – 27.8	

Note on Depth: All deep wells mentioned are typically screened between **12 m and 20 m BGS** (e.g., GW232 borehole ends at 19.5 m). Organic contaminants like **BTEX, Energetics, and PFAS** have been detected in some of these wells (specifically at the Garrison Landfill and Sewage Lagoon) but generally remain **below applicable federal and provincial criteria**.