



*Water Resources
Management Division –
Drinking Water Quality
Improvement Initiative*

**2022-23 Contaminant
Exceedance Mentoring
Program**



Solutions today
Tomorrow  mind

CBCL Offices:

Halifax, Nova Scotia
Bedford, Nova Scotia
Sydney, Nova Scotia
Moncton, New Brunswick
Fredericton, New Brunswick
Saint John, New Brunswick
Charlottetown, Prince Edward Island
St. John's, Newfoundland & Labrador
Ottawa, Ontario

400+
employees

1500+
projects/year



Buildings



Bridges



Climate Resilience



Coastal



Environmental



Geotechnical



Industrial



Municipal



Ports & Marine



Sustainability



Transportation



Water

Terms of Reference
for
Delivery of Mentoring Program for Public Drinking
Water Systems with Contaminant Exceedances in
Newfoundland and Labrador



Water Resources Management Division
Department of Environment and Climate Change
Government of Newfoundland and Labrador
May 25, 2022

Contaminant Exceedance Mentoring Program

CBCL responded to an RFP by the ECC-WRMD

Communities with MAC exceedances for Mn, As

Review water infrastructure, understand issues, discuss options

Provide recommendations to address exceedances

Project Schedule

- Community Outreach and Correspondence (Info Flyer)
- Develop Tools for Corrective Measures
 - Add Input Parameters
 - Obtain applicable CM's
- Conduct site visit, apply tools, discuss potential options
- Determine best CM for community
- Use Existing FCAA Tool
 - Upgrade Costs
 - O&M Costs
- Present recommendation
- Project underway, to be completed in 2023



2022-2023 Contaminant Exceedance Mentoring Program

The Newfoundland and Labrador Department of Environment and Climate Change (ECC) invites communities with recent contaminant exceedances in public drinking water systems to participate in the 2022-2023 mentoring program.

If your community is

This **free** mentorship program is designed to provide communities with guidance to build financial and technical capacity to make informed decisions and reduce health risks to water system users. This project will be administered by consulting engineers and specialists from CBCL Limited, on behalf of the Government of Newfoundland and Labrador.

The program is focused on communities dealing with **Arsenic** or **Manganese** exceedances.

CBCL will present a community specific action plan including:

- Site assessment of existing water quality and operational practices.
- Significance of Non-

NL Communities with Manganese and Arsenic Issues

2013-2023

363
Communities
total



Manganese Mn			
Raw		Treated	
>AO	>MAC	>AO	>MAC
183	39	201	50

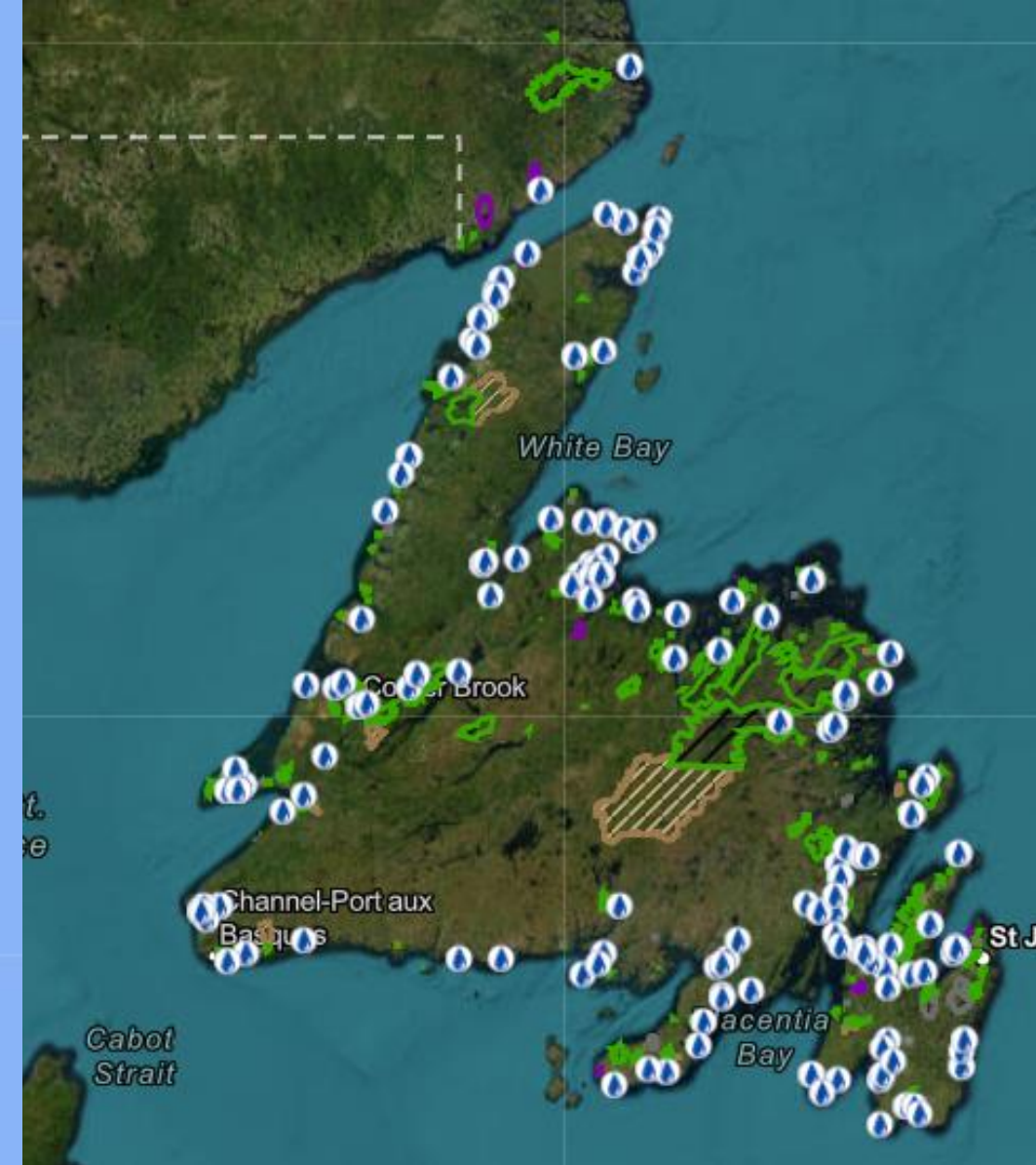
Arsenic As			
Raw		Treated	
>0	>MAC	>0	>MAC
56	14	68	12



Manganese (Mn):

- Found naturally in surface and groundwater sources
- Can be seasonal or continuous issue
- Causes discoloration in water
- Excess amount linked to neurological effects in children
- GCDWQ
 - MAC = 0.120 mg/L (Health Canada, 2019)
 - AO = 0.02 mg/L

**A Widespread Issue - Mn
Exceedances in NL (2019-
2022)**



**Amongst other Issues...
Current BWAs - March 28, 2023**

Nfld. & Labrador

Thousands of St. John's residents warned not to drink city water



Water stations will be set up starting Wednesday

CBC News - Posted: Aug 28, 2018 5:17 PM ADT | Last Updated: August 29, 2018

Manganese – nutrient and nuisance at low levels...



Nfld. & Labrador

Hold my beer: Labatt halts production at St. John's plant after city's water warning



Spokesperson says more testing is being done until company is satisfied beer is safe to drink

CBC News · Posted: Aug 30, 2018 6:53 AM ADT | Last Updated: August 30, 2018



...serious concern at higher levels.



Manganese Treatment Technologies

Oxidative Media (e.g., Greensand Filtration)

Chemical Oxidation

Ion Exchange

Adsorption Media

Potable Water Dispensing Units

Hypolimnetic Aeration

Conventional Water Treatment (with Oxidation)



Historical Manganese Approaches

Reduce or Stop Chlorination

Polyphosphate (Sequestrant)

Challenges with Manganese Removal

- Various oxidation states – Mn^{2+} is highly soluble, slower oxidation rate versus dissolved iron
- Surface Water Sources
 - Found at bottom of surface water sources in sediment
 - Released during lake turnover
 - Large seasonal variation in concentrations
- Groundwater Sources
 - Dissolved oxidation state
 - Must be converted to a solid state for removal
 - Iron can compete with oxidation chemicals

A photograph of a water treatment facility interior. The room is filled with industrial equipment, including large blue cylindrical tanks, complex piping systems with numerous red valves, and metal walkways. A person is visible on a walkway in the upper left. The floor is a light-colored, polished surface. The walls are white with several windows. The lighting is bright, coming from overhead fixtures. Two white text boxes with black borders are overlaid on the image, one on the left and one on the right, each containing text describing a different type of water treatment process.

**Conventional
Treatment (Active)**

**Oxidative Media
(Passive)**



Greensand Filtration



**Oxidation +
Conventional
Treatment**

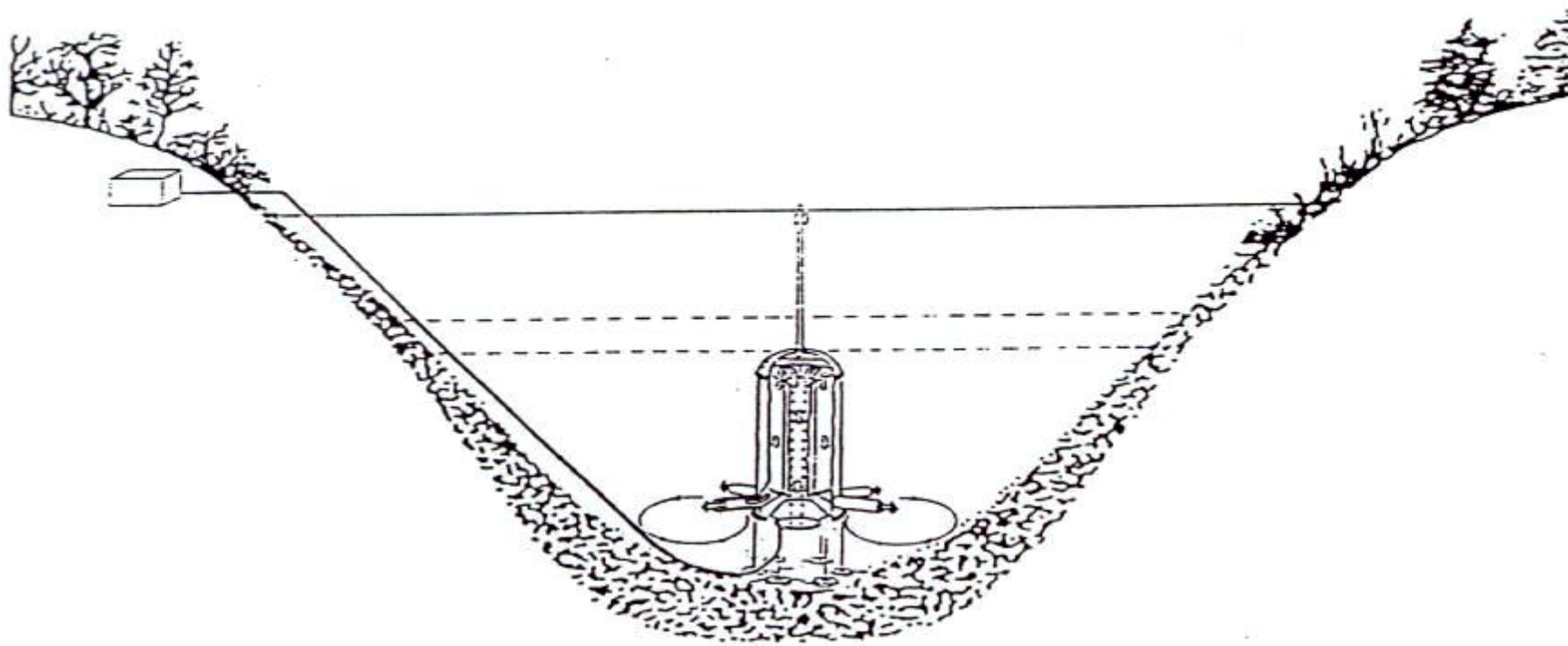
The image shows a complex industrial water treatment system. In the foreground, a control panel with a screen and buttons is visible, with several blue and black cables connected to it. Below the control panel, there's a metal frame structure. Inside this frame, there are rows of aeration devices, likely diffusers, which are illuminated with a bright yellow light. The background shows a large industrial facility with various pipes, valves, and structural elements. The overall scene is a technical and industrial environment.

Oxidation + High-Rate Clarification



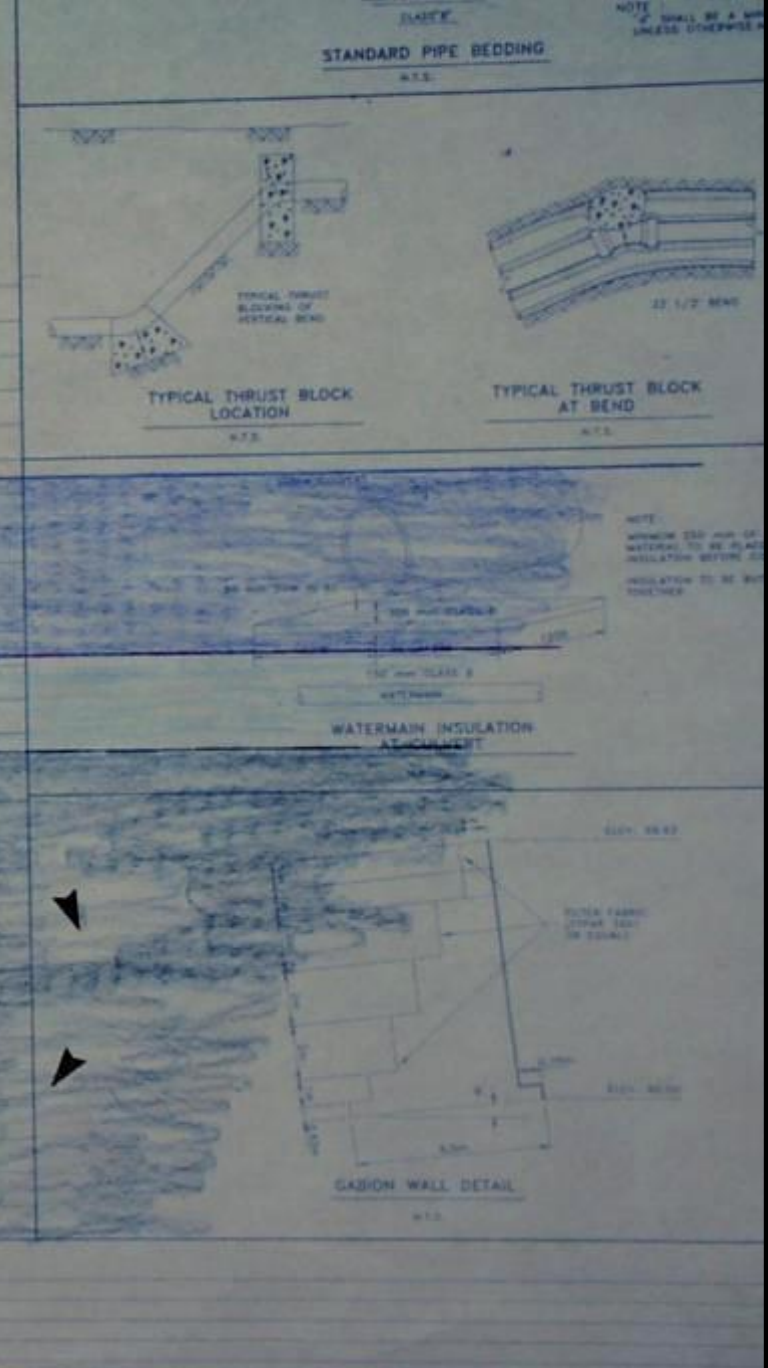
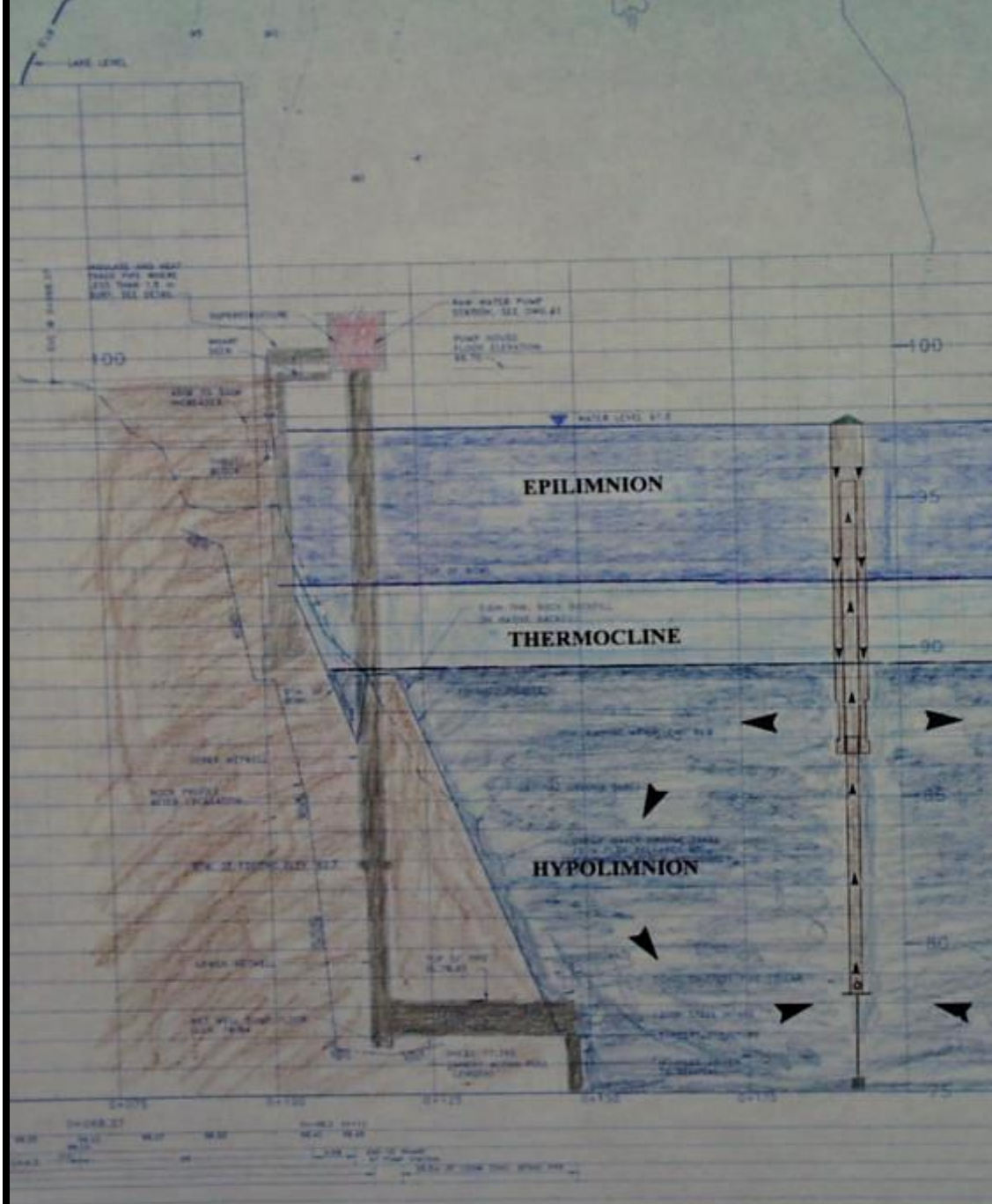
Hypolimnetic Aeration

Intake/Pumphouse



Hypolimnetic aeration (Limno)

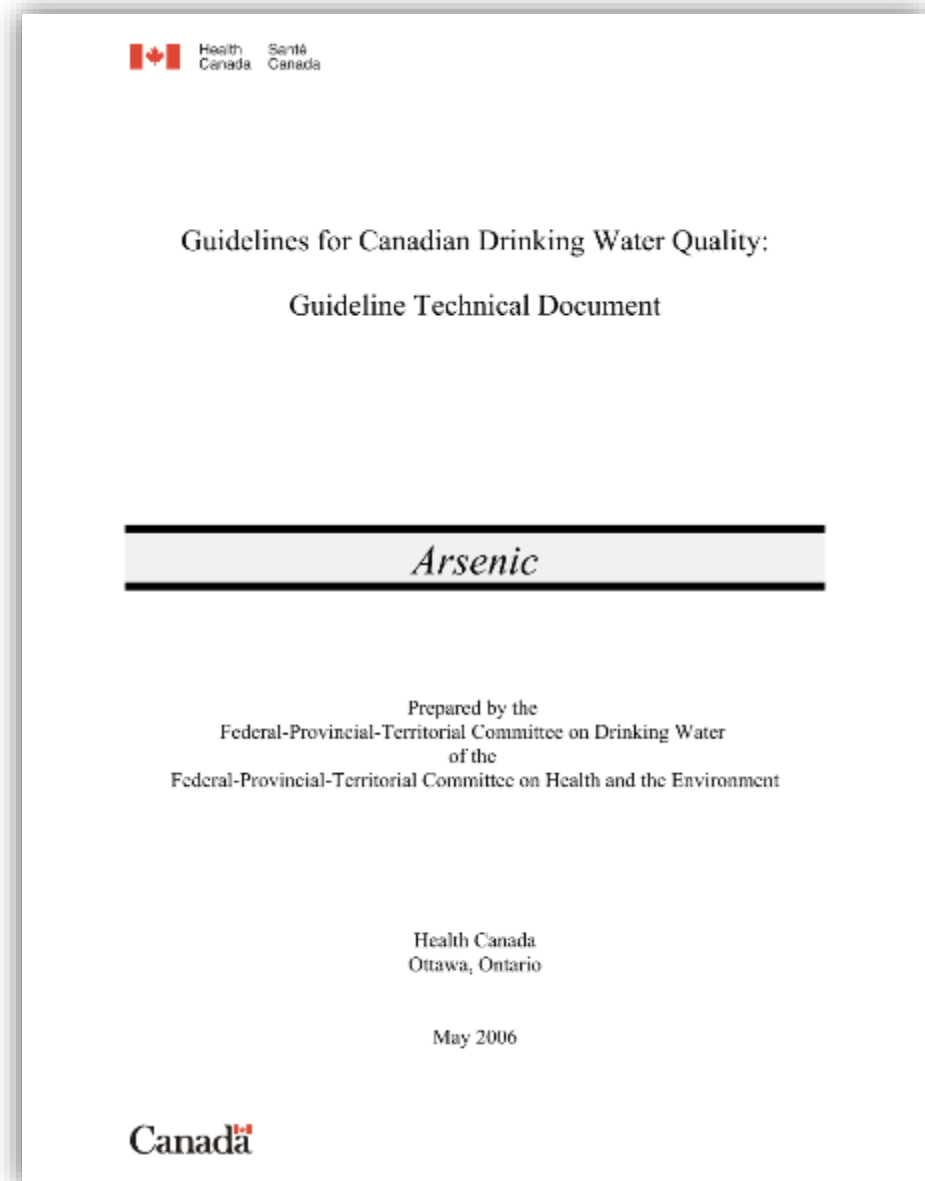
- A. Aerates without destratifying
- B. Maintains oxygen level at critical sediment/water interface
- C. Suppresses release of iron, manganese, phosphorous, nitrogen, and heavy metals
- D. Permits normal biological activity
- E. Long life—no in-lake maintenance
- F. Can operate year-round
- G. Reduces treatment costs
 1. Fewer chemicals required
 2. Less filtration and filter cleaning
 3. Less sludge disposal
- H. Improves water quality—reduces problems at source:
 1. Iron/manganese concentrations
 2. High organic loads
 3. Algae-related taste and odor
 4. Preoxidation—THM formation
 5. Fluctuating water quality



DRAWING NO. W-10001
 DATE: 11/11/10
 SCALE: AS SHOWN
 SHEET NO. 01 OF 02
 PROJECT NO. W-10001

Arsenic (As)

- Arsenic is a known carcinogenic compound with MAC = 0.010 mg/L – **no safe amount**
- Found naturally in geological formations, anthropogenic sources
- More common in groundwater supplies
- Various other negative health effects:
 - Gastrointestinal Issues
 - Poor Blood Production
 - Abnormal Heartbeat
- **No aesthetic impact**
- As³⁺ / As⁵⁺ are typical oxidation states. 5+ is readily treated, 3+ is not



Arsenic Treatment Technologies

Ion Exchange – Anion Exchange

Adsorption Media – Iron Based Adsorptive Media

Lime Softening

Oxidation/Filtration

Potable Water Dispensing Units

Conventional Water Treatment Plant

Contaminant Exceedance Tool

- Microsoft Excel Tool
- Determines valid corrective measures (CM) for As and Mn exceedances
- Decision based on input factors
- Input factors include:
 - Source Water Characteristics
 - Contaminant Properties
 - Existing Infrastructure
 - Water Demand (flow)
 - Source Water Quality



Manganese Assessment Tool (MAS)

Source Water Characteristics

Water Source	Surface Water
Number of Sources	1

Contaminant Properties

Manganese Species	Unknown
Manganese Concentration	All Sources, [Mn]>MAC
Frequency of Occurrence	Continuous

Existing Infrastructure

Pre-Oxidation	Absent
Conventional Treatment	Absent
Membrane	Absent
Chlorination	Present

Plant Flows

Flows	> 35 L/min
-------	------------

Water Parameters of Concern

pH	6-8
Turbidity	< 1.0 NTU
Iron	> 0.3 mg/L
DOC	> 3.0 mg/L

Instructions:

- 1) Click on blue cells and click on the drop down tab
- 2) Select the appropriate response for each step
- 3) Proceed through workbook and answer **all** steps
- 4) Valid Corrective measures will appear in green
- 5) Inputting more information will provide a more detailed analysis and eliminate invalid CM's
- 6) If no valid entries appear, a full assessment may be required.

Corrective Measures (CM)

Selective Pumping	Invalid CM
New Source(s)	Valid CM
Hypolimnetic Aeration	Valid CM
Chemical Oxidation	Invalid CM
Greensand Filter	Valid CM
Multimedia + Greensand Filter	Valid CM with Pretreatment
Ion Exchange	Invalid CM
Prefiltration + Ion Exchange	Invalid CM
PWDU/RO	Invalid CM
Adsorption	Invalid CM

Arsenic Assessment Tool (AAS)

Source Water Characteristics

Water Source	Ground Water
Number of Sources	>1

Contaminant Properties

Arsenic Species	Unknown
Arsenic Concentration	Not All Sources [As]>MAC
Frequency of Occurrence	Continuous

Existing Infrastructure

Pre-Screening	Absent
Pre-Oxidation	Absent
Conventional Treatment	Absent
Membrane	Absent
Chlorination	Present

Plant Flows

Flows	< 35 L/min
-------	------------

Water Parameters of Concern

pH	6-8
Turbidity	< 1.0 NTU
Iron	< 0.3 mg/L
Manganese	< 0.02 mg/L
TDS	< 250 mg/L
Sulfate	< 40 mg/L
Calcium	Absent
Hardness	< 60 mg-CaCO3/L
DOC	< 3.0 mg/L

Instructions:

- 1) Click on blue cells and click on the drop down tab
- 2) Select the appropriate response for each step
- 3) Proceed through workbook and answer **all** steps
- 4) Valid Corrective measures will appear in green
- 5) Inputting more information will provide a more detailed analysis and eliminate invalid CM's
- 6) If no valid entries appear, a full assessment may be required.

Corrective Measures (CM)

Selective Pumping	Valid CM
New Source(s)	Valid CM
Ion Exchange (IX)	Valid CM
Conventional Treatment	Invalid CM
Iron/Manganese Oxidation	Invalid CM
Lime Softening	Invalid CM
Adsorption Media	Valid CM with pH Adjustment
Coagulation Assisted Microfiltration	Invalid CM
PWDU/RO	Valid CM

Full Cost Accounting Assessment (FCAA) Tool

- Publicly available Microsoft Excel Tool
- Designed for small communities in Newfoundland & Labrador
- Tabulates costs for public drinking water systems
- Promotes fiscal planning
- Helps to highlight unforeseen costs



Province of Newfoundland & Labrador Full Cost Accounting Assessment Tool

To Achieve Complete Cost Recovery of Drinking Water
Supply System Operation & Maintenance,
Capital Upgrade Projects and Infrastructure Replacement

Community:

Geographic Region:

1

- Avalon (St. Johns): 1.0
- 2 Eastern (Clarenville): 1.05
- Central (Gander): 1.05
- Central West (Corner Brook): 1.05
- North West (St. Anthony): 1.1

Date:

3

Month Day Year:

Note: Each geographic region is associated with a cost multiplier to represent adjustment of predicted O&M and capital costs by geographic region across the province. The multiplier is displayed next to the geographic region in the dropdown.

4 Begin

FCAA Tool - Sections



Existing Treatment & Distribution Systems



Proposed Capital Upgrades



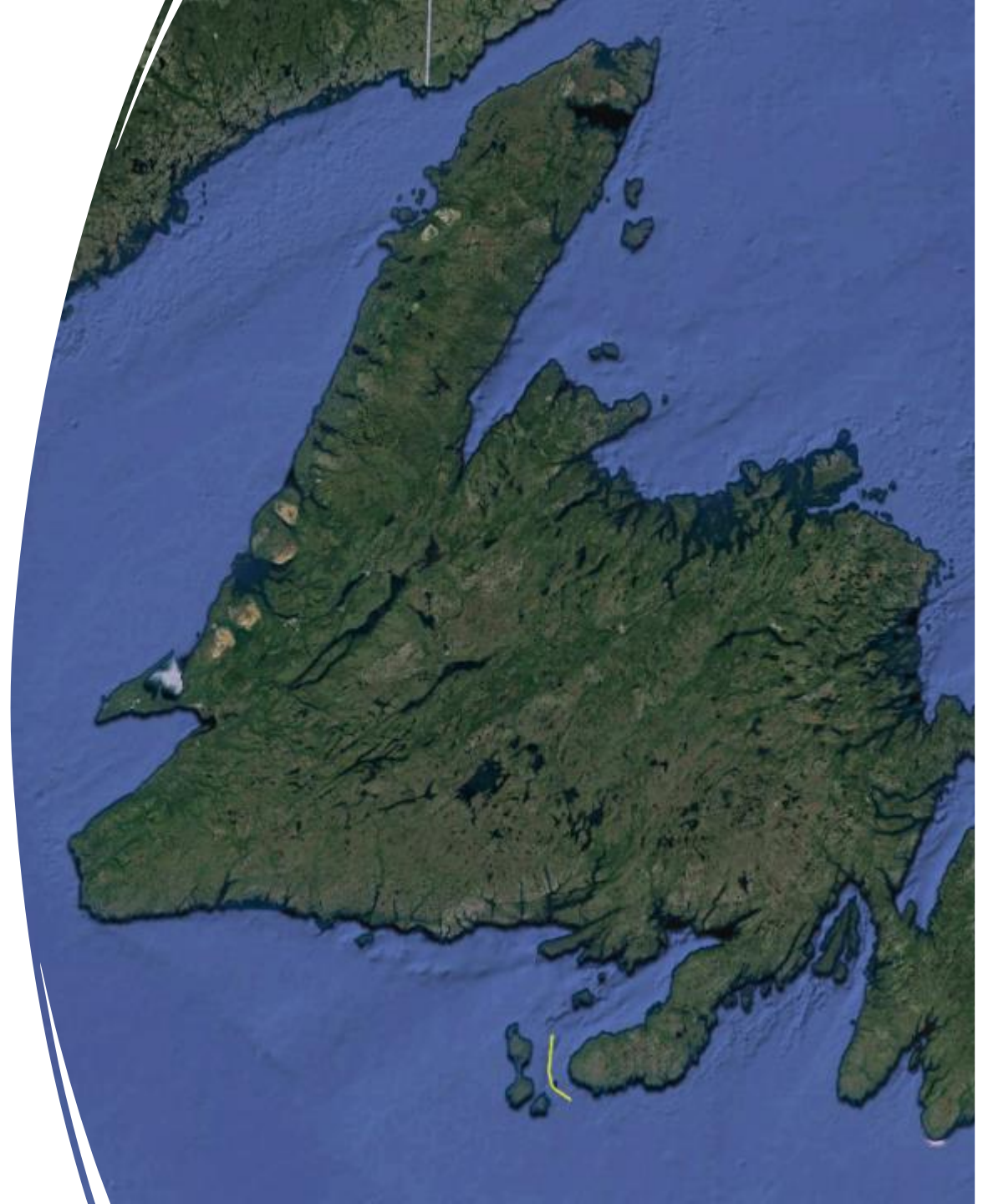
Financing and Cost of Drinking Water System



Discrete Infrastructure Replacement

Case Study #1

- Community of 1826 people
- Existing WTP Infrastructure:
 - Surface Water Supply
 - Rotating Screen
 - Chlorination
 - pH Adjustment
- Exceedances of Manganese MAC & AO
- High organics in drinking water leading to high DBPs



Corrective Measures (CM)

<u>Selective Pumping</u>	Invalid CM
<u>New Source(s)</u>	Valid CM
<u>Hypolimnetic Aeration</u>	Valid CM
<u>Chemical Oxidation</u>	Invalid CM
<u>Greensand Filter</u>	Valid CM
<u>Multimedia + Greensand Filter</u>	Valid CM with Pretreatment
<u>Ion Exchange</u>	Invalid CM
<u>Prefiltration + Ion Exchange</u>	Invalid CM
<u>PWDU/RO</u>	Invalid CM
<u>Adsorption</u>	Invalid CM

Case Study #1

- CE tool determined there were 4 valid corrective measures
 - New source
 - Hypolimnetic Aeration*
 - Greensand Filter*
 - Conventional WTP
- Conventional WTP the recommended CM
- New WTP would address both the Mn and the high organics/DBP's issues.

Case Study #1

<i>Upgrade Component</i>	<i>Capital Cost</i>	<i>Government Contributions</i>	<i>Balance Covered by Community</i>
<i>Water Treatment Facility</i>	\$2,688,000	\$1,344,000	\$1,344,000
Pumping Systems			
Distribution			
Storage			
<i>Range of Probable Cost</i>			
-30%	\$1,881,600	\$940,800	\$940,800
Median	\$2,688,000	\$1,344,000	\$1,344,000
+30%	\$3,494,400	\$1,747,200	\$1,747,200

<i>Item</i>	<i>Predicted O&M Costs¹</i>
Source of Supply	\$7,455
Pumping	\$0
Treatment & Disinfection	\$85,050
Transmission & Distribution	\$246,750
Administration	\$33,915
Total	\$373,170

- FCAA used to estimated cost of a new WTP
- New WTP: \$1.8-3.5 million
- Cost splitting with government a path to reduce community costs
- 50/50 split: Community est. cost \$950,000 - \$1.8 million
- Annual O&M cost expected to be \$373,000 per year

Case Study #2

- Community of 400 people
- Located on the Avalon Peninsula
- Existing WTP Infrastructure:
 - Multiple interconnected wells
 - Chlorination
 - Arsenic adsorption (applicable wells)
- Exceedances of Arsenic MAC in the raw water at three wells



Corrective Measures (CM)

<u>Selective Pumping</u>	Valid CM
<u>New Source(s)</u>	Valid CM
<u>Ion Exchange (IX)</u>	Valid CM
<u>Conventional Treatment</u>	Invalid CM
<u>Iron/Manganese Oxidation</u>	Invalid CM
<u>Lime Softening</u>	Invalid CM
<u>Adsorption Media</u>	Valid CM with pH Adjustment
<u>Cogulation Assisted Microfiltration</u>	Invalid CM
<u>PWDU/RO</u>	Valid CM

Case Study #2

- Contaminant Exceedance tool determined there were 5 valid CM's
 - Selective Pumping
 - New source
 - Ion Exchange
 - Adsorption Media
 - PWDU
- Existing arsenic adsorption media filters are an appropriate CM



Case Study #2

- Arsenic adsorption filters already in use
- Media becomes exhausted with arsenic
- Requires regular replacement
- Recommendations: Focused on operation and maintenance
 - Begin regular arsenic testing pre & post filters
 - Replace media once exhausted

Contaminant Exceedances - Project Summary


- Manganese and Arsenic are a widespread issues, many communities fit criteria for advice / improvements, 15 engaged and project delivery is underway
- Contaminant Exceedance Tool helpful to identify potential solutions as an initial “screening tool”
- FCAA tool
 - Financial planning of water treatment systems
 - Beneficial for infrastructure upgrades & replacement
- Recommendation for approach is highly site specific, tools do not replace advice from a water treatment specialist / engineering consultant

Future Consulting Alternative?

B

ChatGPT bot, what options are there for arsenic treatment in drinking water?



There are several options for arsenic treatment in drinking water, including: 

1. **Activated Alumina:** Activated alumina is a type of filter media that can effectively remove arsenic from water. It works by attracting and adsorbing arsenic ions onto its surface.
2. **Reverse Osmosis:** Reverse osmosis is a water treatment process that uses a semi-permeable membrane to remove ions, molecules, and larger particles from water. It can effectively remove arsenic from water.
3. **Ion Exchange:** Ion exchange is a process that involves the exchange of ions between a solid (usually a resin) and a liquid. It can be used to remove arsenic from water by replacing arsenic ions with other ions (such as chloride or sulfate ions) that are not harmful.
4. **Coagulation/Filtration:** Coagulation and filtration is a process that involves adding chemicals to water to cause impurities (including arsenic) to form clumps, which can then be removed by filtration.
5. **Oxidation/Filtration:** Oxidation and filtration is a process that involves adding an oxidizing agent (such as chlorine or potassium permanganate) to water to convert arsenic into a form that can be removed by filtration.

It's important to note that the effectiveness of these treatment methods can vary depending on the specific water source and the concentration of arsenic present. It's recommended to consult with a water treatment professional to determine the best treatment method for a particular situation.

C B C L

Earth Environment Water
Industrial Infrastructure Building

C B C L

**Thank
you.**