MANAGING AND REDUCING ENVIRONMENTAL LIABILITIES AT THE TOWN OF SLAVE LAKE

A SUSTAINABLE SALT REMEDIATION STRATEGY

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Town of SLAVE LAKE

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PRESENTATION OUTLINE

- Company Introduction
- Background
- Assessments
- Operational Improvements
- Risk Management Plan
- Results and Challenges
- Future Planning and Take Aways
- Acknowledgements

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COMPANY INTRODUCTION

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Building Canada with great people and great ideas.

- Since 1957
- 100% Canadian and employee-owned
- 15 offices (AB, BC, ON, SK)
- Advanced geotechnical, construction materials, and tailings laboratories.
- 500+ dedicated full-time professionals
- 45,000+ completed projects

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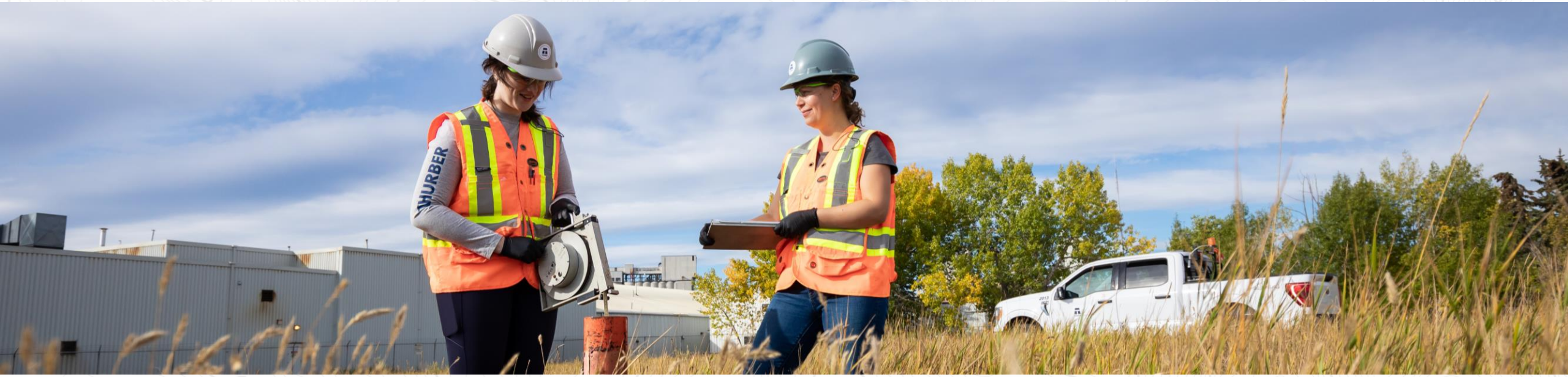
Our key services

- Geotechnical engineering
- Environmental sciences
- Construction materials engineering and testing



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Sectors served

- Buildings
- Transportation
- Infrastructure
- Industrial development
- Oil and gas
- Natural resources and renewables
- Dams, mines, and tailings facilities
- Marine development
- Land development

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CASE STUDY BACKGROUND

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Project Information

- Active town maintenance yard that managed winter salt and sand (pickled sand).
- Pickled sand originally stored and handled directly on the gravel yard resulted in salt infiltration into the soil and groundwater.
- Site assessments by previous consultants between 2004 and 2009.
- Alberta Environment and Protected Areas recommended additional assessments and requested a RAP and RMP for the site in 2009.

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Contaminant of Concern - Salt

- Commonly NaCl, $CaCl_2$, $MgCl_2$, KCl
- Environmental impacts from improper storage or management of salt.
- Potential environmental impacts from salt (SCARG, 2001):
  - Degradation of soil chemical properties and impaired vegetative growth
  - Degradation of soil physical properties caused by excess sodium concentrations
  - Degraded surface water or groundwater quality.

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ASSESSMENTS

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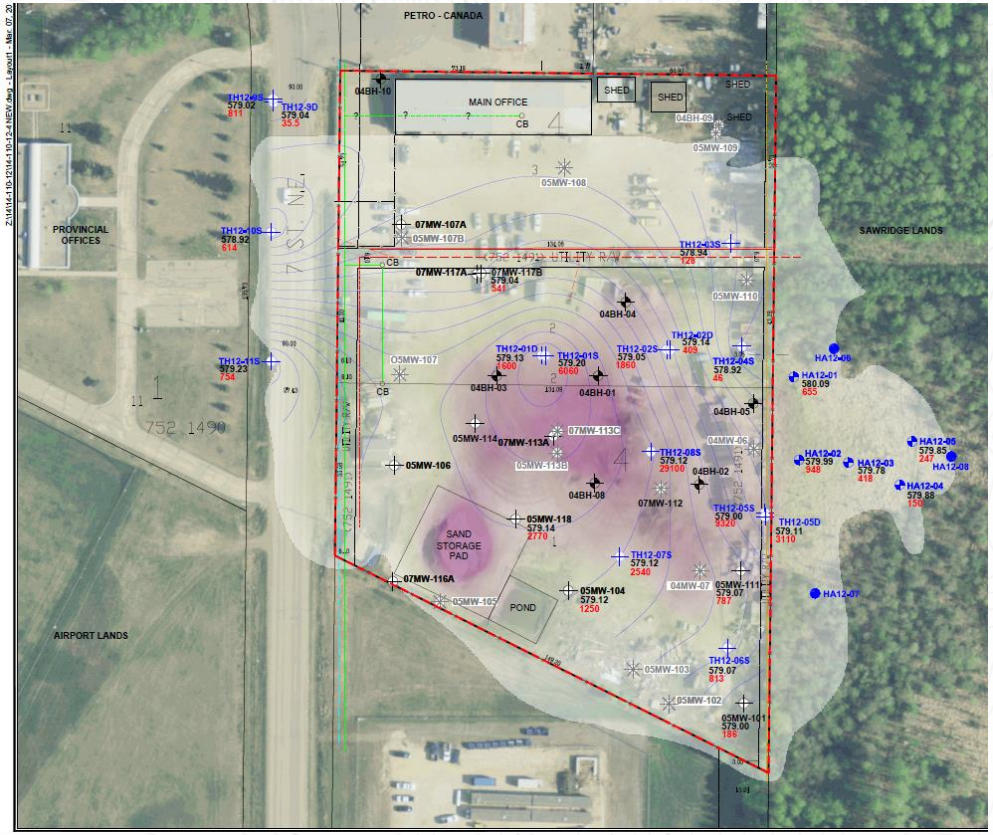
Electromagnetic Survey and Conductivity Profiles



- Electromagnetic (EM) survey completed in 2012 to evaluate the terrain conductivity.
- Vertical conductivity profiles completed during direct-push drilling investigations.
- EM survey identified areas of elevated terrain conductivity:
  - Central area where pickled sand was historically stored.
  - Current (2012) pickled sand storage pad.

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Phase 3 Environmental Site Assessment

- Thurber completed Phase 3 ESAs in 2012 and 2013.
- Expanded the existing monitoring well network:
  - Road allowance area west of 7 Street
  - Sawridge First Nations land east of the site
  - Nested wells to evaluate vertical gradients
  - Sentinel wells around the site perimeter
- Delineated the salinity impacts in the soil.

Phase 3 ESA Results

- Salinity impacts identified on site in the soil and groundwater:
  - Groundwater:
    - Peak chloride ~30,000 mg/L
    - Peak sodium ~14,000 mg/L
  - Soil:
    - Peak chloride ~15,000 mg/L
    - Peak EC ~60 dS/m
- Off-site salinity impacts in the Sawridge FN land east of the site.
- Additional off-site impacts along the road allowance NW of the site.

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OPERATIONAL IMPROVEMENTS

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Operational Improvements

- Winter salt and sand had been stored on the gravel yard.
- Operational Improvements:
  - Asphalt pad for the salt and sand stockpiles
  - Retention pond for leachate management
  - Quonset over the asphalt pad

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RISK MANAGEMENT PLAN

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Preliminary Risk Management Plan

- Thurber developed a Preliminary RMP with input from EPA.
- CoPCs identified:
  - Soil: pH, electrical conductivity (EC), sodium adsorption ratio (SAR), and elevated chloride
  - Groundwater: pH, sodium, chloride, and dissolved metals
- Assessment results:
  - Soil impacts spanned an area of approx. 11,000 m^2 (total soil volume 60,000 to 80,000 m^3).
  - Full remediation costs estimated upwards of $8 Million (in 2013).
  - Risk of plume expanding to impact surrounding environmental receptors (Lesser Slave Lake).
- Preliminary RMP proposed shallow soil treatment, vegetation assessment in Sawridge FN Lands, groundwater recovery, and further assessing and monitoring soil and groundwater conditions.

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Soil Treatment and Monitoring

- Elevated SAR in the Sawridge FN land off-site - soil treatment with gypsum was proposed.
- Elevated sodium in soil hinders plant growth and establishment.
- Gypsum, $CaSO_4 \bullet 2H_2O$, is added to soil.
  - Sodium cations that were adsorbed to soil particles are replaced by calcium cations from the gypsum amendment.
  - The sodium is then mobilized and flushed through the soil.
- Gypsum amendment was conducted during the growing season annually.
- Soil monitoring to assess the soil quality during treatment.
- Managing EC levels during soil treatment.

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Vegetation Assessment

- Evaluated vegetation species and health in the Sawridge FN Lands east of the site.
- Established a baseline for off-site conditions prior to soil treatment and groundwater remediation.

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Groundwater Recovery and Disposal

- Groundwater recovery system (GWRS) installed at a large diameter (150 mm dia.) recovery well (RW1) with a submersible pump.
- A pilot test conducted in 2014.
- RW1 and RW2 and associated infiltration trenches installed in 2015.

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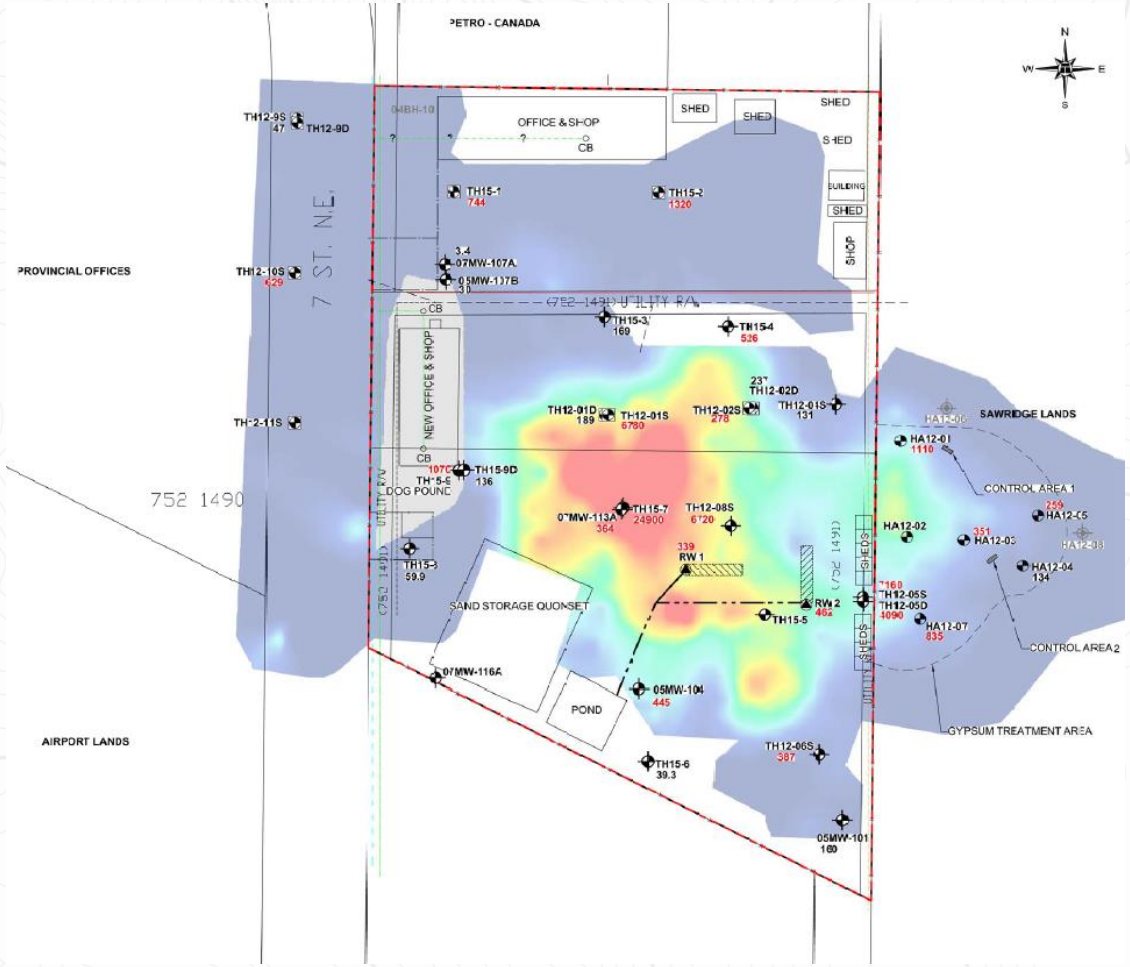
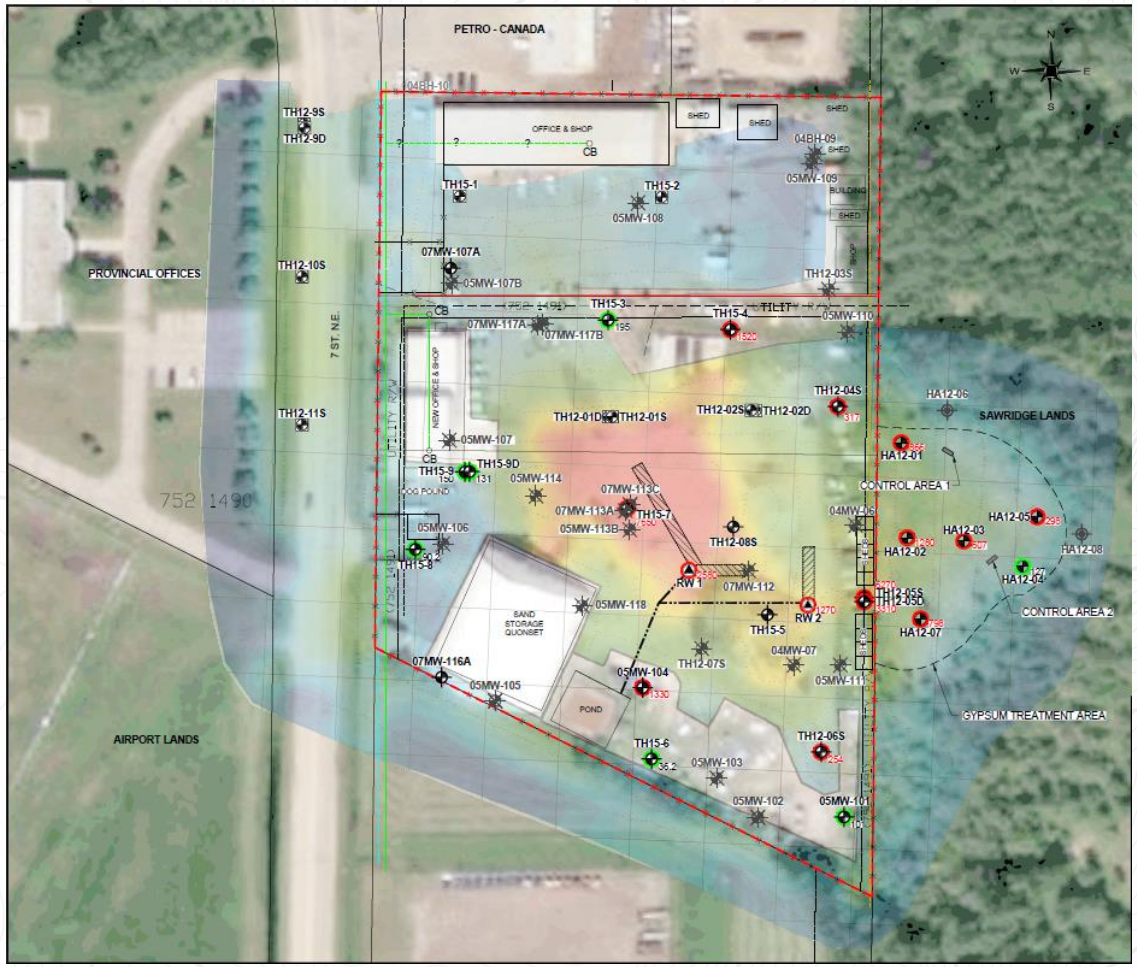
Groundwater Recovery and Disposal (continued)



2019



2024

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Groundwater Monitoring and Subsoil Salinity Tool

- Annual and semi-annual GWMPs.
- Decreasing chloride trends and retracting salinity plume.
- EM surveys completed at the site in 2012, 2018, and 2022.
- Results of the 2021 SST Evaluation
  - Limited reduction in the remedial excavation requirements.
  - Confirmed that the current RMP was protective of the nearest receptors.

RESULTS AND CHALLENGES

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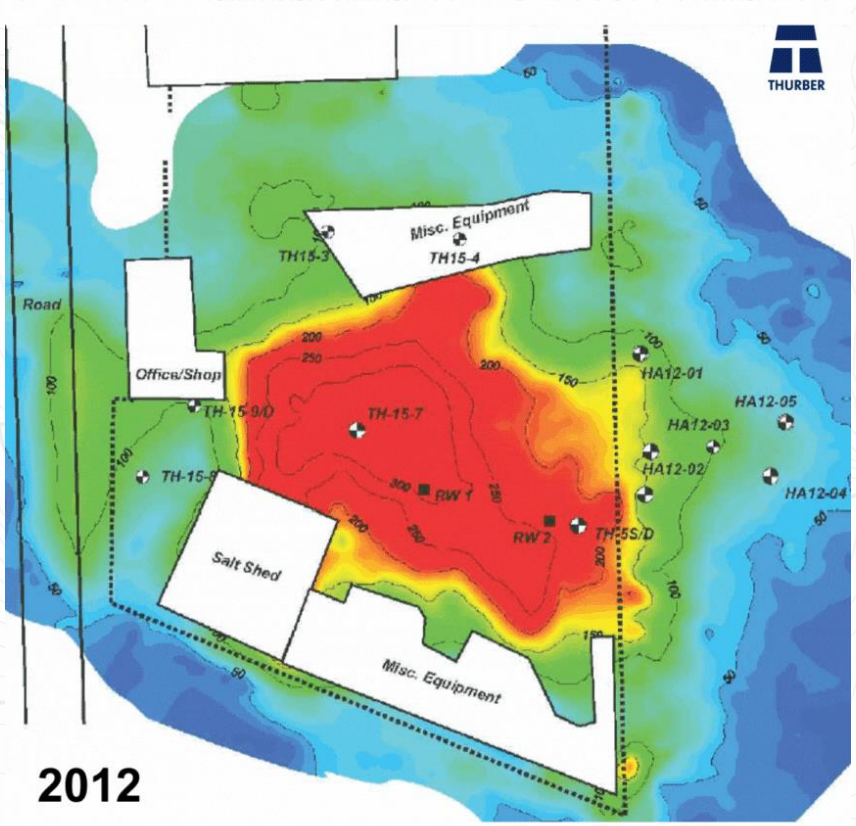
Results



- Original estimate for full remediation was $8 Million (in 2013). To date, total spent on environmental efforts are less than $1 Million.
- Since 2015, over 1,100 m^3 of chloride-impacted groundwater and 8,300 kg of chloride mass has been removed from site.
- Over 55 percent reduction in the contaminant plume area across the site.

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Challenges

- Including operations staff and leadership in planning the work each year.
- Staffing changes at the Town of Slave Lake.
- Thurber became the trusted source of current and historical data for the site to inform the new PMs and new councils and mayors.
- How to pay for this effort?
  - Providing estimates early of the full program costs.
  - Town of Slave Lake included the full costs as a liability on the town's balance sheet.
  - Each year's efforts reduced that liability.
- Becoming more efficient.
  - Engaging with operations staff to find ways to complete more tasks internally.

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FUTURE PLANNING AND TAKE AWAYS

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Future Planning

- Original objective: reduce/remove the salt source, manage the plume, and prevent impact to the lake and other surrounding receptors.
- Progress: improved operational processes, removed a substantial mass of chloride, and shrunk the contaminant plume.
- Next steps: long-term groundwater and soil monitoring while site is operational.

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Key Take Aways

- Continue verifying and calibrating remedial methods by collecting data (e.g. EM surveys, soil and groundwater monitoring, analytical data).
- Closed feedback loop.
- Progress is made with consistent and sustainable effort.
- Client is king.

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THANK YOU!

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