

A New Approach to an Old Problem – Chloride and Sulphate at the Former CN Irma Landfill



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Presentation Outline

- Site Description and Setting
- Contaminants of Concern and Areas of Impact
- A New Way of Looking at an Old Problem...
- 2012 Investigation and Results
- Next Steps!

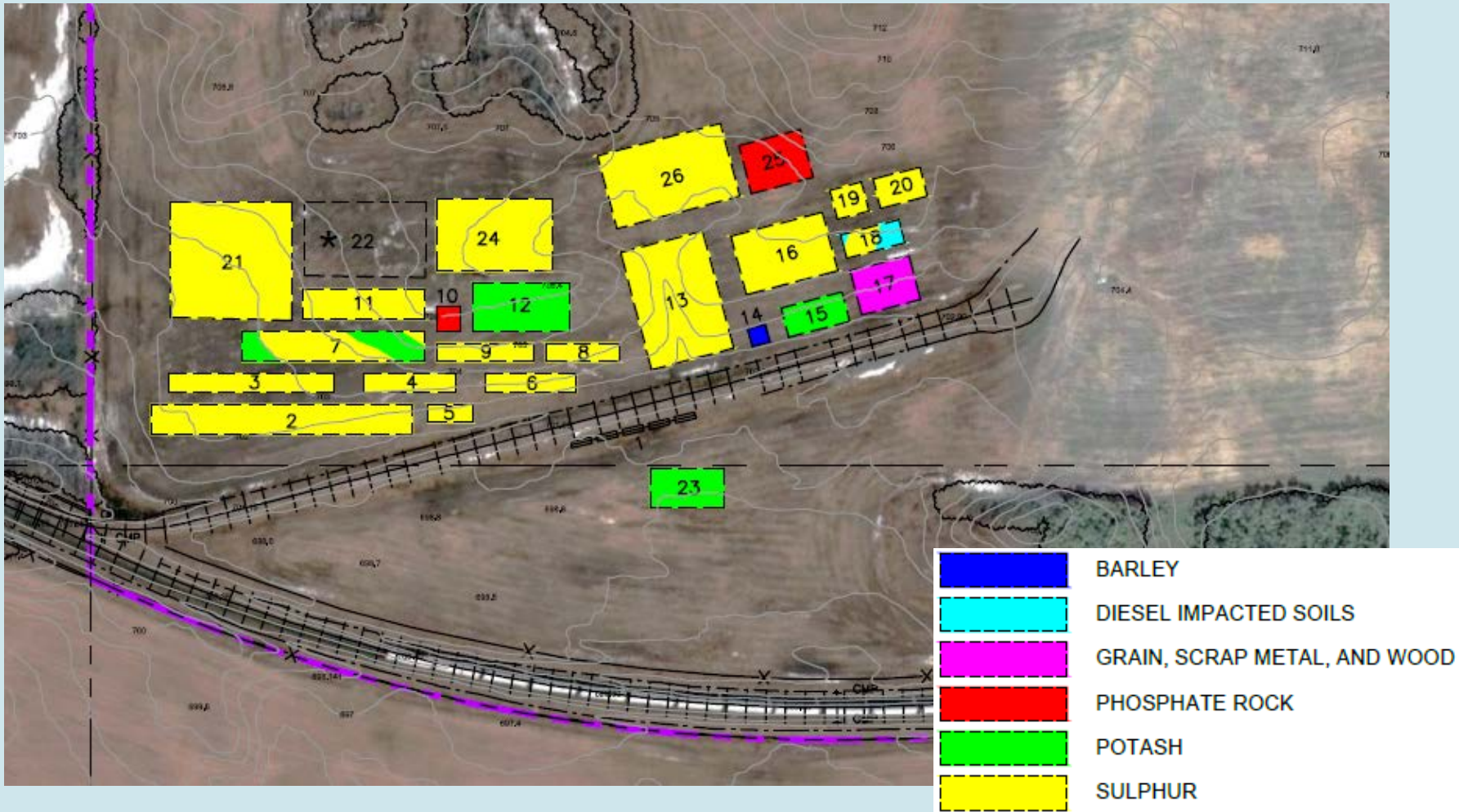


Site Setting





Historical Site Operations

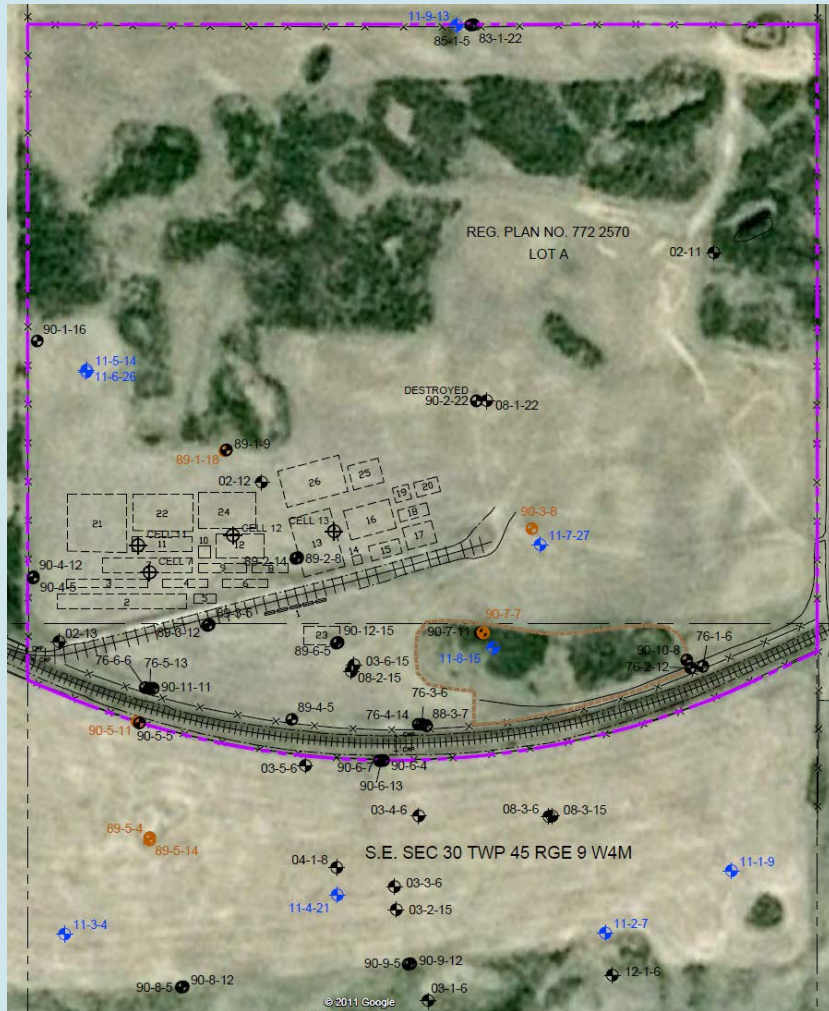


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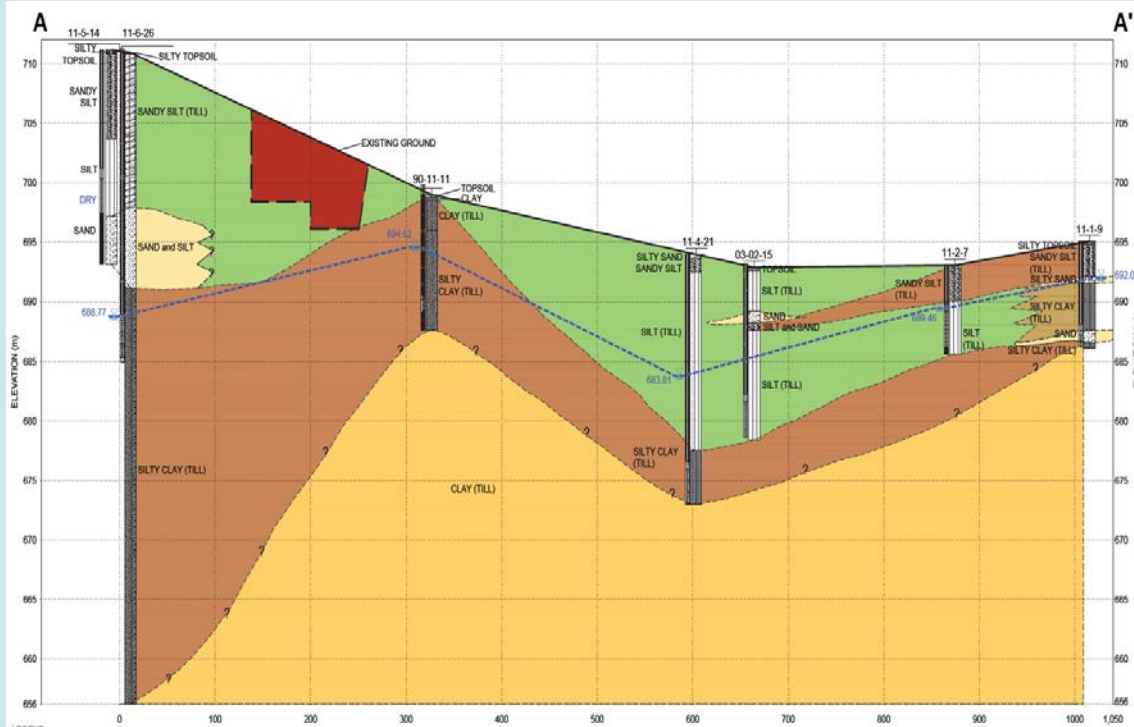
Monitoring Well Network and Topography



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Geology and Hydrogeology



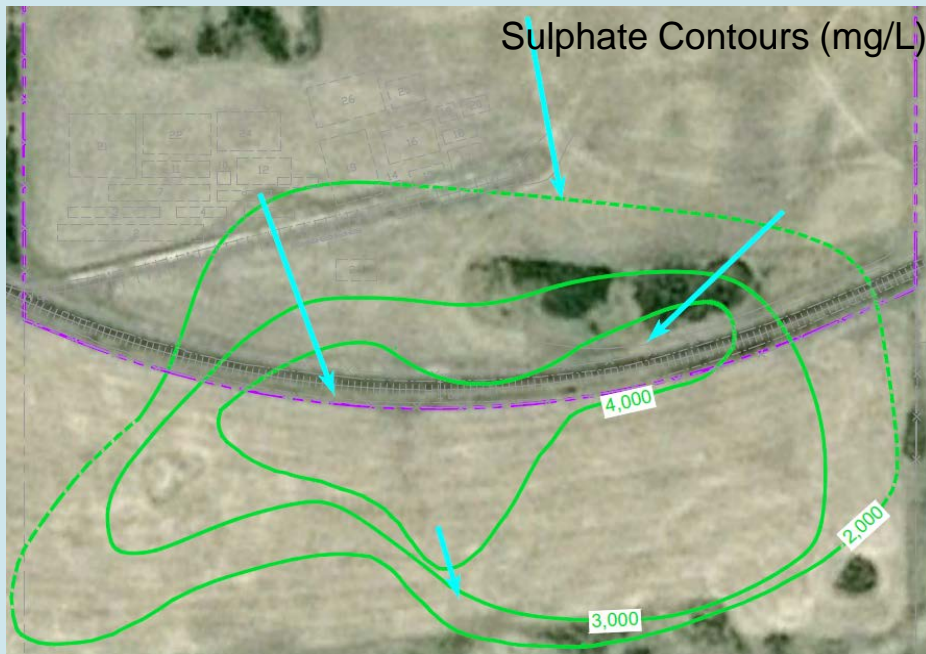
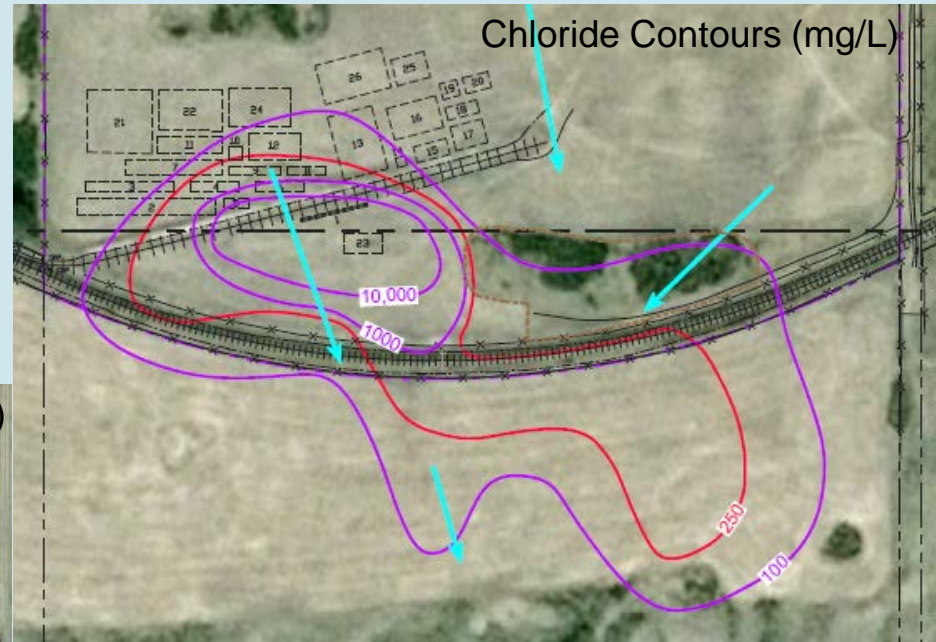
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Contaminants of Concern in Groundwater

- Chloride (From Landfilled Potash)
 - 2 Components:
 - Localized Brine Pool
 - Dilute Plume
- Sulphate (From Landfilled Sulphur?)

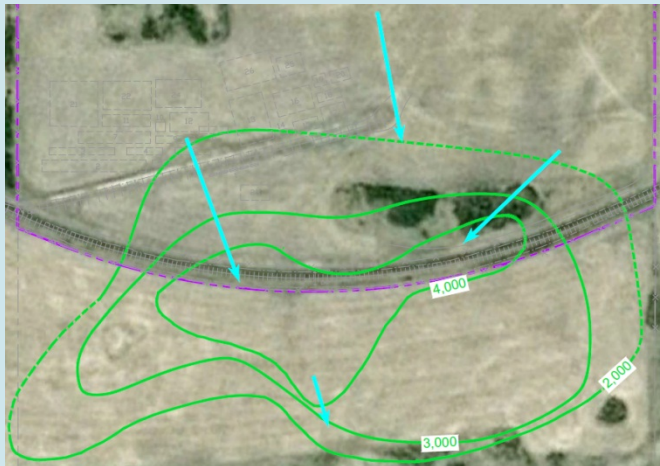




Could it be Natural?

Rational:

- The highest concentrations of sulphate are not centered at the landfill (like chloride), but rather along the rail line;
- Sulphate concentrations upgradient have consistently been comparable or higher than concentrations within the landfill;
- Groundwater in the Interior Plains of Canada are known for having high sulphate concentrations





Natural Formation Process

- High sulphate groundwater is attributed to the weathering of the Laurentide ice sheet glacial deposits.
- During glaciation, the Laurentide and Cordilleran ice sheets met in Calgary, extending north/south through central Alberta.

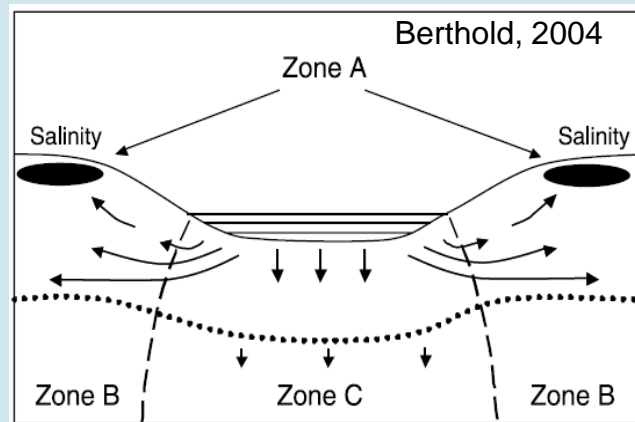


- The two ice sheets transported and deposited different geologic materials
- This resulted in distinct differences in groundwater chemistry between eastern Alberta (Laurentide ice sheet) and western Alberta (Cordilleran ice sheet).
- Sulphate is formed through the oxidation of pyrite in these Laurentide tills.
- Sulphate precipitates from tills and accumulates in areas of groundwater discharge



Evapotranspiration

- Highest concentrations consistently near rail line south of landfill
- Sulphate and sulphate salts can accumulate in groundwater and soil around a depression due to downward recharge and subsequent evapotranspiration
- Evapotranspiration can be enhanced by phreatophytic trees such as willows and poplars and can aid in magnifying sulphate concentrations
- Phreatophytes - deep-rooted, high-transpiring, water-loving trees that send their roots into regions of high moisture (Gatliff 1994)





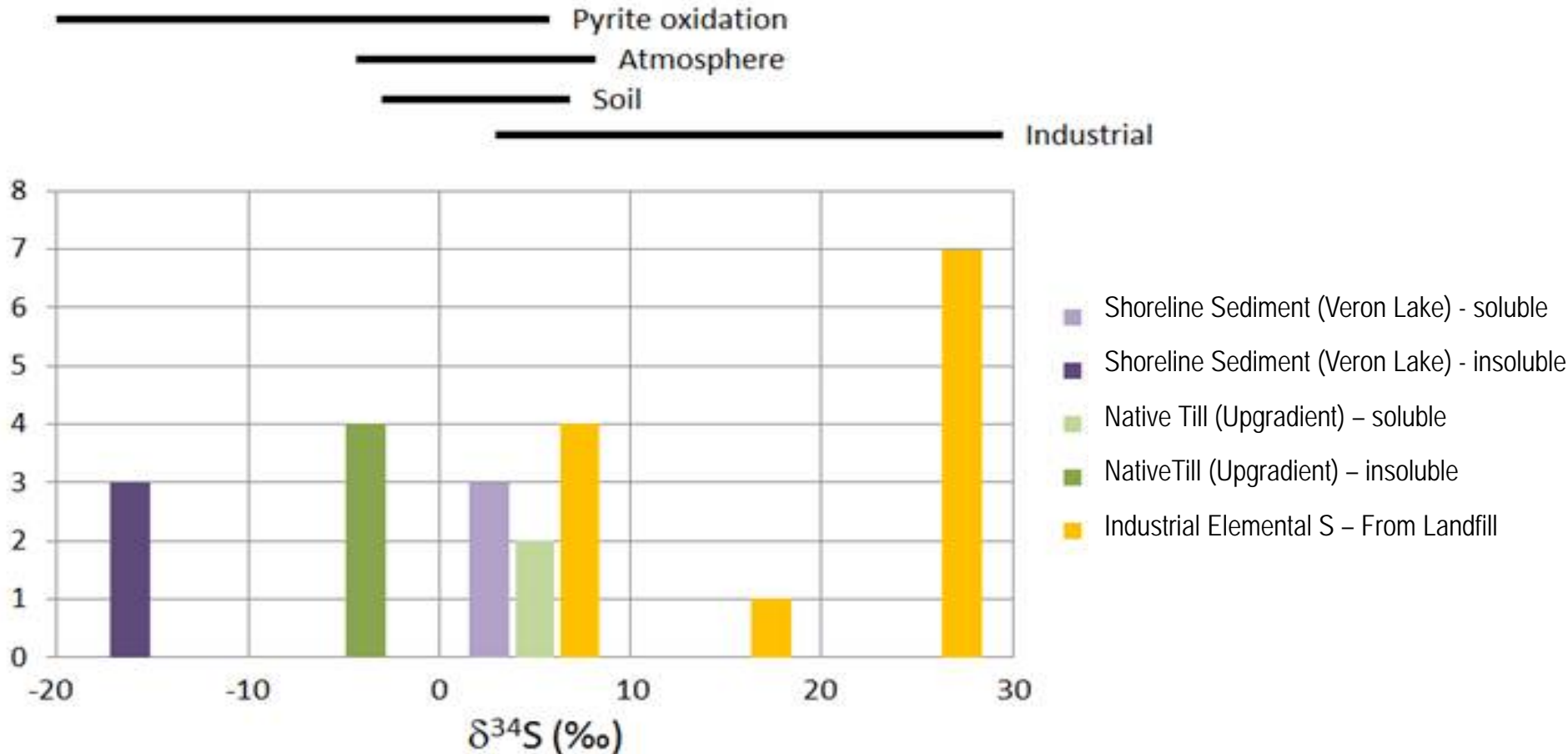
Isotope Sampling Program

- Soil Samples:
 - Thirteen samples from landfill cells which contain sulphur for $\delta^{34}\text{S}_{(\text{SO}_4)}$;
 - Shallow native glacial till samples from upgradient from the landfill for $\delta^{34}\text{S}_{(\text{SO}_4)}$;
 - Sediment samples from Veron Lake for $\delta^{34}\text{S}_{(\text{SO}_4)}$ and $\delta^{18}\text{O}_{(\text{SO}_4)}$.
- Groundwater Samples:
 - 6 wells: upgradient and downgradient of landfill for $\delta^2\text{H}$, $\delta^{18}\text{O}$, and $\delta^{34}\text{S}_{(\text{SO}_4)}$.
- All submitted to University of Calgary

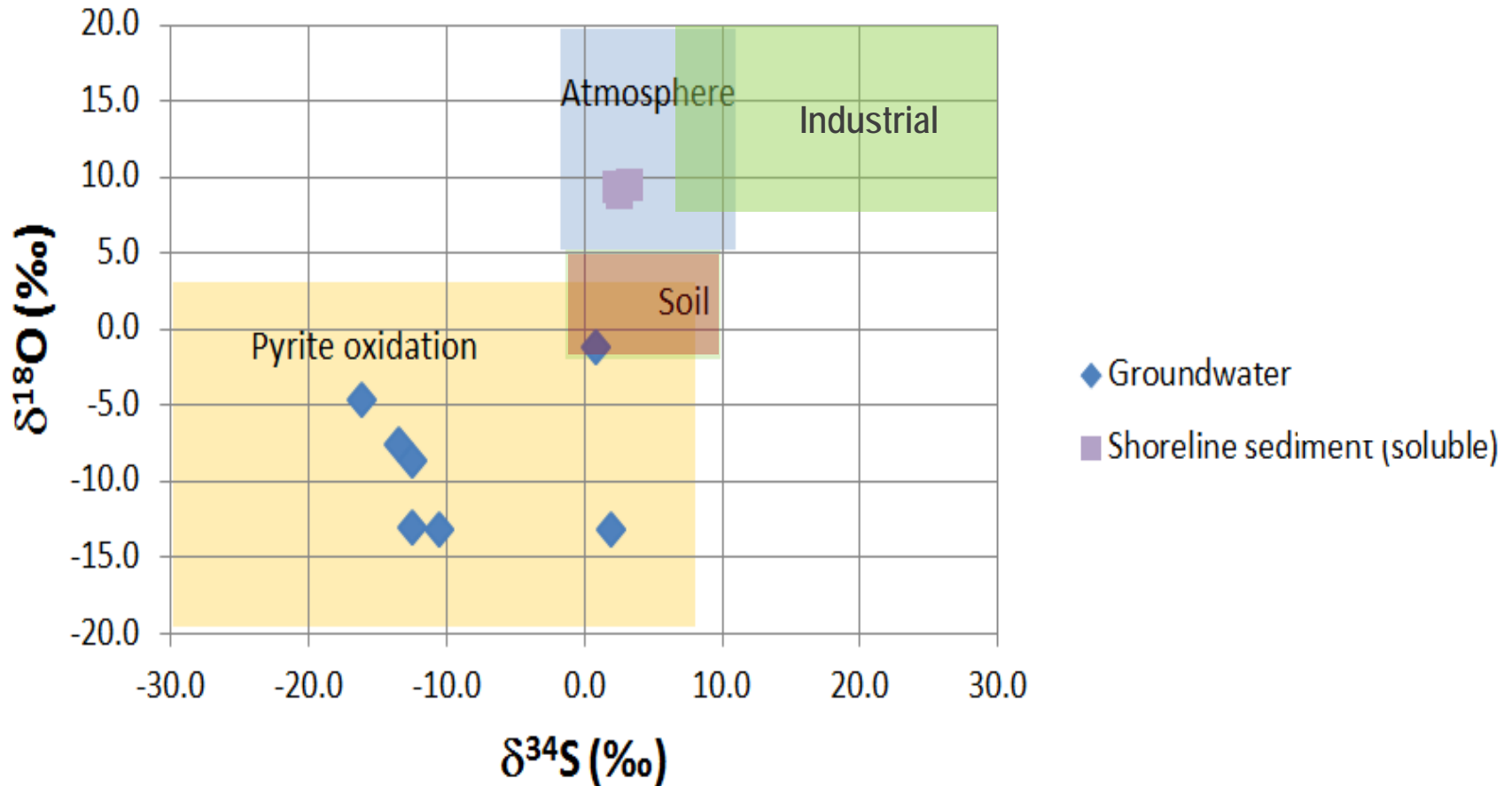




Isotope Results



Isotope Results





Summary of Findings

- There is a clear distinction in the isotope signature between natural sulphur derived from prairie tills and sulphur derived from processing of hydrocarbons
- Concluded that sulphate concentrations down gradient of the landfill are indicative of natural conditions
- The dominant source of sulphate in groundwater is not from industrial sulphur in the landfill but from oxidative dissolution of pyrite dispersed in glacial tills
- And Finally.....Chloride (and not sulphate) is the only contaminant of concern at the Site!



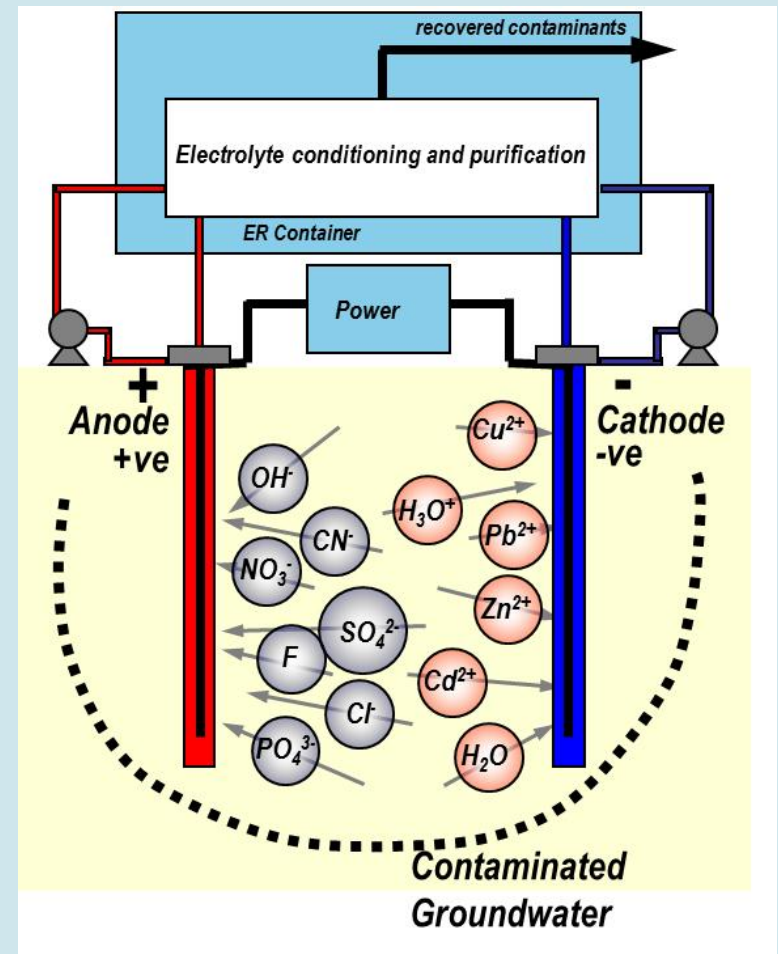
Addressing the Chloride Impacts

- Remedial Options Analysis carried out in spring 2013 to address chloride impacts
- Options were analyzed using the CN Sustainability Evaluation Tool for Site Remediation (GoldSET CN SR®) developed by Golder
- Recommended a combination of Electrokinetics and Phytohydraulics



Electrokinetics

- Low-voltage electric field applied across a section of contaminated soil to move contaminants.
- After electrodes are introduced and charged, ions are mobilized by the electric current.
- Chloride ions accumulate close to the anodes and are removed by groundwater extraction.

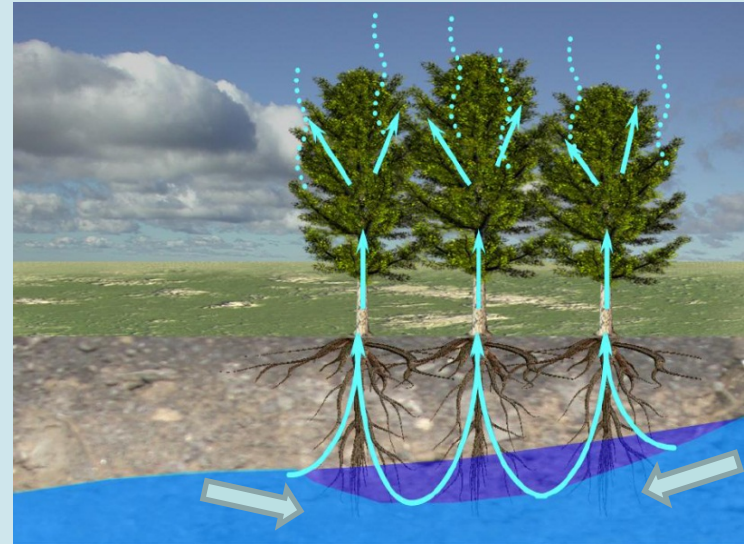




Phytohydraulics

- **Planting a Series of Willows and Poplars**

- **Objective:** Extract groundwater to decrease groundwater flux off-Site and lower rate of water infiltration from the surface



Adapted from ITRC, 2009

- **Secondary Objective:** May assist in extracting chloride from groundwater and lowering the chloride mass flux off-site (phyto-extraction).
- Willows and poplars are phreatophytes and some are haloresistant (can withstand high salinity).
- **Already present at the Site!**



Pilot Testing

- Pilot studies current in progress - results to come in 2014!





Thank You!



Special Thanks To:

David Sutherland of CN
University of Calgary

Golder Colleagues:

Loni Waldner

Hélène Richer

Dan Walker

Hugh Abercrombie

Sylvain Hains