Collaborative Initiative to Review Sulphur Management Guidance

Remediation Technologies Symposium

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Canterra Gas Plant Expansion - Fluor EPC Project in Alberta, Canada

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Matrix Solutions Inc. ENVIRONMENT & ENGINEERING

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Outline

- Sulphur sources, impacts and regulatory guidance
- Reducing liability through closure of large facilities
- Case studies - challenges experienced in the management of sulphur-impacted sites
- Collaborative initiative overview

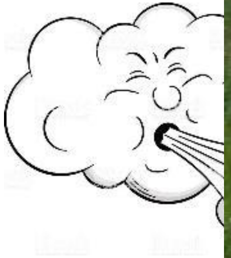
Sulphur Sources – Past, Present and Future

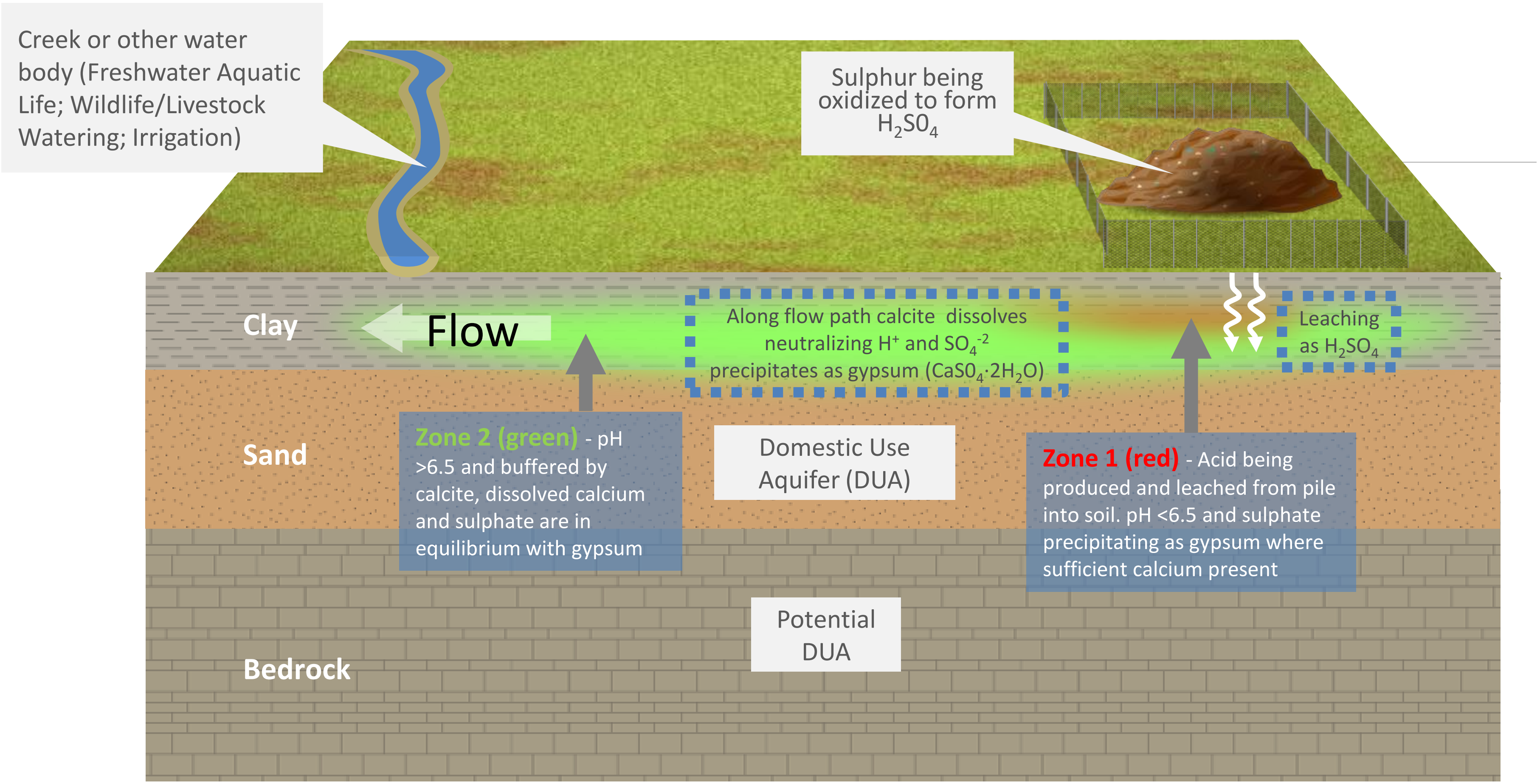
Source: https://www.flickr.co

Acidification of Soil and Water

- Under ae … , soil or water (

$S + {}^{3}/_{2}\,O$ … ction)




Creek or other water body (Freshwater Aquatic Life; Wildlife/Livestock Watering; Irrigation)
Sulphur being oxidized to form H_2SO_4
Clay
Flow
Along flow path calcite dissolves neutralizing H^+ and SO_4^{-2} precipitates as gypsum ($CaSO_4 \cdot 2H_2O$)
Leaching as H_2SO_4
Sand
Zone 2 (green) - pH >6.5 and buffered by calcite, dissolved calcium and sulphate are in equilibrium with gypsum
Domestic Use Aquifer (DUA)
Zone 1 (red) - Acid being produced and leached from pile into soil. pH <6.5 and sulphate precipitating as gypsum where sufficient calcium present
Bedrock
Potential DUA

Limestone Amendment

- The reaction of limestone with S results in:
  1. Raising soil pH due to alkalinity of limestone (converting free H^+ to H_2O);
  2. Binding sulphate with calcium to form gypsum ($CaSO_4$*$2H_2O$), of which the majority precipitates to become immobile; and,
  3. Removing excess sulphate from soil, which can lower EC to a more acceptable range for vegetation growth.
- The neutralization of sulphuric acid with limestone (calcium carbonate, $CaCO_3$) involves the following reaction:

$$H_2O + H_2SO_4 + CaCO_3 \rightarrow CaSO_4{*}2H_2O + CO_2$$

Monitoring and Management Guidance

Guidelines for
Landfill Disposal of Sulphur Waste
and
Remediation of Sulphur Containing Soils

September 12, 2011

- AB Tier 1
- AB Tier 2
- AB Surface Water Quality Guidelines

Alberta Government

Directive for Monitoring the Impact of Sulphur Dust on Soils

Alberta Energy Regulator

Version 2015
Amends the original published December, 2011

MEND MANUAL

VOLUME 1 – SUMMARY

MEND 5.4.2a

March, 2001

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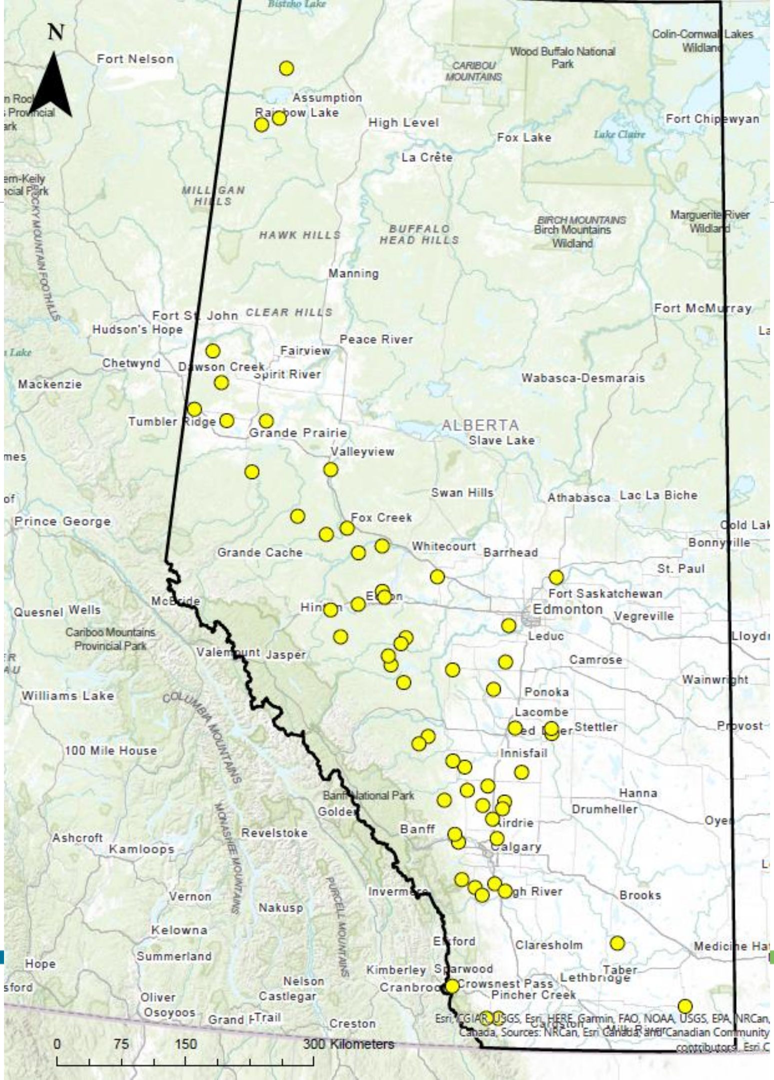
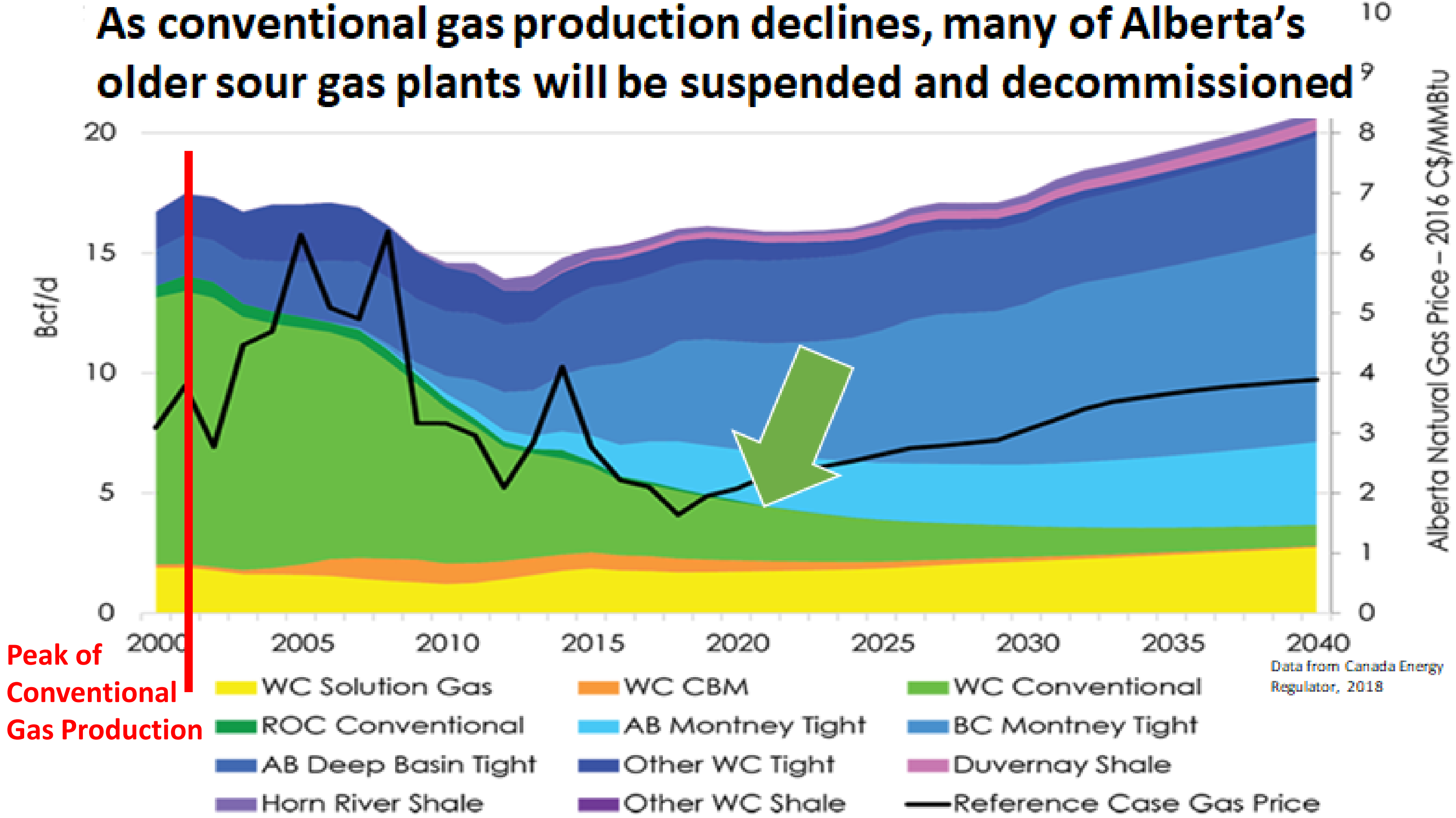
Sponsored by:
Natural Resources Canada
Northern Ontario Development Agreement (NODA- MEND Ontario)
Québec Mineral Development Agreement (NEDEM-Québec)
Organizing Committee for the 4th International Conference on Acid Rock Drainage

Existing and Historical Sour Gas Plants



Data from AER, *ST-50A- Gas processing plants in Alberta*, filtered by "GP Sulphur Recovery", August 2020

As conventional gas production declines, many of Alberta's older sour gas plants will be suspended and decommissioned



Sulphur Impacts – Cost Estimating

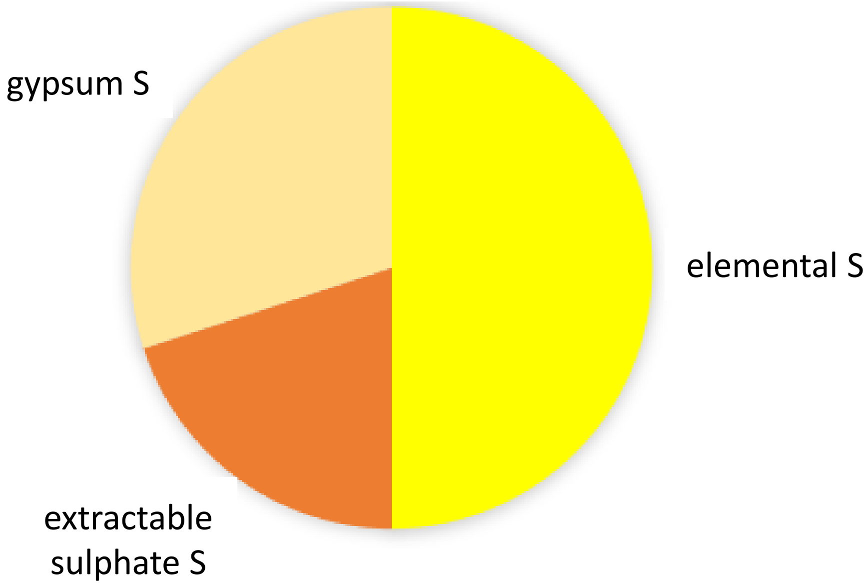
- Onsite treatment limitations and high cost for large volumes of limestone
- Landfill bunkering required: 4 bunkers - Thorhild, Willisden Green (2) or Big Valley
- Roughly \$130/tonne (tipping, site work) + \$10/100 km/tonne (trucking)
- Base pads often 5-10 ha; ~\$10 MM minimum/site

Case Study #1 – Remediation Expansion

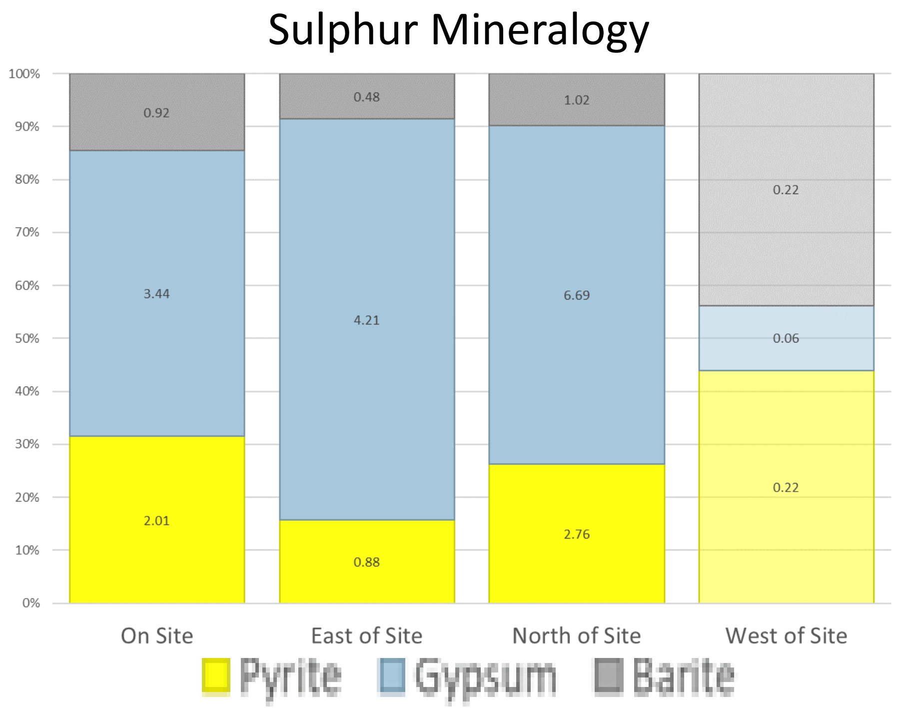
- Friable and patchy distribution = assessment, remediation conceptual site model development challenges
- Follow-up assessment - depth of material with high EC and acidic pH can increase over time:
  - At one site, depth of impact changed from 0.6 m bgs to over 1.0 m bgs after several years
  - This is a 70% increase in the volume of soil requiring remediation!

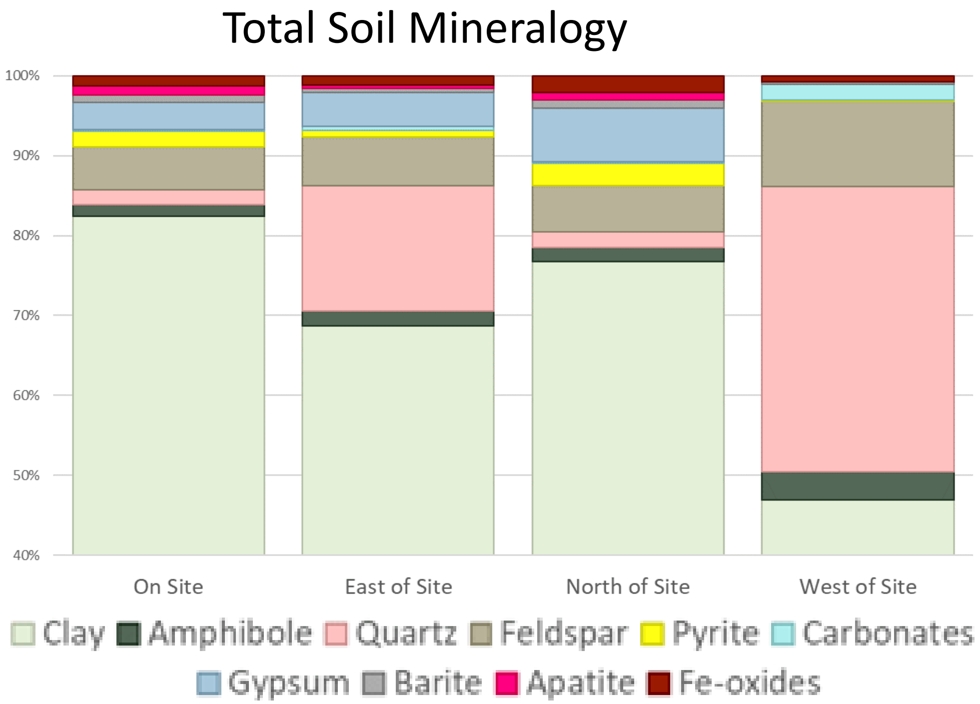
Case Study #2: Analysis Paralysis

- To manage, need to understand:
  - Total S components
    - elemental S
    - extractable sulphate-S
    - gypsum sulphate-S
  - pH
  - Soil buffering capacity
  (i.e., calcium carbonate equivalent, Acid Base Accounting)

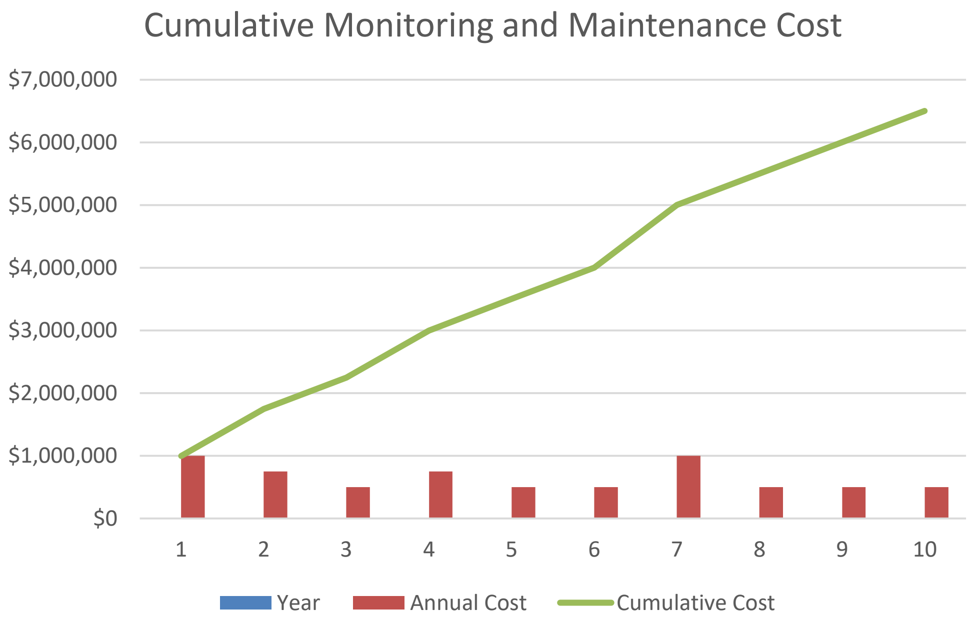


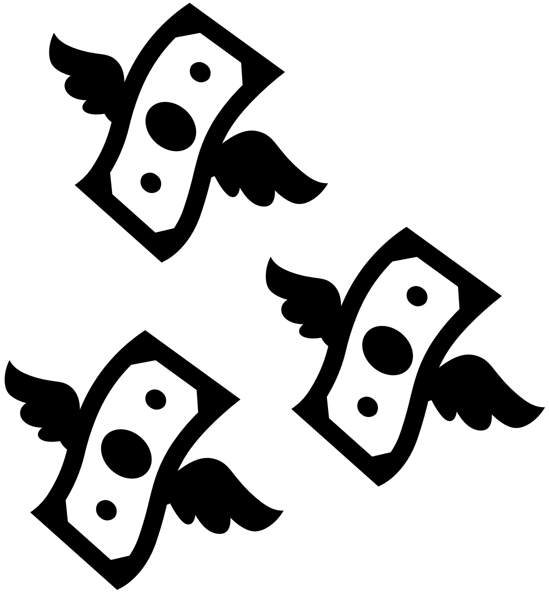
Case Study #2: Analysis Paralysis (cont.)





Case Study #3: Budget Breakdown





Case Study #4: Co-Contaminant Conundrum

- Co-contaminants can be related to acidification and sulphur-related compounds, limestone amendments, AND/OR
- Process or other industrial chemicals released onsite

Case Study #5: Risk Assessment

Managing SO_4 in groundwater

Summary of Identified Needs

- Improve guidance on site assessment, laboratory methods, data interpretation, and advanced testing methods
- Additional guidance on establishing natural onsite buffering capacity and elemental sulphur concentrations that can safely be left in place
- Acceptable methods to treat and dispose soil as Class II waste
- Reference related regulatory directives and provide guidance for alignment, including management of groundwater impacts and strategies to meet regulatory closure
- Method for demonstrating risk to receptors and guidance around post-remedial monitoring

Project Overview

Steering Committee

TIDEWATER
Midstream and Infrastructure Ltd.

Paramount resources ltd.

CONF.

Project Team

Liaison/Coordinator

InnoTech Alberta

Technical Direction and Expertise

Matrix Solutions

S2 Environmental

Key Stakeholders

Regulators
Policy makers
Industry members and associations
Practitioners
Landfills

Project deliverables

- Literature review & Outreach
- Gap analysis
- Recommendations & Follow-up

Project Overview

- Identification of key stakeholder representatives
- Further elaboration of key challenges: Industry and practitioner outreach – survey & follow-up
- Literature review
- Compilation of case studies
- Gap analysis document and follow-up action plan

Opportunities for the Community of Practice

- Survey to come – please provide input
  - Challenges and suggestions
- Recommended contacts and stakeholders
- Catalogue of sites
  - Sites have changed hands; value of historical data and trends
- Case studies
  - Innovative approaches; unique challenges

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