Enhanced Anaerobic Bioremediation – Case Studies

Ryan Riess
Pinter & Associates Ltd

SMART Remediation
Edmonton, AB | March 11, 2020
Calgary, AB | March 12, 2020

SMART is Powered by:
www.vertexenvironmental.ca
Enhanced Anaerobic Bioremediation – Case Studies

Smart Remediation
Ryan Riess, M.Sc. P.Eng
PINTER & Associates
March 2020

Overview

- Anaerobic Bioremediation Background
- Case Study 1
- Case Study 2
- Case Study 3
- Questions
Anaerobic Bio Pros/Cons

- Pros:
  - Generally cost effective
  - COCs removed naturally
  - Little energy/supervision required

- Cons:
  - Timelines generally longer
  - Potential for knowledge gaps
  - Permeability issues
  - Stakeholder buy in may be a hurdle
Anaerobic Bio Basics

Contaminant (Electron donor) e.g. BTEX

Energy Yield
High Fast
Low Slow

Electron Acceptors
1. Oxygen
2. Nitrate
3. Fe(III)
4. Mn(V)
5. Sulfate
6. None (fermentation)

Products
Water, CO₂
Nitrogen, CO₂
Fe(II), CO₂
Mn(II), CO₂
Sulfide, CO₂
Methane, CO₂

EPA study on natural attenuation

Based on median consumptions of electron acceptors at 74 sites
BP-EPA study
Accurate, Current Site Information

Careful planning and preparation

What are three things you want to do in the future?
1. Get a girlfriend
2. Miss her
3. Rule the world
Case Study – Northern AB

PRB Construction for Anaerobic Bioremediation
PRB Post Construction

Results

DENITRIFICATION WALL
FLOW
FERTILIZER BUILDING
CENTER TRANSECT
WEST TRANSECT
EAST TRANSECT
Results Nitrate

Nitrate, East Transect

Results Sulphate

Sulphate, East Transect
Conclusions Case Study 1

• Nitrate removal > 90%, Sulphate >80%
• Downstream well protected
• Installation cost of about $190,000
  – PRB design life approximately 30 years
• Conventional bids were in the 3 – 5 million range
• Project won national Association of Consulting Engineers award of excellence in environmental Category

Case Study 2
Installation

• Installed depth between 9 and 11 m

Results – Case Study 2

• Nitrate removal >99%
• Sulphate removal >95%
• PRB design life about 30 years
• River no longer at risk
• All in costs about $350,000
• Full remediation estimates in excess of $10 million, never seriously pursued
CASE STUDY 3 - PHCs FULL REMEDIATION

- BTEX, F1 - GW flow south, ~30 m/year
- Lake is present 300 m south

ANAEROBIC BIOREMEDIATION PLAN
Installation

Groundwater Results

- About 86% reduction in MW15-4

![Graph showing groundwater results for MW15-4]
Worst Case Soil

- MW15-4, just north of PRB

<table>
<thead>
<tr>
<th>15-4</th>
<th>Date Sampled</th>
<th>D/C</th>
<th>B</th>
<th>T</th>
<th>E</th>
<th>X</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ppm</td>
<td>mg/kg</td>
<td>mg/kg</td>
<td>mg/kg</td>
<td>mg/kg</td>
<td>mg/kg</td>
<td>mg/kg</td>
<td>mg/kg</td>
<td>ng/kg</td>
</tr>
<tr>
<td>15-4</td>
<td>22-Sep-15</td>
<td>1000</td>
<td>7.12</td>
<td>67.6</td>
<td>70.4</td>
<td>205</td>
<td>12500</td>
<td>&lt;90</td>
<td>684</td>
<td>&lt;90</td>
</tr>
<tr>
<td>15-4</td>
<td>25-Sep-17</td>
<td>120</td>
<td>0.145</td>
<td>&lt;0.071</td>
<td>&lt;0.003</td>
<td>&lt;0.11</td>
<td>440</td>
<td>&lt;25</td>
<td>230</td>
<td>78</td>
</tr>
</tbody>
</table>

Results - Soil

- Average Benzene Removal – 98%
Case Study 3 Summary

- Site wide remediation in 2 years, closure from provincial regulators
- No Site downtime
- Costs of approximately $50,000 compared to dig and dump estimates of $500,000
- Project won national awards in 2018 (ACEC) and 2019 (Canadian Brownfield Network)

Summary

- Anaerobic Bioremediation can be a cost effective tool
  - Careful Assessment, planning
  - Will need some time
- Not a magic bullet and ensuring all parties are cognizant of goals and timeframes throughout process are important
QUESTIONS?

306-244-1710
ryan.riess@pinter.ca