Guaranteed Site Remediation Solutions
Presentation Outline

1) Site Background
2) Project Objectives and Challenges
3) Remedial Strategy Selection
4) Remedial Strategy Implementation
5) Project Results
6) Conclusion / Question Period
Project Objectives

1) Soil Conservation
2) On-site Treatment (PHC)
   - Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities (Surface, Fine Grain, Agricultural and Potable Water Pathway)
Challenges

1) Changing PHC Guideline
2) Absence of formally accepted closure sampling method in Alberta
3) Minimal On-site Treatment Experience
4) Project Duration
5) Remediation Contractor Selection
Challenges

1) Biotreatment of Crude Oil Contamination
2) Prairie Gumbo
3) Weather Conditions
4) New Stringent CWS - CCME (F₃)
5) Guaranteed Results (Lump Sum Contract)
Remedial Strategy Selection

1) Volume Estimate
   - Supplemental Site investigation (Grid)
   - 3-D Visualization
2) Treatability Study
PLAN VIEW OF MAXIMAL ISOVOLUMES:

Azimuth: 225°
Elevation: 427
Vertical exaggeration: 2.5x
PLAN VIEW OF MAXIMAL ISOVOLUMES:

PHC (C9-C10) >= 260 mg/kg
PHC (C10-C16) >= 500 mg/kg
PHC (C16-C34) >= 800 mg/kg
PHC (C34-C50) >= 5600 mg/kg
BENZENE >= 0.18 mg/kg
Biogenie’s R&D Services - Treatability
## Treatability Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial Mean* Concentration (mg/kg)</th>
<th>Final Mean* Concentration (mg/kg)</th>
<th>Treatment Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHC – F1 (C6-C10)</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>PHC – F2 (&gt;C10-C16)</td>
<td>1 244</td>
<td>120</td>
<td>90</td>
</tr>
<tr>
<td>PHC – F3 (&gt;C16-C34)</td>
<td>3 526</td>
<td>1 456</td>
<td>59</td>
</tr>
<tr>
<td>PHC – F4 (&gt;C34+)</td>
<td>1 330</td>
<td>824</td>
<td>38</td>
</tr>
</tbody>
</table>

* Triplicate Samples
Remedial Strategy Selection

Design Considerations:
- Space available on-site
- High efficiency biotreatment capability required (High F3)
- Time available to treat material
- Excavation work under winter conditions
EX SITU VENTILATION TREATMENT (BIOPILE)

- Membrane
- Irrigation and Recirculation System
- Humidification Chamber
- Biofilter
- Purified Air
- Soil
- Microorganisms
  - Nutrients
  - Surface-Active Agents
  - Co-Substrates

Air
Water

Biogénie
Remedial Strategy Implementation

Figure 1: Site Layout – Location of Treatment Pads and Excavation Areas
## Project Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial Mean Concentration (mg/kg)</th>
<th>Final Mean Concentration (mg/kg)</th>
<th>Target Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHC – F1 (C6-C10)</td>
<td>148</td>
<td>21</td>
<td>260</td>
</tr>
<tr>
<td>PHC – F2 (&gt;C10-C16)</td>
<td>436</td>
<td>111</td>
<td>900</td>
</tr>
<tr>
<td>PHC – F3 (&gt;C16-C34)</td>
<td>1 274</td>
<td>532</td>
<td>800</td>
</tr>
<tr>
<td>PHC – F4 (&gt;C34+)</td>
<td>607</td>
<td>232</td>
<td>4 000</td>
</tr>
</tbody>
</table>
Project Results

1) Biotreatment of 11,150 m$^3$ to TIER 1 – Surface (fine soil)
2) Segregation of 1,200 m$^3$ before off-site disposal (Class II)
3) Biotreatment duration period - 6 months
4) Overall Success