INSTALLATION AND MONITORING OF THE WATERLOO EMITTER™ SYSTEM

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Presentation Outline

- Introduction/Background
- Emitter Installation Details
- Maintenance Program
- Performance Monitoring Results
- Summary
Introduction

Emitter Evaluation conducted in 2004

Conclusions

- Potentially effective for dissolved phase plume biodegradation
- Based on Modeling – reduction to be evident between 0.5 and 1.5 years
- Regulatory compliance in approximately 10 years
Installation of Emitter “fence”

- Two rows of 5 emitters – offset by 1.5 m
- Located at down gradient toe of plume
- Effective spacing 1.5 m
Emitter locations
Emitter Well Details

300 mm diameter hollow stem.

150 mm Johnson wire wrapped on plastic screens.

0.01 inch slot size.

10–20 frac sand and bentonite to surface.

600 mm sump.
Emitter Details

- 26 m of ⅛ inch Silicone Tubing
- Brass compression fittings
- 1.3 m PVC frame
- 600 mm extension
Emitter Details

Originally connected in series.
Needle valve for line clearing.
Emitter Oxygen Delivery Details

6,900 L Oxygen tank, pressure regulator and pressure relief valve. Operating pressure 15 psi.

Rubbermaid Shed 2m x 2m x 1.5m.
Emitter Maintenance Program

- Ice build up in lines.
- Regulator and pressure relief valve leaks.
- Iron removal and cleaning 6 months intervals
Maintenance Program
Modifications to Oxygen Delivery System

- Dry Oxygen – less than 10 ppm impurities.
- Separate lines to each emitter and needle valve for each emitter.
- Weekly monitoring by local subcontractor
- Six months of continuous oxygen delivery @30 L per day.
Emitter Monitoring Program

- October and December 2004, Jan, April and July 2005.
- Water levels and DO Geochemistry Ferrous Iron, Sulphate and Nitrate.
- BTEX, F1 and F2
- Background data (July 2004) presented last year.
Groundwater Flow

- Seasonal fluctuation of 0.2 m July 2004 to July 2005.
- Groundwater high July groundwater low January.
- Flow in northeast – gradient 0.003 m/m
- Flow rate approximately 5 m to 10 m per year.
Dissolved Oxygen Levels

- Background or upgradient: 0.3 mg/L to 2 mg/L.
- Within the emitters wells: 11 mg/L to 55 mg/L.
- Downgradient of emitter fence: 0.3 mg/L to 5 mg/L.

**Graph:**
- **Down Gradient BH216**
- **X-axis:** Sampling Date [Jun-04, Oct-04, Feb-05, Jun-05, Oct-05]
- **Y-axis:** Dissolved Oxygen (mg/L) [0.0, 2.0, 4.0, 6.0, 8.0, 10.0]
No appreciable changes in Nitrate concentrations.

No appreciable changes in Sulphate concentrations.

Ferrous iron concentration increases upgradient of emitter fence.

Ferrous iron concentrations have increased down gradient emitter fence.

<table>
<thead>
<tr>
<th>Sampling Date</th>
<th>Ferrous iron (mg/L)</th>
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<tr>
<td>Jun-04</td>
<td>5</td>
</tr>
<tr>
<td>Oct-04</td>
<td>0</td>
</tr>
<tr>
<td>Feb-05</td>
<td>0</td>
</tr>
<tr>
<td>Jun-05</td>
<td>25</td>
</tr>
<tr>
<td>Oct-05</td>
<td>30</td>
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Hydrocarbon Parameters

Total BTEX no change upgradient of emitter fence.
Total BTEX no change downgradient of emitter fence.
Similar for F1 and F2 – no appreciable changes in concentrations.

Down Gradient BH216

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<tr>
<th>Sampling Date</th>
<th>Total BTEX (mg/L)</th>
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<tbody>
<tr>
<td>Jun-04</td>
<td>0.0</td>
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<tr>
<td>Oct-04</td>
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<tr>
<td>Feb-05</td>
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<tr>
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<tr>
<td>Oct-05</td>
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Performance Results

- Consistent elevated DO levels in Emitter wells. Delivery has been successful.
- DO and hydrocarbon levels have not shown indications of increased bioremediation.
- Results are consistent with modelling predictions
- Additional monitoring in 2006 is required.
Summary

- Cold temperature installation requires low moisture oxygen, separate lines.
- Cleaning on a six month basis likely required with well re-development.
- No indication of increased enhanced bioremediation as of July 2005 – approximately 6 months.