Outer Loop Landfill, Louisville, KY
Bioreactor Project

David Carson, US EPA ORD, NRMRL, Cincinnati, OH
Roger Green, Waste Management, Inc., Cincinnati, OH

US EPA Workshop on Bioreactor Landfills
February 27-28, 2003
Arlington, VA
Presentation Content

- Purpose and Objectives
- Experimental Design
- Interim Results
  - Gas
  - Leachate
  - Solids
- Next Steps
Project Objectives

- Quantify and evaluate the performance of Aerobic-Anaerobic and Facultative Landfill Bioreactors versus that of a conventional control landfill.
- Will be large enough and last long enough to evaluate economic and operational issues.
- Will generate credible data based on statistically designed studies.
### Experimental Design

<table>
<thead>
<tr>
<th>FLB 51A</th>
<th>FLB 52B</th>
<th>AALB 74A</th>
<th>AALB 74B</th>
<th>CTL 73A</th>
<th>CTL 73B</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-7 years old</td>
<td>2 years old</td>
<td>3-4 years old</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- FLB: Facultative Landfill Bioreactor and
- AALB: Aerobic- Anaerobic Landfill Bioreactor treatments
- CTL: Control (no liquid addition) conventional landfill
- Units composed of independent, paired cells
FLB: Facultative Landfill Bioreactor
AALB: Aerobic-Anaerobic Landfill Bioreactor and Control
Experimental Design: Treatment-Control Comparisons

Adapted from Jim Markwiese, Neptune and Co., Inc.
Critical measures were selected to capture waste stabilization.

Example: Volatile Organic Acids

adapted from Jim Markwiese, Neptune and Co., Inc.
Critical Measures: Gas and Leachate

Gas
• Gas production rate, CH$_4$, CO$_2$, O$_2$, and balance

Leachate
• Head on liner
• Leachate production
• COD, BOD, Temperature, pH, VOA
Critical Measures: Solids

Solid Waste

• Temperature
• Settlement
• Density
• Volatile solids, BMP, moisture content, pH
Statistical Analyses: Visualizing Critical Measures

Concentration

Normalized Time

AALB

FLB

Control
Unit 5 FLB Landfill Gas Flow

Leachate Injection Begins

LFG flow (scfm)

52B
51A

11/01 3/02 7/02 11/02 3/03
Leachate Injection Begins
Interim Leachate Results
Unit 5 FLB, Unit 7 AALB
Area 5 Water Balance

- 2.5 million yd$^3$ in place
- Average moisture content = 35%
- Density = 1,650 lb/yd$^3$
- Moisture required to achieve 45% = 36 gal/yd$^3$

$2.5 \text{ million yd}^3 \times 36 \text{ gal/yd}^3 = 91 \text{ Mgal}$
Cumulative Liquid Addition and Removal for the FLB
Liquid Addition
Leachate Removal
Liquid Addition Rate Summary for Cell 51A
Volatile Organic Acid Comparison

- Sum of Volatile Fatty Acids (mg/L)

- Comparison between FLB, Control, and AALB groups.
AALB cell 7.4

Control cell 7.3

FLB cell 5.2

FLB cell 5.1

Leachate Injection Begins

A detect:  ●  non-detect:  ○  smooth:  ---
B detect:  ▲  non-detect:  △  smooth:  ---
COD: FLB Cells

Leachate Injection Begins

mg/L

6/01 9/01 12/01 3/02 6/02 9/02 12/02
AALB cell 7.4

Control cell 7.3

FLB cell 5.2

Leachate Injection Begins

FLB cell 5.1

pH (Field) (S.U.)

06/27/01 10/05/01 01/13/02 04/23/02 08/01/02

06/27/01 10/05/01 01/13/02 04/23/02 08/01/02

A detect:  non-detect:  smooth:  
B detect:  non-detect:  smooth:  

Leachate Injection Begins
AALB cell 7.4

Control cell 7.3

FLB cell 5.2

FLB cell 5.1

Leachate Injection Begins

Temperature (Field Test) (°C)

06/27/01 10/05/01 01/13/02 04/23/02 08/01/02

A detect: • non-detect: ○ smooth: ——
B detect: ▲ non-detect: ◄ smooth: ——
Interim Solids Results
Biochemical Methane Potential: Baseline
Waste Density Comparison

![Graph showing waste density comparison between FLB, Control, and AALB categories.](image)
Waste Density: Unit 5

Leachate Injection Begins
## Critical Measures as Expected?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>FLB (Unit 5)</th>
<th>AALB (Unit 7)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas</strong></td>
<td>Some inhibition may be taking place, injection rate may be too high, O₂ intrusion in desiccated cover</td>
<td>Early stages of experiment</td>
<td>Changes Made in Operations at Unit 5</td>
</tr>
<tr>
<td>Production Rate, CH₄, CO₂, O₂, Balance Gases</td>
<td>Some inhibition may be taking place, injection rate may be too high, O₂ intrusion in desiccated cover</td>
<td>Early stages of experiment</td>
<td>Changes Made in Operations at Unit 5</td>
</tr>
<tr>
<td><strong>Leachate</strong></td>
<td>Early in process, but as expected</td>
<td>Early stages of experiment</td>
<td></td>
</tr>
<tr>
<td>Head on liner, Leachate production COD, BOD, Temperature, pH, VOA</td>
<td>Early in process, but as expected</td>
<td>Early stages of experiment</td>
<td></td>
</tr>
<tr>
<td><strong>Waste</strong></td>
<td>Early in process, but as expected</td>
<td>Early stages of experiment</td>
<td></td>
</tr>
<tr>
<td>Temperature, Settlement Density, Volatile solids, BMP, moisture content, pH</td>
<td>Early in process, but as expected</td>
<td>Early stages of experiment</td>
<td></td>
</tr>
</tbody>
</table>
Future of Project

• Continue monitoring until at least 2005
  – Modify monitoring parameters and/or frequency?
  – Interim Report this year
• Add new bioreactor site(s)?
Acknowledgements

- Kentucky Department for Environmental Protection
- Doug Goldsmith, Alternative Natural Technologies, Inc.
- Morton Barlaz, N.C. State University
- University of Cincinnati
- Neptune Inc.
Thank You

Contacts:

• David Carson: carson.david@epa.gov
  – EPA Bioreactor Website: http://www.epa.gov/epaoswer/non-hw/muncpl/landfill/bioreactors.htm

• Roger Green: rgreen2@wm.com