Outer Loop Landfill
EPA/WMI Bioreactor Research

2nd Intercontinental Landfill Research Symposium

Asheville, NC

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US EPA Office of Research and Development

Presentation Content

- EPA Bioreactor CRADA with Waste Management, Inc.
  - » Initial Data from Research Project
- Supporting Research
- Discussion Questions

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Bioreactor Fundamentals

- In simplest form, leachate reintroduced to the waste mass
- In more complex forms, sequenced addition of liquids, air or other combinations performed with aim of controlled, accelerated degradation

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Bioreactors – Potential Benefits

- Bioreactors reduce long-term environmental risk
- Bioreactors act as on-site leachate pre-treatment systems, produce less potent leachate
- New bioreactors require relatively few physical modifications compared to traditional landfills
- Bioreactor techniques may be applicable to landfill remediation
- Bioreactors produce the same amount of methane, but at a faster rate corrective actions.

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Key Performance Objectives

- As a research effort: identify key operating parameters and develop guidance on operation and monitoring
- Demonstrate environmental protection benefits of bioreactor operational technique via enhanced control of leachate and gas

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Bioreactors – Research Challenges

- How can bioreactors enhance environmental protection?
- Which bioreactor operational techniques most efficiently degrade waste?
- How can operators distribute leachate and collect gas efficiently?
- Is an interim cover necessary to cover a waste mass that is settling?
- How do operators ensure physical stability over time?
- How much moisture addition is optimal for degradation?
- What limitations exist for natural degradation?
- When can the landfill be “switched off” and closed?
- Can post-closure care be reduced?

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ORD Bioreactor Research

- Bioreactor CRADA
  - » Cooperative Research and Development Agreement with Waste Management Inc.
    - — Share tasks and information
    - — Signed in 2000 designed to end in 2005
- Supporting and Related Research Projects
  - » State-of-the-Practice of Bioreactor Landfills
  - » Microbial Temporal Analysis of Waste Degradation
  - » Liner/GCL Interaction with MSW Leachate
- Upcoming EPA Bioreactor Workshop in February 2003

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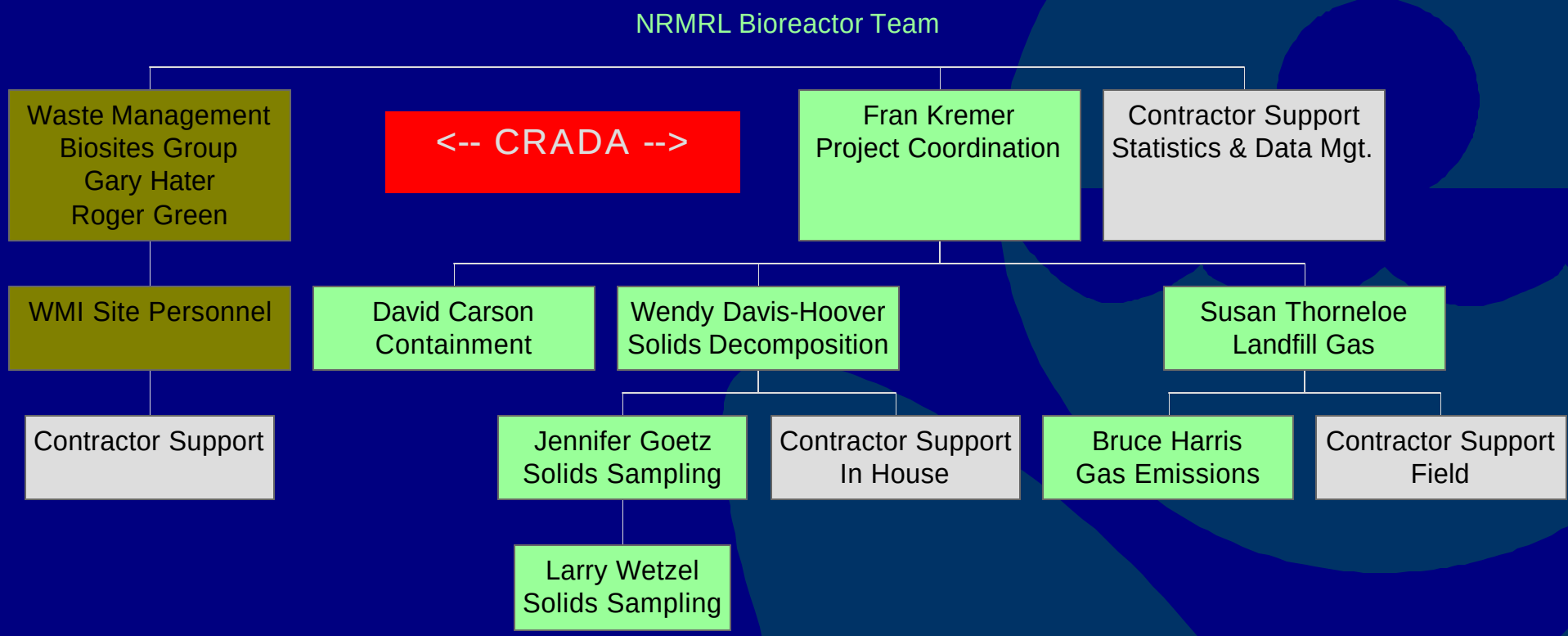
CRADA Bioreactor Research Team



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CRADA Project Objectives

- To determine the parameters and trends that should be monitored to control and assess the performance of a bioreactor landfill.
  - Leachate
  - Gas Management/Fugitive Emissions
  - Solids Decomposition
- Two primary sites
  - Area 7 – New fill
  - Area 5 – Existing fill to be retrofitted, and will use nitirified leachate to control ammonia levels
  - Shared experimental control area

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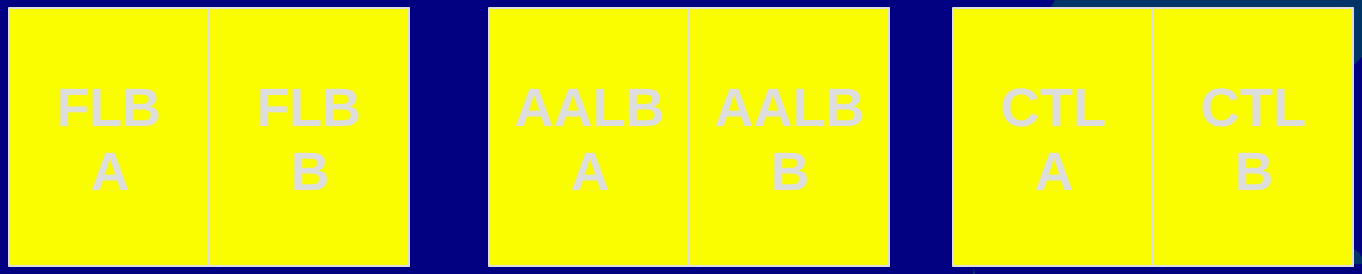
Outer Loop Landfill, Louisville, KY

Experimental Design



- Facultative Landfill Bioreactor (FLB) and Aerobic-Anaerobic Landfill Bioreactor (AALB) treatments
- Conventional (no leachate addition) landfill control
- Treatment and control units composed of independent, paired cells

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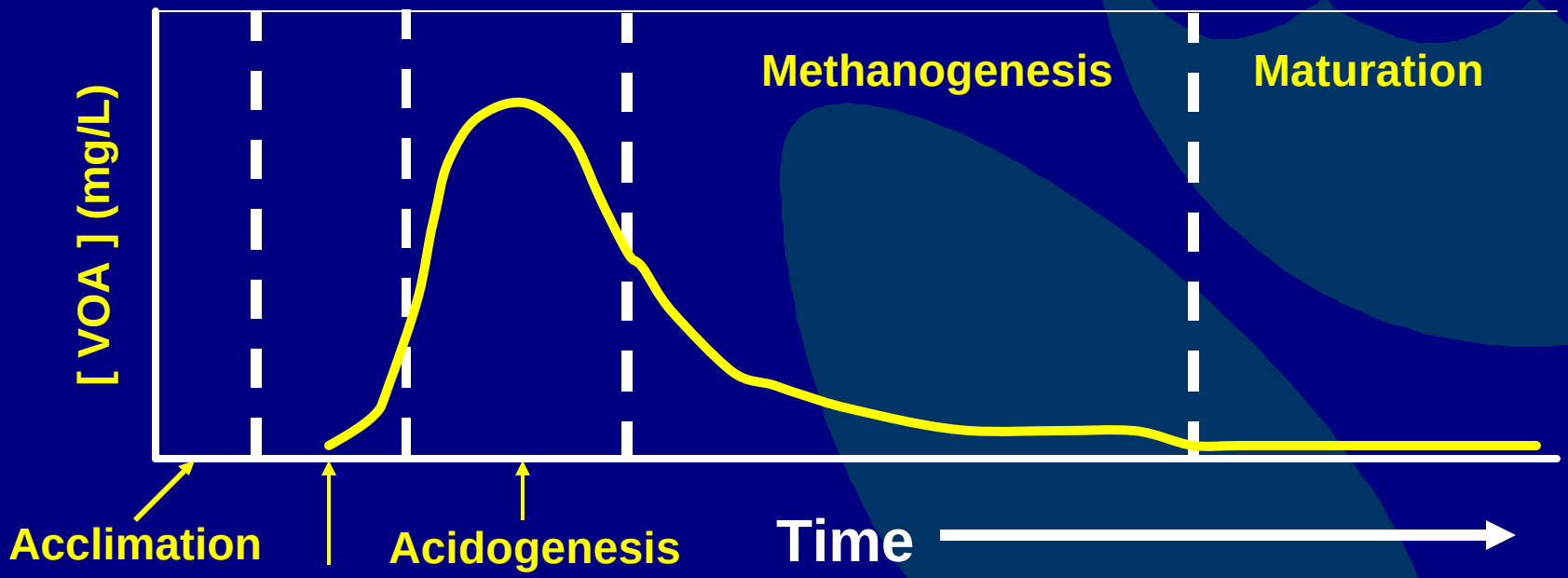
Source: Jim Markwiese, Neptune and Co.

Critical Measures

Critical measures were selected to capture waste stabilization

Example: Volatile Organic Acids



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Source: Jim Markwiese, Neptune and Co.

Critical Measures

- **Leachate**
  - » BOD, COD, Temperature, pH, VOA's
- **Municipal Solid Waste/Solids**
  - » Biochemical Methane Potential, Organic Solids, Temperature, Settlement (GPS), Density, pH, Moisture Content
- **Gas**
  - » Methane, Carbon Dioxide, Oxygen, Volume

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Source: CRADA Quality Assurance Project Plan Final 21 SEP 2001

Facultative Bioreactor

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Figure Courtesy of Waste Management, Inc.

Outer Loop Unit 5

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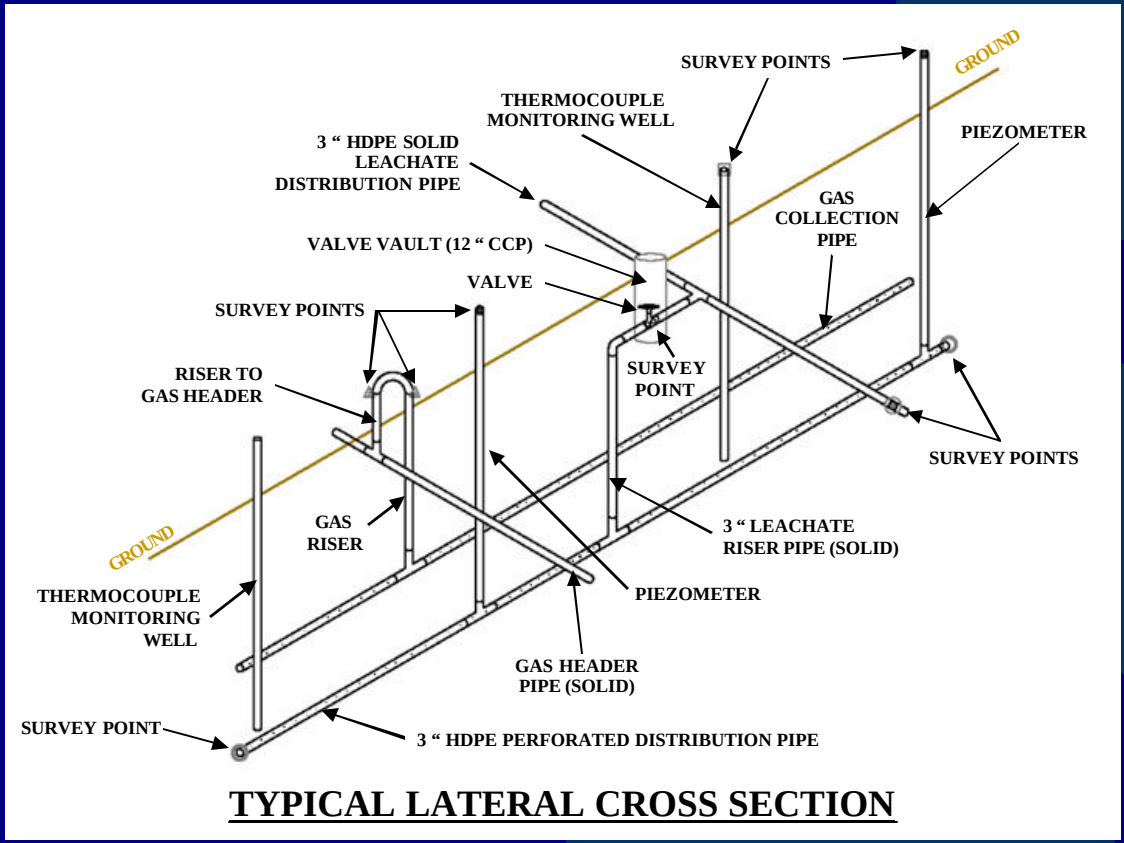
Unit 5 Trench Schematic



TYPICAL LATERAL CROSS SECTION

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Figure Courtesy of Waste Management, Inc.

Unit 5 Trench Infiltration/Gas Collection Gallery

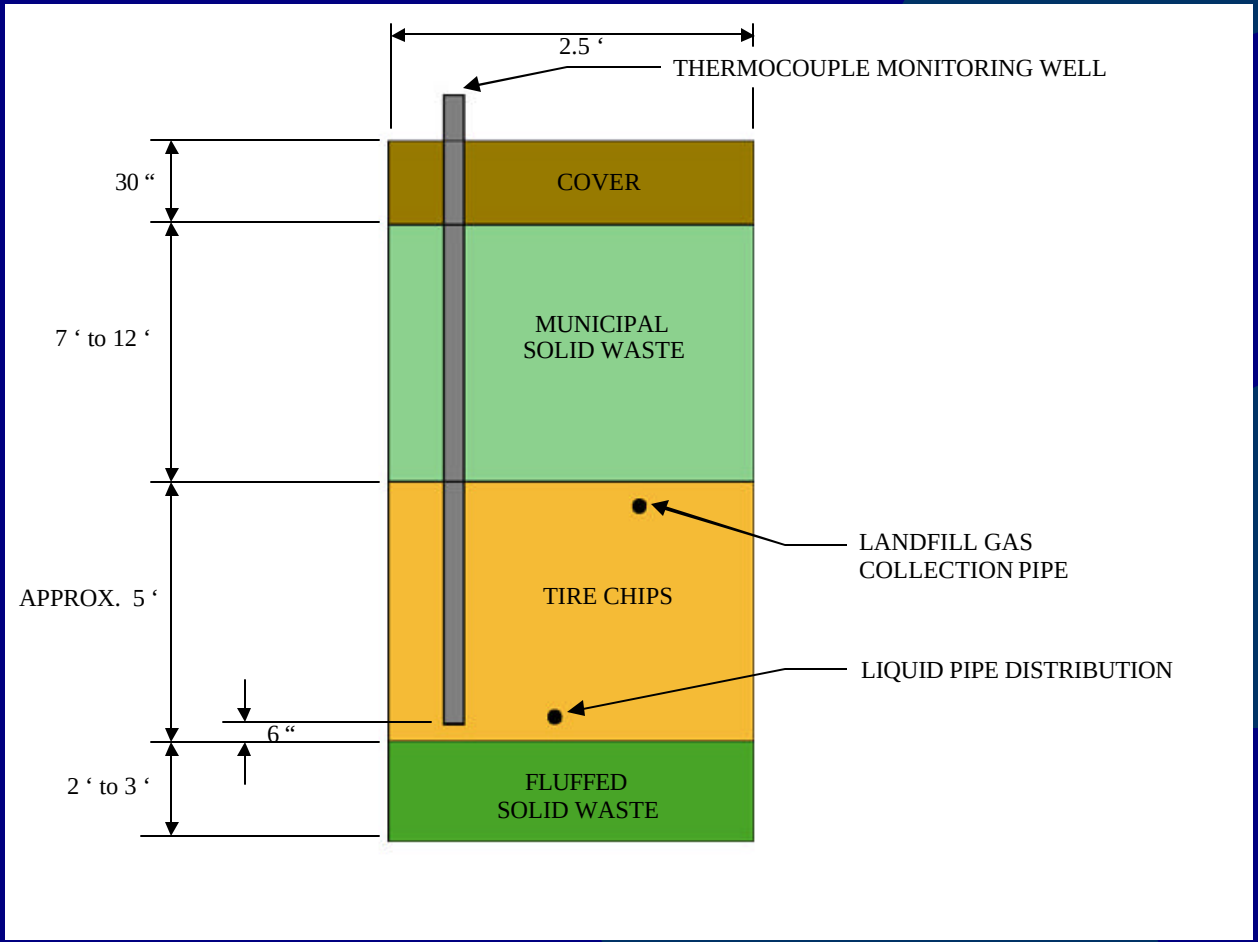
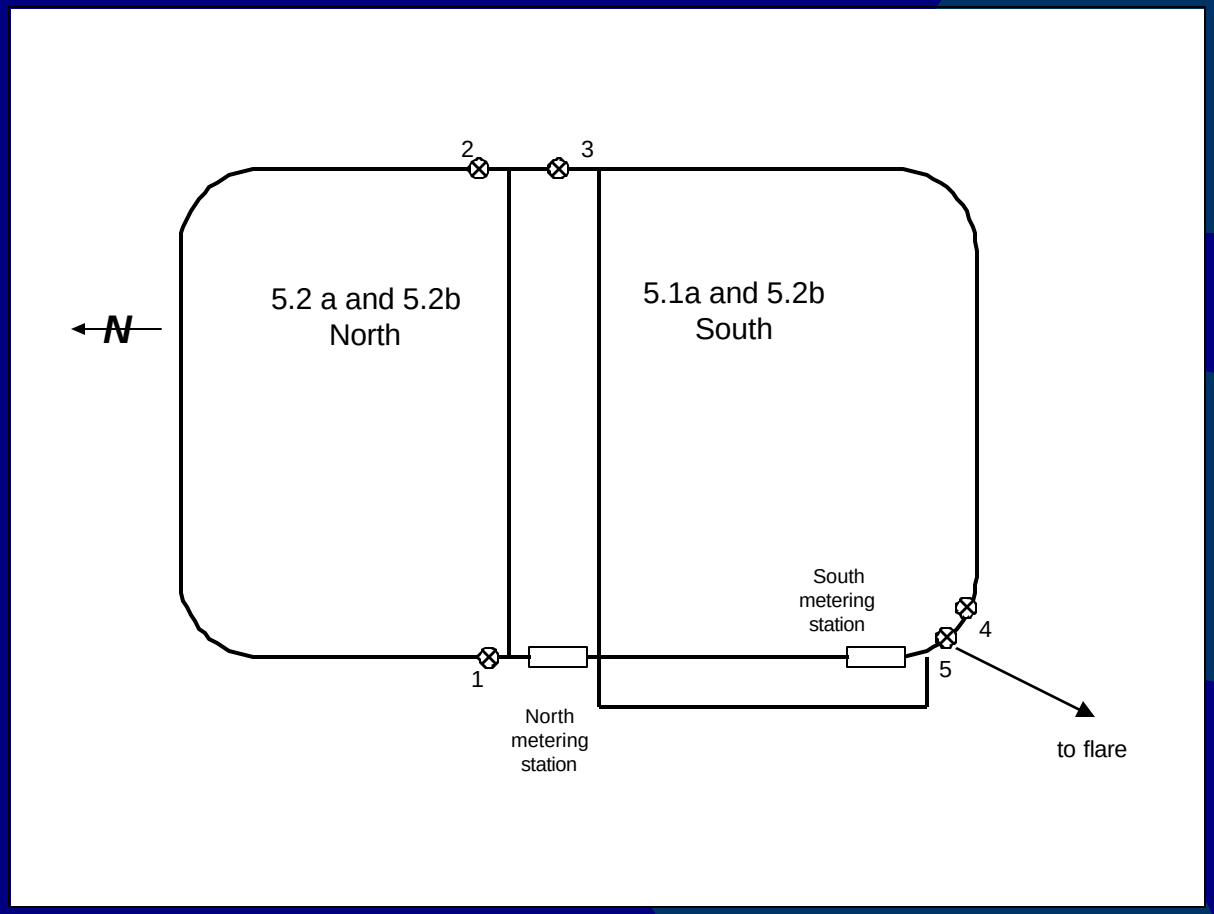


Figure Courtesy of Waste Management, Inc.

Unit 5 Sub Cell Arrangement Gas Monitoring



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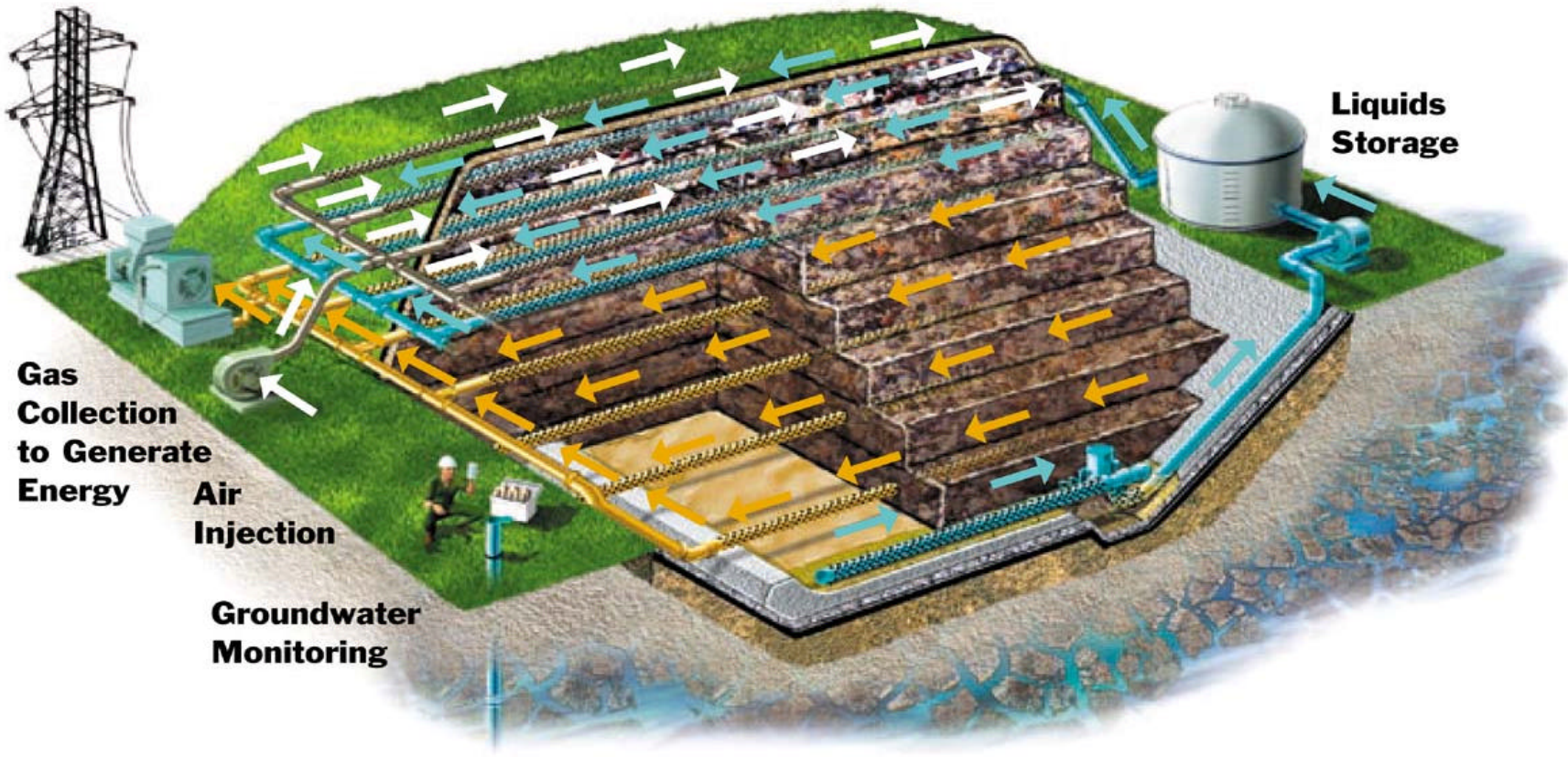
Aerobic-Anaerobic Bioreactor



WASTE MANAGEMENT

Bioreactor Program

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Figure Courtesy of Waste Management, Inc.

Outer Loop Unit 7

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Initial Results
Unit 5
Gas

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Unit 5.1 Gas Composition vs. Time

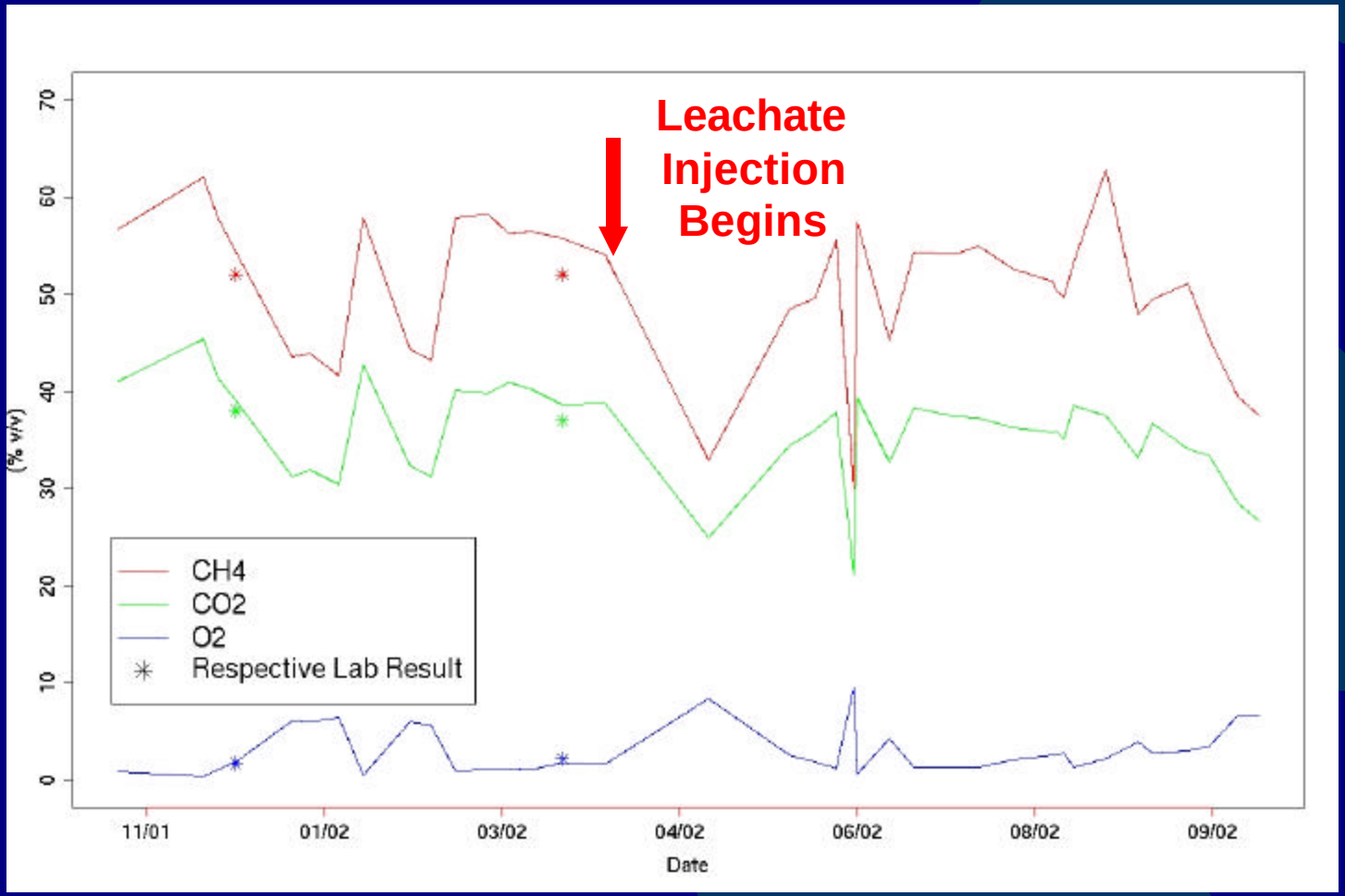

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Figure Courtesy of Neptune, Inc.

Unit 5.2 Gas Composition vs. Time

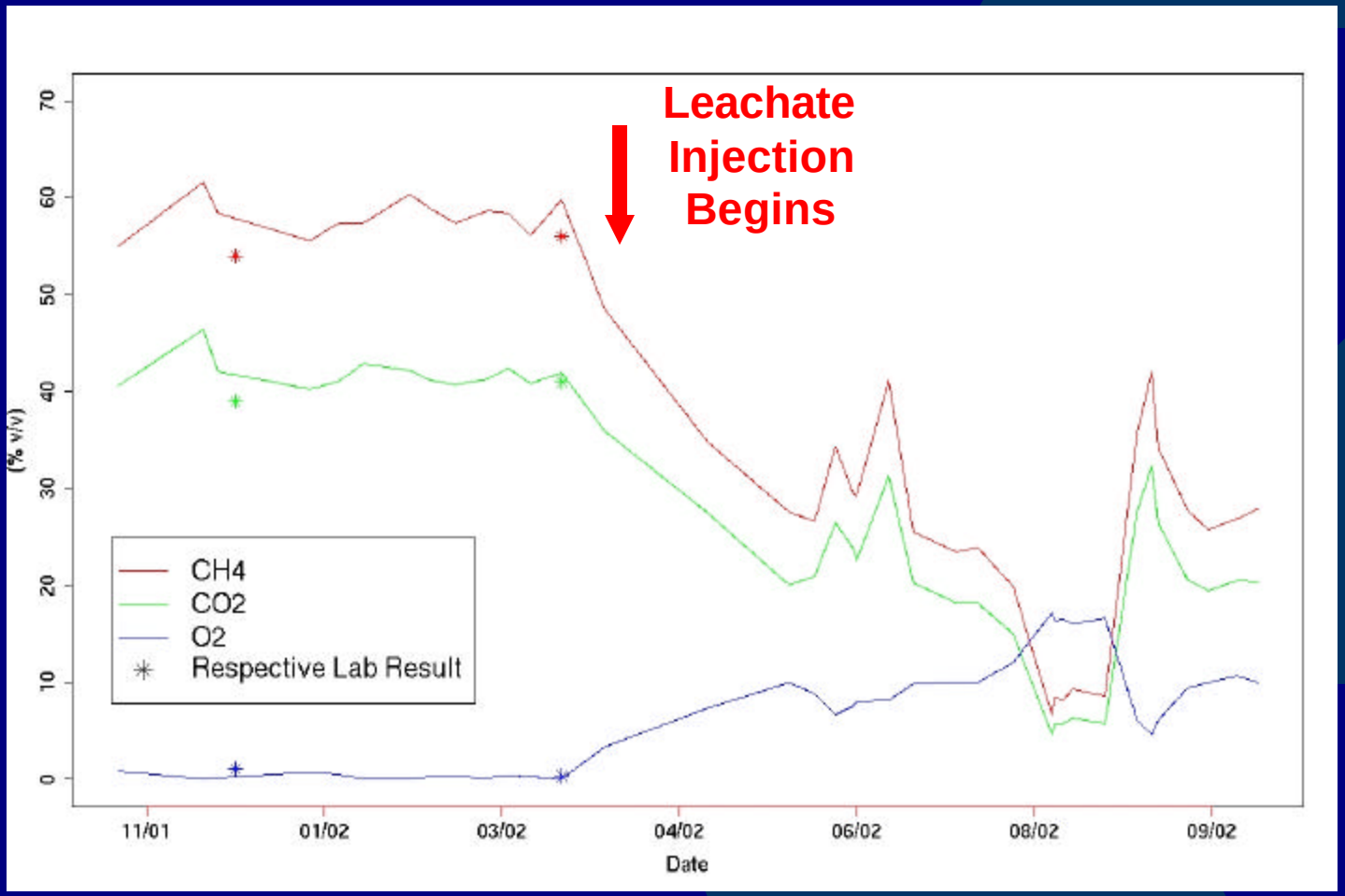

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Figure Courtesy of Neptune, Inc.

Modeled v. Actual Methane Production Unit 5

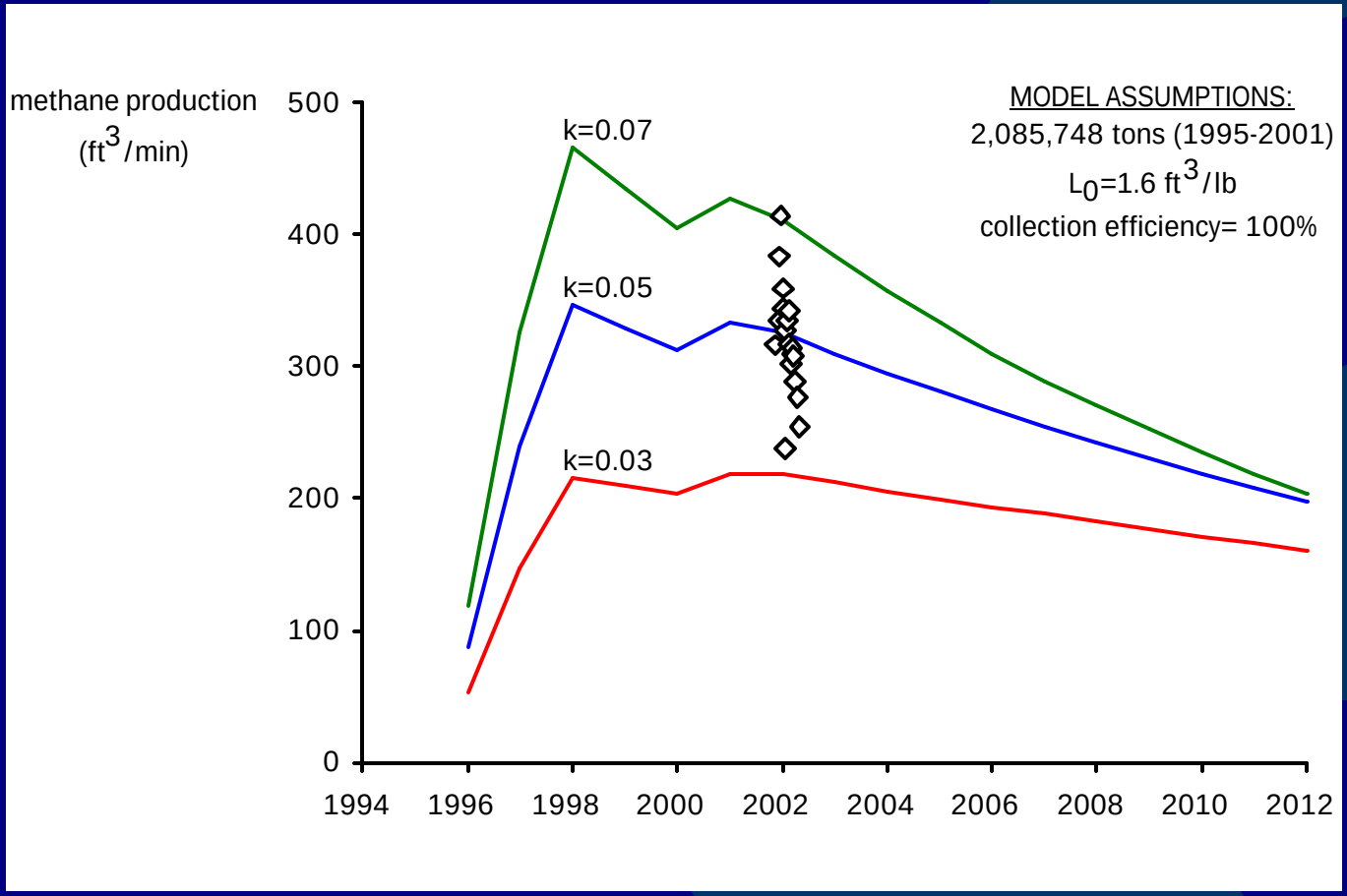

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Figure Courtesy of Waste Management, Inc.

Modeled v. Actual Methane Production Unit 5

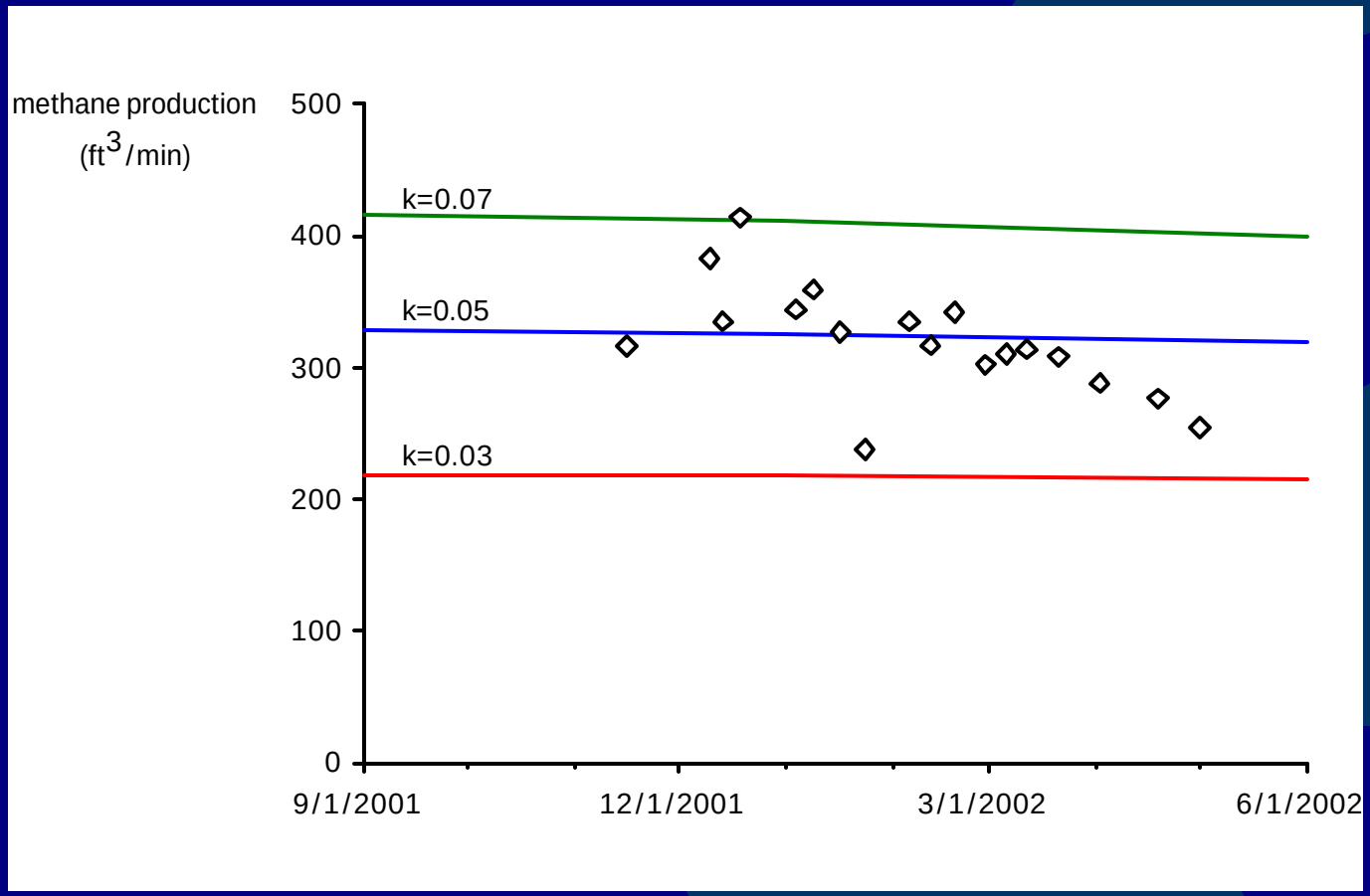

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Figure Courtesy of Waste Management, Inc.

Initial Results
Unit 5
Leachate

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Outer Loop Unit 5 Leachate Sampling

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Outer Loop Unit 7 Leachate Sampling

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Unit 5
Cumulative Liquid Addition and AUF vs. Time

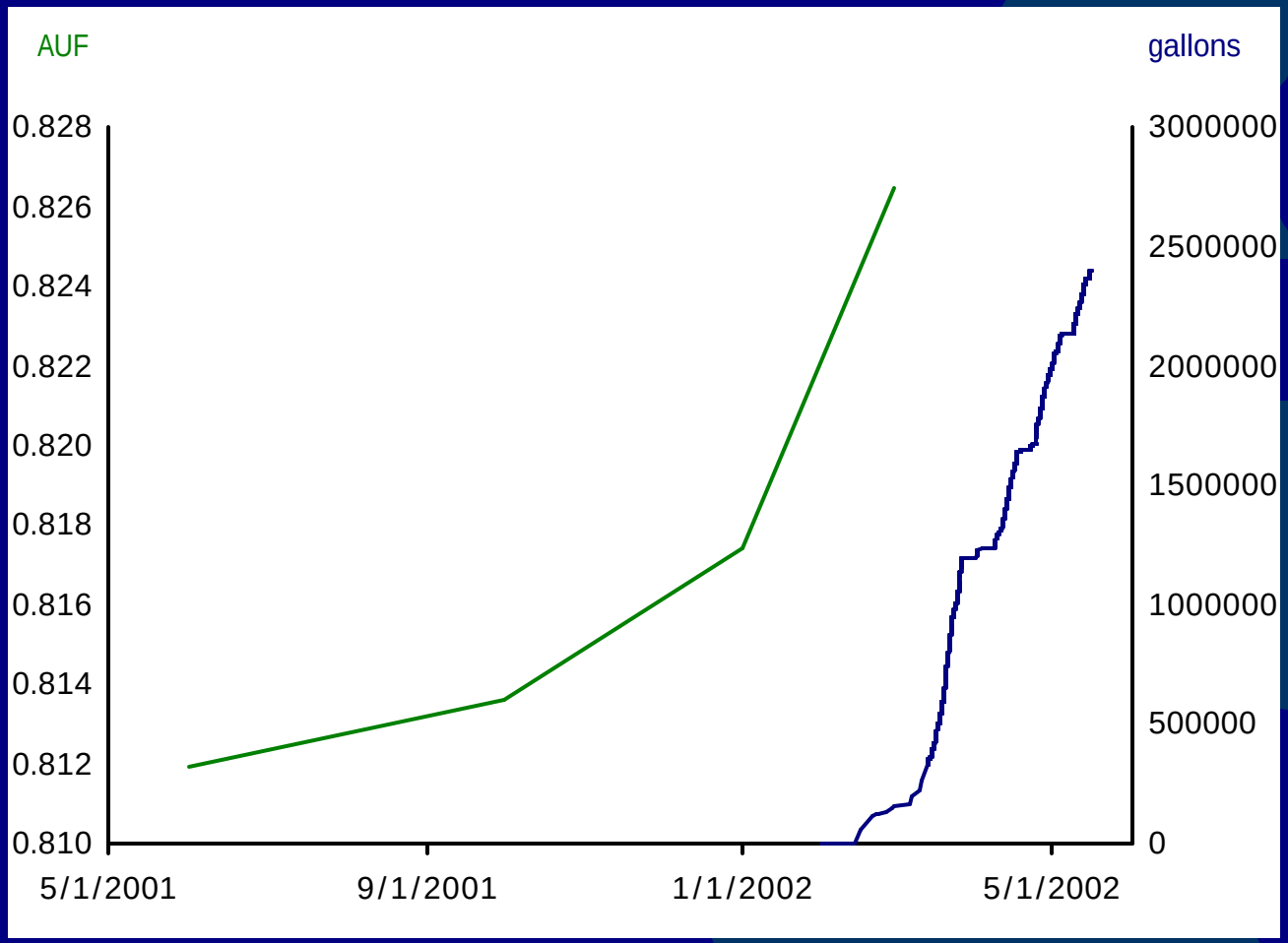

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Figure Courtesy of Waste Management, Inc.

Unit 5
Liquid Addition and Leachate Removal vs. Time

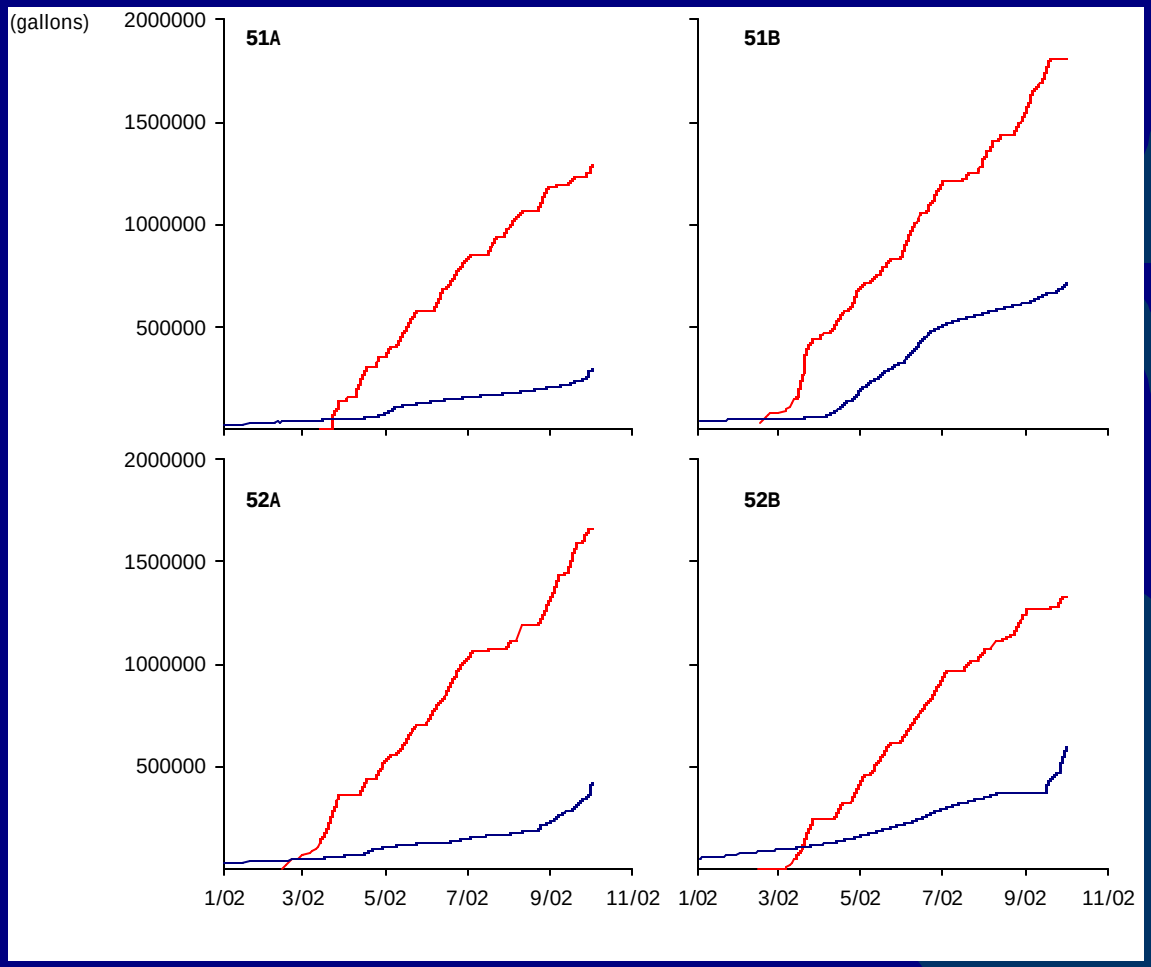

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Figure Courtesy of Waste Management, Inc.

Unit 5 Leachate BOD/COD vs. Time

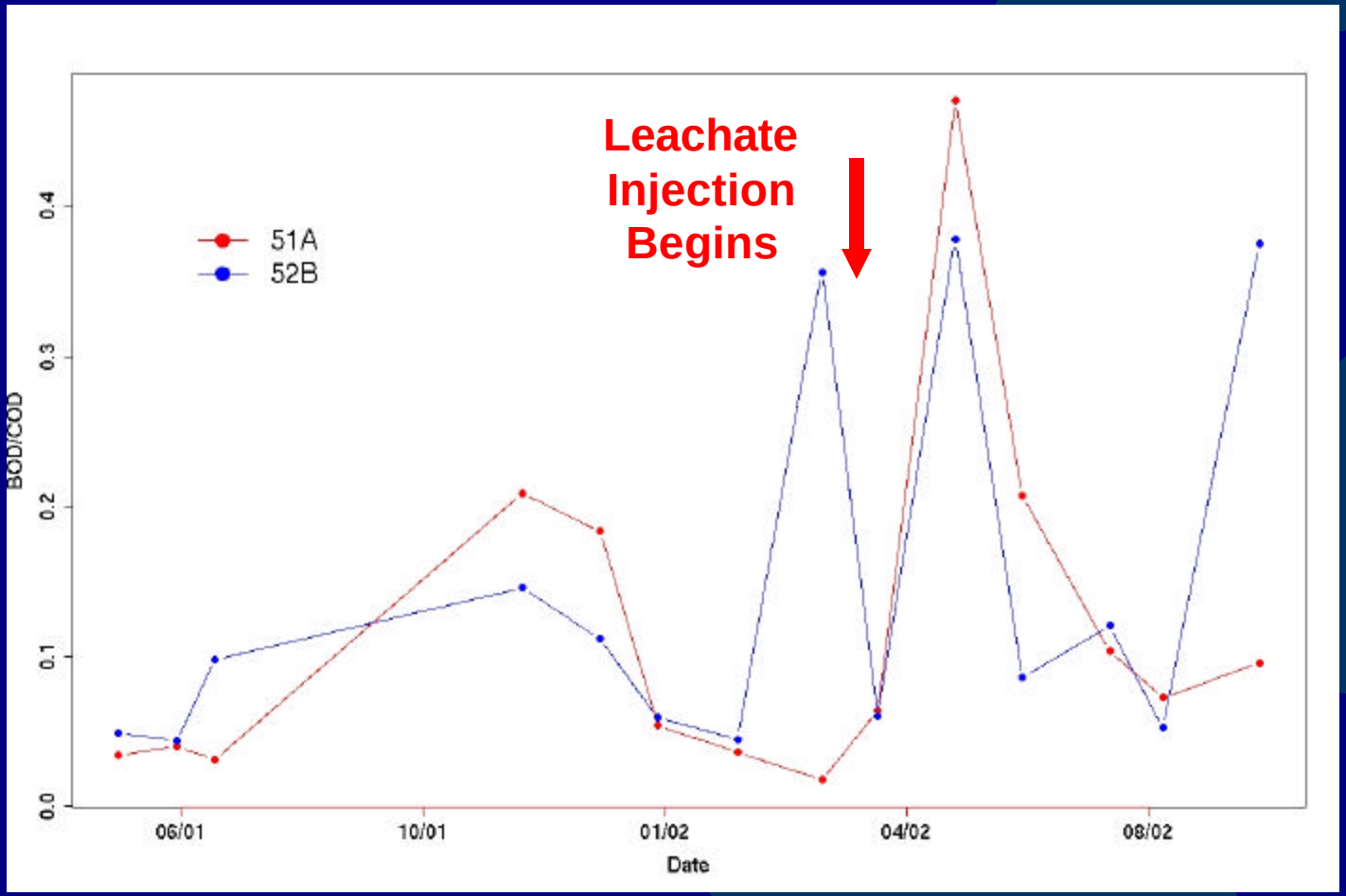

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Figure Courtesy of Neptune, Inc.

Unit 5.1A Leachate Composition vs. Time

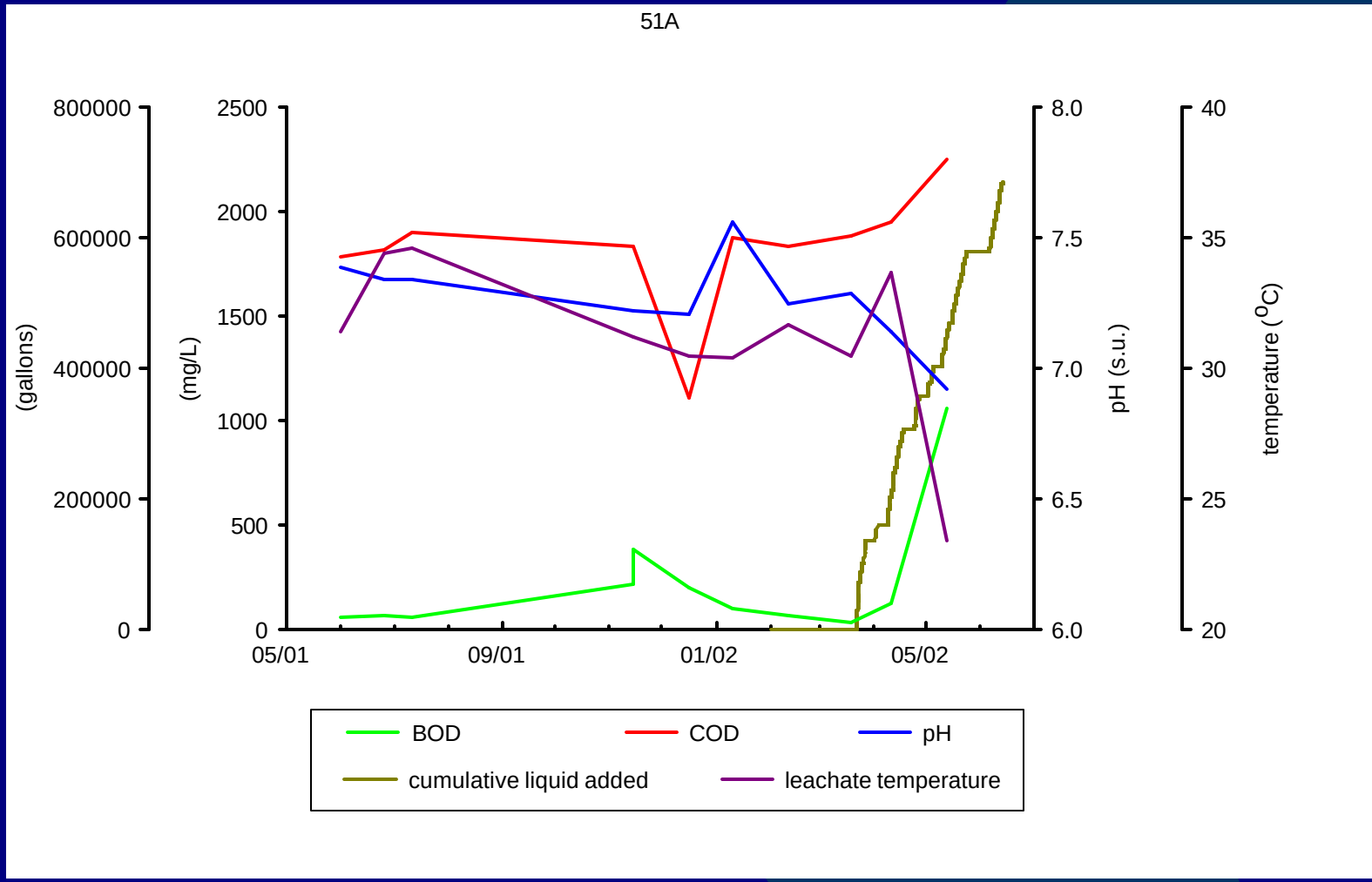

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Figure Courtesy of Waste Management, Inc.

Initial Results
Unit 5
Solids

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Baseline Waste Sampling

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Baseline Waste Sampling

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Solids Analysis

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Unit 5.1A
Waste and Ambient Temperature and Leachate Addition vs. Time

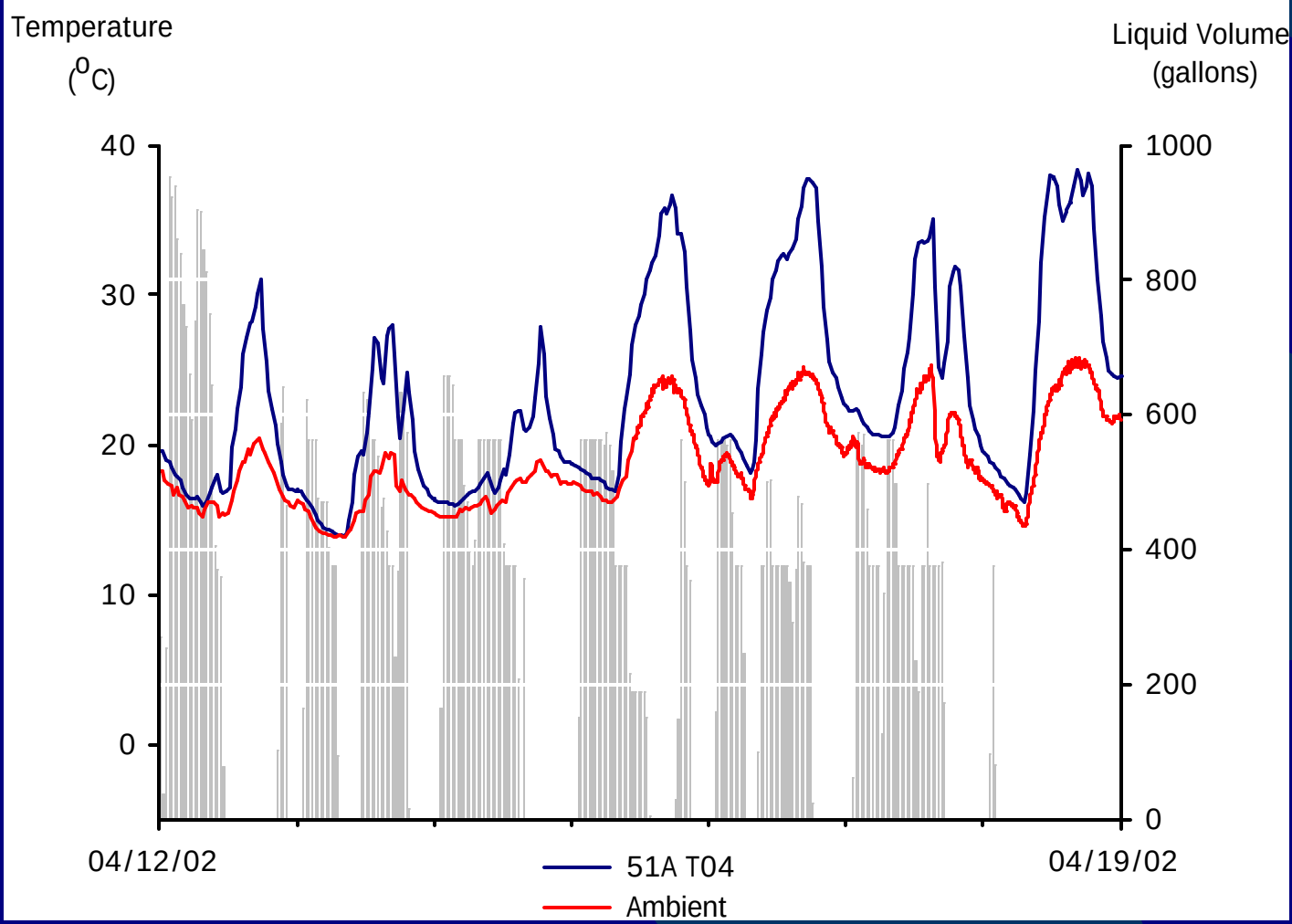

Figure Courtesy of Waste Management, Inc.

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Unit 5 Waste Density vs. Time

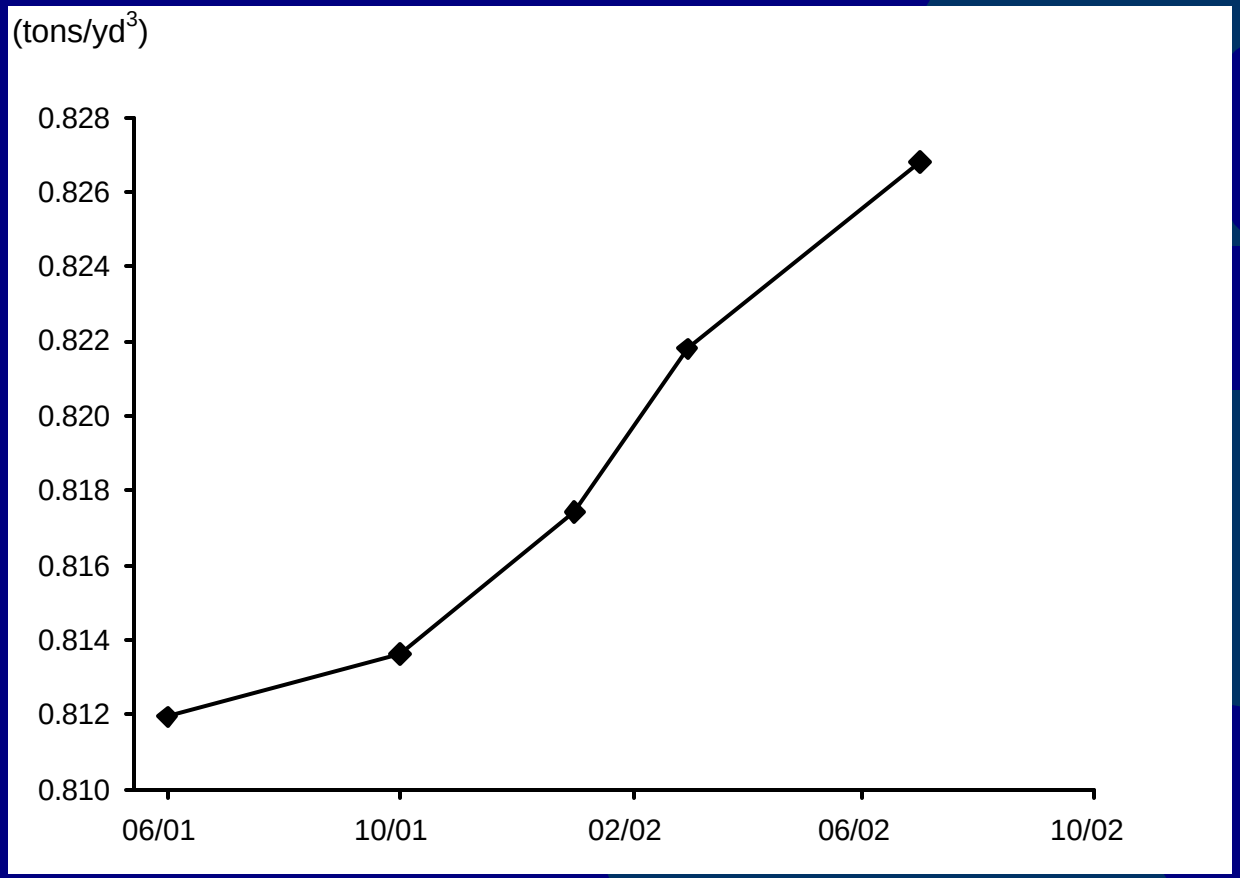

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Figure Courtesy of Waste Management, Inc.

Unit 5 Waste Volume vs. Time

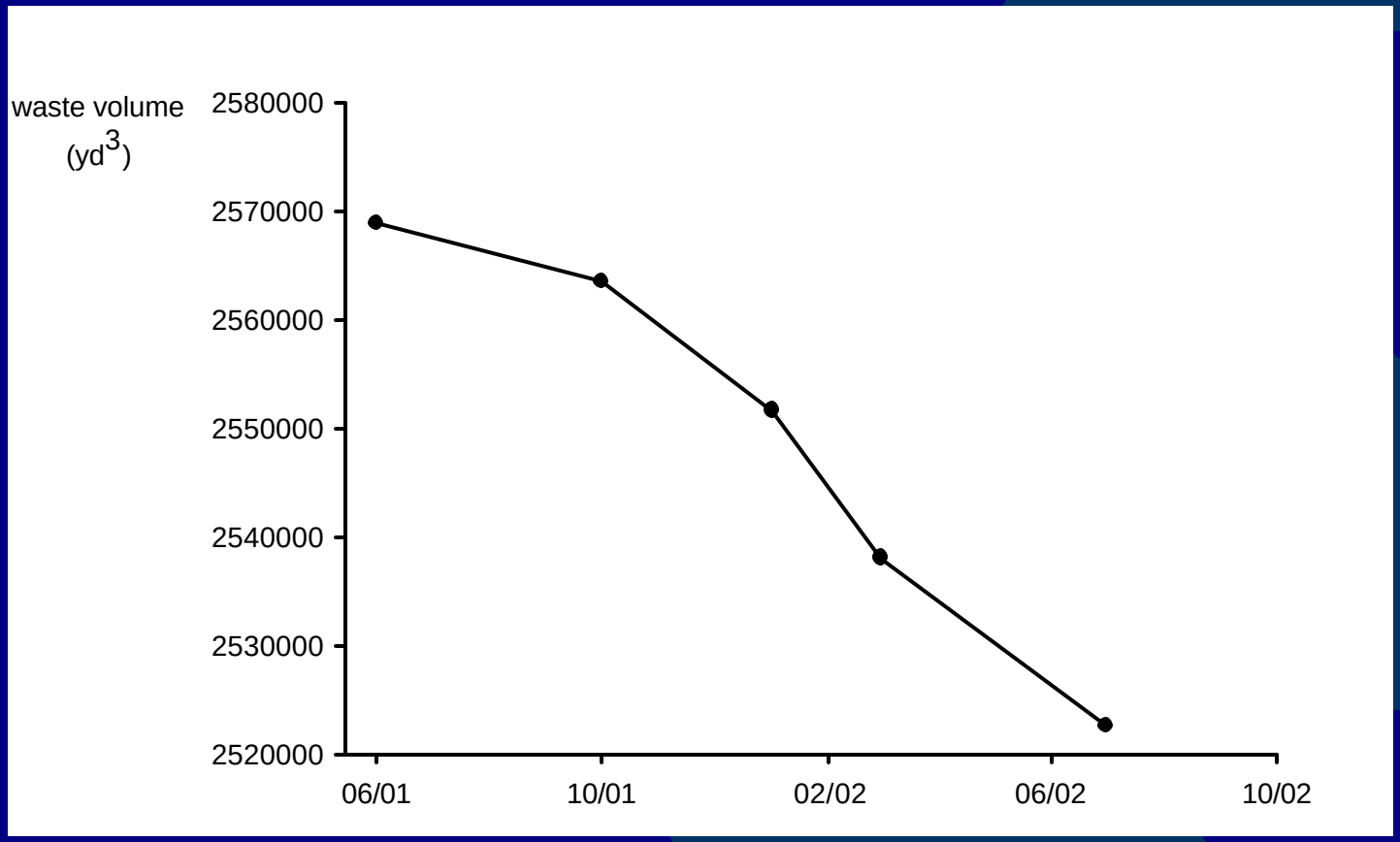

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Figure Courtesy of Waste Management, Inc.

Unit 5 Airspace Recovery vs. Time

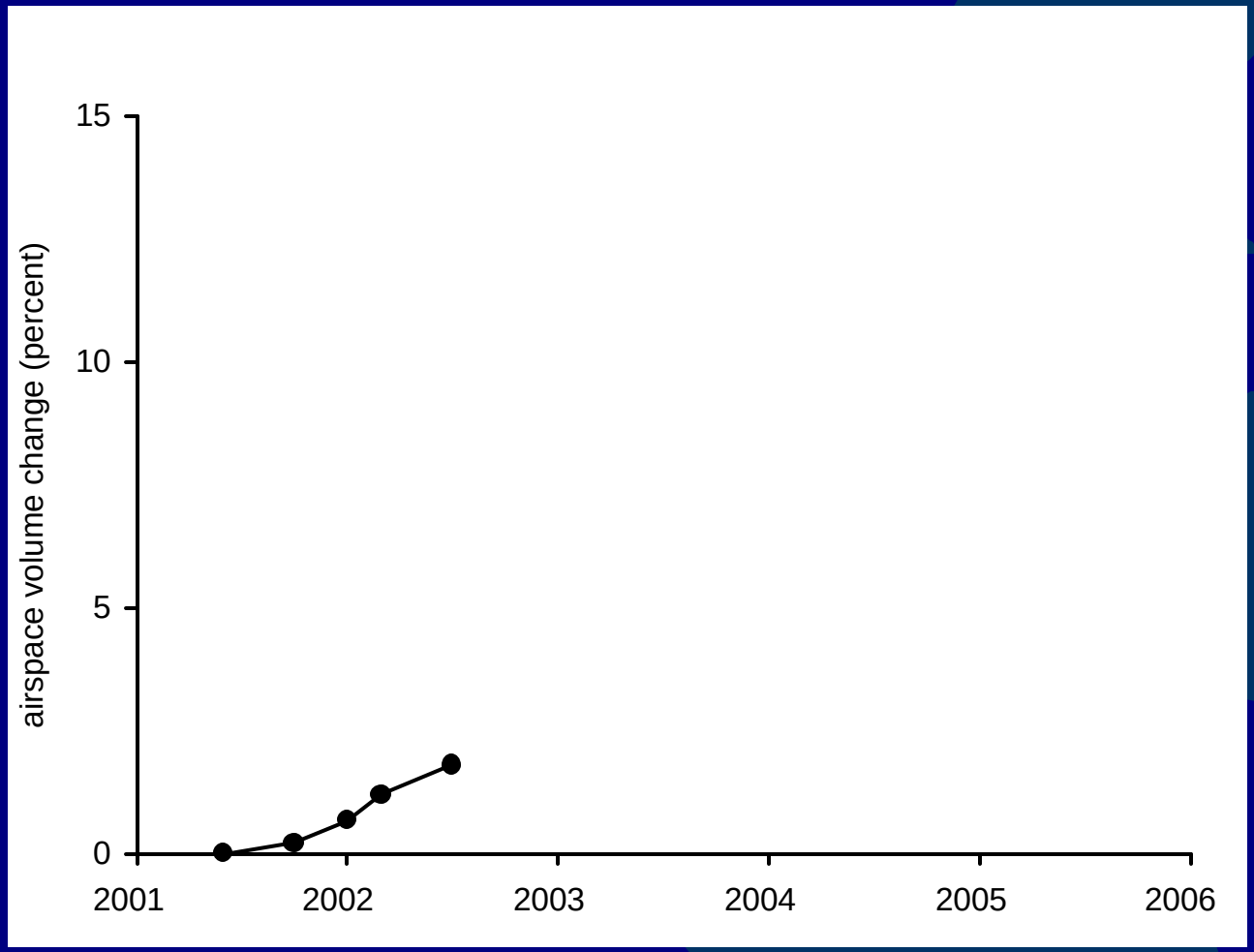

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Figure Courtesy of Waste Management, Inc.

Fugitive Air Emissions Monitoring

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Static FTIR - Background

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Scanning FTIR

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Summary

- Project is in the initial stages of a multiyear study
  - » This project, coupled with supporting research will enhance understanding of bioreactors
    - — Project XL
    - — Assessment of Bioreactor Performance Study
- Early bioreactor results are as expected

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CRADA Next Steps

- Continue Monitoring
  - » Revise Monitoring Plan as Needed
- Issue Interim Report in 2003
- Issue Detailed Technical Report in 2005

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Discussion Questions

- Q. How effective is bioreactor technology in achieving desired aims?
- A. Too early to tell at this project, but beneficial trends as expected.
- Q. What research gaps exist?
- A. Which monitoring parameters needed at working fills to maintain control.
- Q. What challenges were faced?
- A. Continuity of operations, retrofitting of system to existing fill, changing waste stream, daily operations, permit proceedings

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Discussion Questions (cont'd)

- Q. What recommendations can be made for future design and operation?
- A. Waste placement planning, gas collection timing
- Q. How were instruments used in process control?
- A. Parameter control is direct for some parameters, delayed for others, data management is a concern

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