The Outer Loop Bioreactor Landfill Project

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overview

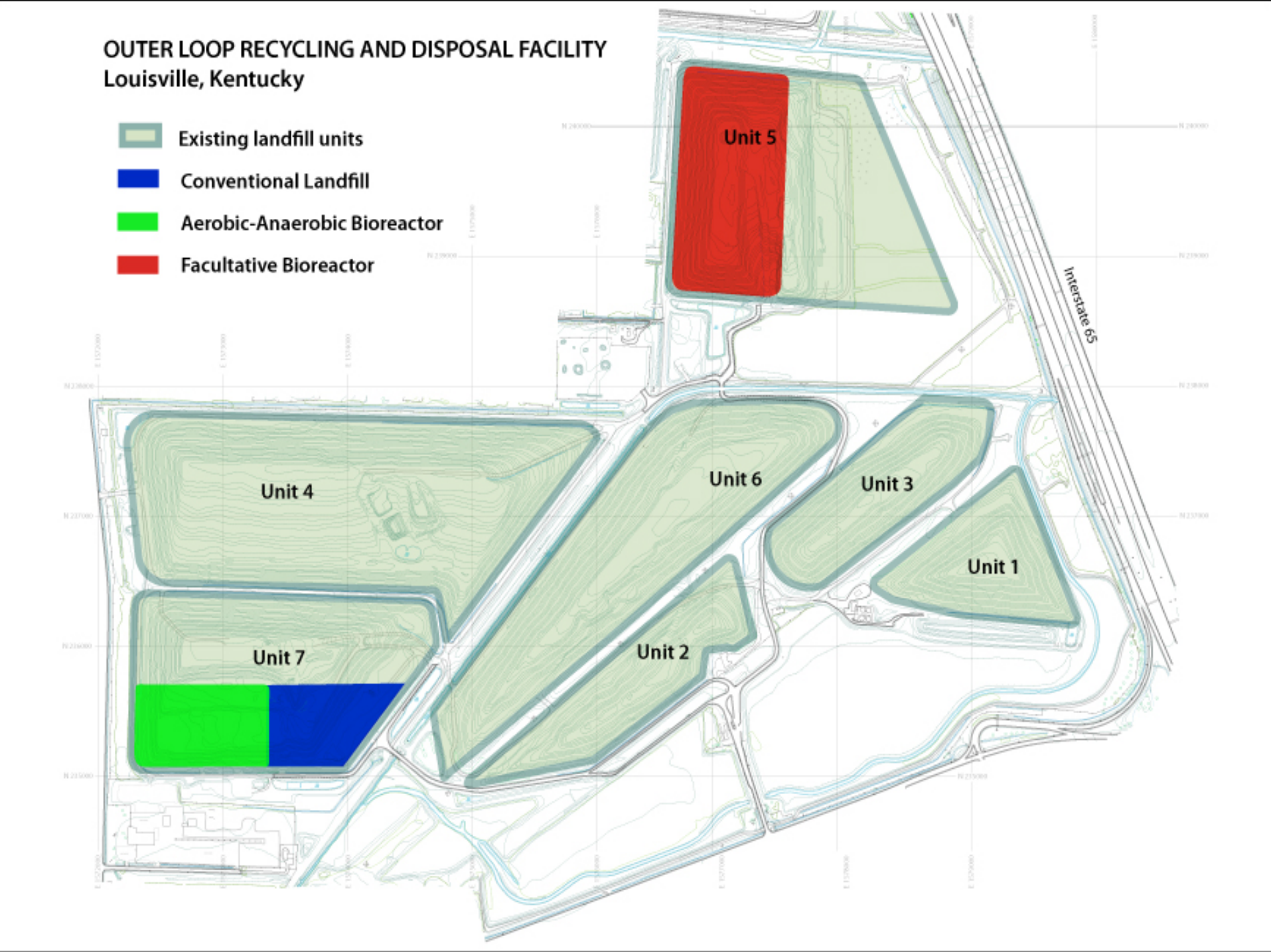
- Project background, site description and operations.
- Highlights of of landfill gas, waste solids and leachate results
- Summary

project background

- In 2000 Waste Management and US EPA's ORD and OSW sign a five-year cooperative research and demonstration agreement (CRADA) for bioreactor landfills.
- CRADA objective is to evaluate environmental and economic performance of the application of two bioreactor landfill processes to newly constructed and existing full-scale landfills.
- Waste stabilization characterization by liquids, landfill gas and waste solids parameters in replicate bioreactor treatment cells and traditional or control landfill cells.
- Two interim reports issued and CRADA renewed until 2010.

outer loop site description

- Outer Loop landfill located in Louisville, Kentucky, USA
- Property area = 3.2 km^2
- 5 inactive and 3 active permitted landfill units
- Waste acceptance rate = 2,500 metric tons per day
- Precipitation = 109 cm yr^{-1}
- Mean annual temperature = 14 ºC (-19 to 37 ºC)


OUTER LOOP RECYCLING AND DISPOSAL FACILITY
Louisville, Kentucky
Existing landfill units
Conventional Landfill
Aerobic-Anaerobic Bioreactor
Facultative Bioreactor
Unit 5
Interstate 65
Unit 4
Unit 6
Unit 3
Unit 1
Unit 7
Unit 2

study summary

landfill type	waste acceptance		liquid addition*		landfill gas collection system	comment
	Dates	Mass (1,000 Mg)	Dates	Volume (m^3)		
conventional	1998-2005	513 (0.565 Mton)	—	—	Vertical Wells	—
aerobic-anaerobic bioreactor	2001-2005	1,461 (1.610 Mton)	2001-2005	299,000 (78.9 Mgal)	Horizontal wells and layers of permeable media	Leachate and other liquids + aeration of waste.
facultative bioreactor	1995-1998, 2000	1,892 (2.085 Mton)	2001-2005	76,000 (20.1 Mgal)	Vertical and horizontal wells	Recirculation of nitrified leachate.

horizontal distribution piping

permeable layer installation

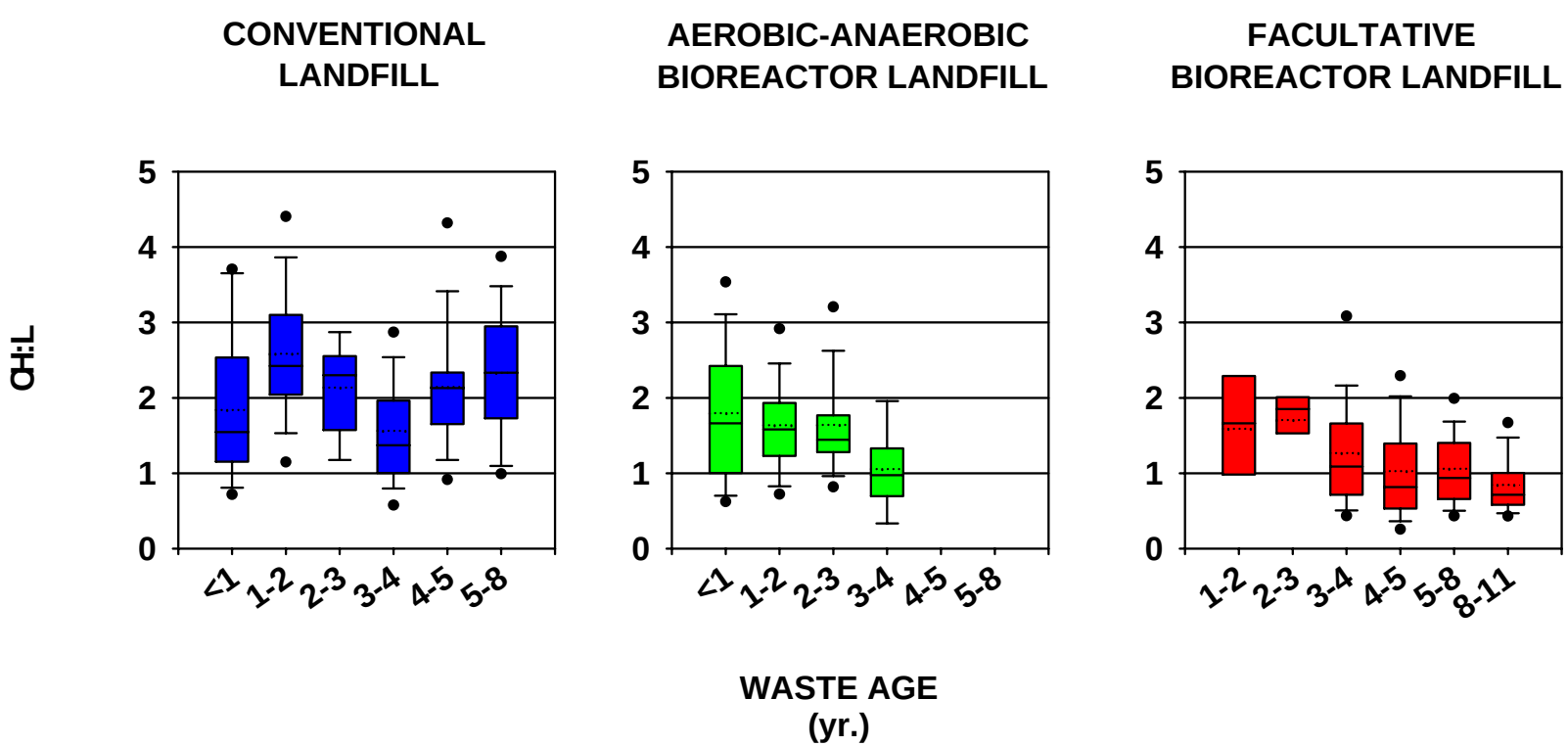
solids sampling

- Sampling campaigns in 2000, 2002, 2003 and 2005.
- Stratified random sampling approach.
- Vertical borings made with~1m diameter bucket auger.
- Samples composited every 3m of depth.
- 20 l (10-30 kg) of sample to lab.

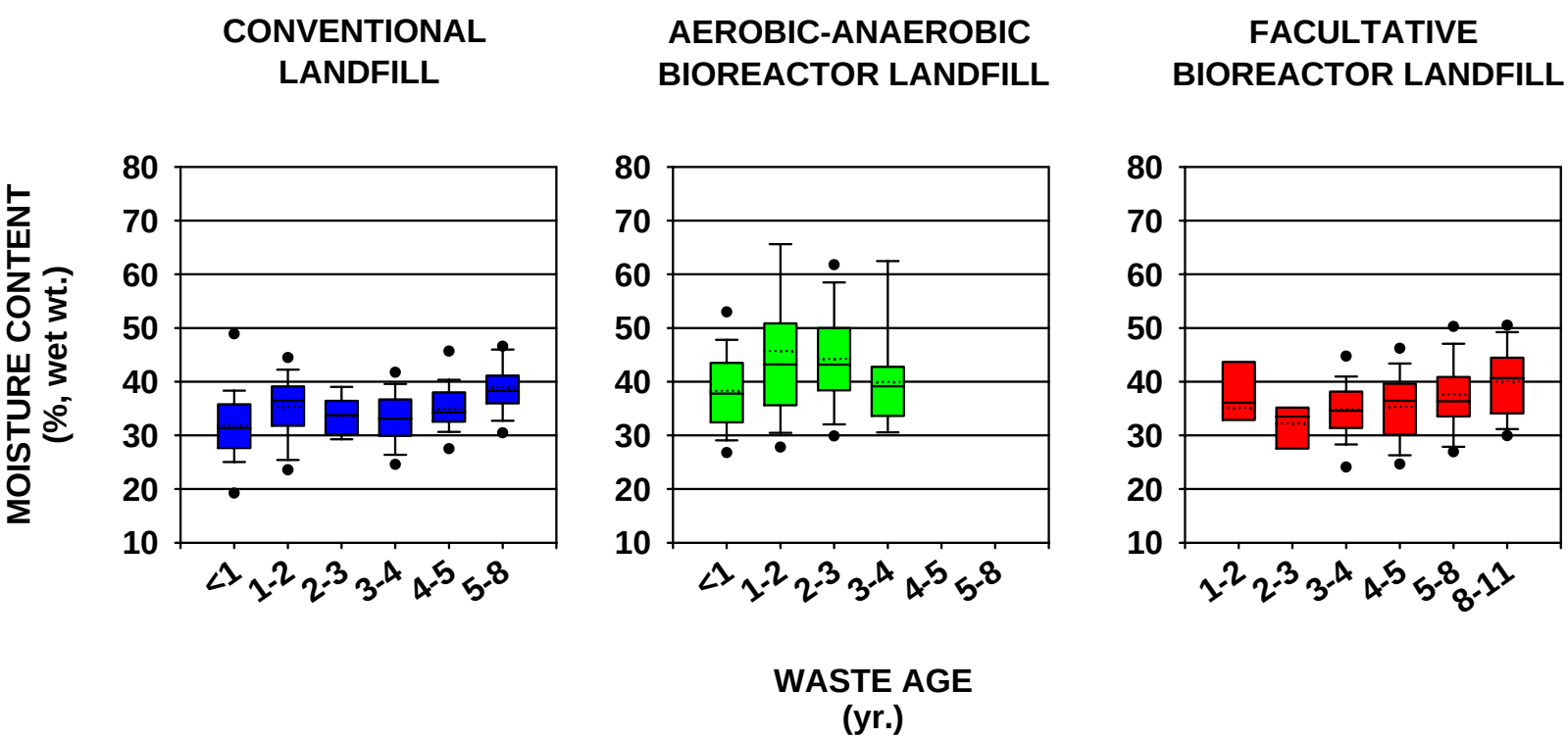
solid sample analyses

- Cellulose
- Hemicellulose
- Lignin
- Biochemical Methane Potential
- Organic solids (550 ^{o}C)
- Gravimetric moisture
- Samples dated by survey records for waste placement

c+h:l ratio vs. waste age range



moisture content vs. waste



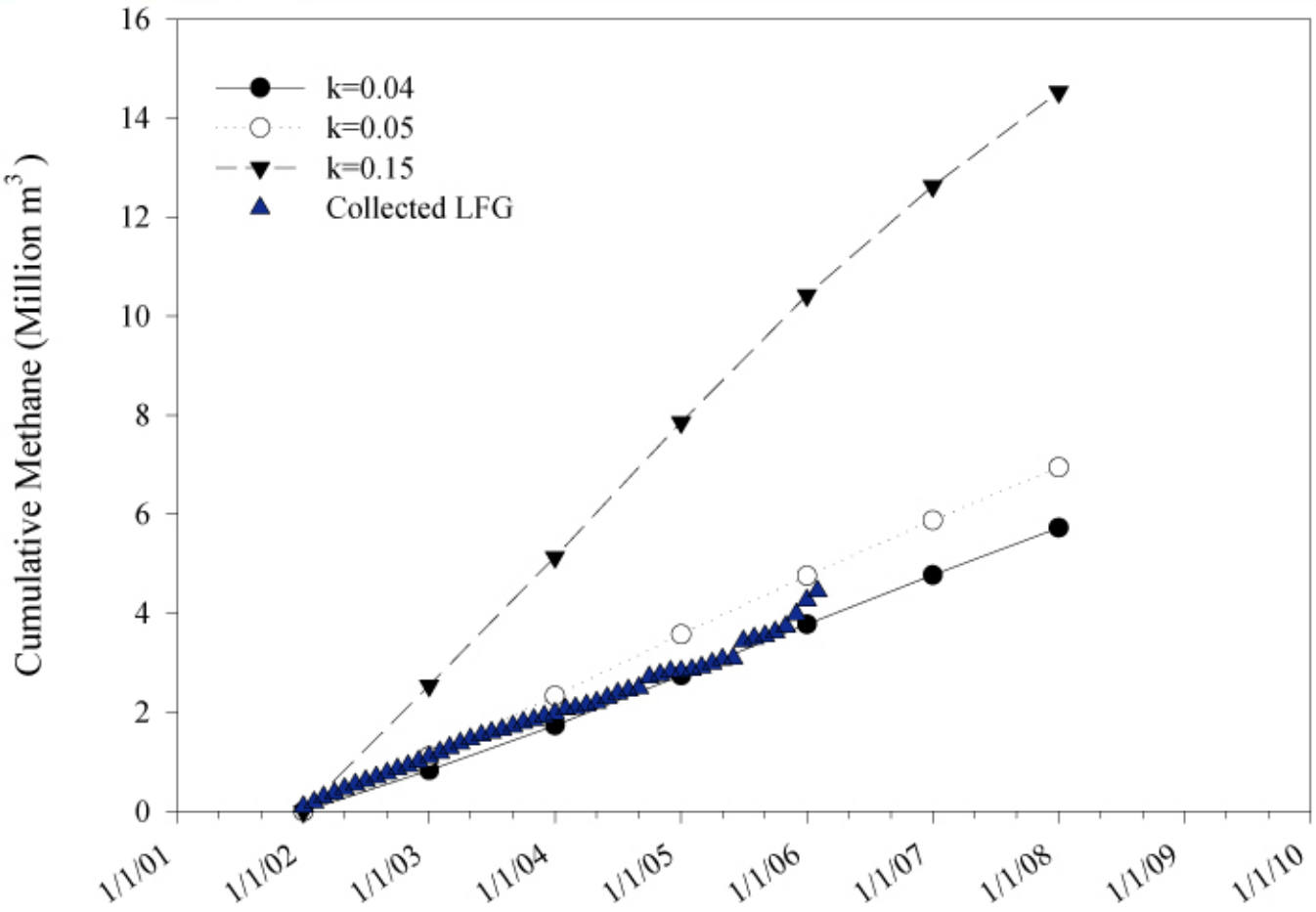
gas sample collection & analysis

- Weekly field measurements of landfill gas composition and flow rate were made using portable landfill gas analyzer.
- Analysis of methane, carbon dioxide, and oxygen by US EPA Method 3
- NMOC by US EPA Method 25C. Samples were collected on quarterly basis in 6-liter stainless steel canisters.

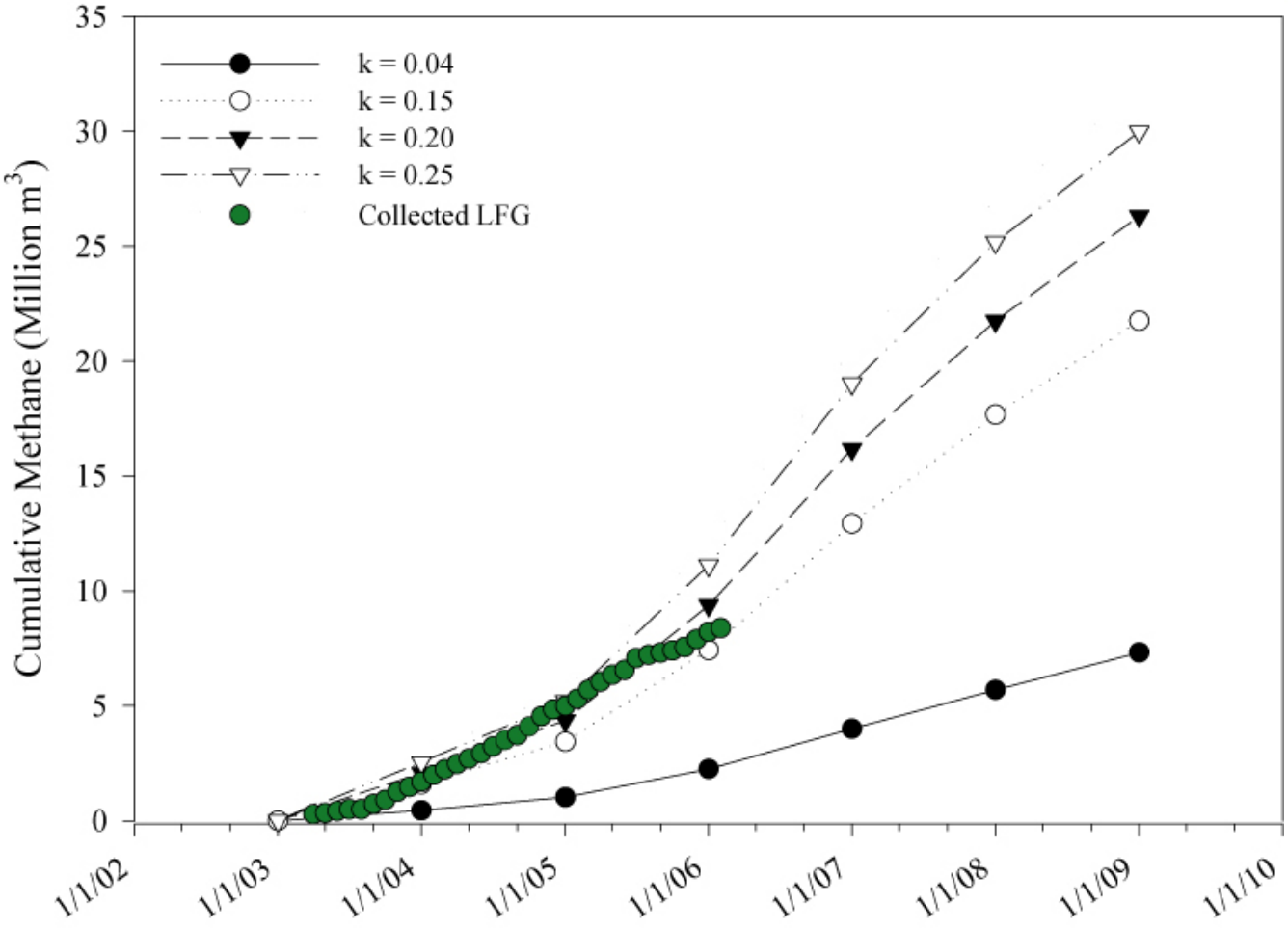
LFG modeling

- The first-order decay equation specified in US EPA's LandGEM 3.02 model was used to predict methane generation for each of the landfill types.
- A site-specific methane generation potential value, (L_0), of 59 m^3/Mg was used based on BMP results of fresh waste.
- Model runs varied the rate constant value, (k), from the default of 0.04 $year^{-1}$ to a value of 0.25 $year^{-1}$, considered to represent the rate at a wet or bioreactor landfill.

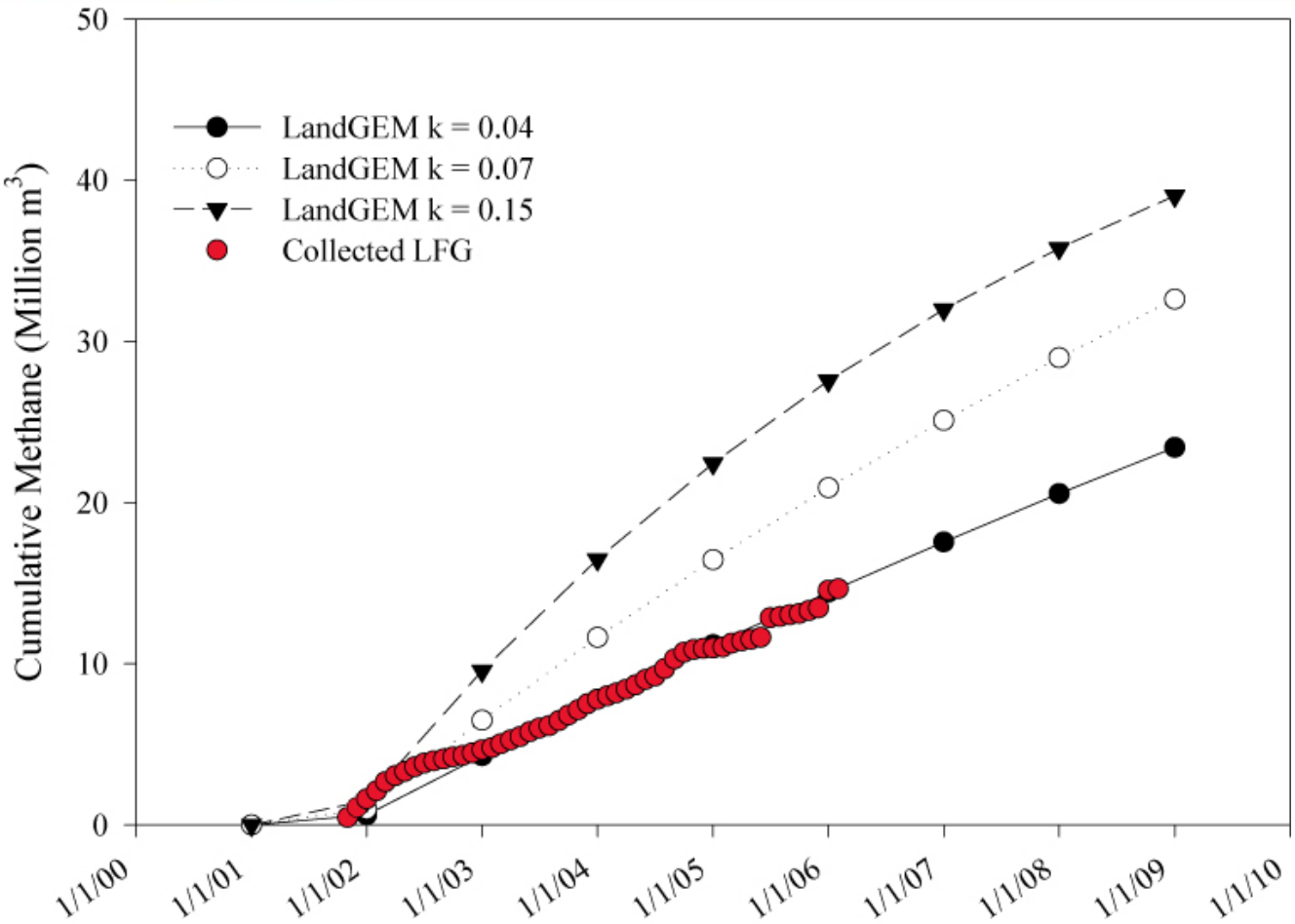
conventional gas production



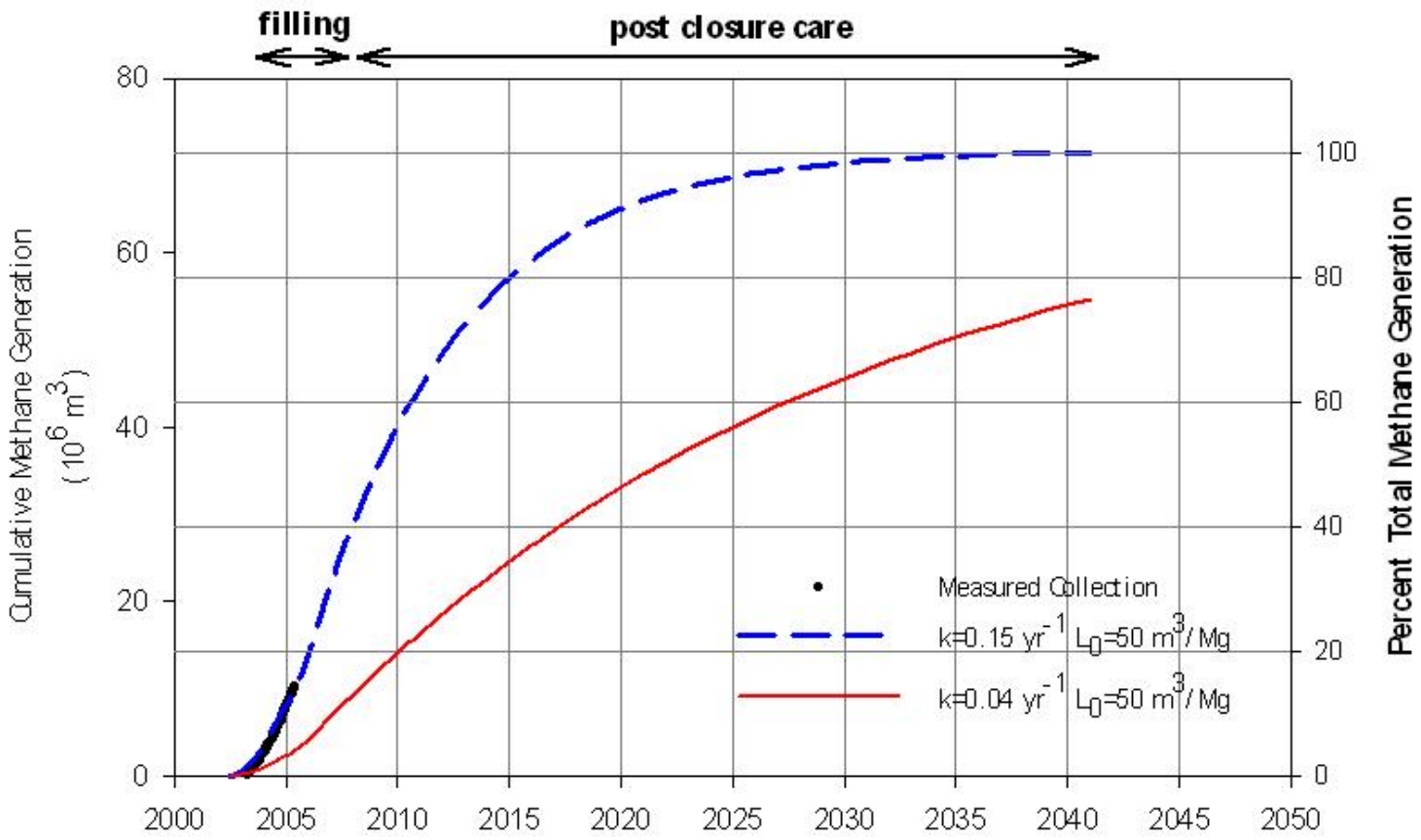
aerobic-anaerobic bioreactor gas production



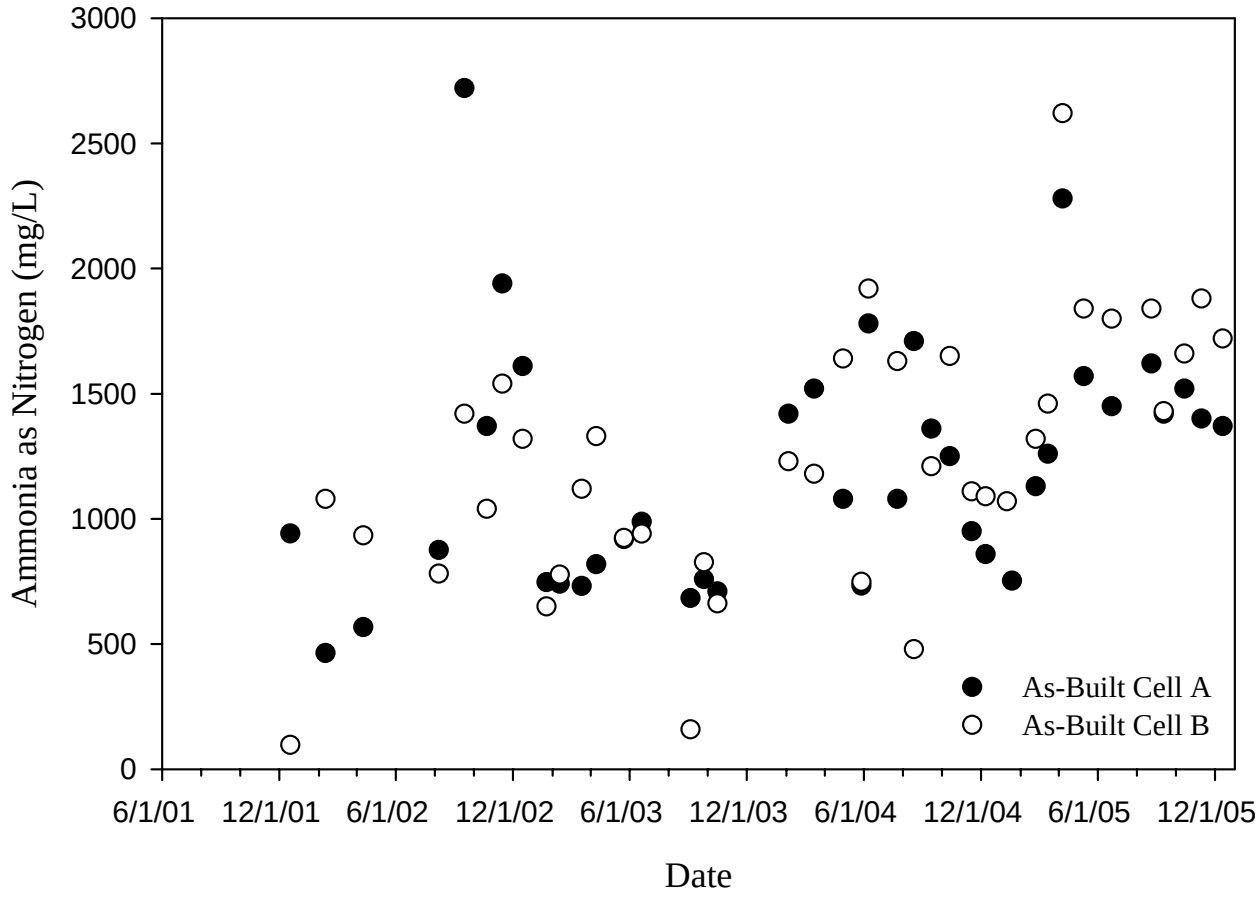
facultative bioreactor gas production



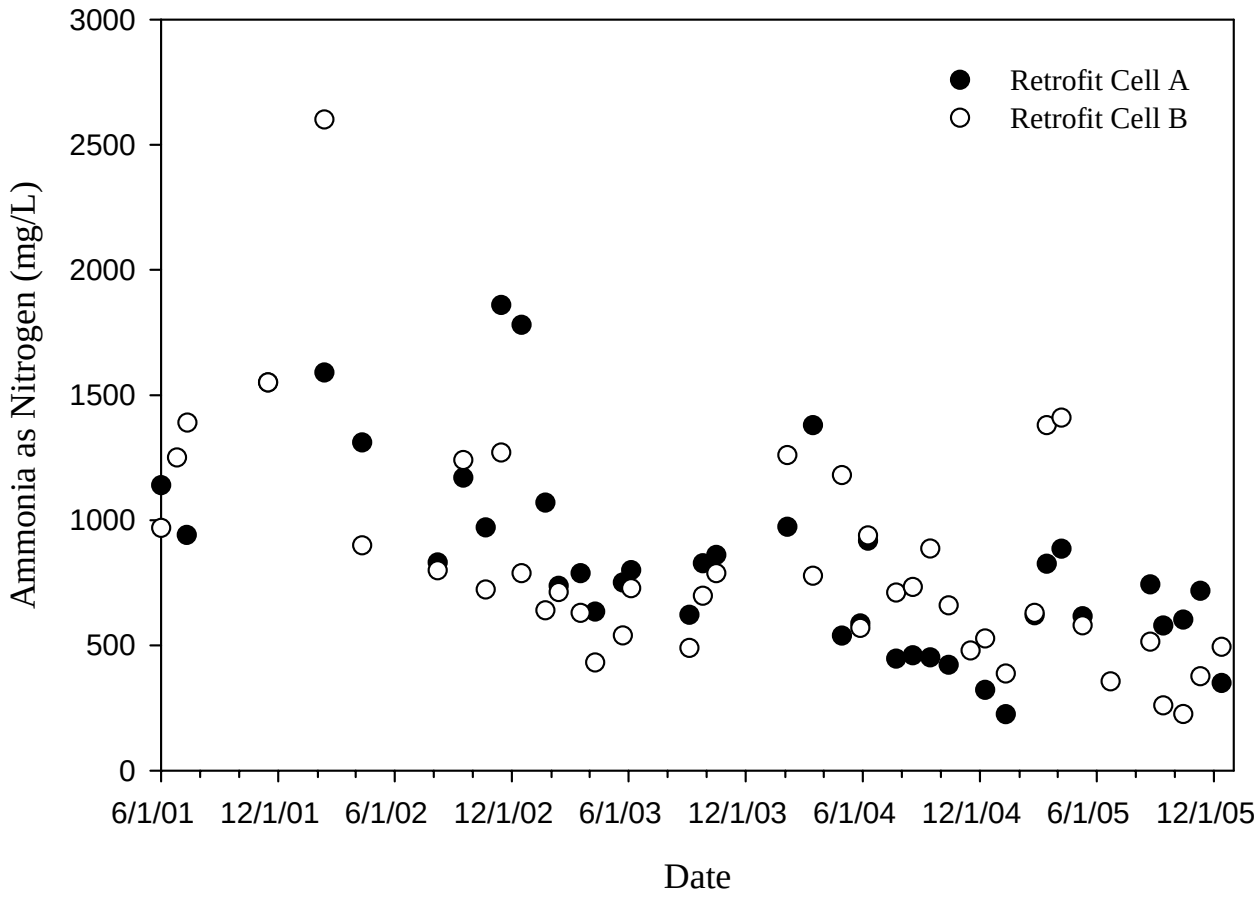
implications of bioreactor technology



ammonia for aerobic-anaerobic cells



ammonia for facultative cells



report conclusions

- The addition of liquids increased the moisture content of waste in the landfill bioreactor cells and accelerated the degradation of waste.
- Leachate quality data indicate that waste degradation may have been enhanced in the as-built landfill bioreactor cells, and solid waste decomposition data for one of the as-built cells supports this conclusion.
- Landfill gas quantity data indicate that more gas was produced in the as-built cells than in the control cells.

report conclusions

- "The most significant conclusion is that, despite the five-year duration of the study, two of the three media analyzed (i.e., solids and LFG) indicated that waste decomposition was accelerated in the As-Built and Retrofit cells relative to the Control cell."
- "…it is concluded that the OLLB generally met the criteria of Subtitle D of the Resource Conservation and Recovery Act for design and operation of MSW landfills, and that other well-designed and well-operated bioreactor landfills should also be able to be operated in compliance with the requirements of Subtitle D."

future work

- One additional bioreactor project and an emissions measurement project will be added to the CRADA.
- A new anaerobic bioreactor cell was permitted in 2006 and now in operation.
- The Quality Assurance Project Plan has been reviewed and revised based on findings from the report. Changes include reductions in the number of parameters monitored and the frequency of monitoring.

final remarks

- Internal WM analysis indicates more than half of the 283 landfills managed by the company are candidates for bioreactor technology.
- Bioreactors viewed as a potential GHG reduction strategy for waste sector by U.S. DoE, California Energy Commission.
- U.S. adoption of bioreactor landfills is proceeding under Research, Development & Demonstration (RD&D) rules.
- Expect final federal rule allowing bioreactors in the near future based on performance of current demonstration projects.

Thank you!

- “Landfill Bioreactor Performance: Second Interim Report Outer Loop Recycling & Disposal Facility Louisville, Kentucky” (2006) National Risk Management Research Laboratory, USEPA. EPA/600/R-07/060
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