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THE SOLID WASTE MANAGER'S GUIDE TO THE BIOREACTOR LANDFILL- 2009 UPDATE

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TABLE 1

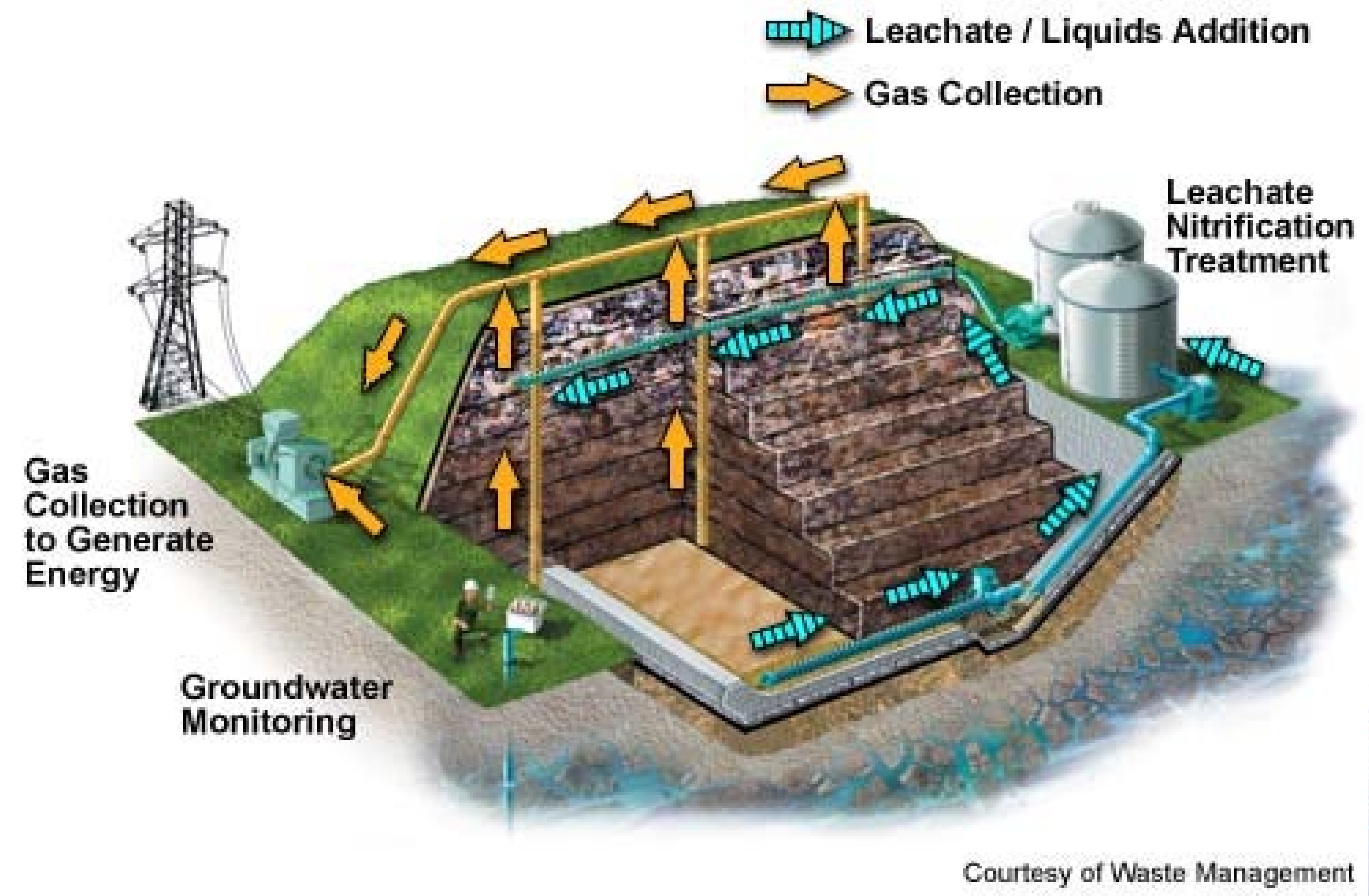
SWANA ARF FY 2009 Disposal Group Subscribers

Jurisdiction	Representative	Title
Chester County Solid Waste Authority (PA)	Robert Watts	Executive Director
Delaware County Solid Waste Authority	Joseph Vasturia, PE	Chief Executive Officer
Delaware Solid Waste Authority	Pat Canzano, PE, BCEE	CEO and General Manager
Denton, TX	Scott Lebsack	Assistant Director of Solid Waste
Greenville County, SC	Marcia Papin	Solid Waste Disposal Manager
King County, WA	Kevin Kiernan	Solid Waste Division Manager
Lancaster County Solid Waste Management Authority (PA)	Brooks Norris	Senior Manager, Technical Services
Los Angeles County Sanitation Districts (CA)	Mario Iacoboni	Supervising Engineer
Mecklenburg County, NC	Bruce Gledhill, PE	Director, Solid Waste
Metro Waste Authority (Des Moines, IA)	Jeff Dworek	Director of Operations
Monterey Regional Waste Management District (CA)	William Merry, PE, DEE	General Manager
New River Solid Waste Association (FL)	Darrel O'Neal	Executive Director
Solid Waste Authority of Palm Beach County (FL)	Mark Hammond	Managing Director
SCS Engineers	Robert Gardner, PE, DEE	Senior Vice President
Solid Waste Authority of Central Ohio	Rick Dodge	Chief Operating Officer
Three Rivers Solid Waste Authority (SC)	Colin Covington	General Manager
Winston-Salem City/County Utilities (NC)	Jan McHargue, PE	Solid Waste Administrator

Bioreactor Landfill Presentation Topics

- Introduction
- Types and Implementation Options
- Benefits
- Concerns
- Conclusions

The Bioreactor Landfill



Bioreactor Landfill Definition

- "A bioreactor landfill is a controlled landfill or landfill cell where liquid and gas conditions are actively managed in order to accelerate or enhance biostabilization of the waste. The bioreactor landfill significantly increases the extent of organic waste decomposition, conversion rates, and process effectiveness over what would otherwise occur with the landfill."

SWANA Bioreactor Committee (2002)

Types of Bioreactor Landfills

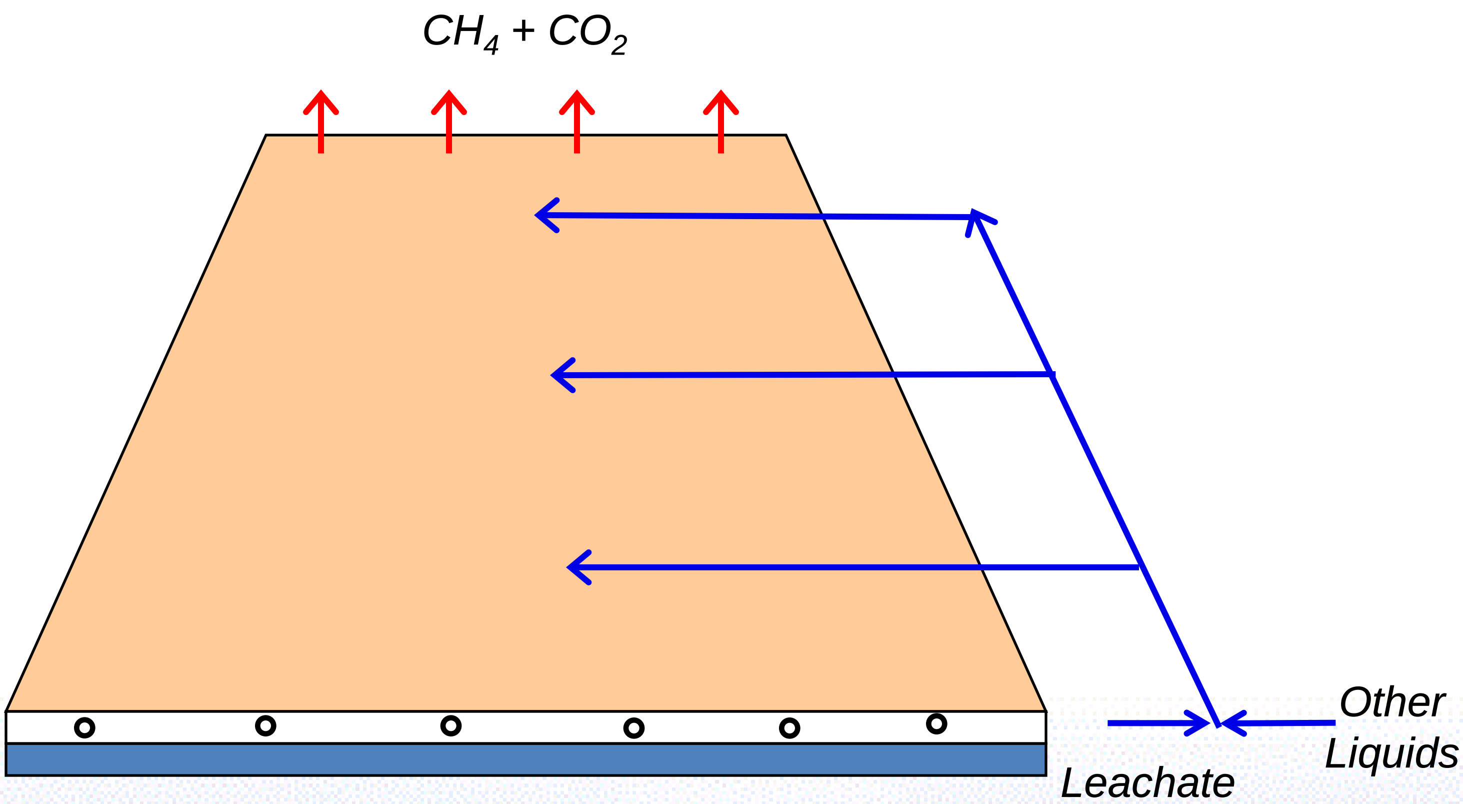
Bioreactor Landfill Type	Implementation Option
Anaerobic Bioreactors	▪ As Built Bioreactor Landfill ▪ Retrofit Bioreactor Landfill
Aerobic Bioreactors	▪ As Built Bioreactor Landfill ▪ Retrofit Bioreactor Landfill
Hybrid Bioreactors (Aerobic/Anaerobic)	▪ As Built Bioreactor Landfill ▪ Retrofit Bioreactor Landfill

Anaerobic Bioreactors

- *Leachate and other liquids are injected into the landfill in a controlled manner*
- *Biodegradation occurs in the absence of oxygen (i.e., anaerobically).*
- *Anaerobic process produces landfill gas*
  - *50% methane/50% carbon dioxide*
  - *Can be recovered for its energy value*
- Most landfills are naturally anaerobic systems.

Bioreactor Configurations

Most Bioreactor Landfills are Operated as Anaerobic Systems



Implementation - As Built Bioreactor Landfill

- Landfill is designed as as a bioreactor
- Landfill is operated as a bioreactor while waste is actively deposited in the landfill.

Implementation - Retrofit Bioreactor

- Landfill that was not originally designed or operated as a bioreactor;
- Bioreactor operations begin most or all of the waste has been placed.
- Methods for liquids and/or air addition are more limited than for as-built bioreactors.

Bioreactor Landfills – Status Report

- Active Bioreactor Landfills
  - Anaerobic Bioreactors – 24
  - Anaerobic/Facultative Bioreactors – 1
  - Hybrid Bioreactors – 1
  - Aerobic Bioreactors – 1
  - Unknown Type – 3

Bioreactor Landfill Benefits

- On-Site Leachate Management
- Increased Disposal Capacity
- More Feasible LFG Recovery
- Increased Environmental Protection
- Long Term Savings

Benefit: Leachate Management

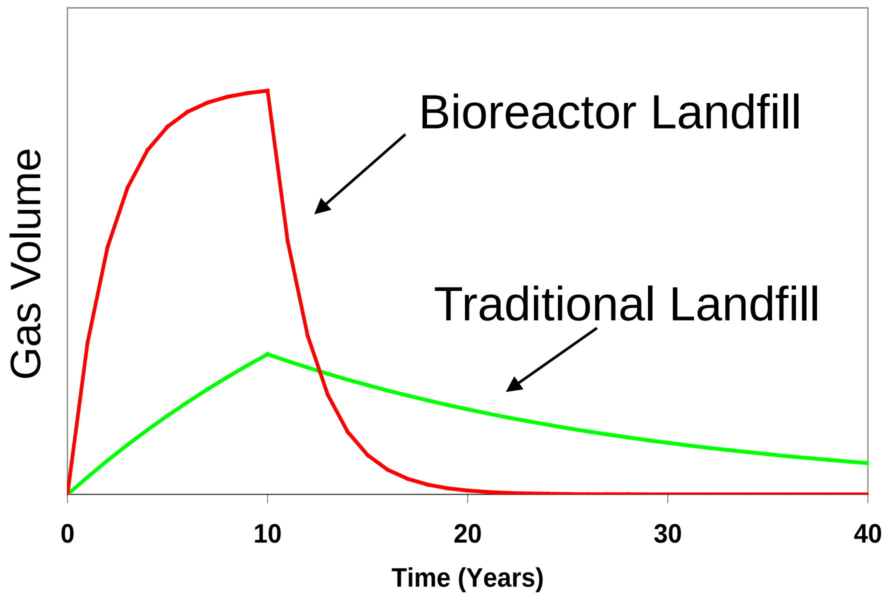
- Waste has a large capacity to absorb moisture.
- Long-term leachate quality may be improved.
- Significant potential cost savings on leachate treatment.

Benefit: Reusable Airspace

- A 15-30% gain in landfill airspace has been demonstrated due to waste biodegradation and settlement.
- It is possible to "resell" this airspace and generate significant revenues.

Benefit: Higher Potential for LFG Recovery

- LFG generation is accelerated in bioreactor and LR landfills.
- Gas production during a shorter time frame may make the economics of landfill gas to energy more attractive.



Benefit: Reduction in Long-Term Environmental Risks

- Landfilled waste is biostabilized over a shorter period.
- Environmental risks of LFG and leachate are managed when LFG and leachate systems are in prime condition.

Bioreactor/LR Landfill Economics

- As-Built Bioreactors
  - Least expensive bioreactor option
  - Less expensive than traditional landfills

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Bioreactor/LR Landfill Economics

- Retrofit Bioreactors
  - Most expensive bioreactor option
  - More expensive than traditional landfills

Areas of Concern

- Leachate Outbreaks
- Sideslope Stability
- LFG Emissions
- Moisture Addition
- Gas Collection
- Short Term Costs.

Concern: Leachate Seeps

- If leachate/other moisture is added at too great of a rate, leachate seeps can occur at increased rates.
- Problems with seeps:
  - Off-site leachate migration
  - Odors
  - Vectors
  - Path for gas emission

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Concern: Sideslope Stability

- Excessive pore water pressures in a landfill can lead to instability problems.
- Shear strength of waste may be reduced following decomposition.

From: Dr. Robert Koerner

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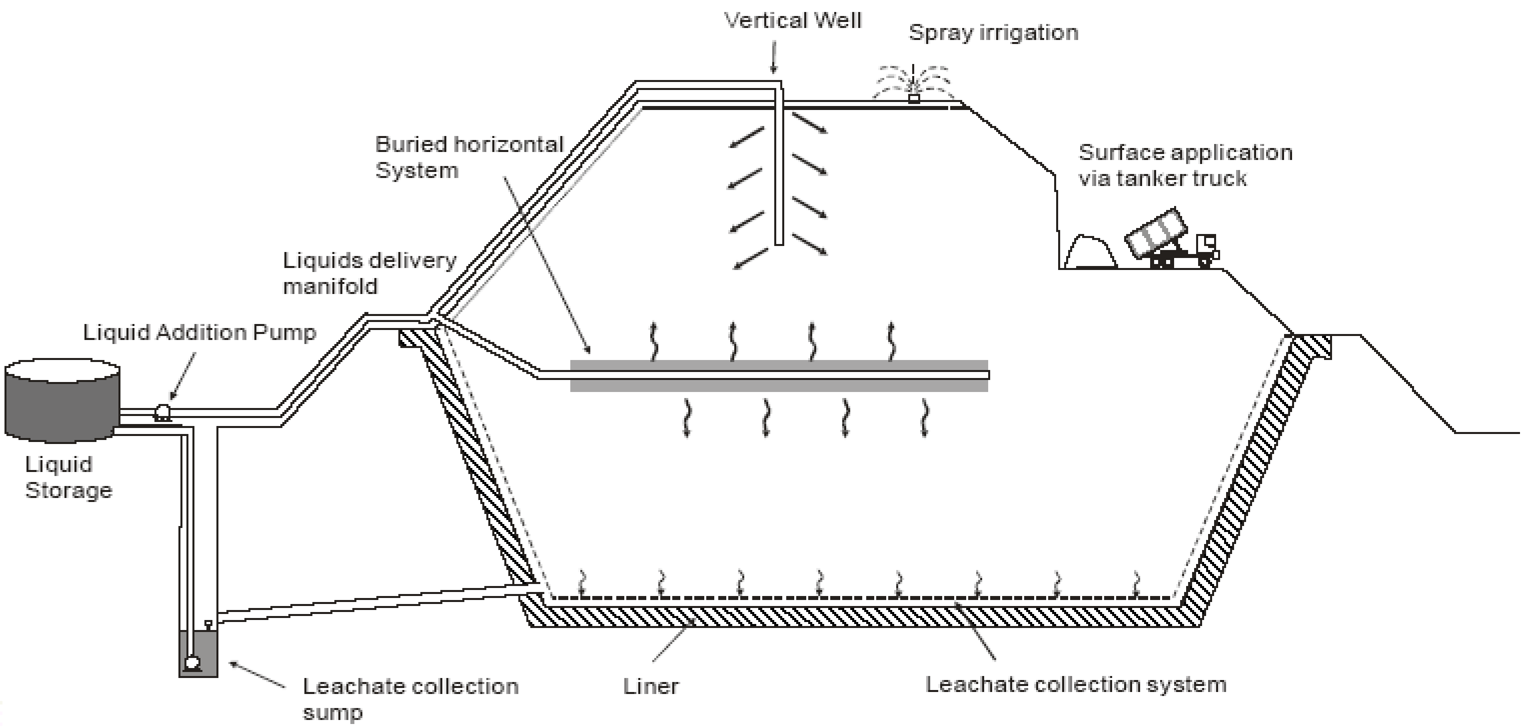
Concern: Increased Gas Emissions

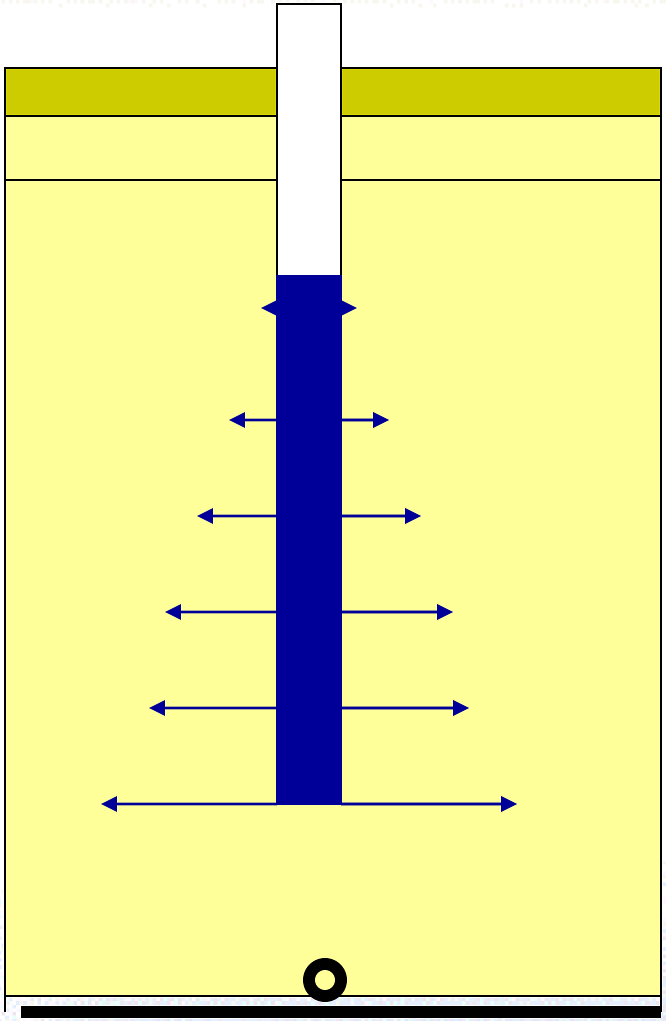
- Bioreactor/LR landfills produce LFG more quickly than traditional landfills.
- If uncontrolled, quicker LFG production from bioreactor operation can result in increased emissions.
- Increased LFG emissions can cause odor and environmental problems.
- Bioreactor landfills may require different types of gas collection systems compared to traditional landfills (e.g., lfg collection wells can become flooded).

Problems with Liquid Addition Systems



Problems with Moisture Addition Systems

- The greatest hydraulic pressure will be at the bottom of the well.
- This might result in more leachate distribution on the bottom of the landfill.



Direct Wetting of the Working Face

- Leachate can be sprayed or pumped onto the waste as it is tipped and compacted.
- Provides good means of moisture distribution.
- Potential concerns:
  - Working conditions
  - Exposure to workers
  - Runoff

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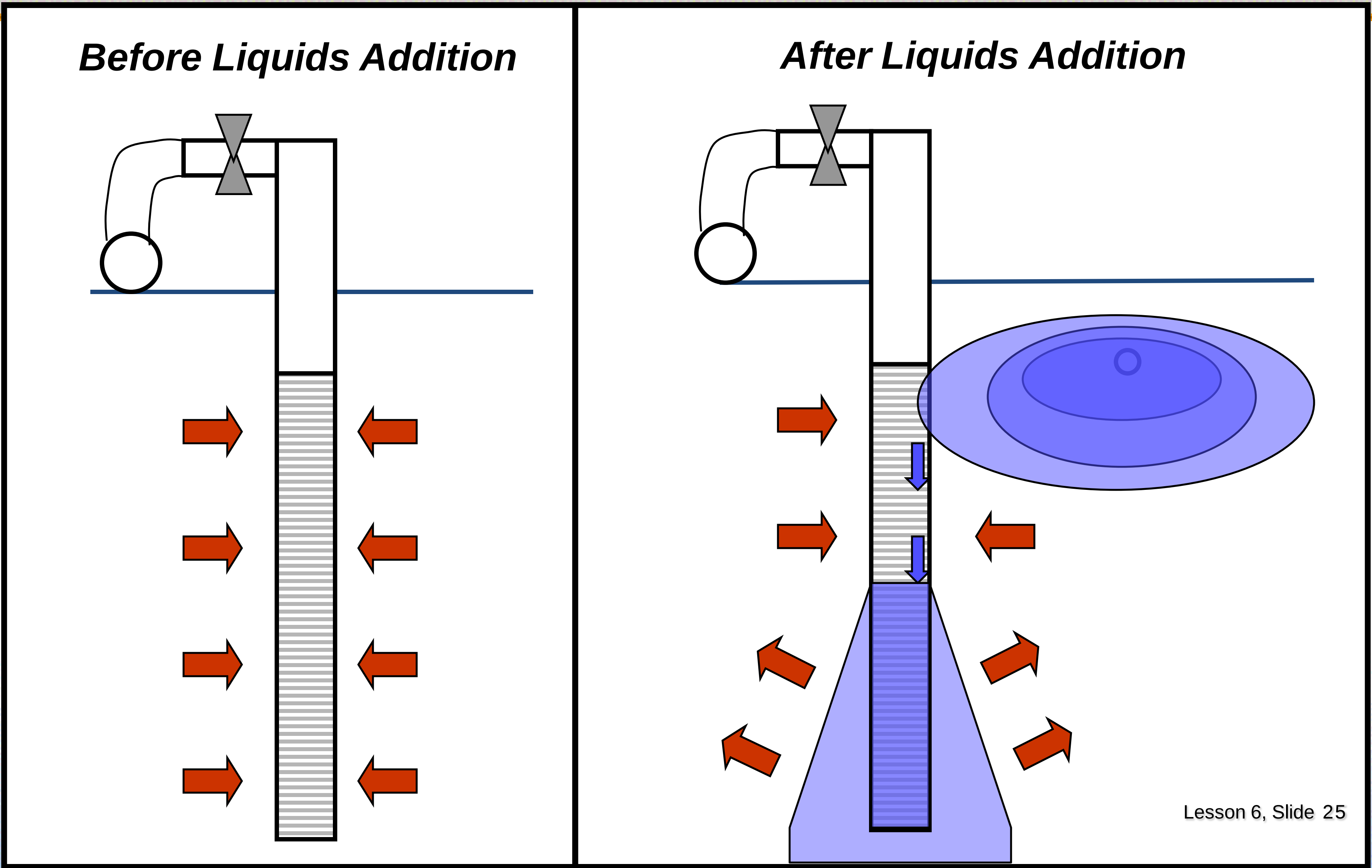
Issues with Gas Collection



“MultiPlane” LFG Collection System

Concern: Short Term Costs

- Initial capital costs and operation costs are higher for bioreactor/LR landfills
- These can be offset by the long-term revenues and reduced costs.

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Bioreactor Landfills - Conclusions

- Still in demonstration stage of development
- Can be more economical than traditional landfills
- Standard Sub D Containment Systems Work Well
- Retrofits can work effectively
- New gas collection systems are needed
- Wetting waste at working face may be best approach
- RD&D Permit Program needs improvement