Landfill Cover Design and Operation

USEPA Workshop on Bioreactor Landfills

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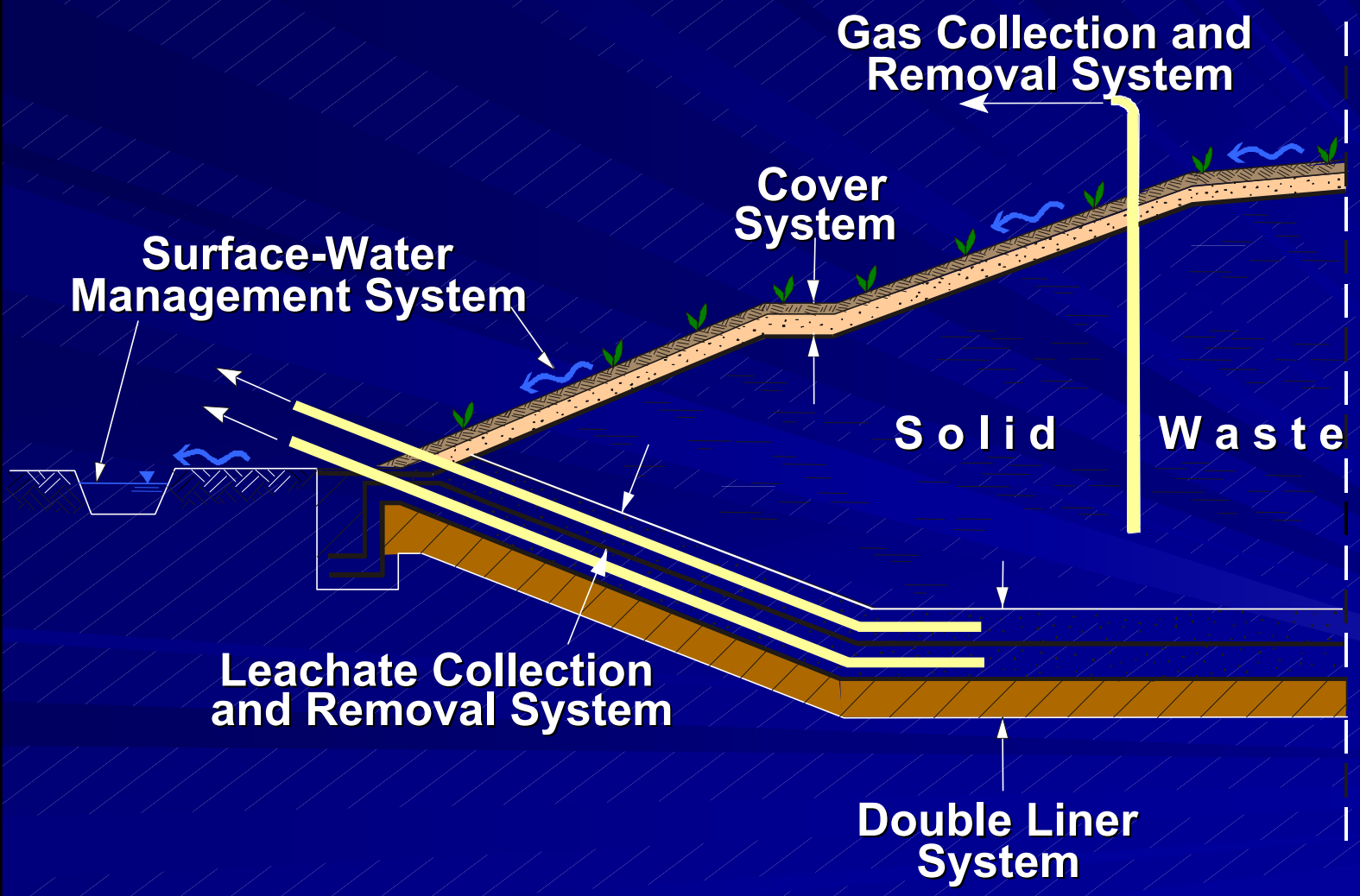
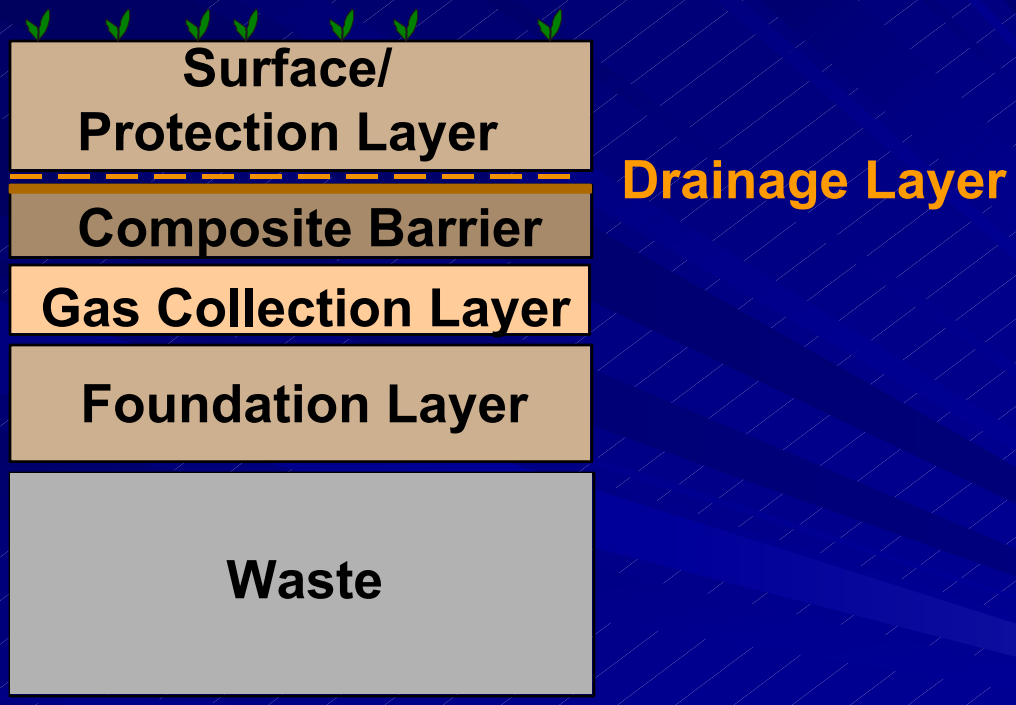
Engineered Systems at Landfills



Cover System Components



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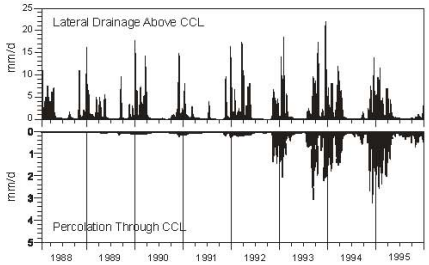
April 2002

Technical Guidance For RCRA/CERCLA Final Covers



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Component Functions

- Surface Layer
  - Resist erosion by wind and water
  - Be maintainable
  - Promote vegetation, if present
  - Satisfy aesthetic, ecological, or end use criteria
- Protection Layer
  - Protect underlying layers from erosion and exposure to damaging environments (freeze-thaw, desiccation, ultraviolet light)
  - Serve as a biobarrier
  - Store water for vegetation, if present

Component Functions

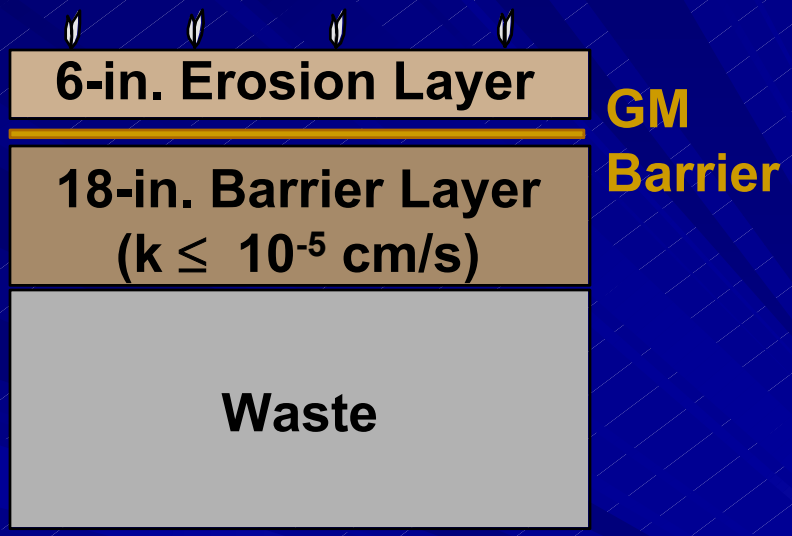
- Drainage Layer
  - Limit hydraulic head on the barrier
  - Drain the overlying soil layers
  - Reduce seepage forces above the barrier
- Hydraulic Barrier
  - Minimize percolation
  - Restrict gas emissions

Component Functions

- Gas Collection Layer
  - Convey gas to a collection point
  - Limit pressure head beneath the barrier
  - May generally be needed for operating bioreactors with a final cover system
- Foundation Layer
  - Provide grade control and smooth surface
  - Provide adequate bearing capacity for overlying layers
  - Reduce differential settlements in overlying layers

Minimum Criteria Cover System for Modern MSW Landfills (40 CFR §258.60)

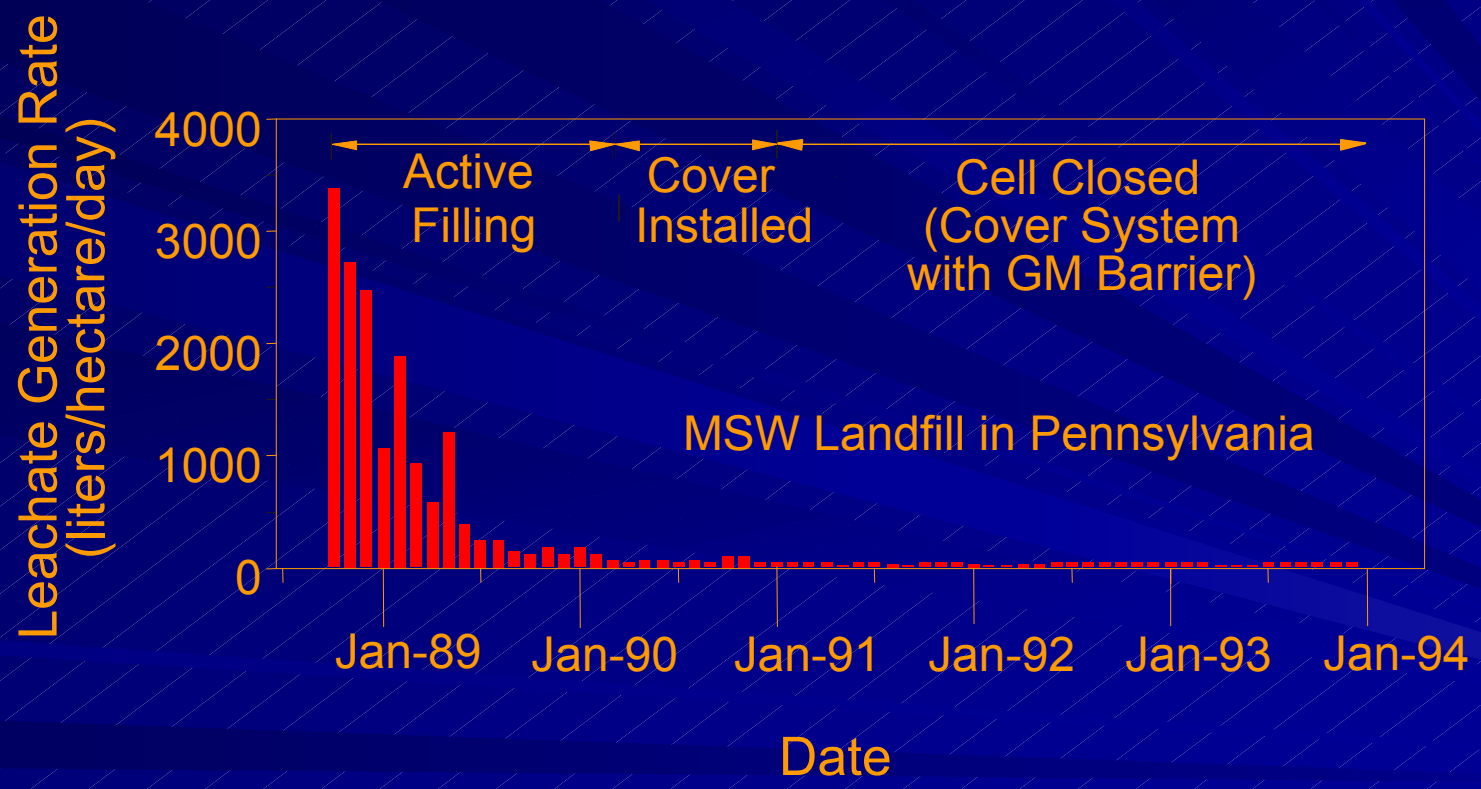
- Minimize infiltration to prevent the “bathtub” effect
- Minimize erosion
- Not a complete design: missing drainage layer, gas collection layer, etc.



Liquids Management Strategy

- EPA regulations for cover systems have evolved within a “liquids management strategy” framework
  - minimizing leachate generation by keeping liquids out of the landfill
  - detecting, collecting, and removing leachate as it is generated
- Draft EPA cover system guidance: for MSW landfills, maximum cover system percolation rate of 0.1 to 1 mm/yr should prevent bathtub effect.

Leachate Generation Rates Over Time (Bonaparte, 1995)



Questions

- What are the special considerations for designing a cover system (interim or final) for a bioreactor landfill?
- What characteristics are important for an interim cover system?
- What is the best time frame for constructing a final cover system over a bioreactor landfill?

Special Conditions: Bioreactor Landfills vs. Conventional Landfills

- Increased rate of gas generation (but shorter time frame for exposure of cover system components to gas constituents)
- With more moisture in the waste, greater potential for leachate seeps
- Increased settlements due to increased degradation and higher waste unit weight
- Decreased slope stability due to higher waste unit weight and lower shear strength

Cover System Design Issues

Layer	Factor
Surface Layer	Erosion by water and/or air Evapotranspiration Native versus exotic vegetation Post-closure land use
Protection Layer	Erosion by water Evapotranspiration Slope instability due to pore pressure buildup Animal burrows Deep root penetration
Drainage Layer	Excessive clogging Insufficient flow rate capacity Insufficient number or flow rate capacity of outlets

Cover System Design Issues

Layer	Factor
Barrier	Cracking due to desiccation (wet/dry or freeze/thaw cycling) Deformations from waste settlement, or seismic motions Root penetration Insufficient resistance to gas flow Slope instability Creep of all materials (CCL, GCL, GM, asphalt)
Gas Collection Layer	Insufficient coverage over waste Insufficient flow capacity
Foundation Layer	Insufficient strength Insufficient slope (inadequate grading or post-construction settlement)

Interim Cover During Bioreactor Operation

Relative Performance of Different Interim Cover Materials

	Relatively Permeable Soil	*Less Permeable Soil*	*Includes GM Barrier*
Infiltration Over Waste Surface	High	Medium	Low
Concern with Deformation	Low	Medium to High	Medium to High
Potential for Leachate Seeps	High	Medium	Low
Potential for Gas Emissions/Air Intrusion	High	Medium	Low
Potential for Erosion	Low	Medium	Low to High
Operations and Maintenance	Low	Medium to High	Medium to High
End Use Flexibility	High	Medium to High	Low to Medium

Final Cover System Installation

- If a final cover system is constructed during bioreactor operations, it may require more maintenance than an interim cover and, potentially, some reconstruction after the waste has stabilized.
- For increased design flexibility, the final cover should be constructed after waste has been sufficiently stabilized.
- When a soil interim cover is proposed, its performance should be monitored and, if necessary, an interim cover that incorporates a geomembrane or a final cover system should be installed.
- The final cover system should be designed to prevent the bathtub effect.

Final Thoughts

- The design considerations for a bioreactor landfill cover system (interim or final) depend on when the cover is to be constructed. For example, when a final cover system is constructed at the end of bioreactor operations, gas and infiltration control and the ability to tolerate deformations would less important than if the cover system was constructed during bioreactor operations. When a final cover system is constructed over a stabilized landfill there is more flexibility in design (e.g., alternative materials).

- An interim cover consisting of a relatively permeable soil layer may enhance bioreactor operations by distributing infiltrating water across the waste surface. The soil layer can subsequently be used as part of the final cover system.

Final Thoughts

- An interim cover such as a vegetated soil layer may be sufficient to control erosion and gas emissions. The soil layer can subsequently be used as part of the final cover system.
- If gas emissions through a soil interim cover are excessive and can not be adequately controlled by the gas collection system, the cover system may require a gas collection layer beneath the soil layer or a geomembrane barrier.
- After bioreactor operation ceases and assuming the toxic constituents in the waste have been degraded or fixated, the primary function of the final cover system would be to prevent the bathtub effect. If the liner system could be made more permeable at his time, the final cover system would only need to serve as an isolation layer.