Back to Basics: Landfill Liner and Cover Systems

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What Will We Cover?

• Brief Background and History of Liners

• Types of Liners and Engineering Considerations
  – Composite System
  – Drainage Layer
  – Base Liner
  – Final Cover

• Technological Advances

• Additional Resources/Questions
BACKGROUND AND HISTORY

• **Liner System**: An engineered barrier to limit migration of contaminants to the environment

• **Subtitle C (40 CFR 264) - 1982**: Type I hazardous landfill (MI-Part 111)

• **Subtitle D (40 CFR 258) – 1991**: Type II non-hazardous landfill (MI-Part 115)

• **Double Liner Vs. Single Liner**

• **Composite System** = Drainage + Synthetics + Low Permeability Barrier (natural or synthetic) + Native
Liner Systems
Liner Systems: Overview

Base Liner

- SYNTHETIC LINER
- COMPACTED CLAY LINER
- DRAINAGE LAYER

Final Cover

- FINAL CLAY AND SYNTHETIC GAP WITH VEGETATION
- LANDFILL GAS TO FLARE STATION OR TO ENERGY UTILIZATION PLANT

Native Soil

- GAS MONITORING PROBE
- GROUNDWATER MONITORING WELL
- LEACHATE COLLECTION SUMP WITH RISER

Final Cover

- GAS COLLECTION WELL
- RAINWATER RETENTION POND
- GROUNDWATER MONITORING WELL
Liner Systems: Base System Overview

**Single Liner**

**Double Liner**
Liner Systems: **Drainage Layer**

**Function**
- Drain Leachate to Sump for Removal
- Maintain Less than 12” of Head on Liner – Mounding Calculation
- Protective Cushion over Liner

**Materials**
- Sand or Stone – Silica Based, Natural
- Synthetic
  - Geonet, Geocomposite
- Combination
- Alternatives: Tire Shred, Auto Fluff, Blast Furnace Slag, other…
Liner Systems: Drainage Layer

- **Considerations**
  - Permeability/Transmissivity
  - Availability
  - Natural Materials
    - Fines (<#200)
    - Carbonate Content – Leaching
  - Synthetic Materials
    - Interface Friction/Slope Stability
    - Factoring in Biologic/Chemical clogging, impingement, core creep reduction
    - UV Degradation
    - Seaming
Liner Systems: Base Liner

- **Function**
  - “Impermeable” Barrier to Leachate
  - Composite
    - Synthetics
    - Installed Low-Permeability Layer
    - Native Low-Permeability Layer

- **Materials**
  - Synthetics
    - HDPE, LLDPE, PVC, EPDM, Others…
    - Textured, Smooth, Reinforced
    - Seamed
  - Low-Permeability Layer
    - Geosynthetic Clay Liner
    - Re-compacted Clay Soil
Liner Systems:
*Base Liner - Synthetics*

- Considerations
  - Chemical Compatibility with Leachate
  - Interface Friction/Slope Stability
  - Differential Settlement Tolerance
  - High Temperature Tolerance
  - Exposure – UV Degradation
  - Proper Installation (QA/QC)
  - Protection during In-Service
Liner Systems: Base Liner – Low Permeability Layer

• Considerations
  – Geosynthetic Clay Liner (GCL)
    • Chemical Compatibility with Leachate
      – Polymer-enhanced Bentonite
    • Exposure – Seam Separation
      – Appropriate Overlap
      – Loose Bentonite Augmentation
    • Interface Friction/Slope Stability
      – Carrier Fabric
      – Internal Shear Strength
        » Method of Construction
      – System Stability

• Compacted Clay Liner (CCL)
  • Availability/Quality
  • Moisture Conditioning/Desiccation
    – Desiccation = Increased Permeability
  • Differential Settlement
    – Fissures = Increased Permeability
Liner Systems: Cover System Overview

- Composite System (Typically)
  - Multiple Material Variations and Configurations

Type I (Hazardous)

Type III (Mono/C&D)  Type II (Municipal)
Liner Systems: Final Cover

- **Function**
  - Environmental Barrier
  - Limit Precipitation Infiltration

- **Materials**
  - Composite System – Similar To Base Liner

- **Considerations**
  - Interface Friction/Slope Stability
  - Gas Venting
  - Internal Drainage
  - Stormwater Management/ Erosion Control
  - Differential Settlement: Material Selection
  - Construction Technique: Equipment Direction
Liner Systems: 
Final Cover – Veneer Stability
Liner Systems: Final Cover Considerations

• Management of Water
  – Internal Drainage
    • Limit Excessive Pore Pressure Buildup -> Stable Slope
  – Stormwater Management
    • 25-Year/24-Hr Storm
    • Manage Runoff
  – Erosion Control
    • Soil Loss < 2 Tons/Ac
      – Diversion Berms/ Swales
    • Erosion Control Products
      – Rip-Rap
      – TRM/Blankets
      – Seed Mixture Selection
Technological Advances
Liner Systems: Technology Advances

- "System" Products
  - Closure Turf
    - Synthetic Grass
  - Super Gripnet
    - Combined Geomembrane/Geonet
  - DrainTube
    - Geocomposite/Drainage Layer
    - Gas and/or Liquid
  - Permeable Caps
    - Multi-Layer
    - Evapo-transpiration
    - Climate Dependent
Liner Systems: Technology Advances

- Liner Products
  - Leak Detection Geomembranes
    - Conductive Layer for Spark Testing (D7240)
  - Exposed Geomembrane Covers
    - Eliminate Protective Cover Layers
    - UV Degradation, Stormwater Control and Uplift Considerations
  - Solar Panel Integration
  - Erosion Control Products
  - Specially formulated stabilizers/polymers/enhancers for site-specific considerations of different materials
References/Questions
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• Resources
  – GRI: Geosynthetic Research Institute
    • [https://geosynthetic-institute.org/](https://geosynthetic-institute.org/)
  – FGI: Fabricated Geomembrane Institute
    • [https://www.fabricatedgeomembrane.com/](https://www.fabricatedgeomembrane.com/)
    • Free Webinars

• Manufacturers

• Books
  • Geotechnical Aspects of Landfill Design and Construction, (2002), Koerner et. al.
  • Designing With Geosynthetics 6th Ed., (2012), Koerner

• Questions?
Thank You!

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