Wet (aka, Bioreactor) Landfills: The Liner System Issues

1. Liner system performance
2. Leachate collection design
3. Leachate removal design
4. Filter/operations layer considerations
5. Daily cover soil blockage
6. Final cover considerations
7. Landfill stability issues
1. Liner System Performance

- single composite liner is acceptable accompanied by downgradient monitoring
- GM/CCL, GM/GCL or GM/GCL/CCL
- double liner system performance is outstanding… prefer using it with less emphasis on monitoring
- perhaps even no monitoring unless the ALR is exceeded!!
Sand as Leak Detection

Leakage Rate (lphd) vs Life Cycle Stage

- GM
- GM/CCL
- GM/GCL
Geonet as Leak Detection Material
2. Leachate Collection Design

- $k_{\text{min}}$ of all regulations is much too low!
- the major impediment to retrofitting existing landfills for liquids additions
- recommend $k_{\text{min}} \geq 1.0 \text{ cm/sec}$
- this is gravel, or GC/sand composite
- if gravel, GM must be protected with GT
- puncture design methods are available
$k \approx 1.0 \text{ cm/sec}$

$k \gg 1.0 \text{ cm/sec}$
3 Leachate Removal Design

- pipe network is both a difficult design and construction item
- high normal stresses (megafills) are suspect w/r to excessive deflection
- higher liner temps for wet landfills is a concern
- periodic pipe monitoring is advisable (currently in 8-states)
- GC designs avoid pipe altogether
4. Filter/Operations Layer Considerations

- smallest voids are most suspect w/r to excessive clogging
- consider avoiding filter over drainage stone; use select waste directly
- take great care in its placement
- forget about operations/protection layer unless it’s a GC design – then use sand layer for a operations layer
This Concept Works….
8 Columns over 5-years showed constant flow rates!
5. Daily Cover Soil Blockage

- avoid silt/clay daily cover soils
- use foam, slurries, sludges or reusable GTs/GMs
- site-specific decision with many options, see EPA/600/R-93/172
6. Final Cover Considerations

- avoid final cover placement until after primary settlement ($5^+$-years)
- many temporary options available
- quest is to contain landfill gas, but allow water to enter waste
- then heavy rolling (or DDC) and placement of final cover
Florida Landfill
Differential Settlement
New Jersey Landfill
Differential Settlement
7. **Landfill Stability Issues**

- major concern is leachate (hydraulic) head building up on liner system
- generates hydrostatic forces
- design is straightforward if liquid level and shear strengths are known
- geotechnical monitoring **within the waste** is readily available
Mixed Waste as a Fluidized Bed
## Summarizing Remarks

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<th><strong>1. liner system</strong></th>
<th><strong>2. leachate collection</strong></th>
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<tbody>
<tr>
<td></td>
<td>use double liner system</td>
<td>increase “k” significantly</td>
<td>H &gt; 50 m challenges deflections</td>
<td>omit filter layer</td>
<td>avoid silts and clays</td>
<td>avoid placement initially</td>
<td>concern during placement and afterward</td>
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<tr>
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<td>set site-specific ALR</td>
<td>consider k ≥ 1.0 cm/sec</td>
<td>consider periodic pipe inspection</td>
<td>place select waste on gravel/sand</td>
<td>consider alternate daily cover material</td>
<td>use temporary cover</td>
<td>design is straightforward</td>
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<td>use monitoring walls if exceeded</td>
<td>gravel or GC/sand</td>
<td>GC design avoids pipe situation</td>
<td>omit operations layer</td>
<td>many options available</td>
<td>place final cover after settlement</td>
<td>internal monitoring is necessary</td>
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Recommendations

• **new** wet landfill/cells very “doable”
• done right – everyone wins!
• retrofitting **old/existing** sites is difficult
• critical issue is “regulatory flexibility”
• permit exceptions and/or regulation revisions are necessary
• it’s time to revisit landfill regulations focusing on **wet** landfills only!
Thanks for Listening