Maximizing Airspace Capacity Through Predicted Overfill Settlement

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Impact of Waste Settlement

- Landfill Gas
- Access Roads
- Final Cover
- Drainage
Worst of all...Loss of Airspace

- 90-Acre Landfill → ~15 Mil CY of Airspace
- 40-Acre Plateau with 15 FT Settlement → ~1.0 Mil CY of Airspace Lost
Looking Back...

Permitted Airspace

Operational filling at 3:1

Operational settlement

Loss of Airspace
Looking Forward...Operational Flexibility

Permitted Airspace

Interim Grade

After Settlement
Operational Flexibility
Looking Forward…

Overfill/ Pre-Settlement Grades

Permitted Airspace
Post-Settlement Final Grades

No Additional Capital Cost → Priceless
What do the Regulations Say…

Standard Operating Procedures for Settlement Accommodation Plan (SAP)
Pennsylvania SAP - Requirements

- Settlement Calculations
- Drawings
- Slope Stability Analysis
- Capping Schedule
- Capacity Lost without SAP
- SAP update in Annual Report
Pennsylvania SAP - Limitations

Settle to Permitted Grades Within 5 Years

Final Cap at your own risk

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Designing for Overfill – Fatal Flaws

- Stability
  - Global
  - Liner
  - Veneer (Cap)

- Integrity
  - Leachate collection pipe loading
  - Baseliner strain (overliner)
Predicting Overfill Waste Settlement

• Subgrade Settlement
  • Post-settlement baseliner slope
  • Conservative = more settlement

• Overfill Waste Settlement to Maximize Airspace Capacity
  • Post-settlement final waste grades
  • Conservative = less settlement
Predicting Overfill Waste Settlement

- Waste characteristics
  - Density
  - Thickness
  - Composition
  - Age
  - Moisture content
- Numerous MSW settlement models exist
- Soil mechanics/ biodegradation models are most popular

Adapted from Park et al. 2007
Settlement Cross Section
Bjarngard and Edger’s Model

\[ \frac{\Delta H}{H} = CR \log \frac{P_o + \Delta P}{P_o} \]

Adapted from Park et al. 2007
## Selecting Coefficients

<table>
<thead>
<tr>
<th>Phase</th>
<th>Bjarngard and Edgers</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
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</thead>
<tbody>
<tr>
<td>II, $C_{a(1)}$</td>
<td>0.003–0.038</td>
<td>0.016–0.036</td>
<td>0.010–0.021</td>
<td>0.003–0.01</td>
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<tr>
<td>III, $C_{a(2)}$</td>
<td>0.017–0.51</td>
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<td>0.091–0.132</td>
</tr>
</tbody>
</table>

Measured Settlement
Measured Settlement
2006-2011 Settlement

Vertical Strain (%) vs. Days (log scale)

The graph shows the measured settlement over the years 2006 to 2011. The equation provided is:

\[ y = -6 \times 10^{-5}x + 0.0342 \]
Case Analysis - Results

• Minor Permit Modification
  → Additional 10 ft Overfill

• ~130 Acre Plateau
  → ~2 Mil CY additional airspace

• Over 2 years additional site life
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