Landfill Mining and Reclamation

Recover latent resources
Clean closure
Reuse of existing landfill volume

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Reasons to Consider Landfill Mining and Reclamation

- Clean closure of industrial disposal sites (primarily homogeneous wastes, e.g., wood processing residues)
- Clean closure of MSW landfills
- Remediation of landfills exhibiting adverse environmental impacts (e.g., groundwater contamination)
- Cost-effective landfill capacity
- Recovery of resources (e.g., metals, soil)
Some Key Assumptions/Variables

- Recoverable percentages and characteristics of secondary materials, especially soil fraction
- New landfill disposal cost (operation, closure, post-closure)
- In-place density and ratio of MSW to cover soil
- Age and degree of decomposition of buried waste
- Potential uses and markets for recoverable materials
Feasibility of Landfill Mining and Reclamation Projects

- Identification of feasible sites (global analysis):
  - site identification:
    - project goals (disposal capacity, remediation, source of cover material, resource recovery)
    - site screening criteria (sources of MSW, age and records of landfill, meteorology, topography, existing facilities and operations)
    - project impacts (dust, odor)
    - site screening
Feasibility of Landfill Mining and Reclamation Projects (cont.)

- Identification of feasible sites (global analysis) (cont.):
  - site evaluation (closer look, local markets/uses, preliminary economic comparison)
  - site investigation (permitting, environmental impact, public review and input)
Landfill Mining and Reclamation Initial Economic Feasibility

- Project definition:
  - objectives
  - boundary conditions (planning period, waste quantities, base case, uses/markets for potentially recoverable materials)
  - project developer (public agency, private enterprise, both)
Landfill Mining and Reclamation Initial Economic Feasibility (cont.)

- Comparative analysis:
  - assumptions
  - base case cost
  - economics:
    - capital and operating costs
    - net cost
  - comparison
Inter-Relationships between Environmental Factors Affecting Generation of Biogas and In-Place Waste Characteristics

- Depth of Fill
- Ambient Temperature
- Rainfall
- Applied Moisture
- Cover Material
- Waste Composition
  - Pre-treatment and Equipment Size

Moisture Content

Temperature
- Oxygen Availability
- Water Content of Fill

Biogas and In-Place Waste Characteristics

- Eh
- pH
- Nutrients
- Waste Particle Size
- In-place Density

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Test methods:
  ‣ prior to excavation
  ‣ during excavation and processing:
    • process streams
    • processing system
  ‣ recovered materials (quality and contamination)
Landfill Mining and Reclamation Detailed Feasibility Study (cont.)

- Site evaluation:
  - environmental review
  - conceptual process design
  - economic review (base case and landfill mining and reclamation):
    - capital costs
    - operating costs
    - revenues
    - net cost and comparative analysis
Site investigation:

- environmental analysis (soil borings, water quality, air quality, waste characteristics, preliminary excavation/processing, site surveying)
- worker safety analysis (exposures and methods of control)
- process design
- economic analysis (base case and landfill mining and reclamation):
  - capital
  - operating costs
  - revenues
  - net cost and comparative analysis
Landfill Mining and Reclamation
Detailed Feasibility Study (cont.)

- Implementation:
  - permitting and environmental impact analysis
  - procurement/service contracts
  - startup and commercial operation

- Health and safety considerations:
  - potential risks to personnel (sharps, dangerous and hazardous wastes, pathogens) and the general public (pathogens, odor)
Health and safety considerations (cont.):

- upset conditions (excavation, processing, dangerous and hazardous wastes)
- development of health and safety plan:
  - planning (staffing, landfill data, emergency response)
  - training (hazardous ID, precautions, procedures)
  - project execution (site preparation, safety equipment, health precautions)
Some Local Landfill Conditions of Significance

- Type of cover: soil, synthetic material, etc.
- Moisture content of landfill: relatively wet or relatively dry
- Type of landfill: area, trench, ravine
- Older landfills may have received hazardous wastes
- Presence of leachate and landfill gas collection systems
- Proximity of fill to human receptors
Excavator – Removing Waste
Simple Processing Operation

Recovered Soil Fraction
Landfill Mining – Basic Processing

1. Excavated MSW
2. Coarse Screen
   - Non-processible Fraction (as oversize)
3. Fine Screen
   - Soil Fraction (as undersize)
4. Magnetic Separator
   - Ferrous Scrap

Process Rejects

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Landfill Mining Alternatives—Clean Closure, Materials and/or Energy Recovery

Legend
- Materials, Air Space Recovery
- Energy/Chemical Feedstock Option

1. Raw MSW
2. Landfill Cell 1
   - Cover Soil Stockpile
     - Cover Soil
     - Excavated Material
     - Combustible Residue
     - Soil Fraction Cover
     - To Stockpile
     - From Stockpile
   - Soil-like Material Stockpile
     - Combustible Residue as Fuel
     - To Stockpile
     - From Stockpile
   - Recovered Recyclables
     - Thermal Gasification/Pyrolysis or Direct Combustion
       - Electrical Energy
       - Chemical Feedstock
       - Biochar
     - Ash
     - Construction Uses or Disposal
     - Industrial Uses, Carbon Sequestration

3. Landfill Cell 2
   - Cover Soil
   - Raw MSW

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<table>
<thead>
<tr>
<th>Sorted Material Categories</th>
<th>Technically Feasible Use by Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Waste Industry</td>
</tr>
<tr>
<td></td>
<td>Fuel</td>
</tr>
<tr>
<td>Food</td>
<td></td>
</tr>
<tr>
<td>Yard</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td></td>
</tr>
<tr>
<td>Paper/paperboard</td>
<td></td>
</tr>
<tr>
<td>Rubber/leather</td>
<td></td>
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<tr>
<td>Textiles</td>
<td></td>
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<tr>
<td>Plastics</td>
<td></td>
</tr>
<tr>
<td>Ferrous</td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td></td>
</tr>
<tr>
<td>Other non-ferrous</td>
<td></td>
</tr>
<tr>
<td>Glass</td>
<td></td>
</tr>
<tr>
<td>Inerts</td>
<td></td>
</tr>
<tr>
<td>Unidentified</td>
<td></td>
</tr>
<tr>
<td>Non-processible</td>
<td></td>
</tr>
</tbody>
</table>

Potential use for excavated materials

Potential use for traditional recycled materials

No potential use

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# Air Quality Monitoring – Species Identified

<table>
<thead>
<tr>
<th>Category</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuisance dust</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Respirable</td>
<td></td>
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<tr>
<td>Microbial agents</td>
<td></td>
</tr>
<tr>
<td>Bacteria</td>
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</tr>
<tr>
<td>Fungi</td>
<td></td>
</tr>
<tr>
<td>Metals</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
</tr>
<tr>
<td>Copper</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td></td>
</tr>
</tbody>
</table>

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Range of Material Balance (wet weight basis)

<table>
<thead>
<tr>
<th>Type of Material</th>
<th>Weight %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recoverable Soil</td>
<td>50 to 80</td>
</tr>
<tr>
<td>Ferrous Metal</td>
<td>1 to 5</td>
</tr>
<tr>
<td>Other Materials</td>
<td>15 to 50</td>
</tr>
</tbody>
</table>

The range is a function of composition of originally landfilled materials, quantity of cover soil, age of landfill/excavated materials, internal moisture content, etc.
For further information or assistance, please contact:

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