Methane to Markets

Landfill Covers and Gas Collection and Control System Construction

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Landfill Methane to Markets Workshop

Delhi, India

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Presentation Topics

- Elements of Landfill Cover
- Elements of LFG collection and control systems
- Development of LFG beneficial use projects

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Objectives for Capping Landfill

- Provide barrier between waste mass and atmosphere, animals, and public
- Reduction of leachate by preventing infiltration of rainwater
- Structural stability for waste mass
- Increase the amount of gas that can be collected and used, increased income stream

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Final Cover Design

- Grade
- Drainage
- Cover materials
- Vegetation
- Gas collection considerations

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Not Ready for Capping

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Correct Grading and Drainage Prior to Capping

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Ready for Final Cap

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Terraced Slopes That Drain Surface Water

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Surface Water Must Go Somewhere

Not through cap…

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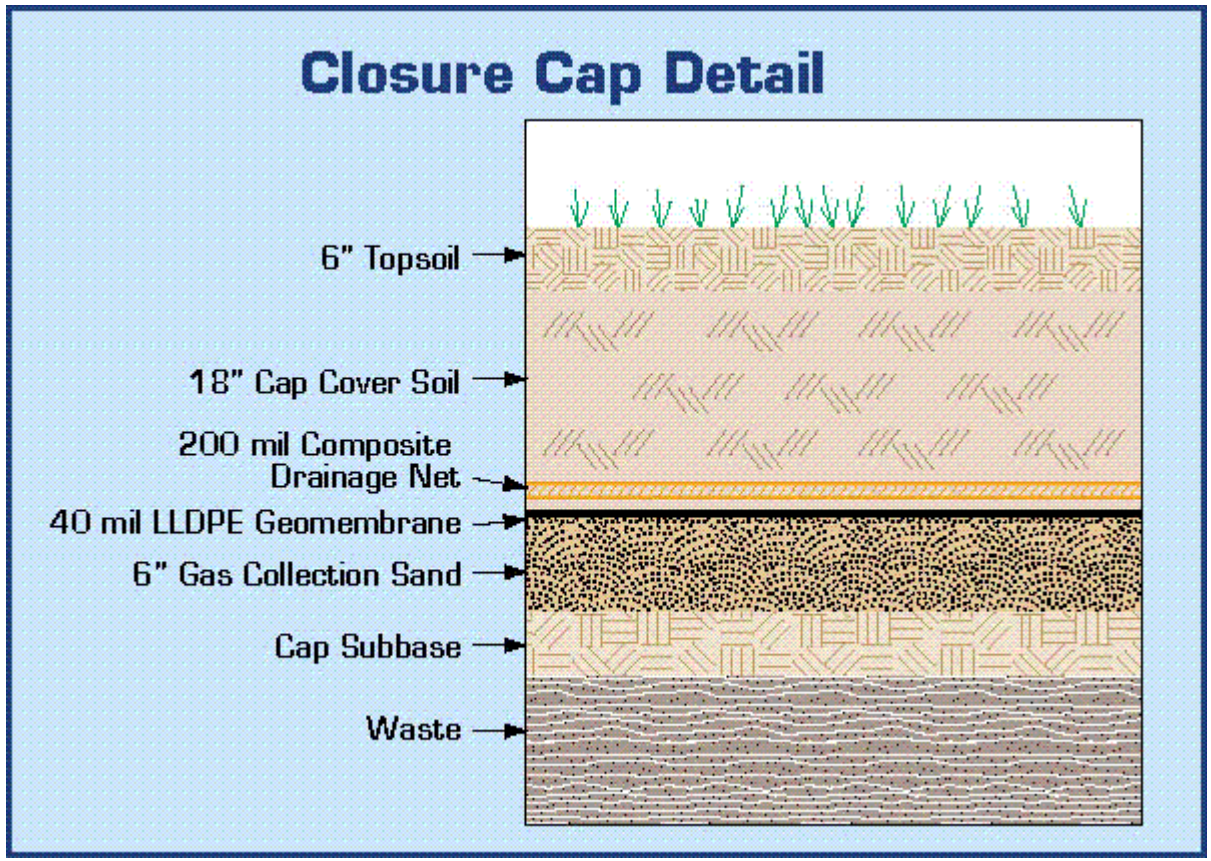
Final Cover



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Landfill Gas Collection and Control Objectives

- Recover and utilize LFG
- Minimize potential environmental impacts
- Control odors
- Control off-site migration
- Greenhouse Gas emission reduction

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Elements of an LFG Collection System

- Network of interconnecting piping
- LFG collection points
  - Vertical extraction wells
  - Horizontal collectors/trenches
  - Connection to existing vents, wells, etc.

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Elements of an LFG Collection System (continued)

- Condensate management
- Well-field management
- LFG blower/flare system

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Vertical Extraction Wells

- Most common approach for recovering LFG
- Install in existing or operational disposal areas
- Waste depth preferable > 10 meters

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Gas Well Auger

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Vertical Extraction Wells

- Install approx 2.5 wells per hectare

(~ 1 well per 0.4 hectare)

- Boreholes typically 60 – 90 cm

Vertical Extraction Wells Design Features

- In-refuse wells - 75% of the refuse depth
- Depth of in-soil wells varies
  - Groundwater level
  - Bottom of refuse
  - Depth of gas migration

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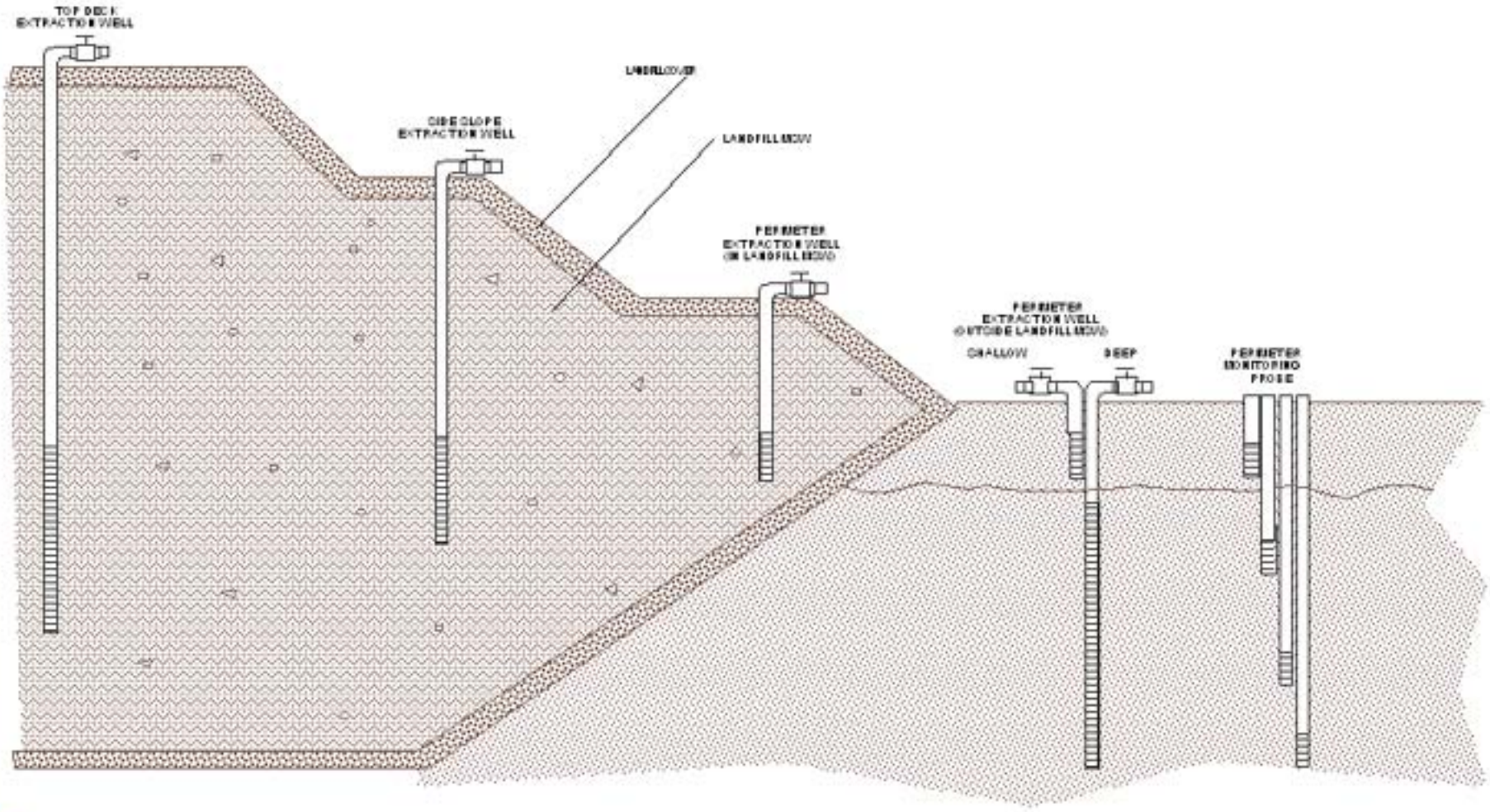
Vertical Extraction Wells Design Features (continued)



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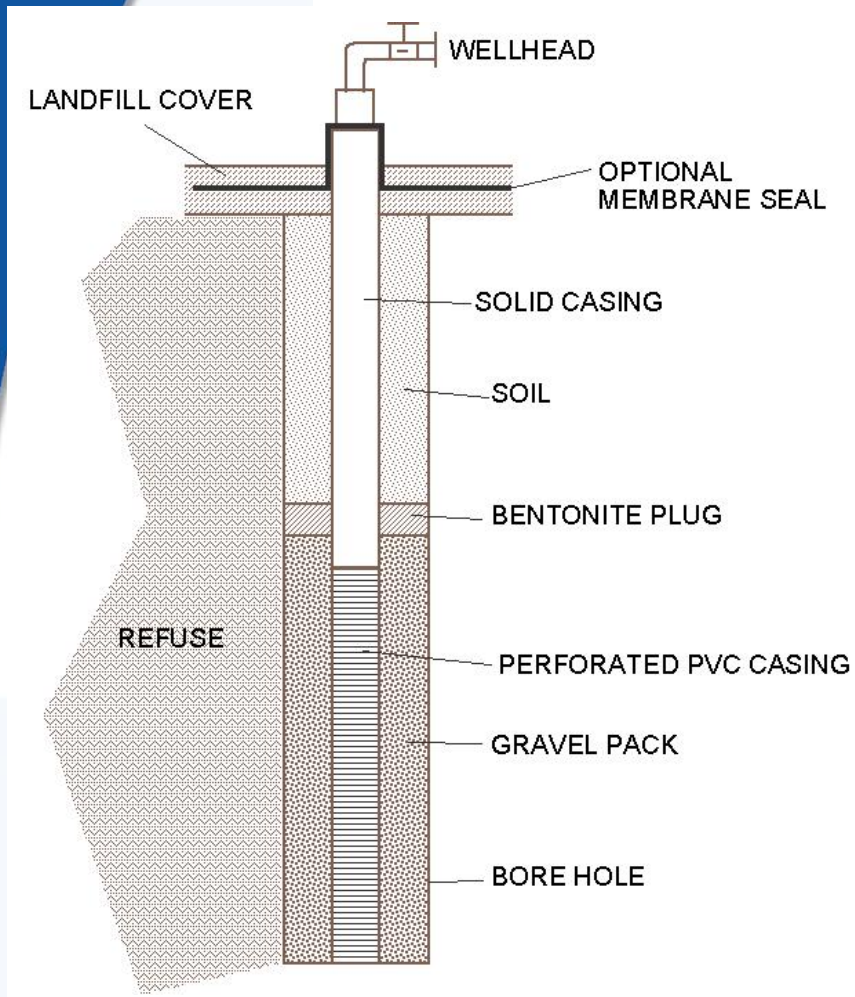
Typical Vertical Extraction Well



- Bentonite seal prevents air infiltration
- Wellhead incorporates:
  - Flow control valve
  - Pressure monitoring port
  - Flow monitoring device (optional)
  - Thermometer (optional)

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Active LFG Control

Gas Well Head - Close Up

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Horizontal Collectors

- Alternative approach for LFG recovery
- Install in shallow areas
- Install in existing or operational disposal areas

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Laterals and Headers

- Pathway for LFG from wellheads to blowers
- Can be above-grade or underground
- Sized on flow rate and pressure drop
- Pipes sloped to promote condensate drainage

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Blower/Flare Station

- Provides vacuum for wellfield
- Combusts methane
- Open or enclosed flame

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Blower/Flare Station (continued)

- May be used in combination with beneficial use system
- Needed for methane destruction if beneficial use project is down

Blower/Flare Station - Design Features

- Location should be central to collection system, close to potential end user or utility service, away from trees
- Design with flexibility to handle future gas flows

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Example

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Development of LFG project

- Why would I consider? Potential Income!
  - $ from destruction of methane
  - $ from energy generation or fuel sales
- Evaluate LFG generation potential
- Evaluate end-use alternatives
- Network with interested parties
- Execute contracts, construct, and operate

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Gas Utilization

- Utilization systems consist of:
  - Direct Gas Use/Sale
  - Electricity Generation
  - Pipeline Upgrade

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Gas Utilization (cont.)

- Direct use
  - Identify local energy users
  - Can provide energy cost savings and stability for the end-user
  - May be used to attract new industry
- Electrical Use
  - Distributed generation or on-site use
  - Option for sites without nearby industry

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Diversity of Project Types
Direct-Use of LFG

- Direct-use projects are growing!

– Boiler applications - replace natural gas, coal, fuel oil
– Combined heat & power (CHP)
– Direct thermal (dryers, kilns)
– Natural gas pipeline injection
  - Medium and high Btu
– Greenhouse
– Leachate evaporation
– Vehicle fuel (LNG)
– Artist studios
– Hydroponics
– Aquaculture (fish farming)

Greenhouse Burlington, NJ

Pottery Studio Sugar Grove, NC

LFG-fired Boiler Ft. Wayne, IN

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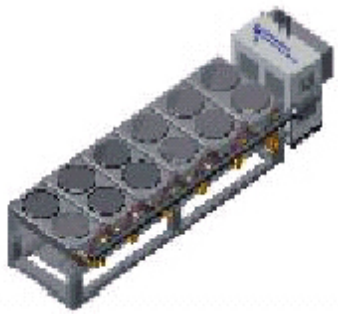
Diversity of Project Types
Electricity Generation

Internal Combustion Engine

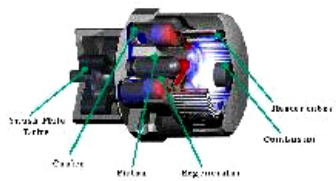
Gas Turbine

Emerging Technologies

Microturbine



Organic Rankine Cycle Engine



Stirling "External Combustion" Engine

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Even in mature markets, issues still exist…

- Significant capital costs
- Transient source of energy
- Slow movement into long-term agreements
- Gas use or power purchase agreements can be complicated
  - Guarantees
  - GHG reduction rights
  - End use stability
  - Environmental compliance responsibility

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However, it can be done…..

- Over 400 operating project in US with continuing growth expected
- Remember that M2M can provide assistance
  - Technical information and support
  - Analysis
    - Initial desktop review
    - Pre-feasibility study for promising sites
  - Networking services