



# Methane to Markets

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*A Public-Private Partnership to Advance  
Recovery and Use of Methane as a Clean  
Energy Source*

**Landfill Wellfield and Project Components**

# Outline

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- Objectives of LFG Collection/Control
- Elements of a LFG collection System
- LFG Destruction/Utilization Options



# Objectives

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- **Recover and utilize LFG**
- **Minimize potential environmental impacts**
- **Control off-site migration**
- **Control odors**
- **Comply with regulatory requirements**

# Elements of an LFG Collection System

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

# Elements of an LFG Collection System (continued)

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- Elements of condensate management
- Flow control
- LFG blower/combustion device (flare, engine, etc.)

# Vertical Extraction Wells

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



# Vertical Extraction Wells

- Install approx 2.5 wells per hectare (~ 1 well per 0.4 hectare)
- May lose efficiency or not work in landfills with elevated leachate levels



# 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



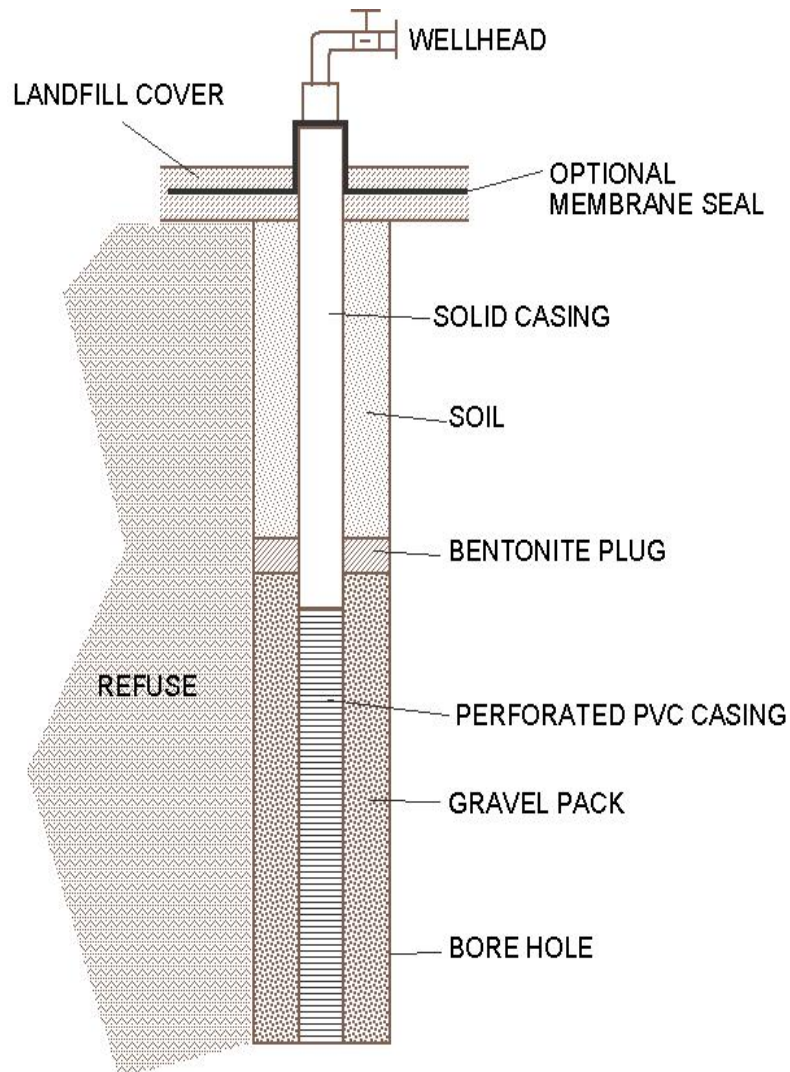


# Vertical Extraction Wells - Design Features (continued)

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- Boreholes typically 60 cm to 90 cm diameter
- Casing is generally PVC or HDPE
- Bottom perforated - start 6 meters below ground surface
- Spacing depends upon “radius of influence” (typical 60 m - 122 m)

# Typical Vertical Extraction Well



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

# Vertical Extraction Wells - Examples

- **Auckland, New Zealand**



- **Los Angeles, California**

# Theoretical Radius of Influence of a Landfill Gas Well

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- Radius of influence 2 to 2.5 times well depth
- Increase vacuum to increase the radius of influence
- Variations in vacuum are the operator's only control tool

# Actual Radius of Influence of a Landfill Gas Well

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- **A well's radius of influence is unlikely to be ideal:**
  - Variations in waste characteristics
  - Interim cover and cell configuration
  - Presence of leachate

# Horizontal Collectors

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



## Horizontal Collectors (continued)

- Install at a spacing of approx. 30 to 100 meters
- Can be used in landfills with elevated leachate levels



# Horizontal Collectors - Design Features

- Install in trenches or place on grade and cover with gravel and waste



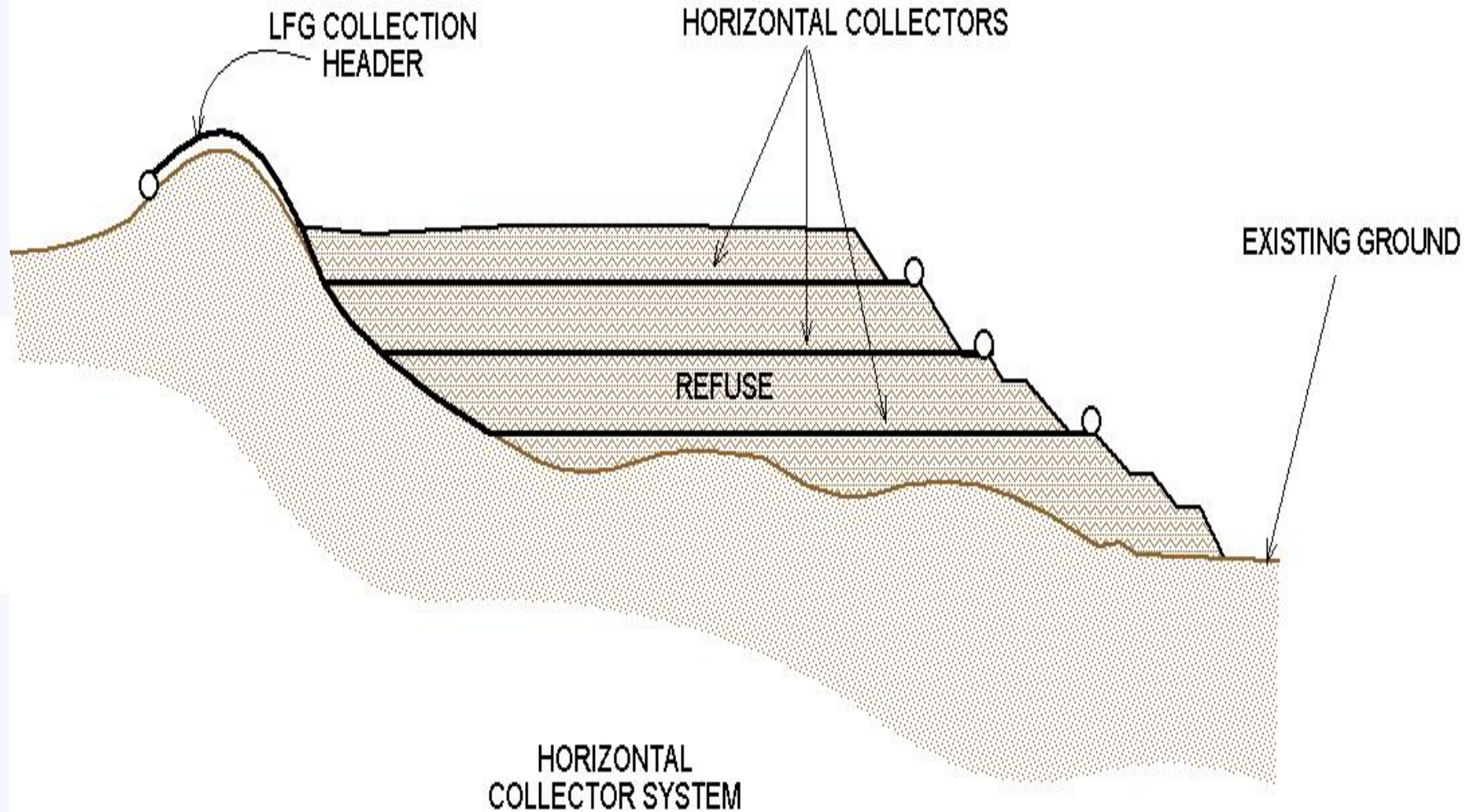


# Horizontal Collectors - Design Features (continued)

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- Construct out of approx 100 mm slotted PVC or HDPE pipe
- Alternatively construct out of “nested” 100 mm an 150 mm pipes

# Typical Horizontal Collector Arrangement



# Examples

- **Bangkok, Thailand**



- **Los Angeles, California**

## Laterals and Headers

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- Pathway for LFG from wellheads to blowers
- Can be above-grade or underground
- Generally HDPE - PVC sometimes used above-grade
- Sized on flow rate and pressure drop

## Laterals and Headers (continued)

- Pipe configuration often “looped” to provide alternative flow paths
- Pipe sloped to promote condensate drainage
- Unusual drops in vacuum normally due to condensate blockages



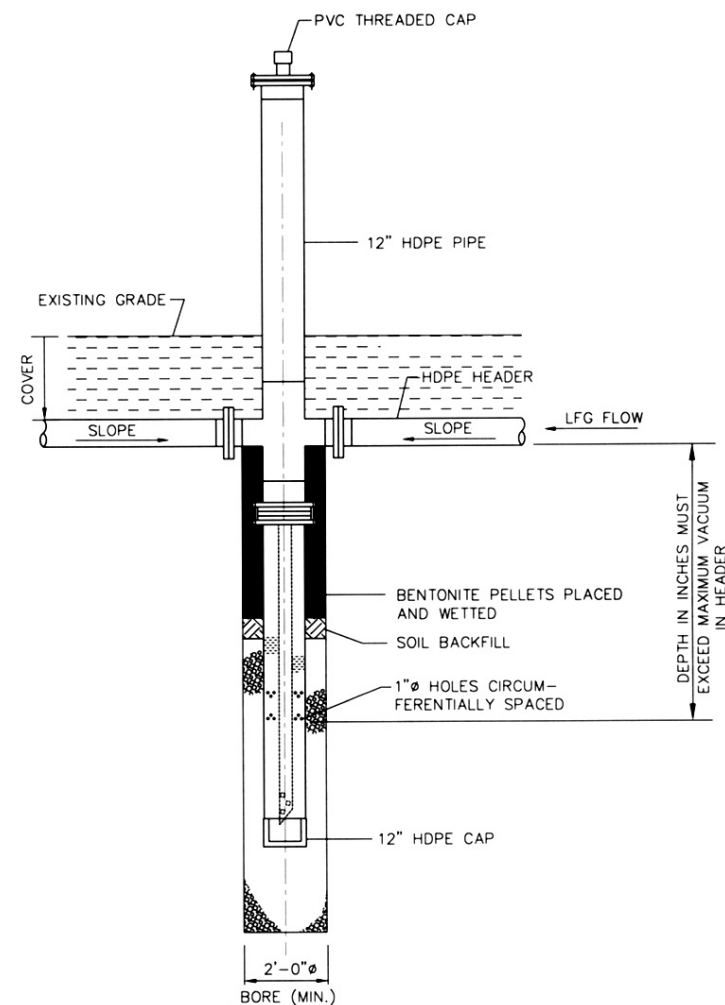
# Condensate System

- Condensate volume depends on LFG temperature and flow
- LFG is assumed to be 100% saturated with water
- LFG temperature is typically 32° to 54° C



# Condensate Removal - Design Features

- LFG cools in the LFG collection piping and the moisture condenses out into the piping
- Piping designed to allow condensate to drain
- Traps allow for drainage by gravity
- Sumps collect condensate



# LFG Destruction/Utilization Alternatives

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- Destruction
  - Open flares (aka: candle-stick flares)
  - Enclosed flares (aka: ground flares)
- Beneficial use
  - Generate electric power
  - Direct use/sale of methane
  - Leachate evaporation



# Blower/Flare Station

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- Combusts methane gas
- Open or enclosed flame



## Blower/Flare Station (continued)

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- May be used in combination with beneficial use system
- Needed during utilization system startup and downtime

# 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



# Blower/Flare Station – Typical Elements

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- Moisture separator
- Blowers
- Flare (open or enclosed)
- LFG piping and flame arrestor
- Flow meter
- Pilot fuel supply
- Control panel (controls both blower and flare)
- Auto shutoff valve

# Example



# Enclosed Ground Flares

- Flare body usually circular: 9 to 12 meters high
- LFG combusted close to ground
- Flame not visible from outside
- Air louvers near stack base



## Enclosed Ground Flares (continued)

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- Typical operating temperature range:  
760 °C to 870 °C
- Typical destruction of 98 to 99 percent (or greater)
- More expensive than candlestick flares

# Open (Candlestick) Flare Components

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- Vertical pipe
- Flare tip at top of pipe - flame visible
- Smaller than enclosed flare





# Gas Utilization

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



## Gas Utilization (continued)

- Other Niche Technologies
  - Greenhouses
  - Leachate Evaporation
  - Alternative Fuels
  - Microturbines



# Design Features

- Utilization systems are very site specific and depend upon the technology applied
- Designed to “grow” with the landfill as gas flows increase



# Examples

## Bangkok, Thailand



## Pipeline Upgrade New York, NY

# Summary

- LFG collection system design - site specific
- Basic Concept
  - Provide path for LFG collection
  - Manage condensate
  - Burn or utilize the gas
- Always consider your operating goals

