Part 6: Basic System Design

Presented By:
Linda Nutting
SCS Engineers

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Outline

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

Objectives

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

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

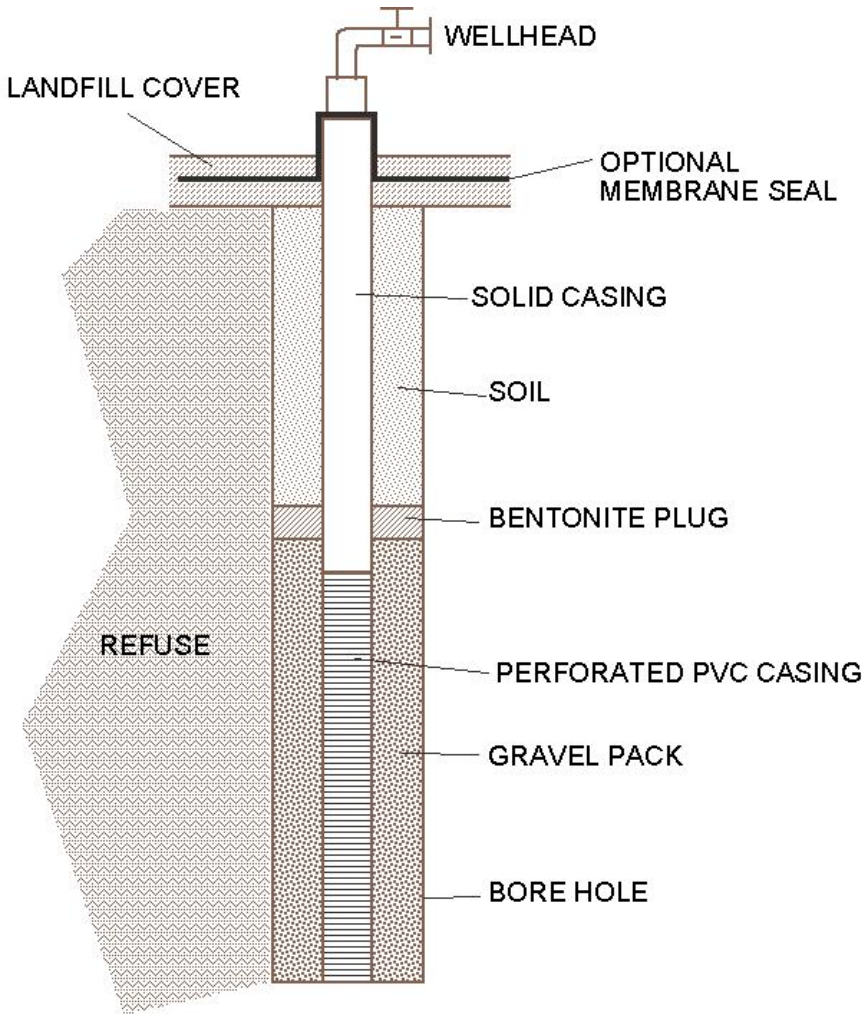
Vertical Extraction Wells

- Most common approach for recovering LFG
- Install in existing or operational disposal areas
- Waste depth preferable > 10 meters
- Install approx 2.5 wells per hectare (~ 1 well per 0.4 hectare)
- Not appropriate for use 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
- 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" (typ. 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

- 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

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

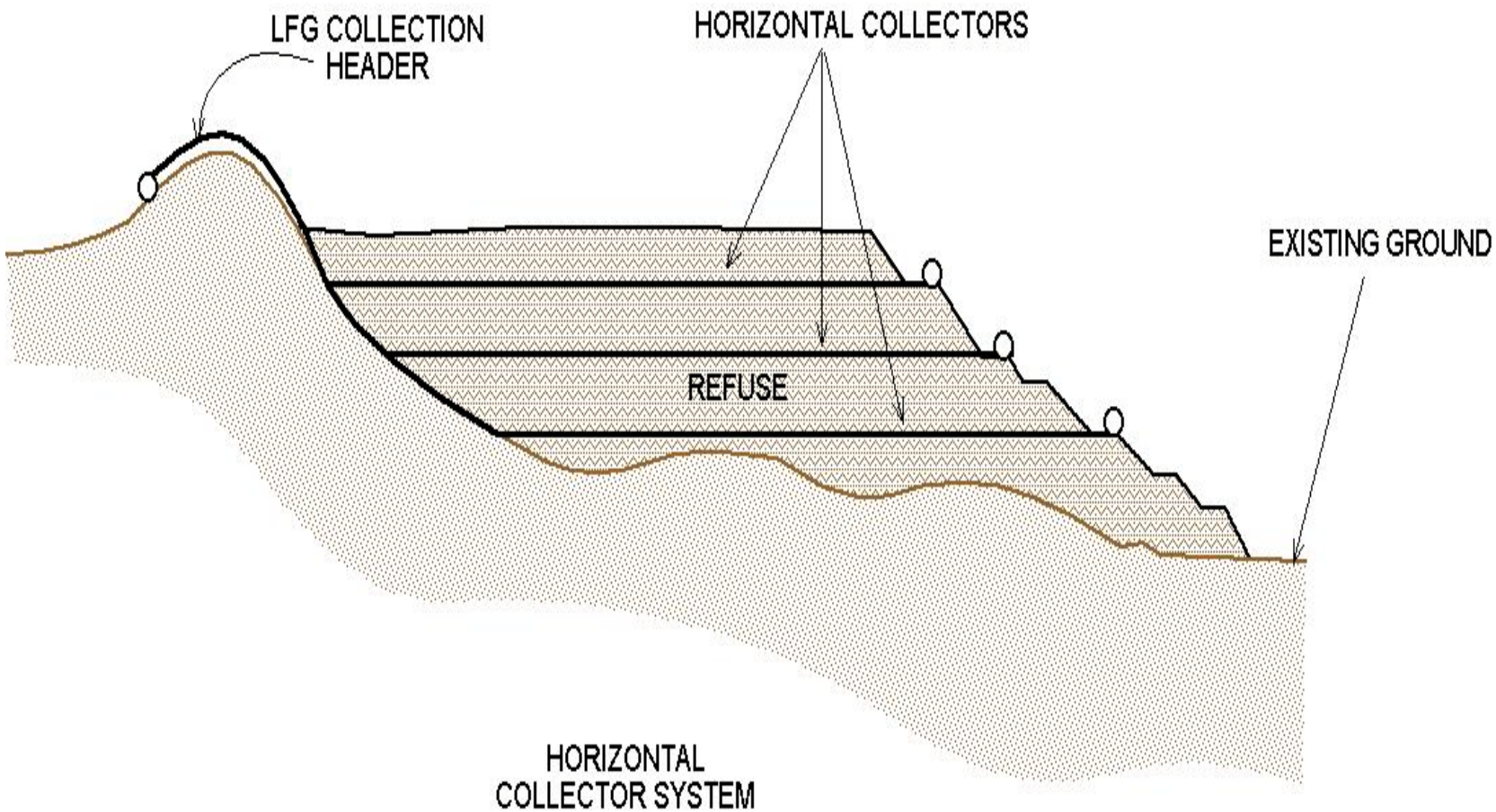
Horizontal Collectors

- Alternative approach for LFG recovery
- Install in shallow areas
- Install in existing or operational disposal areas
- Install at a spacing of approx 30 to 100 meters
- Can be used in landfills with elevated leachate levels

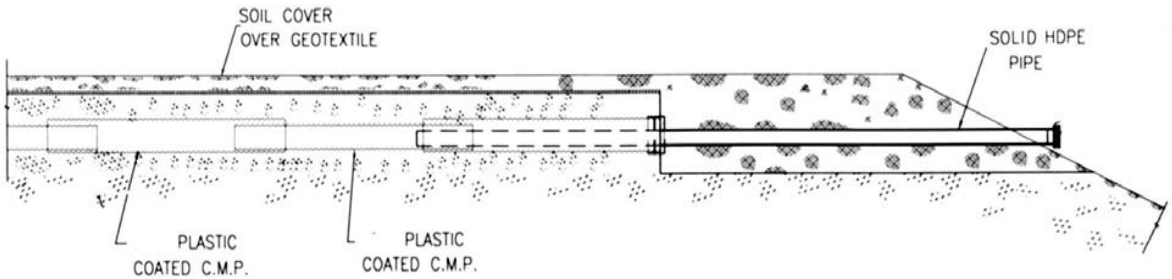
Horizontal Collectors - Design Features

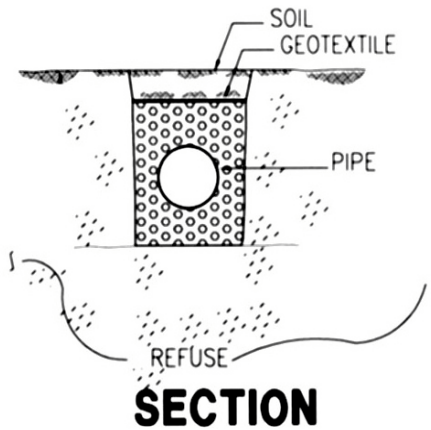
- Install in trenches or place on grade and cover with gravel and waste
- Construct out of approx 100 mm slotted PVC or HDPE pipe
- Alternatively construct out of "nested" 100 mm an 150 mm pipes

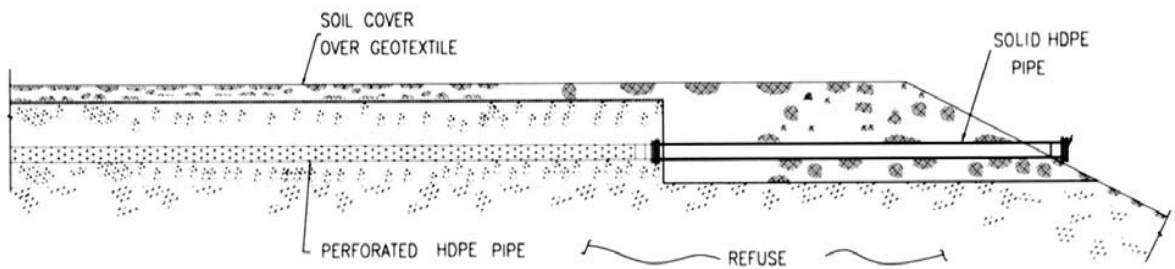
Typical Horizontal Collector Arrangement



Typical Horizontal Collector Arrangement







LANDFILL METHANE OUTREACH PROGRAM

Examples

- Bangkok, Thailand

- Los Angeles, California

Other Collection Points

- Recover LFG from other collection points such as leachate chambers, sumps, vents, and drains
- Controls LFG emissions and odors

Laterals and Headers

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

Examples

- Seoul, Korea

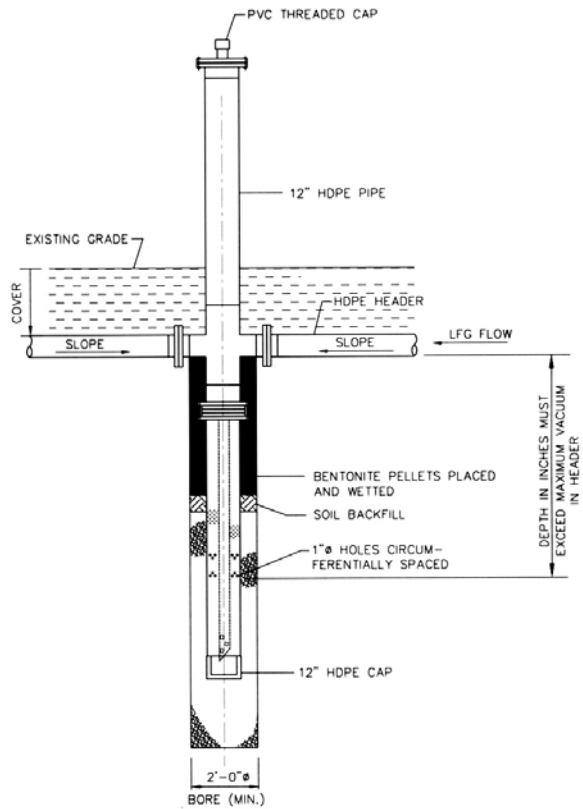
- Los Angeles, California

Condensate System

- Condensate volume depends on LFG temperature and flow
- LFG is assumed to be 100% saturated with water
- LFG temperature is typically 90° to 130° F
- LFG cools in the LFG collection piping and the moisture condenses out into the piping
- Drains to low points in the piping and can restrict flow

Condensate Removal- Design Features

- Piping designed to allow condensate to drain
- Traps allow for drainage by gravity
- Sumps collect condensate



LFG Destruction/Utilization Alternatives

- Destruction
  - Open flares (aka: candle-stick flares)
  - Enclosed flares (aka: ground flares)
- Beneficial use
  - Generate electric power
  - Direct use/sale of methane
  - Leachate evaporation
- Combined arrangements
  - Flare in parallel with beneficial use
  - Flare as stand-by to beneficial use

Blower/Flare Station

- Combusts methane gas
- Open or enclosed flame
- 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
- Typically provide a standby blower
- Provide available vacuum to entire wellfield

Blower/Flare Station - Typical Elements

- 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

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
- Typical operating temperature range: 1,400 °F to 1,600 °F
- Typical destruction of 98 to 99 percent (or greater)
- More expensive than candlestick flares

Open (Candlestick) Flare Components

- Vertical pipe
- Flare tip at top of pipe - flame visible
- Smaller than enclosed flare - easier to toast marshmallows
- Less expensive than enclosed flare
- Typical destruction of 98 percent
- Cannot test effluent

Blower Flare Station - Monitoring System

Gas Utilization

- Utilization systems consist of:
  - Direct Gas Use/Sale
  - Electricity Generation
  - Pipeline Upgrade
  - Other Niche Technologies
    - Greenhouse
    - Leachate Evaporation
    - Fuel Cells
    - Microturbines

Cleaver Brooks Boiler Unit

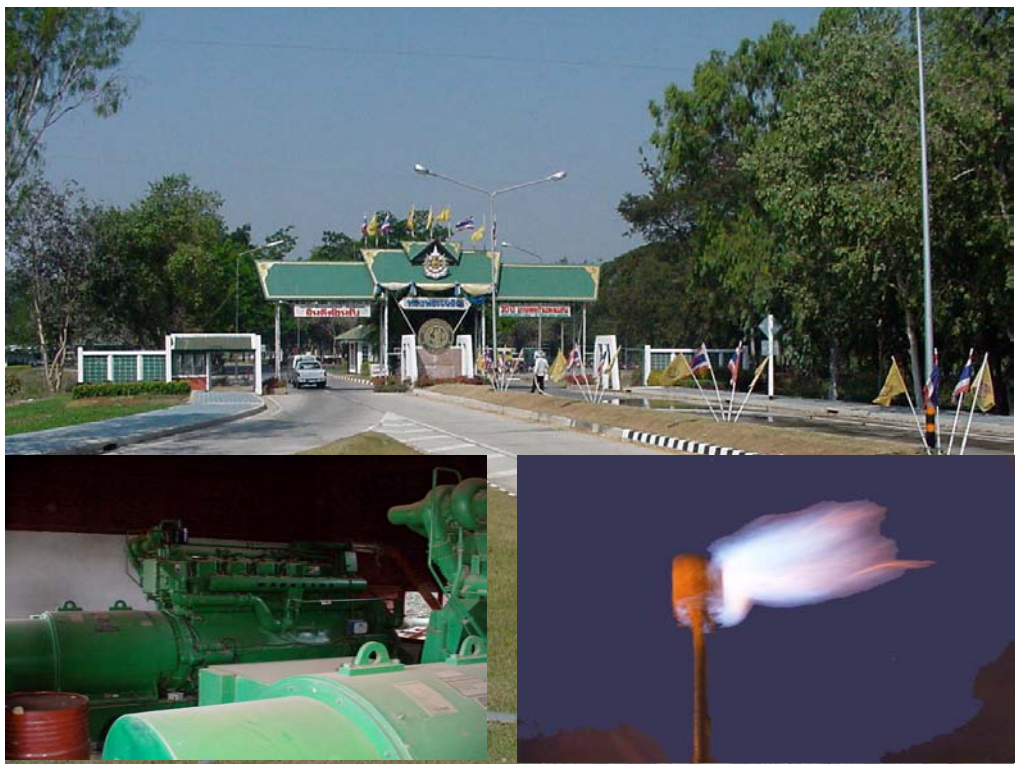
Design Features

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

Caterpillar 3516 800 kW Genset

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 the gas
- Always consider your operating goals