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# PART 2. LFG MONITORING AND DATA INTERPRETATION

# OBJECTIVES

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- Provide familiarity with practical state-of-the art LFG monitoring procedures
- Discuss some conditions that may affect results
- Discuss interpretation of monitoring data

# LFG MONITORING

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- Why do we monitor?
- How do we monitor?
- What do we monitor?

# WHY DO WE MONITOR?

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- **Section 20921. CIWMB - Gas Monitoring and Control.** (a) To provide for the protection of public health and safety and the environment, the operator shall ensure that landfill gas generated at a disposal site is controlled in such a manner as to satisfy the following requirements:
  - (1) The concentration of methane gas must not exceed 1.25 percent by volume in air within any portion of any on-site structures.
  - (2) The concentration of methane gas migrating from the disposal site must not exceed 5 percent by volume in air at the disposal site permitted facility boundary or an alternative boundary approved in accordance with Section 20925.
  - (3) Trace gases shall be controlled to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds.

# LANDFILL GAS HAZARDS - Flammable/Explosive

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- LFG is explosive when methane is between 5% and 15% by volume
- These limits are known as lower explosive limit (LEL) and upper explosive limit (UEL)
- Do not assume that 15%+ is safe. The LFG can easily be diluted to 15% or be explosive at air-to-LFG interface point
- Enclosed or partially enclosed spaces, where LFG can accumulate (vaults, manholes, underground conduit, crawl spaces, basements, etc.,) are areas of great risk

# LANDFILL GAS HAZARDS - Suffocation

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- Humans are extremely sensitive to oxygen deficiency. Ambient air is about 21% oxygen
- The legal definition of oxygen deficiency varies, but 19.5% is considered to be a safe number to employ
- Confined space entry procedures must be established and followed
- Oxygen deficiency and explosive conditions can occur in "semi-confined" spaces such as trenches

# LANDFILL GAS HAZARDS - Trace Compounds

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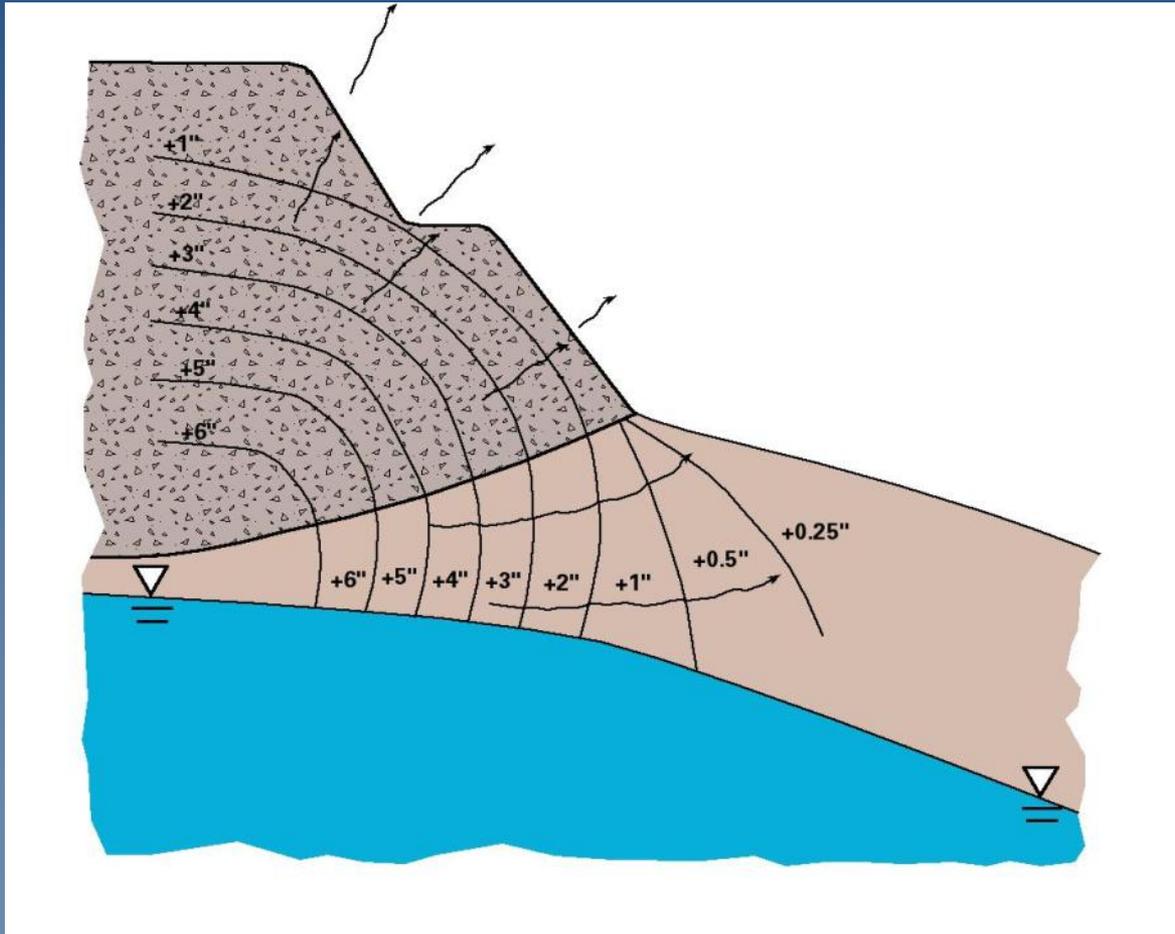
- LFG contains trace quantities of many other compounds
- Hydrogen sulfide is generally in the 20 ppmv to 60 ppmv range, but it can be much higher. H<sub>2</sub>S is very odorous, but the nose will become insensitive to the odor surprisingly quickly. At these levels, H<sub>2</sub>S irritates the eyes – higher levels lead to increasingly severe health conditions (NIOSH IDLH = 100 ppmv)
- LFG contains trace quantities of benzene, carbon tetrachloride, methylene chloride and other volatile organic compounds

# LANDFILL GAS MOVEMENT

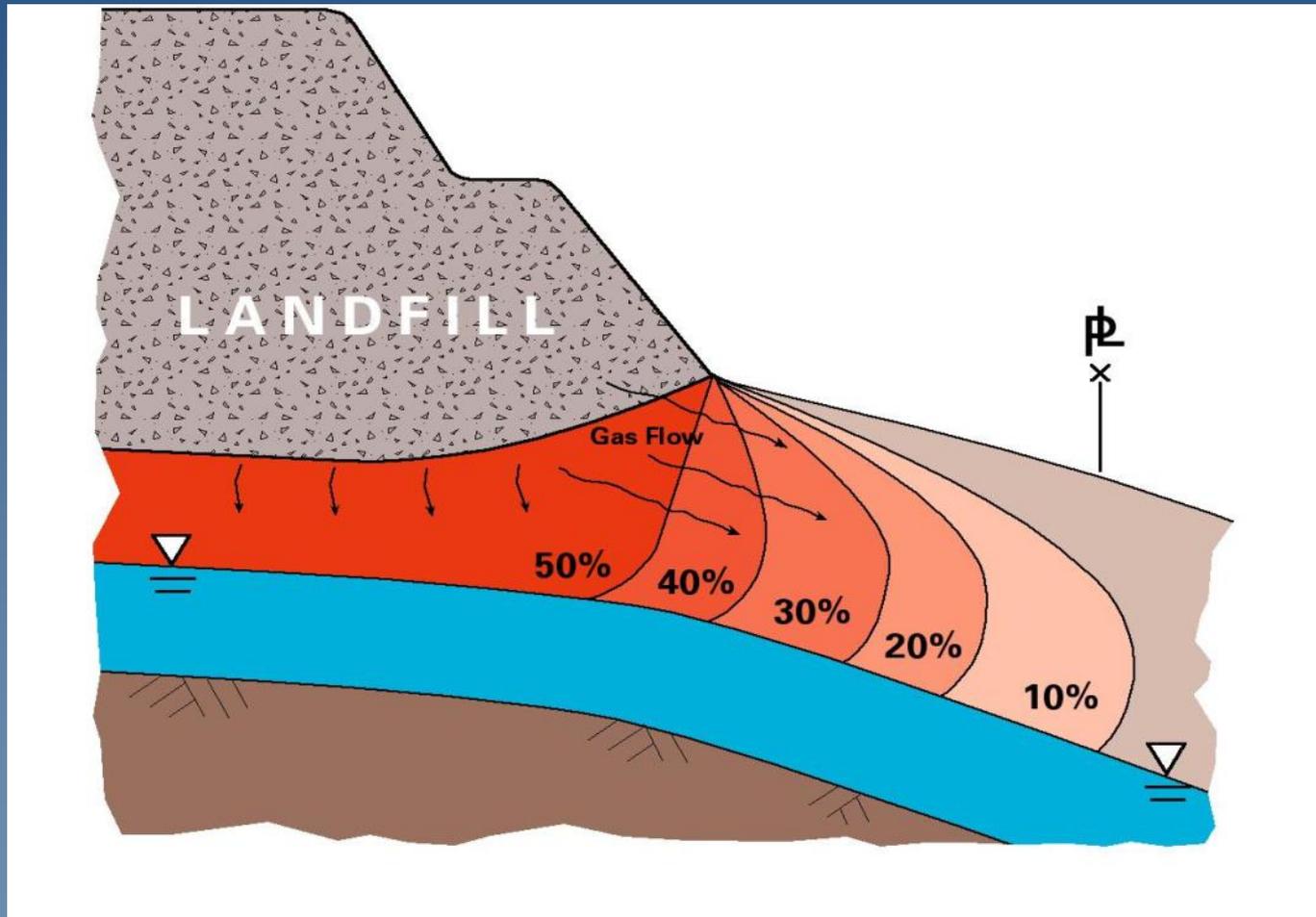
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- Driven by Pressure and Concentration Differential:
  - LFG migrates from areas of high pressure to areas of low pressure (i.e., interior of the refuse mass to the atmosphere and soil). This process is known as convection.
  - LFG is driven from areas of high concentration to low concentration. This process is known as diffusion.

# LANDFILL GAS MOVEMENT— Pressure Impact



# LANDFILL GAS MOVEMENT— Concentration Impact



# LANDFILL GAS MOVEMENT (cont.)

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- Pressure generally governs in LFG applications. But when pressure does not govern (i.e., in old landfills), diffusion will cause LFG movement.
- Liners block underground migration, but are not always 100% effective. Unlike water, LFG will move toward defects in any direction and LFG exploits small defects.

# HOW DO WE MONITOR?

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- Probes
  - Construction
  - Placement
- Surface Scans
- Continuous Monitoring Systems
  - Uses
  - Placement

# HOW DO WE MONITOR? (cont.)

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- When is best time of day to monitor?
- What can cause inaccurate readings?
  - Improper calibration
  - Probe Functionality
    - Watered In?
    - Plugged/crushed/bent?

# HOW DO WE MONITOR? (cont.)

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- Best Practices for Determining Subsurface Gas Conditions
  - Determine Waste Extent
    - Records
    - Geophysical Methods
    - Soil Gas Survey
    - Drilling & Pot-holing
    - Probes
  - Determine Gas Source
    - Records
    - Analyses

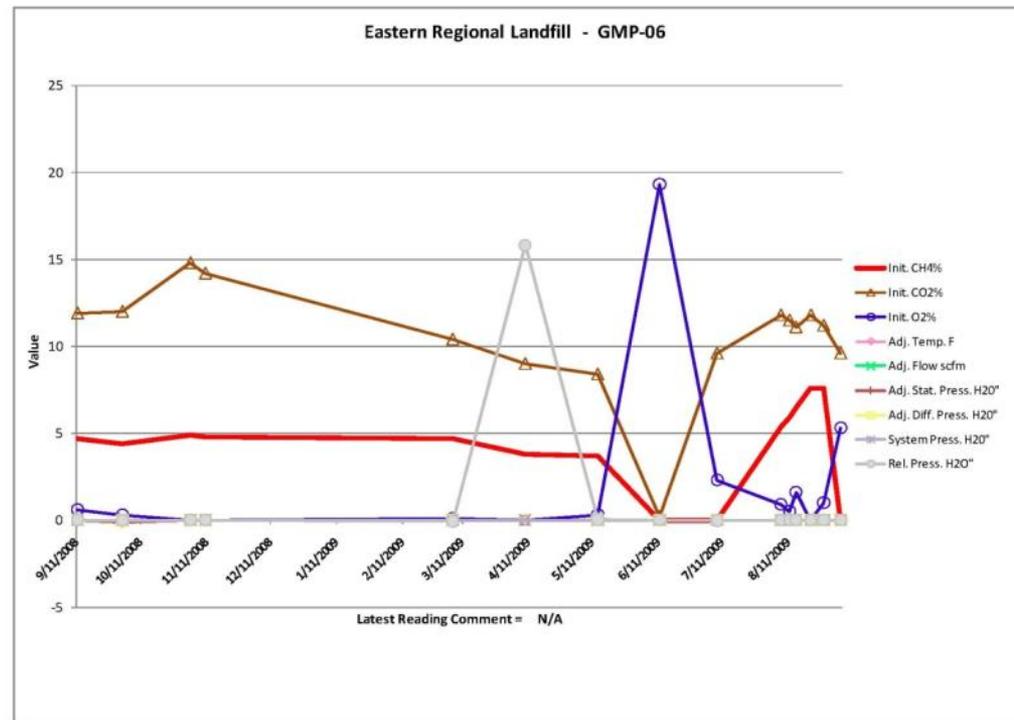
# WHAT DO WE MONITOR?

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- Methane (CH<sub>4</sub>)
- Oxygen (O<sub>2</sub>)
- Carbon dioxide (CO<sub>2</sub>)
- Balance Gas (assume calculated N<sub>2</sub>)
- Pressure
- VOCs (optional)
- Probe depths (optional)

# WHAT DO WE MONITOR? (cont.)

- Documentation
  - Data Storage
  - Time-trend data



# SUMMARY

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- Questions?