Big Bang Theory:
Evaluation of Sub-Slab Methane at Large Warehouse Sites

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International Symposium on Bioremediation and Sustainable Environmental Technologies

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Methane 101

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Toxicity:

- Non-toxic
- Asphyxiation risk (oxygen displacement)

Hazard:

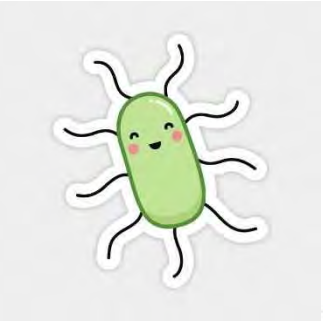
- Lower explosive limit: 5% (50,000 ppm)

Sources:

- Thermogenic: natural gas
- Biogenic: methanogenesis

THERMOGENIC

BIOGENIC



Large Warehouses

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Agenda

- Case Study #1
- Guidance
- Case Study #2
- Case Study #3
- Wrap-up / Conclusions

Case #1: Methane Mitigation

PROBLEM SUMMARY

- Newly constructed 1,000,000 ft^2 warehouse
- During buildout, prospective tenant discovered very high methane (>90%) below foundation
- Mitigation system reduced methane, but not enough
- Methane source not identified

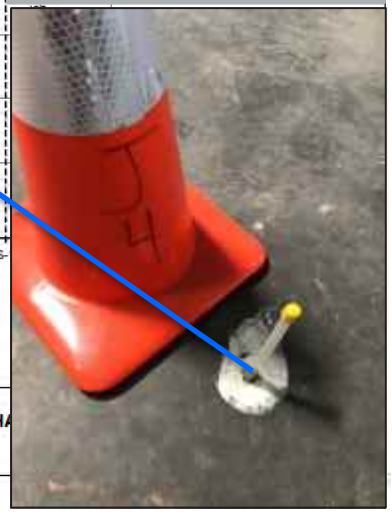
Case #1: Methane Mitigation

18 Horizontal (sub-slab)

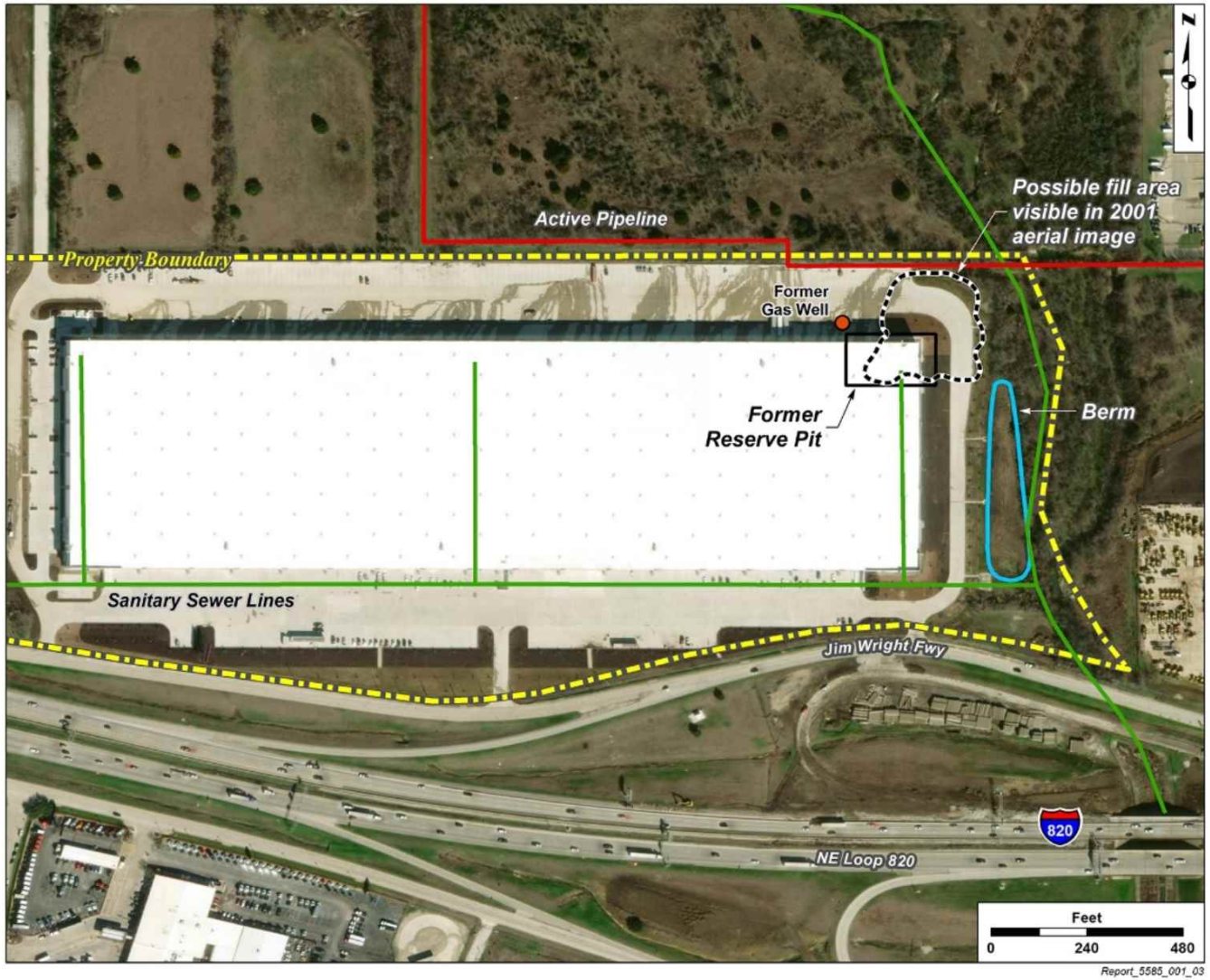
6 blower skids (roof)

8 vertical wells

25 Vapor pins



Case #1: Methane Source - The Suspects



POTENTIAL SOURCES

1) On-Site Gas Well
2) Sanitary Sewer Line
3) Buried Vegetation (reserve pit, fill area, berm)
4) The Clay Fill

Suspect #1: Gas Well

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Who:

- Unconventional gas well
- Drilled 2004
- Plugged 2015

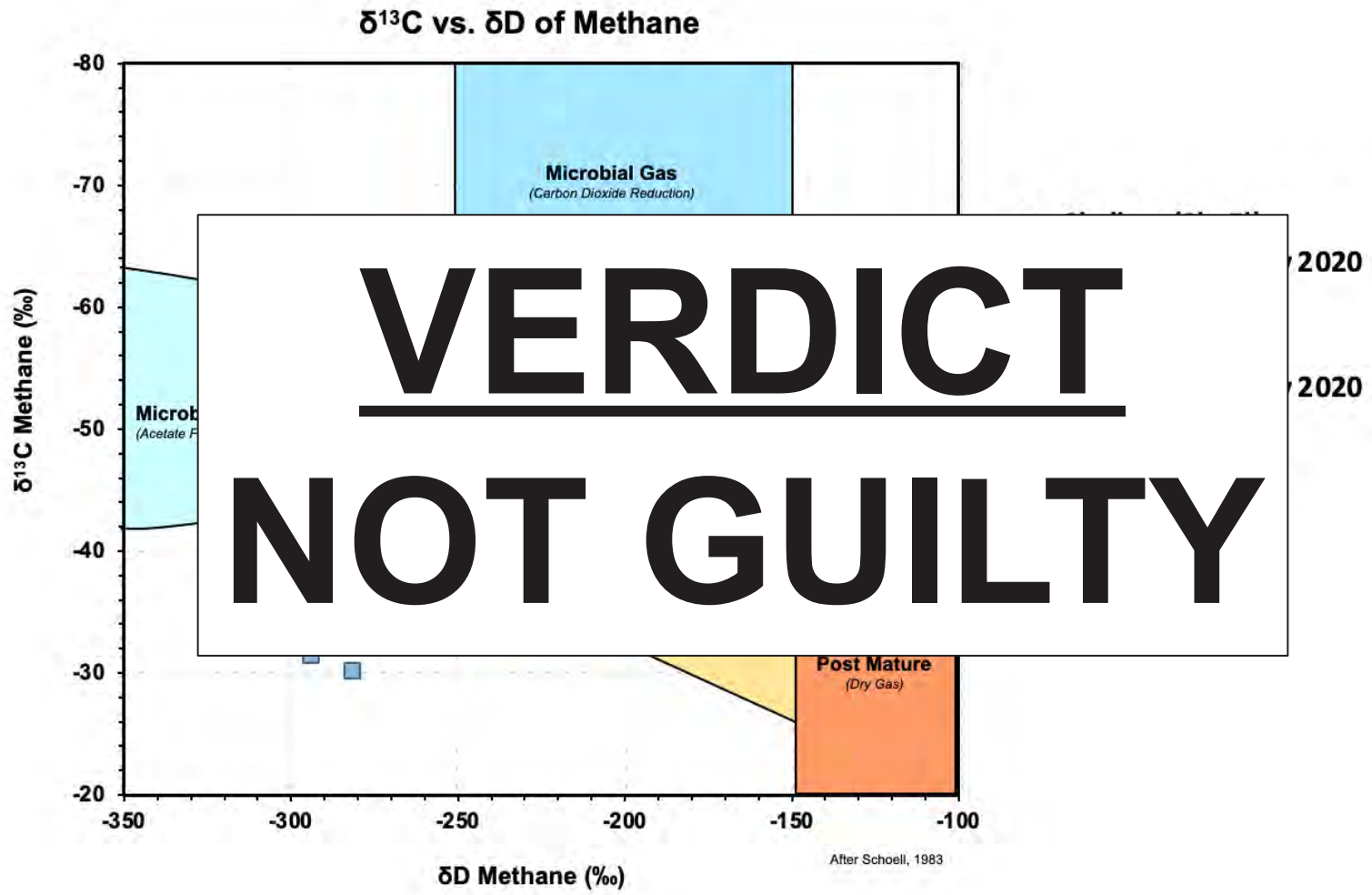
Interrogation Method:

- Stable isotope analysis on methane samples
- Thermogenic vs. biogenic

2005 Aerial Photo

Suspect #1: Gas Well

Schoell Plot with Soil Gas Sample Results



VERDICT

NOT GUILTY

Suspect #2: Sewer Line

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Who:

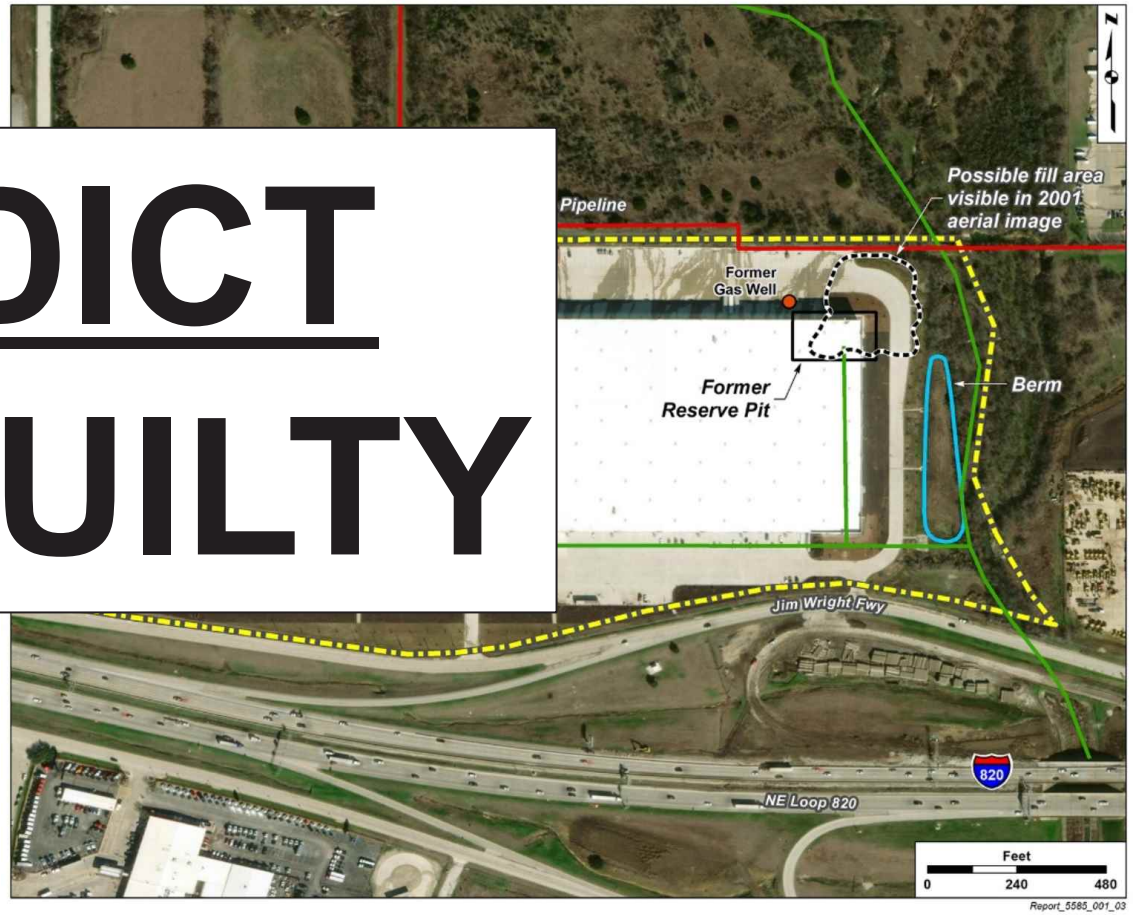
- Sanitary sewer line
- Connects site to sev
alo

Interrogation Method:

- Me
me
concentrations in sewer and in backfill

VERDICT

NOT GUILTY



Suspect #3: Buried Vegetation

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Who:

- Berm (with top soil)
- Fill area (2001 Aerial)
- Rese
  (200

Interrogation Method:

- Borin
- Verti
  distr
- Vertical vapor extraction wells

VERDICT

NOT GUILTY

2005 Aerial Photo

Suspect #4: The Clay Fill

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Who:

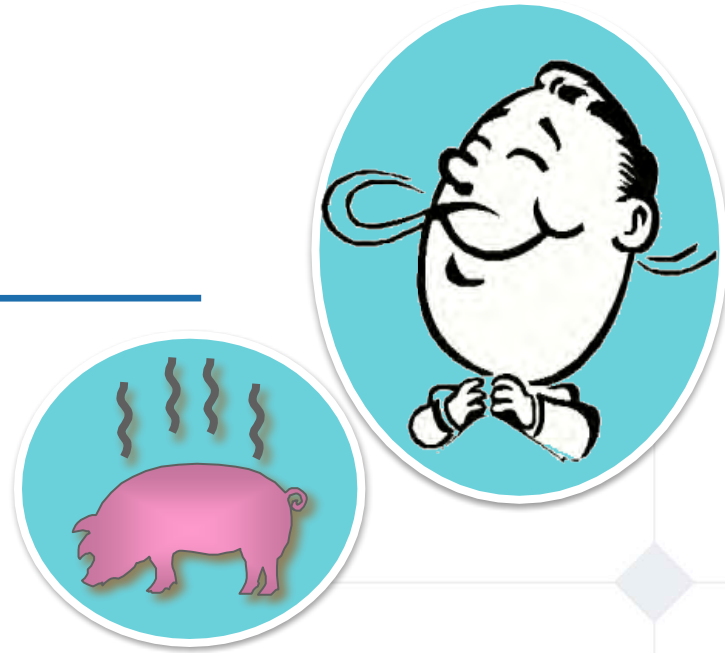
- Fill material used to bring east side of warehouse up to grade
- Thickness: 4 – 12 ft
- Material taken from site (no outside soil)

Interrogation Method:

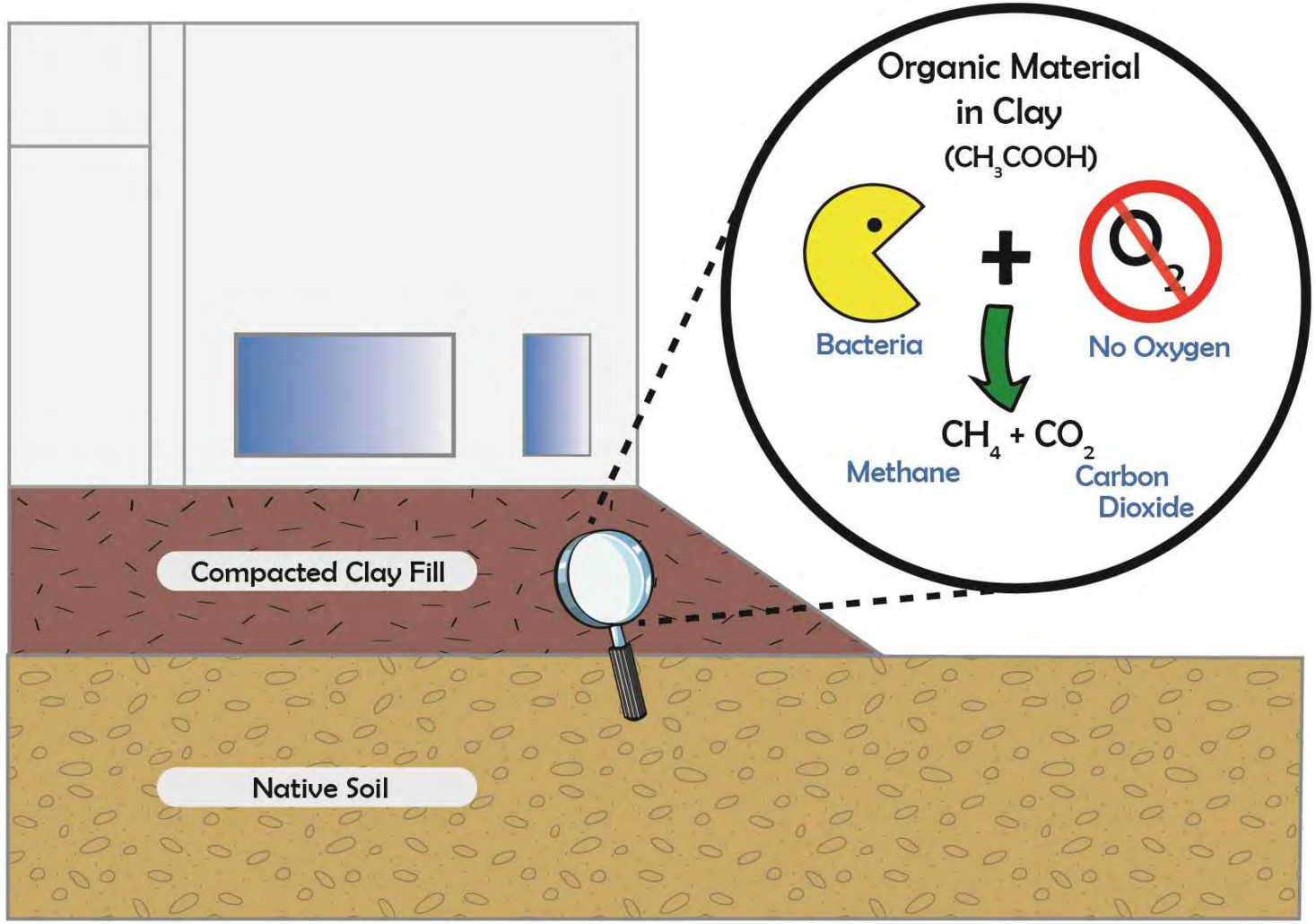
- Smell test
- TOC measurements
- Laboratory microcosms

Evidence:

- Odor
- Organic Carbon: 1% to 4% (Average = 2%)
- Microcosms generated methane



Suspect #4: The Clay Fill



Suspect #4: The Clay Fill

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Subsurface Methane: Guidance

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Department of Toxic Substances Control

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ADVISORY ON
METHANE ASSESSMENT AND COMMON REMEDIES AT SCHOOL SITES

SCHOOL PROPERTY EVALUATION AND CLEANUP DIVISION
DEPARTMENT OF TOXIC SUBSTANCES CONTROL

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Advisory Contents

Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases

Chartered Institute of Environmental Health

The Local Authority Guide to Ground Gas

Steve Wilson, Geoff Card and Sarah Haines

September 2008
The Chartered Institute of Environmental Health: London

ASTM E2993-16

Standard Guide for Evaluating Potential Hazard as a Result of Methane in the Vadose Zone

Significance and Use

5.1 Several different factors should be taken into consideration when evaluating me
than, for example, use of a single concentration-based screening level as a de-facto
level. Key variables are identified and briefly discussed in this section. Legal backgr
provided in Appendix X3. The Bibliography includes references where more detaile
found on the effect of various parameters on gas concentrations.

ASTM INTERNATIONAL

EVALUATION OF BIOGENIC METHANE

A Guidance Prepared for the Evaluation of Biogenic Methane in Constructed Fills and Dairy Sites

Prepared By:
California Environmental Protection Agency
Department of Toxic Substances Control

March 28, 2012

Subsurface Methane: Guidance

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Risk Factors:

- Natural gas (seep, leaking line, leaking well)
- Landfills
- Buried organic matter
  (e.g., dairy waste, other agricultural waste)
- ~~Small amounts of organic material in fill soil~~

Hazard Evaluation:

- Methane concentrations inside building
- Methane generation rate / flux
- Driving pressure
- ~~Methane concentration in subsurface~~

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Case #2: Field Survey

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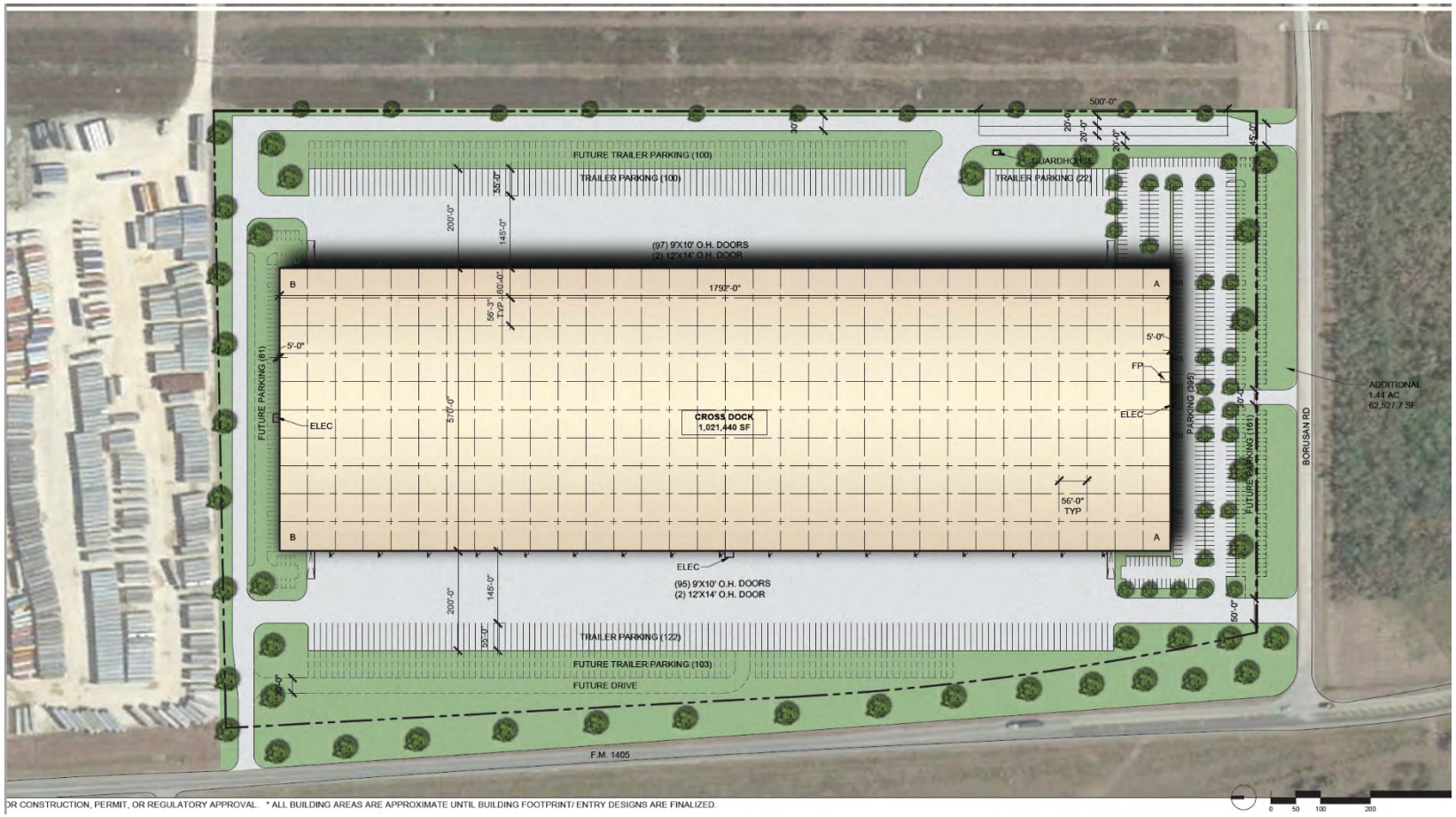
What:

- New 1,000,000 ft² spec. warehouse
- No methane risk factors
- Is methane a concern?



Case #2: Field Survey

What:

- New 1,000,000 ft^2 spec. warehouse
- No methane risk factors
- Is methane a concern?

How:

- Survey of indoor air and foundation joints using field methane meter

Results:

- 60-90 ppm methane in indoor air
- Up to 400 ppm methane at foundation joints

Reminder: Lower Explosive Limit is 50,000 ppm

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Case #3: Sub-Slab Methane

What:

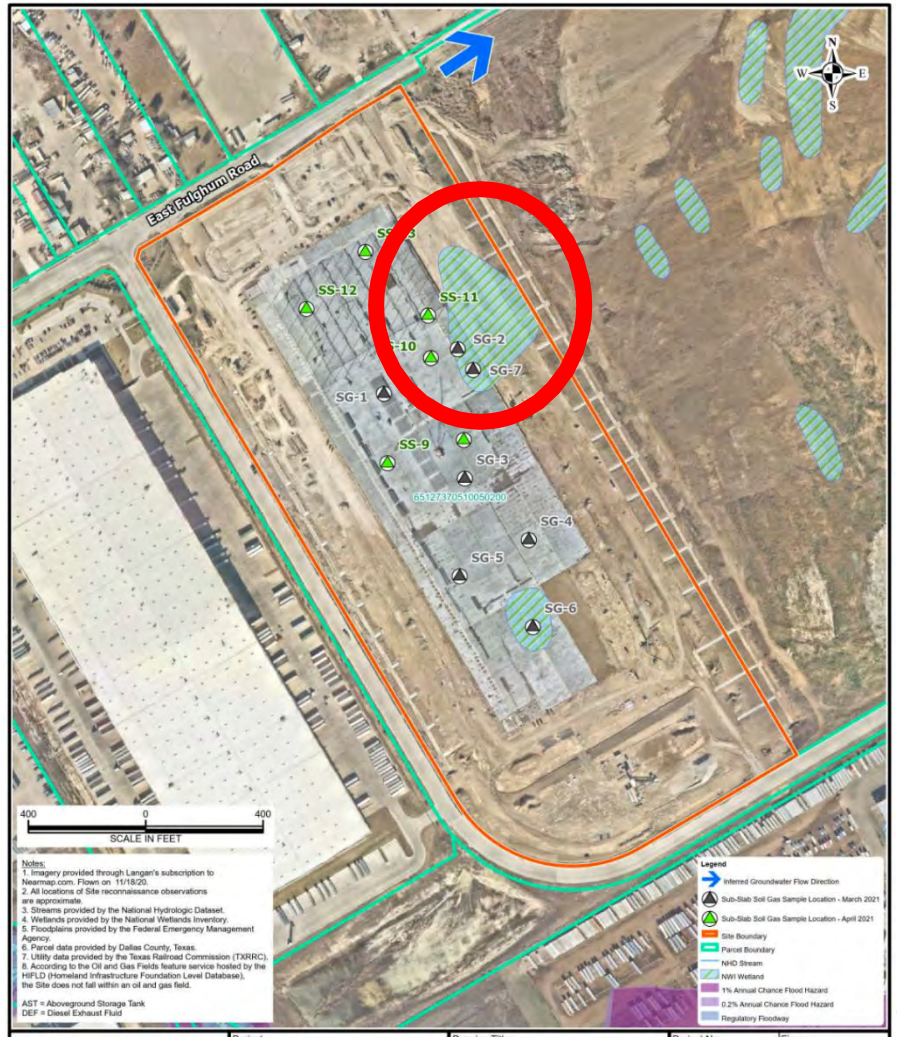
- New 1,000,000 ft^2 spec. warehouse.
- Prospective tenant identified methane below foundation.

Details:

- 2 locations = ND
- 10 locations <1% methane
- 1 location = 5.3% methane

Conceptual model:

- Former “wetlands” near sub-slab location with 5.3% methane



Case #3: Sub-Slab Methane

Note: Warehouse slab poured in January 2021

March 2021:

- 5.3% methane – one location
- <1% - eleven locations

May 2021:

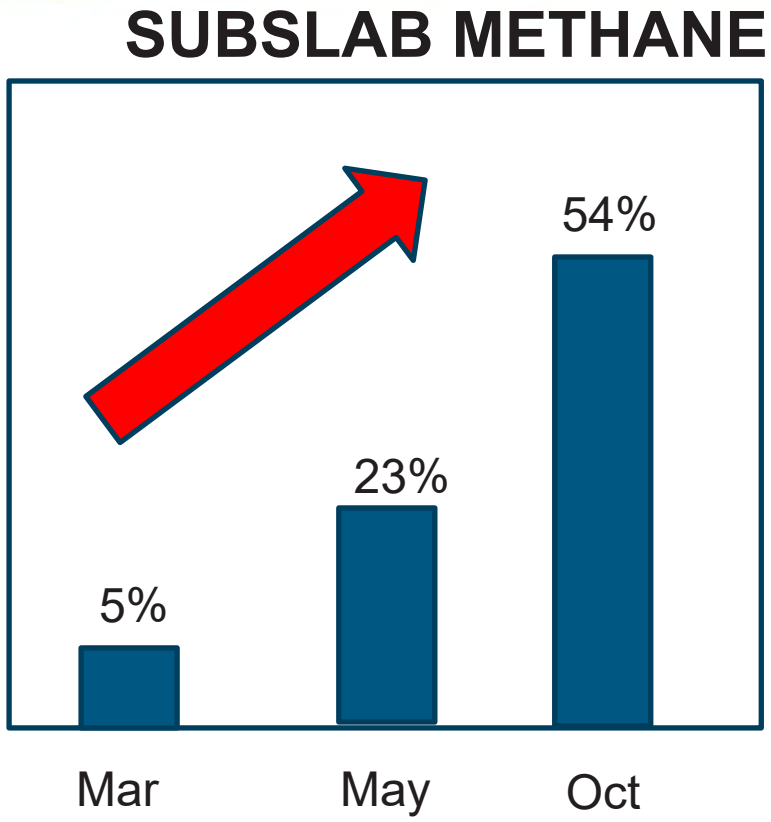
- Same location = 12% methane
- Near-by: up to 23% methane

June-Sept 2021:

- Yada, yada, yada

Oct 2021:

- Building-wide survey
- Sub-slab (70 locations): >5% at 1/3rd of locations (Max = 54%)
- Indoor air (70 locations): 11 to 15 ppm in bulk air, up to



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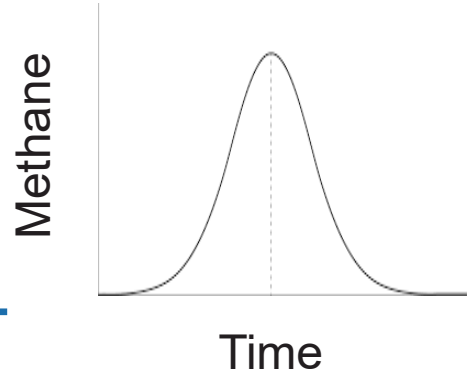
Wrap Up

Sub-Slab Methane:

- Not typically measured
- Likely present (>5%) below most newly constructed, large, slab-on-grade buildings



Methane Risk Factors:

- Natural gas (seep, leaking line, leaking well)
- Landfill
- Buried organic matter

Hazard Evaluation:

- Methane concentrations inside building
- Methane generation rate / flux
- Driving pressure