Advances in Existing Building Methane Mitigation

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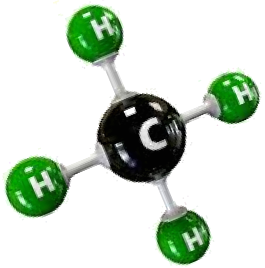
Outline

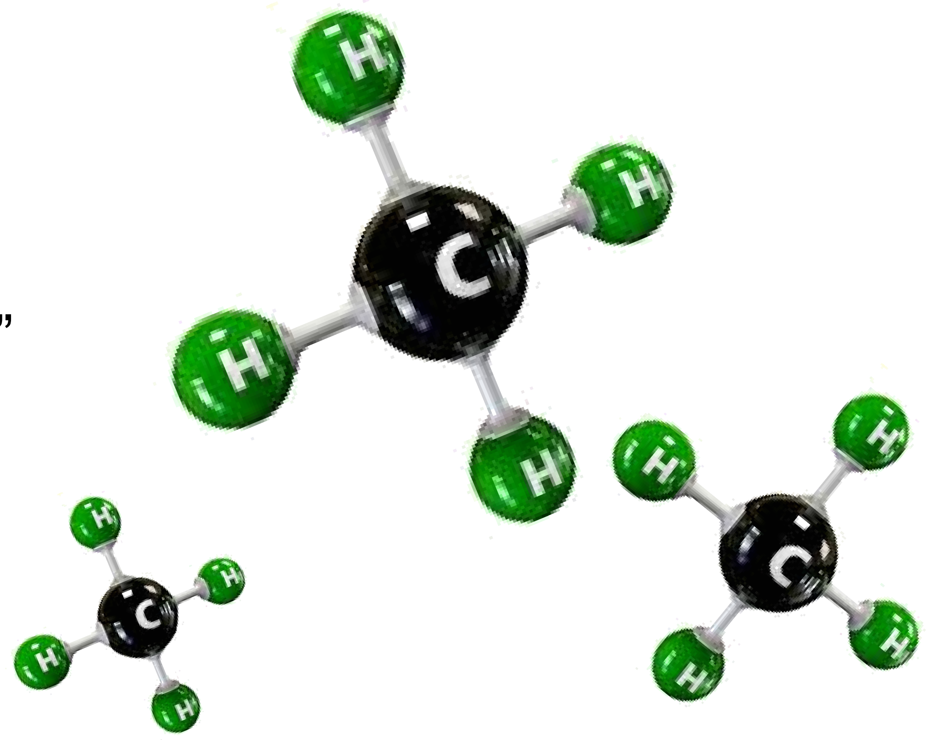
1. **Introduction to Methane**
2. **Methane Mitigation vs. Vapor Intrusion Mitigation**
3. **Existing Building Mitigation Strategies**
4. **Commissioning, Operation, Maintenance, and Monitoring (OM&M)**
5. **Efficacy of Response Driven Controls**



Introduction to Methane

What is Methane?

- C-4 - Formed through anaerobic decomposition
- Principal component of natural gas
- One of the six main so called “greenhouse gases”
- 0.00018% of the earth's atmosphere
- Life span 12.4 years – becomes CO_2 and H_2O
- Non-toxic to humans
- Combustible
- Asphyxiant displaces oxygen
- 5% methane by volume equals 100% of the Lower Explosive Limit (LEL)
- Small amounts of decaying organic material below a building can create LEL exceedances



Introduction to Methane

Where does Methane come from?

- **Biogenic Methane**: Produced by the decay of organic material under anaerobic conditions (i.e., in the absence of oxygen).
  - Wetlands, Landfills, Rice Cultivation, Organic Yard Waste, Construction Debris

- **Abiogenic Methane**: Formed through inorganic chemical reactions
  - Hydrothermal Vents, Ophiolite Complexes (uplifted oceanic crust), Deep-seated Earth's Mantle Reactions

- **Thermogenic Methane**: Produced from the thermal decomposition of buried organic material. It occurs in deeper geological strata, typically between 157°C and 221°C.
  - Sedimentary Basins, Isotopic Distinction

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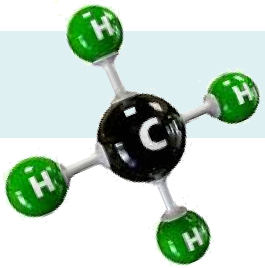


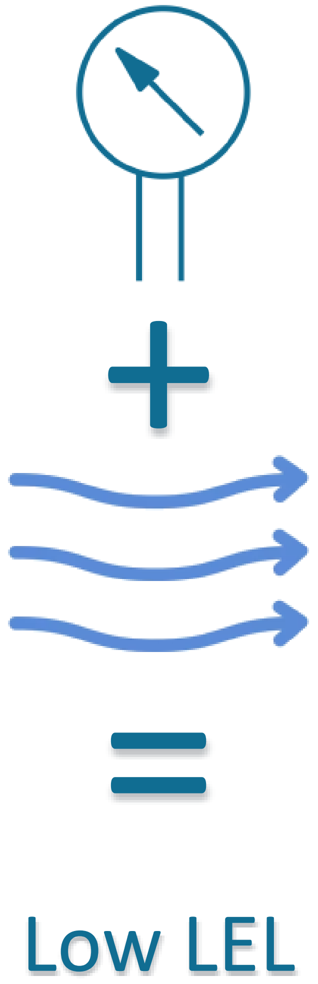
3 Existing Building Mitigation Strategies

4 Commissioning, Operation, Maintenance, and Monitoring (OM&M)

5 Efficacy of Response Driven Controls

Methane Mitigation vs. Vapor Intrusion Mitigation

Vapor Intrusion – Pressure Differential	Methane – Pressure Differential + ***<u>Airflow</u>***
Typically exhaust vents only	Exhaust vents + Fresh air inlet ports
Applied vacuum + Pressure differential monitoring	Continuous Active Methane monitoring sub-slab and indoor air
Occasional airflow monitoring, usually for mass discharge.	Active notification – building evacuation
Annual OM&M for physical metrics, applied vacuum-pressure differential	Annual OM&M for physical metrics applied vacuum-pressure differential-airflow
	Methane sensor calibration
Low risk of fire or explosion	Elevated risk of fire or explosion
	Explosion proof or Intrinsically safe blowers



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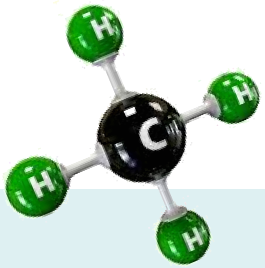


Existing Building – Investigation Considerations

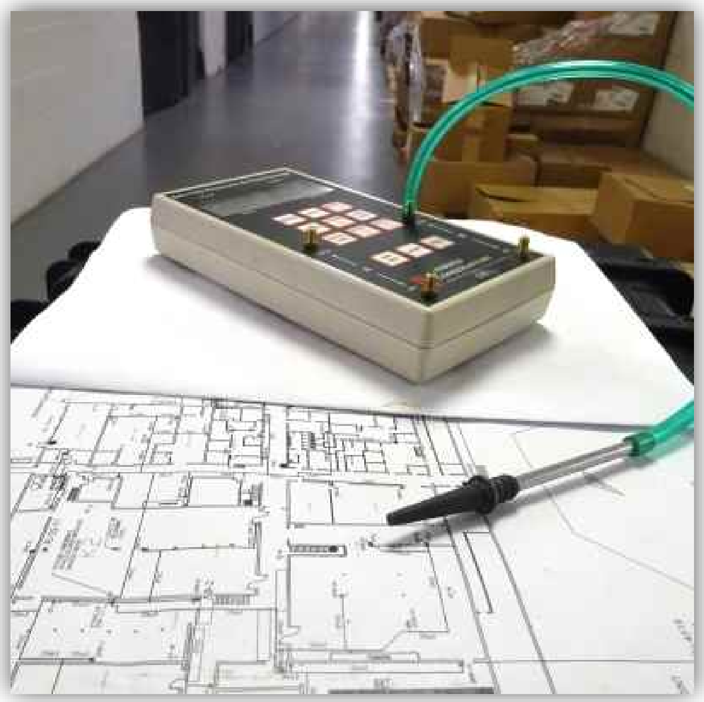
- Implement sub-slab sampling to define methane soil gas throughout the slab.
- Foundation types and sub-slab fill material are mostly unknown
- If a builder cuts corners on removing organic fill material, often they do the same on the fill material and vapor barrier.
- Vapor Barrier presence/quality is almost always unknown
- Soil gas entry points need to be identified by onsite inspections, which can be intrusive.
- Floors are finished, limiting test locations
- Intrinsically safe tools, blowers, and exterior venting of soil gases are requirements for pressure field testing.

Existing Building – Investigation Considerations

- Health & Safety, workspace monitoring
- Vacuum field extension is relatively easy to test. Spatially quantifying source airflow is not. – Many variables
- Sub-slab soil types i.e. crushed vs. clay can make a significant difference in airflow yields and sub-slab air exchange rates
- It is possible to have good vacuum field extension and spotty or almost undetected airflow.
- Locations of riser vents, fresh air inlets need to be strategically located to achieve targeted sub-slab vacuum and air exchange rates based on measured applied vacuum, soil gas yields, vacuum field extension and flow rates.
- Because buildings are subject to not only seasonal pressure changes but rapid pressure changes, response-driven controls are preferable.

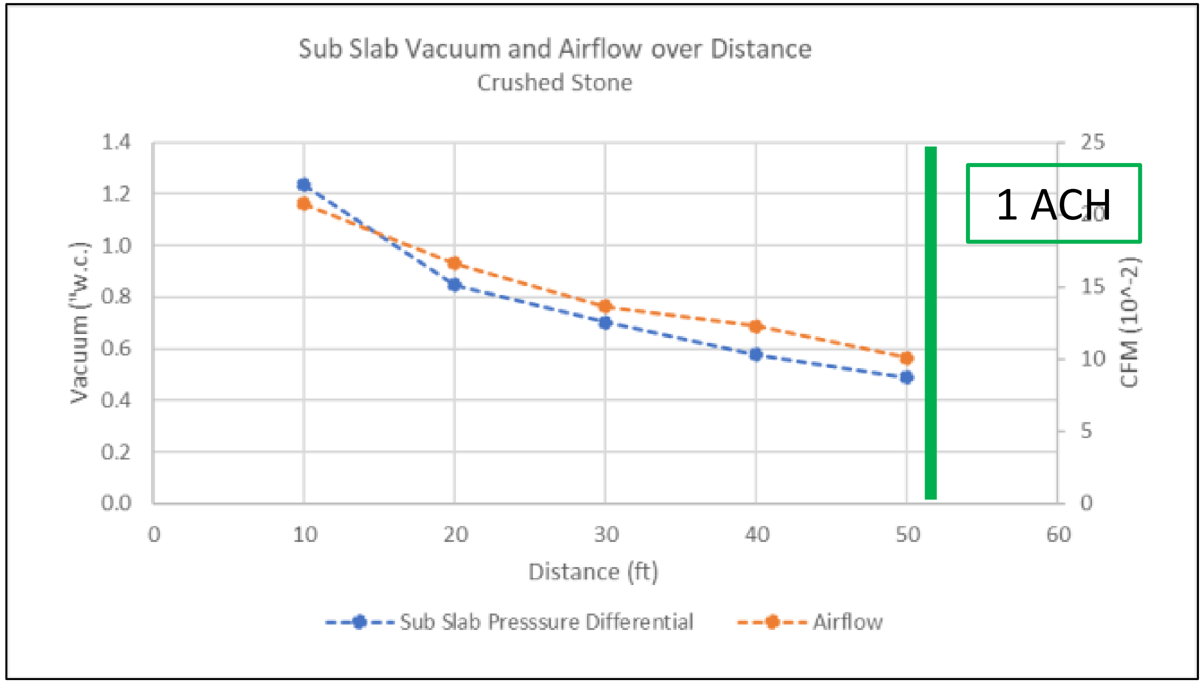
Methods of Data Collection

- Quantifying The Relationship Between Sub-Slab Vacuum and Airflow

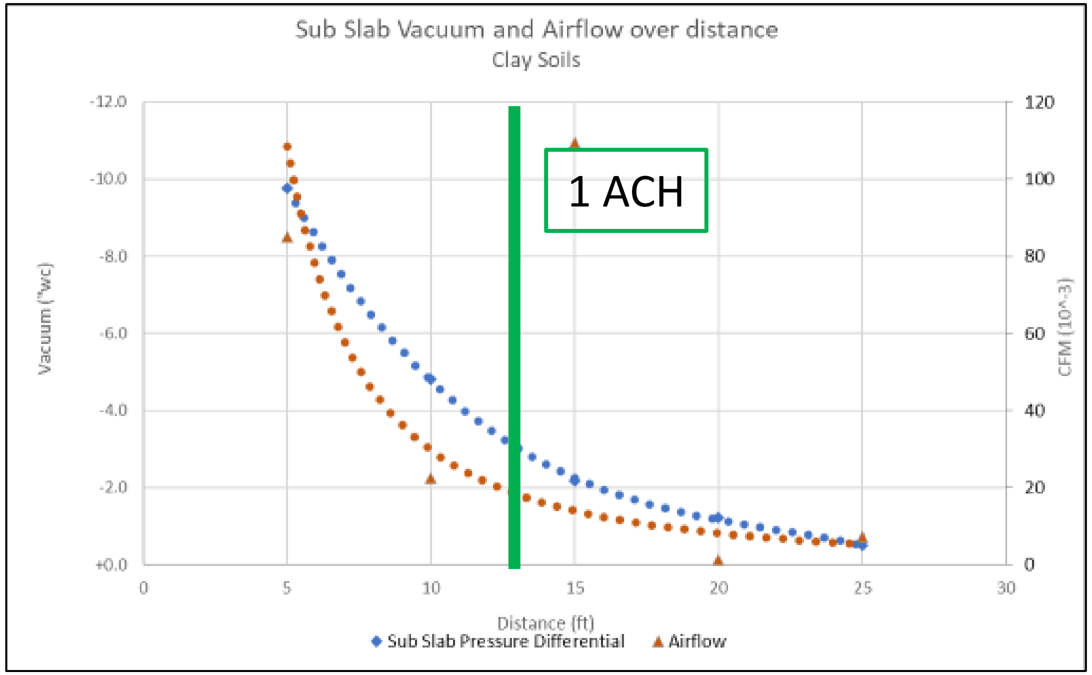


Sub-slab Vacuum & Airflow over Distance

For low K value soils, air exchange radius decreases exponentially

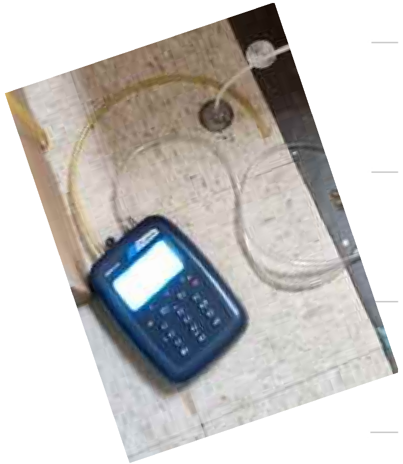


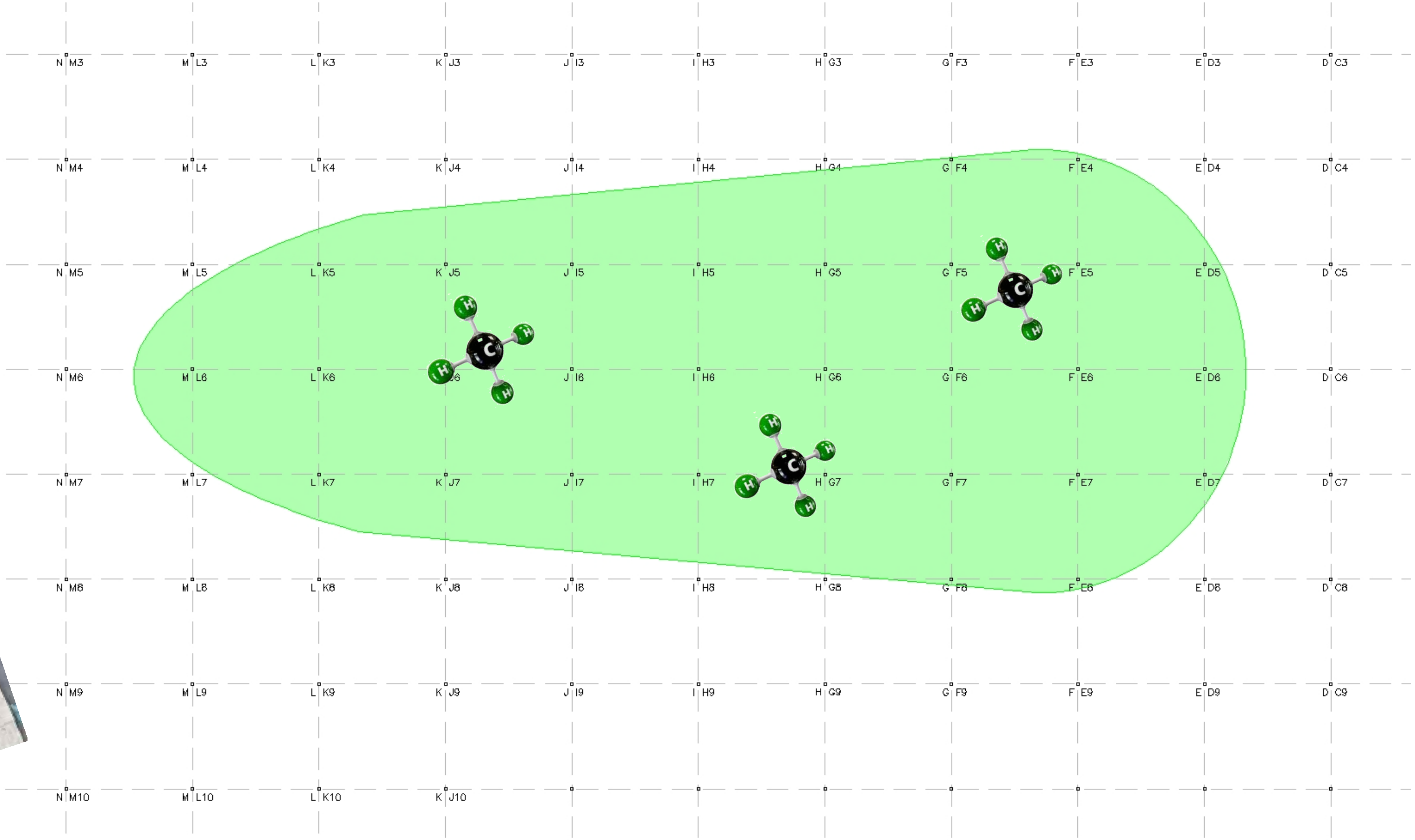
Crushed Stone (high K value)



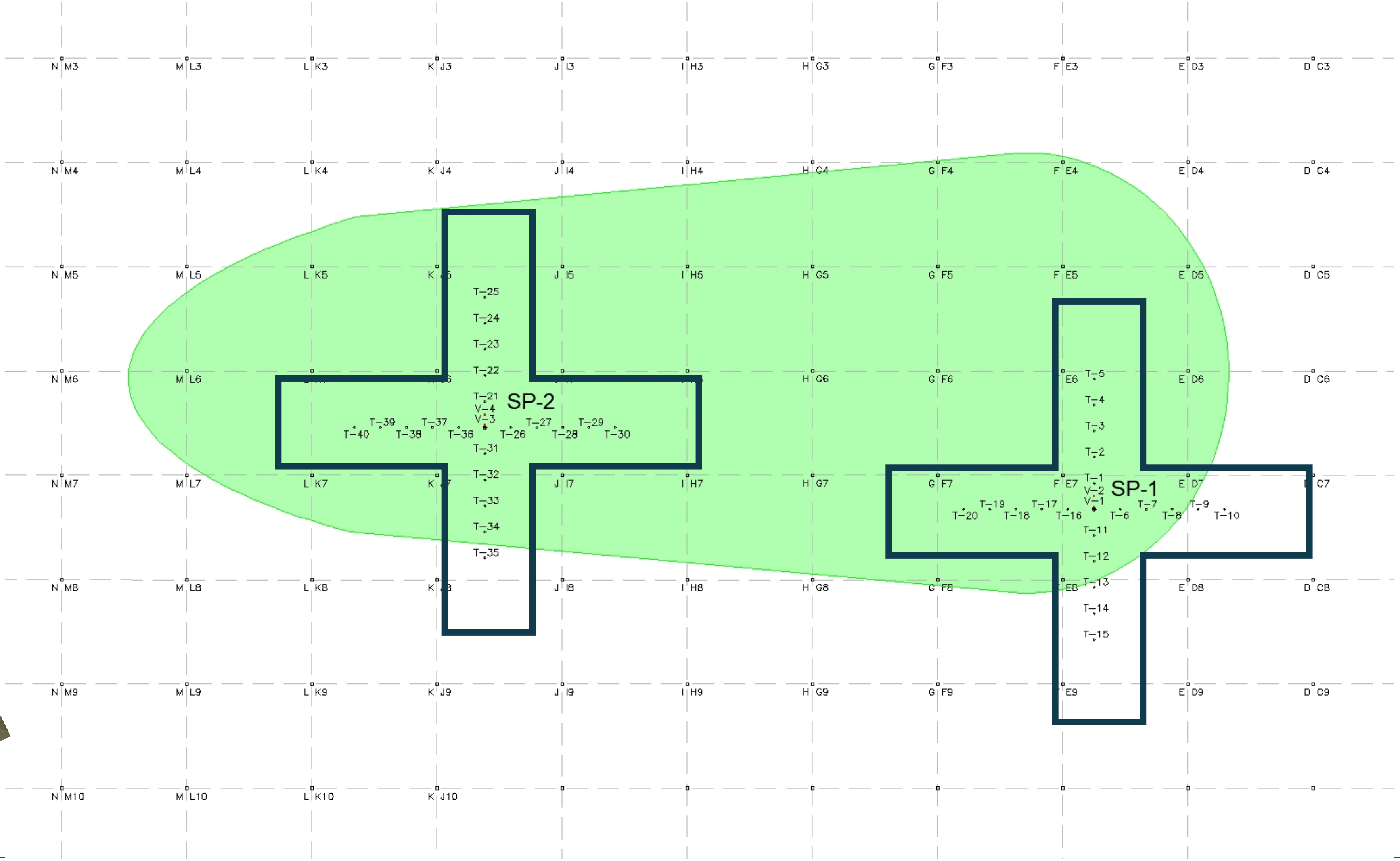
Loamy Clay (low K value)

Design Process – Methane Plume Delineation

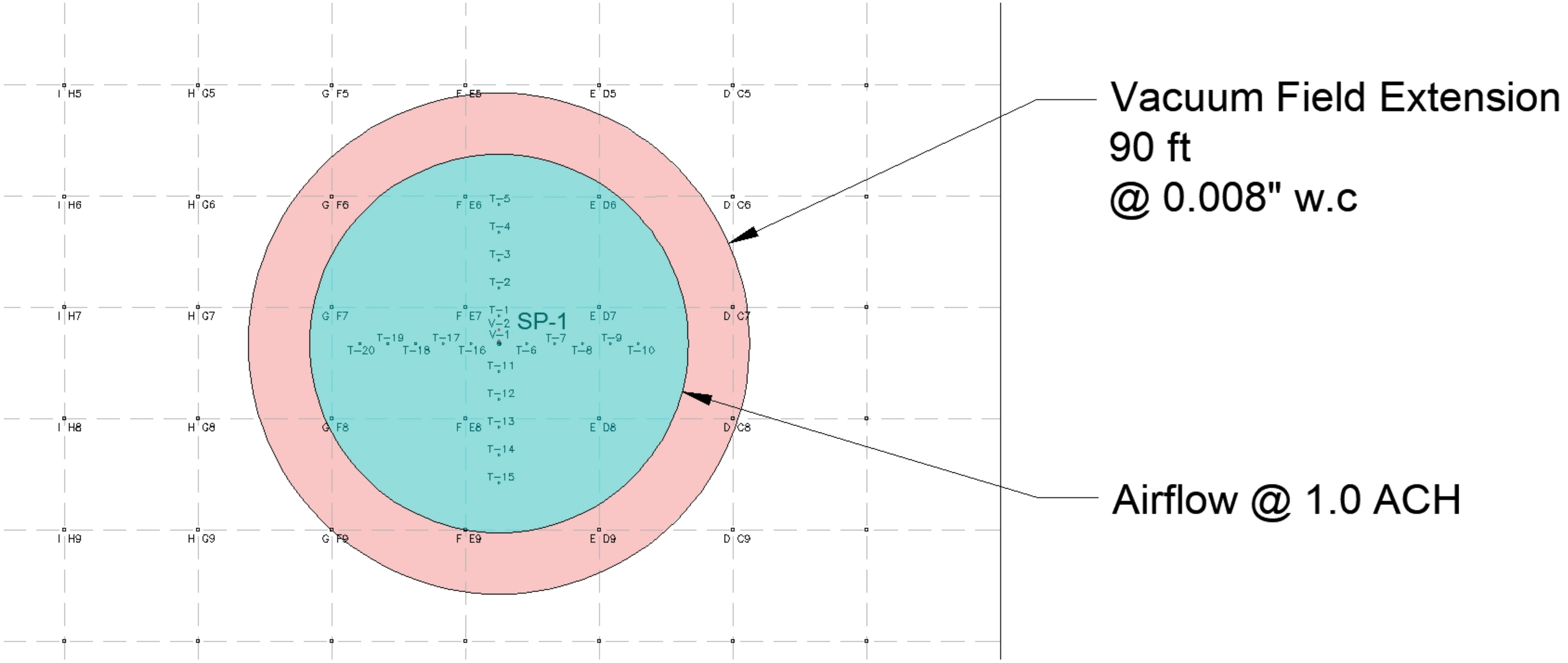




Design Process – Diagnostics & Transects



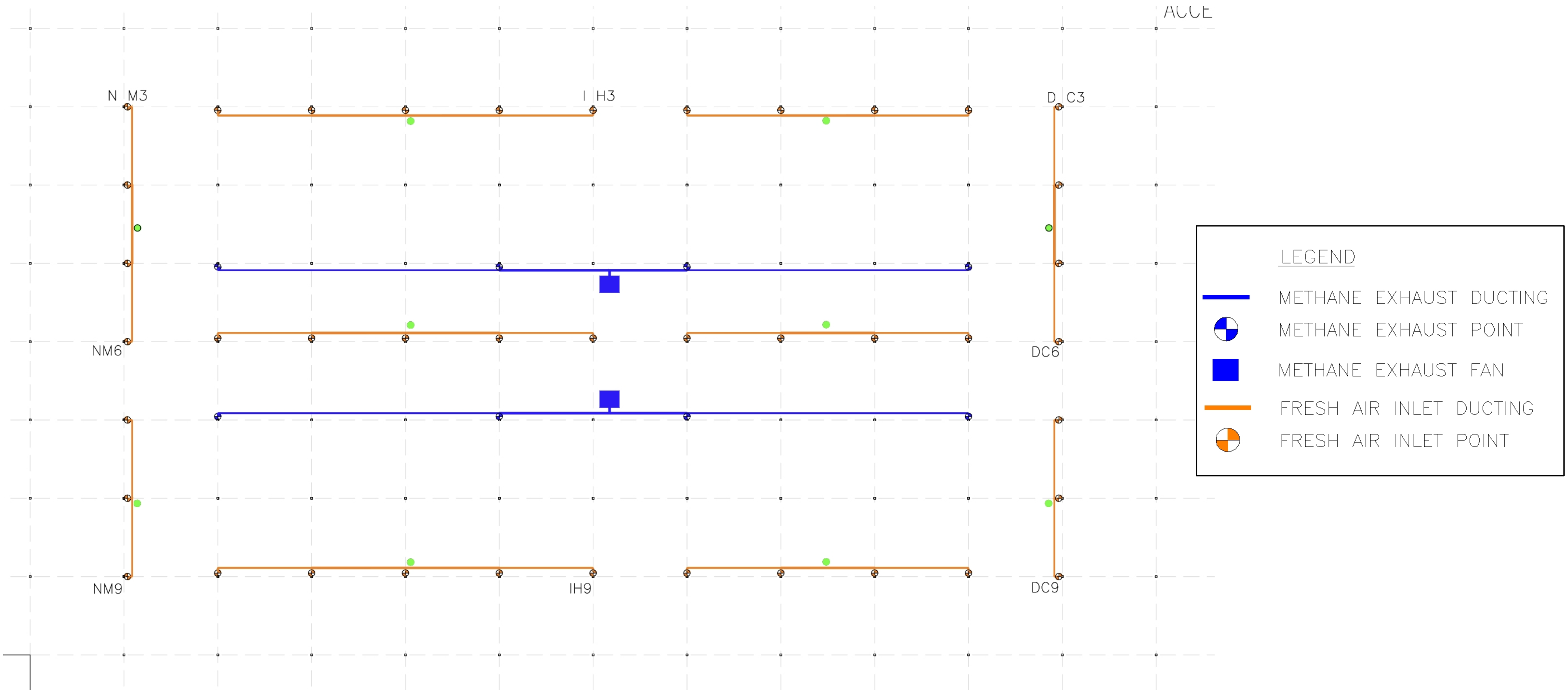
Design Process – Vacuum vs Airflow ROI



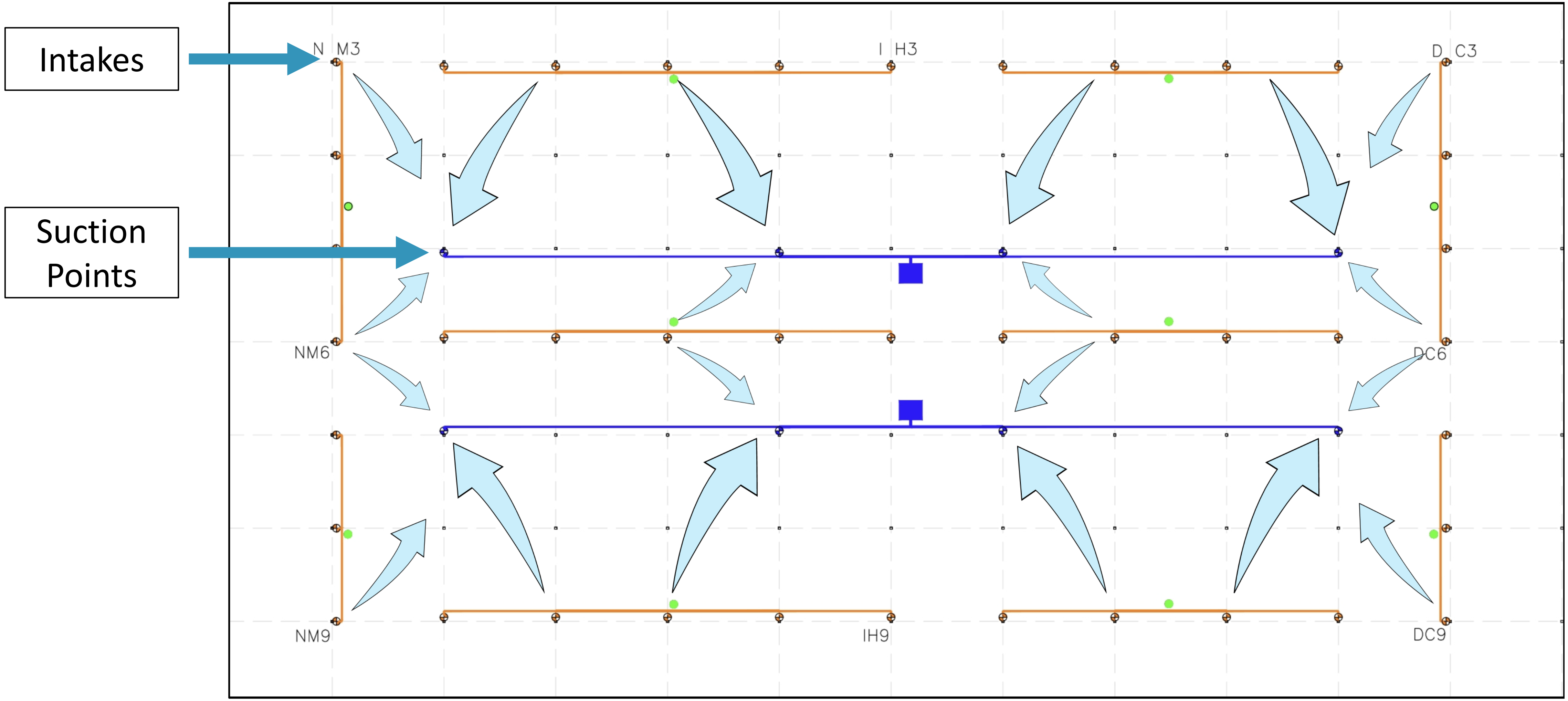
Design Considerations

- Pressure differential to demonstrate vacuum field extension.
- Determine targeted sub-slab *Air Exchange per Hour* in the depressurization zone and method of measurement
- Determine the location of suction points and fresh air inlets.
- Select Manually or Electronically regulated fresh air inlets
- Selection of explosion-proof or extrinsically safe blowers to meet pressure field extension and air exchange objectives
- Method and equipment measurement for vacuum and airflow.
- Selection of methane sensors and electronic management platform.
- Selection of response-driven controls and performance metrics
- Selection of owner/occupant and fire department notification criteria
- Best Practices for system maintenance and repair

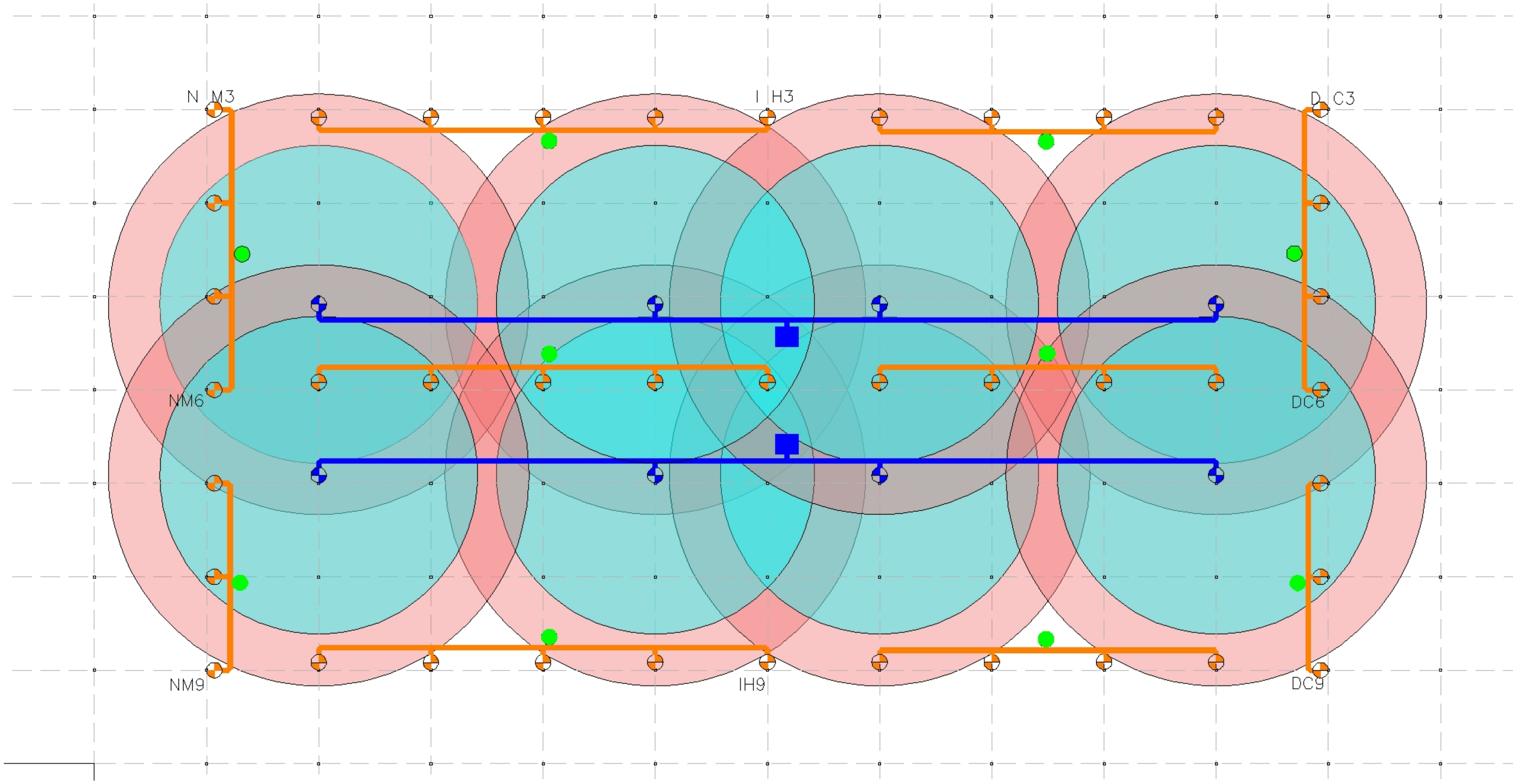
Design Process – Air Intakes, Ducting, & Risers



Air Exchange - Fresh Air Intakes & Risers



Design Process – Suction Points to ROI Mapping



Installation Considerations

- Building occupant health & safety – evacuate building or work area
- Worker Health and Safety
- Methane Monitoring
- Amended construction sequence to vent the sub-slab as soon as it is opened
- Spark resistant tools
- Wet coring with a water dam

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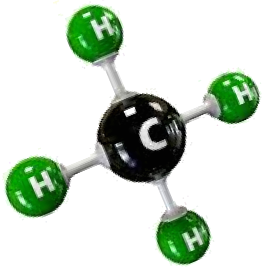

OM&M Schedule

- Active electronic surveillance/ system management
- Inspection schedule i.e., quarterly first year – annually thereafter
- Physical metrics to be inspected vacuum-airflow
- Sensor calibration
- Procedures for adjusting set points, motor speed, pressure differential, exhaust airflow, fresh air induction airflow

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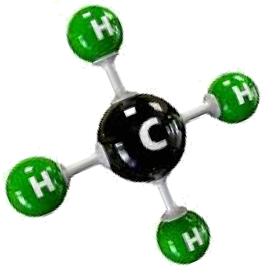
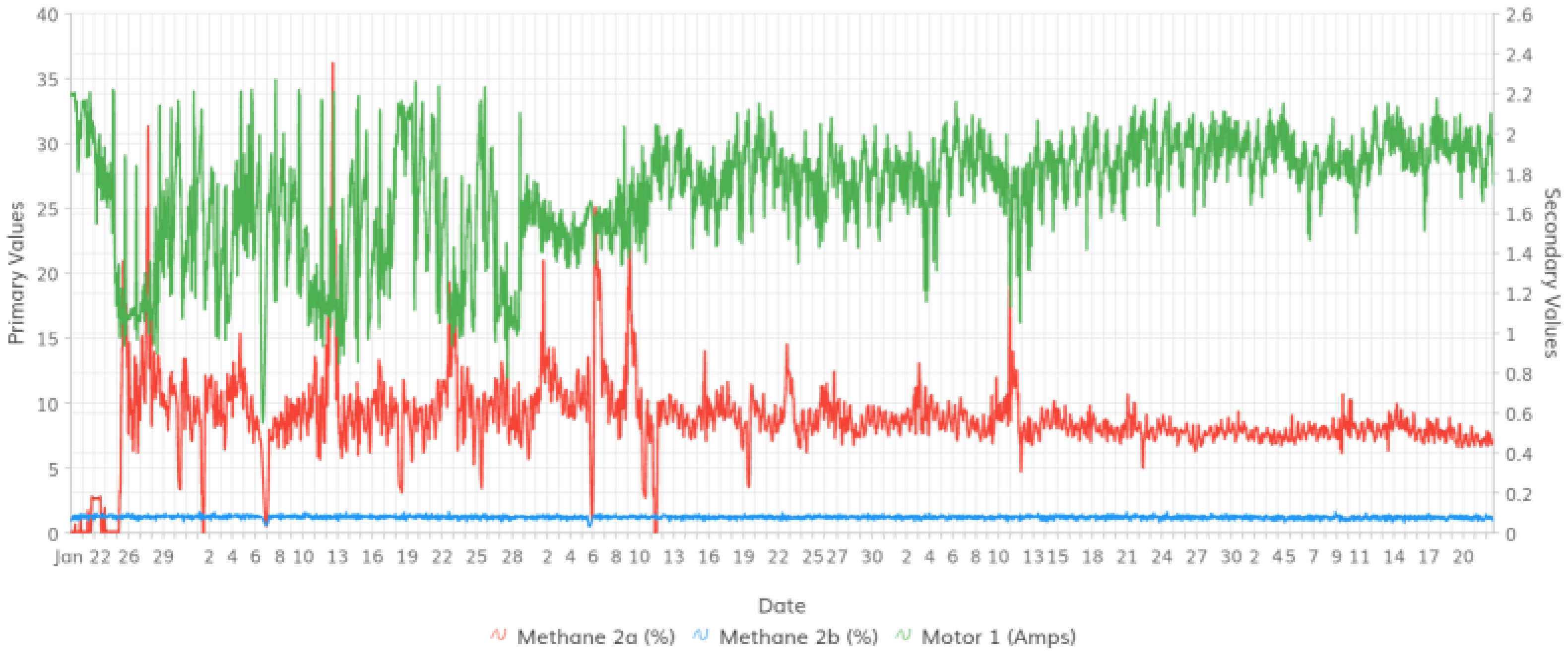


Methane Mitigation – Controls, Indoor Air, & Sustainability

Indoor Air pressure changes due to outside change in temperature, windspeed, & barometric pressure

VIMS Motor Speed self regulates to maintain required pressure differential

Methane Indoor Air %LEL stays at 0% as forces act upon the building due to response driven controls



Motor Speed

Riser – Methane %LEL

Indoor Air – Methane %LEL

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Dynamic Controls Applied to Methane Sites Enable Significant Energy & Cost Savings

- Documented Power Consumption of a Site by 90%
- Blower Size Reduction (5HP → 1HP running at average of 50% capacity)
- Reduction in Greenhouse Gas Emissions

Methane Mitigation – System Implementation

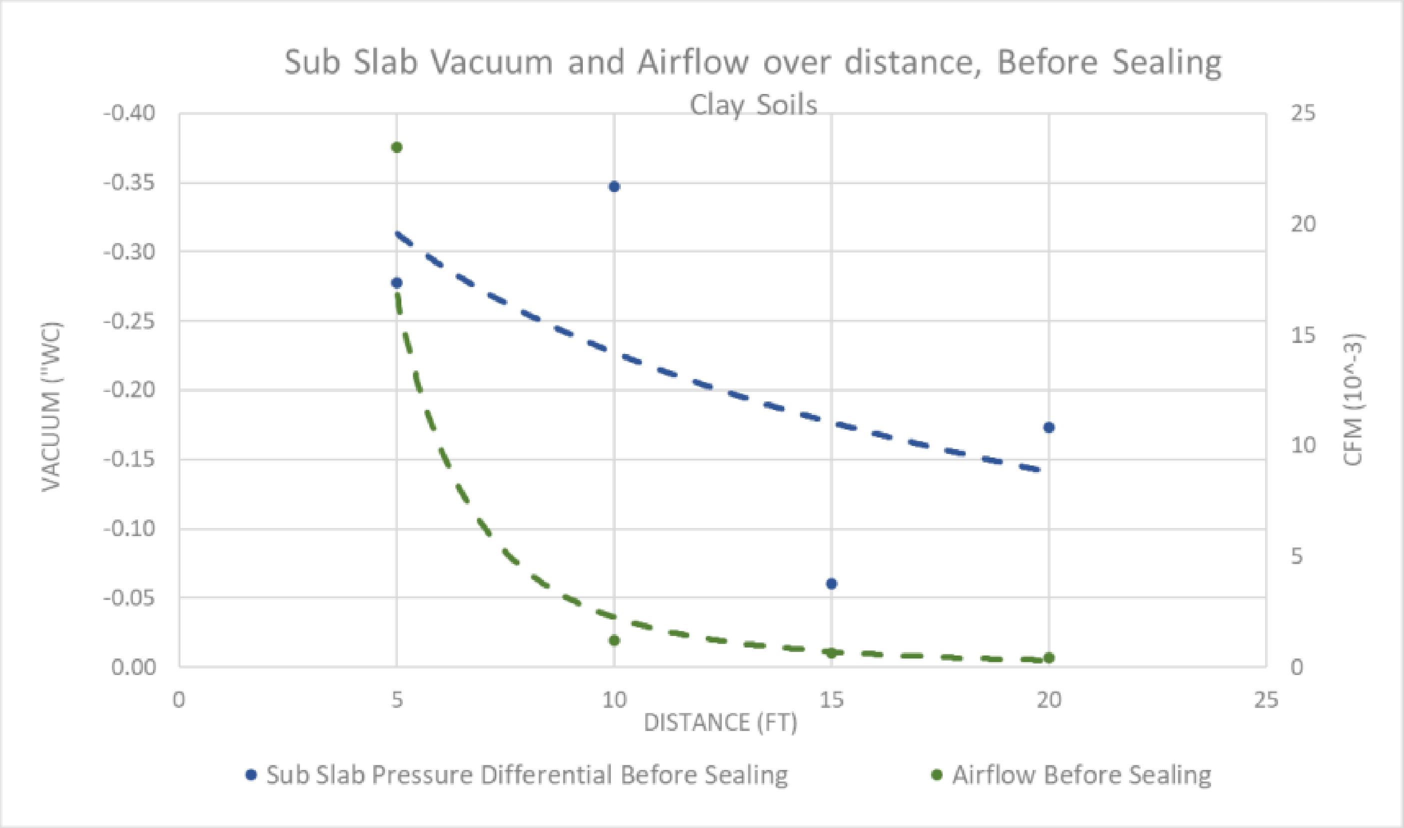
Rooftop Venting & Methane Blower

Vapor Guardian

Methane Sensor

Methane Mitigation - Lessons Learned

- Complete methane source delineation is essential
- Sub-slab vacuum field extension and airflow can be disparate and non-linear
- Source airflow is spatially variable and can only be quantified through physical measurements
- Slab integrity, conduit openings, and foundation types significantly influence the design.



Methane Mitigation - Conclusions

1. Continuous controlled sub-slab pressure and flow of methane is better control than on/off blower systems that apply overwhelming applied vacuum.
2. Sub-slab ventilation rates are a combination of slab/foundation integrity, soil K values, foundation structure and strategic placement of suction points and fresh air inlet ducts.
3. Controlled directional sub slab ventilation is essential for effective and energy-efficient methane management
4. Implementing methane source sensor-based control logic with a mechanical action-based response efficiently prevents methane from entering occupied space.
5. Source methane control, advances system efficiency, building and occupant protection and is best achieved through managed a response-driven controls.

Presentation Discussion

To discuss these findings, please contact Thomas Hatton, at thatton@cleanvapor.com

Thank you!