Safe & Successful Development at Methane-Impacted Brownfield Sites

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Brownfields Redevelopment Gold
2023 Colorado Brownfields Conference

Agenda



- Fonda Apostolopoulos, CDPHE
  - CDPHE's new Methane Intrusion Guidance
- Dave Folkes, Geosyntec Consultants
  - Overview of methane assessment and mitigation options for new development at Brownfields sites
- Scott Clark, Burns Figa & Will
  - Legal considerations at Brownfields sites impacted by methane
- Mary Hashem, RE Solutions
  - Financial considerations at Brownfields sites impacted by methane

Colorado Methane Intrusion Guidance

- Purpose of CDPHE guidance
- What it addresses
- What it doesn't address
- Key considerations

methane assessment & mitigation options

- Sources of methane at Brownfield sites
- Factors contributing to methane hazard
- CDPHE guidance hazard levels
- CDPHE guidance mitigation options

Note: this presentation provides a general overview of portions of the anticipated CDPHE methane intrusion guidance – the final guidance should be reviewed in full when published before making any assessment or mitigation decisions at sites impacted by methane. The following information is general in nature and should not be used or relied on for site-specific decisions or actions.

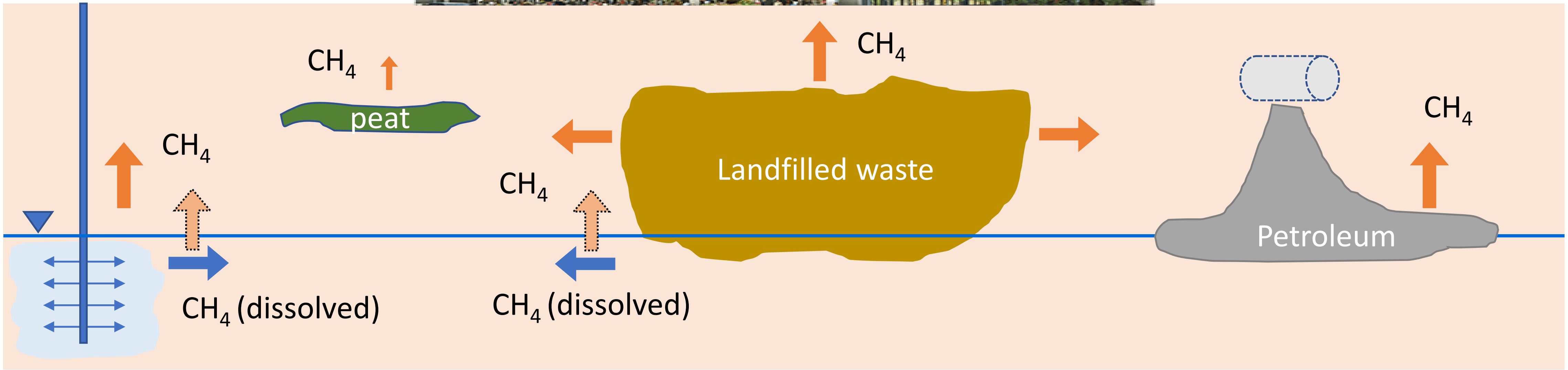
Sources of methane at Brownfield sites*



Biogenic sources of methane (CH_4)

- Due to biodegradation of organic matter

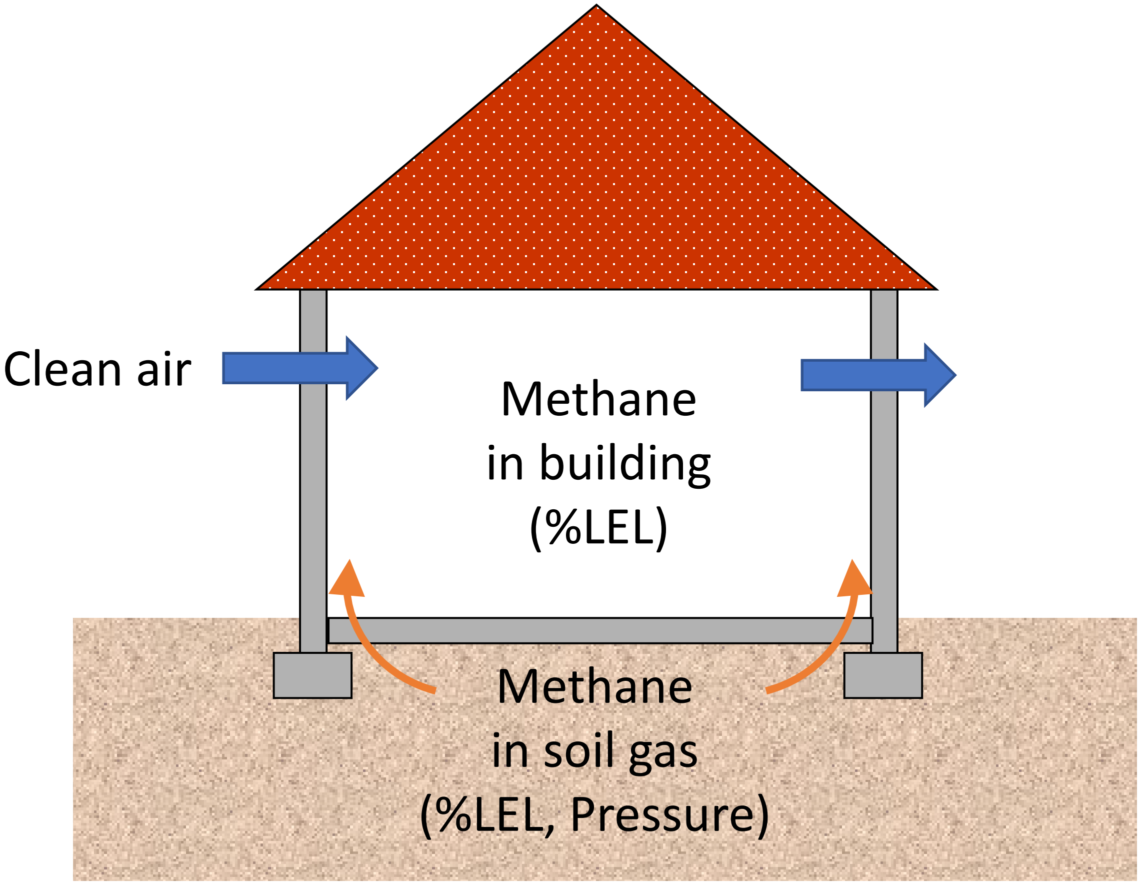
in situ remediation
electron acceptors



*May also be subject to other regulatory requirements, including OPS, Solid Waste, RCRA, local codes (e.g., Adams County)

Not addressing thermogenic methane

Methane hazard – key factors



Methane in building

- Lower explosion limit (LEL) = 5% by volume
- Upper explosion limit (UEL) = 15% by volume
- Combustion also requires oxygen and ignition
- Alarms typically set at 10% of the LEL

Methane in soil gas

- Will not explode in soil*
- Methane soil gas entering building is diluted in building air
- Risk of exceeding the LEL in buildings is typically low*
  - ≥33% dilution of soil vapors in 95% of homes**
- UNLESS soil gas pressure is elevated (> 2" water column or 500 Pascals)*

* ASTM E2993-16 ** EPA 2015 Final VI Guidance

Measurement of both methane CONCENTRATION and PRESSURE in soil gas is key for evaluating hazard potential

Methane concentration vs pressure



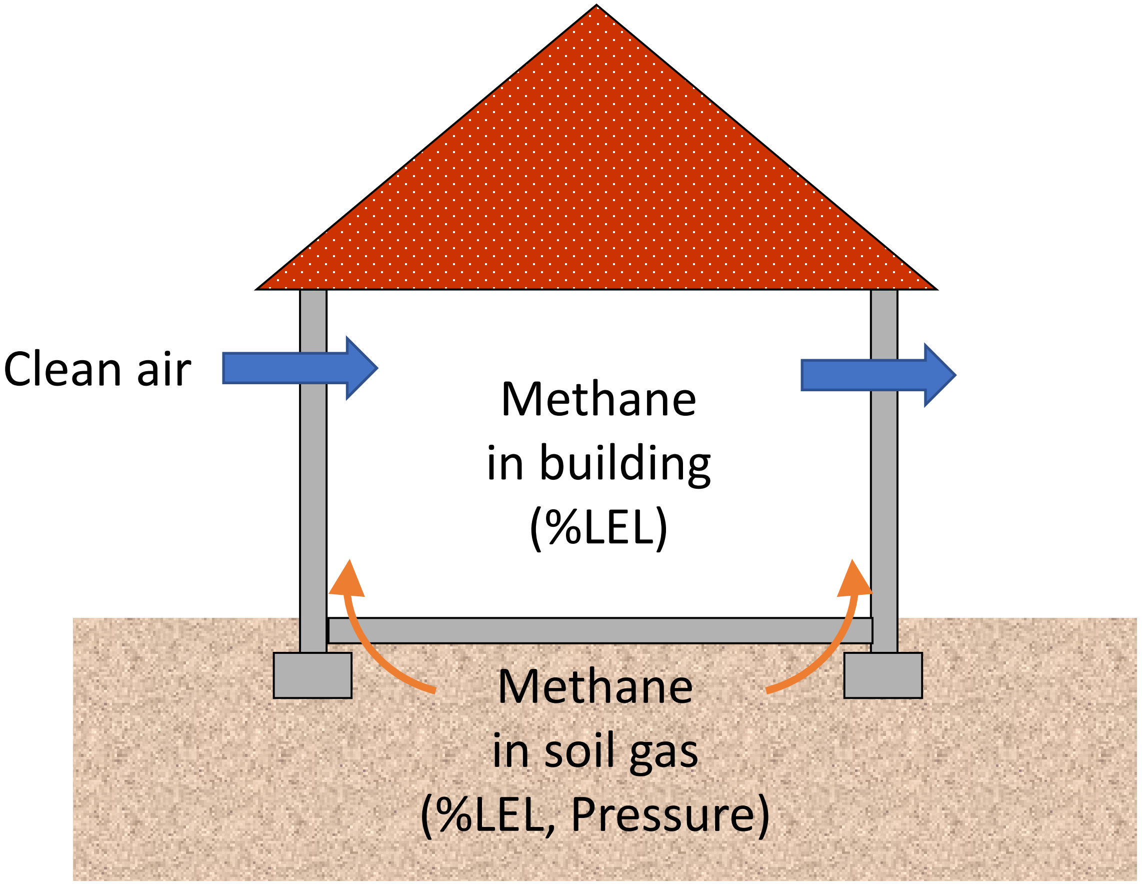


Table 1 New Construction MI Hazard Evaluation Table (draft)

Soil Gas Methane Concentration[1]			Soil Gas Differential Pressure[2]		Proposed Action[3]
% LEL	%v	ppmv	Pascals, Pa	"WC	
≤50%	≤2.5%	≤2,500	≤500	≤2.0	Screen Out
			>500	>2.0	Case specific
>50% and <100%	>2.5% and <5.0%	>2,500 and <50,000	≤500	≤2.0	
			>500	>2.0	Preemptive Passive SSD with active contingency OR may elect active MMS (either SSD or SSV)
≥100%	≥5.0%	≥50,000	≤500	≤2.0	
			>500	>2.0	Active MMS (either SSD or SSV)

[1] maximum concentration measured at site
[2] maximum pressure measured at site (correcting for barometric pressure changes)
3 SSD – Sub-Slab Depressurization SSV – Sub-Slab Venting MMS – Methane Mitigation System

Measurement of both methane CONCENTRATION and PRESSURE in soil gas is key for evaluating hazard potential

Methane assessment locations

Soil Gas Methane Concentrations and Pressures

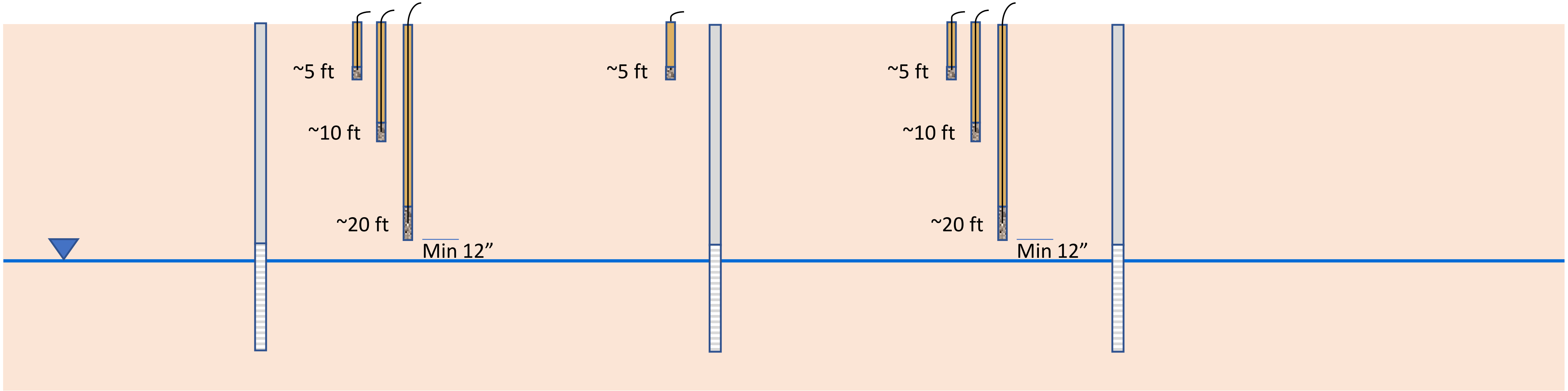
- 1 shallow soil gas measurement location per 10,000 SF of site area* (minimum 2)
- 1 deep soil gas probe set (nest) per 20,000 SF site area (minimum 2)

Groundwater Methane Concentrations

- Sufficient well locations to characterize GW flow and extent of dissolved methane
- Collect samples near water table

Landtec
GEM 5000

Courtesy of Pine Environmental



*For very large sites, this area may be calculated as building area including 100-foot offset around building

Methane Intrusion Mitigation Options



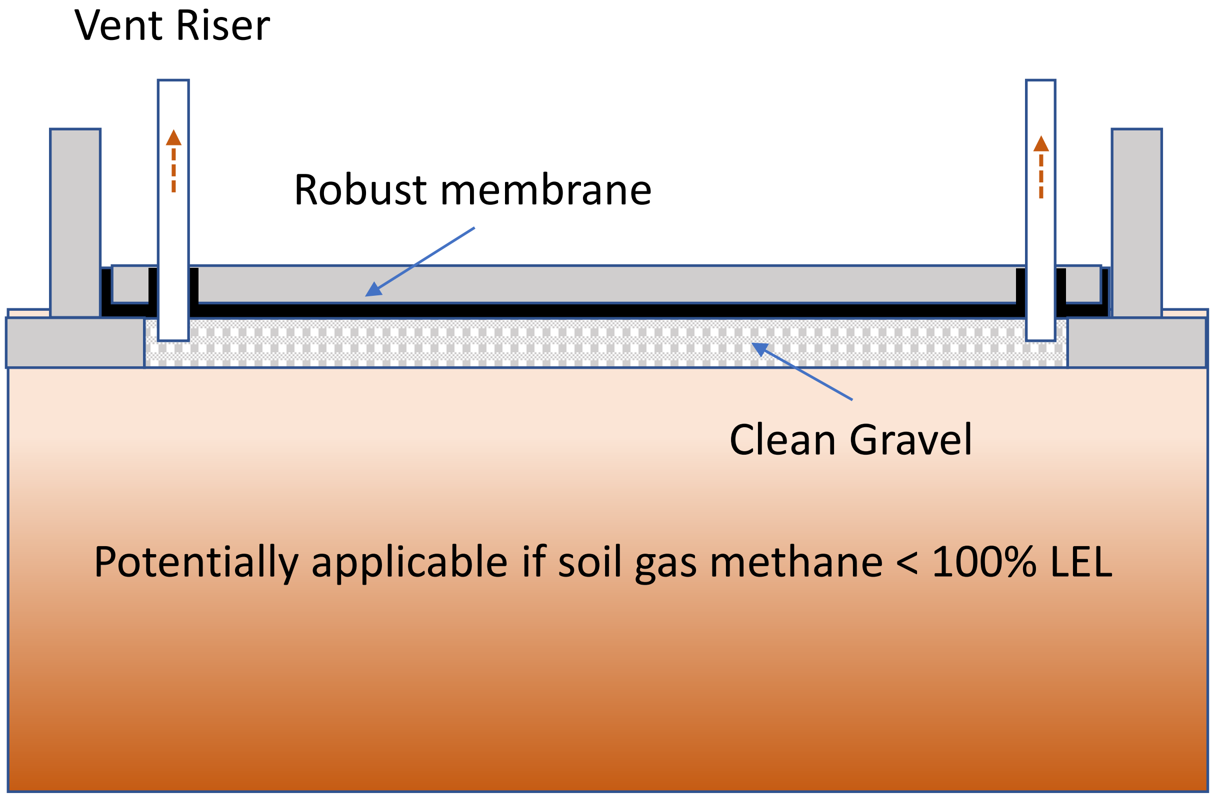
Soil Gas (max values)		Methane Mitigation System Type		
Methane Level (%LEL)	Pressure (Pa)	Passive	Active SSD or SSV*	
>400% LEL	≥500	NA	A	D
	<500	NA	B	D
>100% LEL to 400% LEL	≥500	NA	B	D
	<500	NA	C	D
>50% LEL to 100% LEL	≥500	A	B	D
	<500	B	C	D

*SSD – Sub-Slab Depressurization   SSV – Sub-Slab Ventilation

	Minimum methane barrier requirements (draft)
A	30+ mil barrier with spray-on seams and seals to foundations e.g., Geo-Seal EV40S by EPRO, Liquid Boot® by CETCO**
B	20+ mil barrier intended for methane mitigation, e.g., VaporBlock® Plus by Raven Industries, DRAGO® by Stego Industries
C	15+ mil barrier general use vapor barrier, e.g., Stego® Wrap by Stego Industries
D	Aerated floor system, e.g., Cupolex™ by Cupolex Building Systems

***examples only - the use of company, product, and tradenames does not necessarily constitute endorsement by CDPHE.*

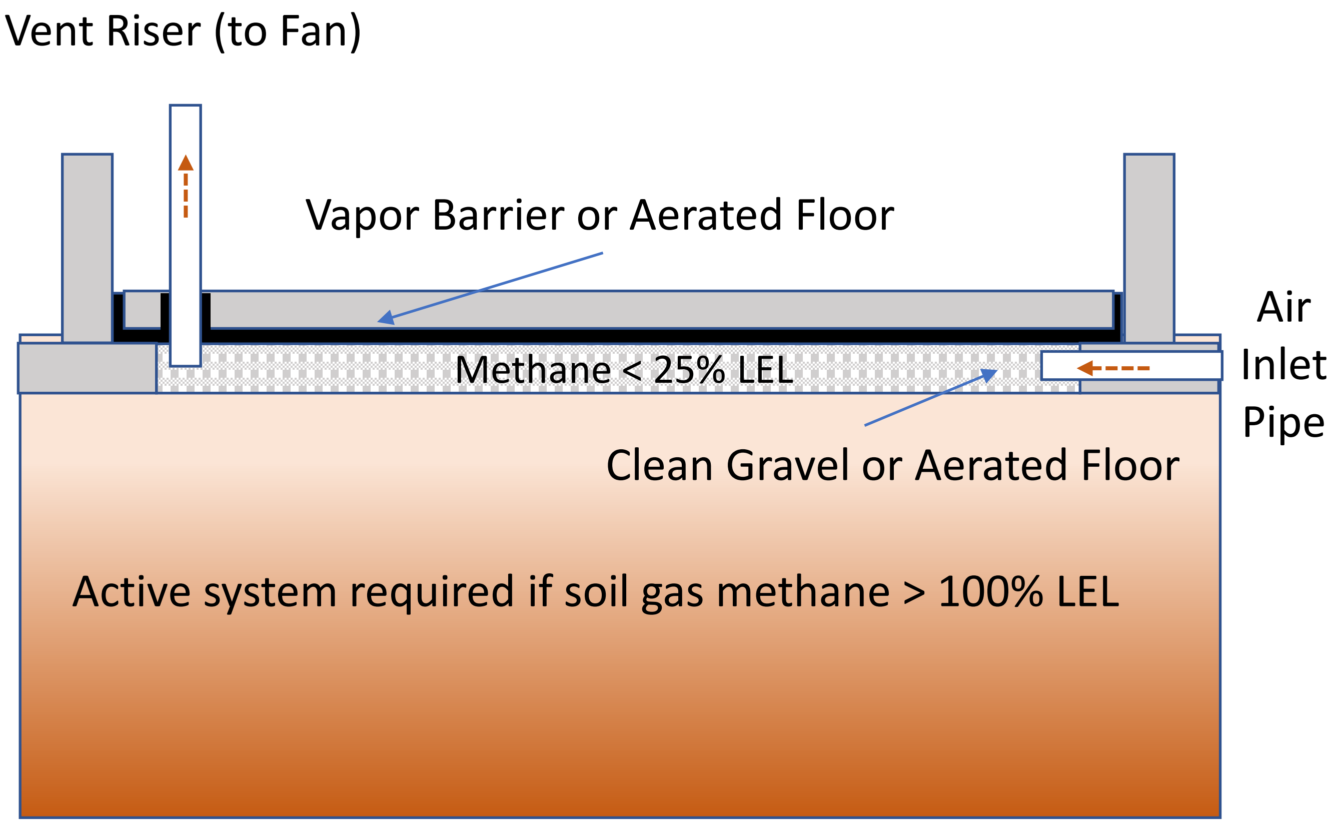
Passive Barrier & Venting System

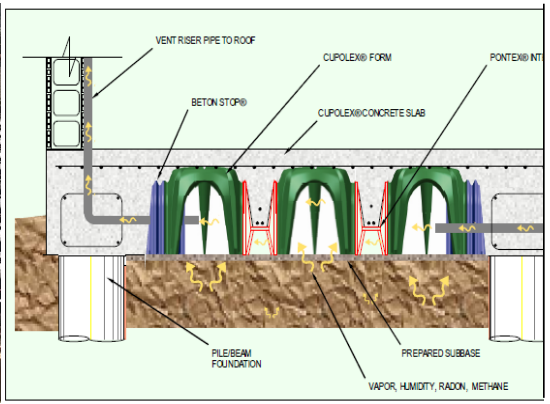


KEY POINTS

- Passive venting relies on barrier and natural venting forces (no electric fans)
- Requires highly permeable venting media
- 20+ mil sheet barriers ($\Delta P \leq 500$ Pa)
- 30+ mil spray-on barriers ($\Delta P > 500$ Pa)
- Must include active venting contingency

Active Sub-Slab Venting (SSV)





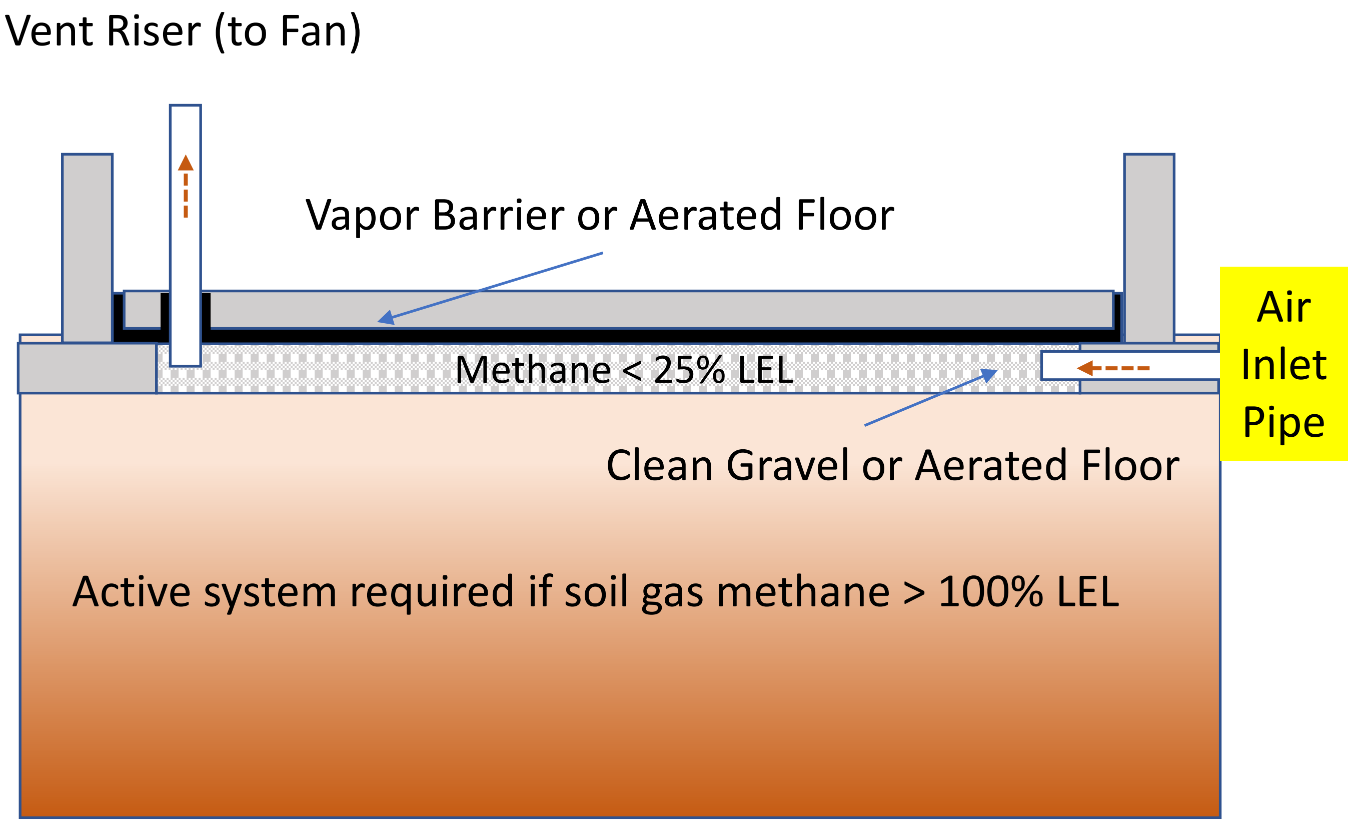
Courtesy of Geosyntec and Cupolex Building Systems

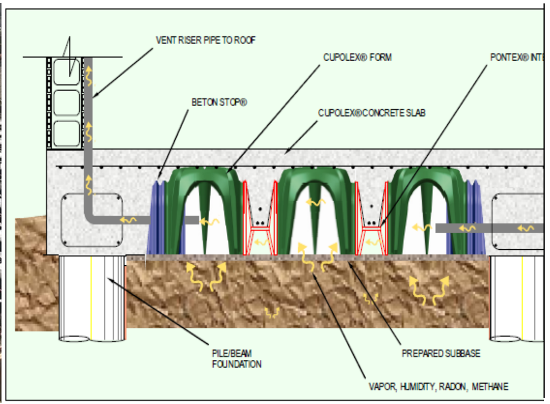
KEY POINTS

- Active venting relies on dilution of methane in sub-slab venting system to <25% LEL
- Requires electric fan with sufficient air flow
- Air inlets typically required
- Vapor barrier requirements depend on soil gas methane concentration and pressure
- Aerated floors suitable for all conditions

Active Sub-Slab Venting (SSV)







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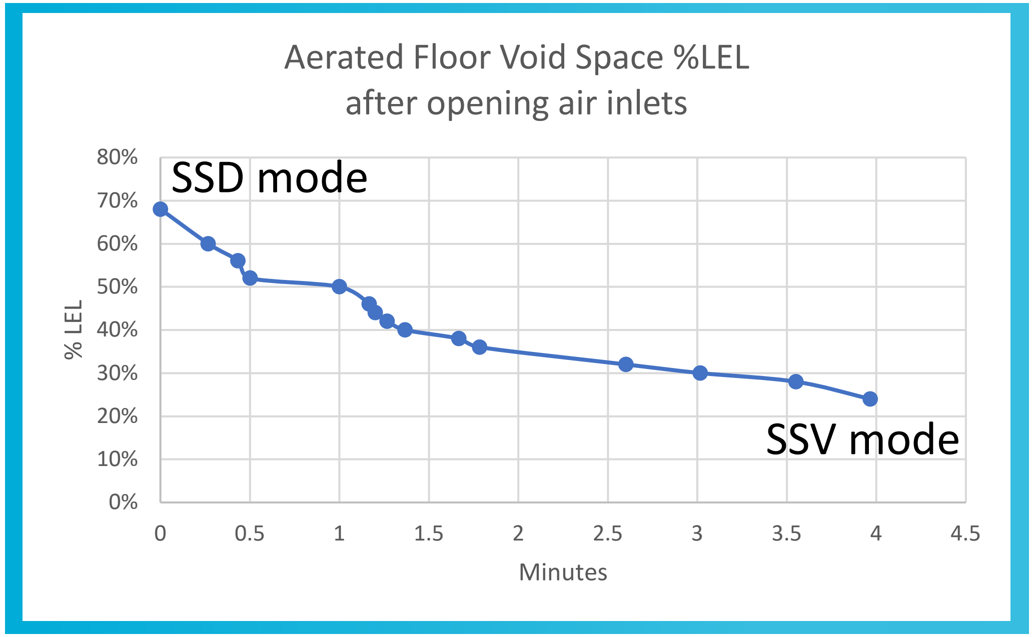
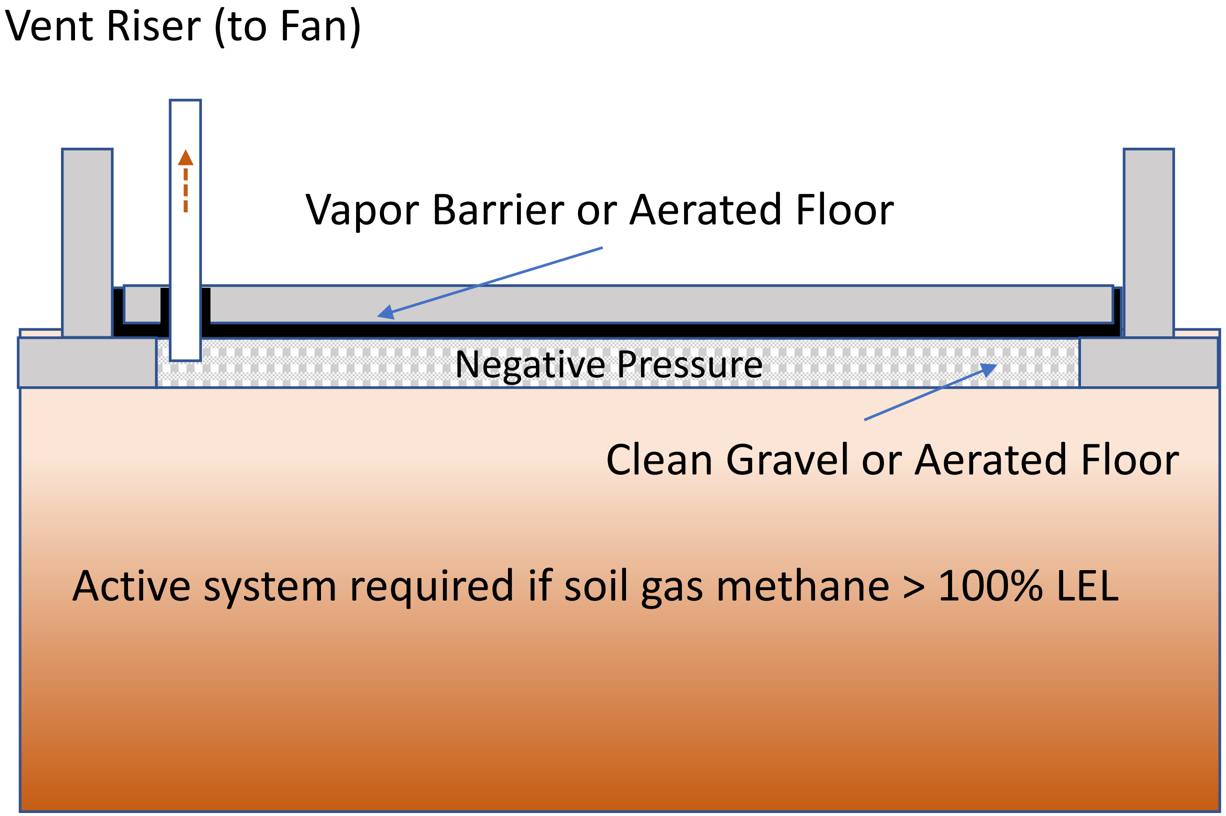


Active Sub-Slab Depressurization (SSD)



KEY POINTS

- SSD relies on negative sub-slab pressures to prevent intrusion of methane
- Requires electric fan with sufficient vacuum
- Vapor barrier requirements depend on soil gas methane concentration and pressure
- Vapor barrier increases system efficiency (negative pressures)



Legal Considerations

- Liabilities
  - CERCLA/RCRA
  - Toxic Torts
- Scare Factor
  - Explosion
  - Asphyxiation
- Managing
  - Avoidance
  - Source Removal
  - Mitigation

Financial Considerations

Underwriting / Due Diligence

- Quantification of Risk
- Outside investors / lenders

Financial Risk Management

- Insurance
- Reserves
- Additional Mitigation / Remediation
- Trade-offs