Preferential Pathways: Responding to Changes in the Vapor Intrusion CSM

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No Identified Significant Preferential Pathways

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Significant Preferential Pathway Identified

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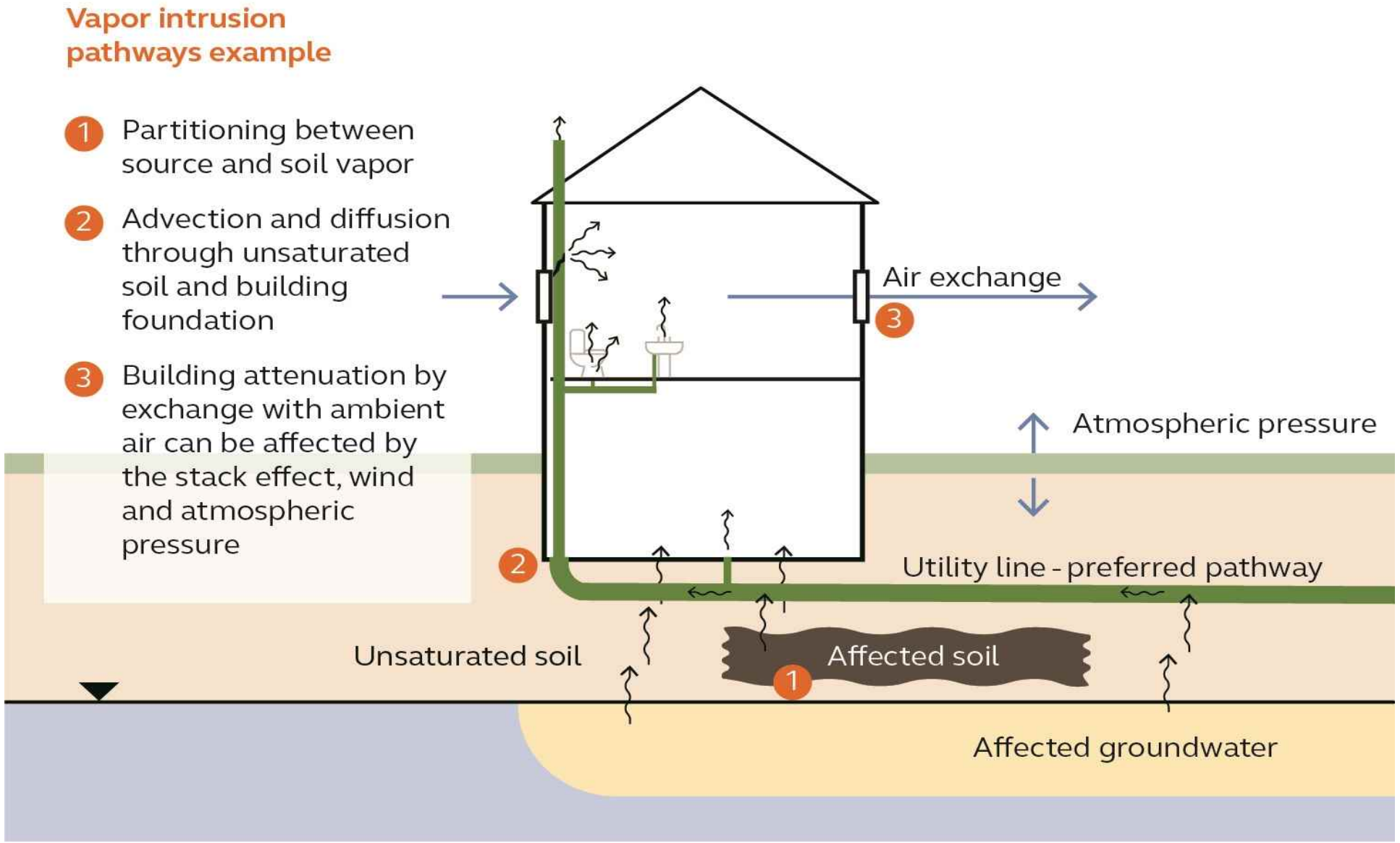
Standard Conceptual Site Model of the Vapor Intrusion Pathway



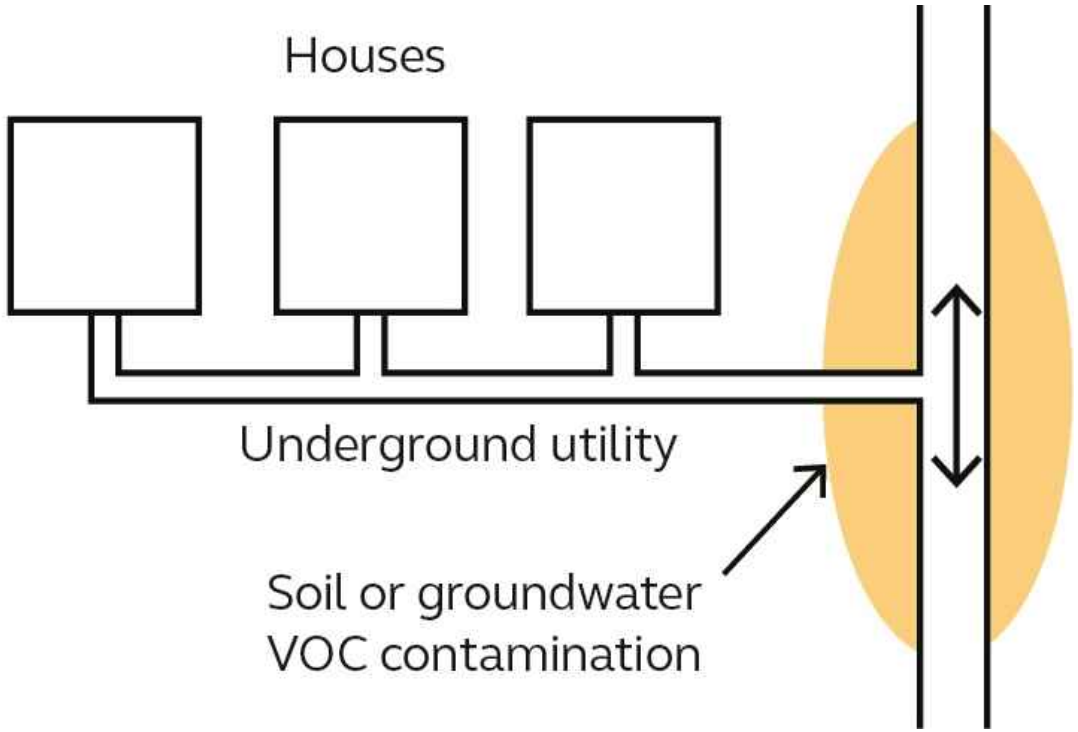
Preferential Pathways

The Changing Vapor Intrusion Conceptual Site Model

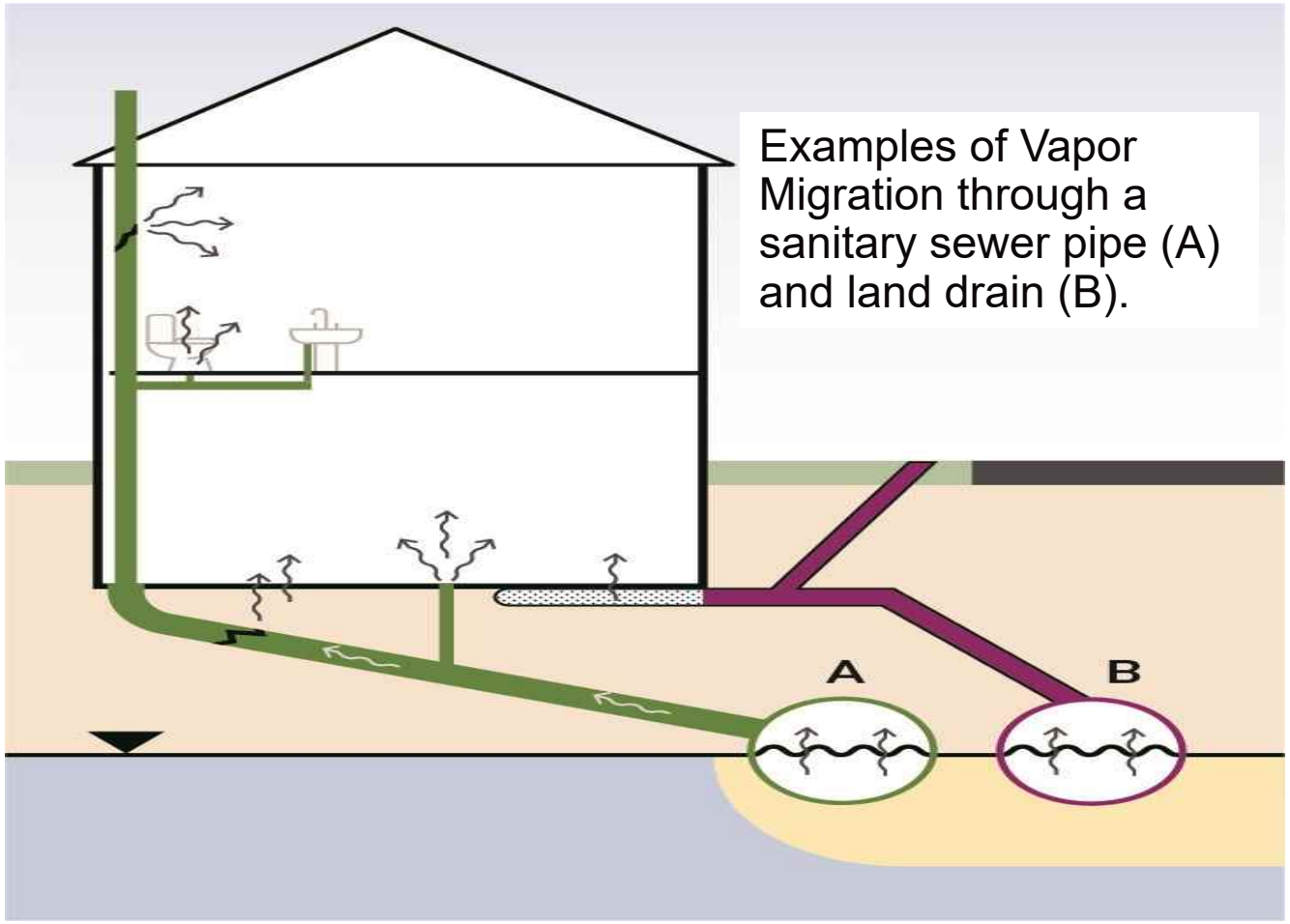
Potential Preferential Pathways

ARCADIS

Significant Preferential Pathway???



"Pipe" Pathway



Examples of Vapor Migration through a sanitary sewer pipe (A) and land drain (B).

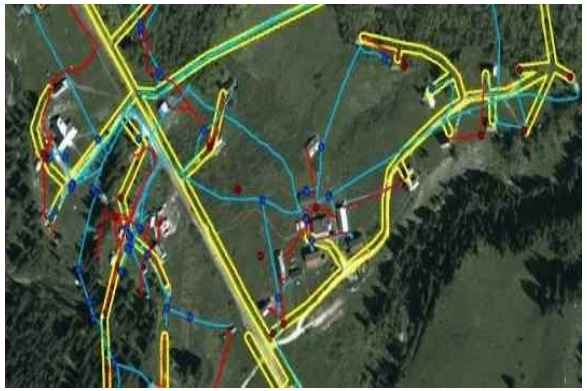
Investigative Tools

The Changing Vapor Intrusion Conceptual Site Model

Planning Tools

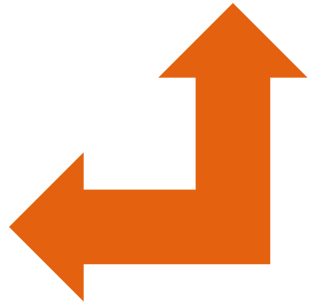
- Conducting an initial desktop review should ALWAYS be your first step when planning an investigation.
- When considering preferential pathways, a few extra steps may be included in this initial investigative phase.

Utility Mapping



Building Survey

Investigative Tools

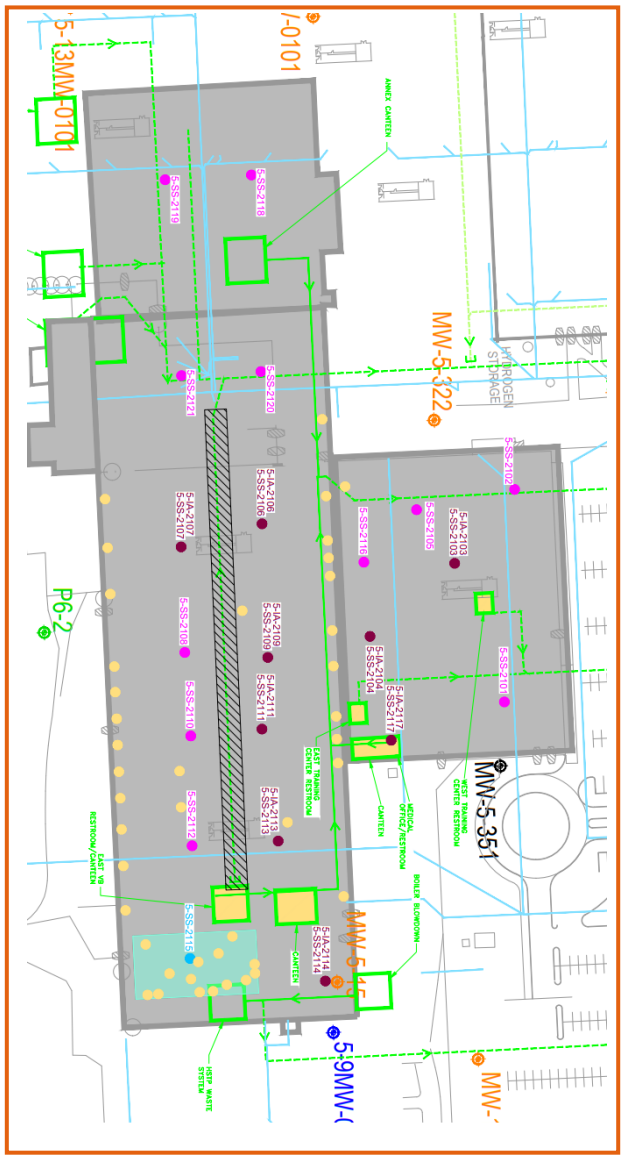


Case Study 1

No identified significant preferential pathways

Case Study 1 – Background

- Large Operating Manufacturing Facility in Indiana
- Located in a mixed commercial, industrial, and residential area
- Historical releases of Chlorinated Volatile Organic Compounds (CVOCs) to soil and groundwater
- No known releases through the sanitary sewer.
- Depth to groundwater approximately 20 – 25 feet bgs
- Groundwater flows to the southeast and concentrations of PCE and TCE have migrated from the Site property at concentrations above the Maximum Contaminant Levels (MCLs).
- PCE and TCE are only Site compounds present in the groundwater at concentrations above the Vapor Intrusion Ground Water Screening Levels (VIGWSLs).
- Sub-slab sampling in the facility buildings determined that vapors exist underneath the two facility buildings at concentrations exceeding the applicable screening levels.
- USEPA requested paired indoor air and sub-slab sampling and a preferential pathway evaluation.



Case Study 1 – Desk Top Review of Potential Preferential Pathways

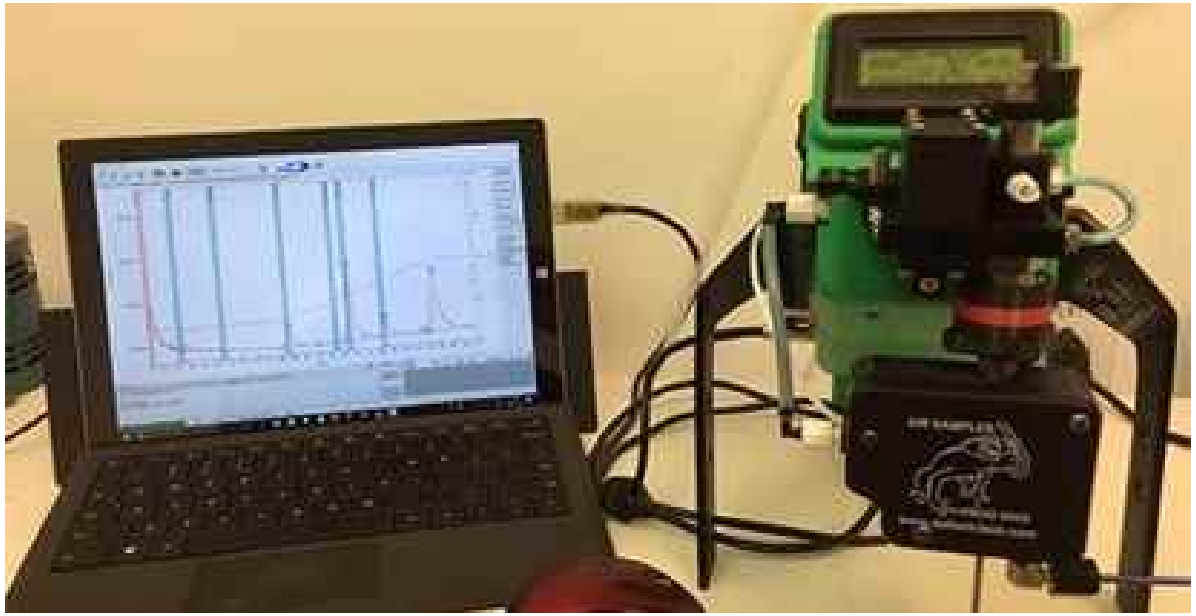
Desk Top Evaluation Findings:

- Sanitary and storm sewers are not submerged or in contact with contaminated groundwater.
- No known releases through the sanitary sewer.
- All storm water at the Site discharges to a lined detention basin on the north-eastern part of the Site; therefore, the storm sewer was ruled out as a potential off-site preferential pathway.
- The site sanitary sewer lines discharge to the public sanitary sewer system north of the property.
- Neither storm nor sanitary sewer lines are present in the off-site areas where TCE and PCE groundwater concentrations above the VIGWSLs are present.
  - Sanitary sewer service does not extend to the area south of the Site.
  - Wastewater in the area south of the Site is diverted to septic systems and the septic systems are not in contact with the groundwater.
- Based on the desktop evaluation, no significant potential preferential pathways were identified on-site or off-site.
- EPA requested further on-Site preferential pathway evaluation based on the on-site sanitary and storm sewer conduits being located above groundwater concentrations that exceeded the VIGWSLs and elevated sub-slab concentrations underneath the facility buildings.

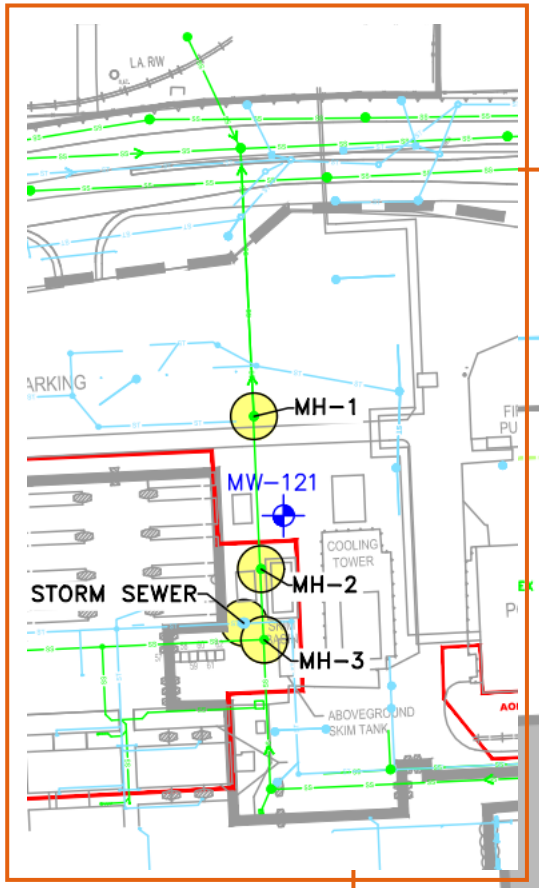
Case Study 1 - Planning

Investigation Response

- On-Site Preferential Pathway Evaluation using FROG-5000.
  - Storm and below grade sanitary sewer clean-outs.
  - Onsite monitoring of floor and sink drains, plumbing seals, and indoor air in small enclosed spaces. Evaluate foundation cracks.
  - Sanitary line that discharges to public sewer main. To identify potential issues offsite.
- Add sub-slab monitoring points and repeat sampling with indoor air paired locations.



Case Study 1 – FROG Sample Locations



Case Study 1

Mitigation

- Install a Green Drain seal in the identified floor drain with elevated detections.
- Hire a certified plumber to conduct an evaluation of all plumbing fixtures.
- Repair damaged floor drains, toilet seals, and sink drains.

Confirmation Sampling

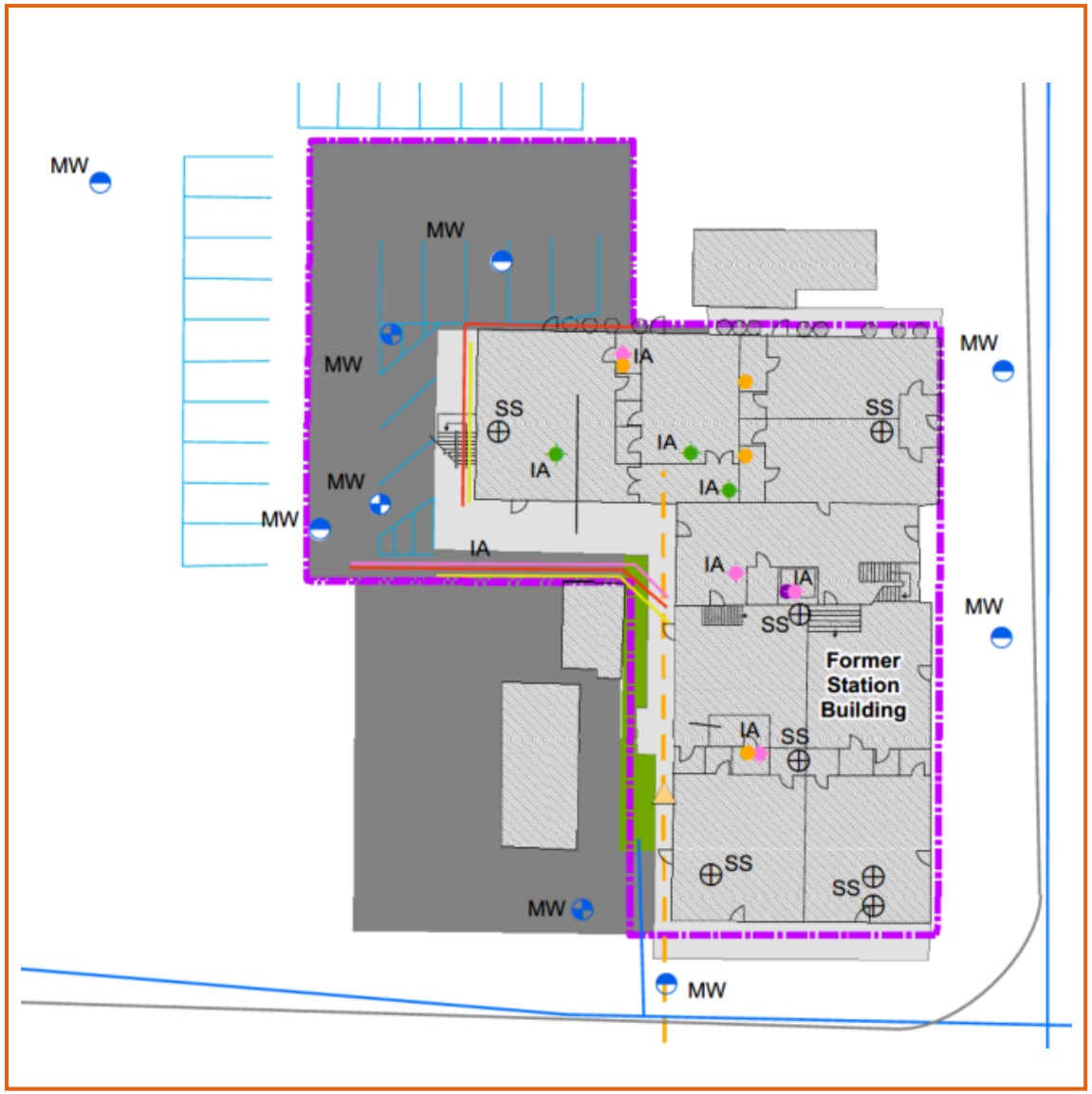
- Conduct paired indoor air and sub-slab vapor sampling in two facility buildings.
- Add and indoor air sample to the restroom where floor drain was mitigated.
- Sample during both winter and summer worst-case conditions.

Case Study 2

Significant Preferential Pathway Identified

Case Study 3 - Background

- One mixed commercial and residential building with slab-on-grade foundation constructed on former petroleum filling station site in Indiana
- Historical releases of petroleum constituents to soil and groundwater
- Occasional petroleum odor complaints on the first floor during heavy rain events No known releases through the sanitary sewer
- Paired indoor air and sub-slab sampling in the building indicate petroleum concentrations less than applicable screening levels
- Depth to groundwater approximately 2 – 11 feet bgs
- Sump in elevator shaft ~ 5 feet bgs
- Sump ventilation system was installed to address petroleum odors
- Sub-slab depressurization system (SSDS) was planned to mitigate petroleum odors



Case Study 3

Conceptual Site Model and Desktop Review

- Historically impacted groundwater and impacted soil beneath the building contributing to impacted soil gas accumulation beneath building
- Impacted soil gas trapped beneath the building is pushed into the building during heavy rains as groundwater level rises causing odors in the building

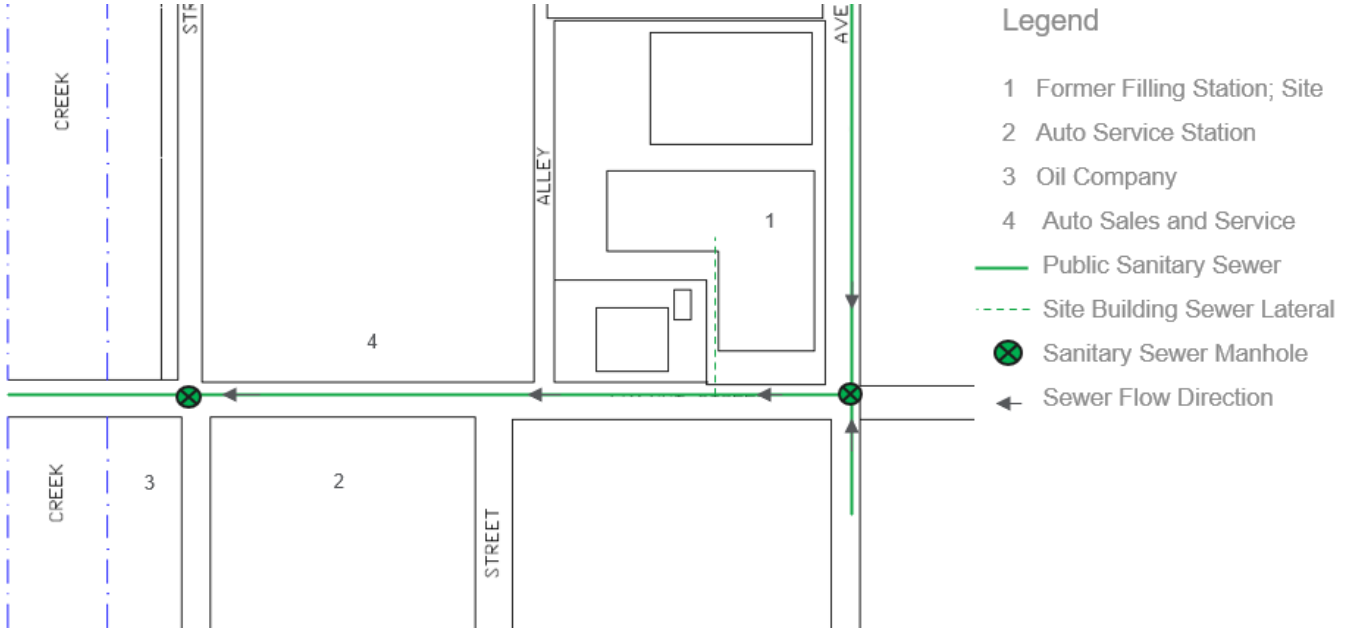
Problems with CSM

- Six sub-slab sampling events do not indicate petroleum constituents in soil vapor beneath the building
- Groundwater concentrations less than applicable screening levels
- Petroleum odors only detected during heavy rain
  - Assumes groundwater immediately raises during rain events
  - Site and surrounding areas are mostly covered by buildings, concrete, or asphalt. Surface water infiltration generally takes time to raise the groundwater level
  - Building roof drains discharge to the street and not onto the surface or into the subsurface

Case Study 3

Desk Top Review and Revised CSM

- Chloroform and methane detected in the indoor air samples could indicate sewer gas is entering the building
- The building sanitary sewer lateral discharges to the south and flow is to the west
- There are three historic businesses connected to the sanitary sewer line with potential contributions to petroleum odors in the sewer system – automotive service station, automotive sales, and oil company.
- Petroleum odors may originate from the sanitary sewer



Information Gathering

- Inspect sanitary sewer vents and floor drains
- Inspect sump pit and sump ventilation system
- Collect 8-hour indoor air samples via USEPA Method TO-15 after significant rain
- Collect grab sump ventilation air sample via USEPA Method TO-15
- Contacted local city sewer department to determine age, size, and flow direction of sanitary sewer
- Obtain permission to sample inside the public sanitary sewer via passive samplers

Case Study 3

PVOCs were detected in the sanitary sewer with passive samplers

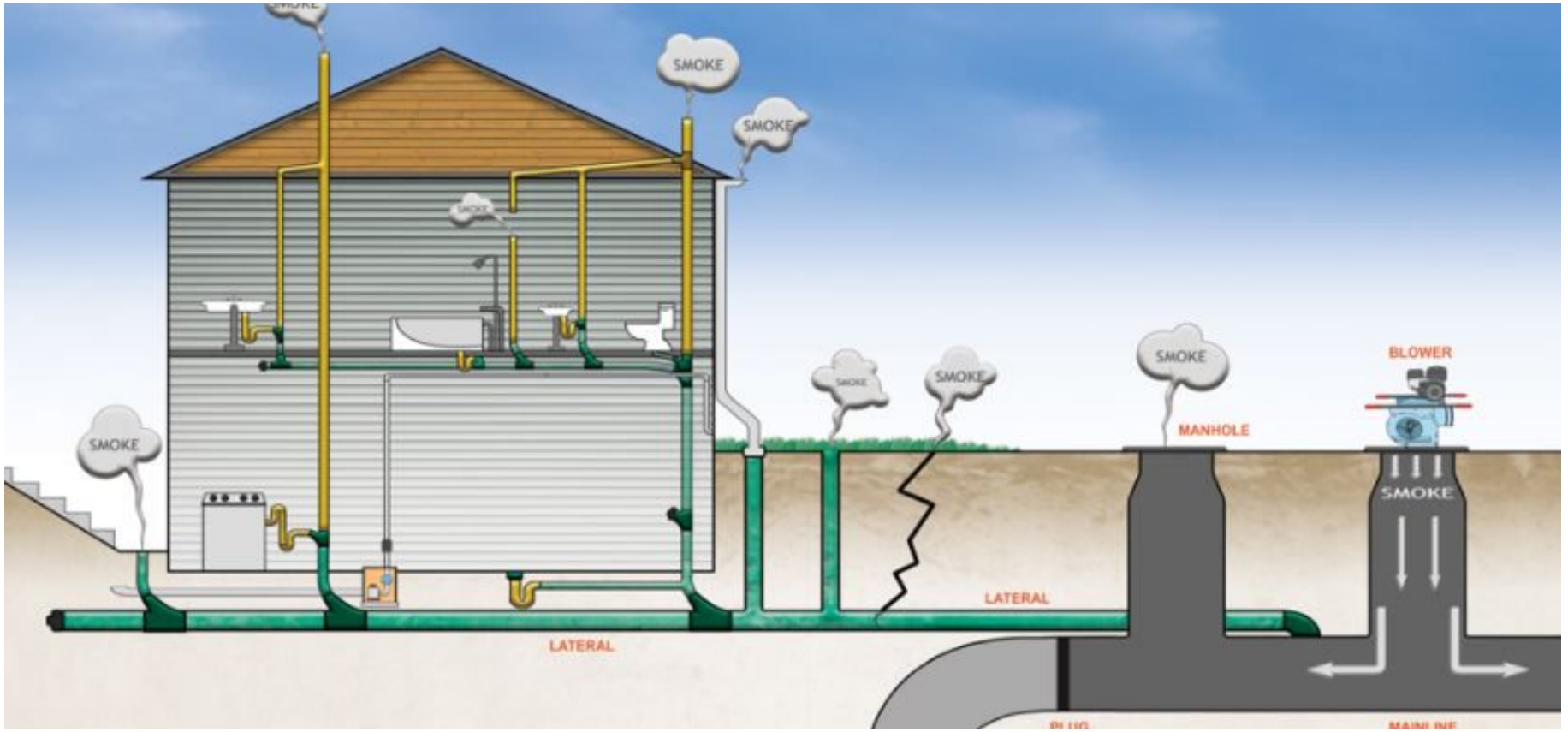
Sewer Gas	
Date	2019
Benzene	2.2
Ethylbenzene	1.6
m,p-Xylene	2.8
o-Xylene	0.88
Toluene	10
Chloroform	NA
Methane	NA

SG-2

MW
IA
SS
Former Station Building
SG-1

Sewer Gas	
Date	2019
Benzene	**4.4**
Ethylbenzene	1.4
m,p-Xylene	1.6
o-Xylene	0.40
Toluene	0.91
Chloroform	NA
Methane	NA

Case Study 3 - Smoke Test of the Plumbing System



- Local plumbing company assisted with evaluation of the plumbing venting system, floor drains, and p-traps by completing a smoke test.
- Smoke test revealed multiple issues with smoke emanating from several floor drains and an improperly connected plumbing vent.

Case Study 3 - Mitigation

- Several of the floor drain p-traps were dry potentially due to a siphoning effect
- Local plumbing company installed floor drain trap seals in all floor drains and repaired the plumbing vent
  - A floor drain trap seal has a one-way flap that allows water to enter the drain but prevents sewer gas from entering the building if the p-trap is dry
- The building's sewer lateral was uncovered and cut to allow for an inline camera to inspect the lateral for damage
- Backflow preventer was installed in the building's sewer lateral. The backflow preventer is a simple one-way spring flap that is closed until sewage from the building pushes open the flap and then returns to the closed position.
- The stand-pipe allows for inspection and maintenance of the backflow preventor

VI Preferential Pathways have changed the standard Conceptual Site Model

There are several tools to investigate preferential pathways

A desktop review is a necessary first step prior to ANY vapor intrusion investigation

Investigations of significant preferential pathways can require multiple stages of planning and information gathering

Don’t be afraid to think outside the box

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