SMART Remediation

Vapor Intrusion Through Sewers: Investigation and Mitigation

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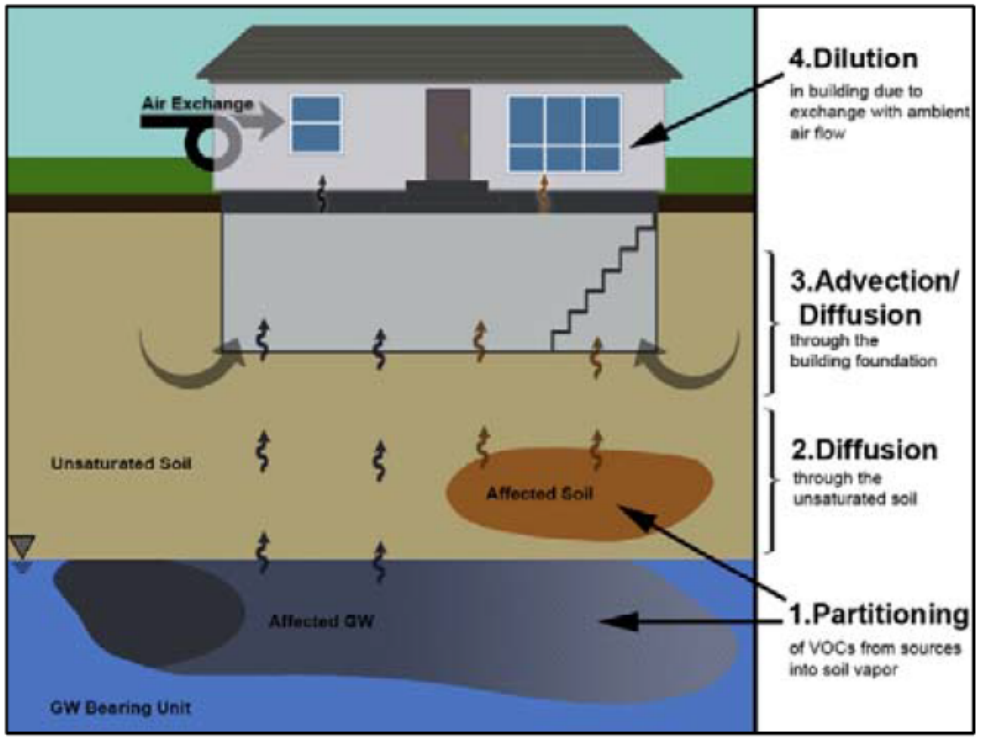
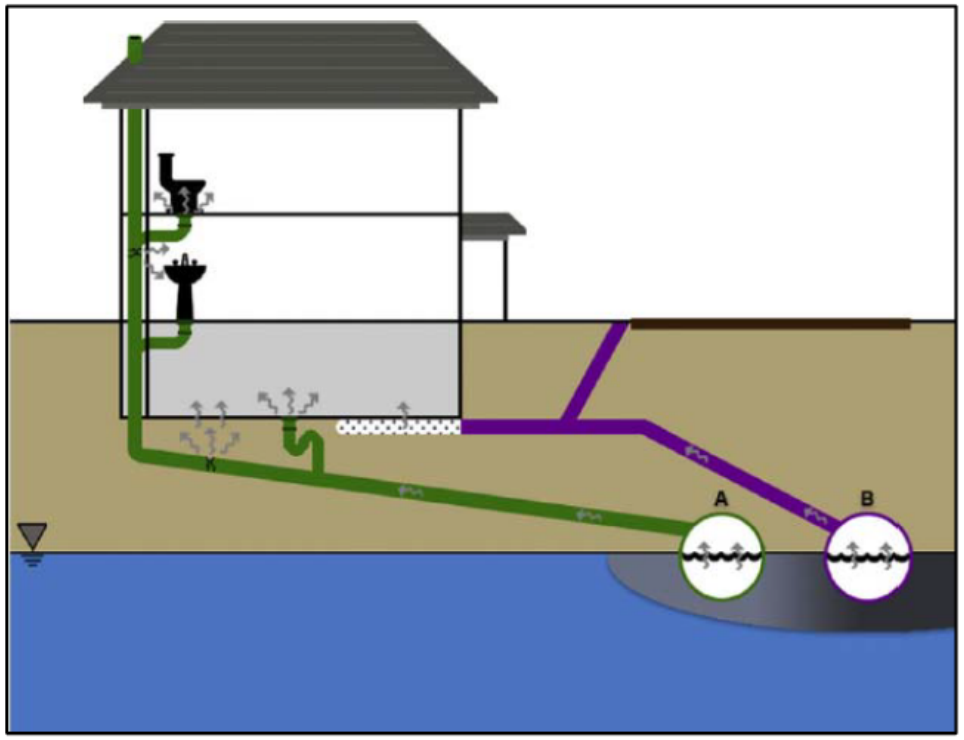
OVERVIEW – VI CONCEPTUAL SITE MODEL

CONVENTIONAL (STANDARD) VI

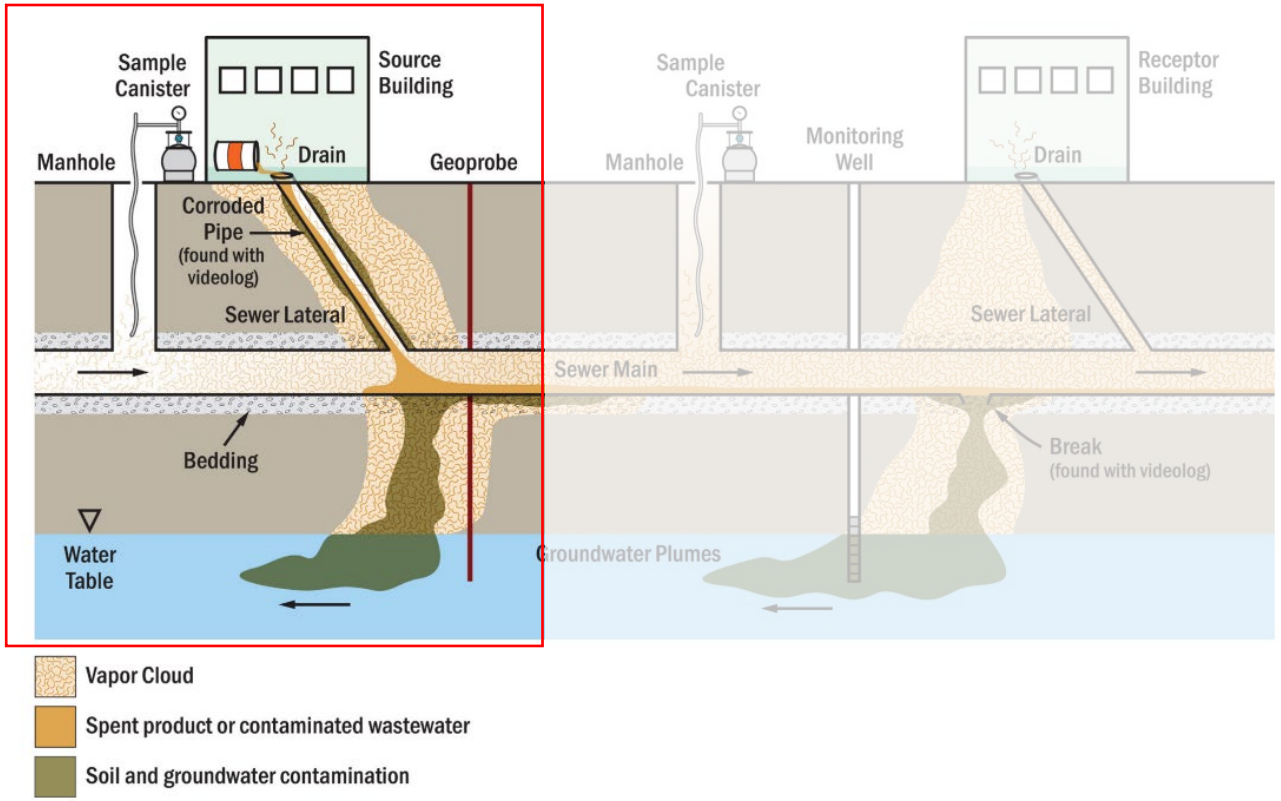


SEWER/UTILITY TUNNEL VI



Note: Figures from McHugh et al. (2017)

OVERVIEW – PREFERENTIAL PATHWAY OF SEWERS

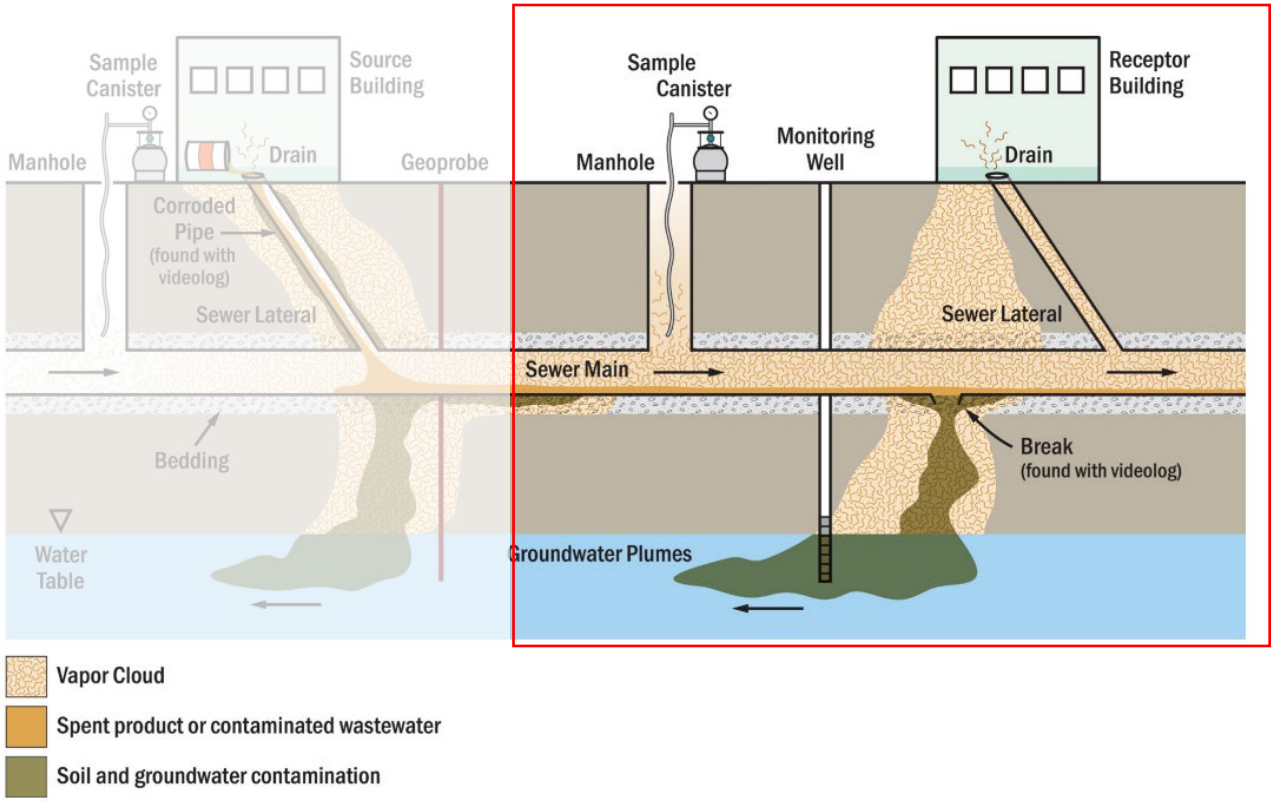


Source: Guidance for Documenting the Investigation of Human-made Preferential Pathway Including Utility Corridors, Wisconsin DNR, 2021. Publication RR-649

Contaminant Migration into Sewer Systems:

- Waste discharge into drains and sewer laterals
- Vapour migration into utility corridors
- Groundwater intrusion of sewers below the water table

OVERVIEW – PREFERENTIAL PATHWAY OF SEWERS



Source: Guidance for Documenting the Investigation of Human-made Preferential Pathway Including Utility Corridors, Wisconsin DNR, 2021. Publication RR-649

Preferential Pathway for Vapour Intrusion:

- Sewer laterals and drains (p-traps not functioning)
- Migration through utility corridors to below slab

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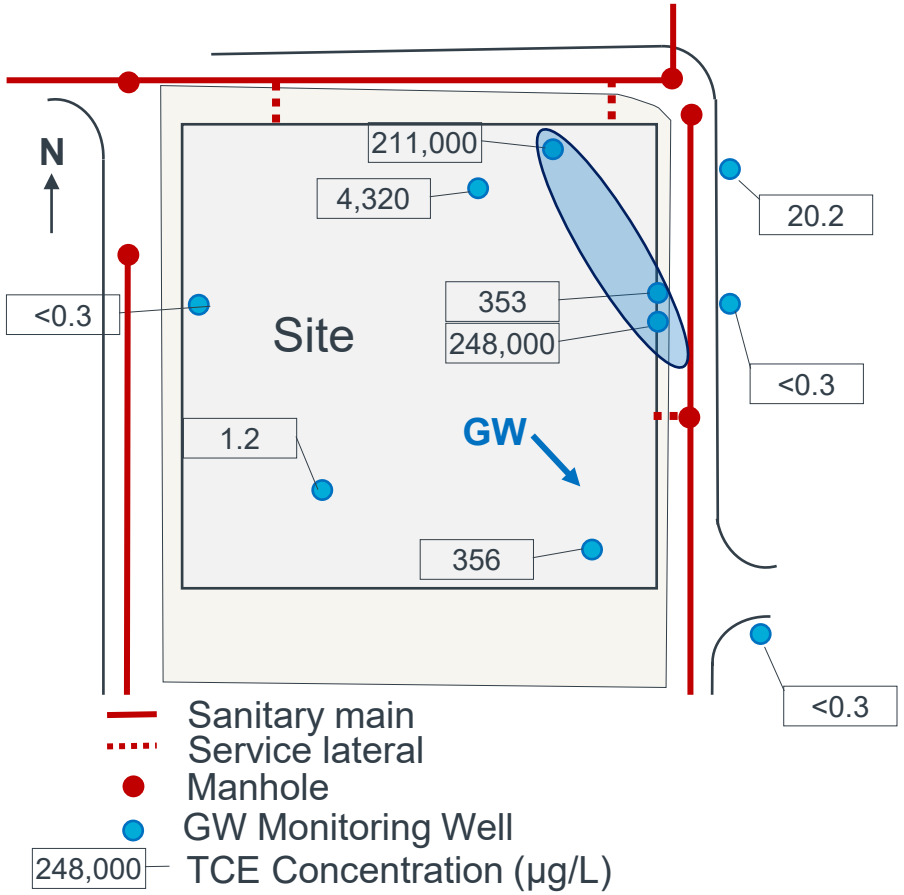
CASE STUDY

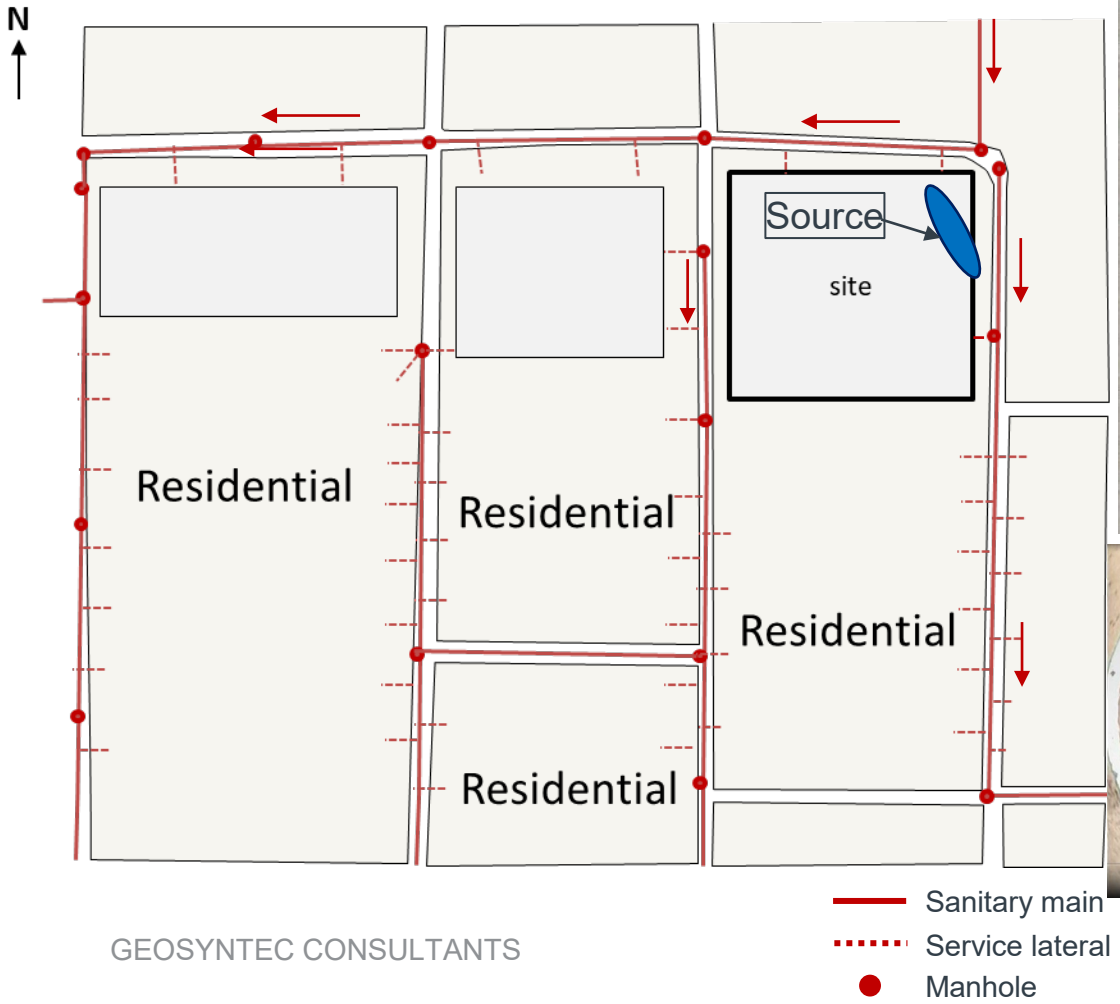
Sewer Gas Preferential Pathway Investigation and Mitigation

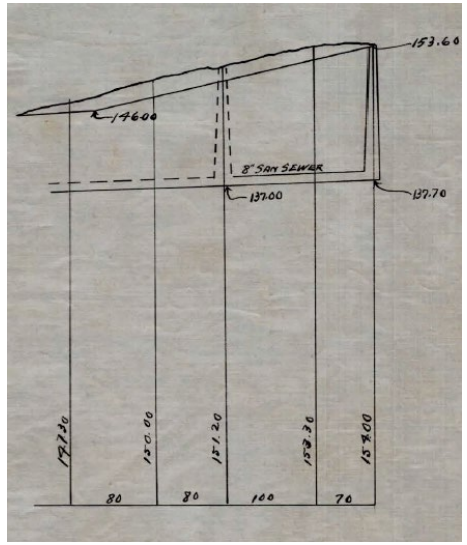
SITE DETAILS



- TCE in groundwater up to 248,000 µg/L
- Groundwater flow direction to southeast
- Existing sub-slab depressurization system
- Sanitary sewer mains to north, east, and west
  - Multiple service laterals from site building
- Surrounding property use
  - Industrial/commercial (north)
  - Residential (south, east, and west)

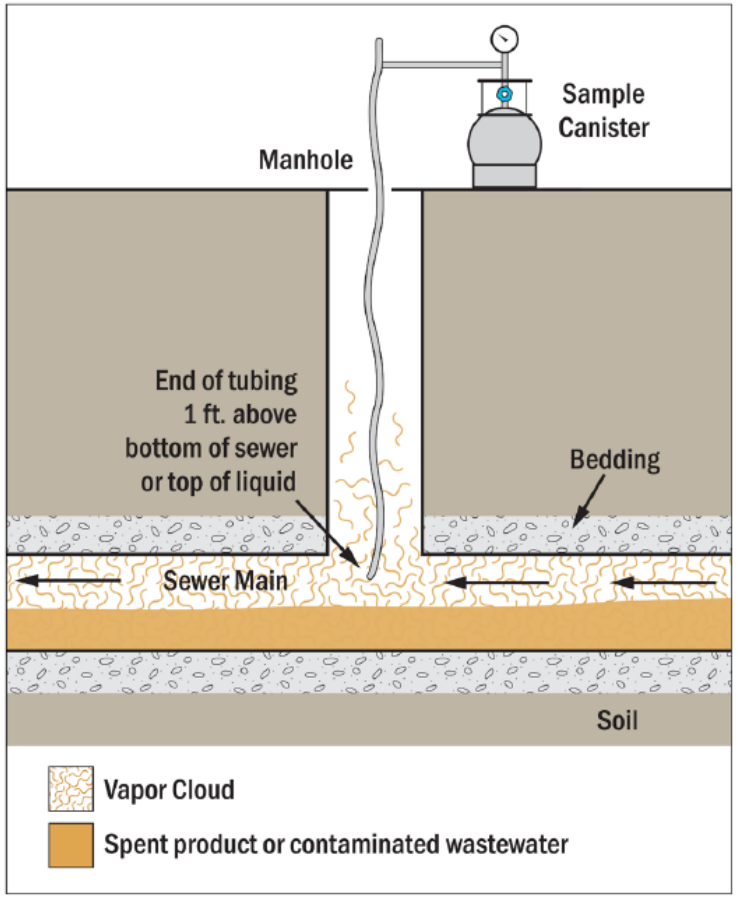
SANITARY SEWER DUE DILIGENCE





- Surveyed sewer manholes
  - Sanitary sewers located below the water table
- Reviewed sewer construction and flow directions
  - Eastern sewer vitrified clay pipe installed in 1911
  - Northern and western sewers are PVC pipes installed in 2019 and 2021
- Reviewed sewer condition
  - Publicly available video inspection footage

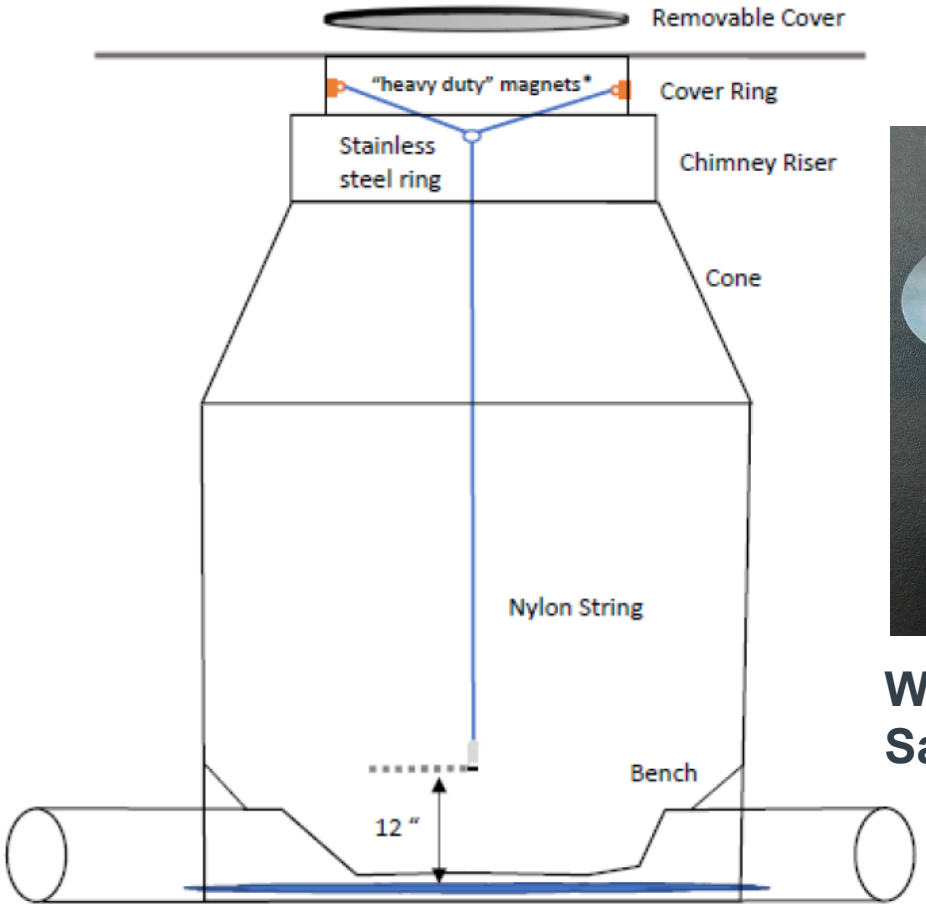
ACTIVE SEWER VAPOR SAMPLING

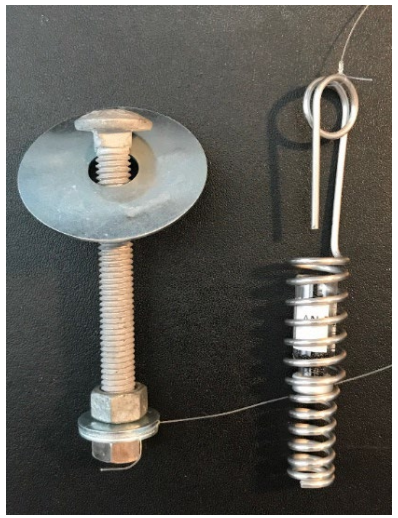


Summa canister

- Short-term grab sample
- Access limitations due to traffic during sample deployment
- Potential temporal variability due to short duration sample
- Availability of canisters can restrict scheduling of sampling programs

PASSIVE SEWER VAPOR SAMPLING



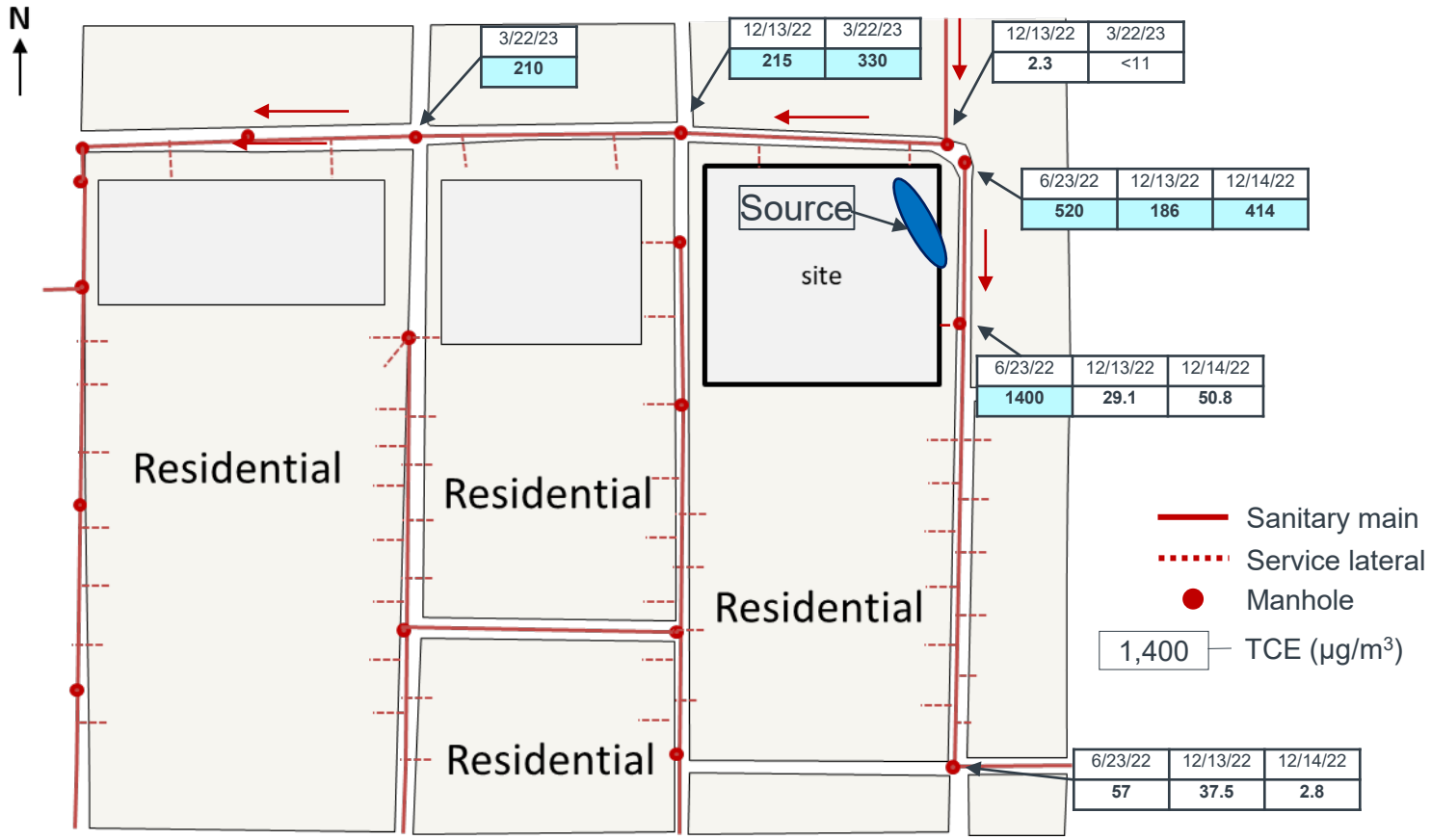


Waterloo Membrane Sampler (WMS)

Passive Sampler

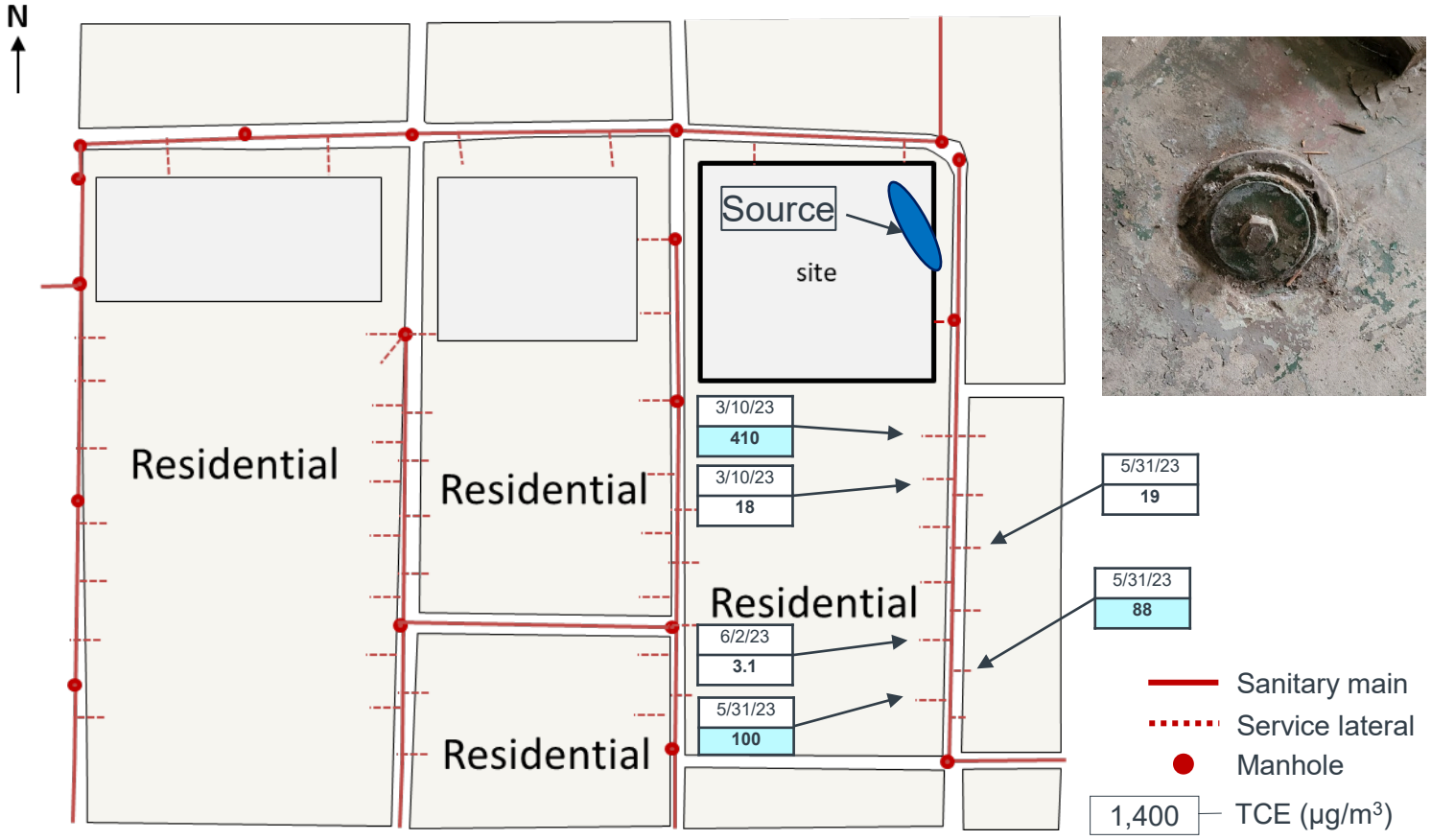
- Reliable quantitative data and low reporting limits
- Smaller, easier to transport and deploy
- Longer deployment time (weeks) provides average vapor concentrations which may address concerns of temporal variability
- Requires a return visit
- Consider sampler applicability based on site constituents of concern

SANITARY MANHOLE RESULTS



- Manholes sampled from east and north sanitary mains
- Exceedances of sanitary sewer gas screening level (70 µg/m^3)
- Data indicate sanitary mains acting as preferential pathway

RESIDENTIAL CLEANOUT RESULTS

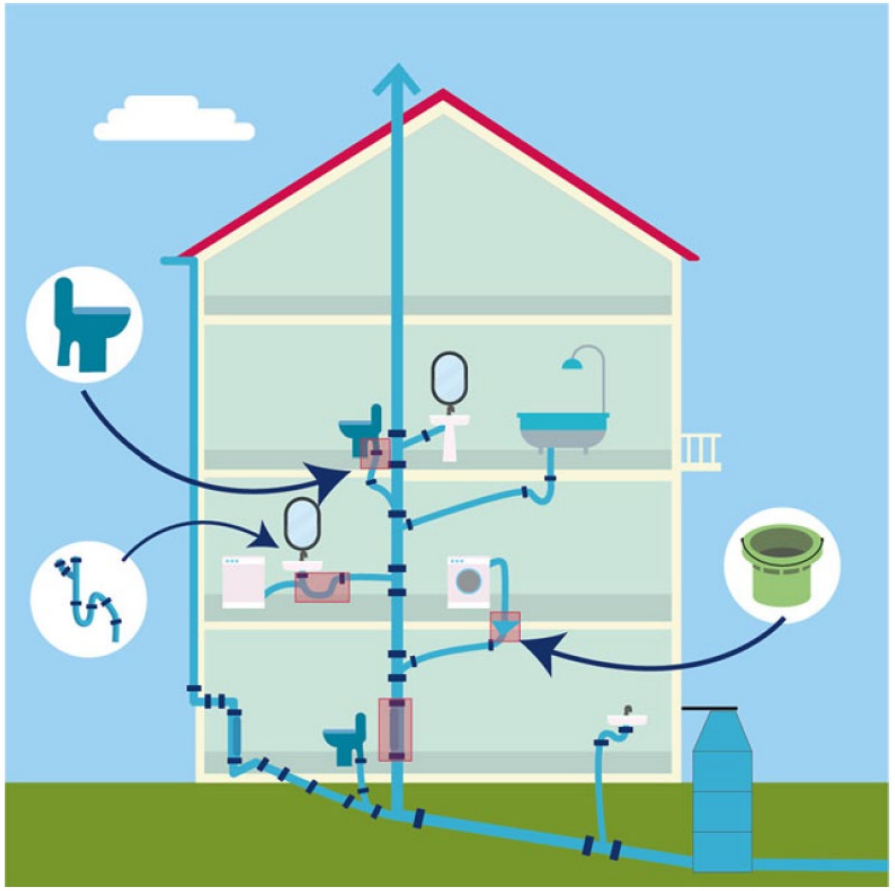


- Sewer cleanouts sampled at residential buildings
- Exceedances of sanitary sewer gas screening level (70 µg/m^3)
- Data indicate potential VI risk from sewer laterals
  - No exceedances of applicable screening levels (2.1 µg/m^3) in indoor air samples collected concurrently

SEWER GAS PATHWAY MITIGATION MEASURES

Options for Remediation/Mitigation of Sewer Gas Pathway

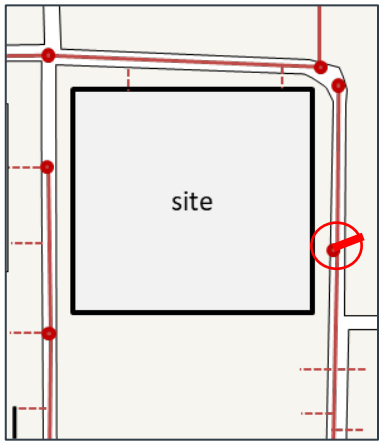
- Removing contaminant source
- Lining or replacement of sewer pipes
- Sealing the plumbing system in the building
- Passive venting of manholes
- Active depressurization/venting of sewer system



Source: Nielsen and Hvidberg 2017

PILOT VENTING TEST

- Completed along east sanitary main
- Investigate TCE distribution and mass flux into sewer
- Support design of sewer venting system



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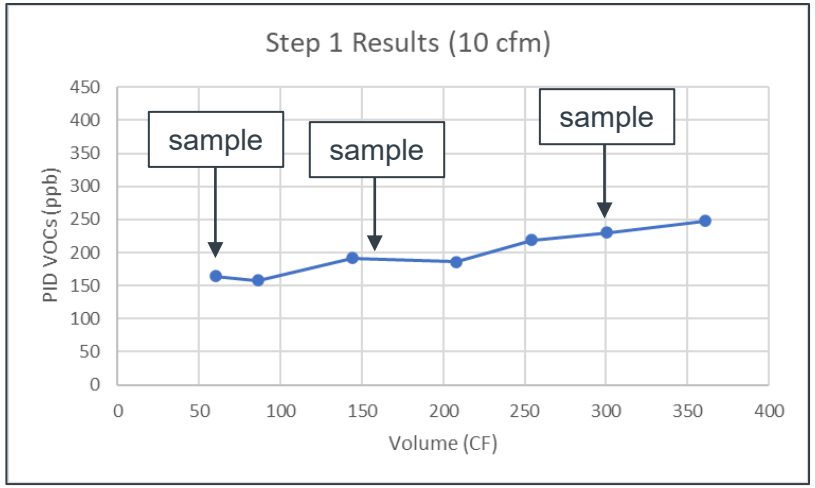
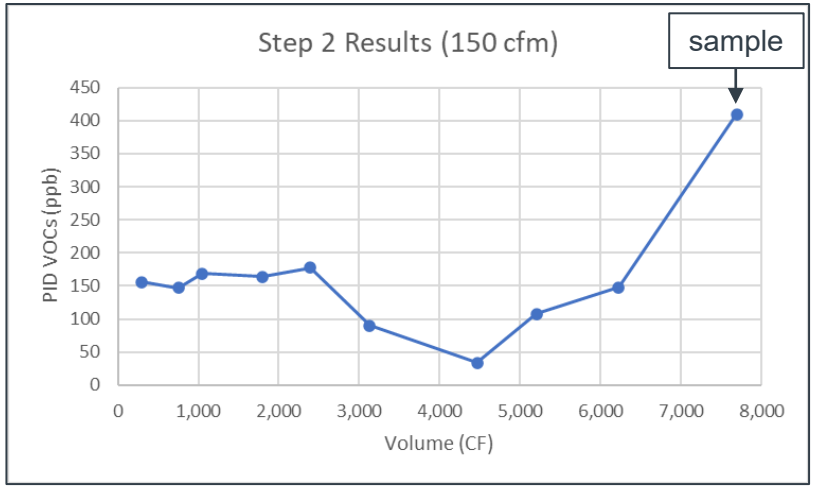
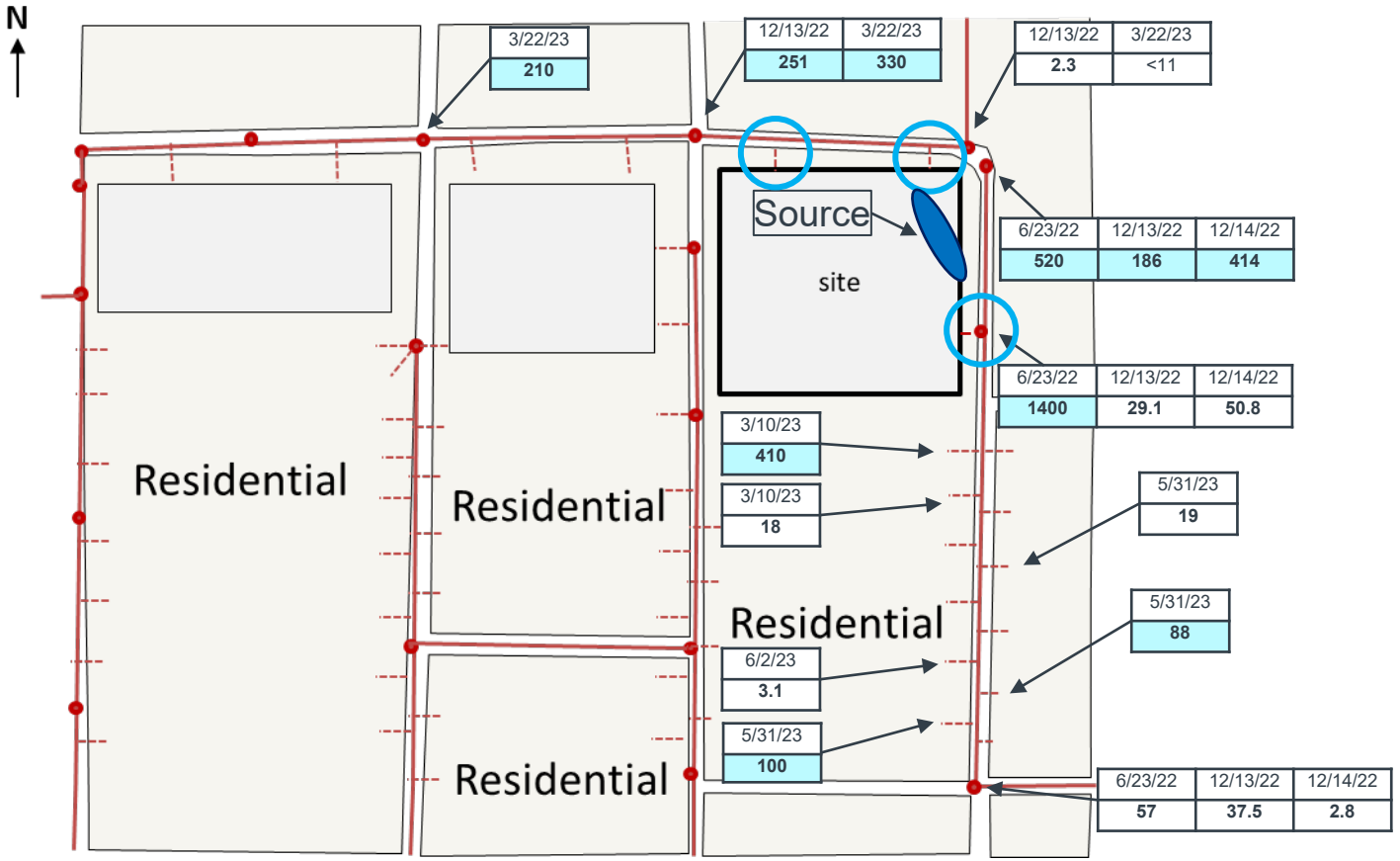




Purge Volume (CF)	60	160	300	7000
TCE ($\mu g/m^3$)	185	194	361	189
cDCE ($\mu g/m^3$)	53.2	55.3	107	36.6
VC ($\mu g/m^3$)	1.5	1.8	3.1	1.7

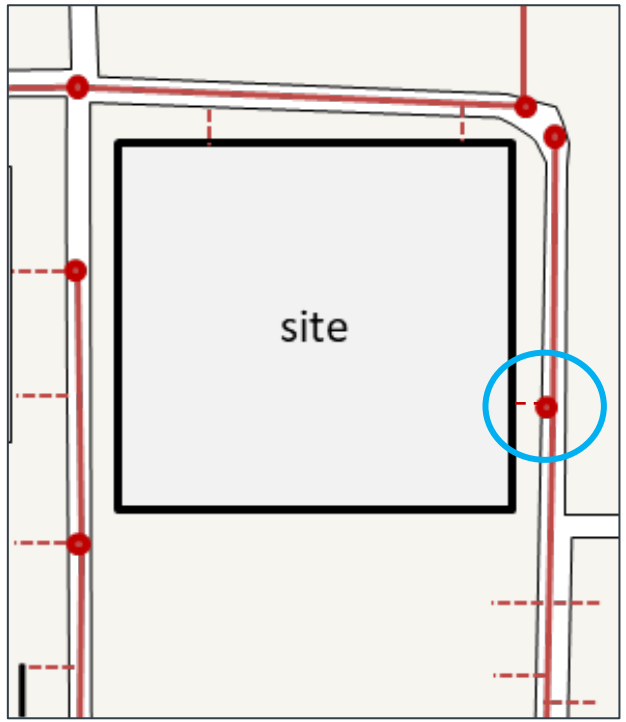
SEWER VENTING SYSTEM

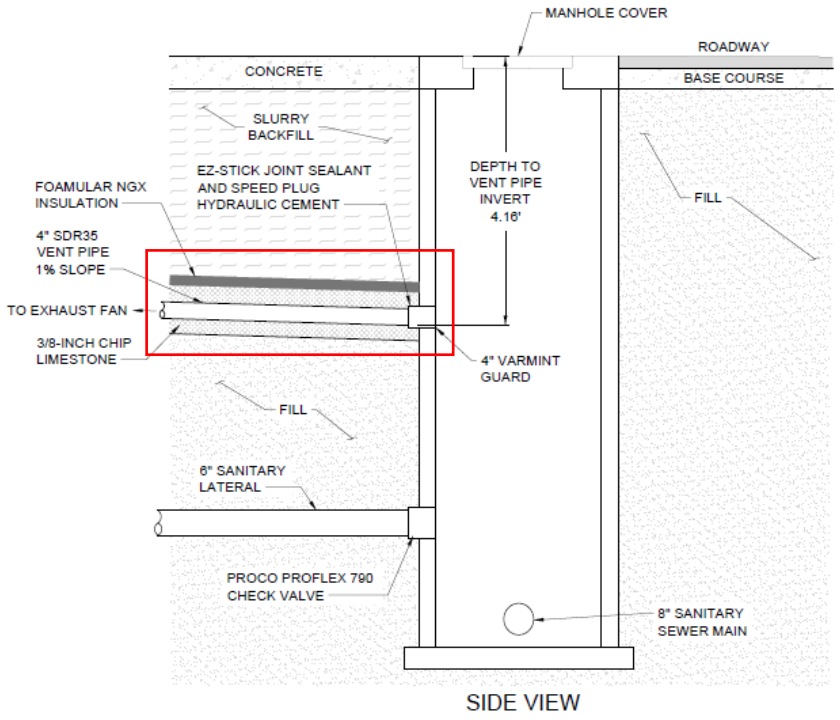


- Extraction points – 1x manhole and 2x sewer cleanouts
- Ventilate east and north sanitary mains

SEWER VENTING SYSTEM

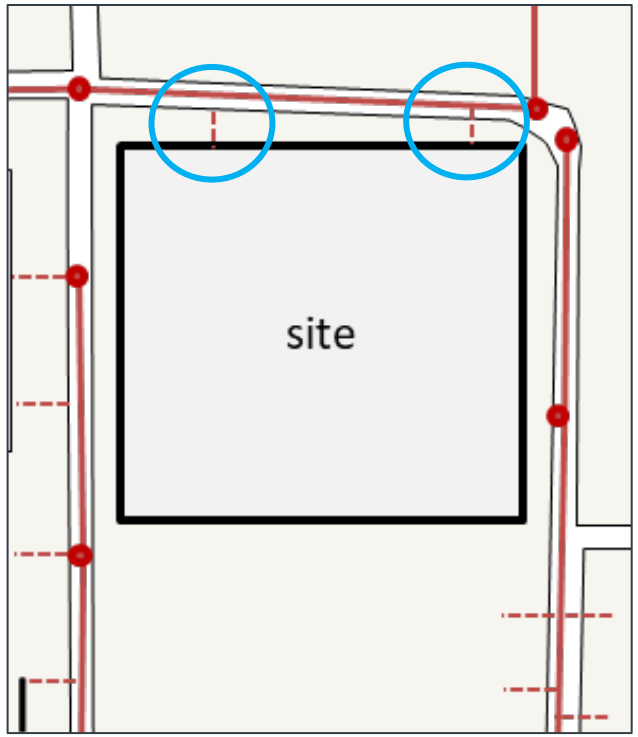
Manhole Extraction Point

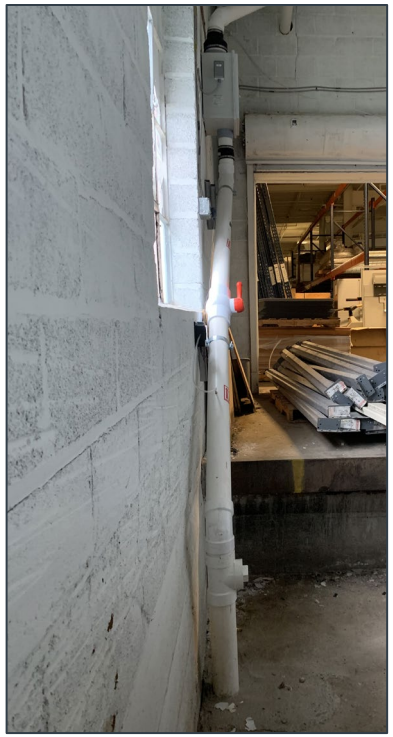




SEWER VENTING SYSTEM

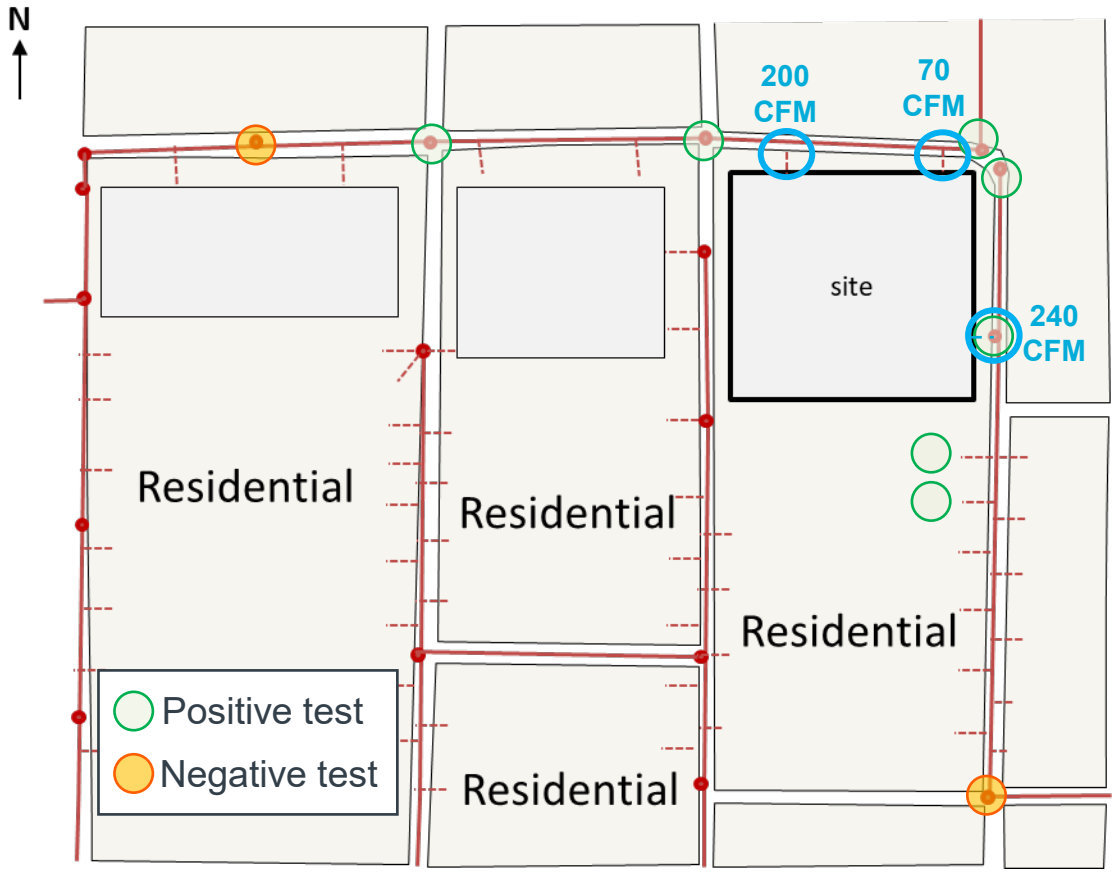
Sewer Cleanout Extraction Points

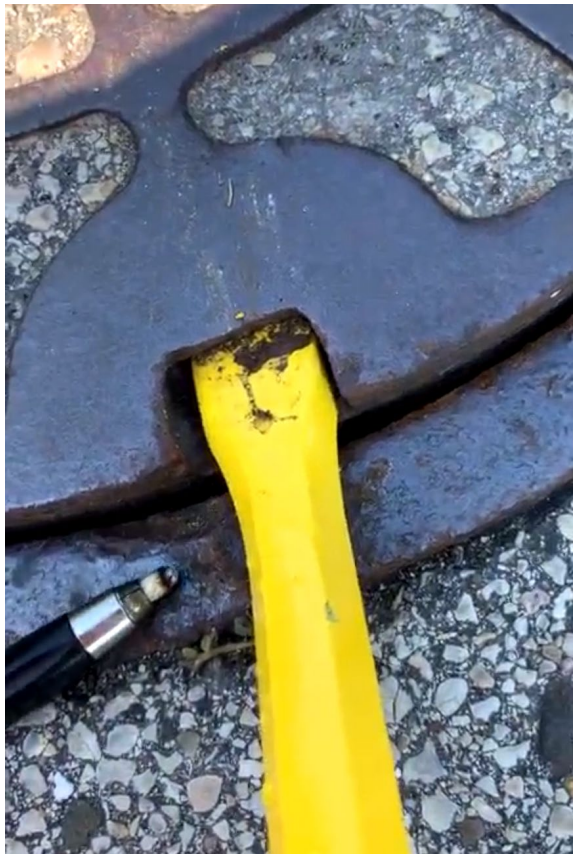




*Photos of NW location

SEWER VENTING SYSTEM PERFORMANCE





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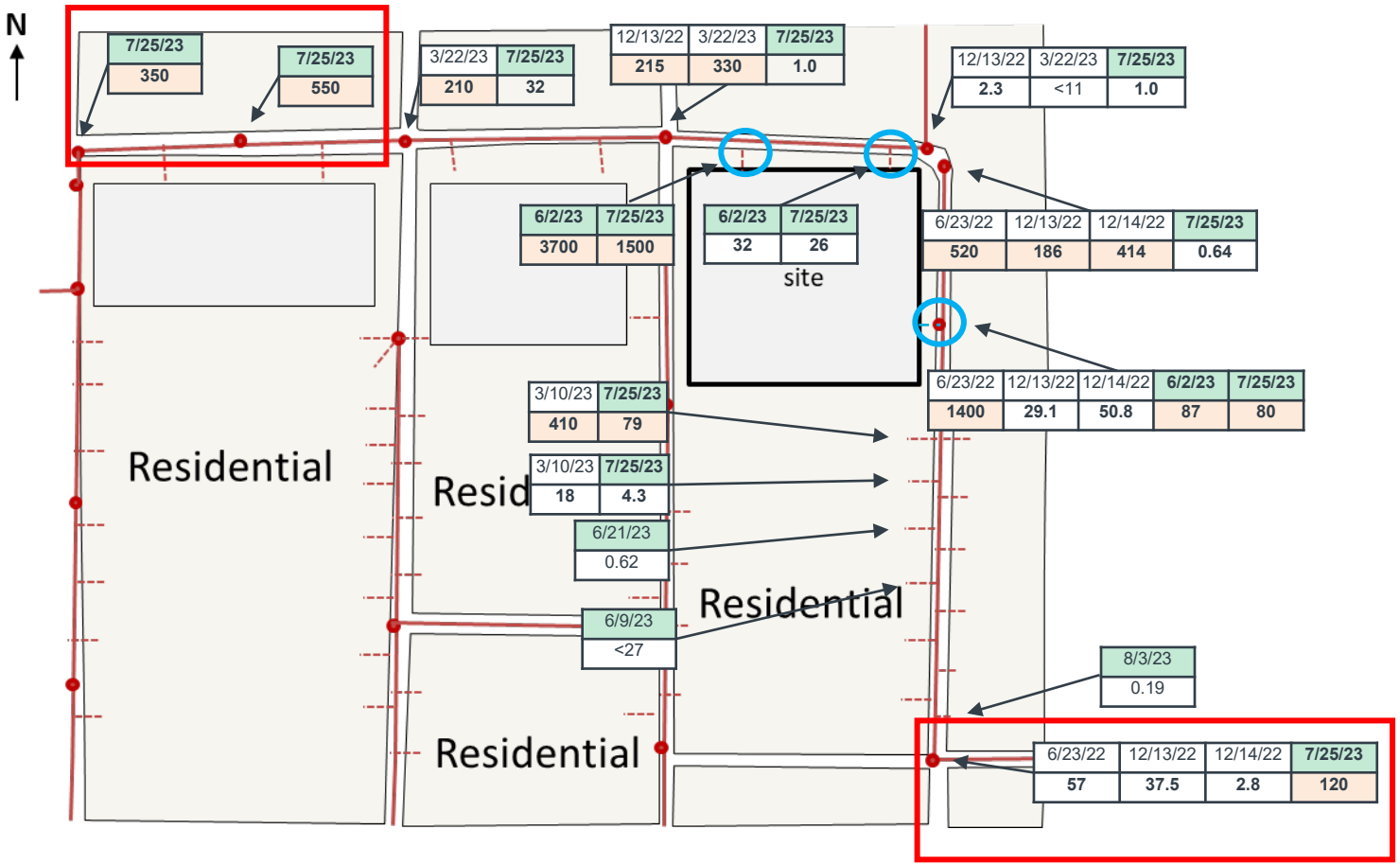
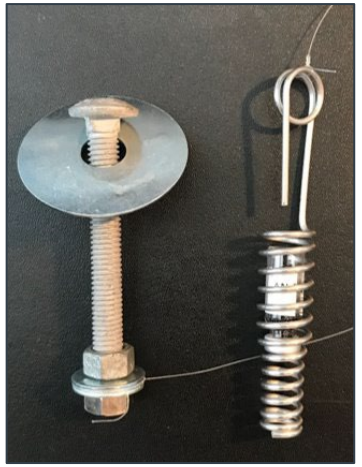
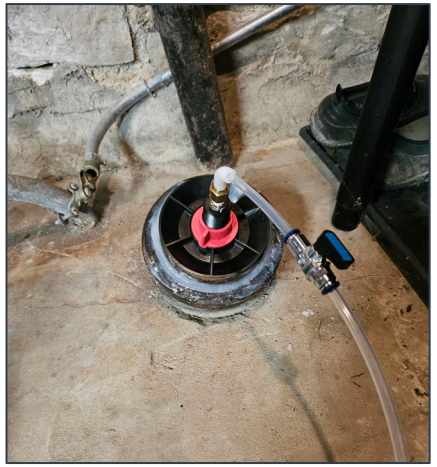


- Reduced concentrations at
  - Sewer manholes
  - Residential sewer cleanouts
- Elevated concentrations remain beyond reach of venting system

NEXT STEPS

- Residential sampling along northern sewer
- Winter season sewer gas and indoor air sample collection from residential buildings
- Evaluate seasonality of groundwater levels and their impacts on sewer vapor concentrations



CONCLUSIONS

- Migration through sewers and other preferential pathways is an important consideration when developing a VI Conceptual Site Model
  - Investigation and mitigation methods differ from conventional VI through bulk subsurface materials
  - Disregarding this pathway could lead to improper characterization, and inadequate or unnecessary mitigation.
- Passive samplers can be used for sewer gas and indoor air sampling to address temporal variability
- Active sewer venting systems are readily implementable and can be effective in mitigating the sewer VI pathway

Geosyntec consultants

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