Considerations for Long-Term Monitoring of a Sewer Ventilation System for Ongoing Assessment of the Vapor Intrusion Pathway

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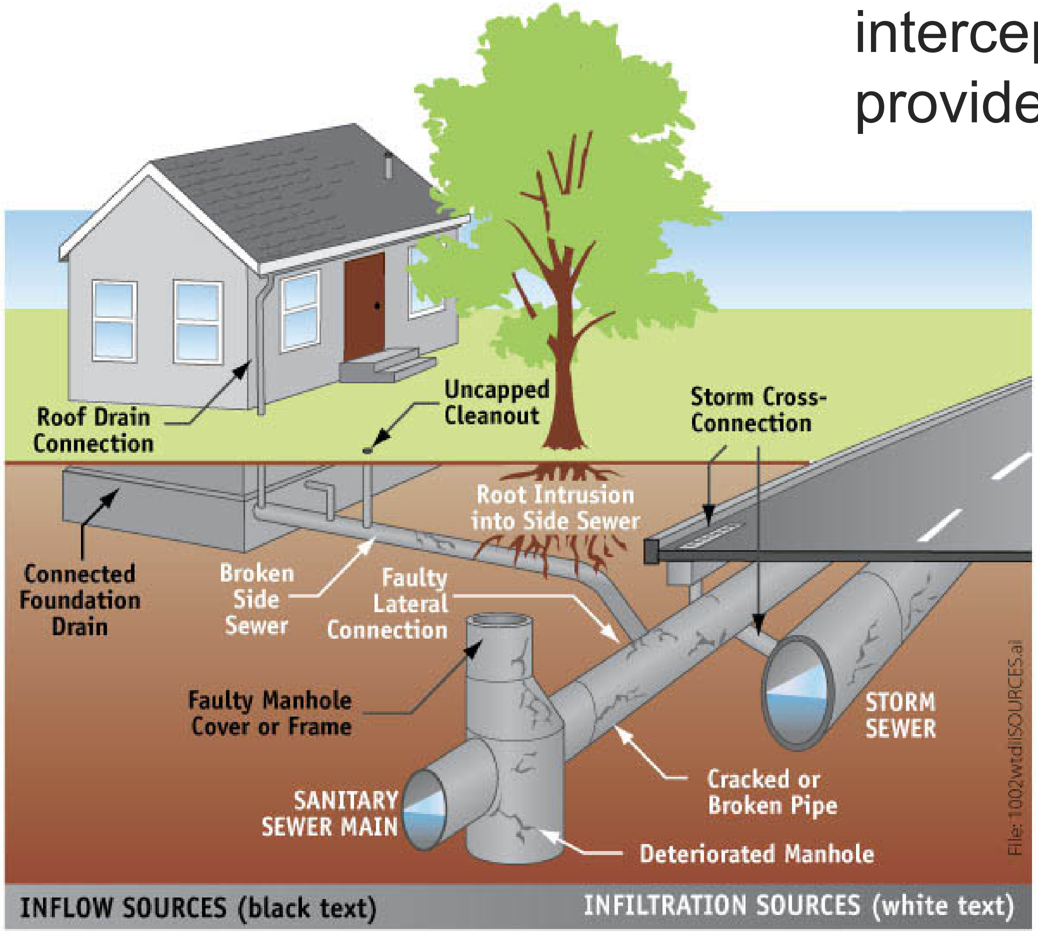
Presentation Outline

- Overview of the Sewer Vapor Intrusion Preferential Pathway
- Case Study Background
- Objectives and Approach
- Results
- Conclusions
- Considerations for Long-Term Monitoring

Sewer Atypical Preferential Pathways

Definition: A conduit into building (e.g., sewer line) that intercepts a relatively strong VOC source area and provides little resistance to vapor flow



www.kingcounty.gov/services/environment/wastewater/ii/what.aspx

- Gravity sewers – large headspaces (facilitates vapor flow)
- Most sewers leak both in and out
- Sewers receive flow from smaller pipe networks
- Larger receiving pipes can be over 20-ft below ground

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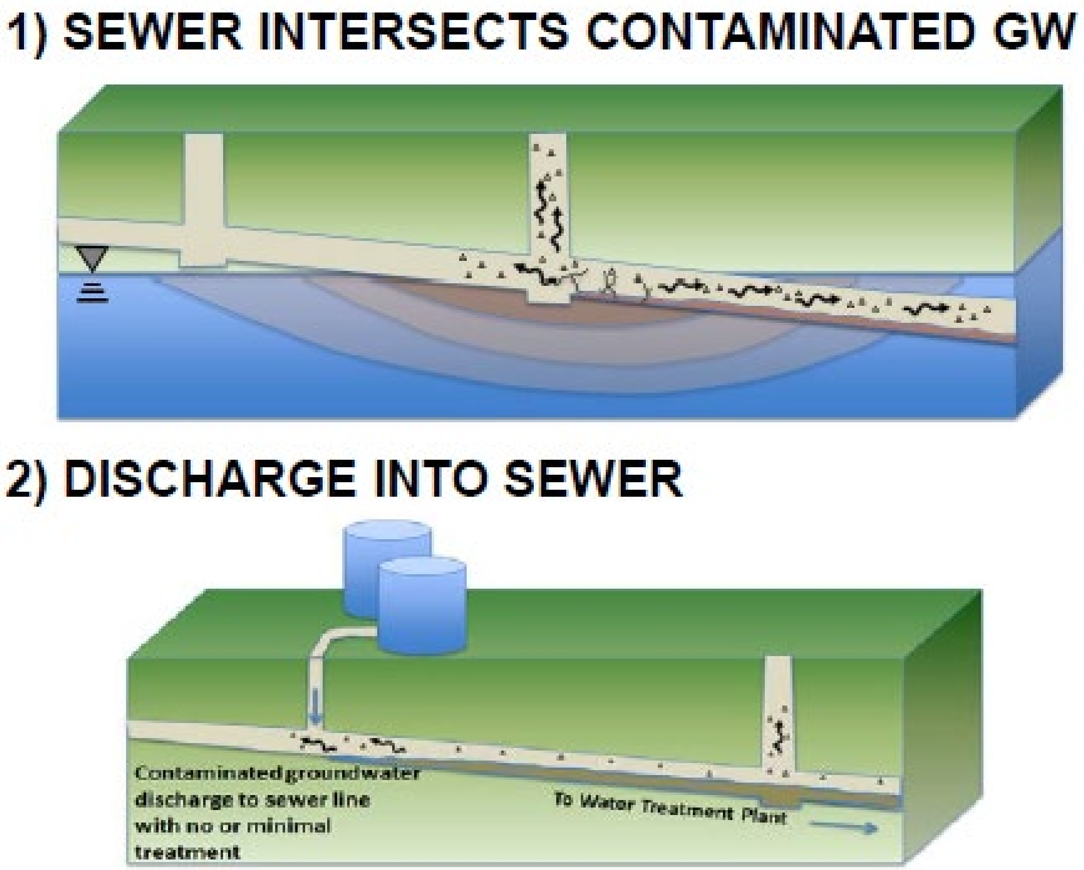
VOCs in Sewer Gas

- VOCs enter sewer gas through 2 primary mechanisms
  - Contaminated groundwater (may include NAPL) and/or soil gas enters sewer
  - Direct discharge of water containing VOCs to sewer system

https://www.fvrobertson.com/sewer-video-inspection/



Adapted from McHugh and Beckley AEHS 2017

Case Study

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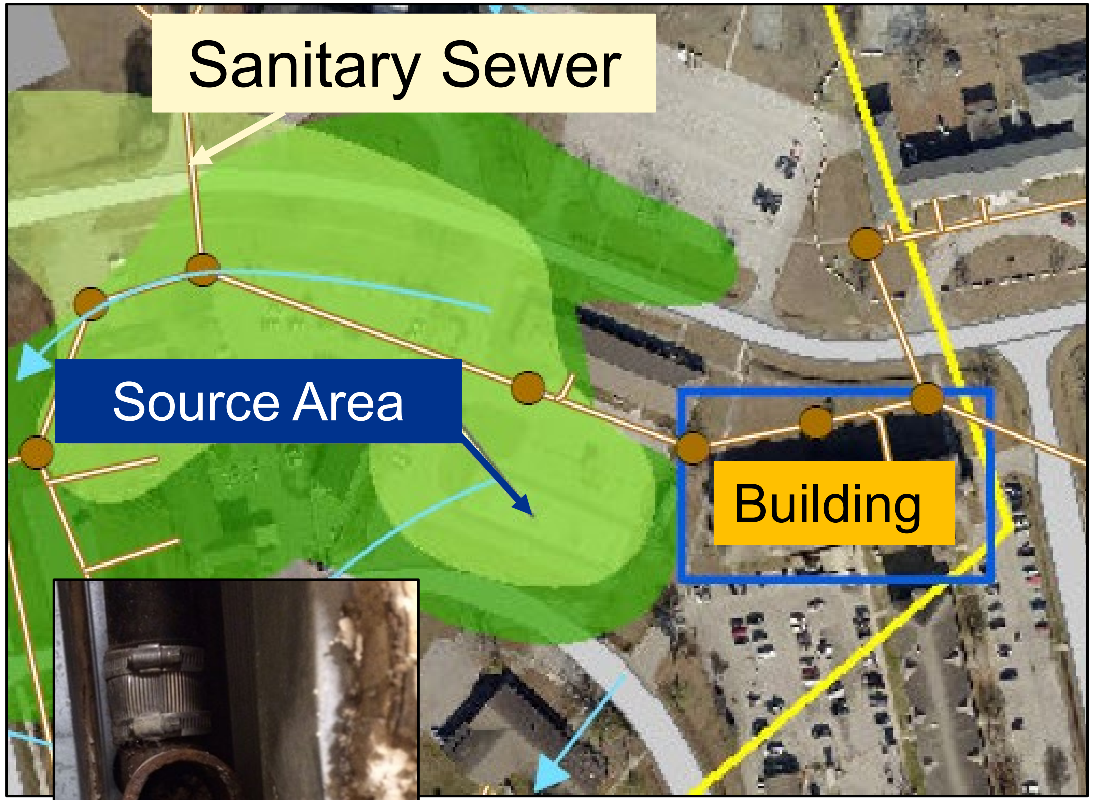
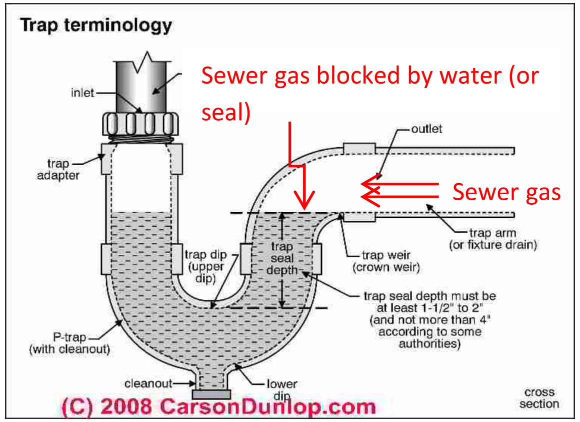
Background

- Upgradient of source area (100 feet)
  - PCE ~600 µg/L and TCE ~300 µg/L
  - Residual soil DNAPL
- Sewer connects relatively strong source area to building
- TCE periodically detected in indoor air
  - Above regulatory targets
  - IA and SG concentrations did not correlate
- Additional investigation to determine source
  - Uncapped pipe in mechanical room
  - HAPSITE confirmed PCE and TCE inside plumbing



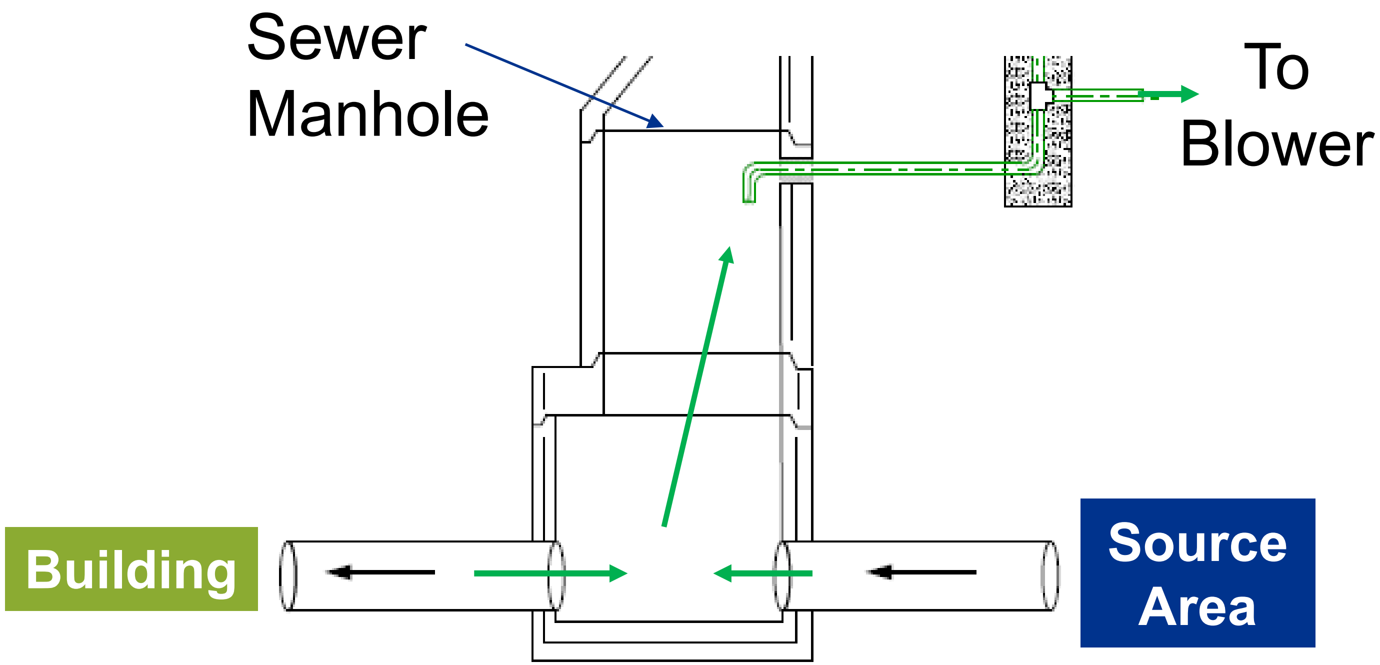
Background

- Initial Actions
  - Uncapped pipe was sealed
  - Dry/damaged p-traps replaced
  - Preliminary sewer ventilation was conducted with a test blower (~240 cfm)
    - Data indicated reductions of PCE and TCE within the sewer line as well as indoor building plumbing
- Implemented longer-term pilot study with more frequent monitoring



Sewer Ventilation
Pilot Study Objectives

- Prevent VOCs in sewer gas from entering occupied space by:
  - Intercepting vapors between source area and target buildings
  - Preventing vapor build-up in sewer headspace
  - Reversing flow of vapors away from target buildings



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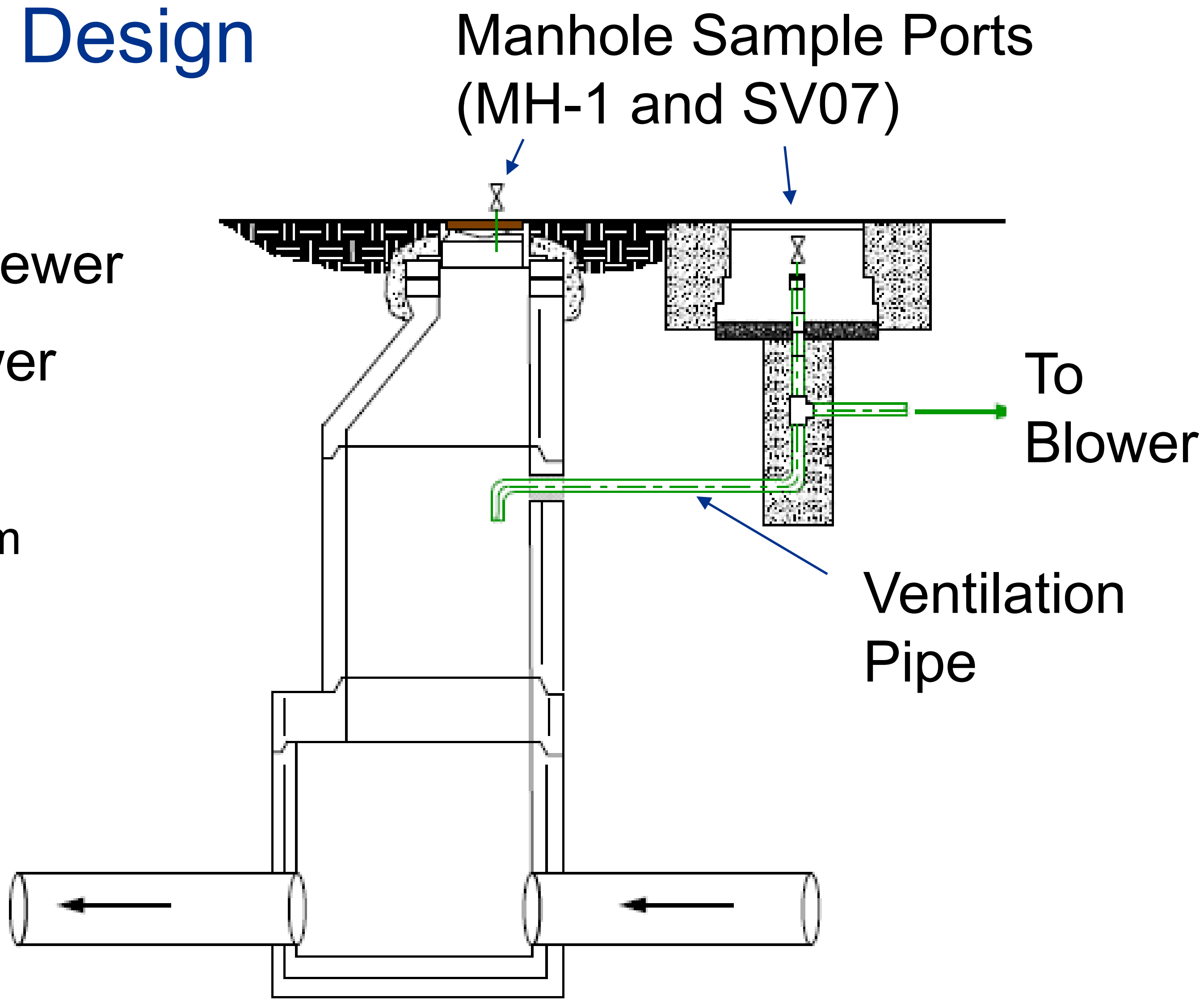
Sewer Ventilation System Design

- 4-inch ventilation pipe from the sewer
- Connected to skid mounted blower
  - 3-hp, explosion-proof
  - 240 cfm, 25-30” H_2O column vacuum
- Blower exhaust vented above roofline
- Sewer vapor monitoring ports installed at 3 manholes and 1 between manhole and blower



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Sewer Ventilation System Installation

Manhole Sample Port

System Connection

Piping into manhole

Blower Enclosure and Stack

Blower System

Blower Connection to Manhole

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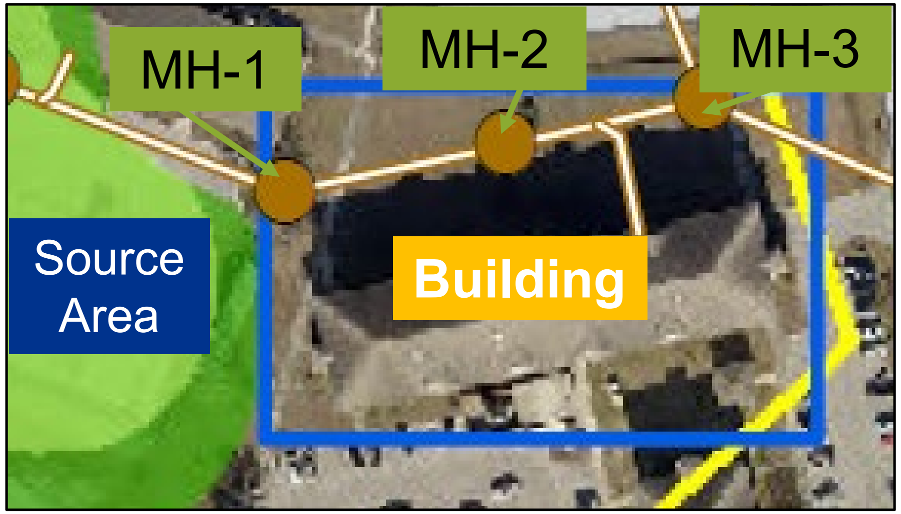
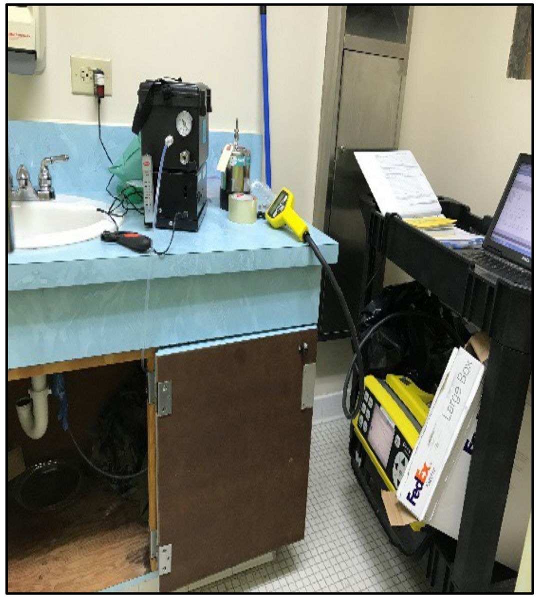
Sewer Ventilation System Startup

- Baseline sampling and post-startup performance monitoring
  - Post-startup monitoring 36 hours after startup
    - SUMMA, HAPSITE, pressure cycling
  - Highest sewer vapor concentrations observed at MH-1 (located closest to source area)
  - VOCs not detected in indoor air above screening levels during baseline or during post-startup performance monitoring
  - Venting at MH-1 reduced PCE and TCE concentrations in sewer vapor and within building plumbing by 1 to 2 orders-of-magnitude
  - Under controlled depressurization, PCE and TCE concentrations remained low within building interior plumbing



IA Sampling

Office Restroom Plumbing



Wall Plumbing

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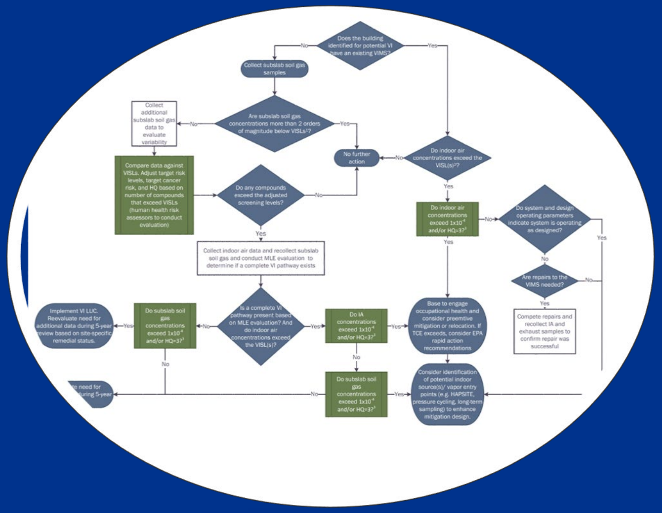
Long-Term Monitoring

- Response Action Decision Matrix
  - Site-specific
  - Considers multiple lines of evidence (e.g., VOCs, fan speed, vacuum, differential pressure)
  - Navigate potential need for follow-up sampling or rapid response actions



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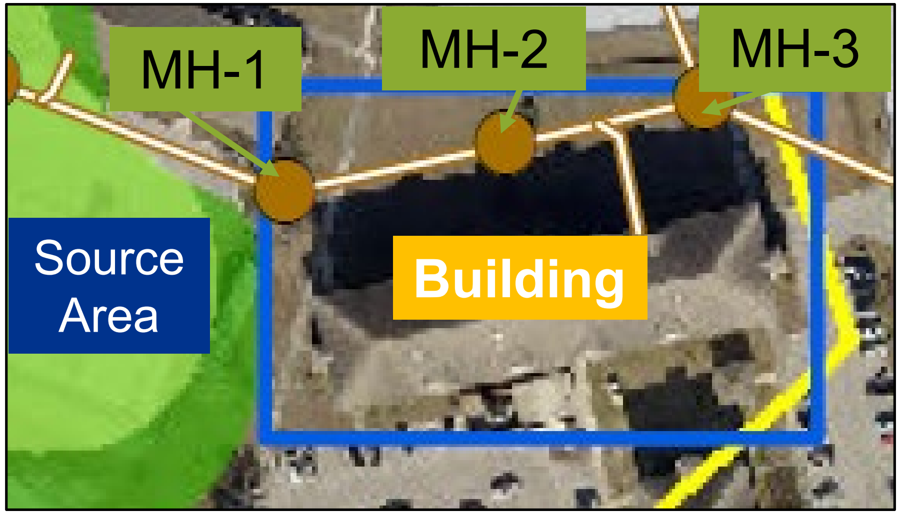
Long-Term Monitoring

- Analysis
  - PCE and TCE by EPA Method TO-15
- Locations
  - Office Restroom Indoor Air and Outdoor Air
  - Sewer vapor sampling at 3 manholes
  - Blower discharge vapor sampling
- Frequency
  - Quarterly for 2 years
    - December 2016 – September 2018
  - Semiannual sampling beginning June 2018
    - Exit strategy will consider source reduction and data analysis
  - Monthly operational checks beginning in 2017
    - High level in the condensate tank caused the blower to shut down following a period of heavy rainfall
    - Record system flow rate, operating pressure, run time, and condensate tank level

IA and OA Sampling

Blower Enclosure and Stack



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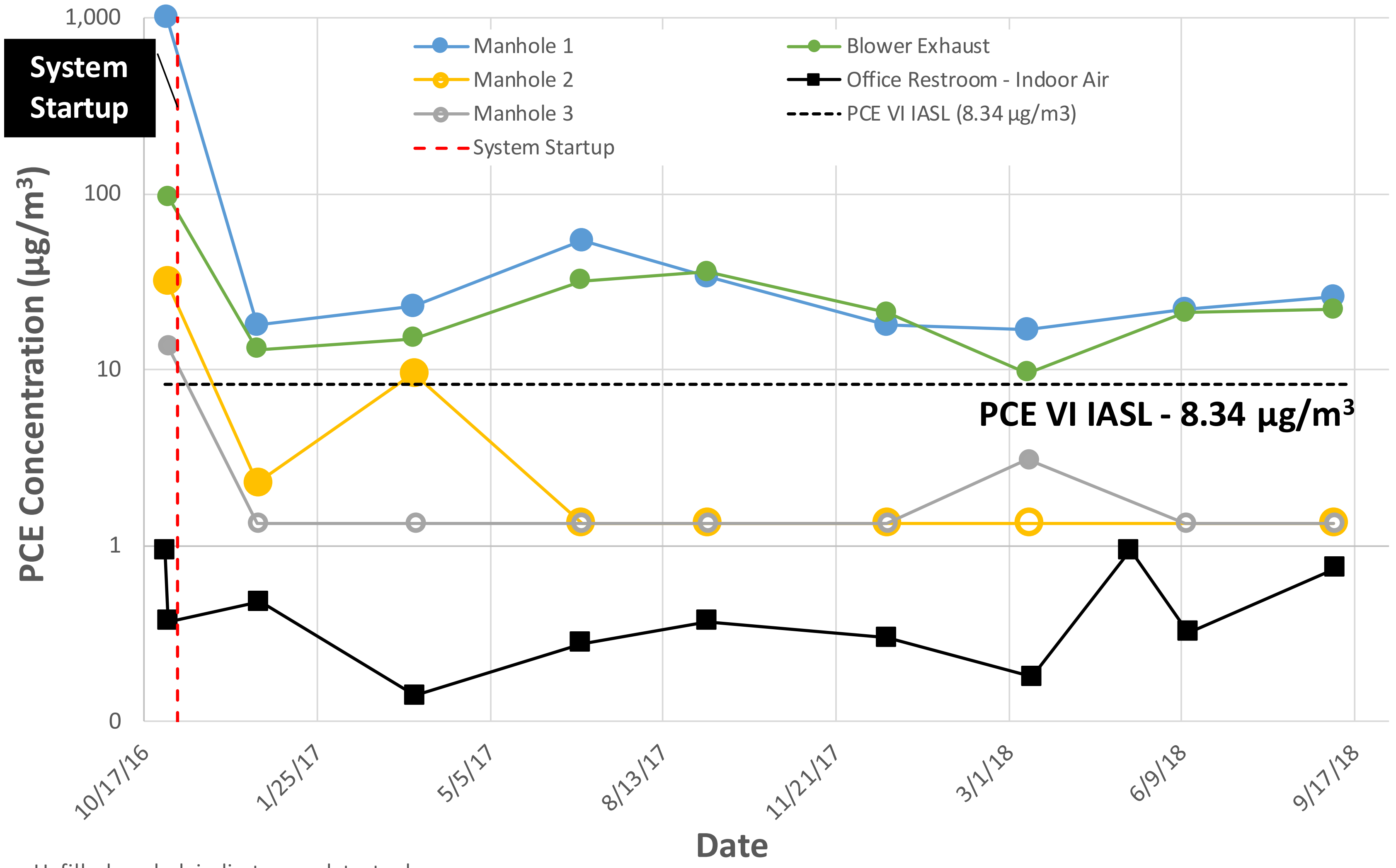
Long-Term Monitoring – PCE



Unfilled symbols indicate non-detect value

- PCE in sewer vapor decreased by 1 to 2 orders of magnitude
- Typically non-detect at MH-2 and MH-3 since startup
- PCE in indoor air detected, but consistently below IASL

VI = Vapor Intrusion
IASL = Indoor Air Screening Level

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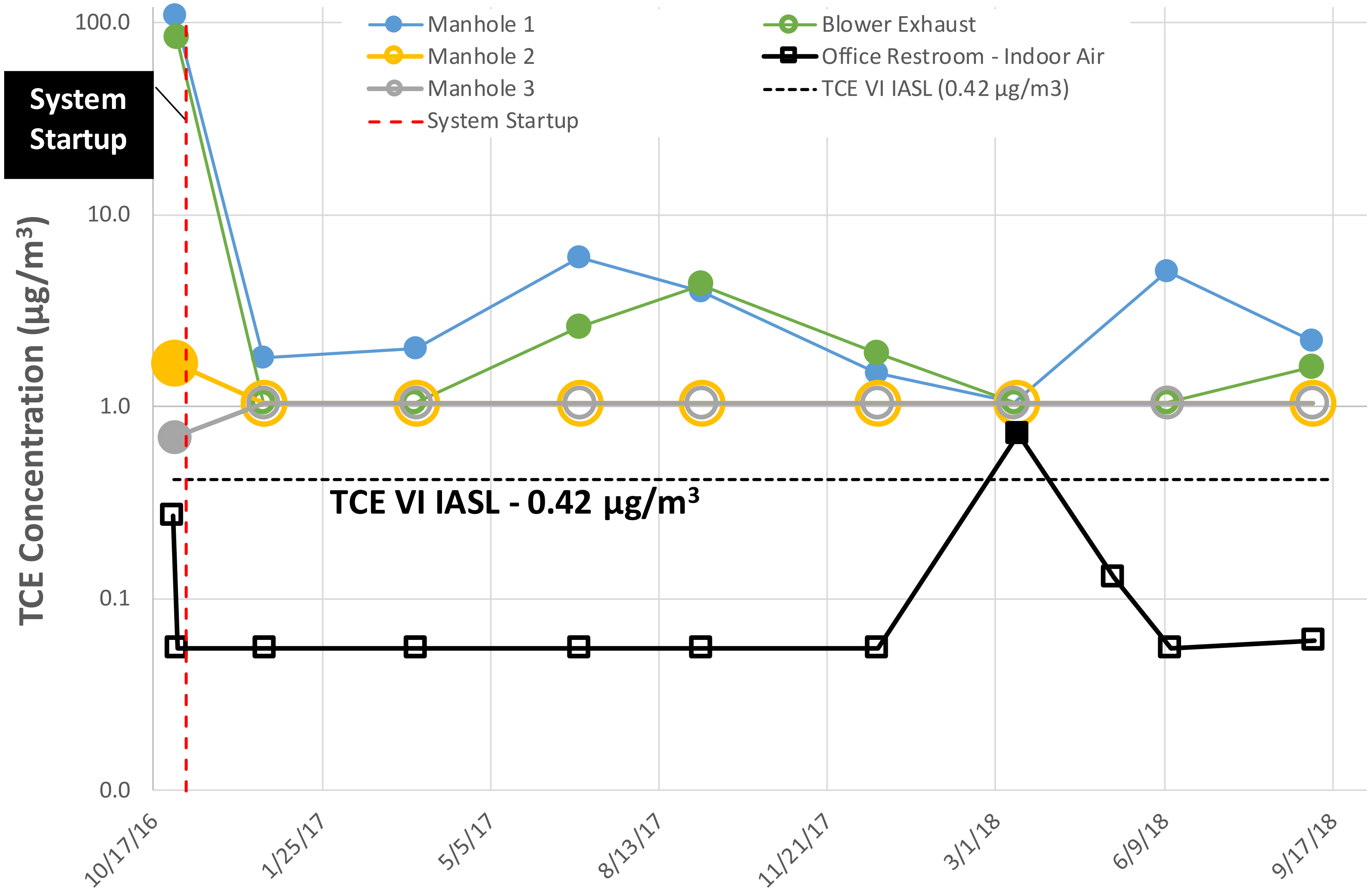
Long-Term Monitoring – TCE



Unfilled symbols indicate non-detect value

- TCE in sewer vapor decreased by 1 to 2 orders of magnitude
- Typically non-detect at MH-2 and MH-3 since startup
- TCE in indoor air typically non-detect

VI = Vapor Intrusion
IASL = Indoor Air Screening Level

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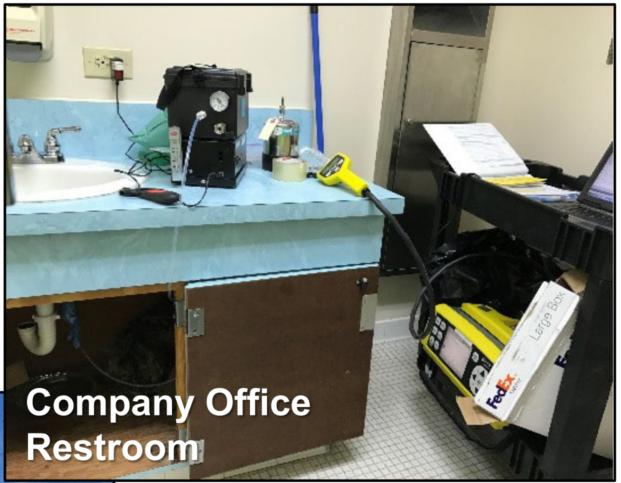
Long-Term Monitoring – March 2018

- Office Restroom Indoor Air
  - First TCE detection/exceedance of the IA VISL since startup
    - Result of 0.72 µg/m^3 exceeded the IA VISL (0.42 µg/m^3)
    - First event TCE was not detected in sewer vapor or blower exhaust
  - TCE was detected in the outdoor air sample (0.78 µg/m3)
    - TCE is generally not detected in outdoor samples collected
    - Indicates that the TCE exceedance was likely a result of a background source



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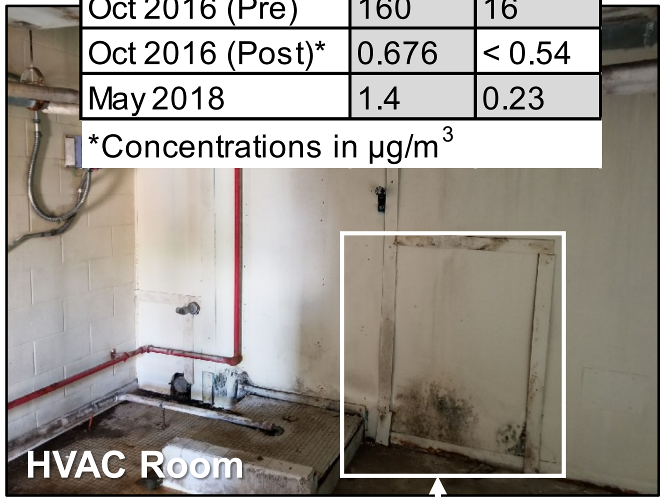
Long-Term Monitoring –
May 2018 Follow-On Sampling

- Office Restroom Indoor Air
  - TCE was detected (0.13 J µg/m3), but below IASL (0.42 µg/m3)
  - TCE was not detected in the outdoor air sample
- Wall Plumbing
  - PCE and TCE were detected at low concentrations, ~two orders magnitude below baseline
- Subslab Soil Gas
  - TCE not detected; PCE observed at 1.1 J µg/m3
- Summary
  - MLE (VOC results and system performance parameters [blower air flow and vacuum]) support that the VI pathway is being mitigated
  - Results supports that the TCE exceedance in indoor air was due to an outdoor source of TCE

Wall Plumbing	PCE	TCE
Oct 2016 (Pre)	160	16
Oct 2016 (Post)*	0.676	< 0.54
May 2018	1.4	0.23

*Concentrations in µg/m^3



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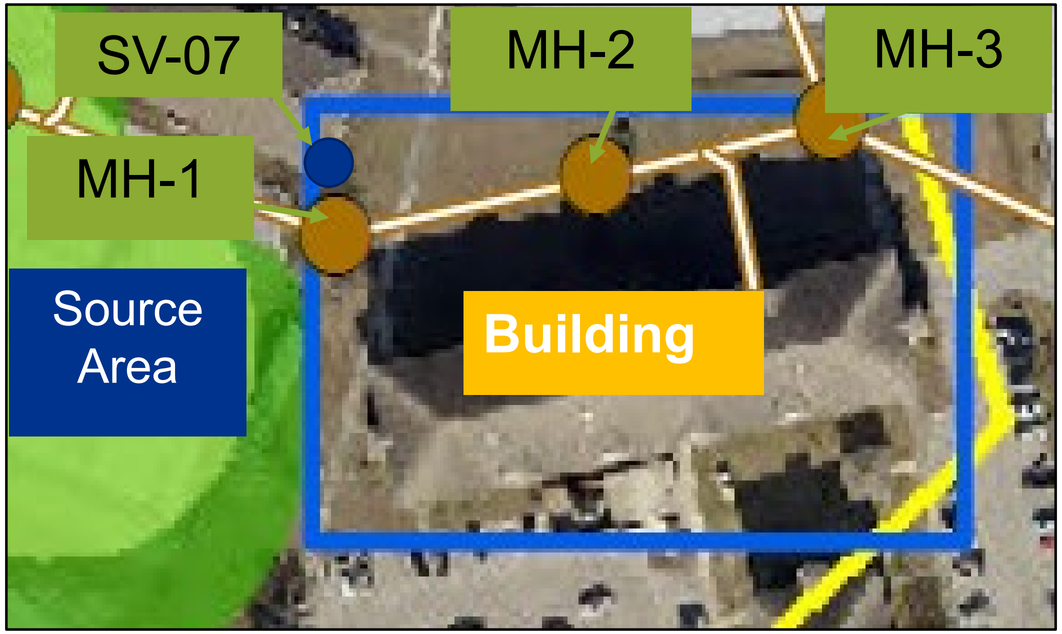
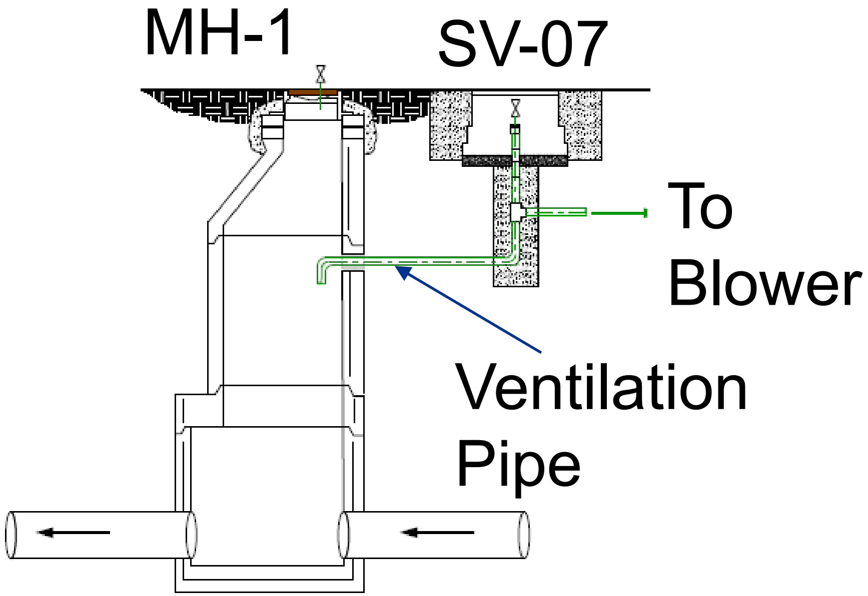
Long-Term Monitoring – Additional Follow-On Actions

- Measure differential pressure at manholes as an additional line of evidence for vacuum/air flow influence closer to building:
  - MH-1 = +0.0911 in. WC
  - MH-3 = +0.0900 in. WC
  - SV07 = -3.04 inches WC
  - – DP readings from large manholes may not provide representative results, smaller dedicated sewer vapor sampling ports are likely needed to provide this line of evidence.





Manhole Sample Port

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Conclusions

- Sewer ventilation effectively mitigates VI:
  - Concentrations of PCE and TCE at sewer manholes and in building plumbing were reduced/maintained at concentrations 99-percent less than baseline results
  - System performance data
    - Blower air flow, vacuum, DP measurements (SV07)
  - Overall IA concentrations < IASLs, or due to outdoor source

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Considerations for Sewer Ventilation Long-Term Monitoring

- Develop a site-specific response action matrix
  - Helps navigate potential need for follow-up sampling or rapid response actions (HAPSITE and/or pressure cycling)
  - Collect data that allows for a robust multiple lines of evidence assessment
    - Performance monitoring evaluation should not rely on indoor air data alone
    - Consider more frequent monitoring indoor plumbing rather than indoor air due to influences of non-VI-related sources
- Implement routine system operational checks (as needed)
  - Routine checks on condensate levels, especially during rainy months
    - If condensate issues become a frequent issue, consider installing telemetry or an automatic condensate drain valve to minimize blower downtime

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Thank you!

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