Temporal and Spatial VOC Distributions in Sewers and Land Drains that Act as Alternative VI Pathways

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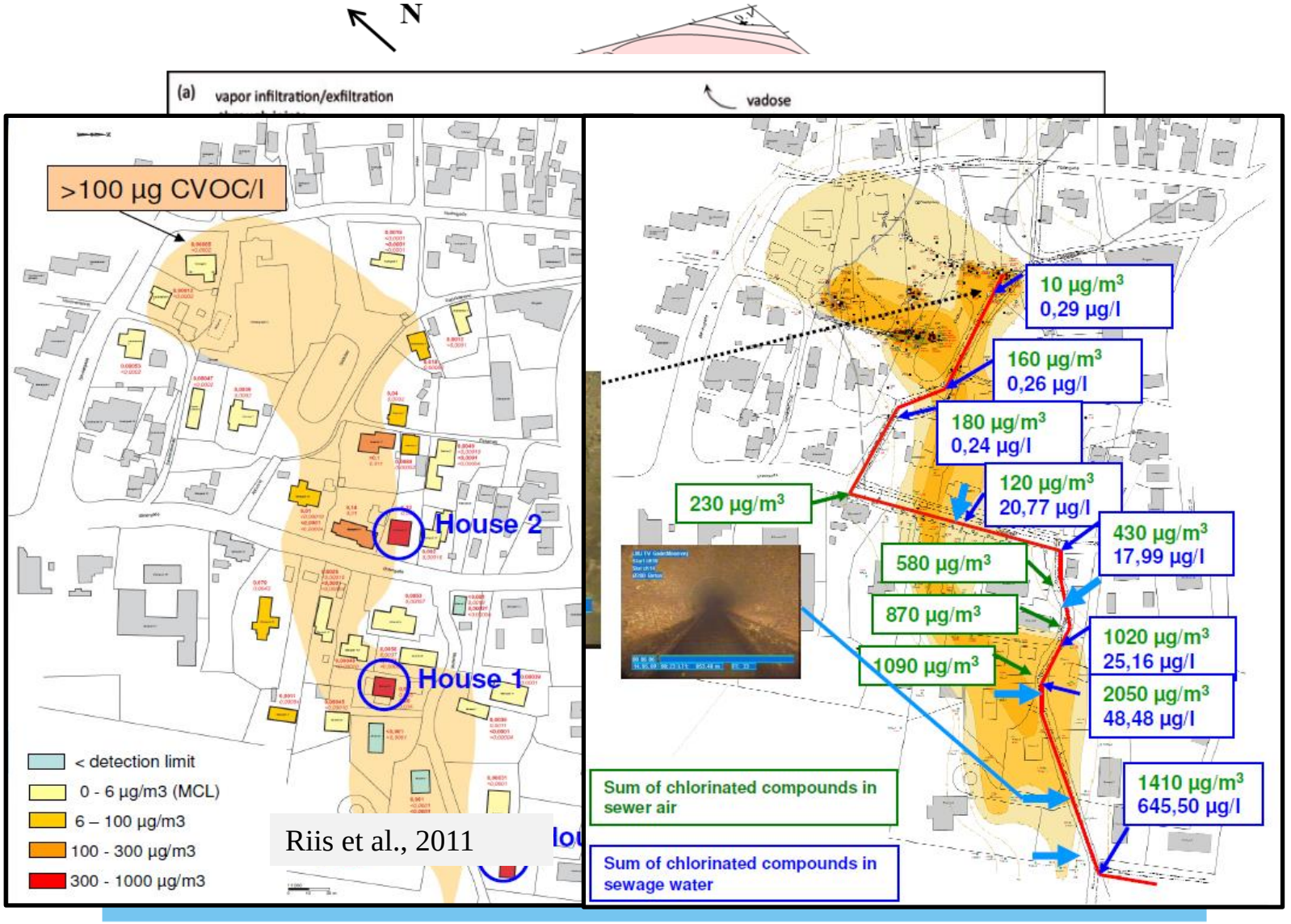
VI from Sewer/Land Drain



- **VOCs in sewer or utility tunnels are detected at VI sites.**
- **VOCs can move from sewer or utility into buildings.**
- **Utility may distribute VOCs beyond groundwater plume boundary.**

Can VOCs in Sewers and Land Drains be a Line-of-Evidence for at-Risk Building Identification?

- **Spatial distribution:** Is there any spatial correlations between indoor air and sewer VOCs?
- **Temporal variability:** How many sewer samples does one have to take?

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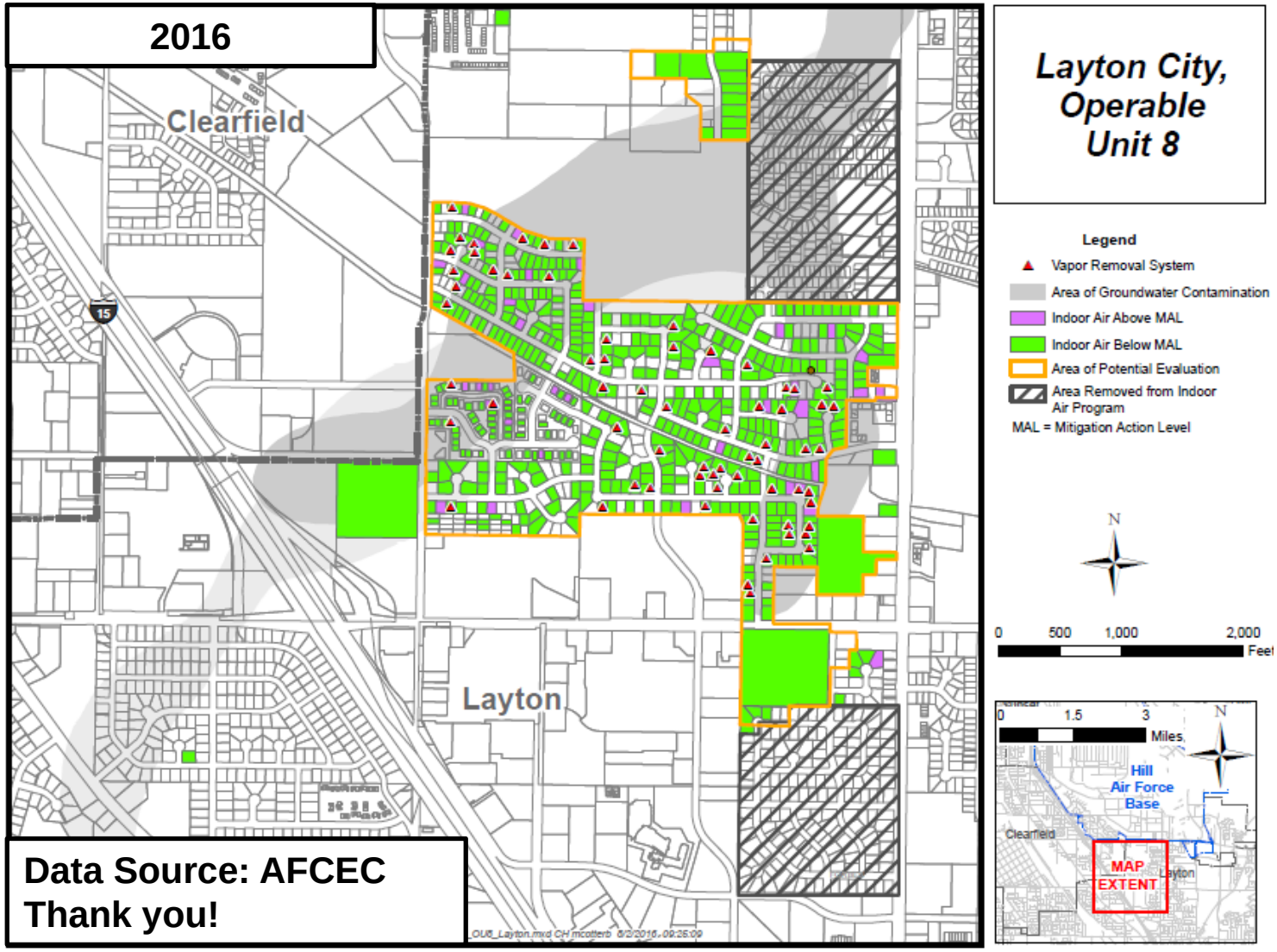
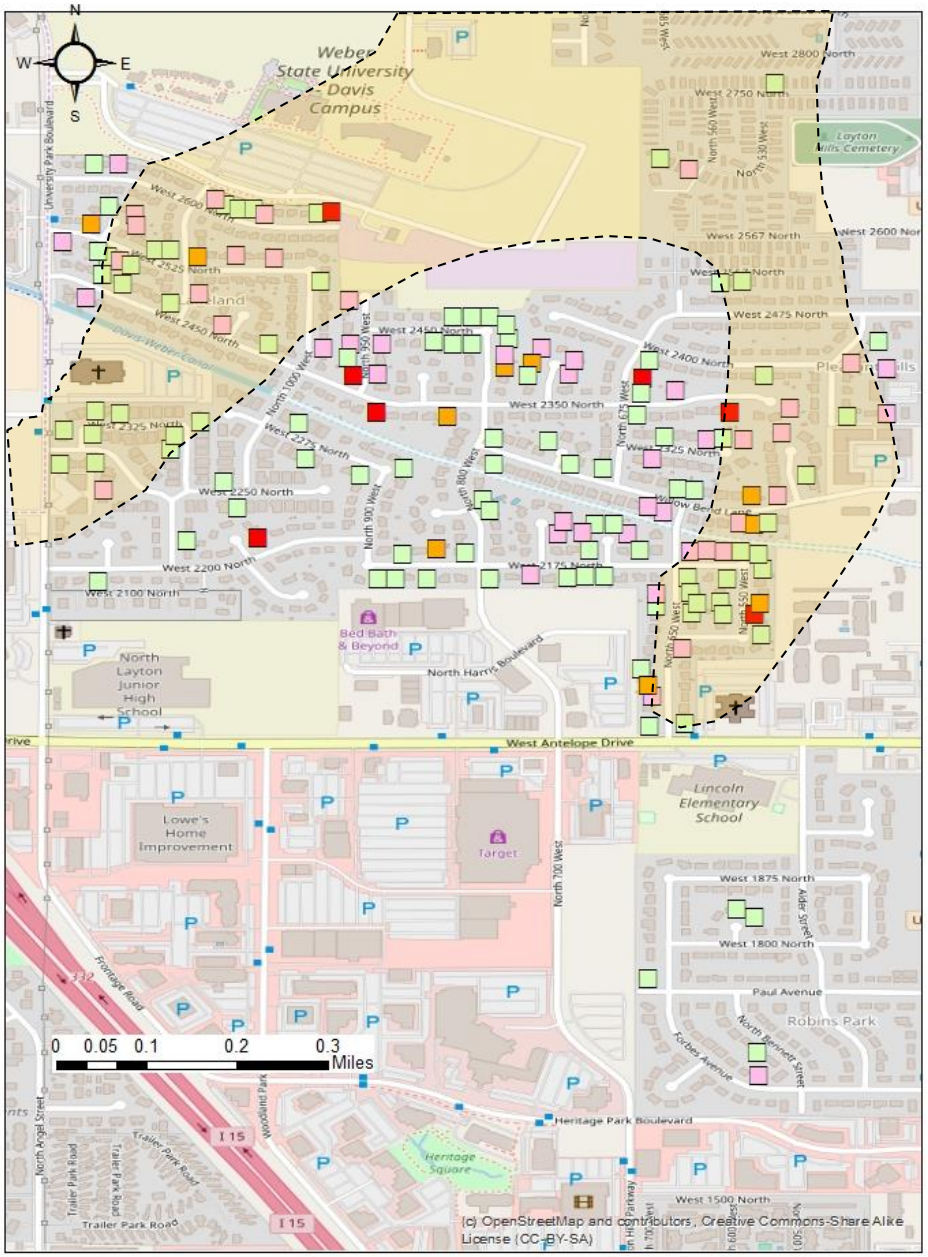
Study Site: OU-8 near Hill AFB



Data Source: AFCEC
Thank you!



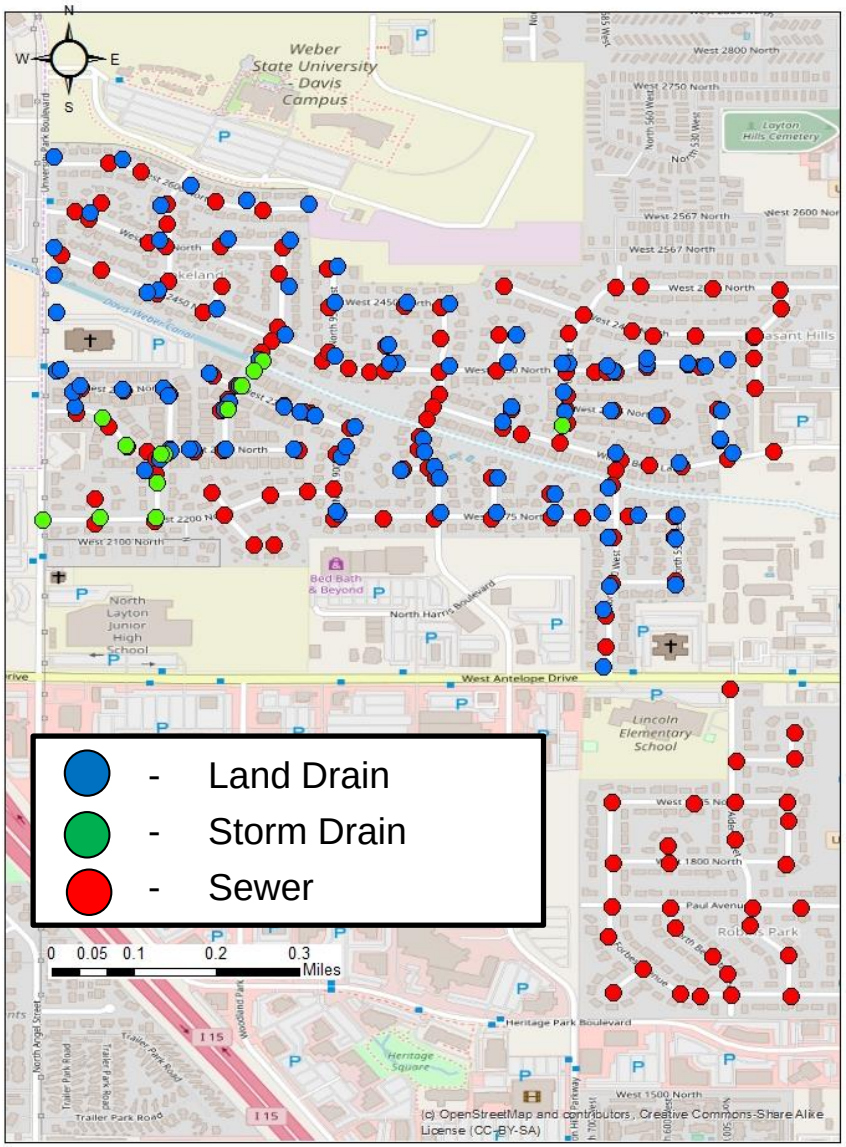
TCE Indoor Air Conc. in Residents

- Historic indoor air monitoring results in OU-8 from 1997 to 2015 (Thanks to Hunter Anderson and Mark Roginske from AFCEC).
- Maximum indoor air TCE monitor results.
- Data may or may not reflect contributions from indoor sources.

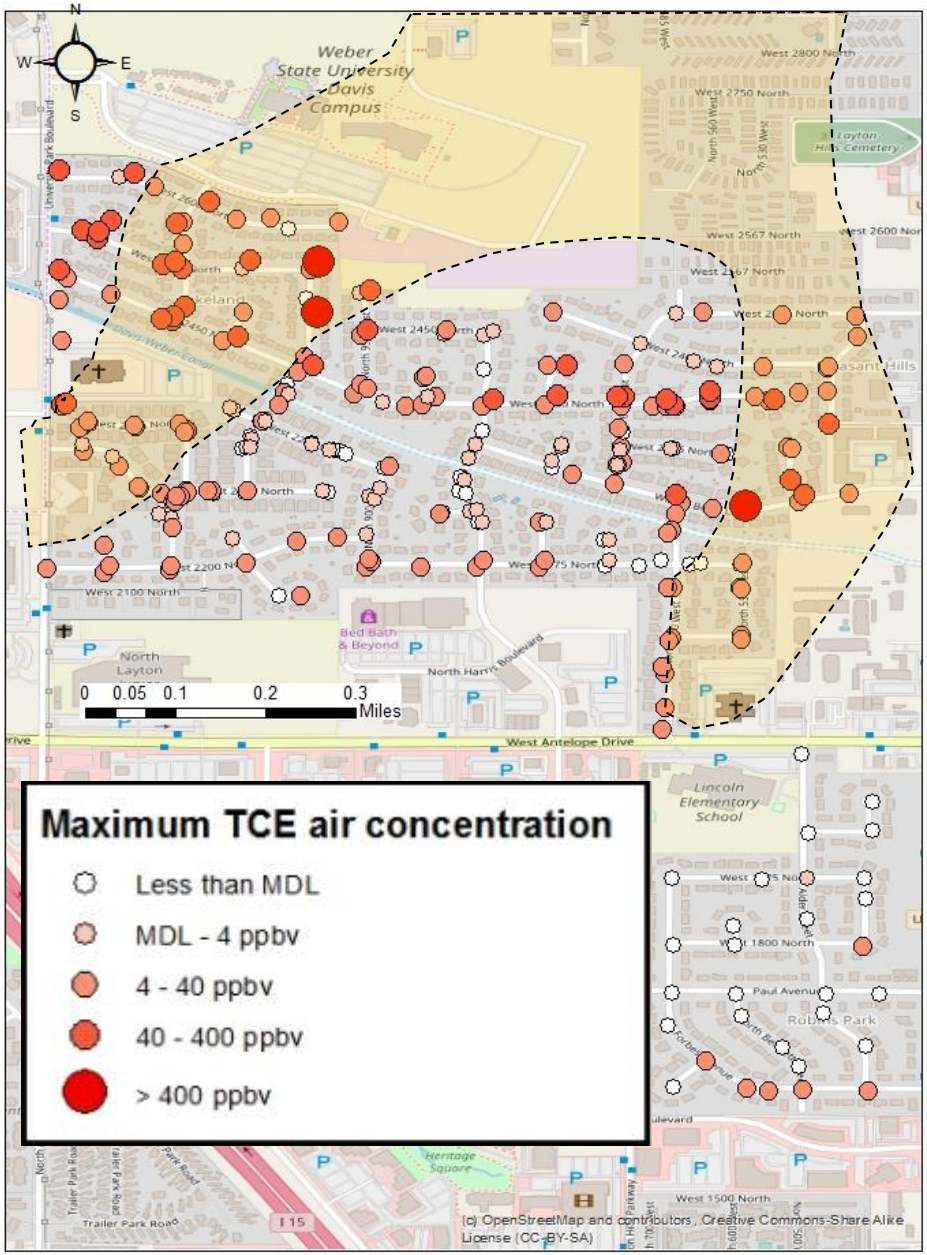
- TCE < 0.4 ppb_v
- TCE conc. 0.4 ~ 2 ppb_v
- TCE conc. 2 ~ 4 ppb_v
- TCE conc. > 4 ppb_v
- Groundwater Plume

VOCs in Sewer/Land Drain: Quarterly Survey

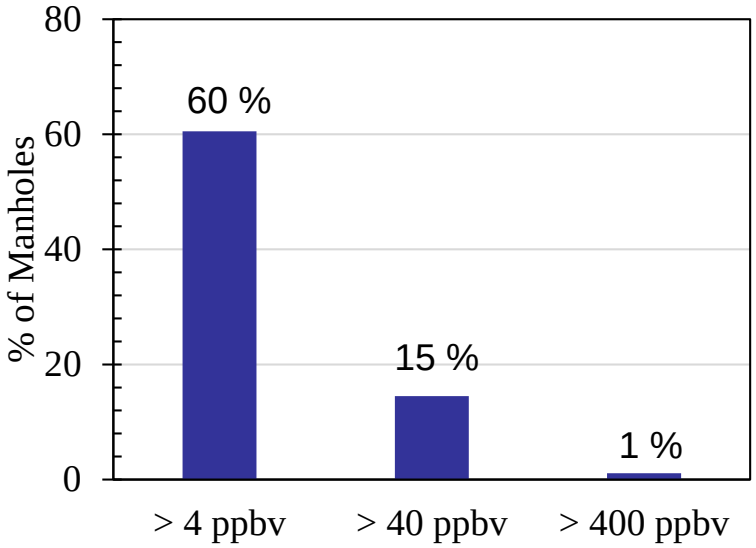
Sampled Manholes



Event	Vapor Sample Locations	Water Sample Locations
Jan 2016	82	25
May 2016	119	41
Aug 2016	268	67
Dec 2016	277	73
Apr 2017	276	75

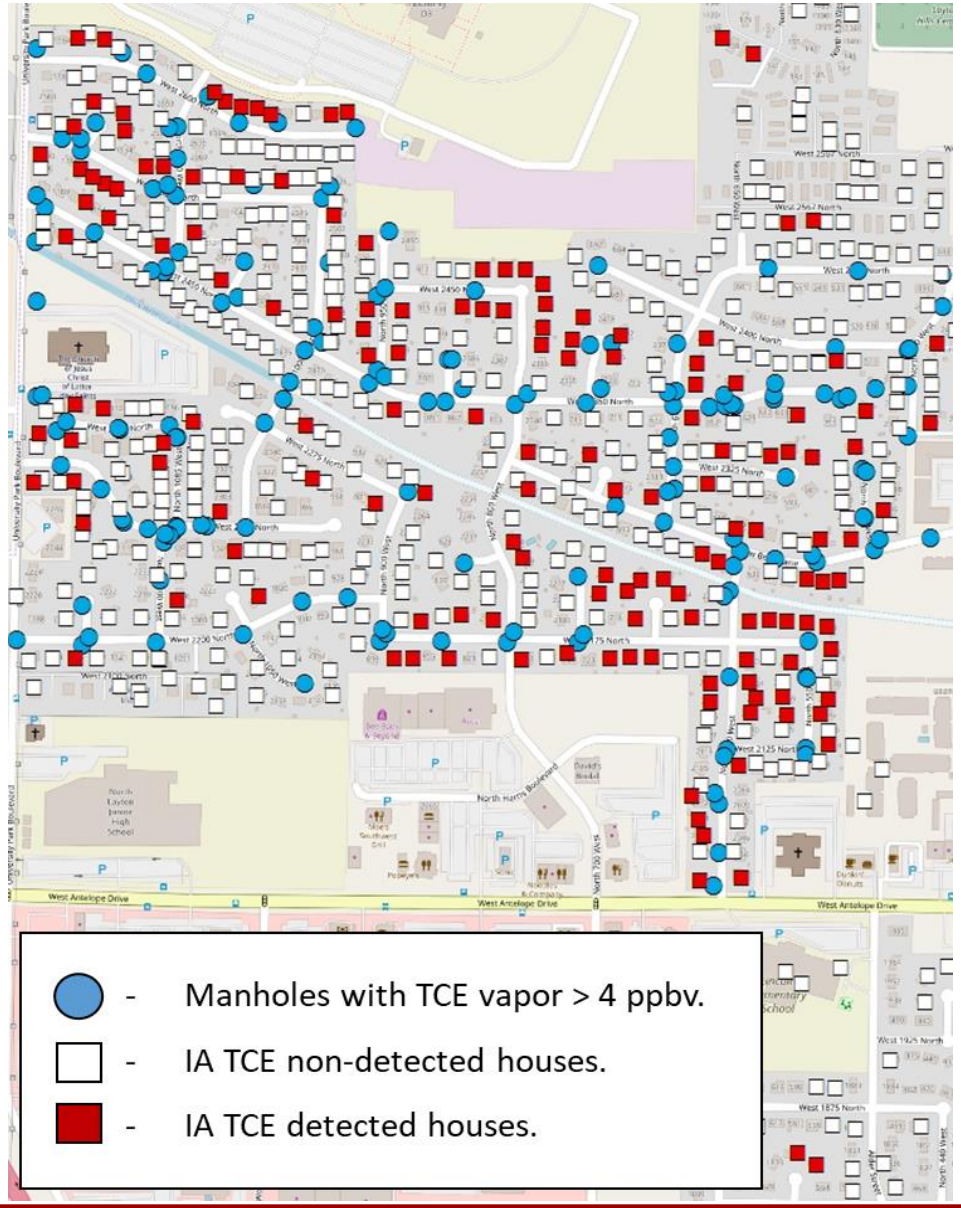


Maximum TCE Air Conc. in Manholes



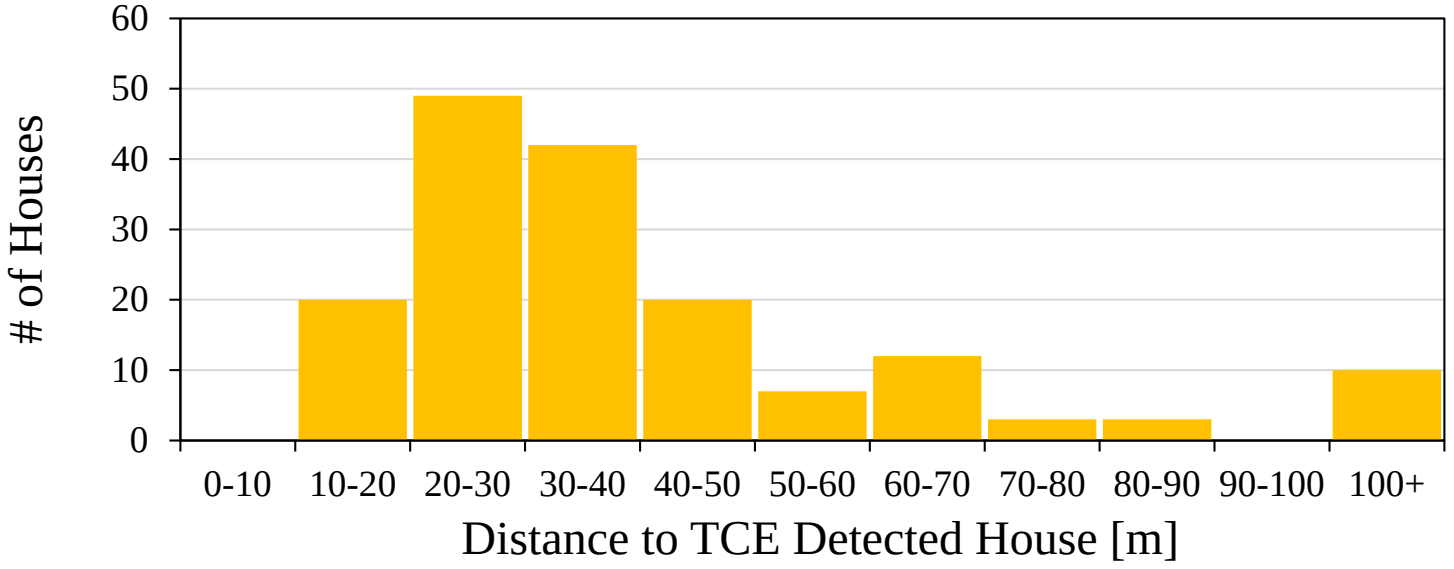
About 60% manholes have TCE vapor detected 10x greater than 0.4 ppb_v at least once.

Spatial Distribution: Indoor Air vs. Sewer/Land Drain

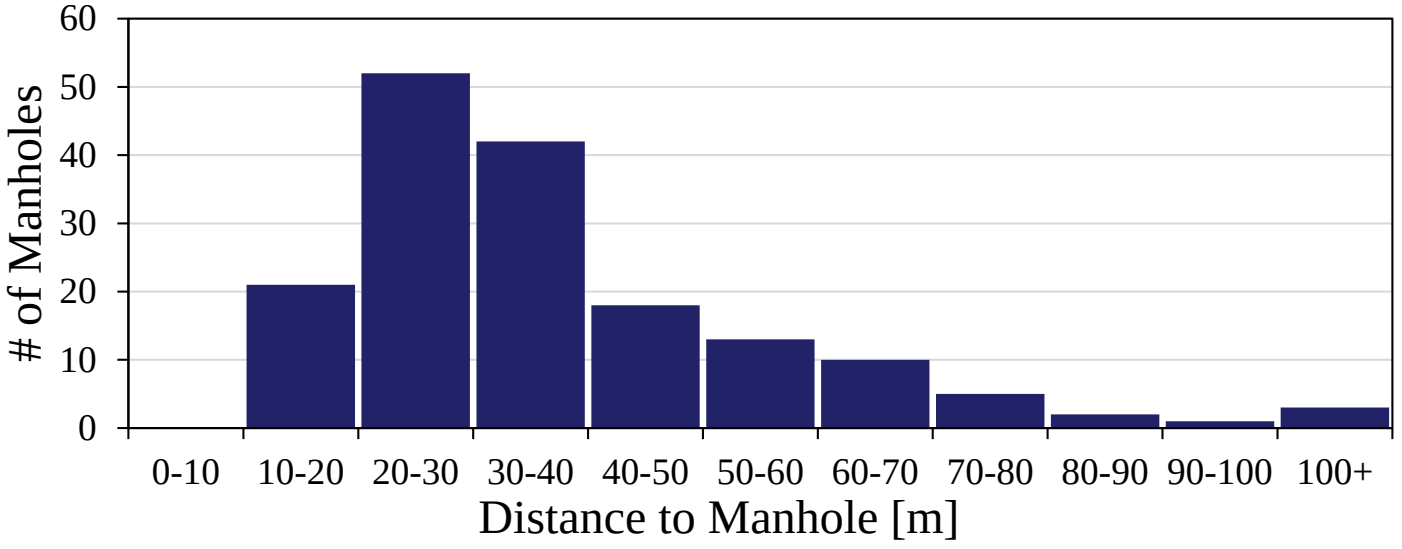


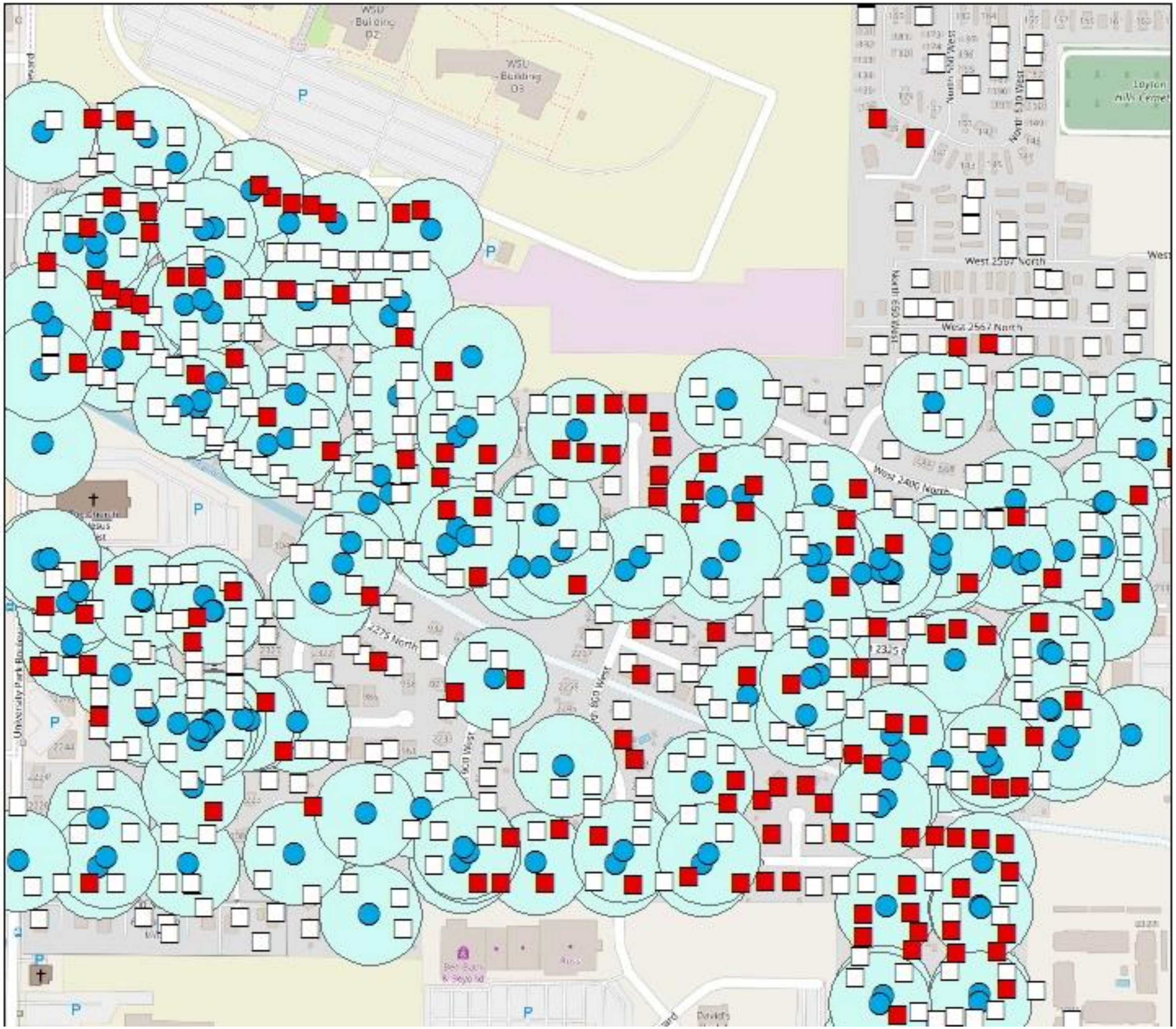
- Total of 668 houses were monitored at least once.
- Indoor air TCE was detected in 166 houses, and non-detected in 502 houses.
- TCE vapors in 109 of 276 manholes were detected greater than 4 ppb_v at least once.

Distance: The nearest manhole (> 4 ppbv) to a TCE detected house



Distance: The nearest TCE detected house to a manhole (> 4 ppbv)




WSU Building 03
West 2567 North
West 2567 North
2275 North

Spatial distribution:

Is there any spatial correlations between indoor air and sewer VOCs?

Key Points:

- **TCE vapors are detected > 4 ppb_v in 60% manholes; and > 40 ppb_v in 15% manholes.**
- **TCE vapors are detected in sewer/land drain and indoor air both inside and outside groundwater plume.**
- **Further researches are need to evaluate the correlations.**

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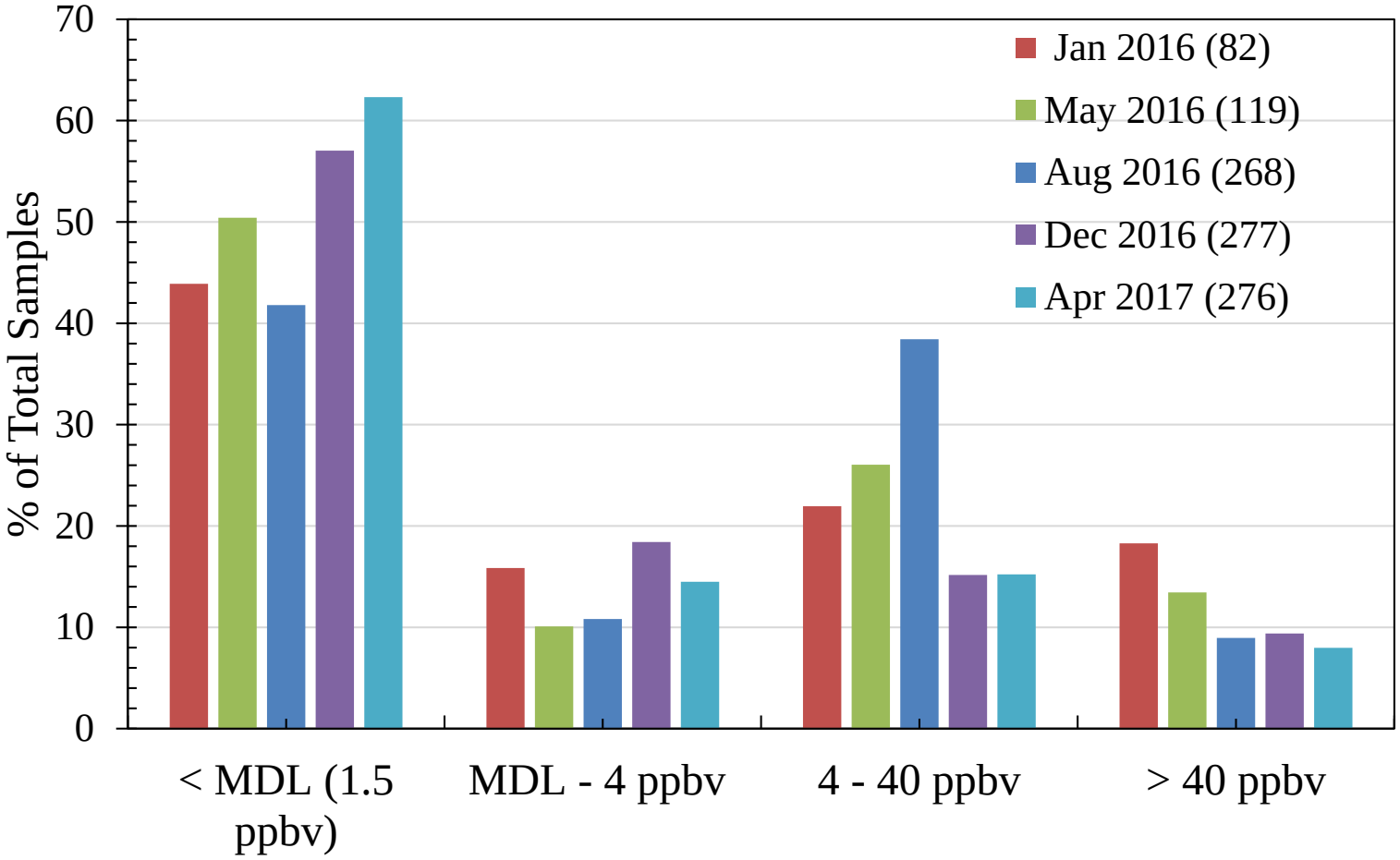
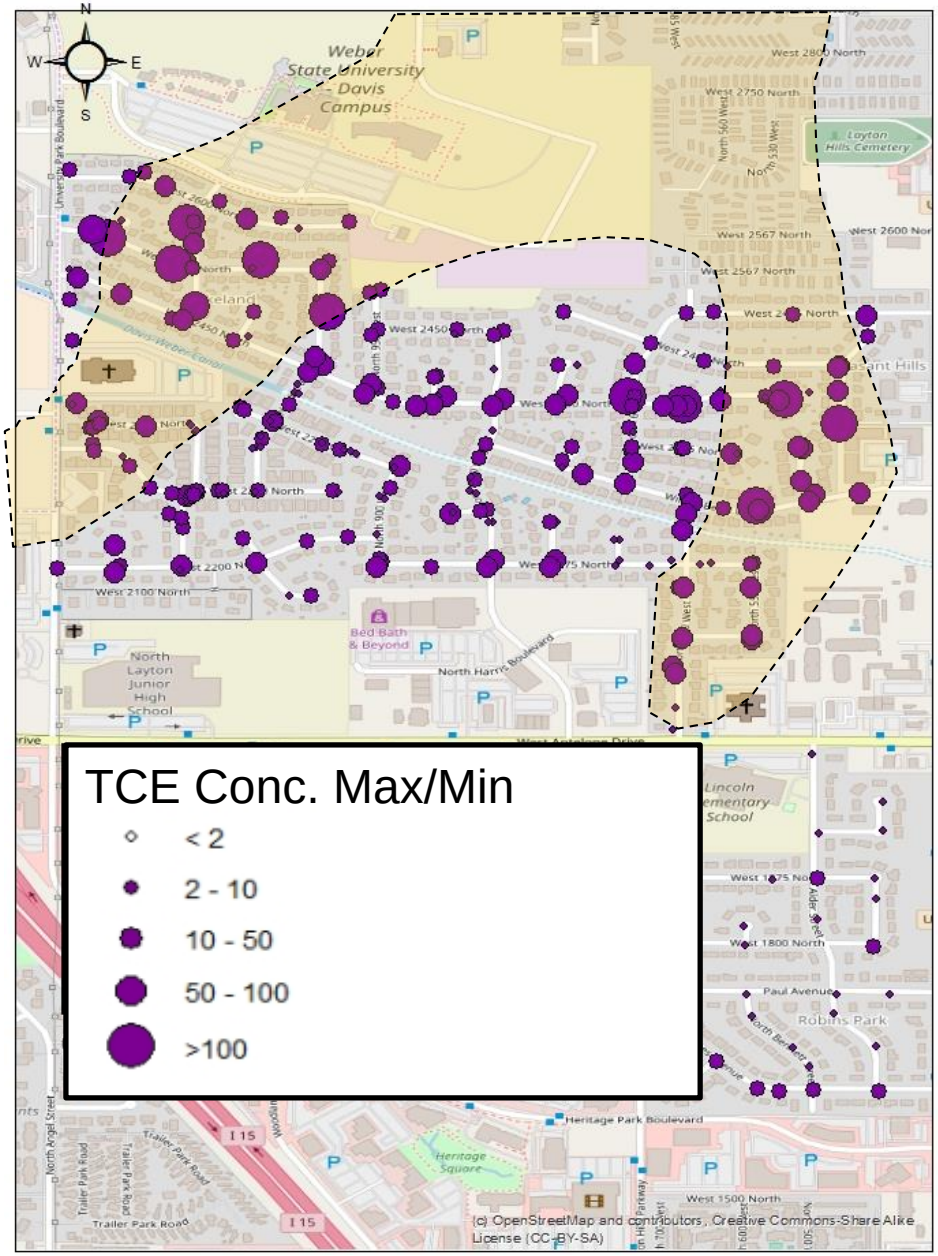
- **Temporal variability:** How many sewer samples does one have to take?

Vapor Concentrations Distribution Changes over Time

[in all manholes: land drain, storm drain, and sewer]



TCE vapor concentration > 40 ppbv in about 10 – 15 % of sampled manholes



Variation in Vapor Concentrations

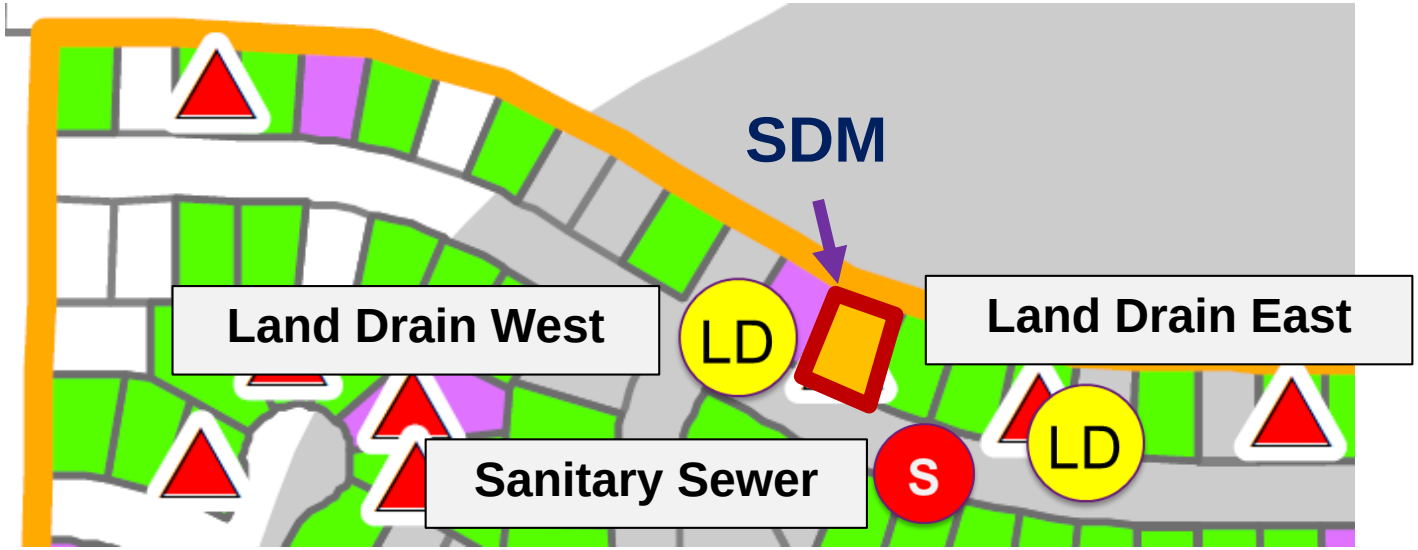
(from **268** manholes sampled at least 3X)

Variation (Max/Min)	# of Manholes
< 10 x	178
10 – 100 x	80
> 100 x	10

165 manholes TCE conc. > 4 ppb_v at least once

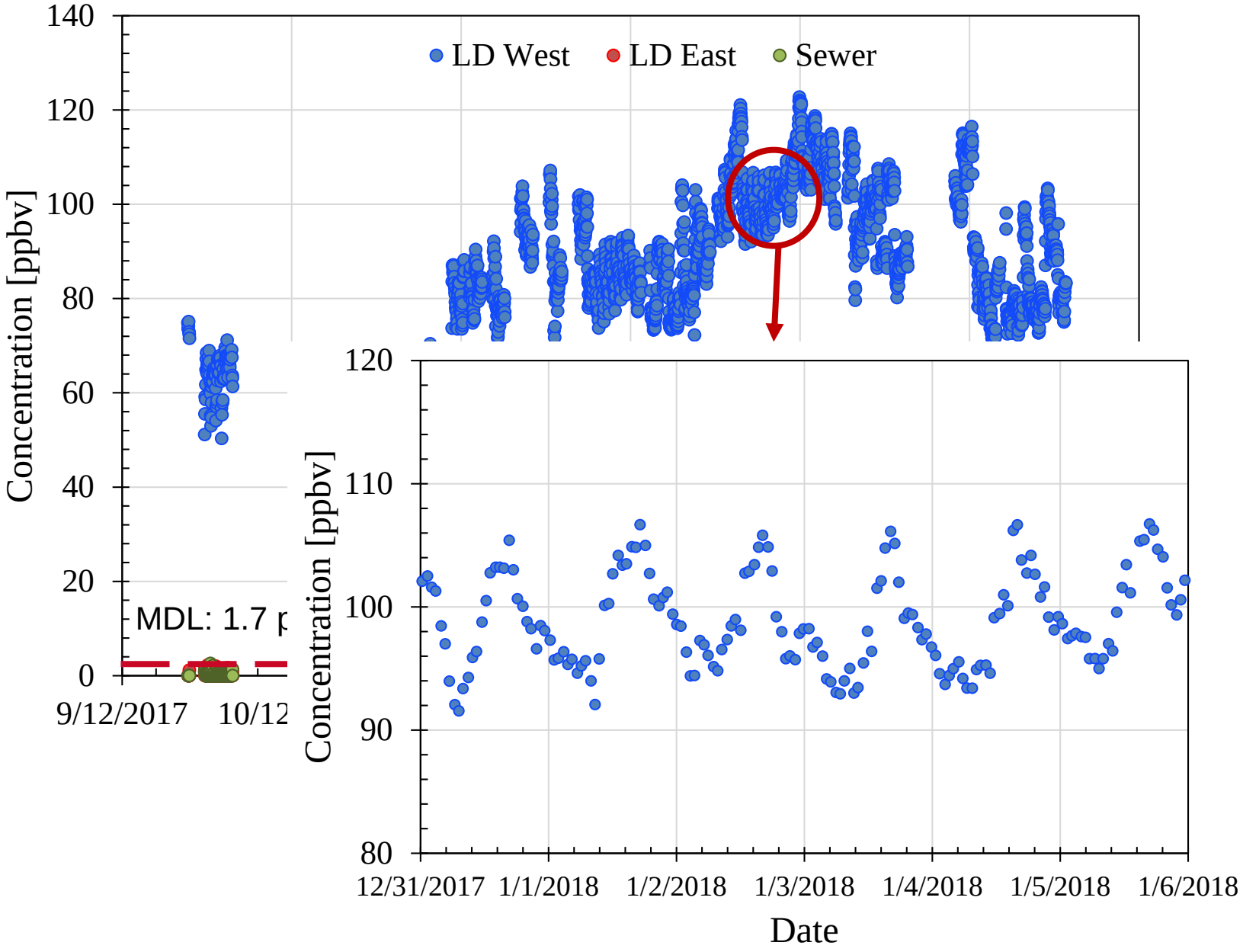
Variation (Max/Min)	# of Manholes
< 10 x	85
10 – 100 x	70
> 100 x	10

VOCs in Manholes: High-frequency Monitor



Snapshot Results [ppb_v]

	Jan-16	May-16	Aug-16	Dec-16	Apr-17
LD West	101.2	103.2	93.9	49.0	94.4
LD East	-	ND	ND	6.3	ND
Sewer	7.9	6.5	ND	ND	ND


LD West
LD East
Sewer
Concentration [ppbv]
140
120
100
80
60
40
20
0
MDL: 1.7 p
9/12/2017
10/12
120
110
100
90
80
12/31/2017
1/1/2018
1/2/2018
1/3/2018
1/4/2018
1/5/2018
1/6/2018
Date

Temporal variability:

How many sewer samples does one have to take?

Key Points:

- **Temporal variability is mixed, about 66 % manholes varied less than 10x; whereas the variation for the rest may affect decision making.**
- **A diurnal trend was observed in one land drain manhole: from night- to daytime, TCE vapor concentrations varied less than 2X.**

Future Research

- **How to use external measures to identify at-risk buildings?**
  - Static analysis on correlation between VOCs in sewer/land drain and indoor air concentrations.
  - CPM test validation
- **VOCs temporal variability in sewer and land drain**.

Thank you!

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