Site 5 CRREL – Mitigation Monitoring & Temporal Trends at a Large TCE site, Hanover, NH

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- 22 October 2019

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US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

Acknowledgements

- Laurie Haines-Eklund (U.S. Army Environmental Command)
- Terry Harwood (USACE ERDC-CRREL)
- Darrell, Moore, Dan Groher (USACE NAE)
- Dave Becker (USACE EMCX)
- Jack Besse, Scott Calkin, Rod Rustad, Jeffrey Picket, Glen Gordon, Wolfgang Calicchio (Wood Plc)

Building Specifics

- Government laboratory building built in 1954, multiple additions
  - Two stories with basement and subbasement
  - Foundation slab on prepared excavation
  - Building footprint 16,000 ft^2 - total all floors 52,000 ft^2
  - No HVAC system in main laboratory
    - ► Cooling water utilized
  - Air distribution in laboratory addition

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Building Occupancy

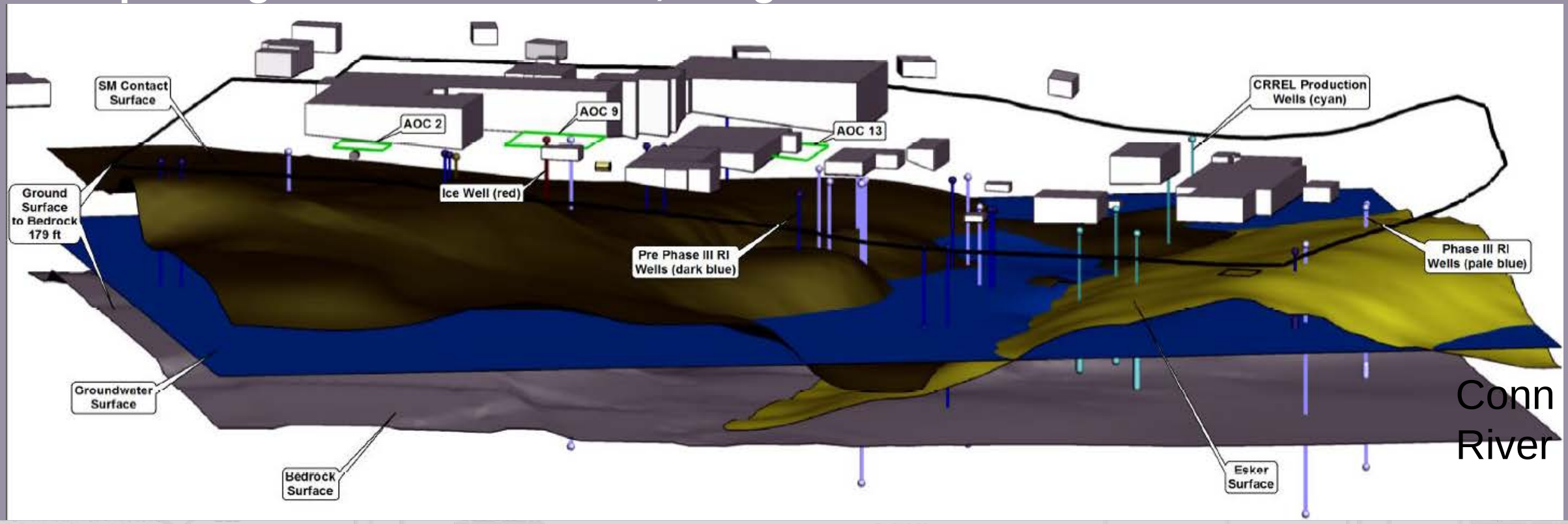
- Government laboratory facility
  - Over 50 office and laboratories per floor
  - Over 150 people in the building
  - Rooms occupied during sampling events
- Sampling Indoor Source Investigation
  - Carbon Air Purifier's installed in offices in 2012 - 2014
  - Deployment of Summa canisters biannually
  - Daily HAPSITE™ use, 30+ rooms/day
  - Sleuthing of sources with HAPSITE™
- Action Plan developed to respond to elevated readings
- Site Action Level of 8.8 µg/m^3 established

Contaminant Site Specifics

- **Release conditions**
  - Catastrophic and repetitive slow release from TCE leaks
  - Limited DNAPL observed initially in shallow soil
  - Subsurface vapor plume feeds VI and groundwater plume
  - Releases within 100 ft north of building and 300 ft west of building and adjacent
- **Pre-remedial contaminant distribution**
  - Subsurface soil gas TCE concentrations near main laboratory in excess of 10,000,000 ug/m^3
  - Sub-slab TCE concentrations up to 5,900,000 µg/m^3
  - Indoor air sub-basement TCE concentrations, 25 to 91 µg/m^3
  - Indoor air basement TCE concentrations, 15 to 241 µg/m^3
  - Indoor air 1st floor TCE concentrations, 0.86 to 4.7 µg/m^3
  - Indoor air 2nd floor TCE concentrations, 2.5 to 11 µg/m^3

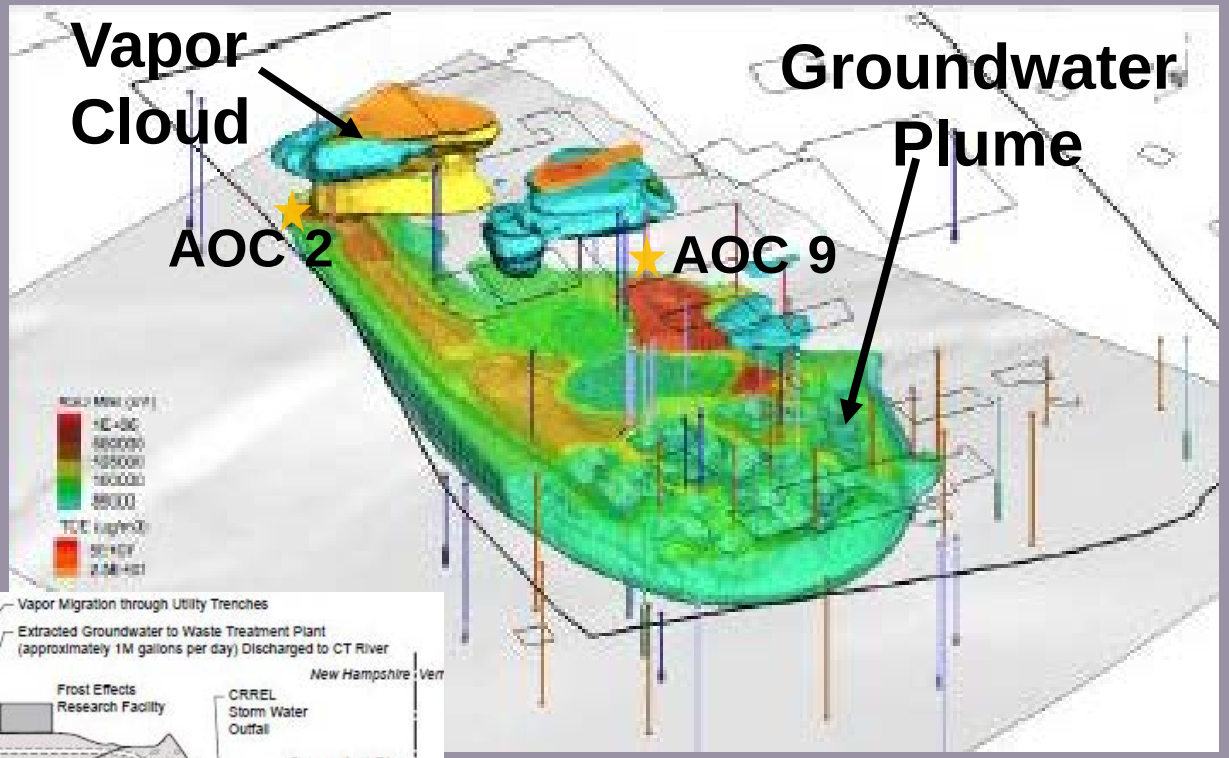
Site Location

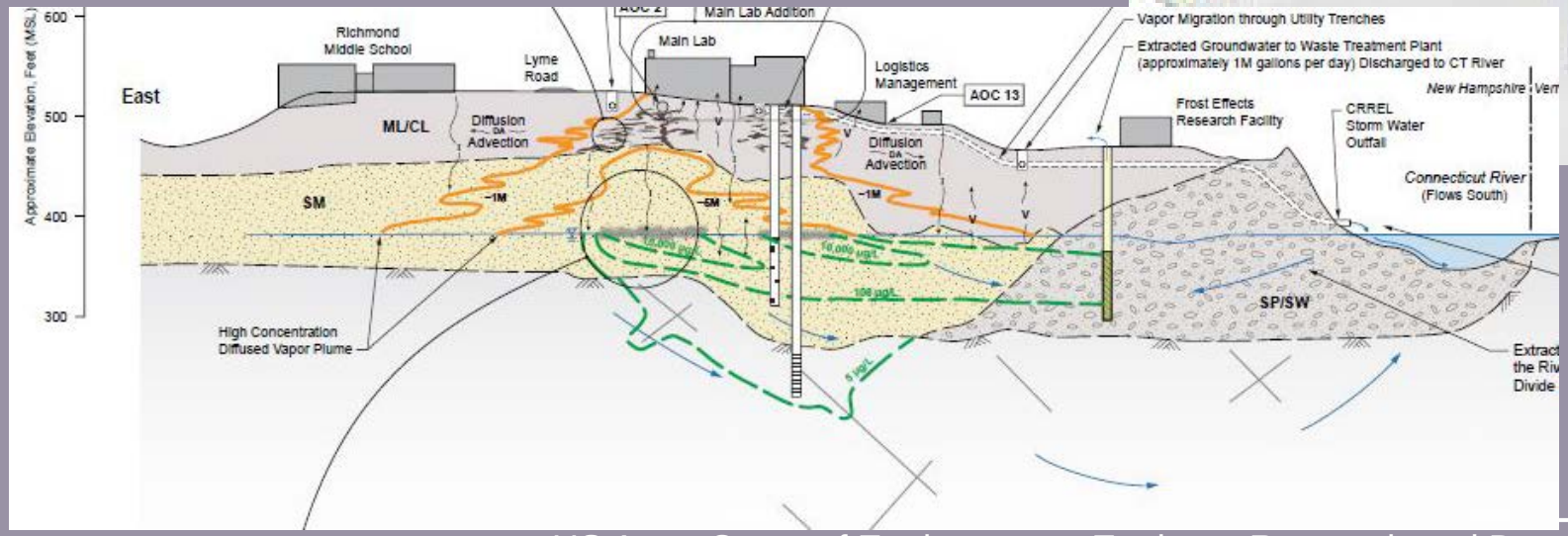
- Hanover, NH, Climate zone 4b
- Fine lacustrine sands coarsening downward to bedrock
- Esker located downgradient by river
- Depth to groundwater ~ 150 ft, flat gradient



Conceptual Site Model

- TCE mass primarily in vapor phase
- Secondary source soil
- Pathway from vapor to Groundwater
- Conventional advection/ diffusion





Mitigation Measures

- 1960 - 1987 - TCE released from various leaks and spills at the Cold Regions Research and Engineering Laboratory in Hanover, NH
- 2010 - Vapor Intrusion (VI) detected in main laboratory
- 2012 - 2014 - Carbon Air Purifier's installed in offices in
- 2015 - Sub-slab Depressurization System (SSDS) installed
- 2015 - 2018 – Soil Vapor Extraction (SVE) Pilot Tests conducted at two locations
- 2016 - One-way valves installed on roof drain piping
- 2017 - TCE pumped out of old refrigeration lines in building
- 2018 - Smoke Test conducted and VI utility leaks fixed
- 2019 - Refrigeration lines removed
- 2019 – Carbon Air Purifier’s installed in Plenum/Roof Truss Space

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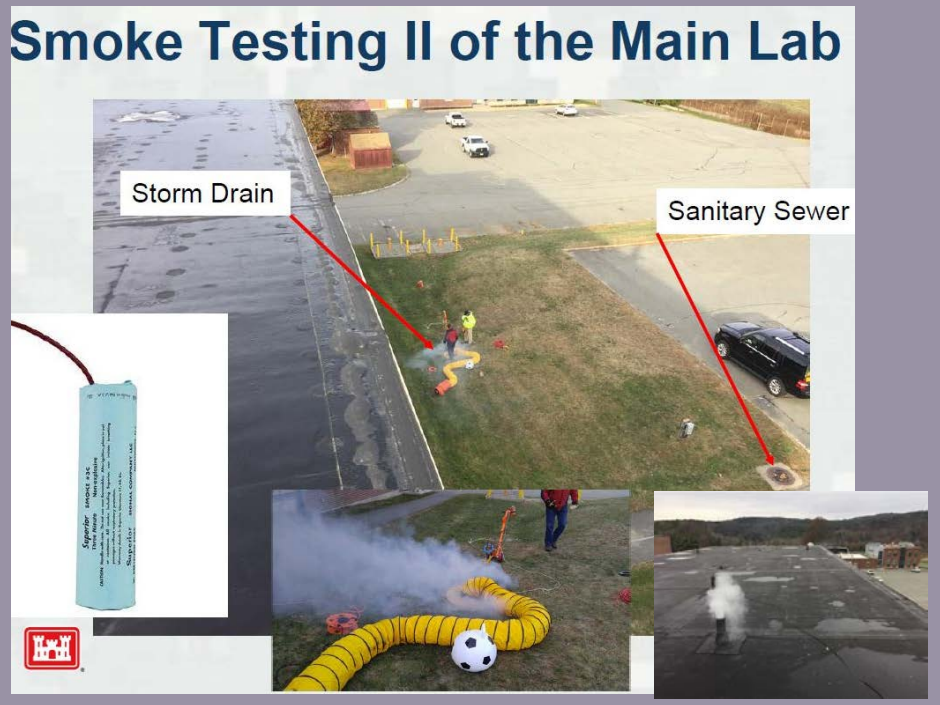
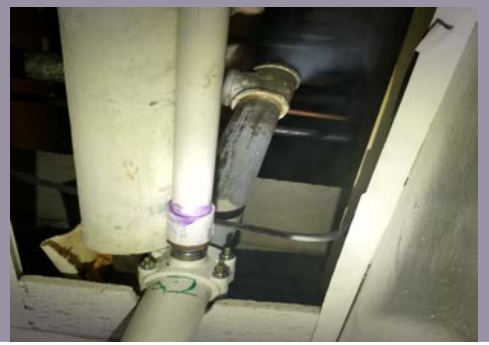
Investigation/Monitoring Information

- Initially full VOC suite analyzed
- Subsequent focus on TCE
  - Summa and HAPSITE™
- Ancillary data collected daily
  - Outside air temperature and pressure
  - Subsurface soil temperature and pressure
  - Building temperature and pressure
- HAPSITE™ Sleuthing



Toilet Seal

Sanitary Sewer Line Above Suspended Ceiling



Open Pipe Beneath Raised Floor

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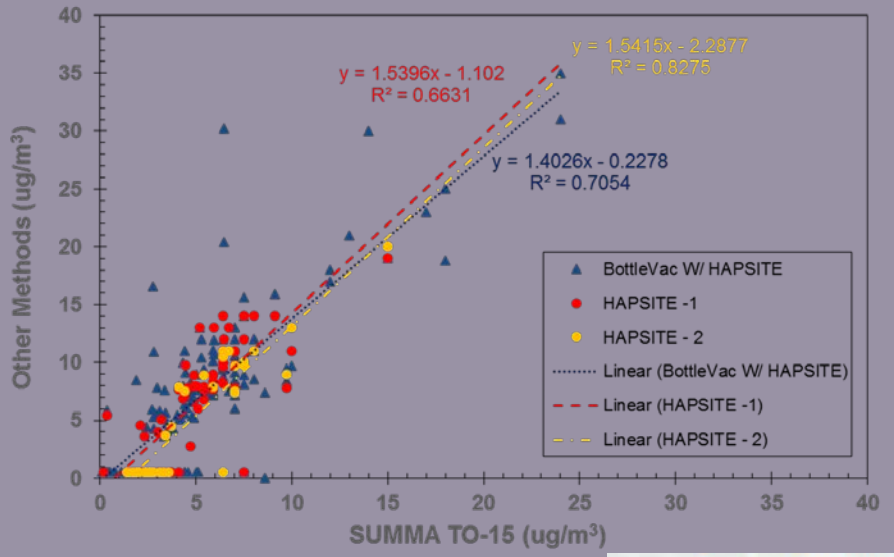
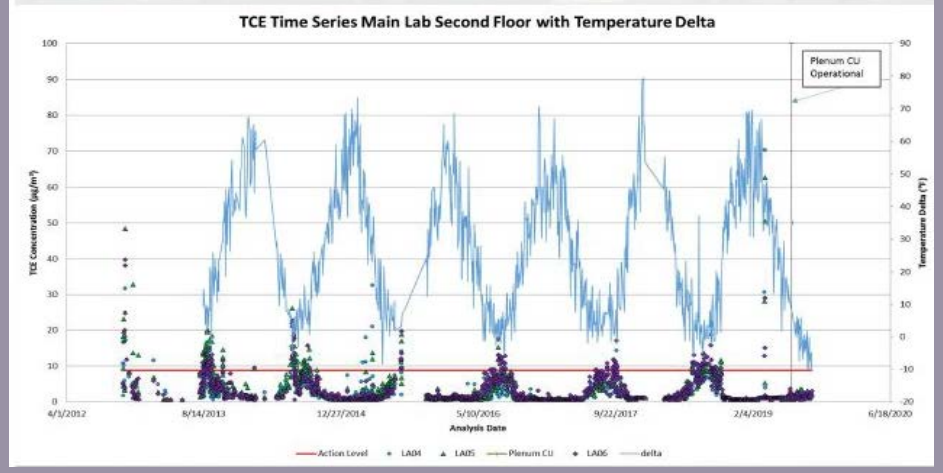
Data Analysis

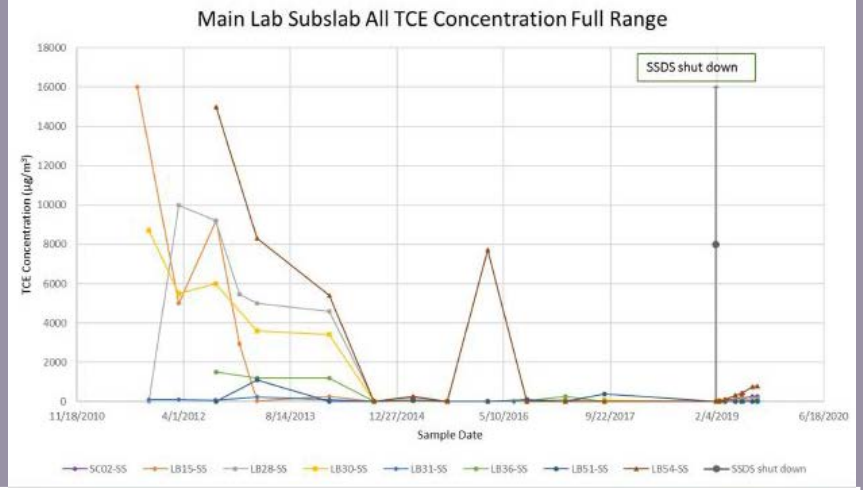
- Distribution Maps
- XY Plots
- Regression Time Analysis
- Correlation Analysis



2nd Floor Plenum Sampling



Sub-Slab Depressurization Shutdown



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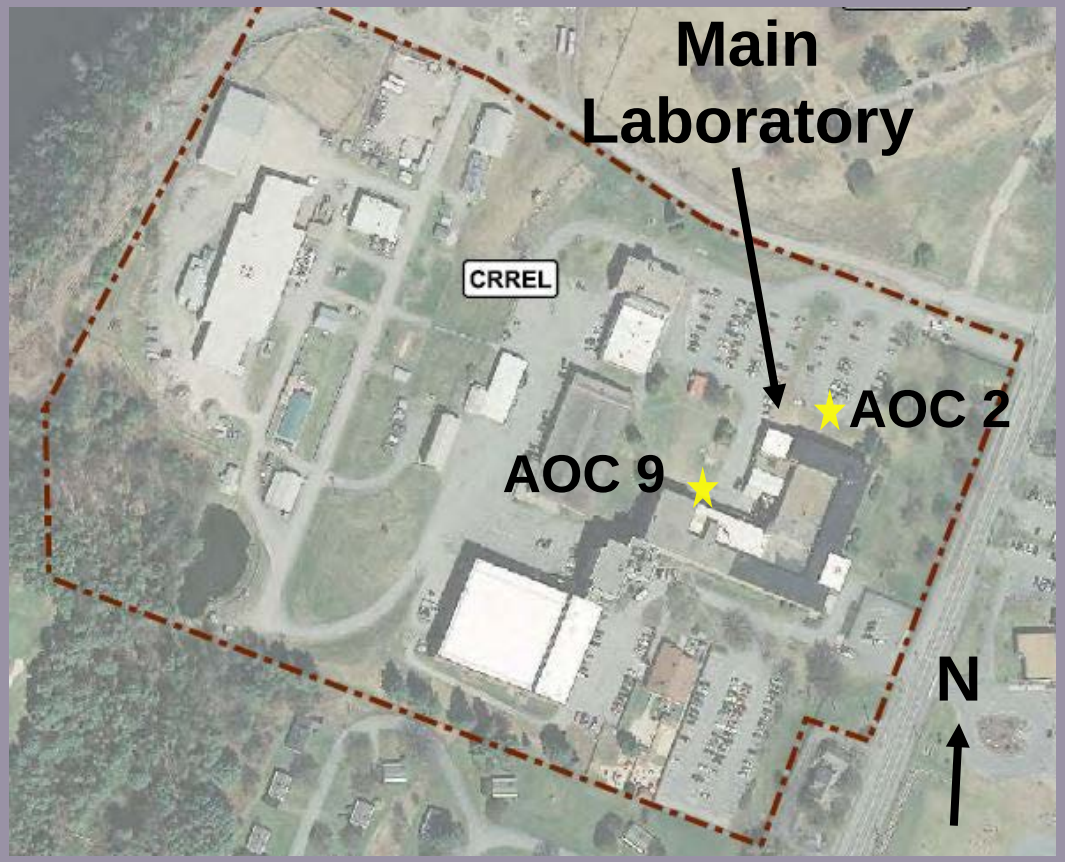
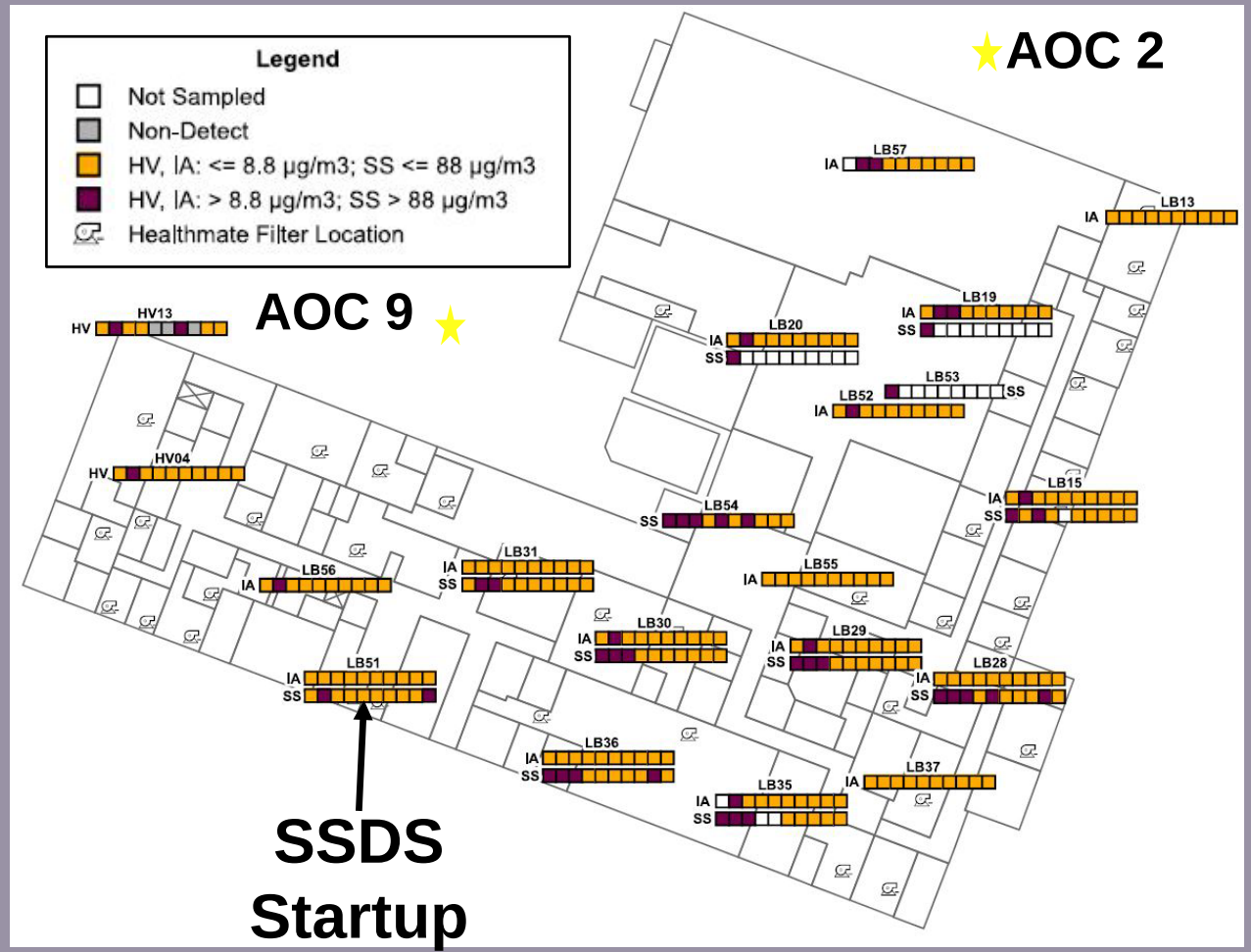
TCE Building Spatial Distribution



Basement TCE Levels



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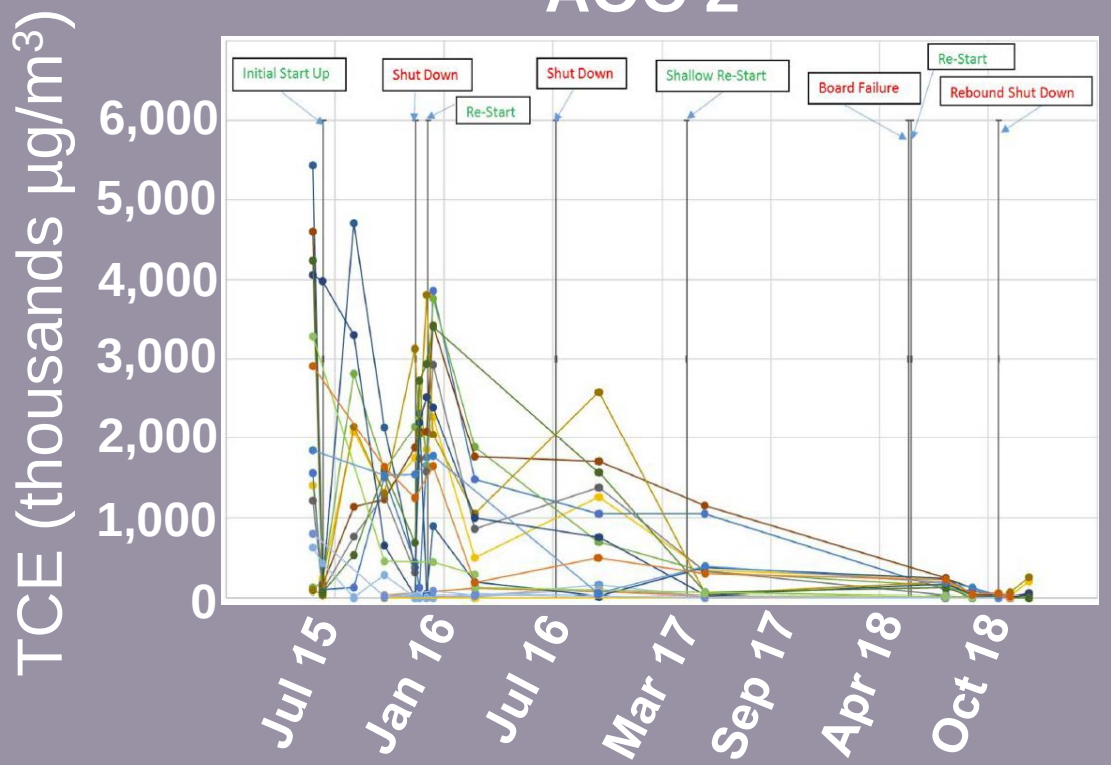
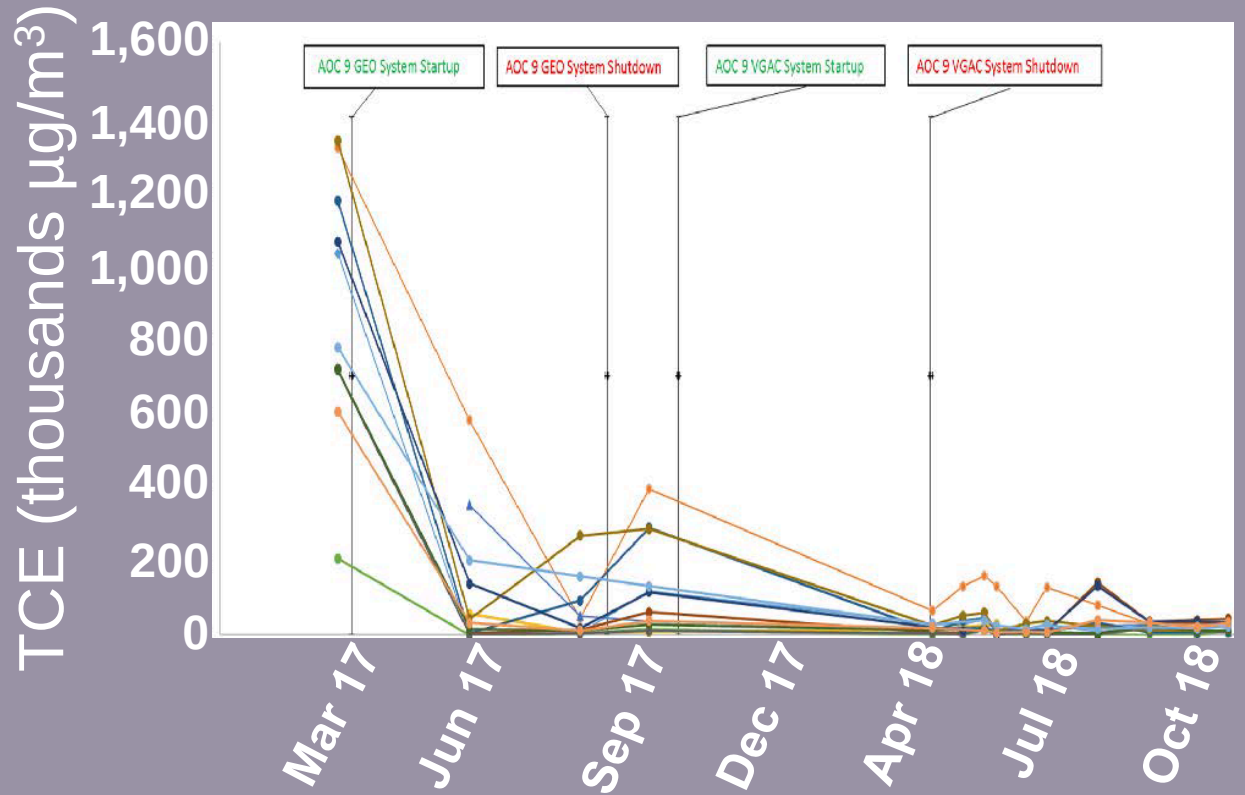
SVE Soil Gas Level Variability

AOC 2



AOC 9



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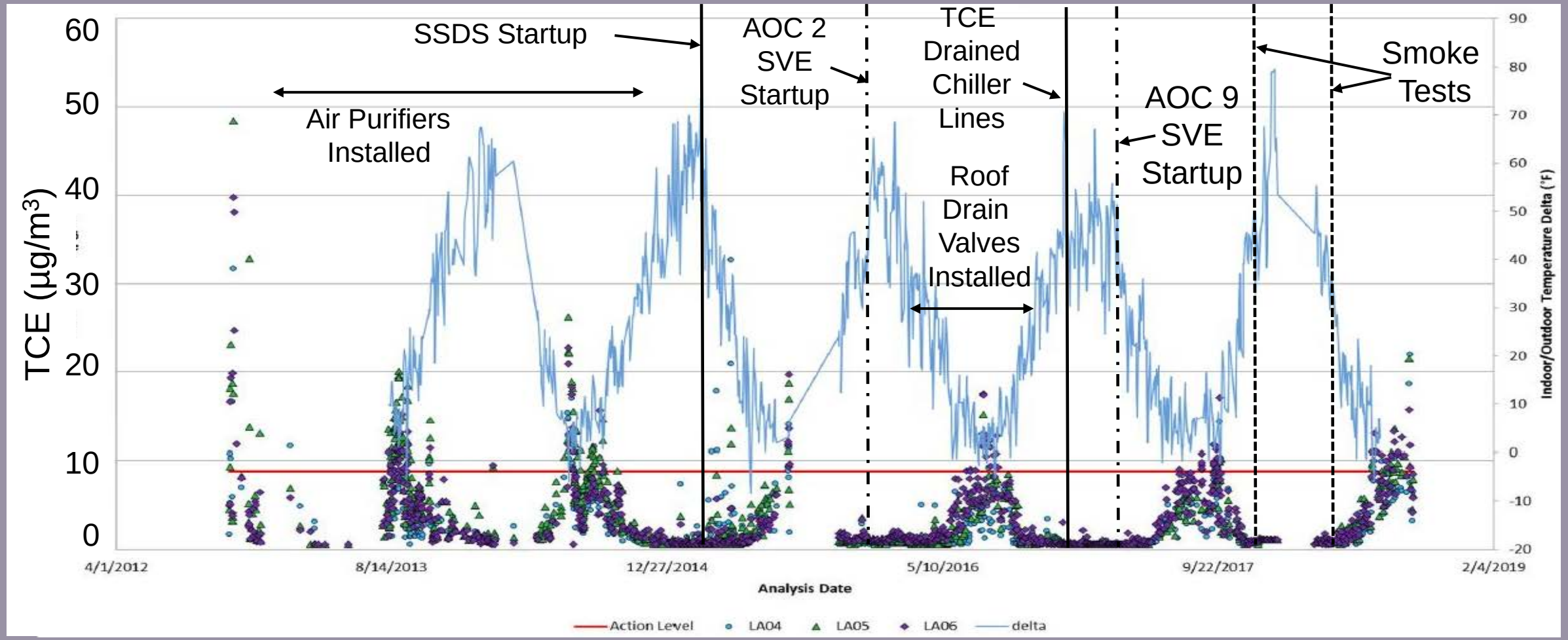
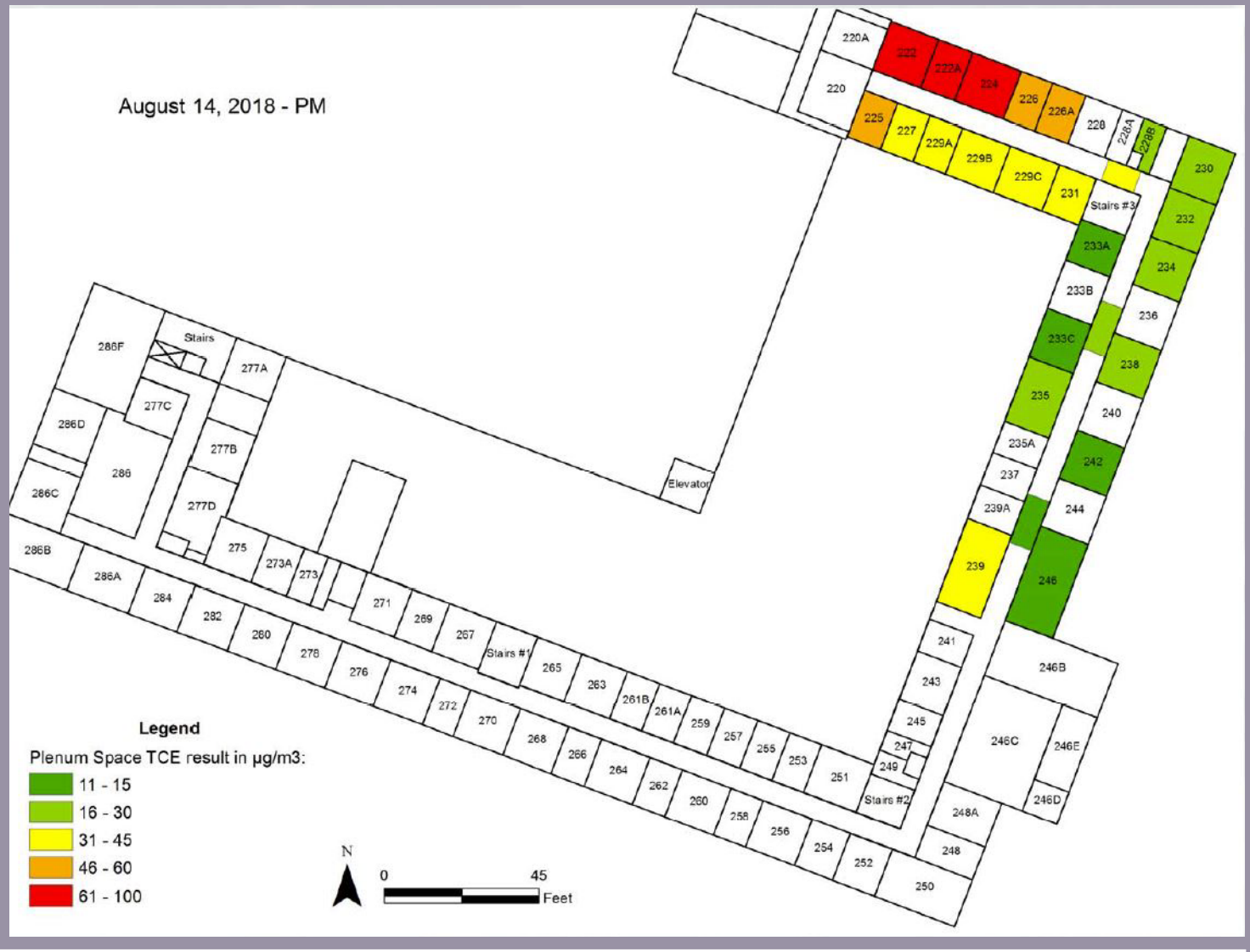
TCE Seasonal Variability (2nd Floor Main Laboratory)

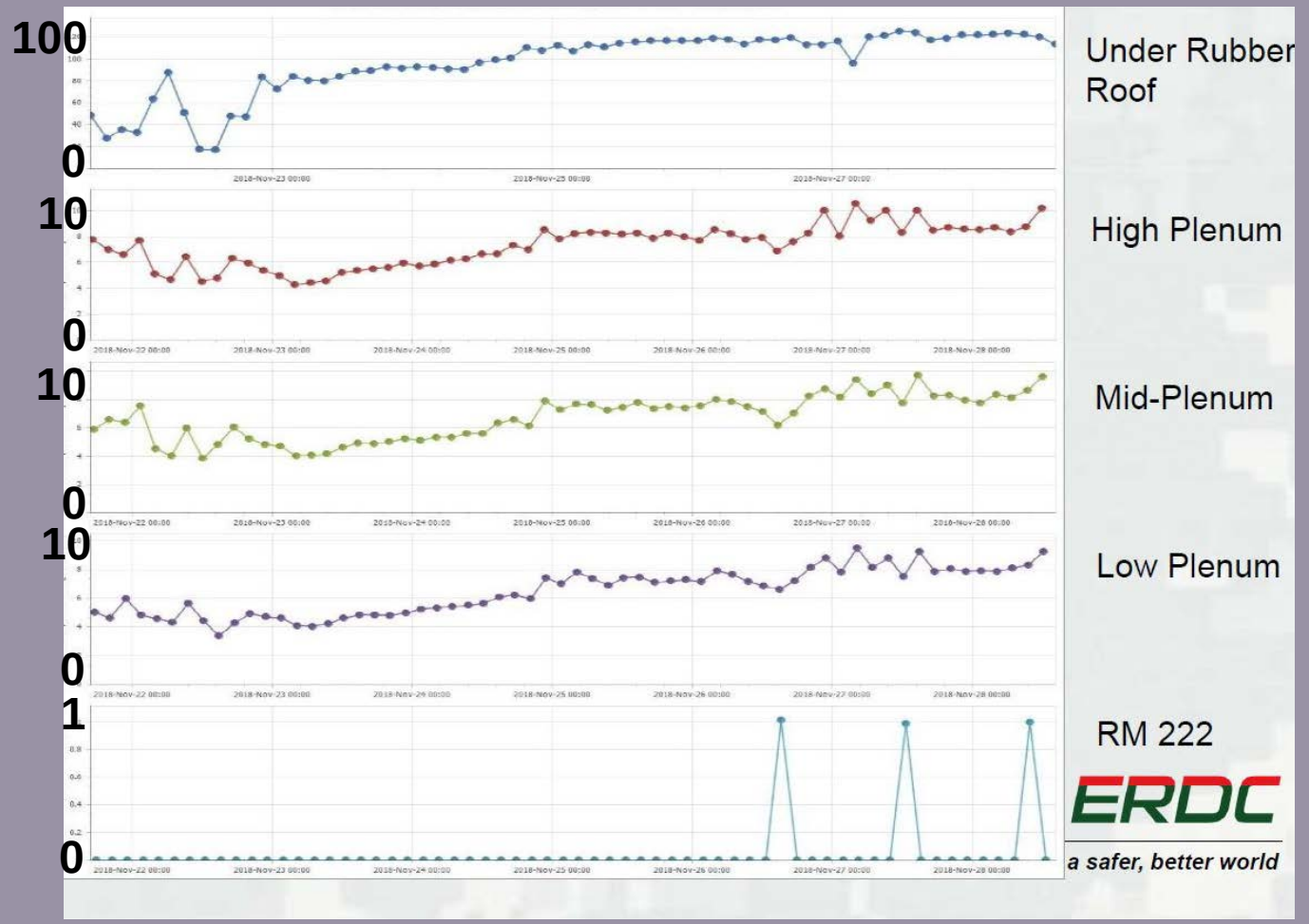


TCE Distribution in Plenum

August 14, 2018 - pm



Plenum TCE Levels



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Current Status

- No rebound of TCE observed at SVE pilot-test locations
- SSDS influent TCE levels below 880 ug/m^3 regulatory guideline
- SSDS TCE vapor concentrations generally below 100,000 ug/m^3
- Periodic TCE fluctuations above action levels in second floor north wing offices in late Summer, mitigated since carbon purifiers installed in plenum/truss space
- Air in roofing material space contaminated

Conclusions

- Vapor emanations along utility lines (roof drains, sewer lines, refrigeration lines), elevator shaft, from volatile back diffusion from building materials (concrete, insulation, roofing) and other sources contributed to indoor TCE
- Periodic SUMA canister sampling is insufficient for assessing VI
- Extrapolation of VI pathways from residential studies to industrial sites is inappropriate and misleading
- Term VI should be broadened to not only include emanations through sub-slab but emanations from volatile back diffusion of building materials and subsurface preferential pathways (utility lines)