

Cyclical SVE for VI Mitigation of High Strength Soil Gas VOCs at Active Military Building Naval Air Station North Island, San Diego, CA

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** Presenting*

Presentation Overview



- 1. Objective**
- 2. Background**
- 3. Remedial Activities**
- 4. SVE Results**
- 5. Approach**
- 6. Findings**
- 7. Results/Lessons Learned**

1.0 Objective



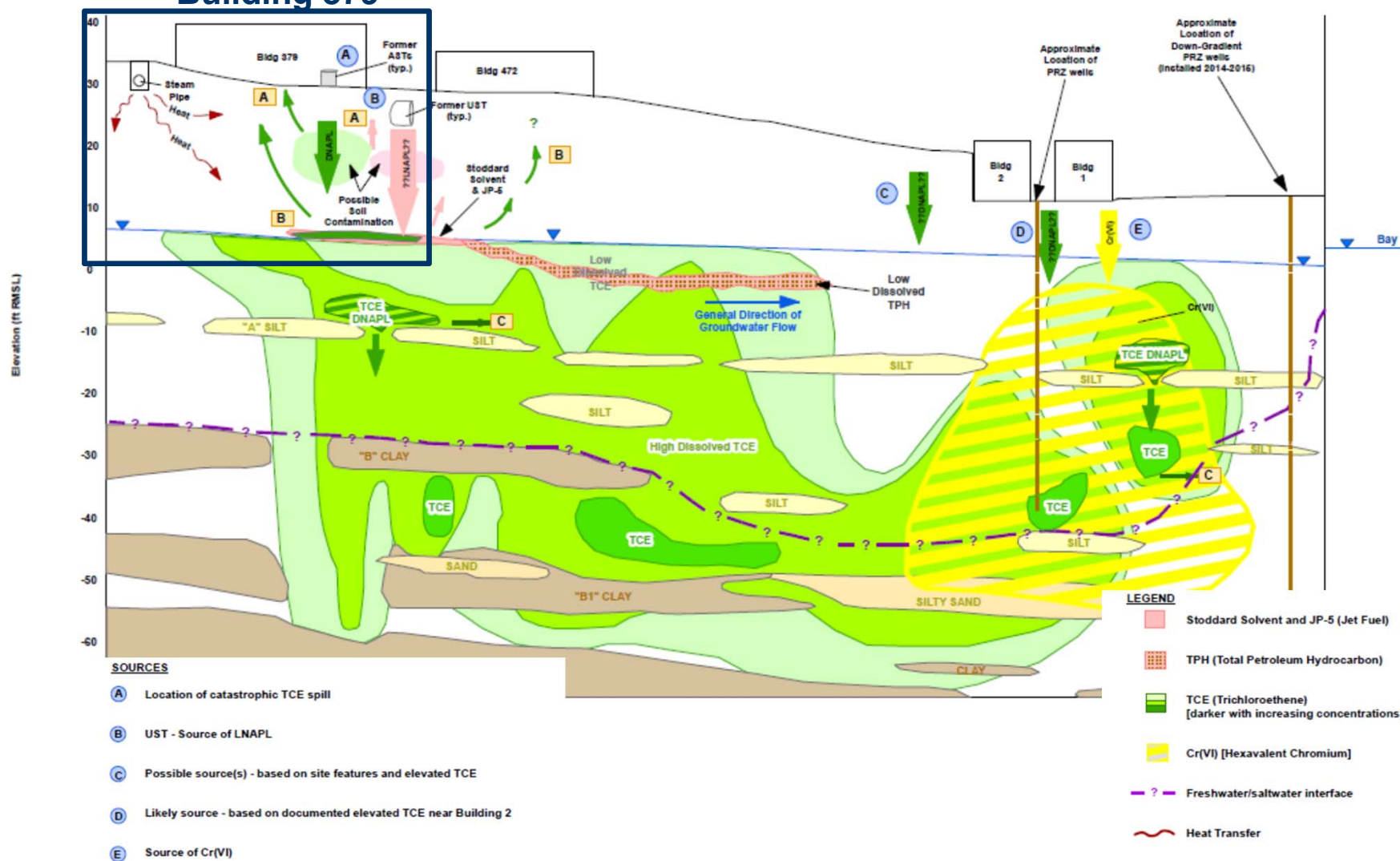
- Currently a soil vapor extraction (SVE) system is in continuous operation at Building 379 at NASNI to mitigate chlorinated volatile compounds (cVOCs) in indoor air
- Cyclical SVE is being considered to optimize costs, while maintaining a safe environment for workers in the building

The objective is to determine how long the SVE system could remain off before indoor air and sub-slab soil gas cVOCs increased to unacceptable levels.

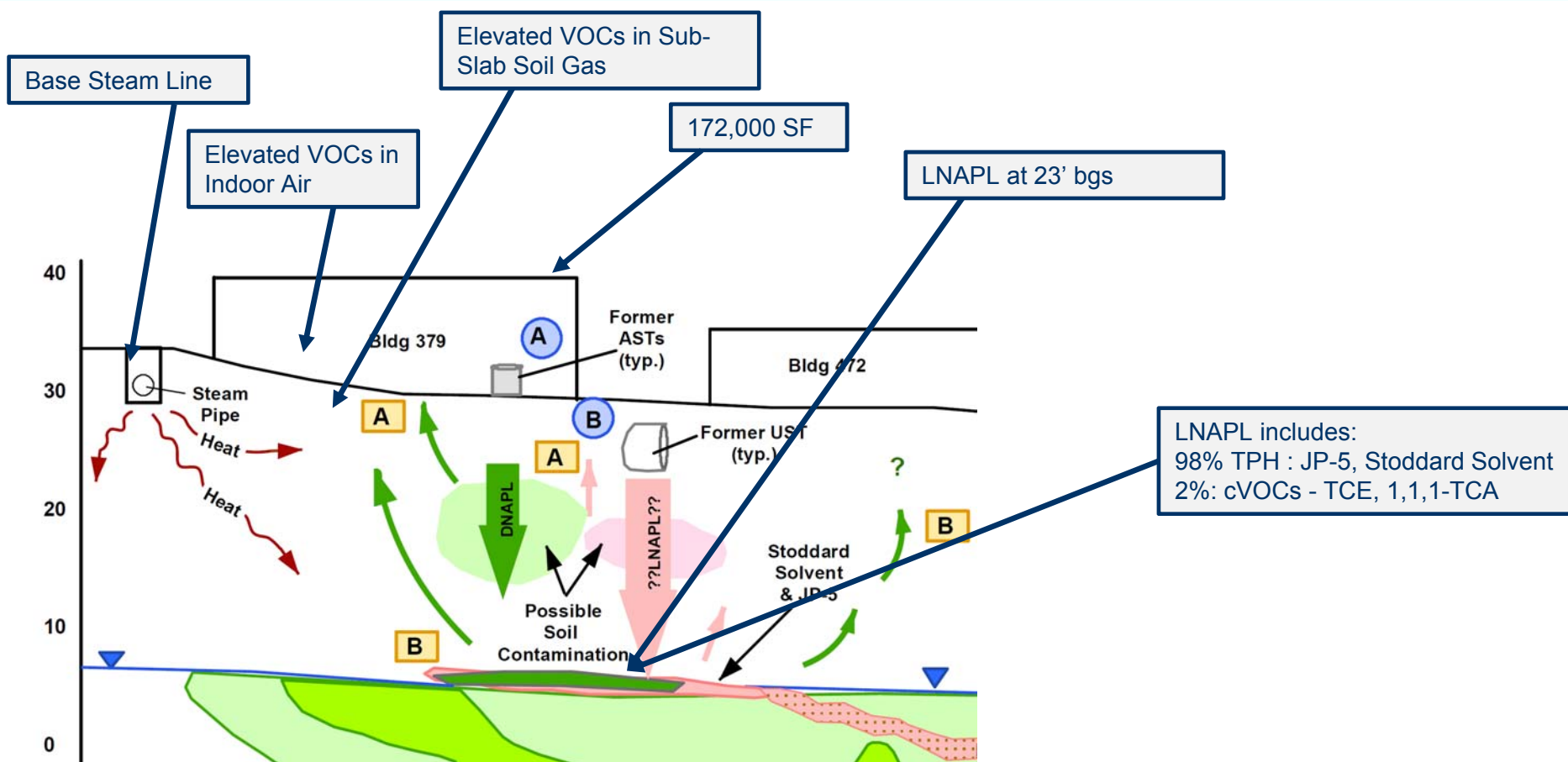
2.1 Building 379



Building 379



2.2 B379 Conceptual Site Model



2.3 Pre-TCRA Site Conditions

- LNAPL volume estimates - range from tens to hundreds of thousands of gallons, >98% TPH and <2% cVOCs
- Approximately 40% of the LNAPL footprint includes cVOCs
- A portion of the LNAPL plume is at temperatures above 100 °F, due to Base steam line
- Elevated levels of cVOCs are present in sub-slab soil gas (over 6,000,000 $\mu\text{g}/\text{m}^3$) and in indoor air [above indoor air screening levels (IASLs)]
- cVOCs represent approximately 50% of the soil vapor concentrations (although < 2% of LNAPL is cVOCs)

2.4 Building 379 VI TCRA

Based on the elevated levels of TCE (and other cVOCs) in sub-slab soil gas, and levels of TCE above Accelerated Response Action Levels (ARALs) in indoor air, a VI TCRA was initiated:

- Offered relocation to sensitive receptors
- Modified operation of the ventilation system
- Sealed over 15,000 LF of cracks and joints
- Sealed pathways in both restrooms, floor in lunch room received seal coat
- Deployed Air Purification Units in selected rooms
- Implemented SVE system – dual-screened horizontal SVE well under Building 379
- Operation started on May 18, 2016
- System enhancements constructed in 2017

3.0 Remedial Activities



- An SVE system has been in operation since May 2016, implemented as a mitigation measure for sub-slab and indoor air VOC concentrations.
- The system consists of:
 - Two horizontal wells under the northern portion of the building at 10 feet bgs
 - A vapor extraction and treatment system that uses compression and refrigeration to condense the TPH/cVOCs in extracted vapor to liquid product
- To date, 17,000 lbs of VOCs have been recovered, resulting in lowered indoor air concentrations to acceptable levels

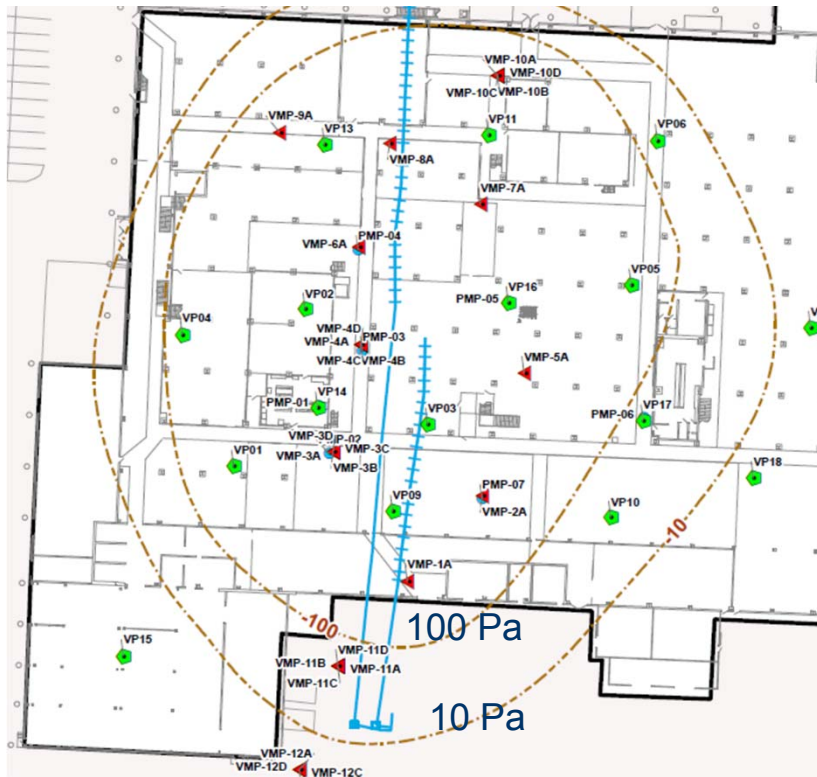


4.1 SVE Results: Sub-Slab Vacuum Responses

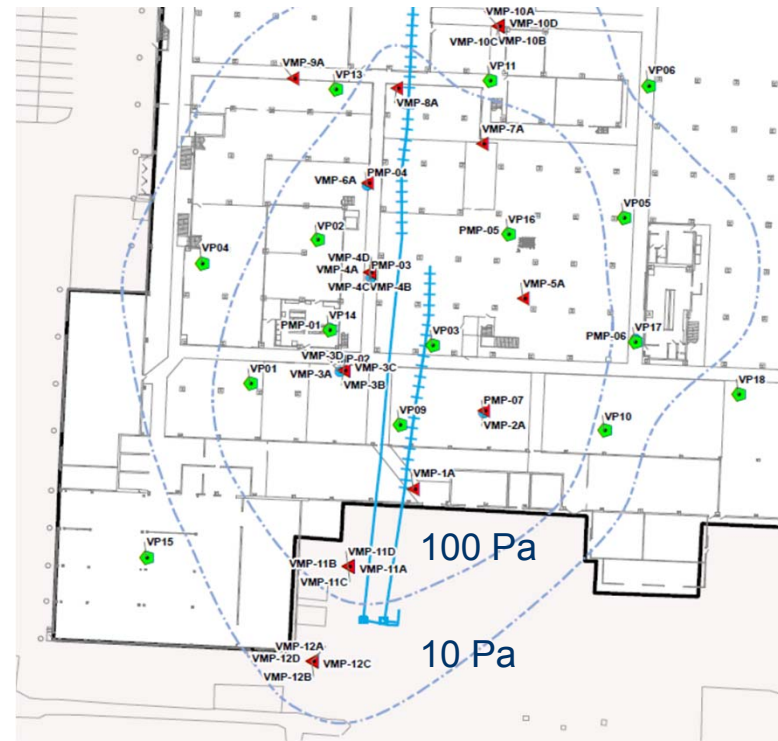
Results in Pascals (Pa)



September 2016 – Both Wells extracting



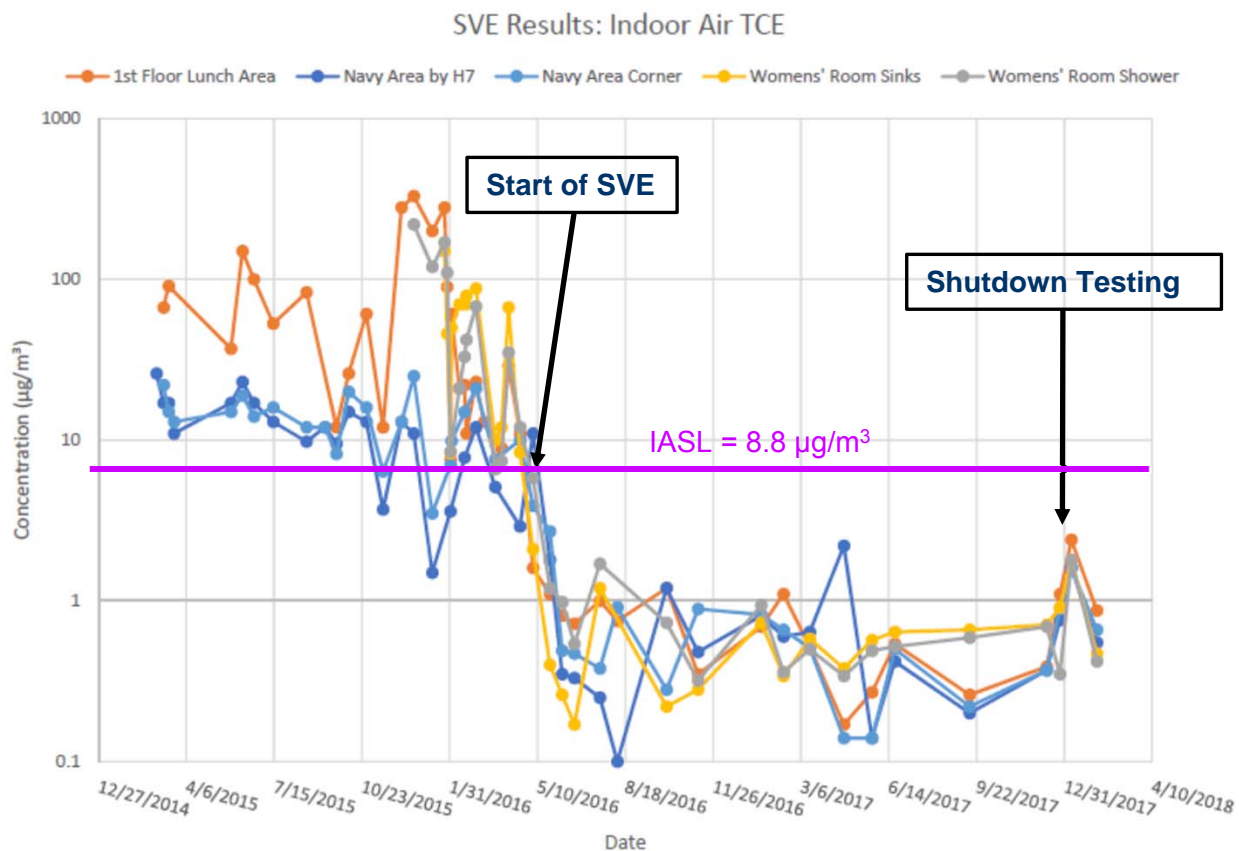
February 2017 – Only Short Well extracting (since November 1, 2016)



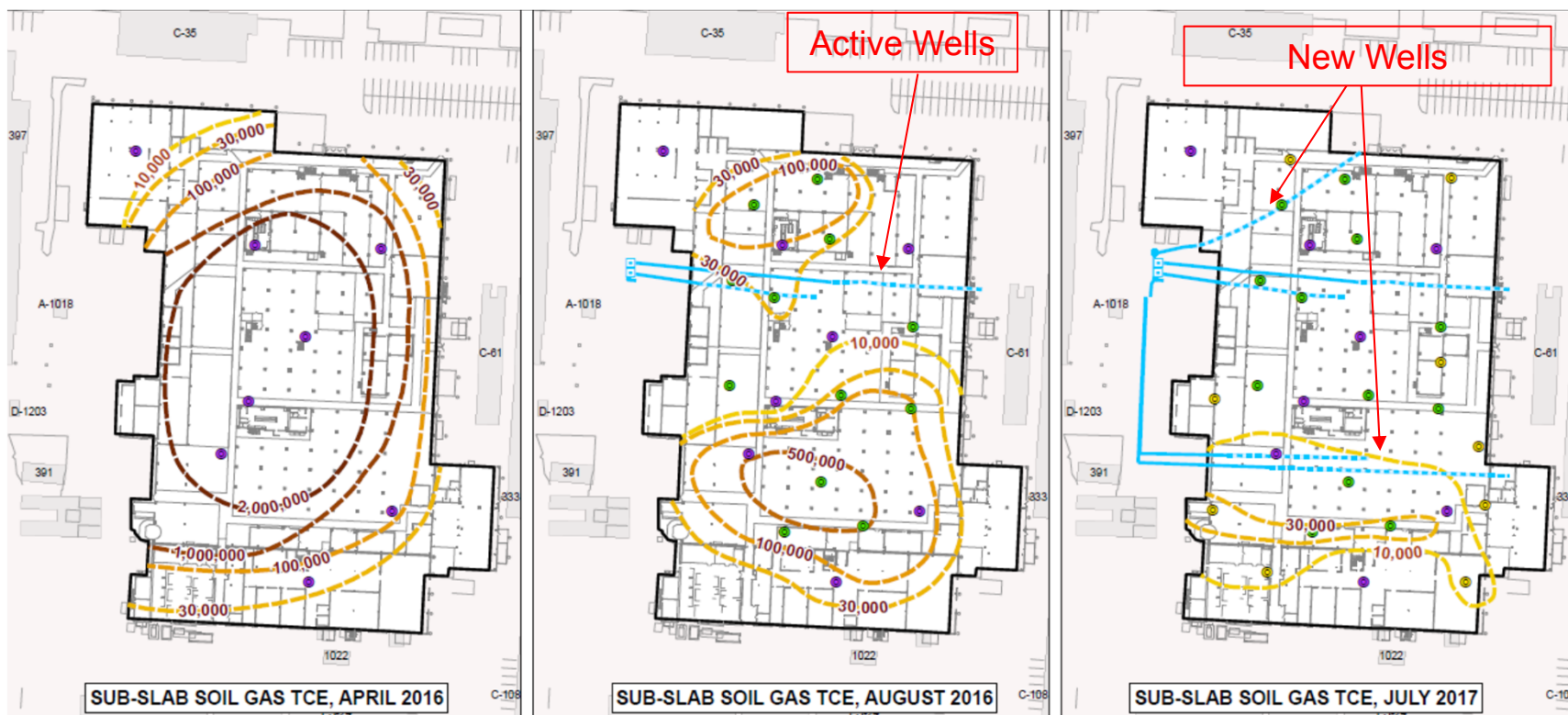
- Laterally, vacuum responses were observed >100 feet away from the SVE wells (well depth is 10 feet bgs)
- Vertically, vacuum responses were observed at 20 feet bgs

The large ROI (>100 feet) is likely enhanced by the sealing of the cracks and joints.

4.3 SVE Results: Indoor Air TCE



4.4 SVE Results: Sub-Slab Soil Gas TCE



- TCE footprint decreased after 15 months of operation of 2 wells
- Samples were collected under “dynamic” conditions, i.e., SVE wells were extracting

4.5 Effects of SVE on IA and Sub-Slab SG

- Indoor air
 - ❖ Levels of TCE decreased to acceptable levels within few days of starting SVE
 - ❖ Levels of TCE have remained below acceptable levels (SVE has been on over 80% of the time since May 2016) [including intentional shutdown]
- Sub-slab soil gas/vacuum
 - ❖ The levels of VOCs in soil gas beneath the building floor have decreased by orders of magnitude
 - ❖ A number of locations at deeper depth still show $>1,000,000 \mu\text{g}/\text{m}^3$ of TCE. A separate remedial action is in progress for removal of LNAPL and source of VOCs
 - ❖ Vacuum responses indicate a vacuum of over 50 pascals at 150 feet from the extraction well
 - ❖ Levels of cDCE were detected in soil vapor, both in sub-slab and at depth – this is most likely due to biodegradation of TCE

Although the SVE system performance is very satisfactory, continuous operation is expensive and unnecessary. Therefore, the Project Team evaluated the possibility of using cyclical SVE to optimize costs and maintain protectiveness.

5.0 Approach to Evaluate Cyclical SVE

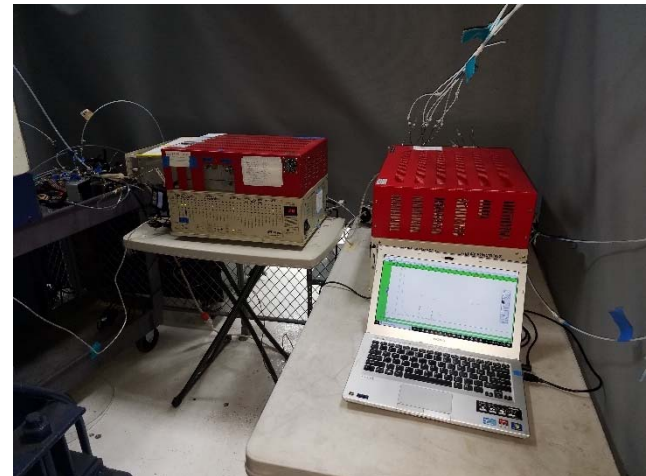
- The SVE system was shut down for approximately 5 weeks in late 2017/early 2018
- Levels of VOCs were measured in sub-slab soil gas at multiple locations and multiple depths:
 - ❖ Collected Summa samples: before and 1, 3, and 5 weeks after shutdown
 - ❖ Measured VOCs with PID (ppbRAE) 1, 3, 7, 14, 16, 17, 23, 29, and 36 days after shutdown
 - ❖ Measured fixed gases with GEM2000
- Measured Indoor air VOCs:
 - ❖ Collected Summa samples: before and 1, 3, and 5 weeks after shutdown
 - ❖ Indoor air was monitored continuously using a continuous monitoring system (ECD)
- Developed simple predictive models to predict the time that the SVE system could be off before
 - ❖ Indoor air TCE exceeded IASL
 - ❖ Sub-slab soil gas TCE increased to a level that caused indoor air TCE to exceed the IASL



ppbRAE



GEM 2000



ECD

6.1 Findings – TCE in Indoor Air



TCE in indoor air samples did not increase to the IASL of 8.8 µg/m³ in 5 weeks

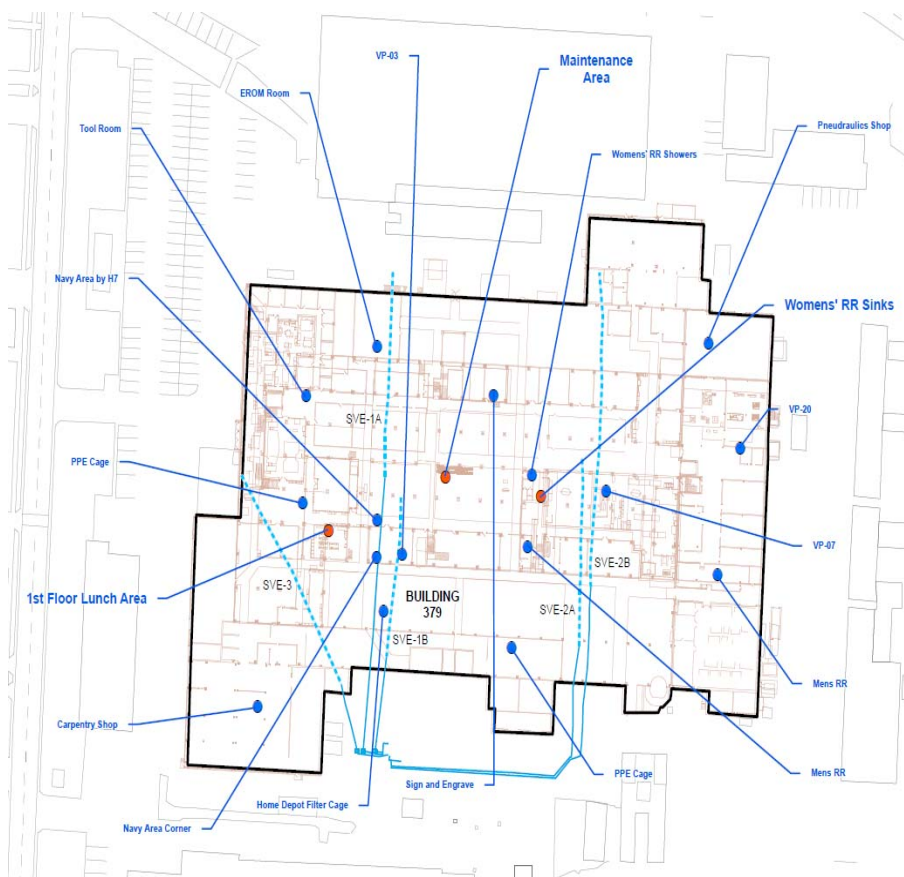
1st Floor Lunch Area			Womens' Room Sinks			Maintenance Area		
Number	Date	TCE	Number	Date	TCE	Number	Date	TCE
WP39-01	9/14/2017	0.20	WP39-12	9/14/2017	0.66	WP39-10	9/14/2017	0.87
WP40-01	12/11/2017	0.36	WP40-12	12/11/2017	0.71	WP40-10	12/11/2017	0.65
WP41-01	12/27/2017	1.1	WP41-12	12/27/2017	0.91	WP41-10	12/27/2017	0.71
WP42-01	1/8/2018	2.3	WP42-12	1/8/2018	1.8	WP42-10	1/8/2018	1.1
WP43-01	2/6/2018	0.84	WP43-12	2/6/2018	0.47	WP43-10	2/6/2018	0.23

Note:
SVE system off 12/4/2017
SVE system on 01/16/2018

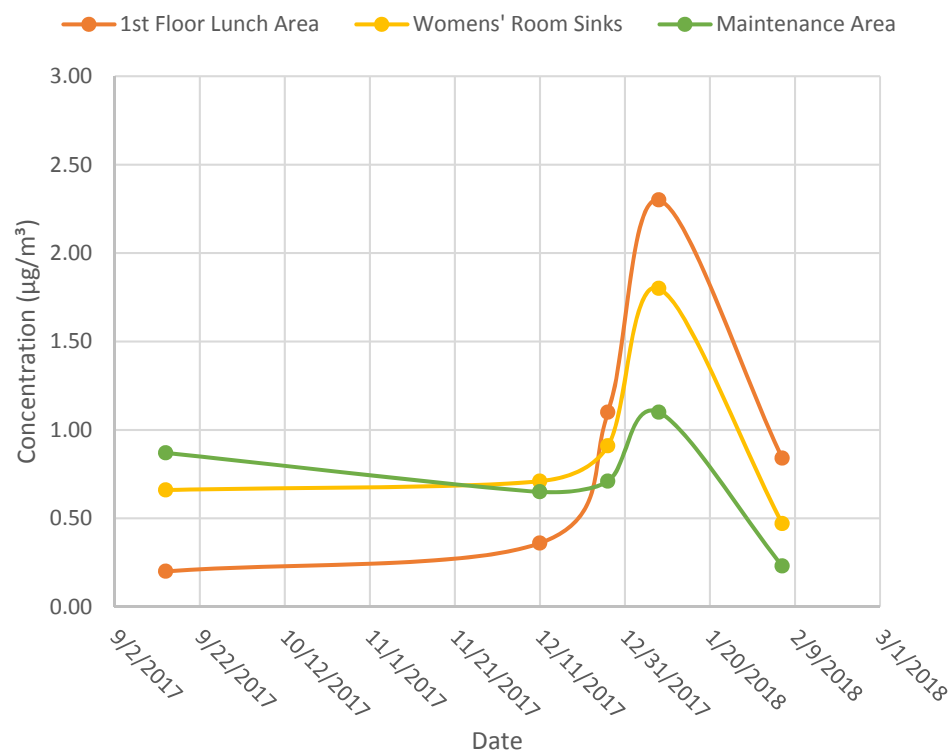
6.2 Findings – TCE Trends in Indoor Air



TCE in indoor air samples did not increase above IASL of $8.8 \mu\text{g}/\text{m}^3$ after 5 weeks

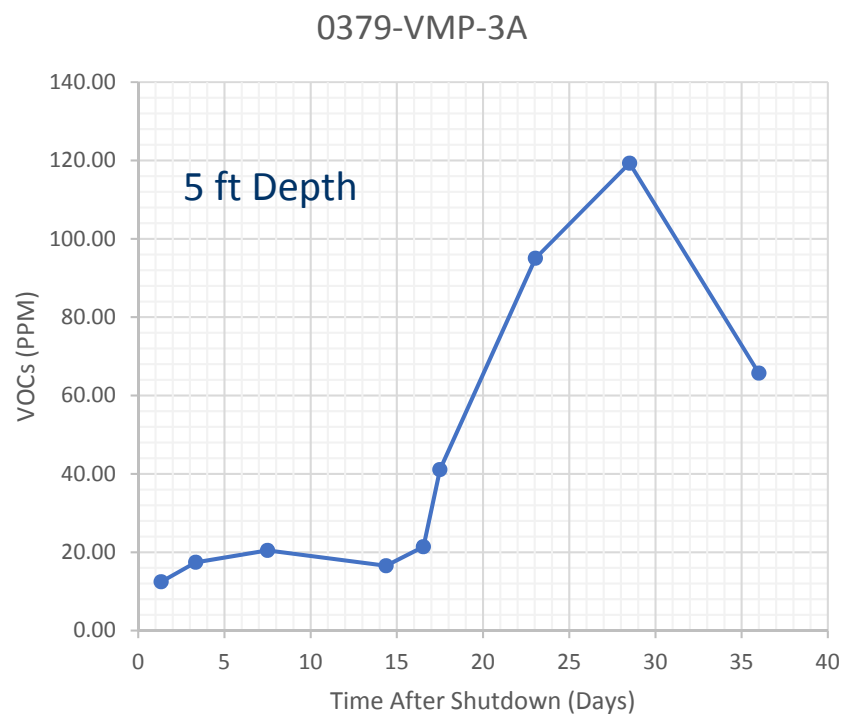
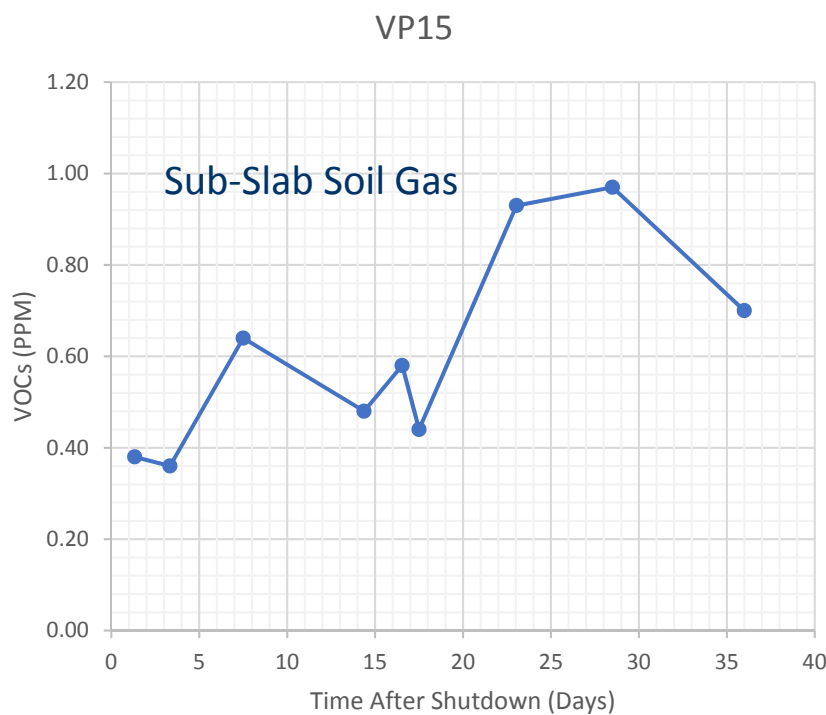


SVE Results: Indoor Air TCE



6.4 TCE in Sub-Slab Soil Gas - PID

- Measured sub-slab soil gas with PID (ppbRAE)
- Levels of VOCs were measured in sub-slab soil gas at multiple locations and multiple depths
- VOCs in sub-slab soil gas (long term) increased, but peaked within a few days, followed by a decrease





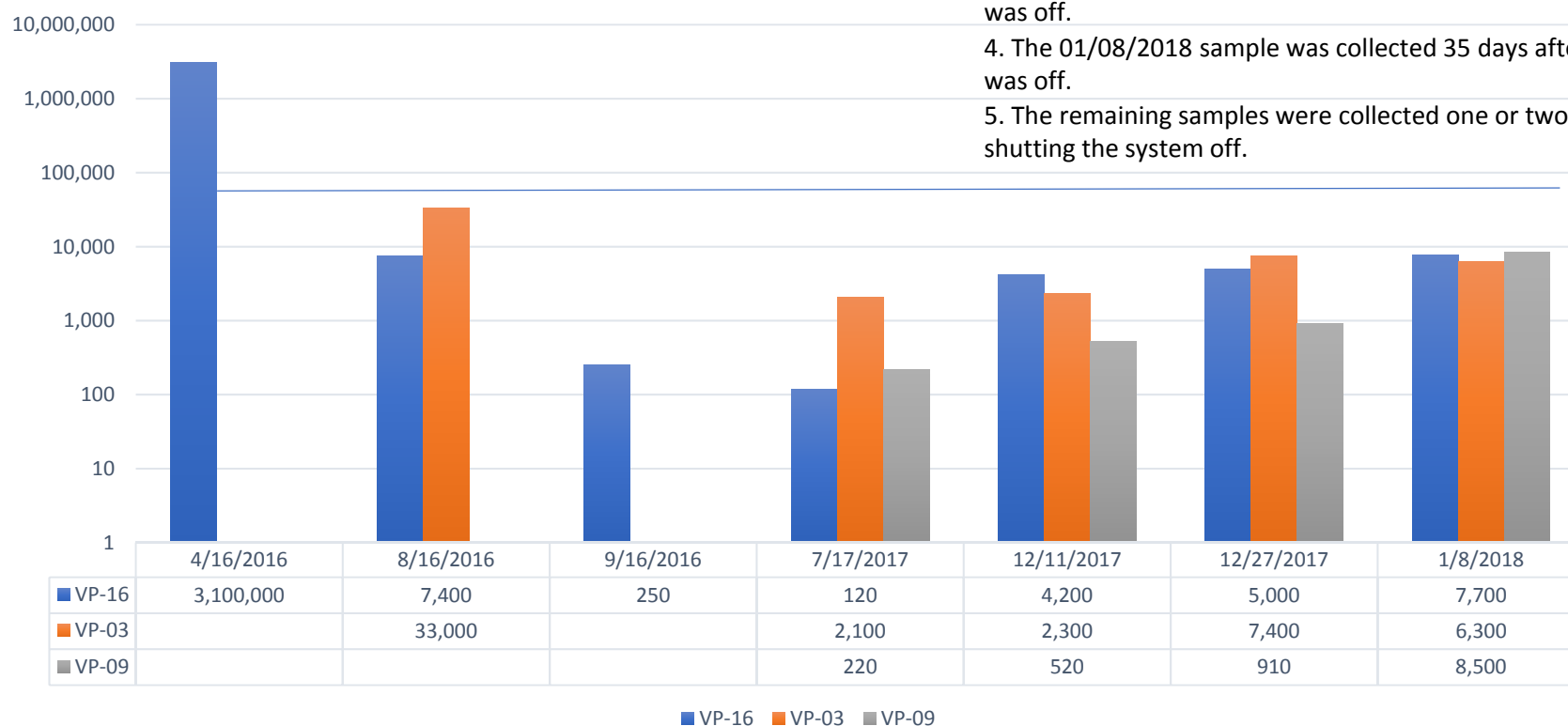
6.6 TCE in Sub-Slab Soil Gas – Overall Trends

- TCE in sub-slab soil gas decreased by orders of magnitude after SVE was started
- A slight increase was observed during the 5 week shutdown, but remained below the theoretical threshold* at 88,000 $\mu\text{g}/\text{m}^3$

Note:

- 04/16/2016 sample is pre-SVE.
- The 12/11/2017 sample was collected 7 days after the SVE was off.
- The 12/27/2018 sample was collected 23 days after the SVE was off.
- The 01/08/2018 sample was collected 35 days after the SVE was off.
- The remaining samples were collected one or two days after shutting the system off.

VPs (TCE)



* See next slide

6.7 Theoretical Threshold – Sub-Slab Soil Gas TCE

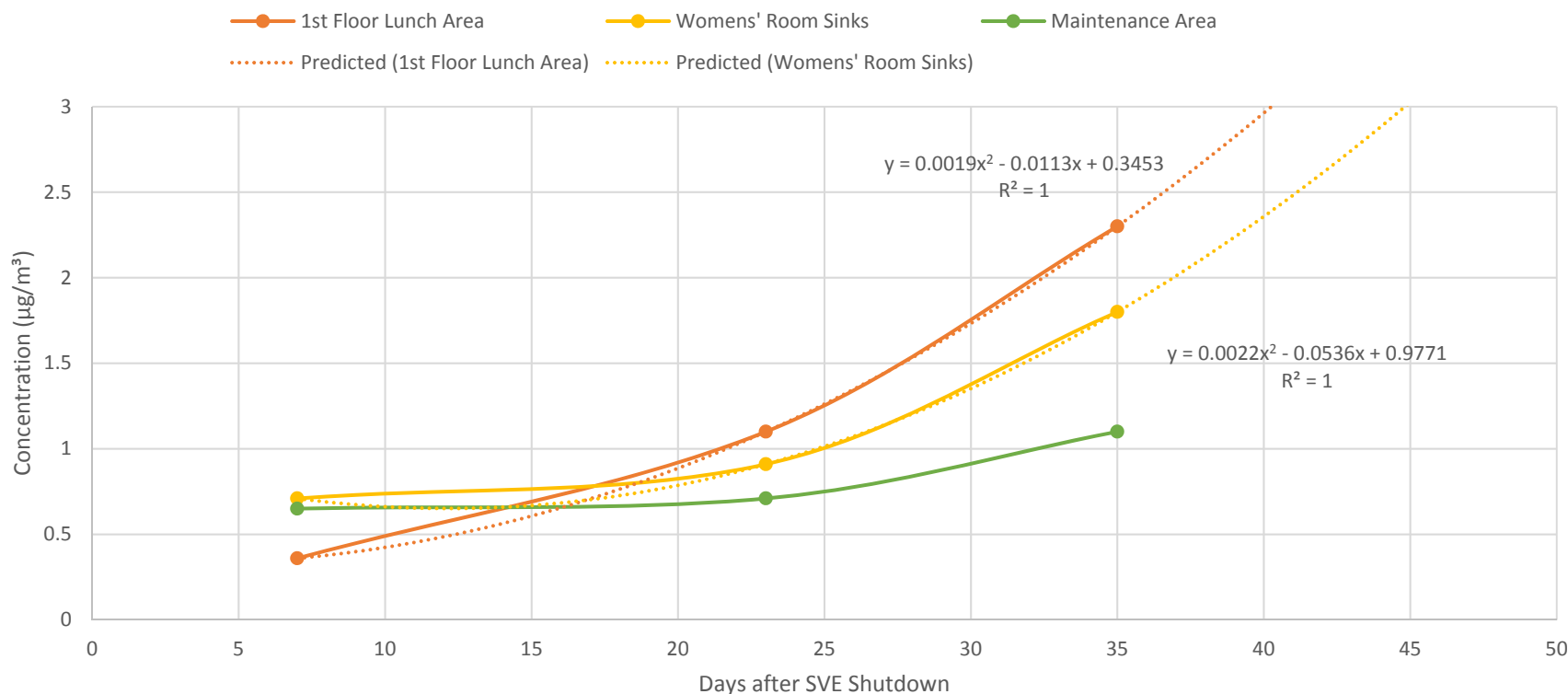
Explanation of Theoretical Threshold

- IASL is $8.8 \mu\text{g}/\text{m}^3$
- An inverse building specific attenuation factor (IBSAF) of over 100,000 was calculated for Building 379 (sub-slab soil gas : indoor air) using collocated samples
- To be conservative, an IBSAF of 10,000 was used
- Sub-slab soil gas TCE would need to reach 88,000 $\mu\text{g}/\text{m}^3$ before there is a potential for indoor air to reach $8.8 \mu\text{g}/\text{m}^3$

6.9 Predictive Model – Indoor Air TCE

- Selected 3 locations (out of 20) that had highest TCE levels and showed a distinct increasing trend
- Extrapolated to determine number of days to reach IASL of $8.8 \mu\text{g}/\text{m}^3$
- Most conservative estimate is approximately 69 days

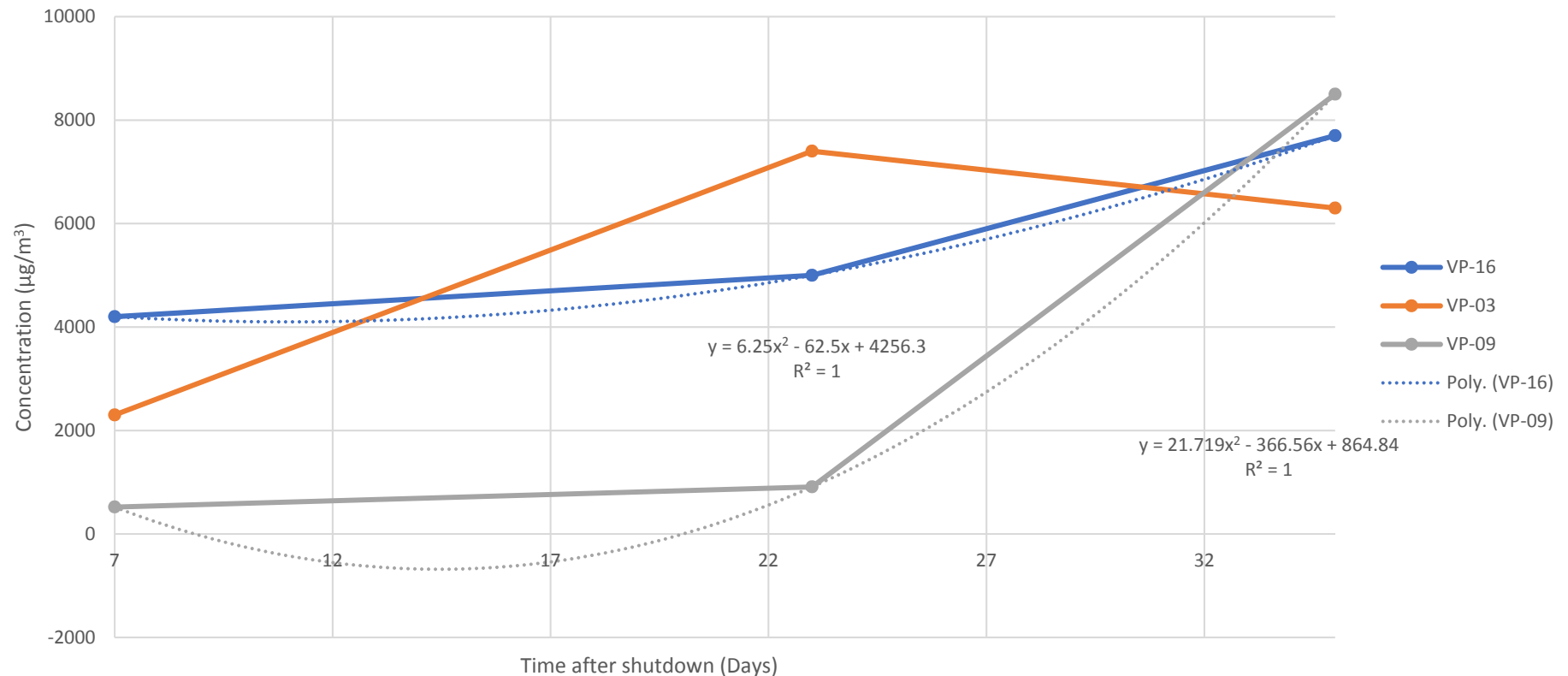
SVE Results: Indoor Air TCE



6.10 Predictive Model – Sub-Slab Soil Gas TCE

- Selected 3 locations (out of 6) that had highest TCE levels and showed a distinct increasing trend
- Extrapolated to determine number of days to reach threshold of 88,000 $\mu\text{g}/\text{m}^3$
- Most conservative estimate is approximately 72 days

SVE Results: Sub-Slab Soil Gas TCE



7.0 Summary of Results/Lessons Learned

- Operation of the SVE system has decreased sub-slab soil gas TCE levels by several orders of magnitude after 18 months of operation
- During a 5-week shutdown after 17 months of operation:
 - ❖ Levels of TCE in indoor air showed a slight increase, but were well below the IASL of $8.8 \mu\text{g}/\text{m}^3$
 - ❖ Levels of TCE in sub-slab soil gas and soil gas at depths above the horizontal well increased, but appear to have plateaued at most locations
- The SVE system can (theoretically) be shut down for 2 months before indoor air TCE exceeds IASLs or sub-slab soil gas TCE reaches levels such that indoor air TCE would exceed IASLs – this would allow for cyclical operation, resulting in lower operating costs
- If indoor air or sub-slab soil gas VOCs were to increase significantly during a planned shutdown, resumption of SVE would cause a significant decrease in a few days (based on historical data)

QUESTIONS?