



Thermally Enhanced Bioremediation for Xylene – Using Conductive Heating to 35°C

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Co-Author Acknowledgement

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- Justin King (CHA)
- Dennis Keane, Michael Marley (XDD)



Case Study Presentation Overview

- Site history, contaminants, cleanup goals
- Remediation concept
 - Touch on bioremediation bench scale study
- Site remedial design
 - Touch on Waterloo profiling
- Operations
- Interim soil sampling results
- Optimization
- Final Sampling/Site Closure
- Conclusions

Site (confidential) – Aerial 1980s



Site Cleanup Contaminants & Goals

Mass estimate in treatment zone = 21,000 lbs

Contaminant	Concentration	Contaminant	Goal
Xylenes (total)	15,000 mg/kg	Xylenes (total)	1,000 mg/kg
Ethylbenzene	3,500 mg/kg	Ethylbenzene	780 mg/kg
Toluene	630 mg/kg	Toluene	1,000 mg/kg
Naphthalene	63 mg/kg	Naphthalene	1,000 mg/kg

Goal: Restore site to pre-disposal conditions to the extent feasible

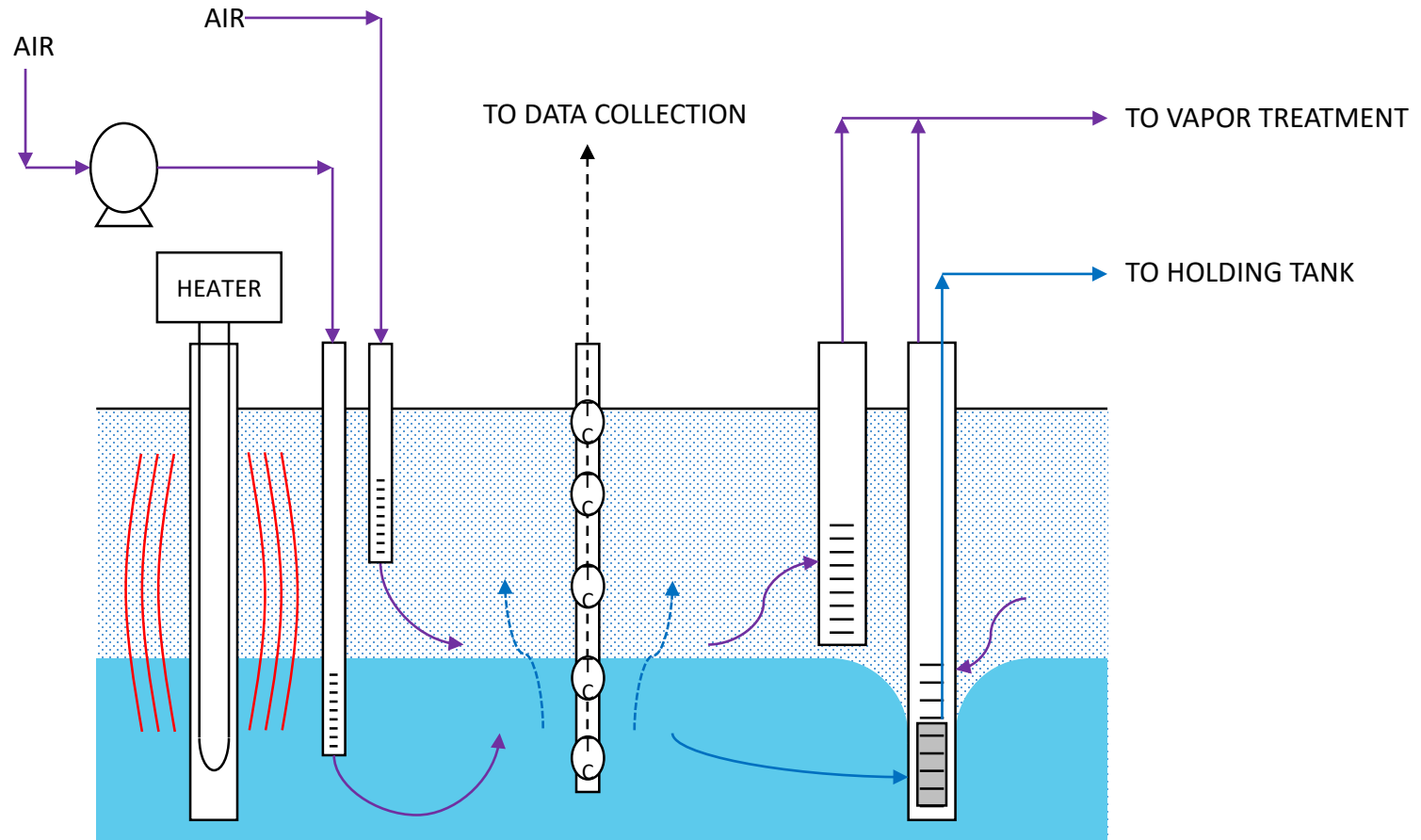
Site contaminants less than 1000 mg/kg (industrial)

Bench Scale Study- Identify Target Temp

XDD Environmental performed bench scale testing to evaluate TSVE/Bioventing in 2015

- Target treatment temperature of 35°C identified as optimal for all treatment areas in bench scale study
 - 65-90% reduction of contaminants observed
- Uniformity of treatment will be a function of the uniformity of air/oxygen flow in the subsurface
 - Tightness of soil observed during bench scale testing
- Nutrient addition does benefit rate of contaminant reduction, but deemed not significant enough to be necessary at this site

Remediation Technology Summary



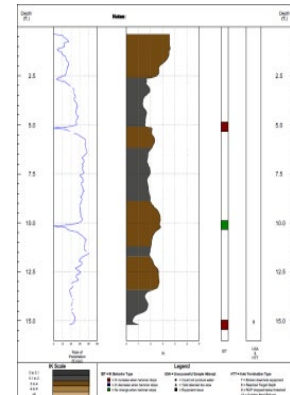
Site – Thermal Treatment Zone (TTZ)



Area: 31,700 ft²
TTZ: 0 to 15 ft bgs
Volume: 17,600 cy
Estimated Mass: 21,000 lbs





Site Characterization- Waterloo Profiling

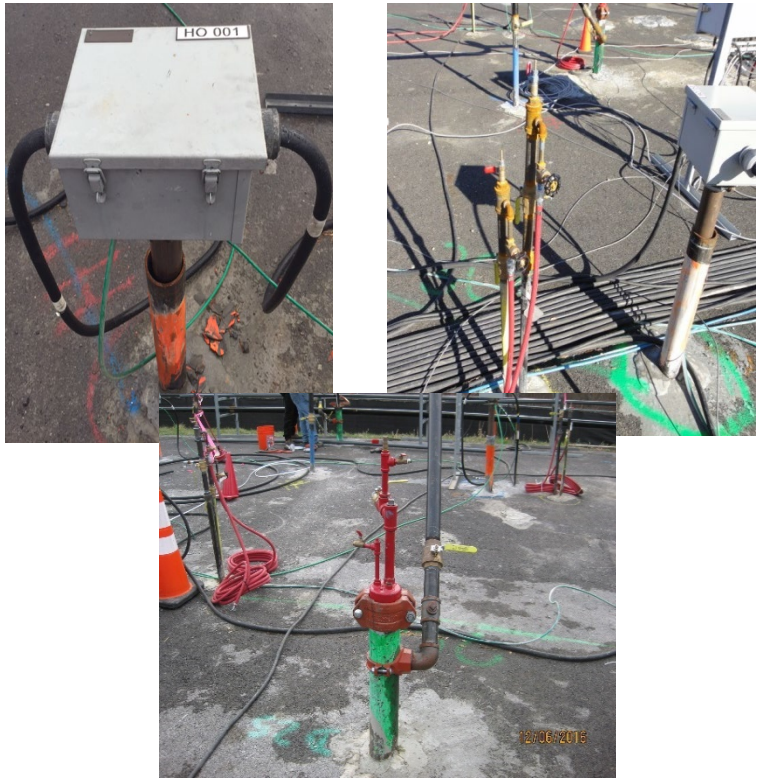
- Historical site investigations revealed that there is a low permeability silt/clay layer that varies in thickness and depth across the TTZ.
- Shallow SVE and AIW well screens designed to target the low permeability layer to ensure contamination in that layer is removed.
- Waterloo^{APS} profiling used to locate the low permeability layer and determine screen locations in the subsurface for all shallow screened wells



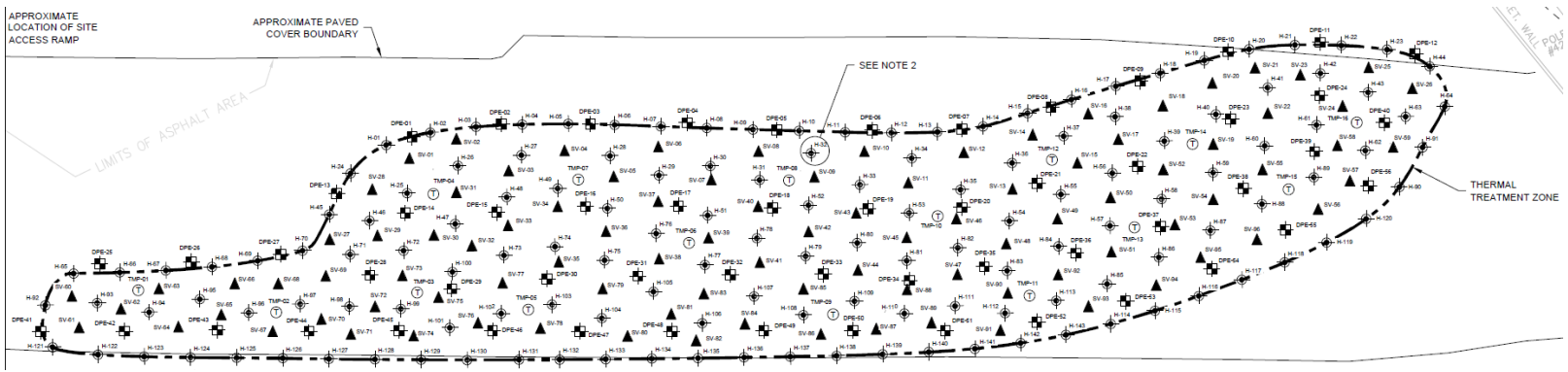
Thermally Enhanced SVE Wellfield Construction

LEGEND:

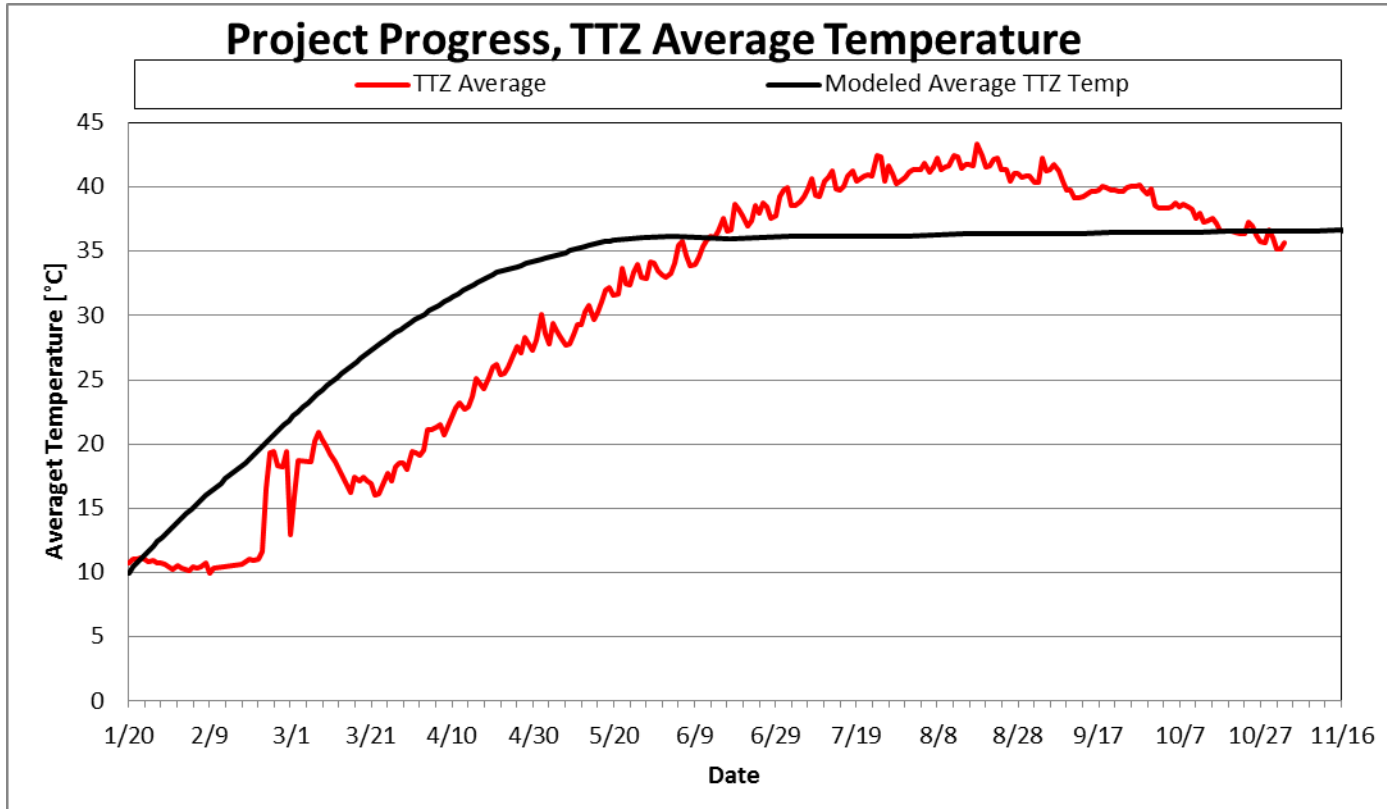
- H-01  ISTD HEATERS (143)
- DPE-01  DUAL-PHASE EXTRACTION WELLS (56)
- SV-01  SOIL VAPOR EXTRACTION WELLS (96)
- TMP-04  TEMPERATURE MONITORING POINTS (16)



Air Injection Wells (286 nested), adjacent to heater wells

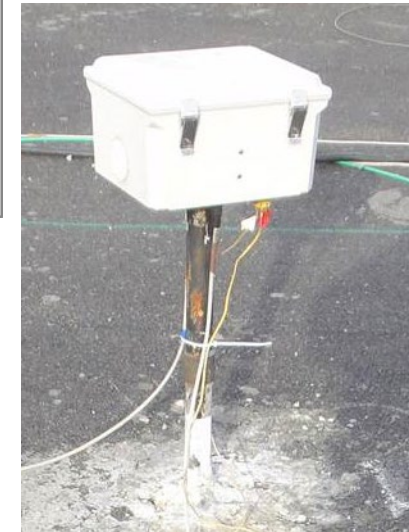


Operations: Temperatures



Centroid location monitoring

Sensors located 2', 5', 10', 14', 18' bgs

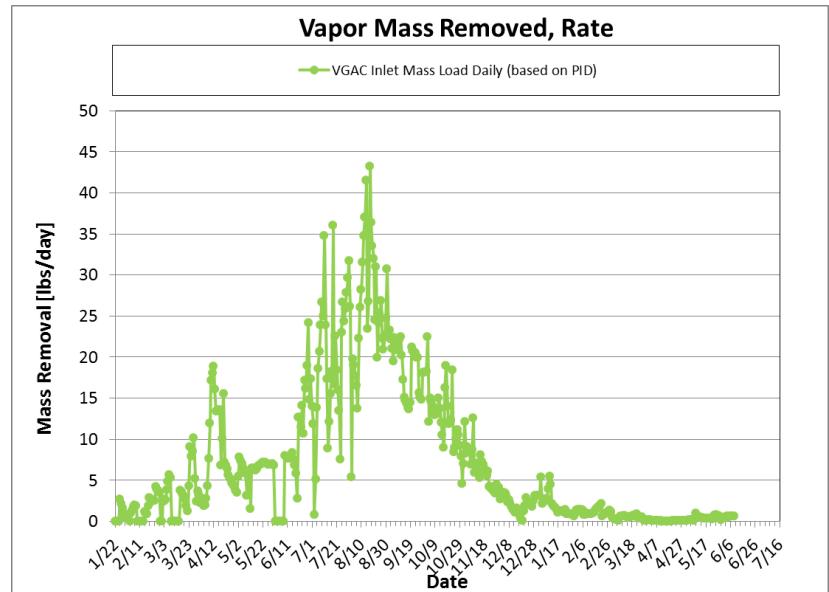
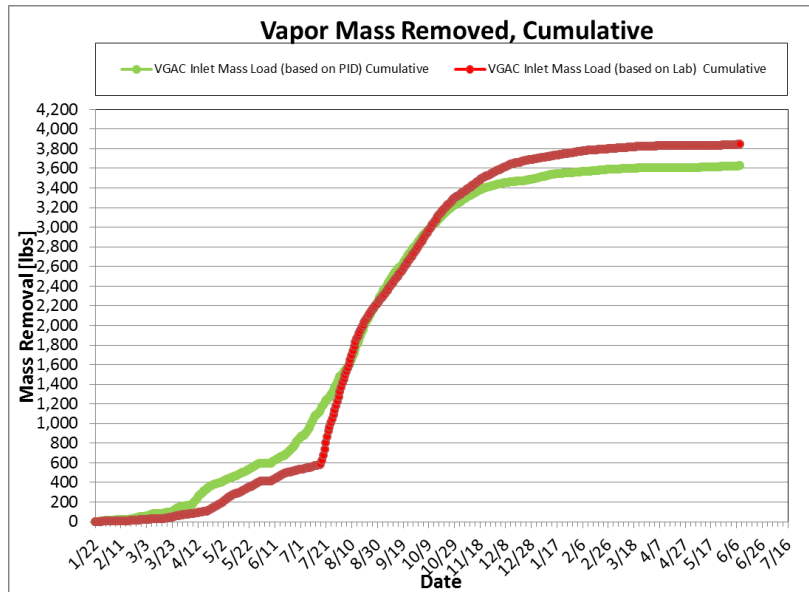


Operations: Mass Removal

VGAC Mass (based on PID): 3,633 lbs

VGAC Mass (based on lab): 3,854 lbs

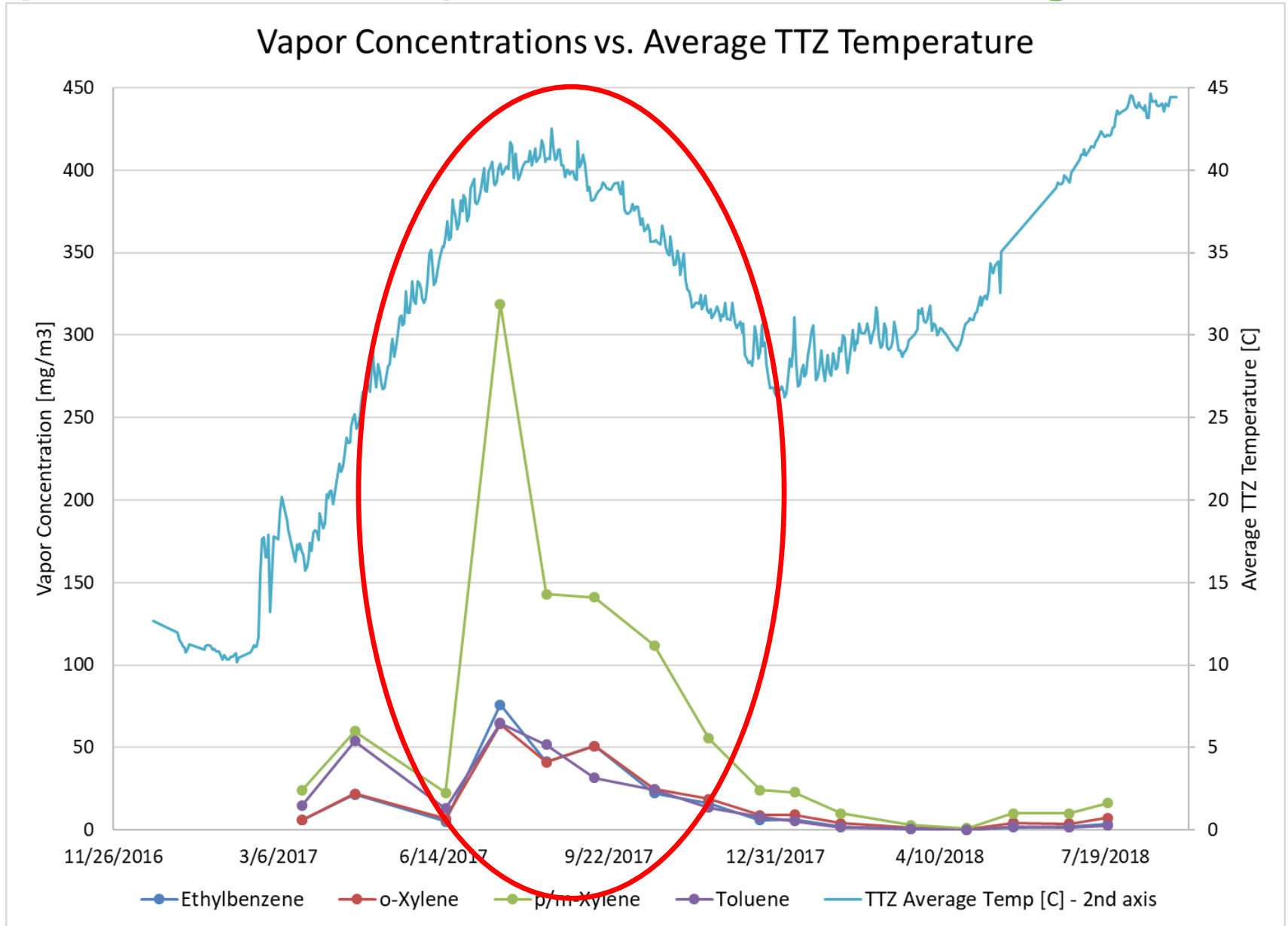
Peak mass removal rate 40-45 lbs/day



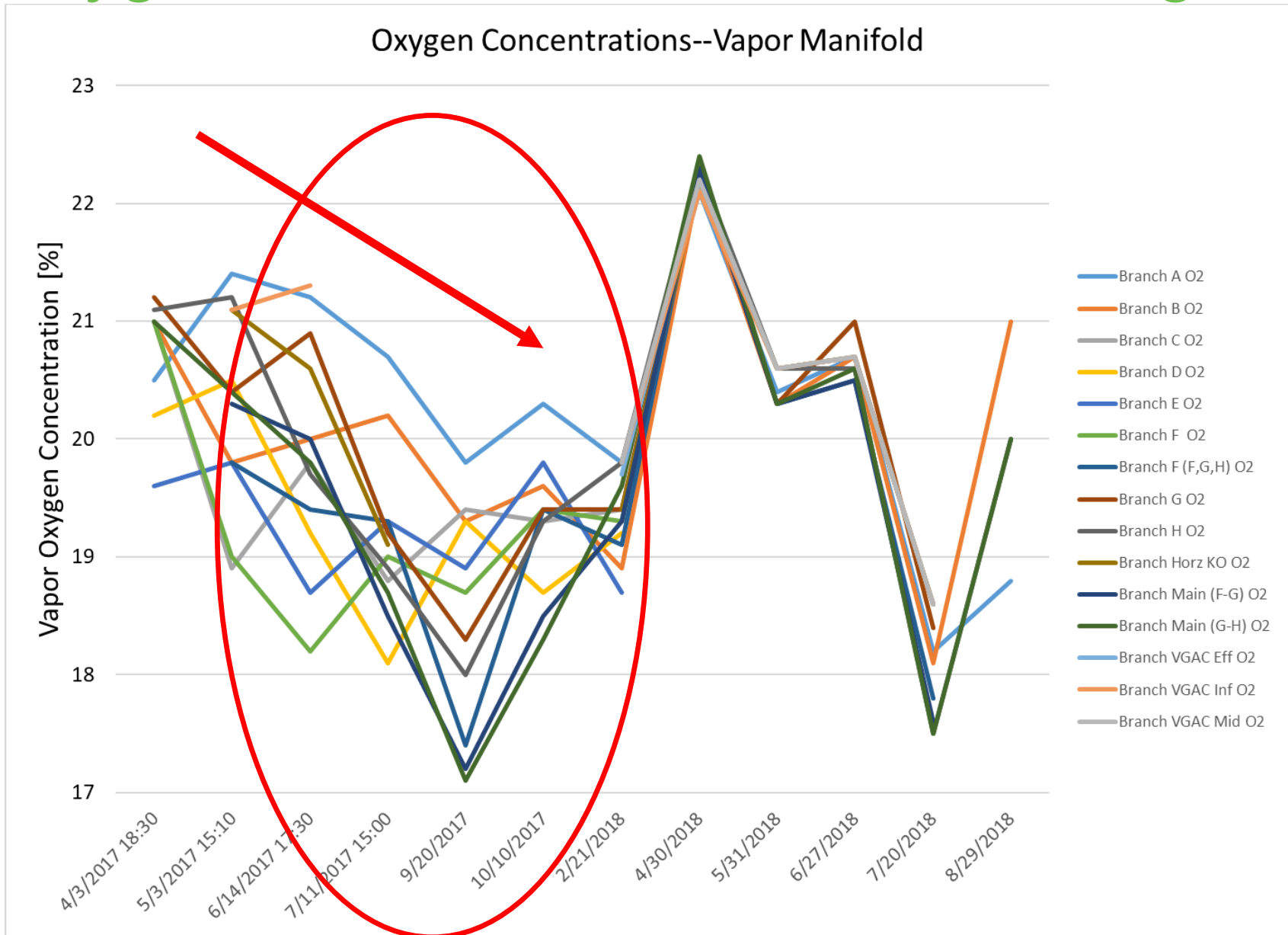
Mass estimate in treatment zone = 21,000 lbs

~4,000 lbs removed in vapor; rest attributed to bioremediation in situ

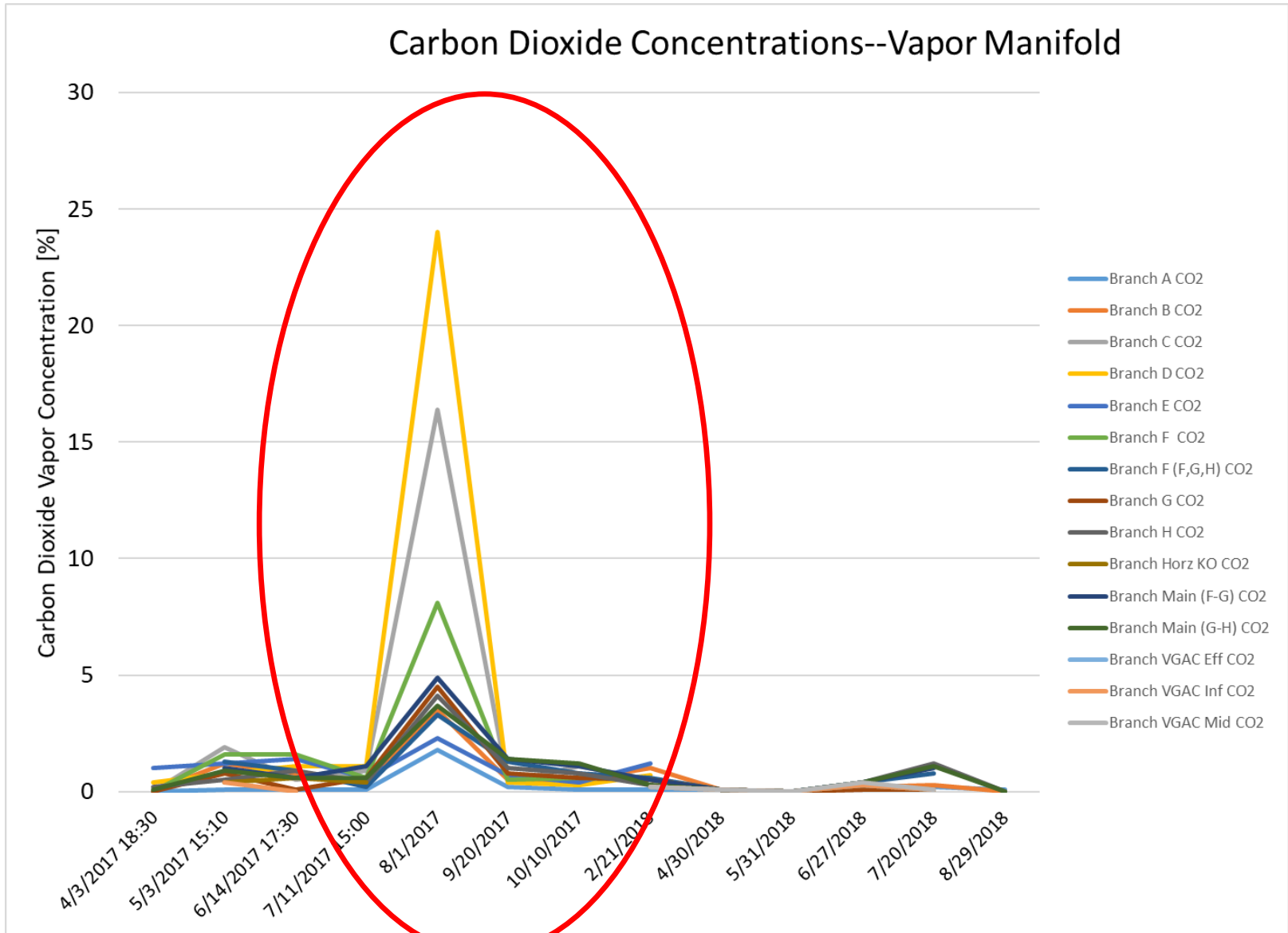
Operations: Vapor VOC Monitoring



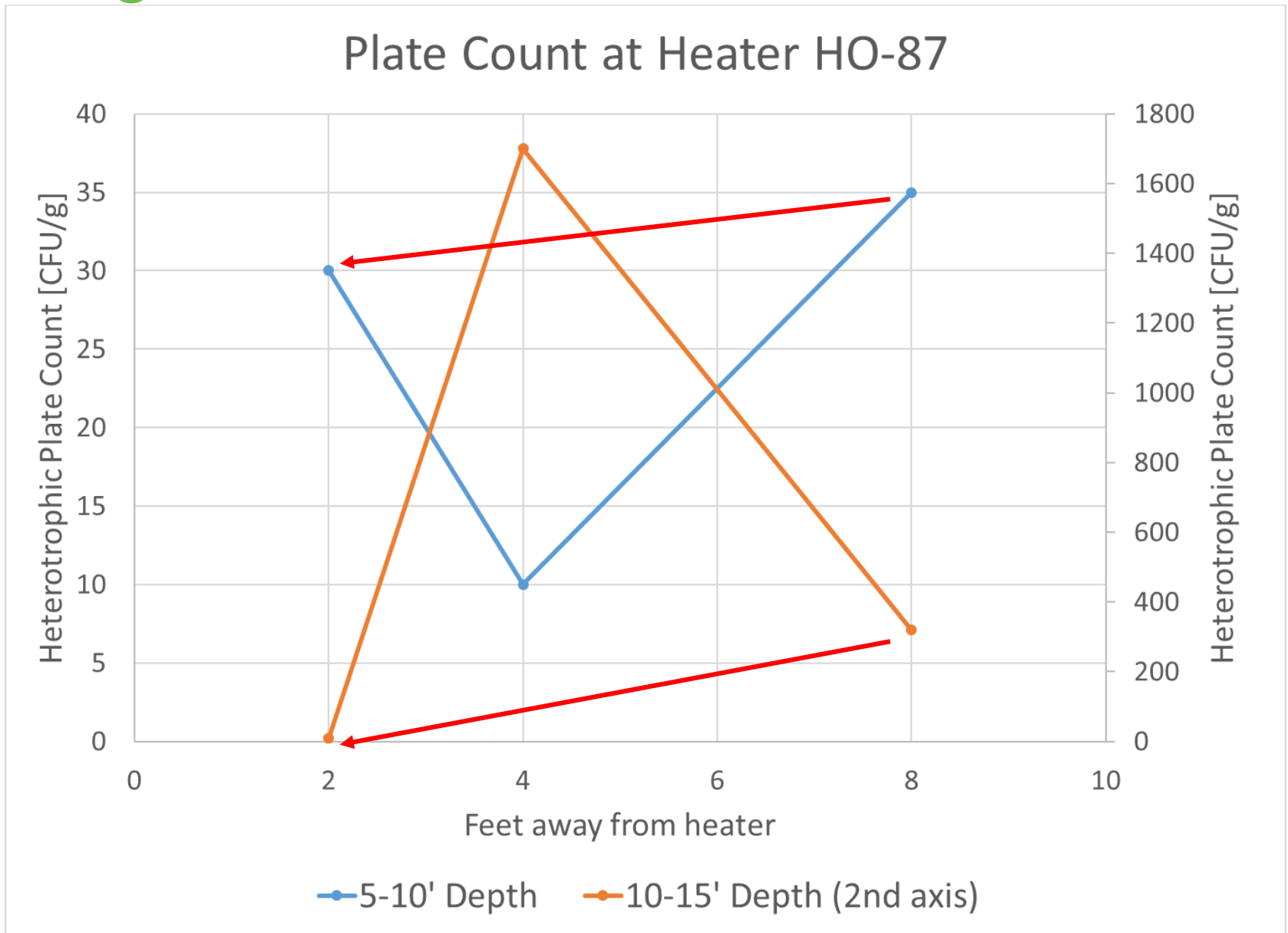
Oxygen & Carbon Dioxide Monitoring



Oxygen & Carbon Dioxide Monitoring



Biological Plate Counts Near Heater

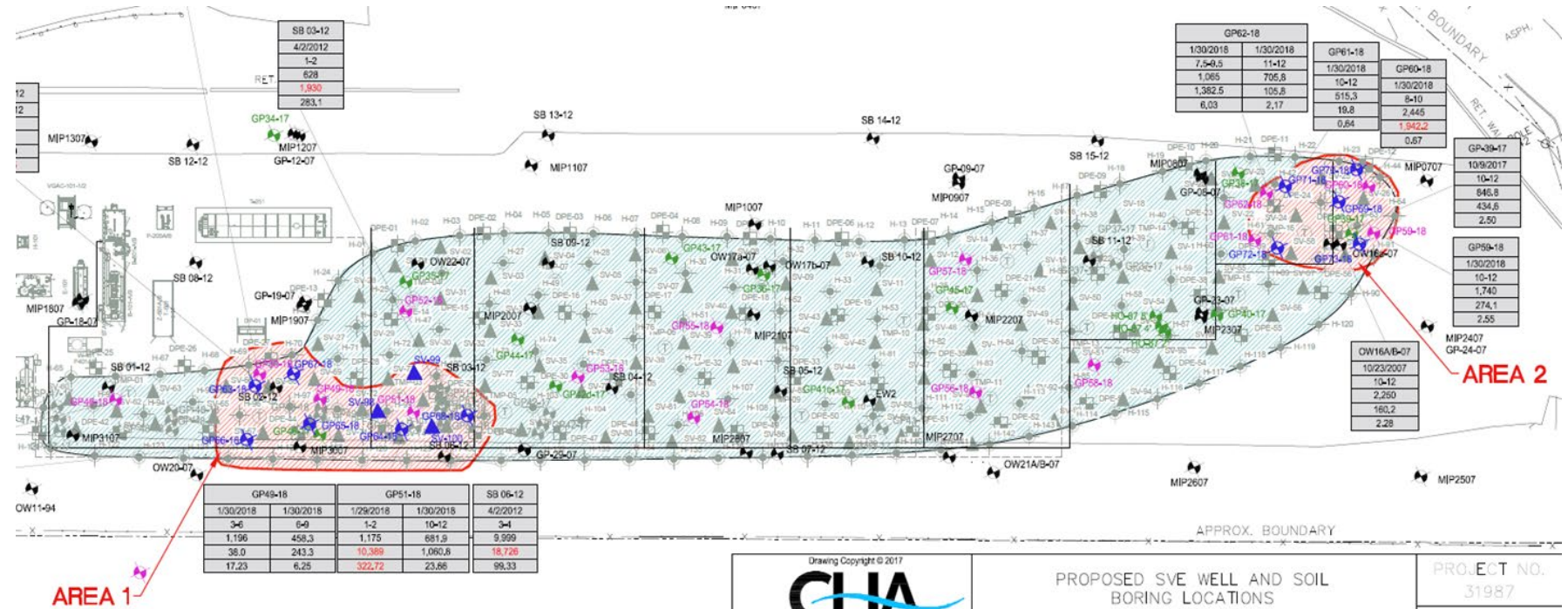


Interim Soil Sampling Results

Oct. 2017: Identified 2 areas needing further treatment

Jan. 2018: Interim sampling to assess progress

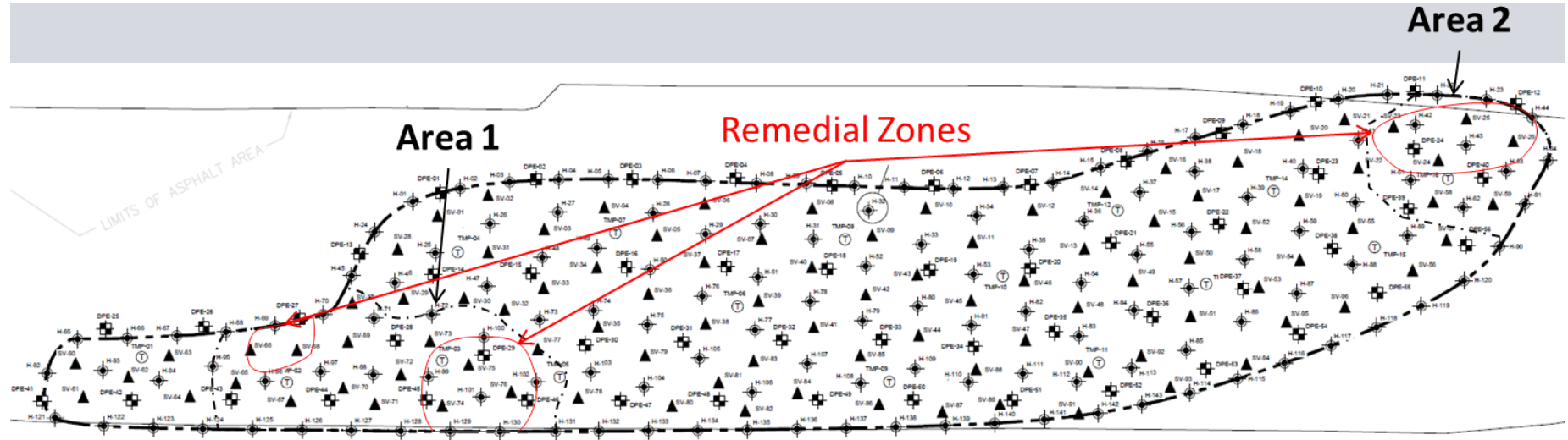
May 2018: Interim sampling to assess progress



PROPOSED SVE WELL AND SOIL BORING LOCATIONS

PROJECT NO. 31987

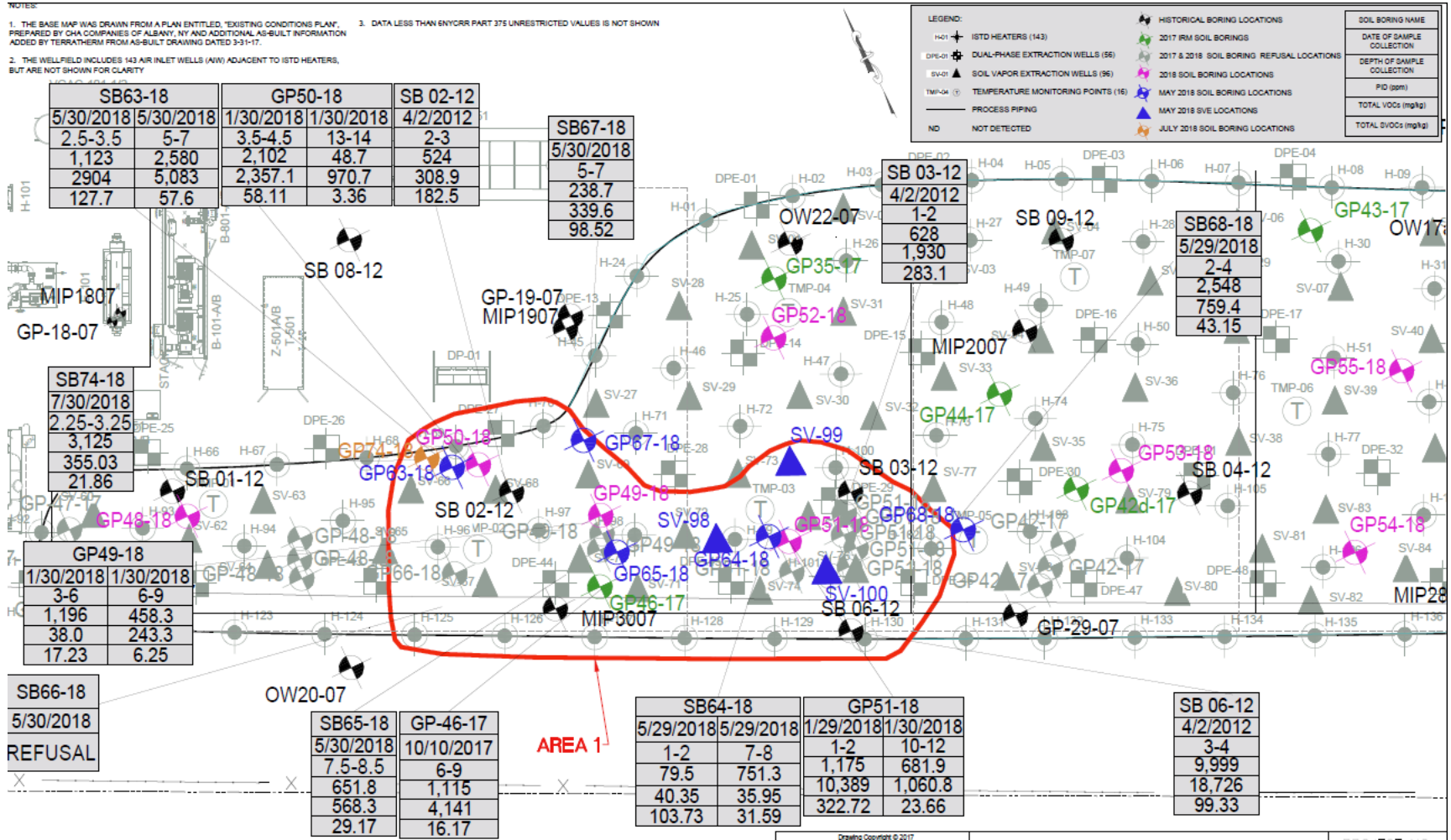
Revised Focus Areas & System Optimization



- Re-wiring circuits to focus power to remaining hotspots; allowed power to be turned off in zones that met goal
- 3 shallow SVE points installed in Area 1
- Install foam board insulation to increase R value of cover and counter heat losses at surface

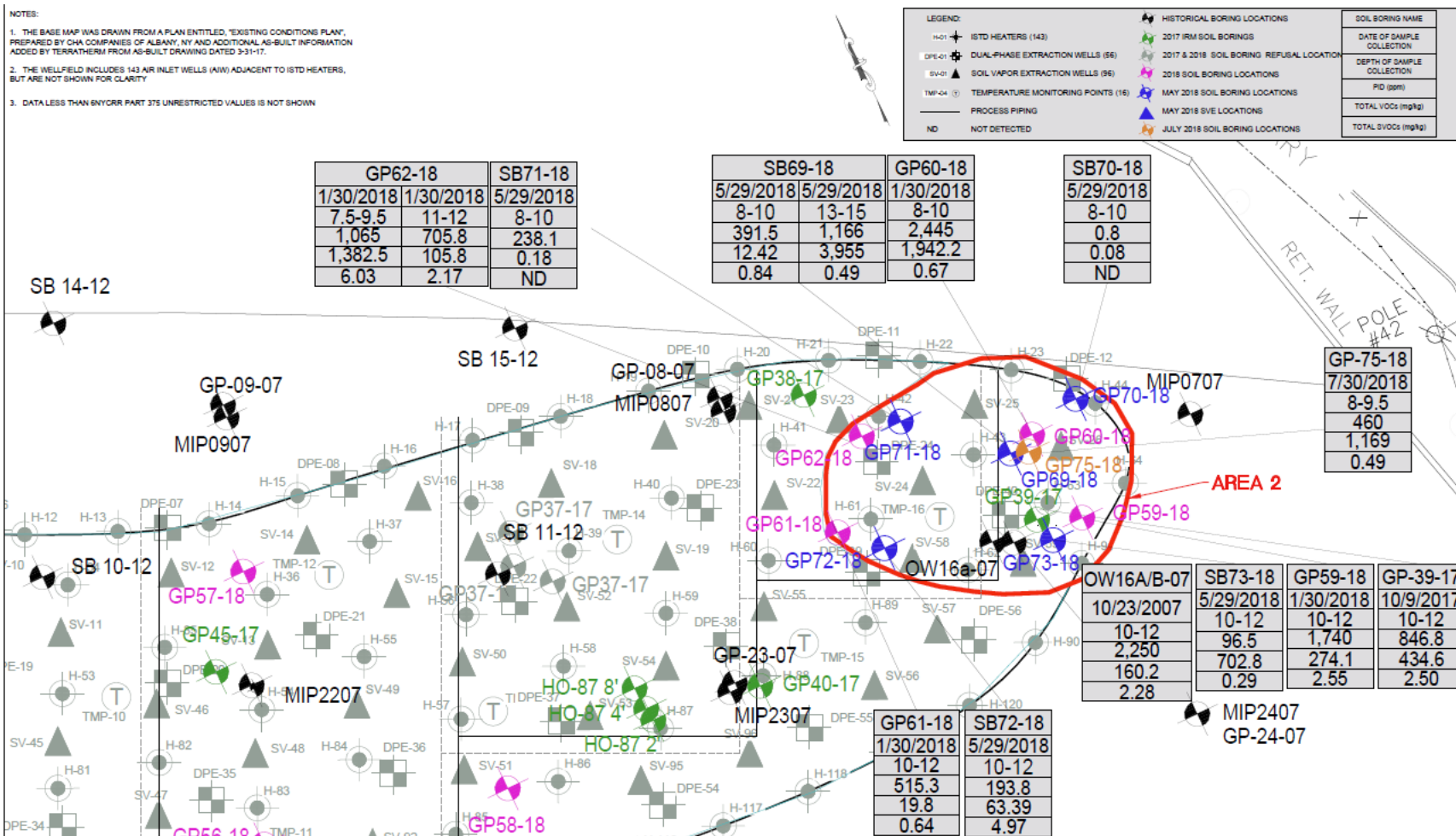


Final Soil Sampling Results



GP74-18 (2.25-3.25) Total Xylenes = 213mg/kg = **PASS**

Final Soil Sampling Results



GP75-18 (8.0 – 9.5) Total Xylenes = 1,020mg/kg = **20mg/kg over goal**

NYSDEC site closure granted fall 2018!

Lessons Learned & Conclusions

- Thermal Conductive Heating (TCH) was successfully used for mild heating to 35°C, as part of the overall site remedy
 - Allowed for combination of vaporization & in situ contaminant destruction from native microbial populations
 - Wider than normal heater spacing proved effective
 - Could have easily implemented 100°C treatment if needed
- Closure achieved for this site
- Other 100°C TCH sites have had documented post thermal treatment benefits where biological populations were stimulated and further contaminant degradation was observed

Questions?

