



TETRA TECH

Implementation and Optimization of Air Sparge/Soil Vapor Extraction System with Horizontal and Vertical Wells – a case study

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Presentation Outline

- Site History
- Site Conceptual Model
- Selecting a Remedial Technology
- Interim Measures and Pilot Tests
- Full Scale Implementation
- Implementation Challenges
- Results
- Conclusions

Site History

- Active manufacturing facility
– 1966 to present
- 180 acres
- 1.6 million square foot building and several outbuildings
- Multiple OUs and SWMUs
- Contaminants of concern
 - Chlorinated solvents
 - PNAs
 - Hydraulic oils/PCBs
 - VOCs
 - Heavy metals



Site History – Former UST Farm

➤ Former UST Farm

- 16 USTs (730 to 15,000 gallons)
- Fuels, waste paints and solvents

➤ History

- Previous activities removed a number of tanks
- Process utility lines not removed or abandoned
- Interim remedial actions
 - Passive recovery
 - Vacuum enhanced recovery



Conceptual Site Model

- Geology
- Hydrogeology
- Contaminant concentrations
- Extent of impacts

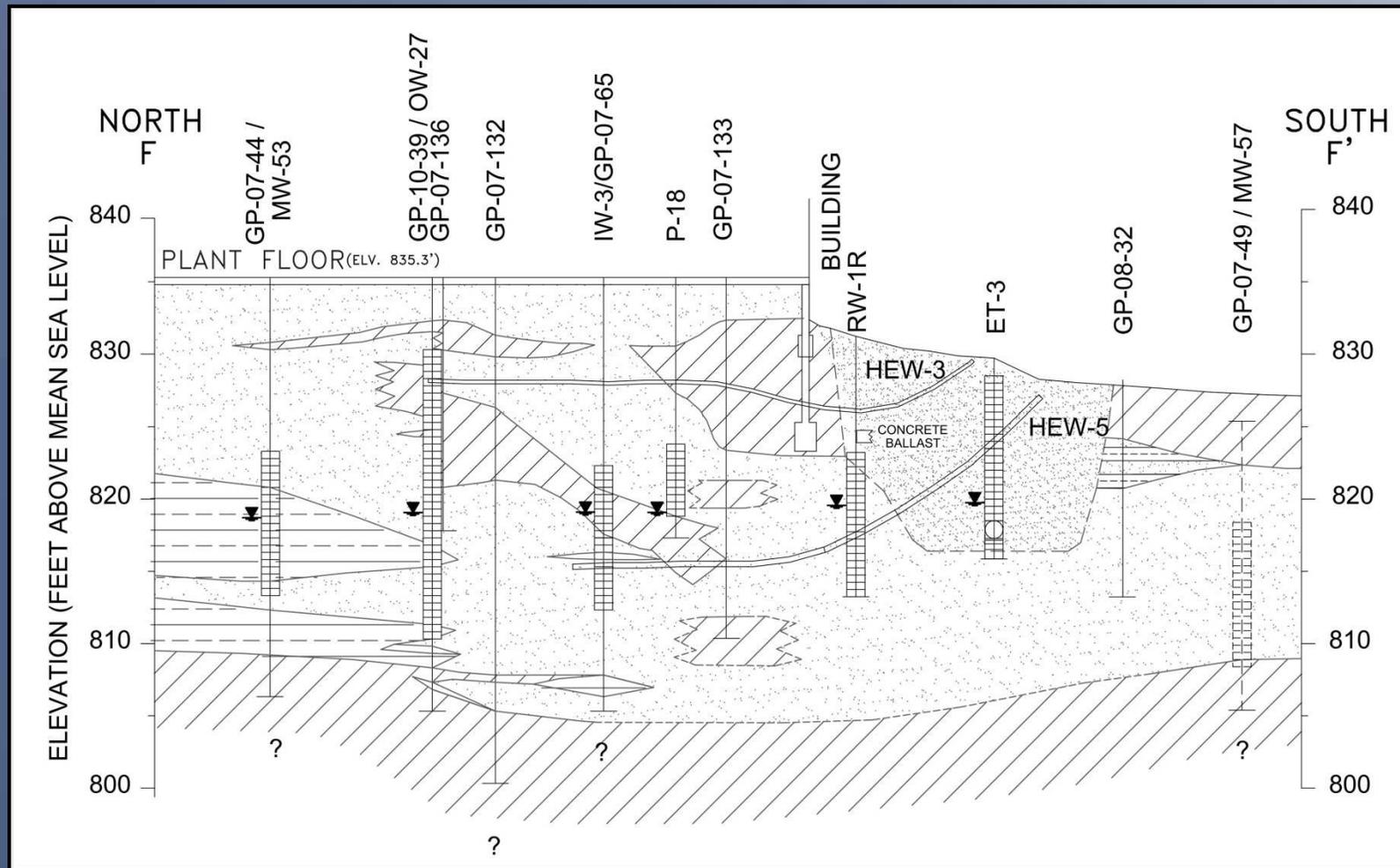


Conceptual Site Model – *Geology*

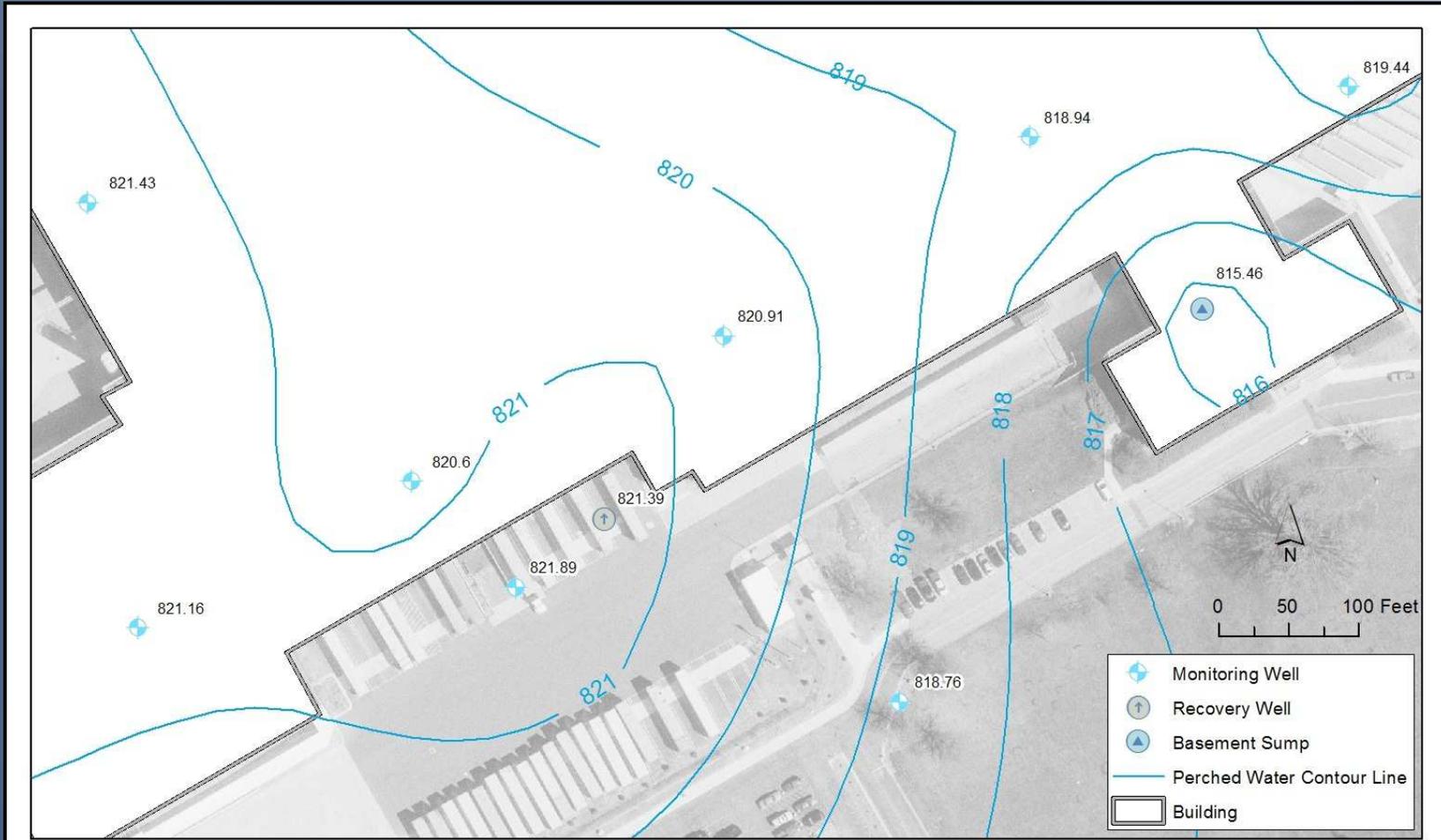
- Profile orientation
 - North to South



Conceptual Site Model – Geology



Conceptual Site Model – Hydrogeology



Conceptual Site Model – Concentrations in Perched Water

| Contaminant of Concern | Maximum Detected Concentration (µg/L) | Cleanup Standard (µg/L) |
|------------------------|---------------------------------------|-------------------------|
| Acetone | 11,000,000 | 2,100 |
| Benzene | 51 | 5 |
| Cis-1,2-DCE | 645 | 70 |
| Ethylbenzene | 7,900 | 74 |
| MEK | 5,200,000 | 38,000 |
| MIBK | 55,000 | 5,200 |
| TCE | 180 | 5 |
| 1,2,4-TMB | 96 | 63 |
| Toluene | 410,000 | 790 |

Total Mass: ~17M µg/L

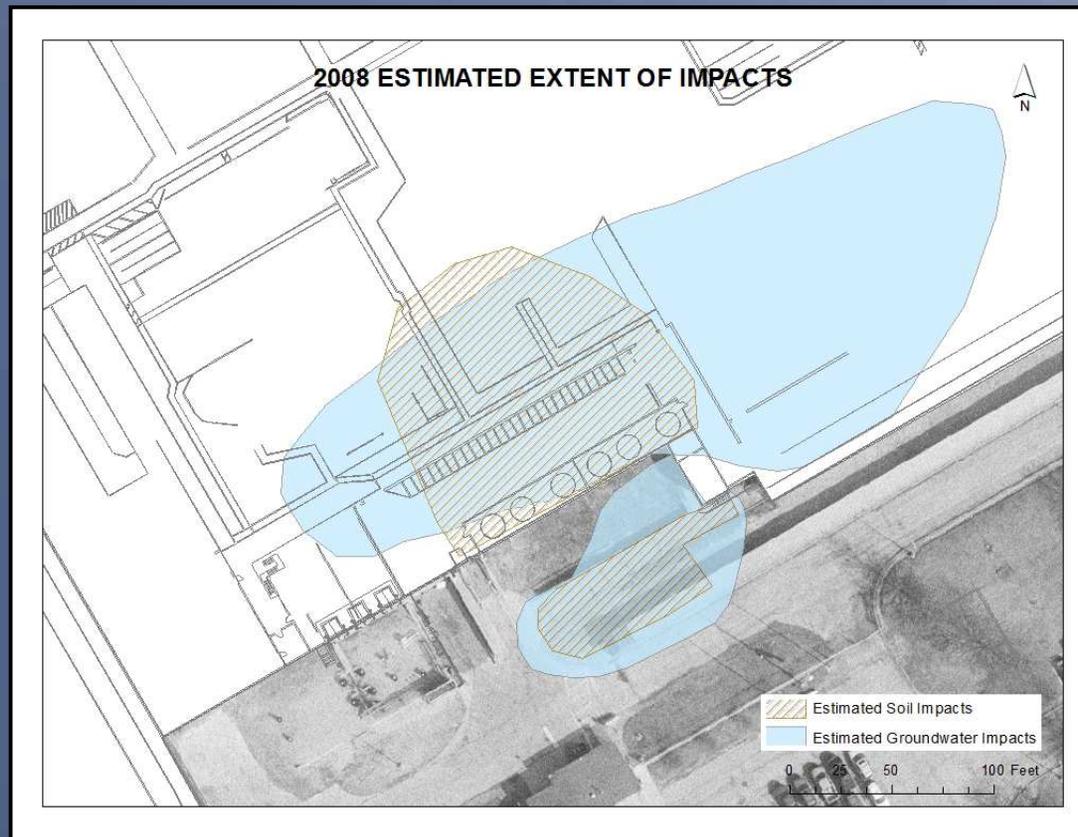
Conceptual Site Model – Concentrations in Soil

| Contaminant of Concern | Maximum Detected Concentration (µg/Kg) | Cleanup Standard (µg/Kg) |
|------------------------|--|--------------------------|
| Acetone | 1,000,000 | 15,000 |
| Benzene | 130 | 100 |
| Ethylbenzene | 690,000 | 1,500 |
| MEK | 240,000 | 260,000 |
| Methylene Chloride | 150 | 100 |
| PCE | 190 | 100 |
| 1,2,4-TMB | 2,000 | 2,100 |
| Toluene | 3,000,000 | 16,000 |

Total Mass: ~5M ug/Kg

Conceptual Site Model – Contaminant Extent in Perched Water and Soil

- Lateral Extent soil impacts: ~0.42 acres
- Lateral extent of perched water impacts: ~1.1 acres



Selecting a Remedial Technology

- Completed a Corrective Action Matrix (CAM)
- Technologies evaluated against metrics
 - Threshold Criteria
 - Balancing Criteria
- Other metrics
 - Site end use
 - Stakeholder's additional remedial objectives
 - Identification and screening of remedial technologies
 - Media specific corrective measures standards

Selecting a Remedial Technology

➤ Remediation technologies evaluated

- Institutional Controls
- Containment
- Removal and Offsite Disposal and/or Alternate Discharge
- Ex-Situ Treatment
- In-Situ Treatment

Selecting a Remedial Technology – *Corrective Action Matrix Results*

- Soil
 - SVE
 - Excavation with offsite disposal*
- Perched Water
 - Extraction with onsite treatment and POTW discharge
 - Extraction with onsite treatment and NPDES discharge
 - Air Sparge
 - Bioremediation
 - Chemical oxidation
- Interim Measures* vs. Pilot Testing



Interim Measures and Pilot Tests

➤ Interim Measures

- Source excavation*
 - Excavation of tanks, soil and dewatering
 - Installed perched water recovery trench
 - Abandoned tank in place (under building)
- Vacuum enhanced recovery

➤ Pilot Tests

- ISCO desktop study for perched water
 - Data was not supportive of full scale
 - Access to plant floor was limited

Interim Measures – *Source Removal*



Interim Measures – *Utility Relocation*



Implementation Challenges

- Active manufacturing plant
 - Interior – multiple obstacles
 - Exterior – truck parking, traffic
- Multiple stakeholders
- Security issues
- Plant projects
 - Scheduling
 - plant re-configuration and construction projects
 - Utility relocation and re-installation (water, gas, fire line, electric)
- Existing above and below grade infrastructure

Results of Pilot Testing and Selection of Remedial Technology

- Combined Remedial Technology Selected
 - SVE/AS using Horizontal Wells
 - SVE/AS data indicated good zone of influence

- Remedial Technology Not Selected
 - Groundwater extraction with onsite treatment and POTW discharge
 - Groundwater extraction with onsite treatment and NPDES discharge
 - Bioremediation

Full Scale Implementation *Horizontal Well Installation*



Full Scale Implementation *Horizontal Well Installation*

➤ SVE Horizontal Well - April 2010

- 150' total length
 - 130' of 3" 304SS screen
 - 64 slots/foot (0.012" x 1.5")
 - 20' of 3" SS casing
 - ~7' below plant floor (final elevation)

➤ AS Horizontal Well – November 2010

- 130' total length
 - 60' 4" SS screen
 - 80 slots/foot (0.012" x 1.5")
 - 70' 4" SS casing
 - ~18' below plant floor (final elevation)

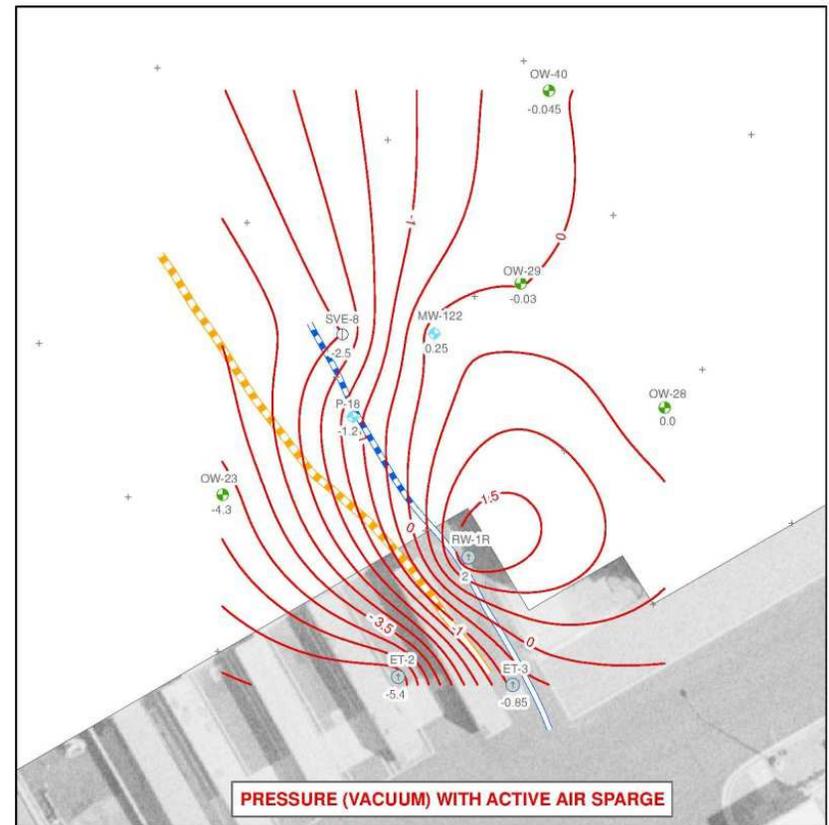
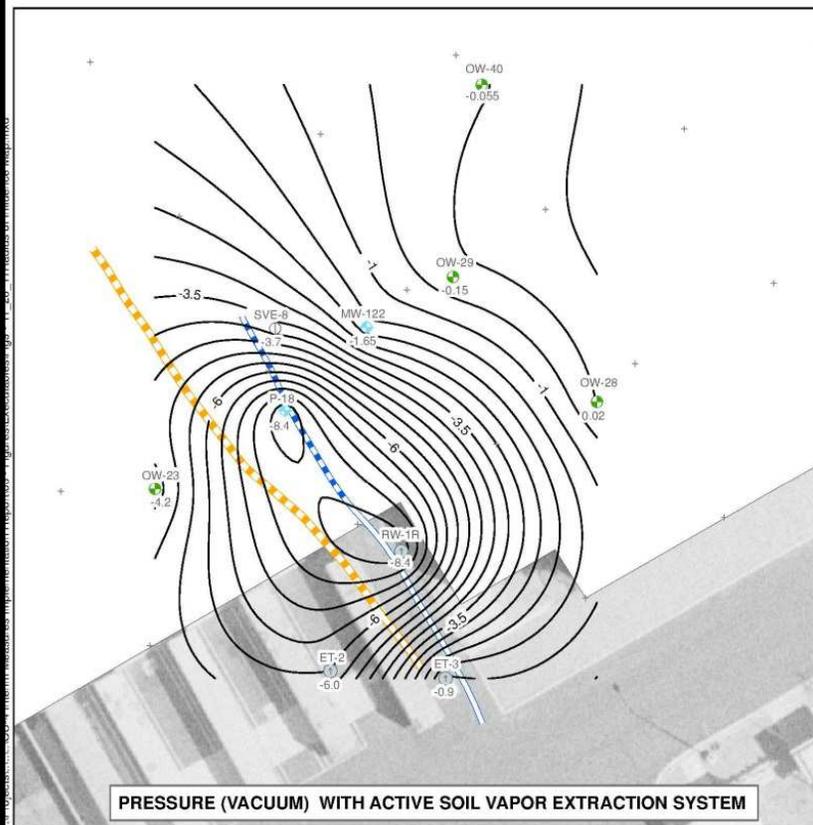
Full Scale Implementation – SVE/AS

➤ System Details

- Roots Rotary Blowers
 - SVE max extraction rate 450 cfm with typical operation rate at 350 cfm
 - AS max flow rate 150 cfm with typical operation rate at 30 cfm
- 80 gallon internal KO tank
- 300 gallon external KO tank
- 3 carbon vessels used in series



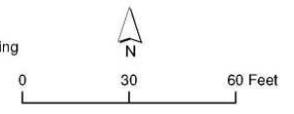
Radius of Influence SVE/AS with Horizontal Wells



BASE MAP: 2009 AERIAL PHOTOGRAPH

- Observation Well
- Perched Water Monitoring Well
- Recovery Well
- Soil Vapor Extraction Well
- Pressure (Vacuum) with Air Sparge and Soil Vapor Extraction
- Pressure (Vacuum) with Soil Vapor Extraction
- Perched Water Injection/Extraction Well Screen
- Perched Water Injection/Extraction Well Casing
- Soil Vapor Extraction Well Screen
- Soil Vapor Extraction Well Casing
- Column & Column Name
- Saline Plant

Notes:
Data collected November 28, 2011.
Contours generated with Surfer 10 using standard Kriging settings
Contour interval 0.5 inches of H₂O.

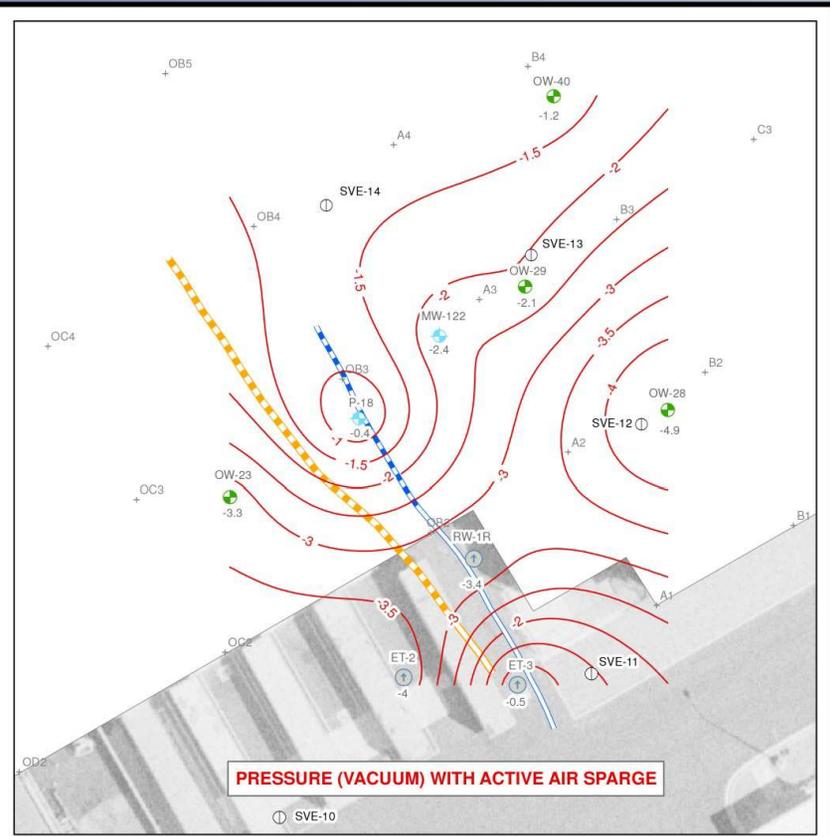
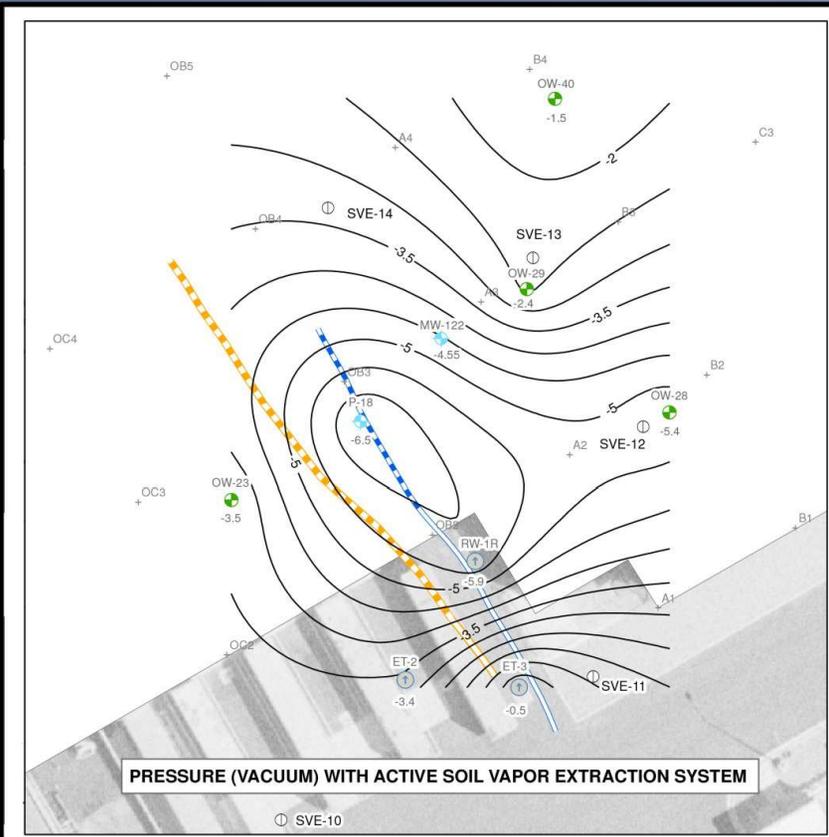


Full Scale Implementation – SVE/AS

- Installation of vertical SVE wells in January 2012
 - 3 interior vertical SVE wells
 - 2 exterior vertical SVE wells

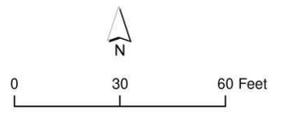
- Interior plant reconfiguration
 - Required 4 changes to interior SVE vertical wells
 - System down time

Radius of Influence SVE/AS with Horizontal and Vertical Wells

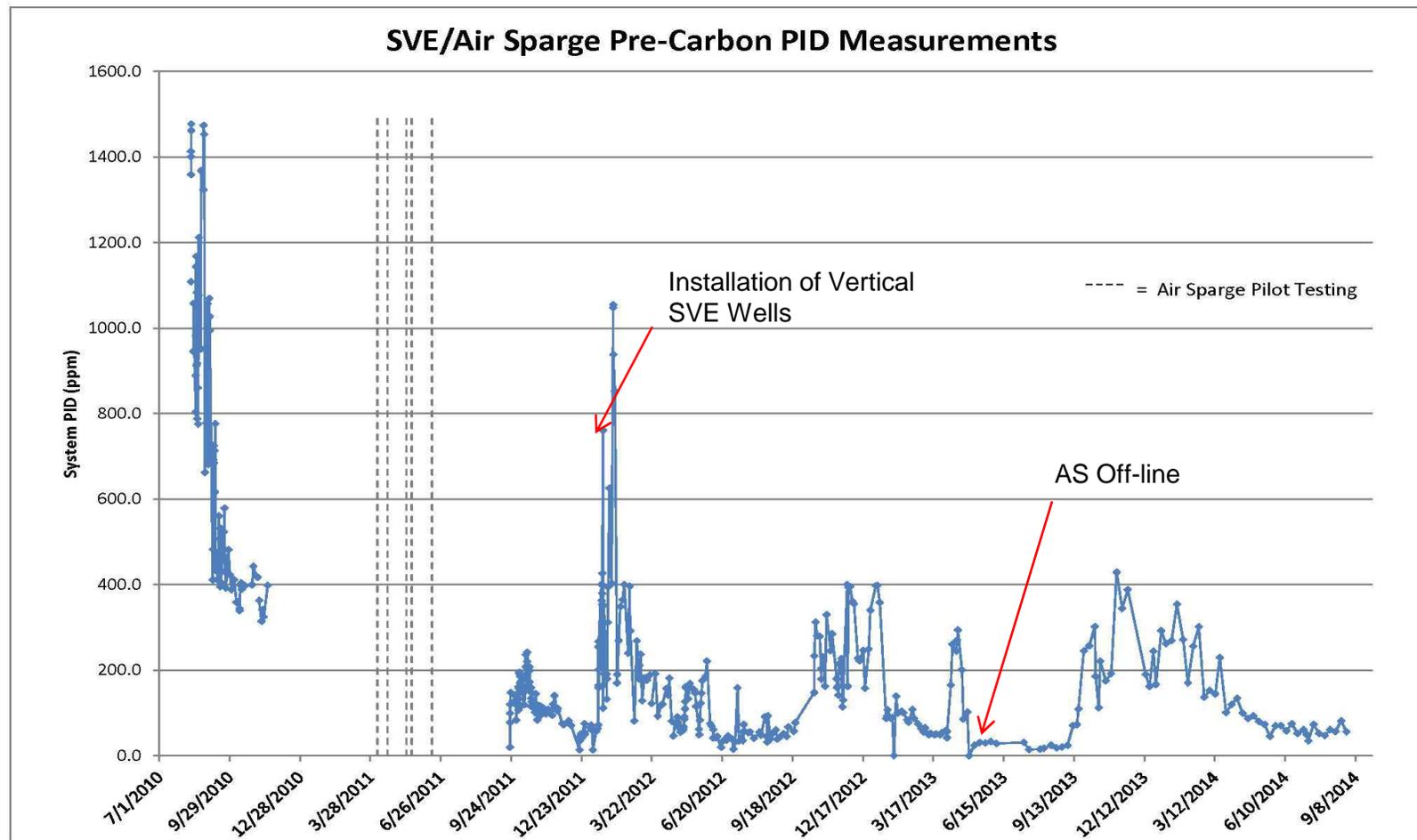


- BASE MAP: 2009 AERIAL PHOTOGRAPH
- Observation Well
 - Monitoring Well
 - Recovery Well
 - Soil Vapor Extraction Well
 - Pressure (Vacuum) with Air Sparge and Soil Vapor Extraction
 - Pressure (Vacuum) with Soil Vapor Extraction
 - Perched Water Injection/Extraction Well Screen
 - Perched Water Injection/Extraction Well Casing
 - Soil Vapor Extraction Well Screen
 - Soil Vapor Extraction Well Casing
 - A1 + Column & Column Name
 - Plant

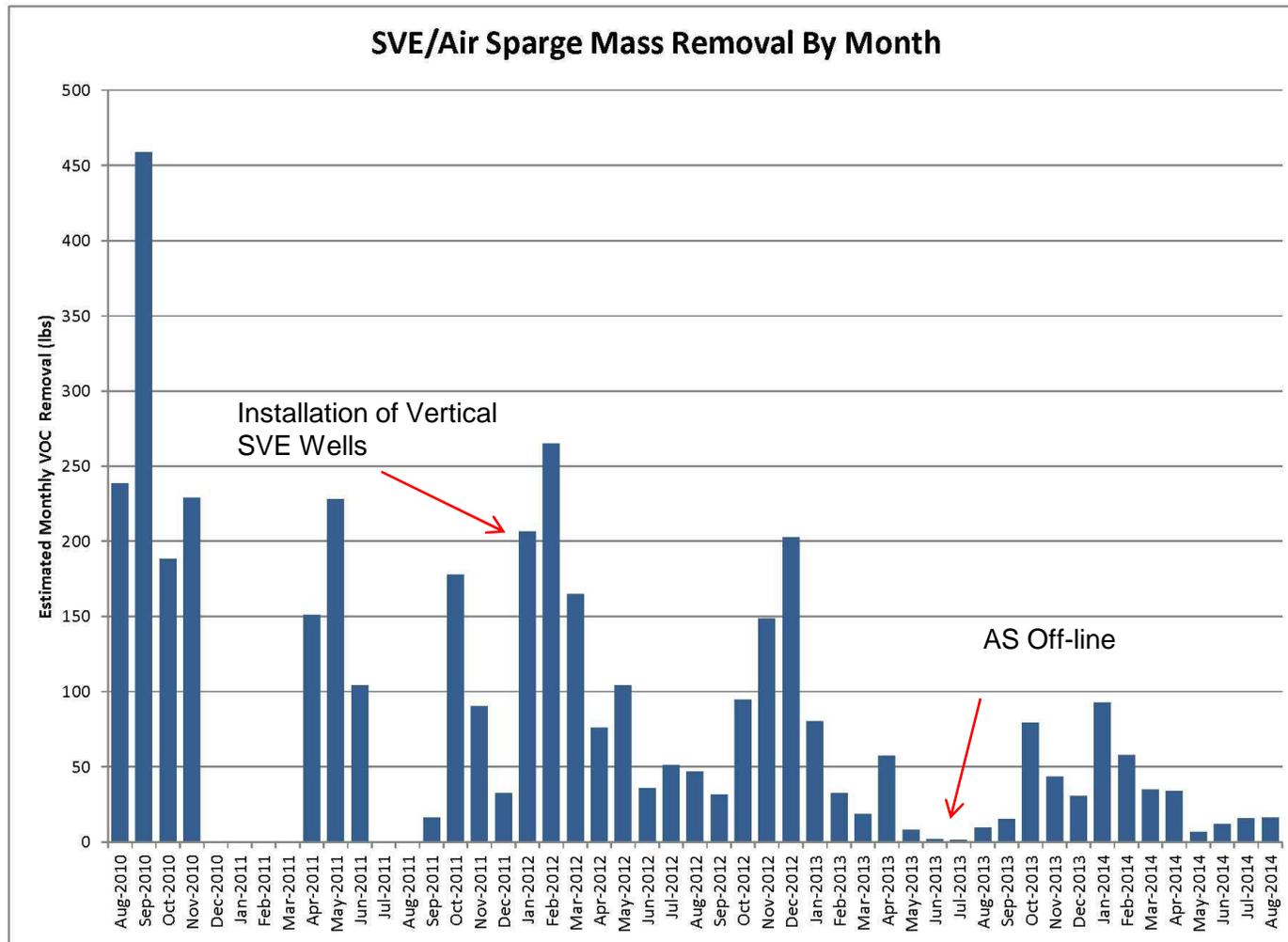
Notes:
Data collected January 12, 2012.
Contours generated with Surfer 10 using
standard Kriging settings
Contour interval 0.5 inches of H₂O.



Results – SVE/AS with Horizontal Wells

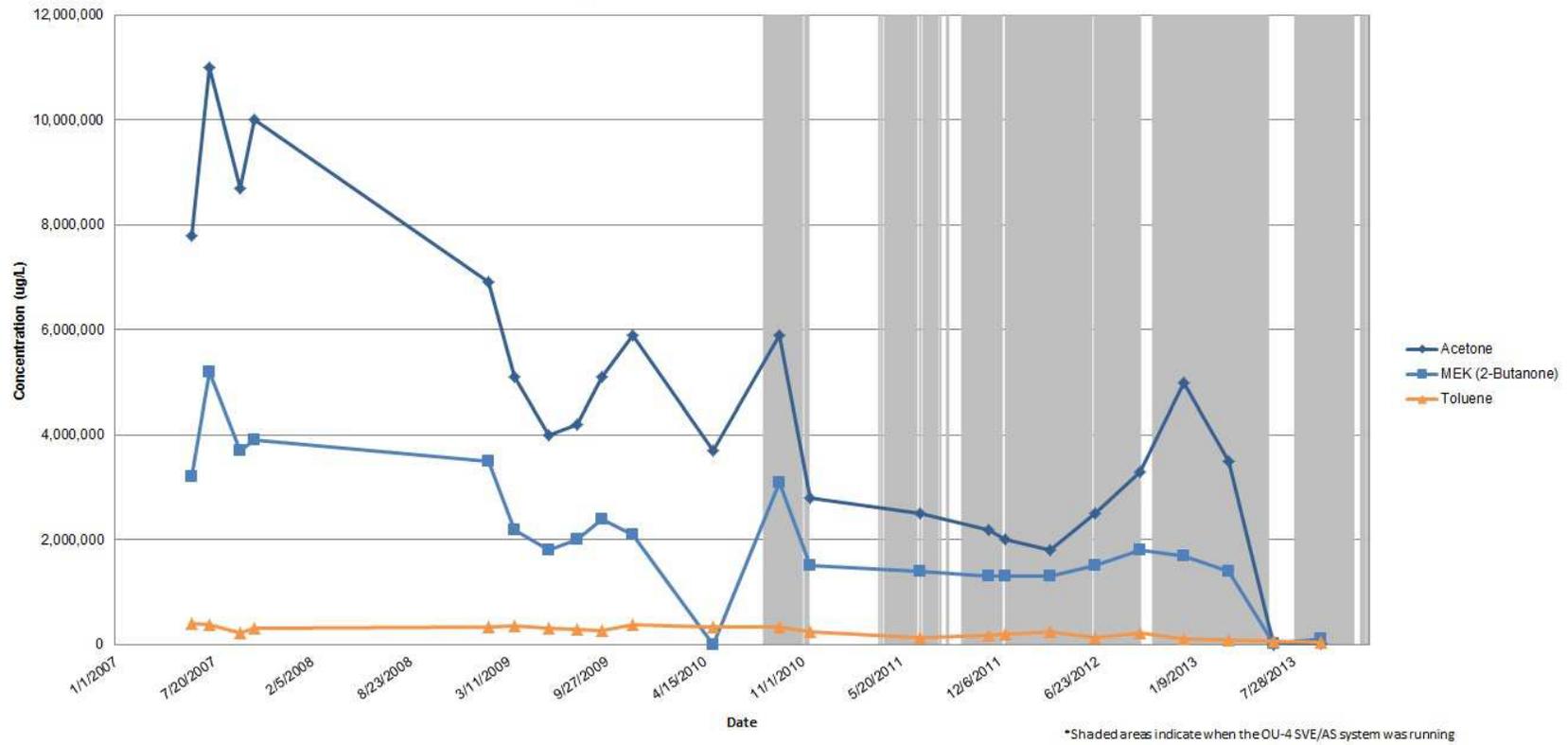


Results – SVE/AS with Horizontal Wells



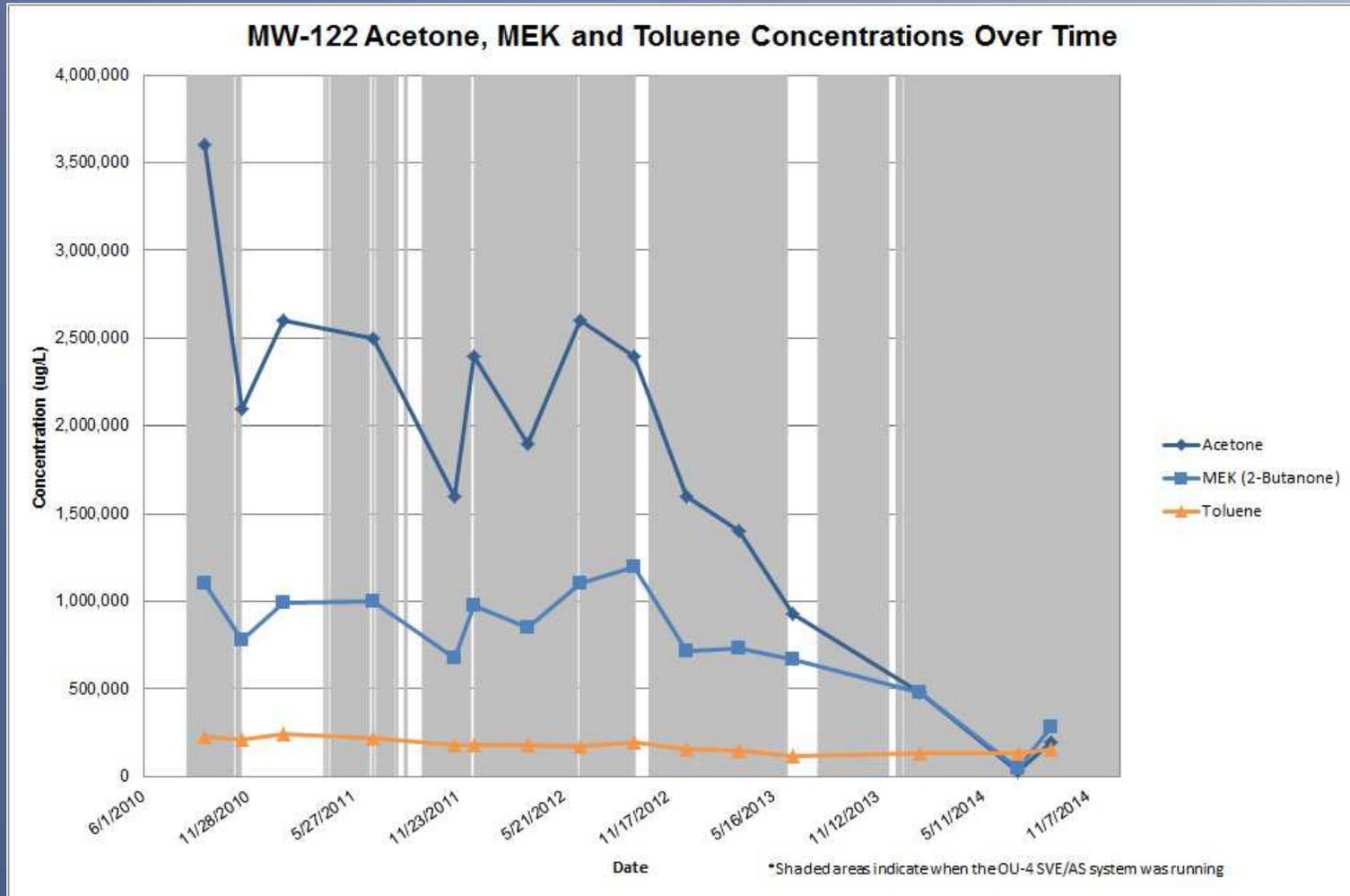
Groundwater Results - SVE/AS with Horizontal Wells

P-18 Acetone, MEK and Toluene Concentrations Over Time



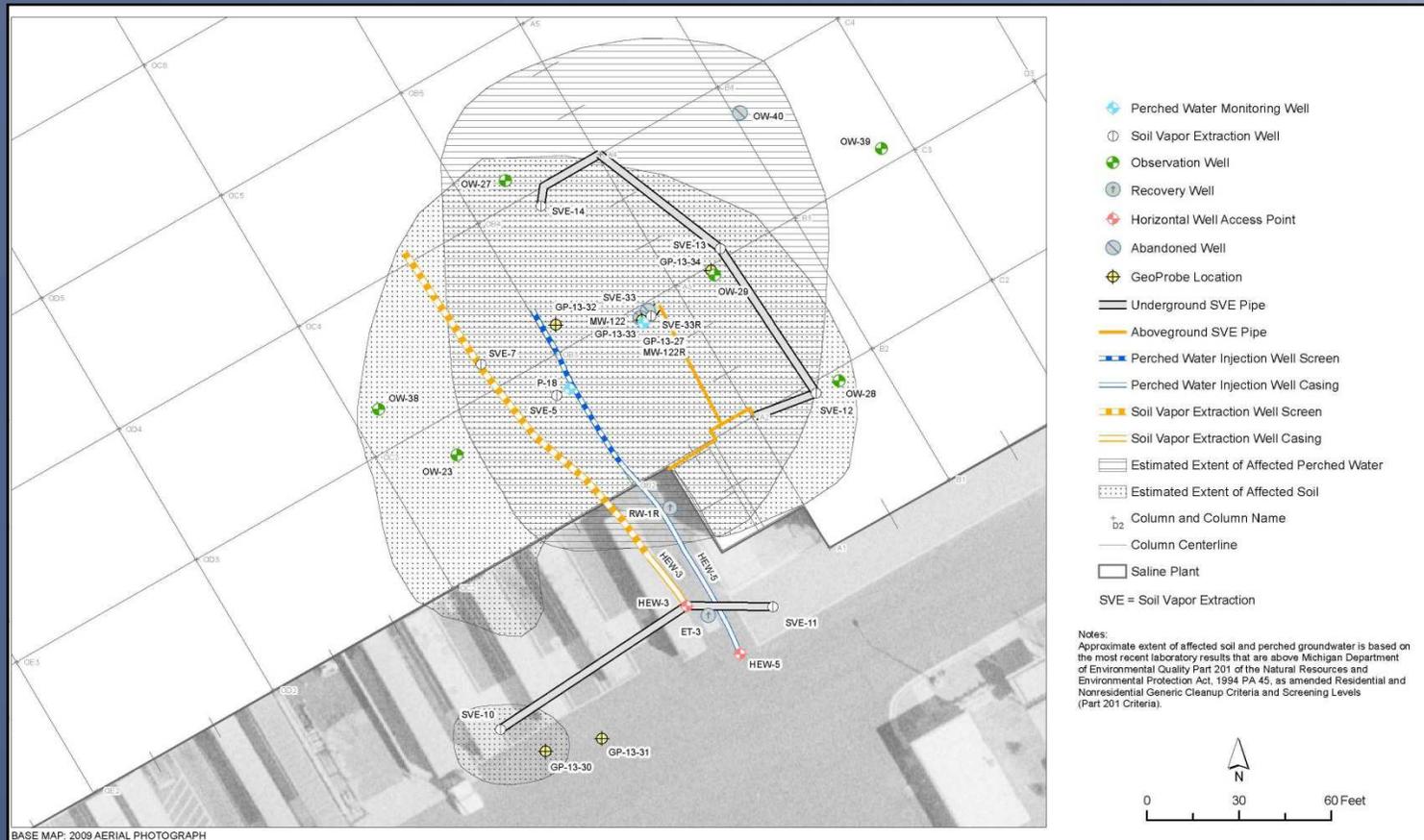
*Shaded areas indicate when the OU-4 SVE/AS system was running

Groundwater Results - SVE/AS with Horizontal Wells



Results – Contaminant Extent in Perched Water and Soil

- Lateral Extent soil impacts: ~0.44 acres
- Lateral extent of perched water impacts: ~0.41 acres (63% decrease)



Conclusions

- Remedial activities were completed in conjunction with multiple Plant projects
- Above ground infrastructure installed during periods of Plant shutdown
- Installation of horizontal wells
 - Competent drilling firm
 - Accurate location of well during drilling
 - Threading the needle during installation
 - Proper well development
- Operation and Maintenance of system in winter
 - Generating a larger volume of condensate
 - Carbon vessel hoses froze
 - Heated cargo container to house the carbon vessels

Before and After



Thank You