

# 1,2,3-Trichloropropane Occurrence and Remediation



*Matt Marlatt*

*CH2M HILL, Sacramento, CA*

*Presented GRA Symposium February 5, 2014*

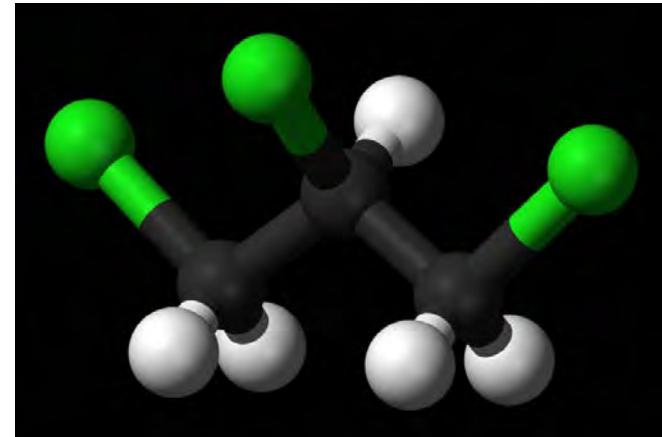
# Outline

- 1,2,3-Trichloropropane (TCP)
  - Sources
  - Toxicity and Regulation
  - Properties
  - Remediation
- Case Study - Thermal Treatment

# Sources and Occurrence

## ■ Sources

- Degreaser
- Chemical Production
  - Polymer production
  - By-product
- Agricultural
  - Byproduct/Impurity in pesticide production (dichloropropane-dichloropropene)



## ■ Occurrence

- California Drinking Water Sources
  - 336 active and standby sources with 2 or more detections
- Agricultural Spills/Releases
  - Davis, Dixon, Merced, etc

# Toxicity / Regulation

- Likely human carcinogen (EPA IRIS 2009)
- Known to the State of California to cause cancer (CA OEHHA 1999)
- Non-cancer Toxicity – kidney, liver damage



- Federal
  - No Maximum Contaminant Level (MCL)
  - One of 16 VOCs in EPA's Drinking Water Strategy
- State
  - Hawaii MCL = 0.6µg/L
  - California Dept. of Public Health:
    - No MCL; draft MCL in progress, planned 2014 release
    - Notification Level = 0.005 µg/L
    - Response Level = 0.5 µg/L
    - Public Health Goal = 0.0007 µg/L

# Properties

	TCP	TCE
Physical Description (at room temperature)	Colorless to straw-colored liquid	Clear colorless
Water solubility (mg/L)	1,750 (slightly soluble)	1000
Boiling point (°C)	156.8	87.2
Vapor pressure at 25°C (mm Hg)	3.1	74
Specific gravity	1.39	1.465
Octanol-water partition coefficient (log Kow)	1.98 to 2.27	2.29
Soil organic carbon-water partition coefficient (log Koc)	1.70 to 1.99	2
Henry's law constant (atm m <sup>3</sup> /mol)	3.43 x 10 <sup>-4</sup>	91 x 10 <sup>-4</sup>

US EPA, 2012. Technical Fact Sheet - 1,2,3-Trichloropropane (TCP); National Primary Drinking Water Contaminants, TCE. <http://water.epa.gov/drink/contaminants/index.cfm>; Montgomery, J. 2000. Groundwater Chemicals Desk Reference.

# Remediation

- Pump and Treat (P&T)/ Activated Carbon
- Soil Vapor Extraction
- Ultraviolet
- Chemical Oxidation
- Enhanced Reductive Dechlorination – documented, but variable results
- Thermal Treatment



# Case Study

# Frontier Fertilizer Site History



- 1972 - 1983: Unused chemicals disposed into unlined ponds
- Chemicals of concern (COC): TCP, 1,2-dibromo-3-chloropropane (DBCP), 1,2-dibromoethane (EDB), 1,2-dichloropropane (1,2-DCP), carbon tetrachloride
- 1993: P&T system installed
- 1995: Upgraded P&T, 80 gpm, removed over 1,500 lbs of COCs as of 2013, still operating.
- 2006: Record of Decision, Remedy Component – Thermal Treatment
- 2011: Thermal Treatment of Source Zone

# Thermal Treatment – What? Why?

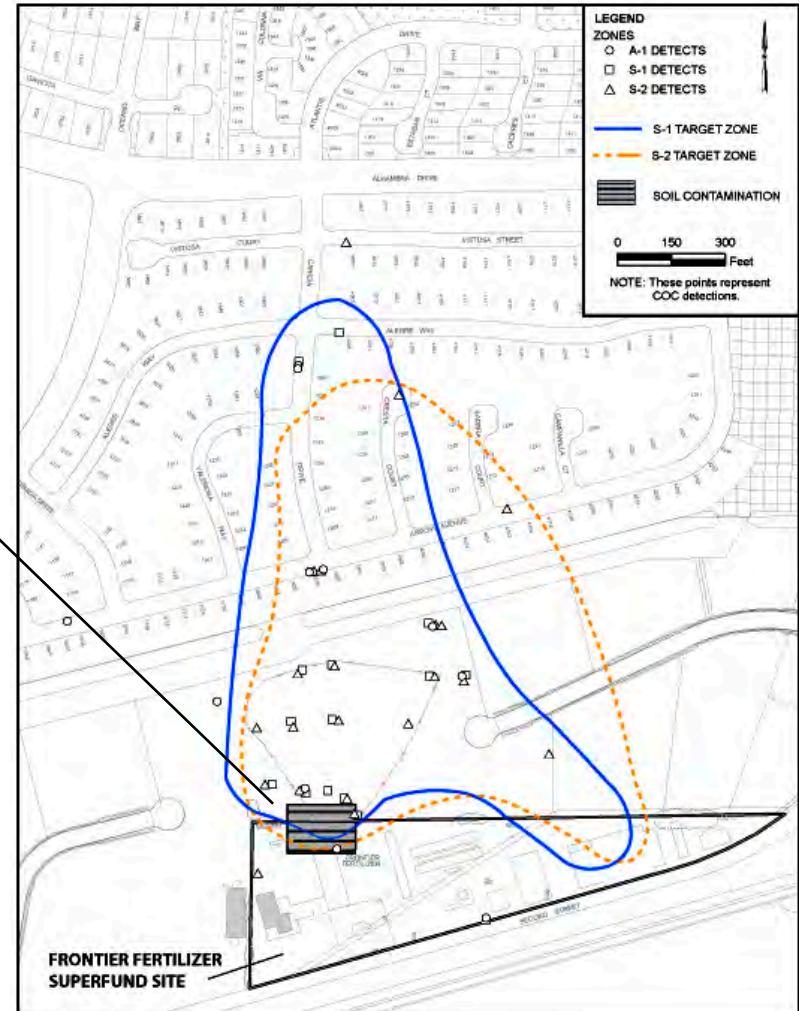
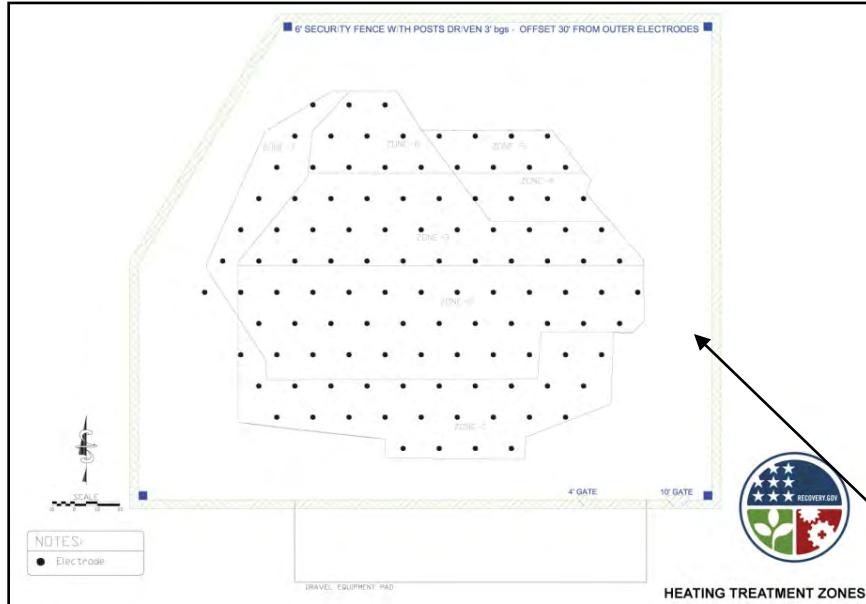
## ■ What is Thermal Treatment?

- In-Situ delivery of heat for remediation of groundwater and soil
  - electrical resistivity, heating elements, steam, etc.

## ■ Benefits

- Accelerated Mass Transfer
  - Vaporization
  - Increased Solubility
  - Enhanced Desorption
- Chemical Destruction
  - Hydrolysis
  - Oxidation
- Enhanced Microbial Degradation

# Source Zone Contamination



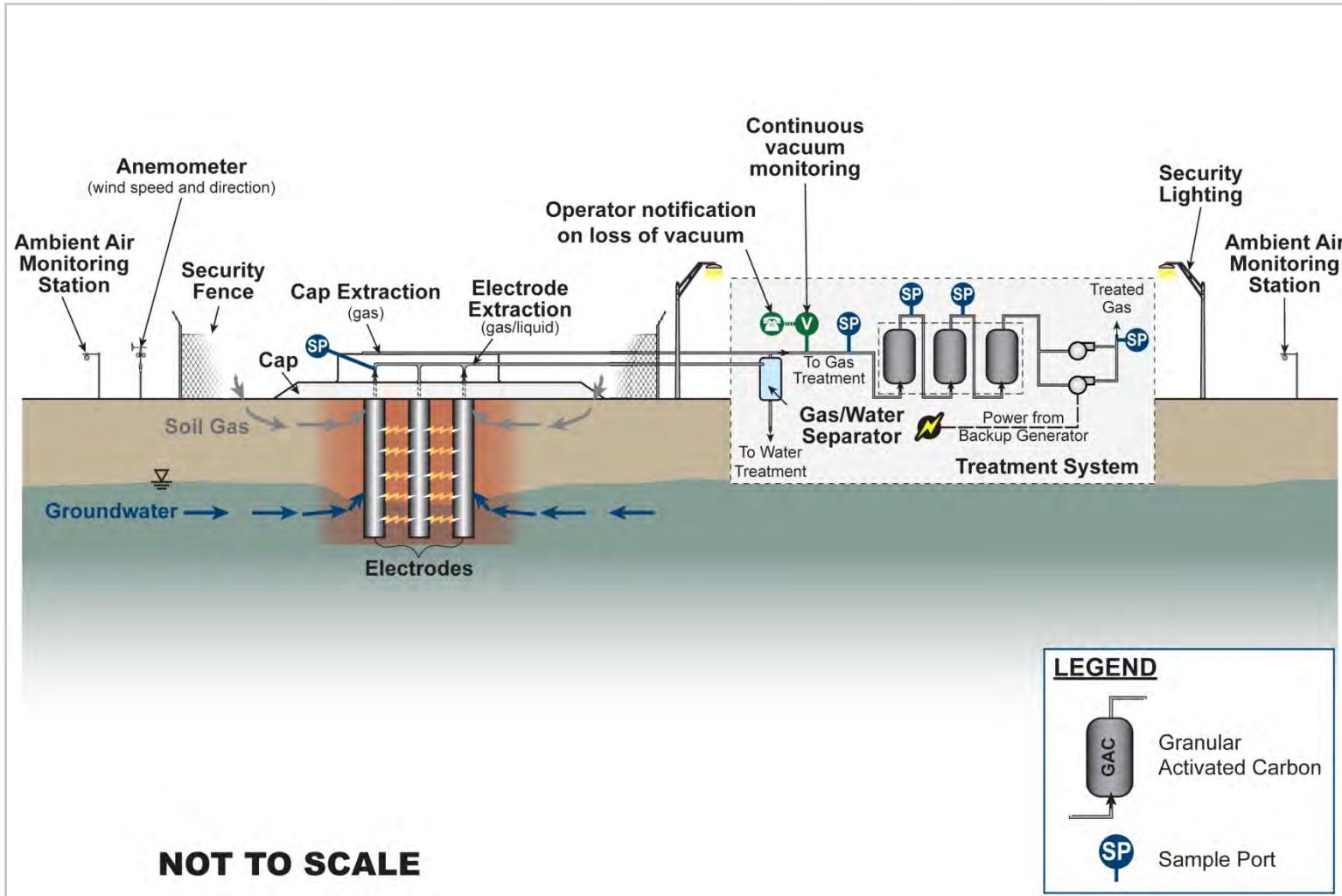
	<b>Max. Soil (<math>\mu\text{g}/\text{kg}</math>)</b>	<b>Max. GW (<math>\mu\text{g}/\text{L}</math>)</b>
DCP	90,000	68,000
EDB	50,000	50,000
DBCP	1,000,000	800
TCP	10,000	1,100

# Treatment Objectives

- Treat highly contaminated source, shorten overall site treatment time.
- Treatment Objectives
  - Soil concentrations for protection of groundwater
  - Groundwater MCLs (TCP detection limit)

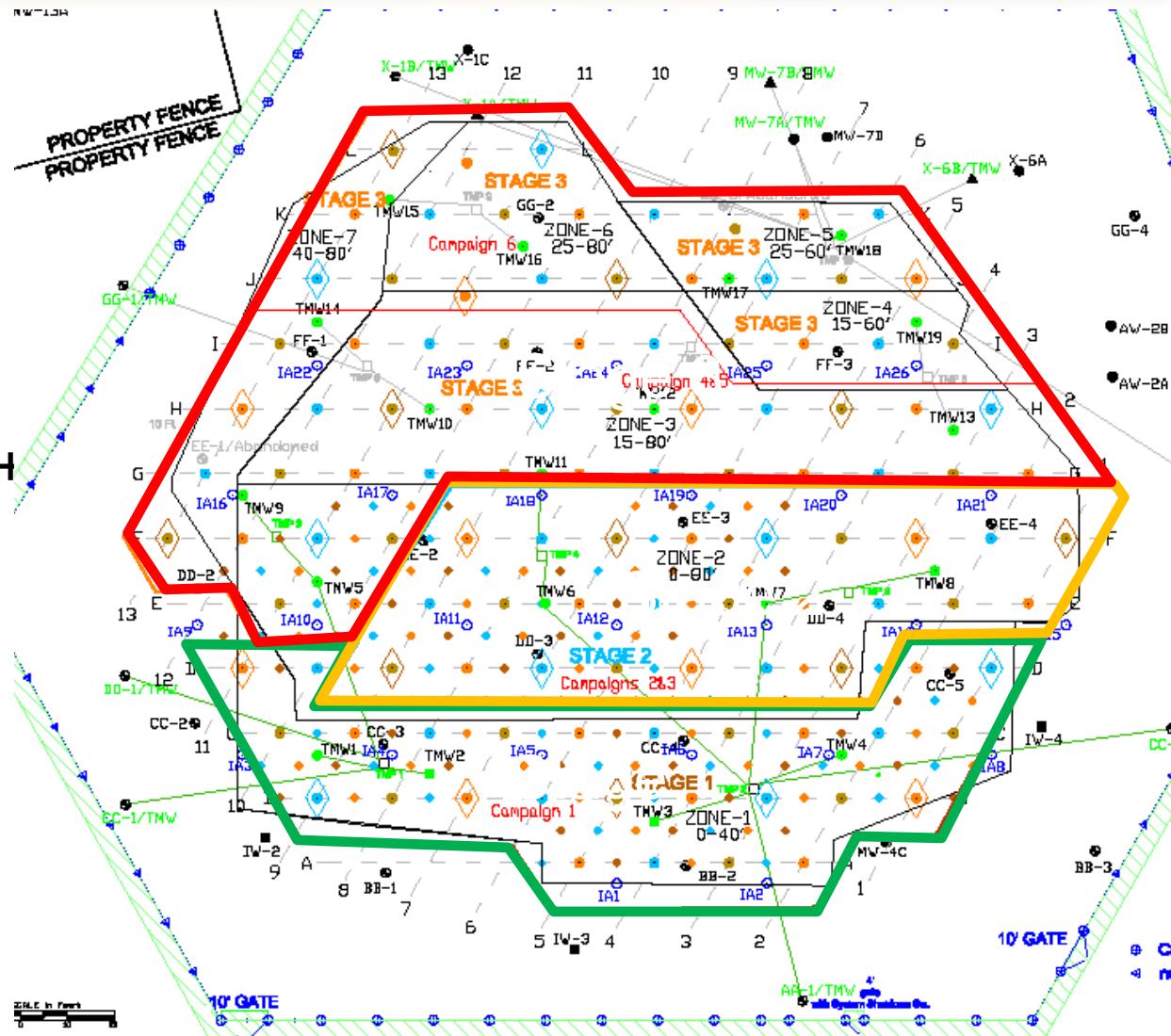
Contaminant of Concern	Soil Cleanup Values ( $\mu\text{g}/\text{kg}$ )	Groundwater MCL ( $\mu\text{g}/\text{L}$ )
DBCP	1.2	0.2
EDB	0.18	0.05
DCP	20	5
TCP	2.5	0.5

# Thermal System



# Thermal Design

- 27,000 ft<sup>2</sup>
- 40 - 80 feet deep
- 52,000 yd<sup>3</sup>
- 111 Electrodes/SVE
- 19 Temperature monitoring wells (290+ sensors)
- 3 Stages
  - Mar '11 – Nov '11
  - Aug '11 – Mar '12
  - Jan '12 – Oct '12

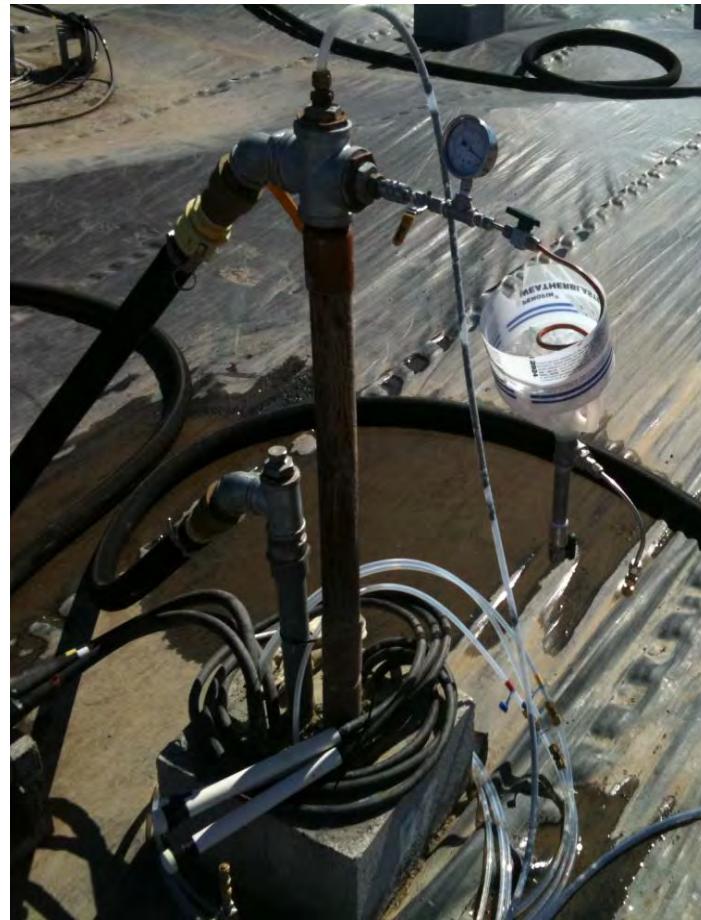


# Process Monitoring

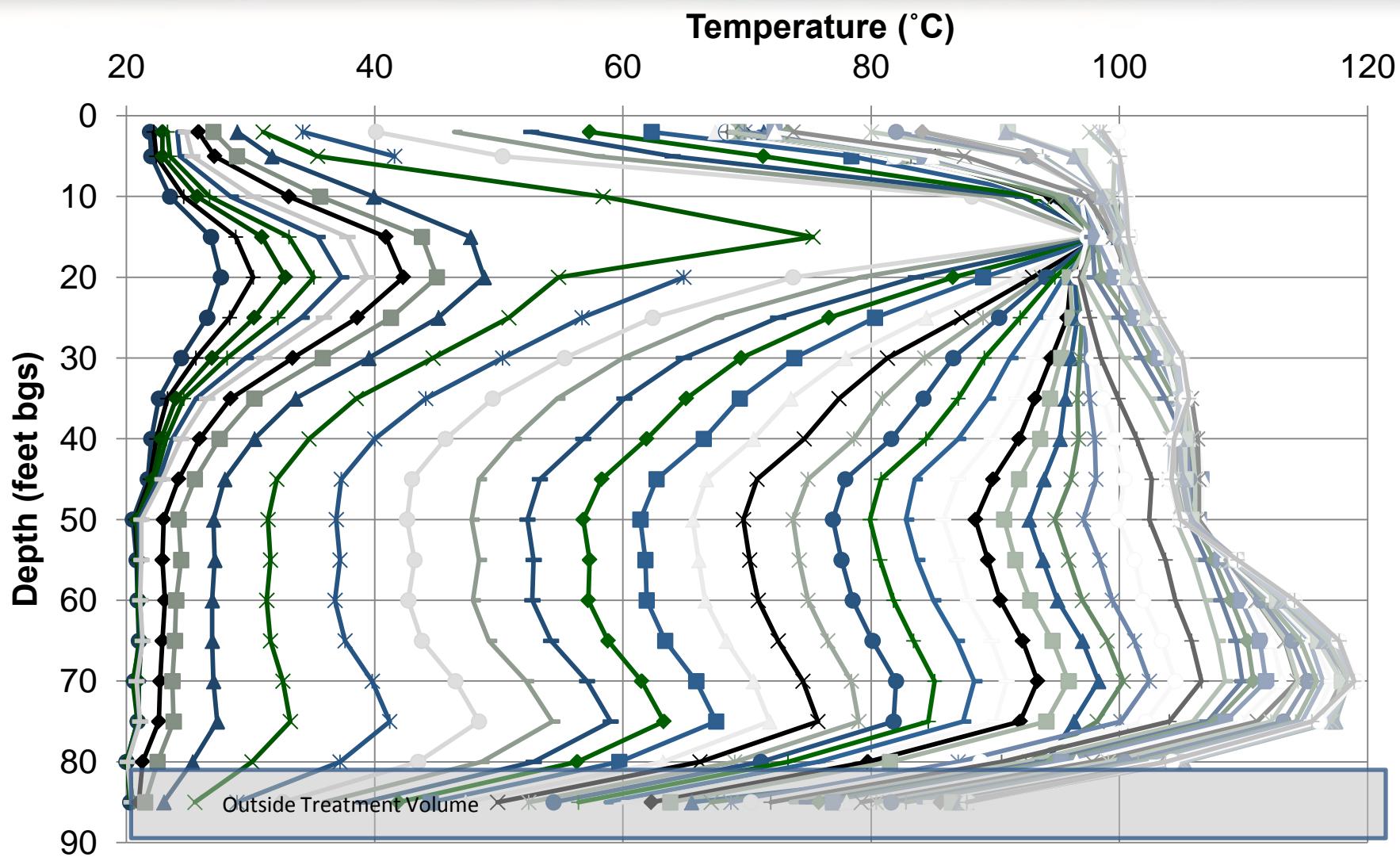
- Power
  - In-Situ Temperatures
  - Mass Extraction
  - Electrode Concentration
  - Site Perimeter Ambient Air
- 
- Process Samples
    - GAC Monitoring
    - In-situ Vacuum



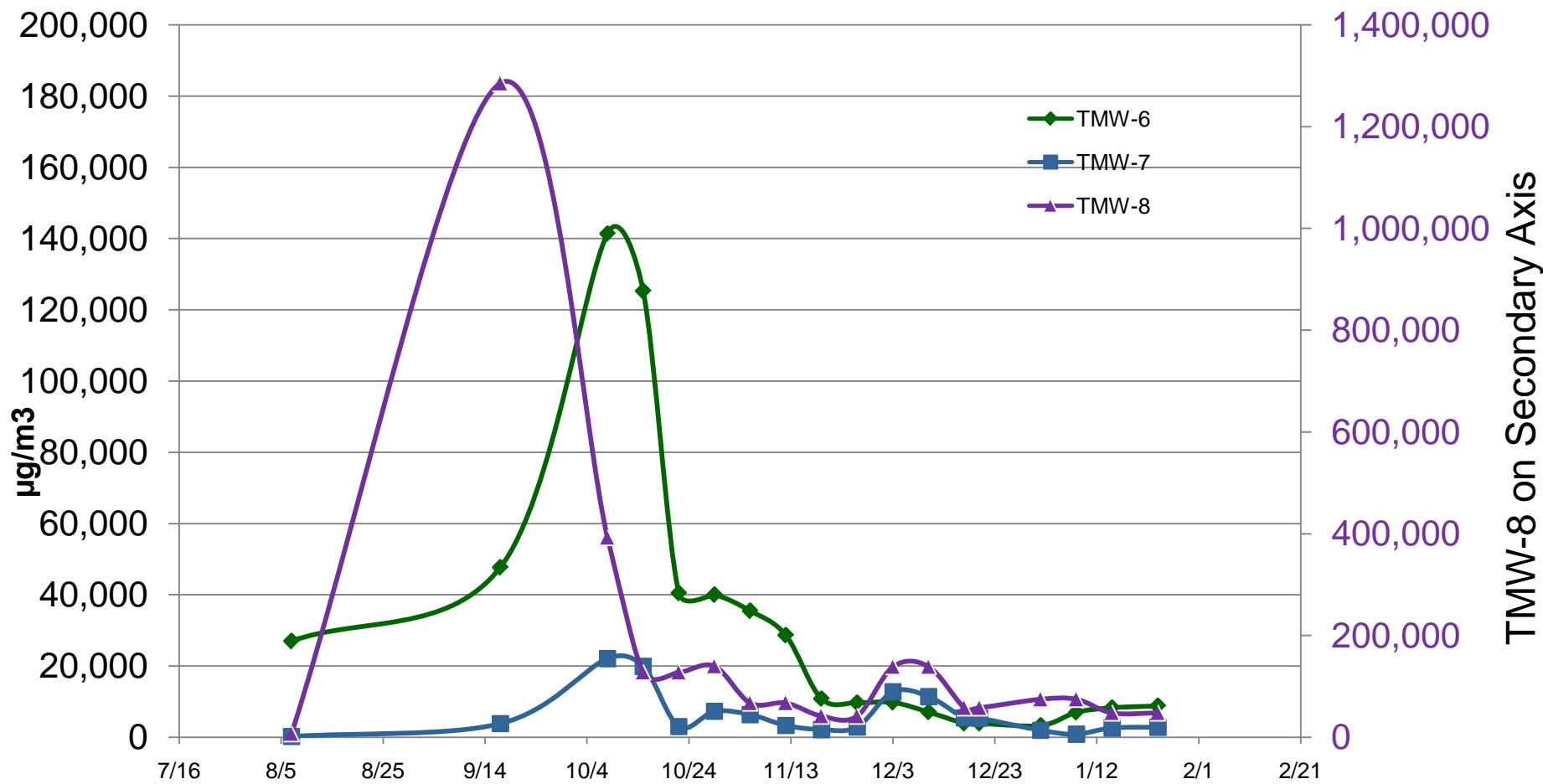
# Process Monitoring



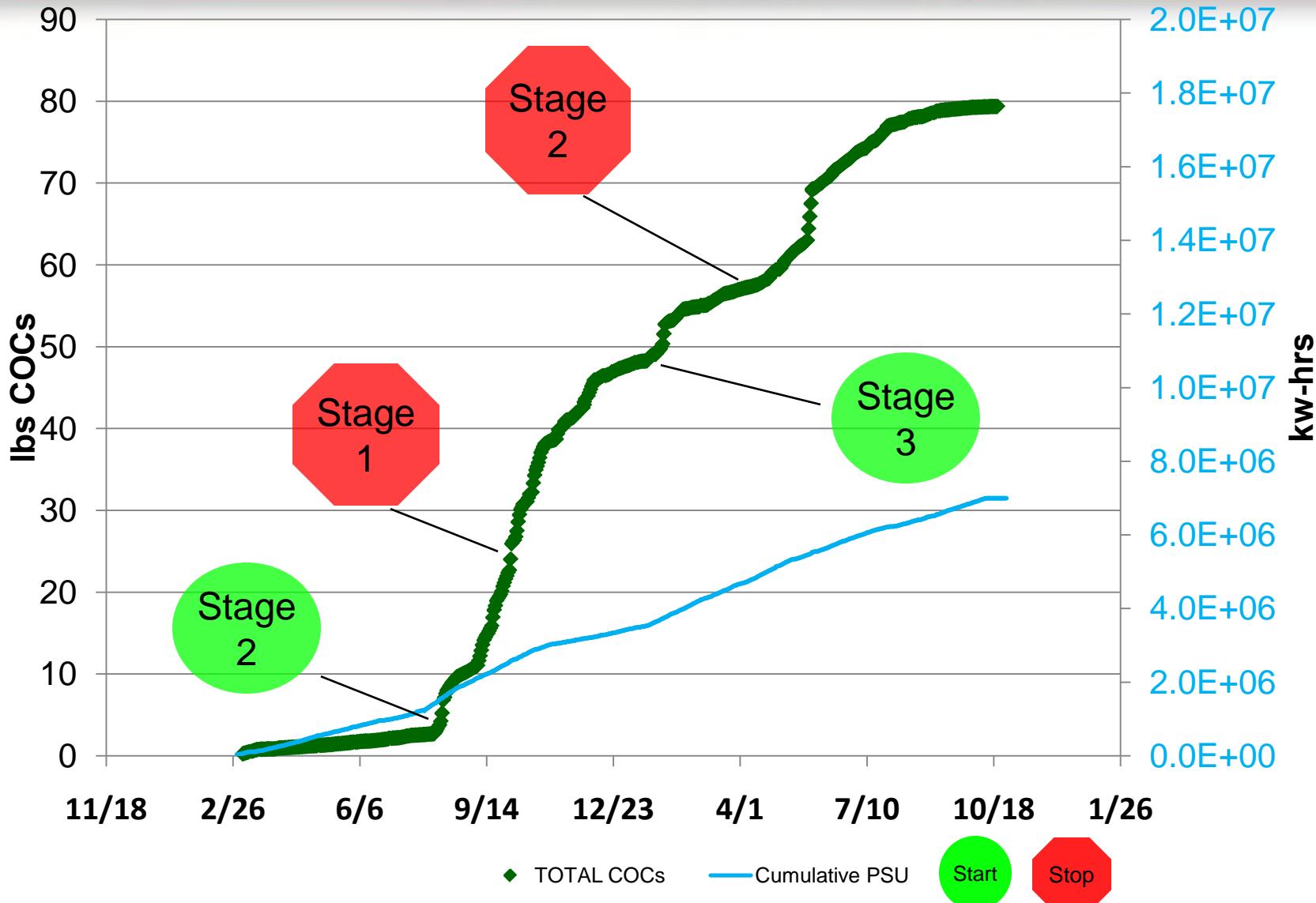
## Temperature (TMW-6)



# Electrode Vapor Concentration



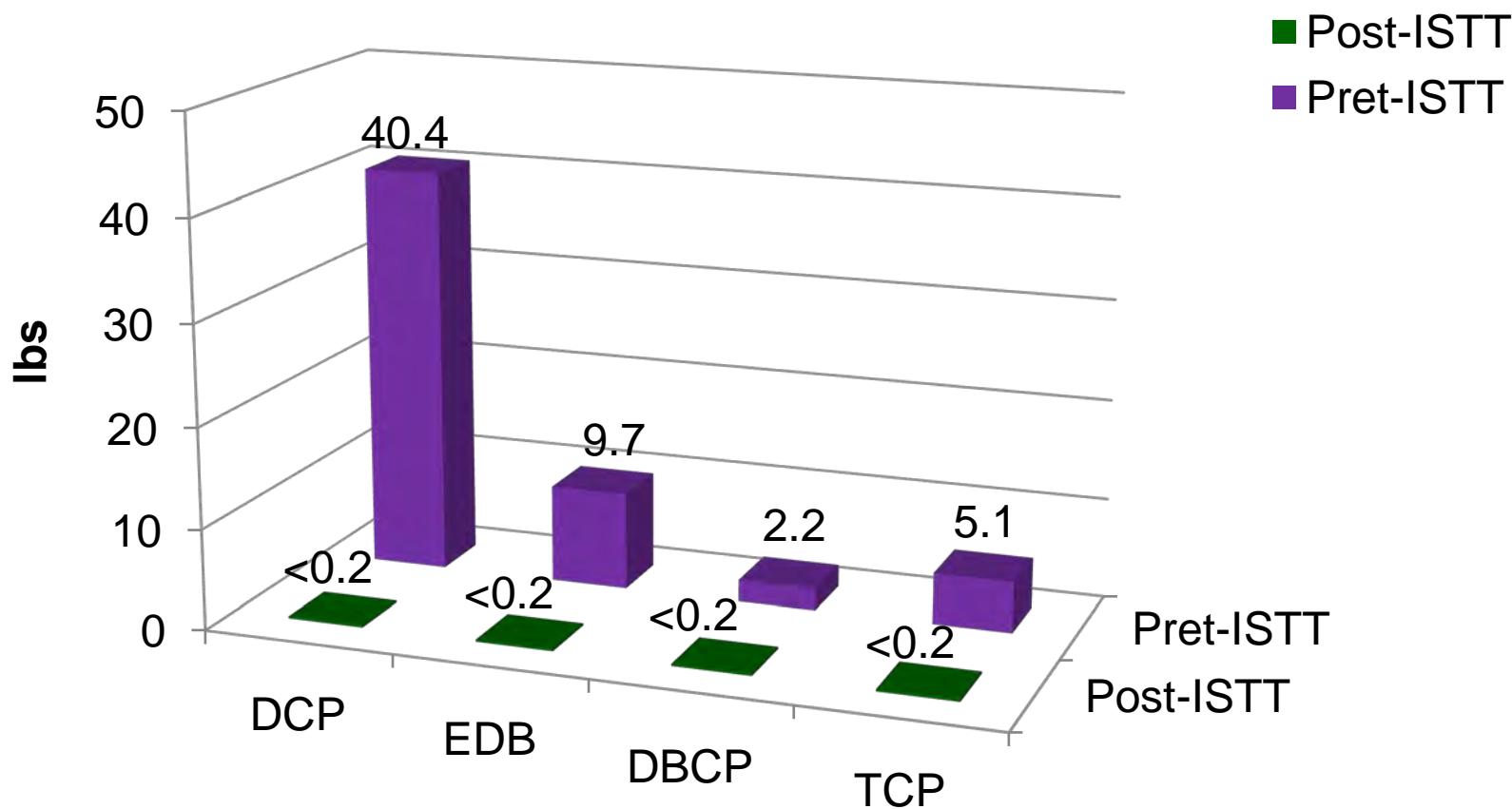
# Mass Removal / Power



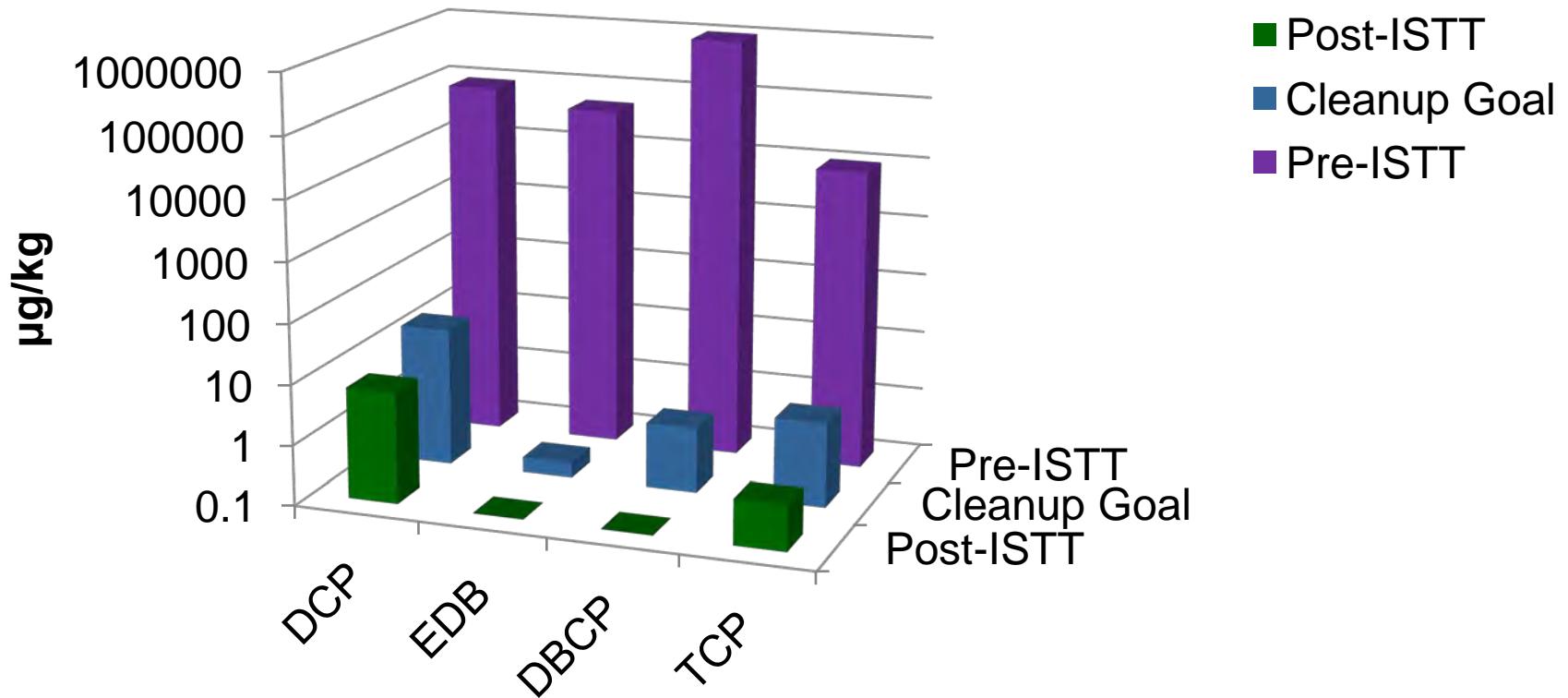
# Post-ISTT Sampling



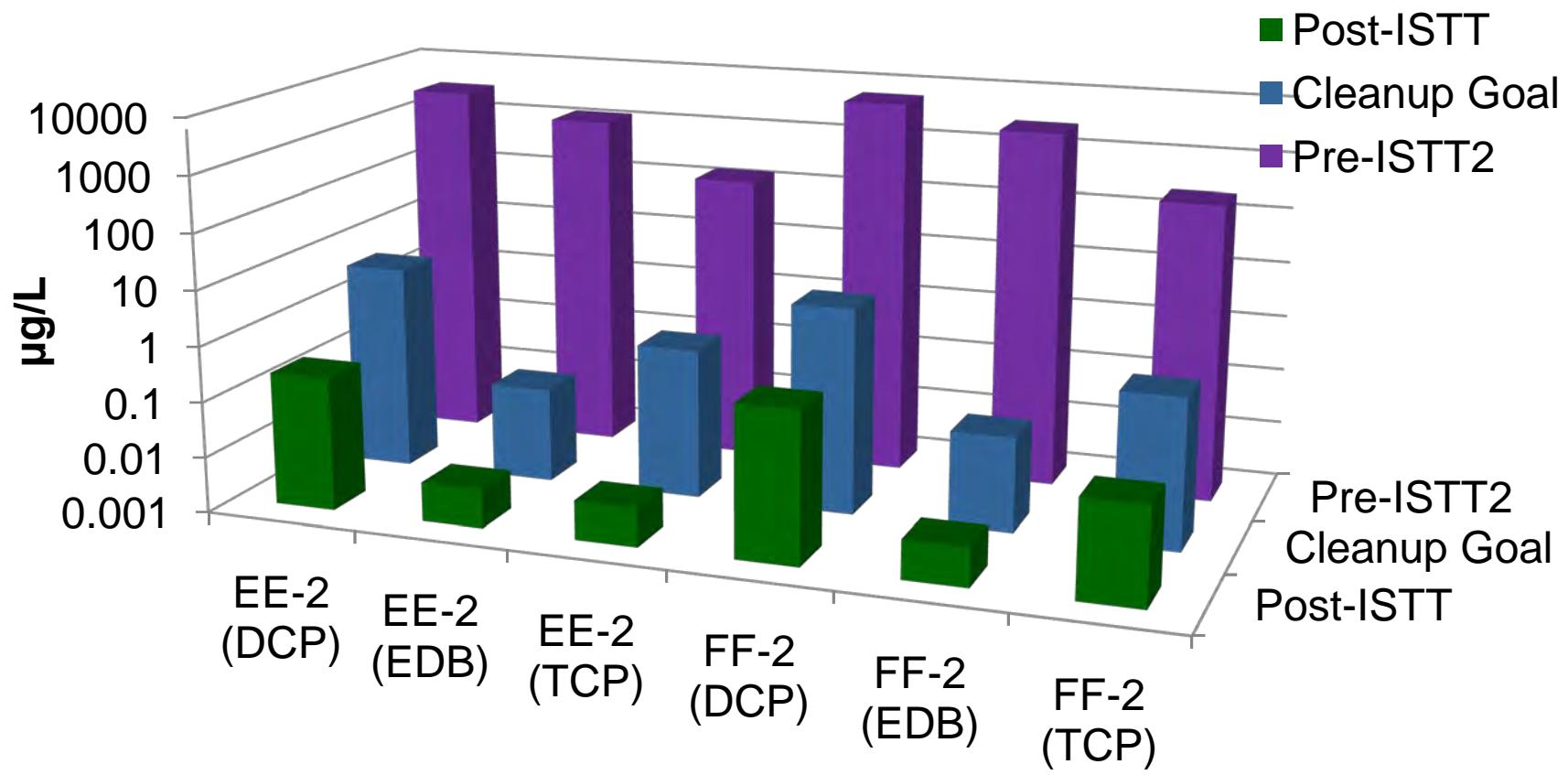
# Performance – Soil Mass (lbs)



# Performance – Maximum Soil Concentrations



# Performance - Groundwater



Post-ISTT: All Wells Below Cleanup Goals

# Questions

