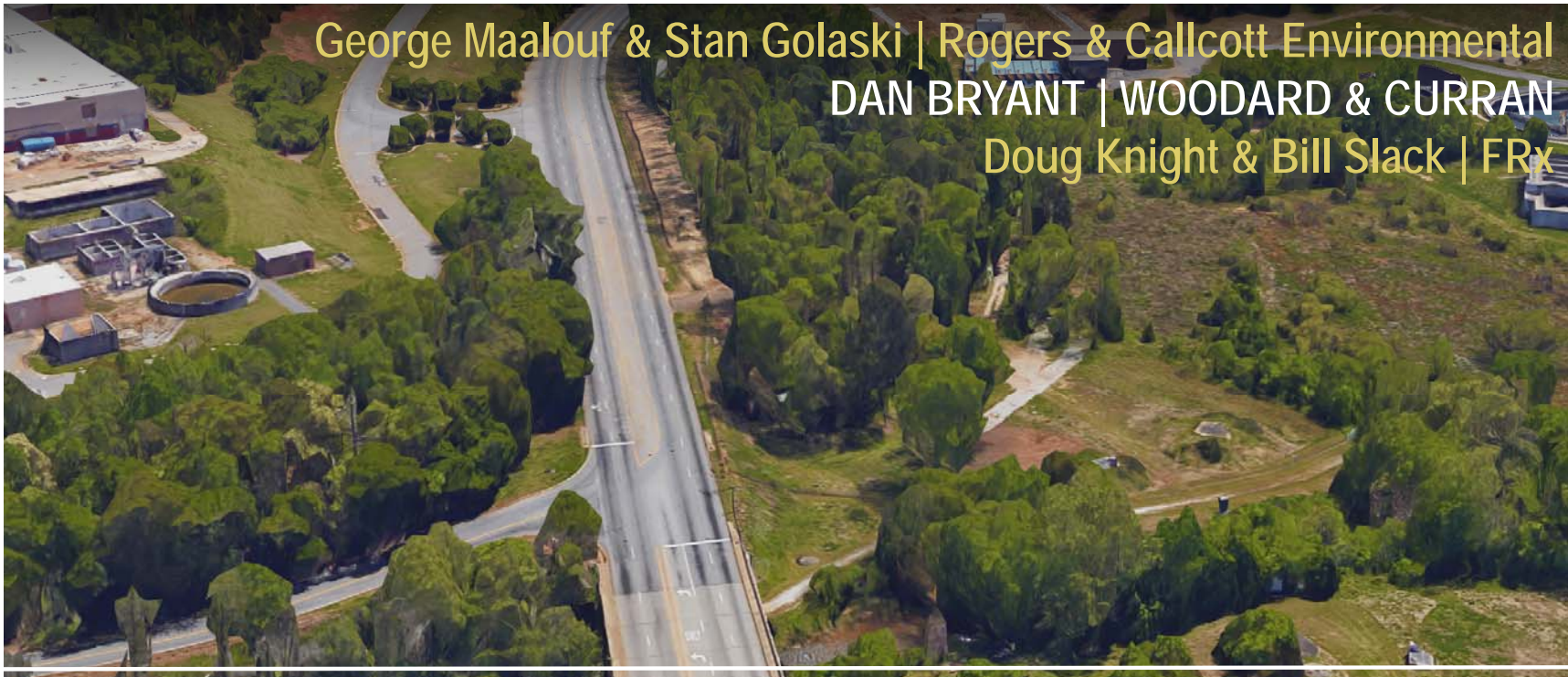




Contraction of a 15-Acre TCE Plume in Overburden and Bedrock Three Four Years After Full-Scale Barrier Construction by Controlled-Jet ZVI Injection



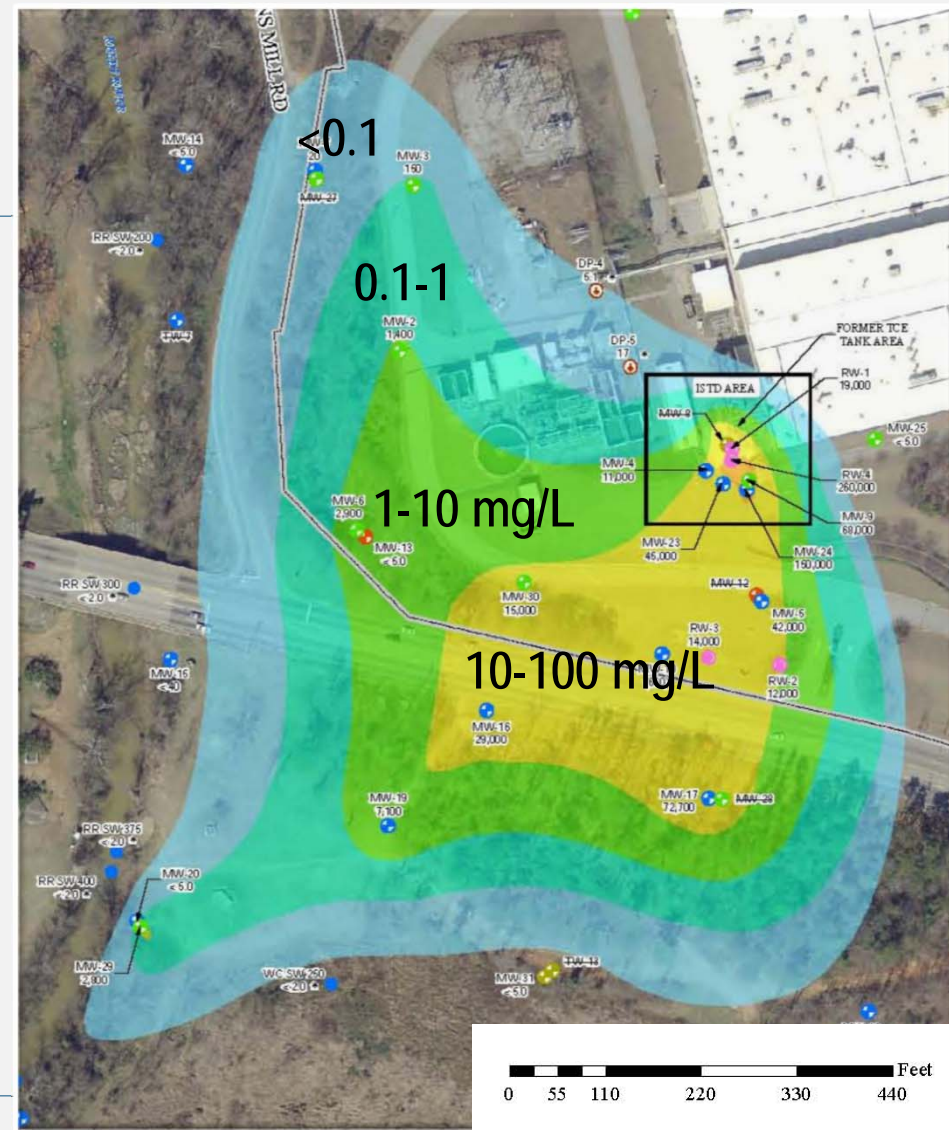
George Maalouf & Stan Golaski | Rogers & Callcott Environmental
DAN BRYANT | WOODARD & CURRAN
Doug Knight & Bill Slack | FRx

COMMITMENT & INTEGRITY DRIVE RESULTS



Multiple Site Challenges

- 15-Acre plume area
- Very high TCE concentration
- Very little attenuation
- Discharge to surface water





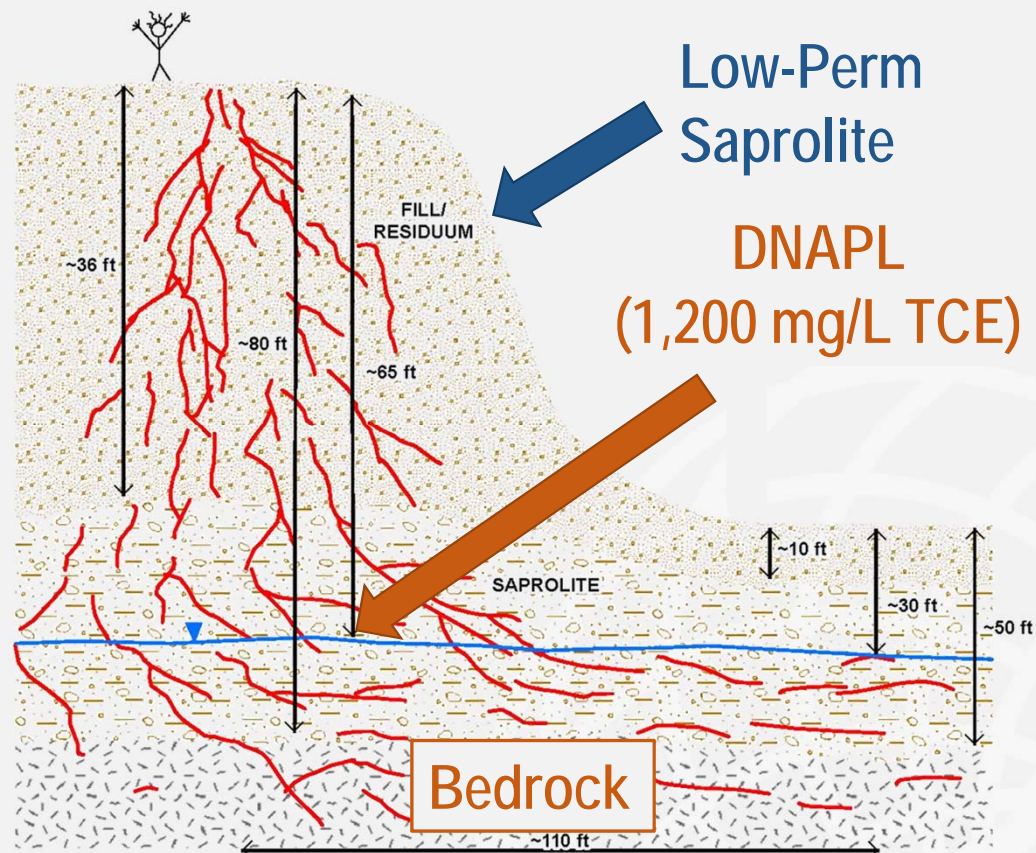
Very Limited Site Access

Rogers & Callcott
ENVIRONMENTAL



Saprolite & Bedrock

- Low-permeability saprolite
- Partially-weathered rock transition zone
- Fractured bedrock
- Dual-porosity system





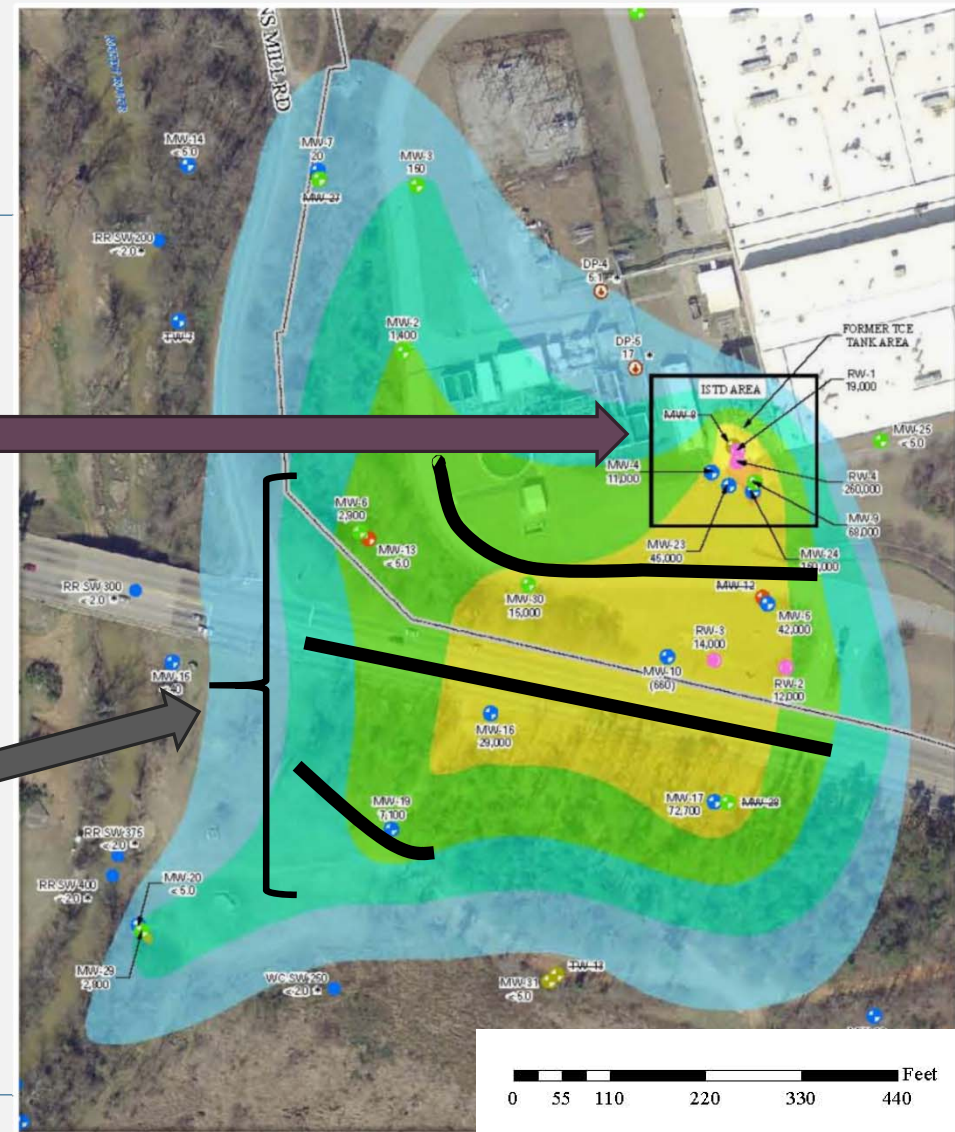
Combined Remedy

Rogers & Callcott
ENVIRONMENTAL



Source Area
Permanganate ISCO
Golaski et al. poster
Poster Group 1, Session C3

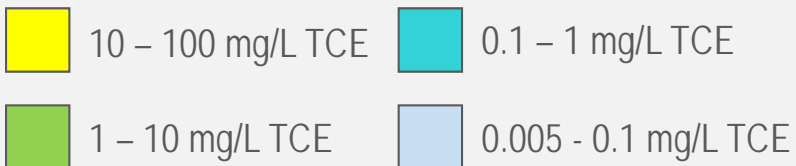
Plume Area
Injected ZVI ISCR Barriers





Baseline – 2011-Q2

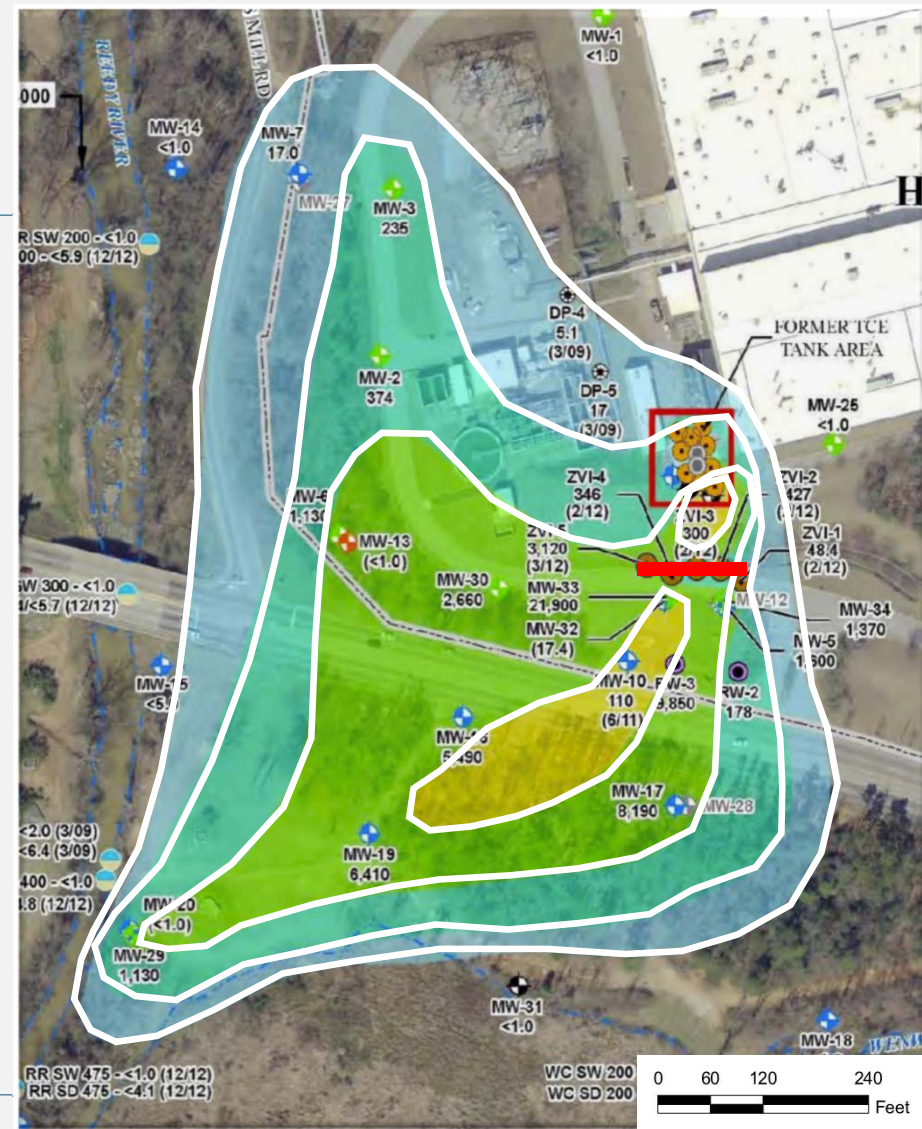
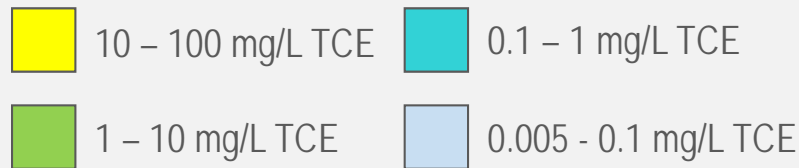
- Pilot Injection
 - May 2011, August 2011
- Different delivery methods
- 5 borings / 24 intervals
- 73.3 tons ZVI
- Post-injection borings





Pilot Test Results

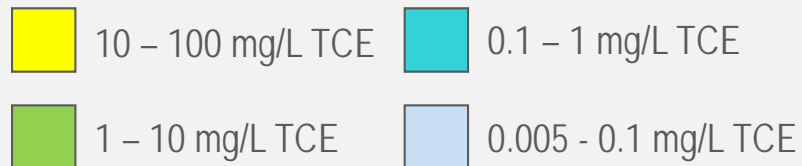
- Optimized delivery methods
- Confirmed distribution
- Two years of monitoring
- 2013-Q1 data





Full-Scale Scope

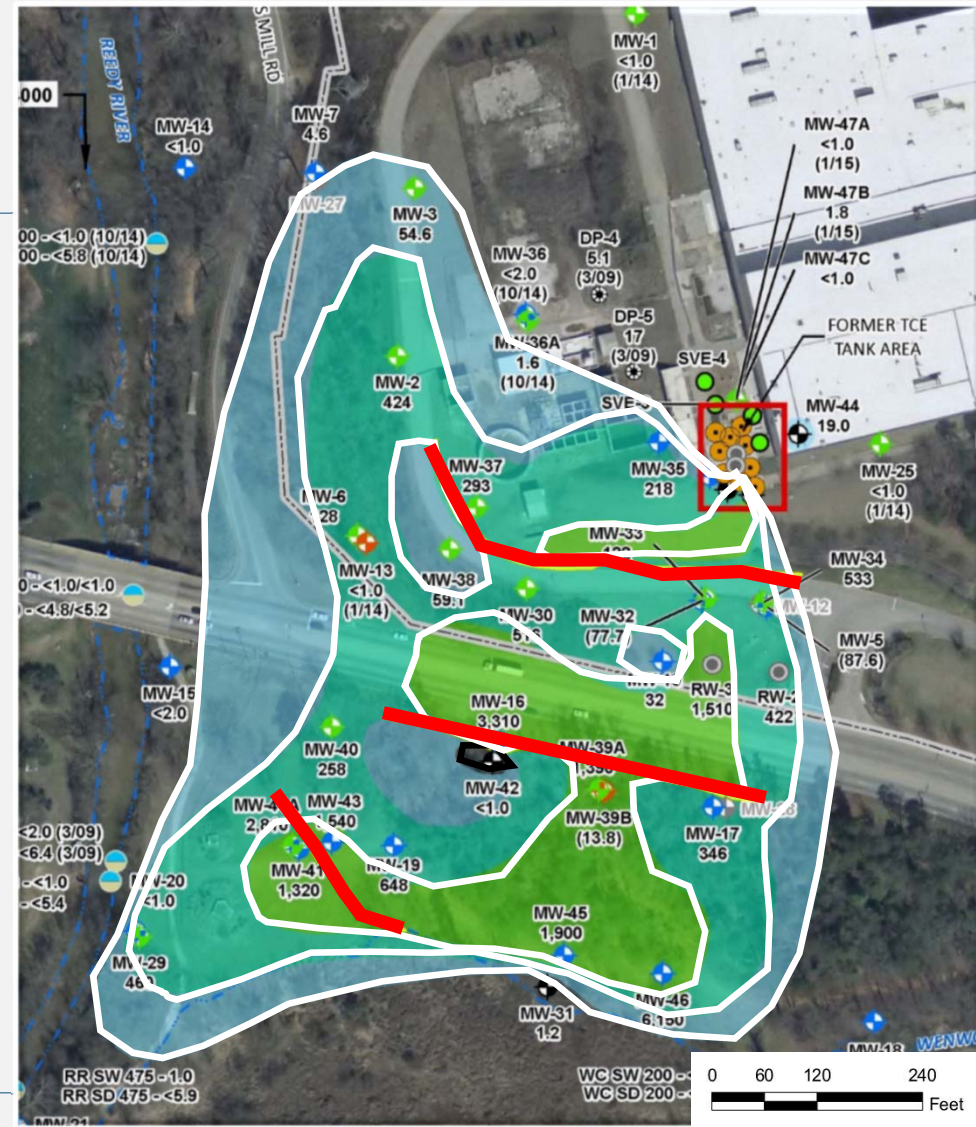
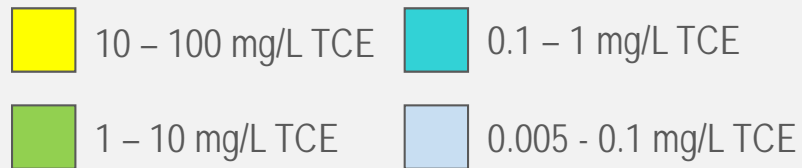
- August 2013 – March 2014
- 3 Barrier Zones
 - 508', 441', 219' length
- 67 Borings
- 725 Tons ZVI
- 391 Intervals





Year 1 – 2015-Q2

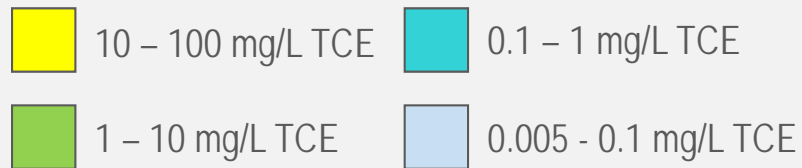
Rogers & Callcott
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Year 2 – 2016-Q2

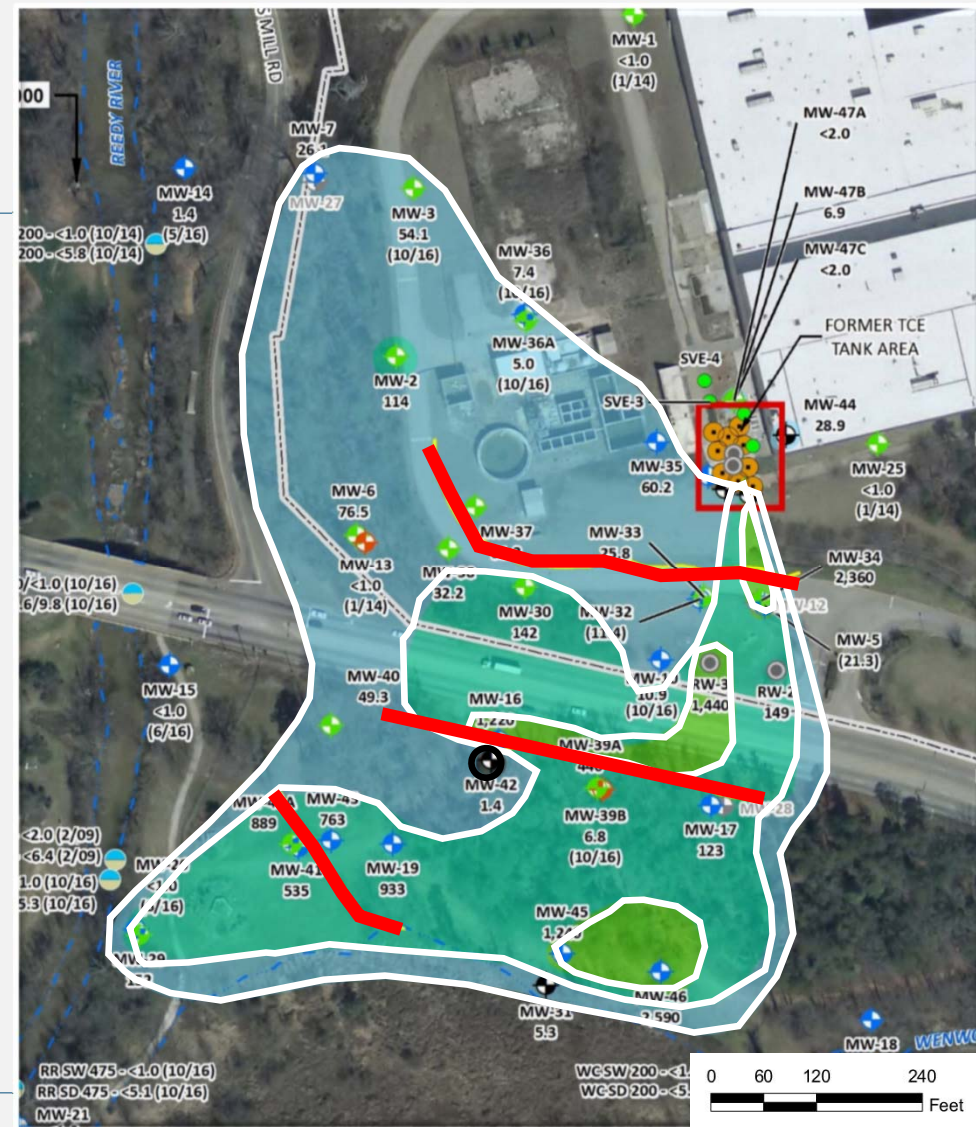
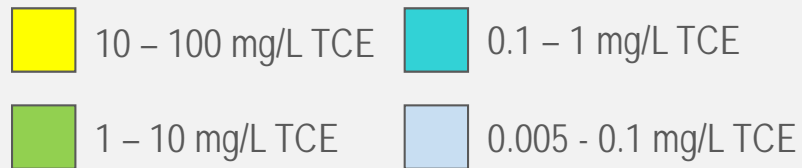
Rogers & Callcott
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Year 3 – 2017-Q2

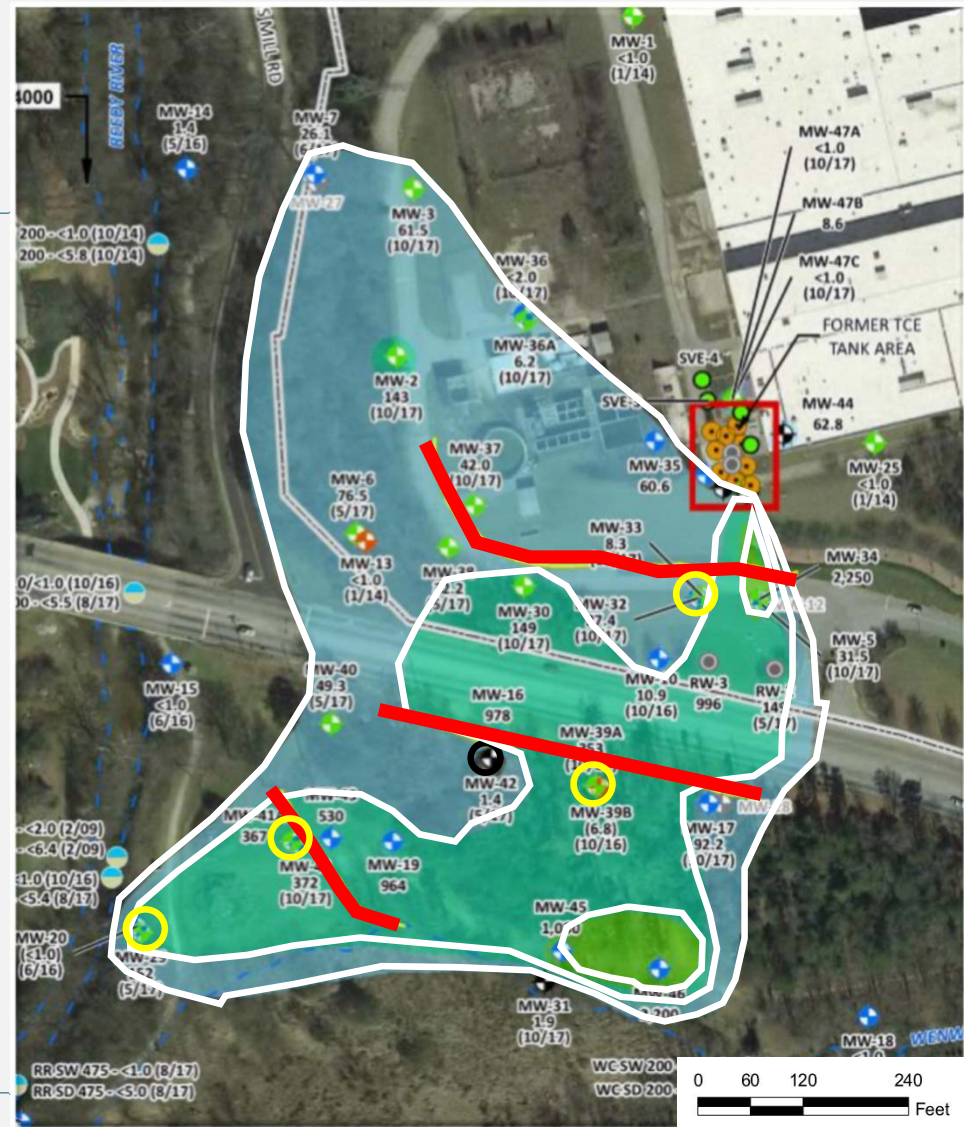
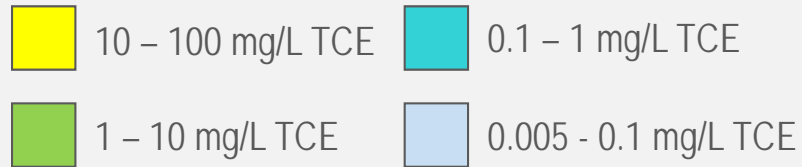
Rogers & Callcott
ENVIRONMENTAL



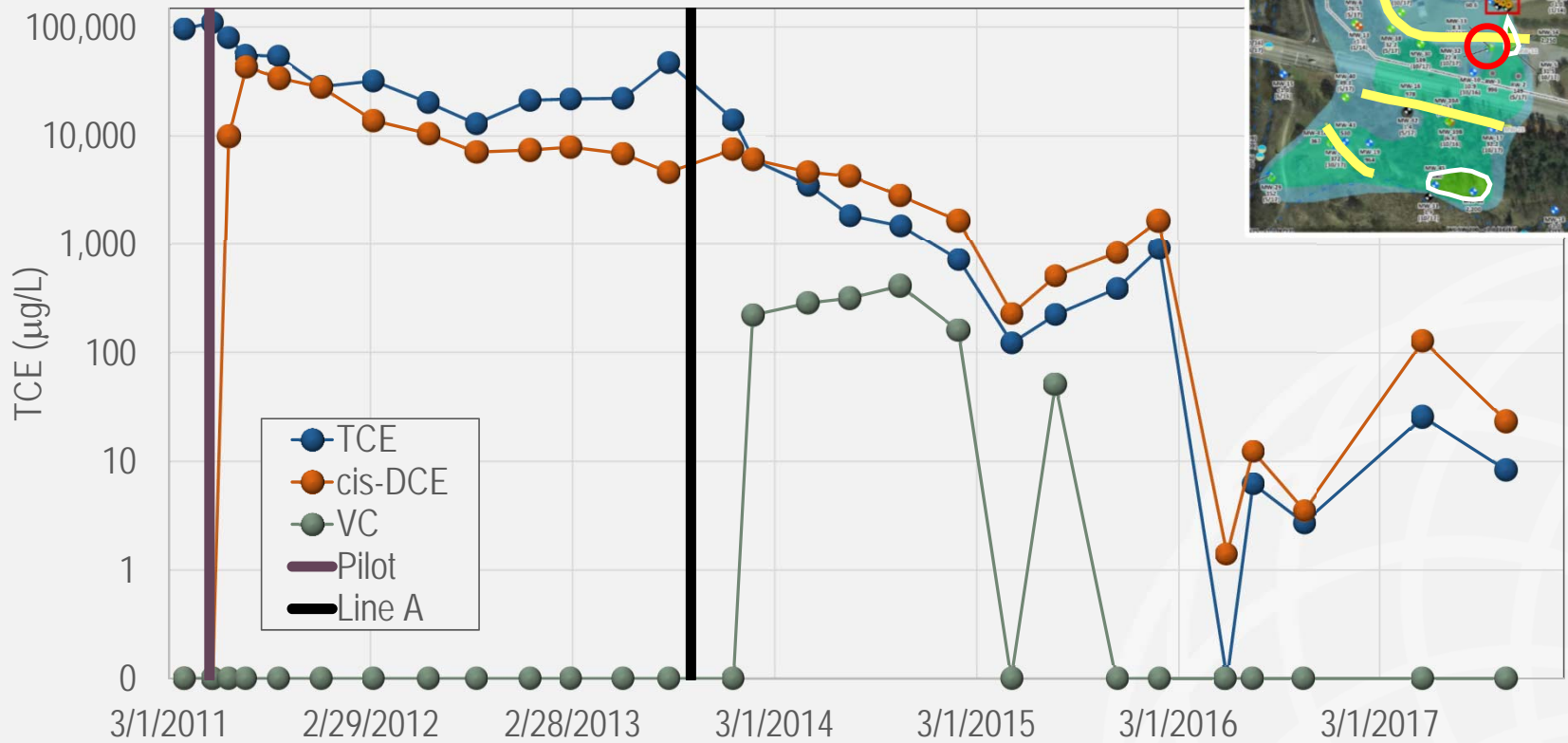


Year 4 – 2018-Q1

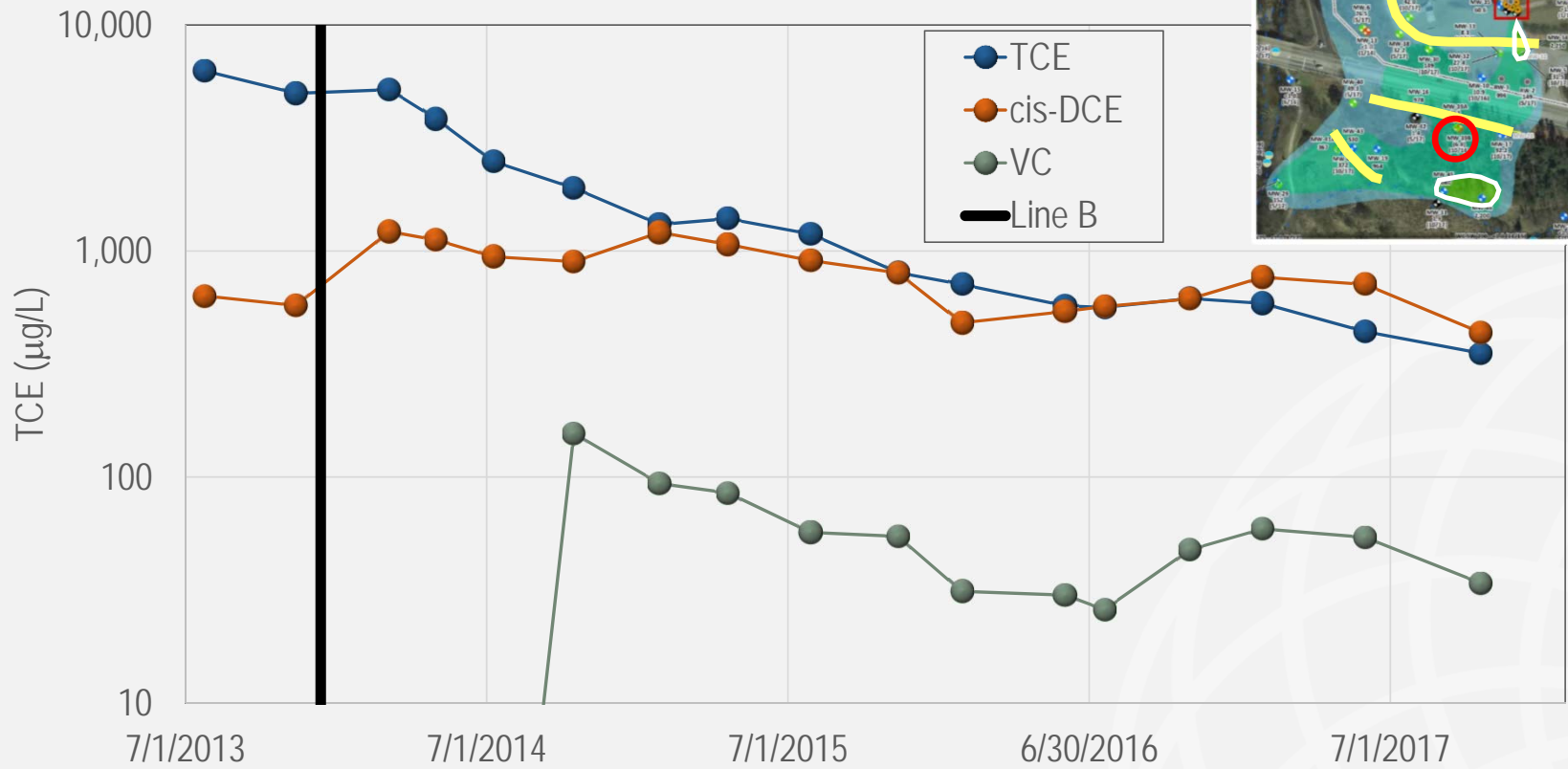
Rogers & Callcott
ENVIRONMENTAL



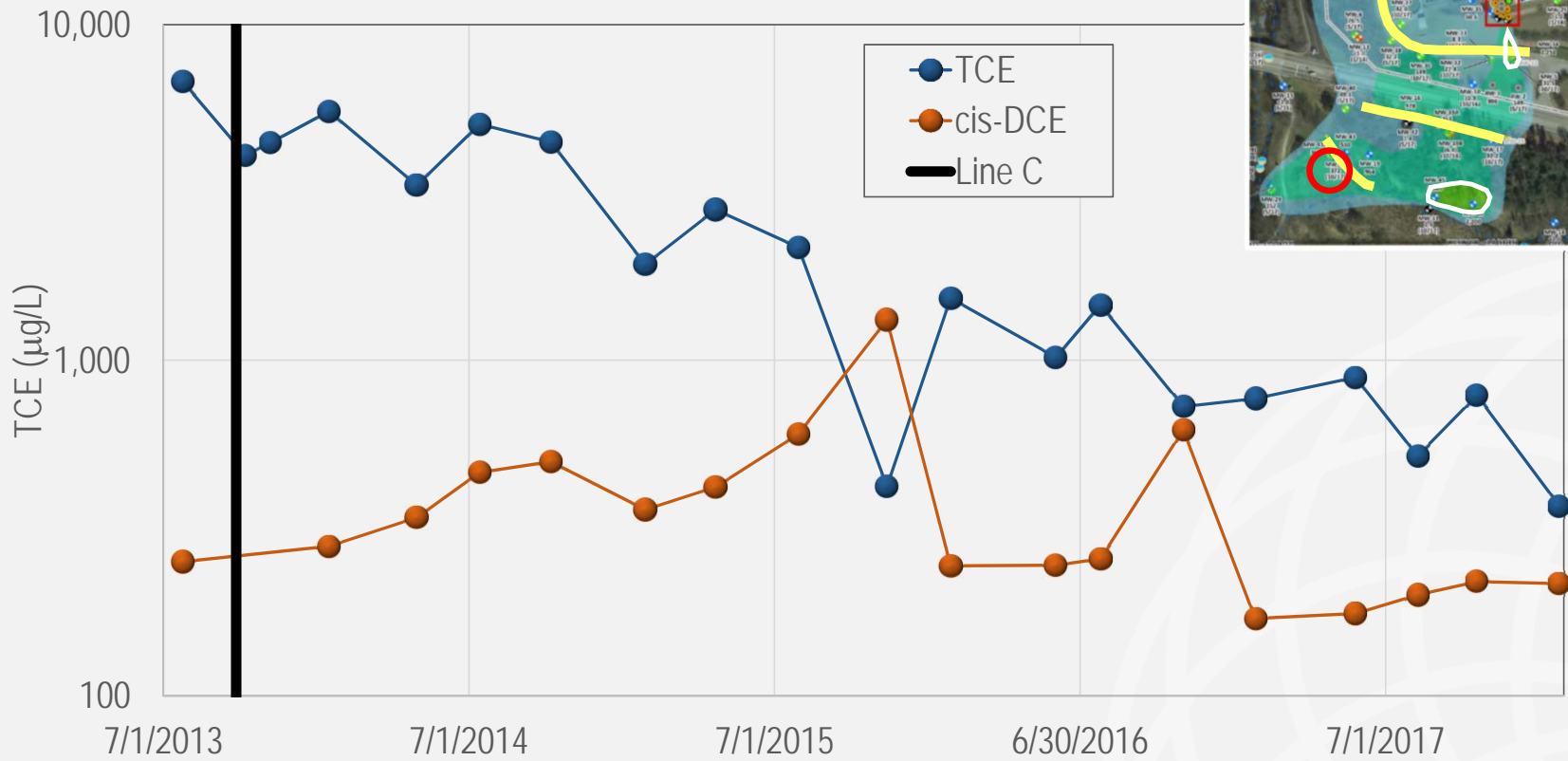
MW-33 – Highest [TCE] in Plume



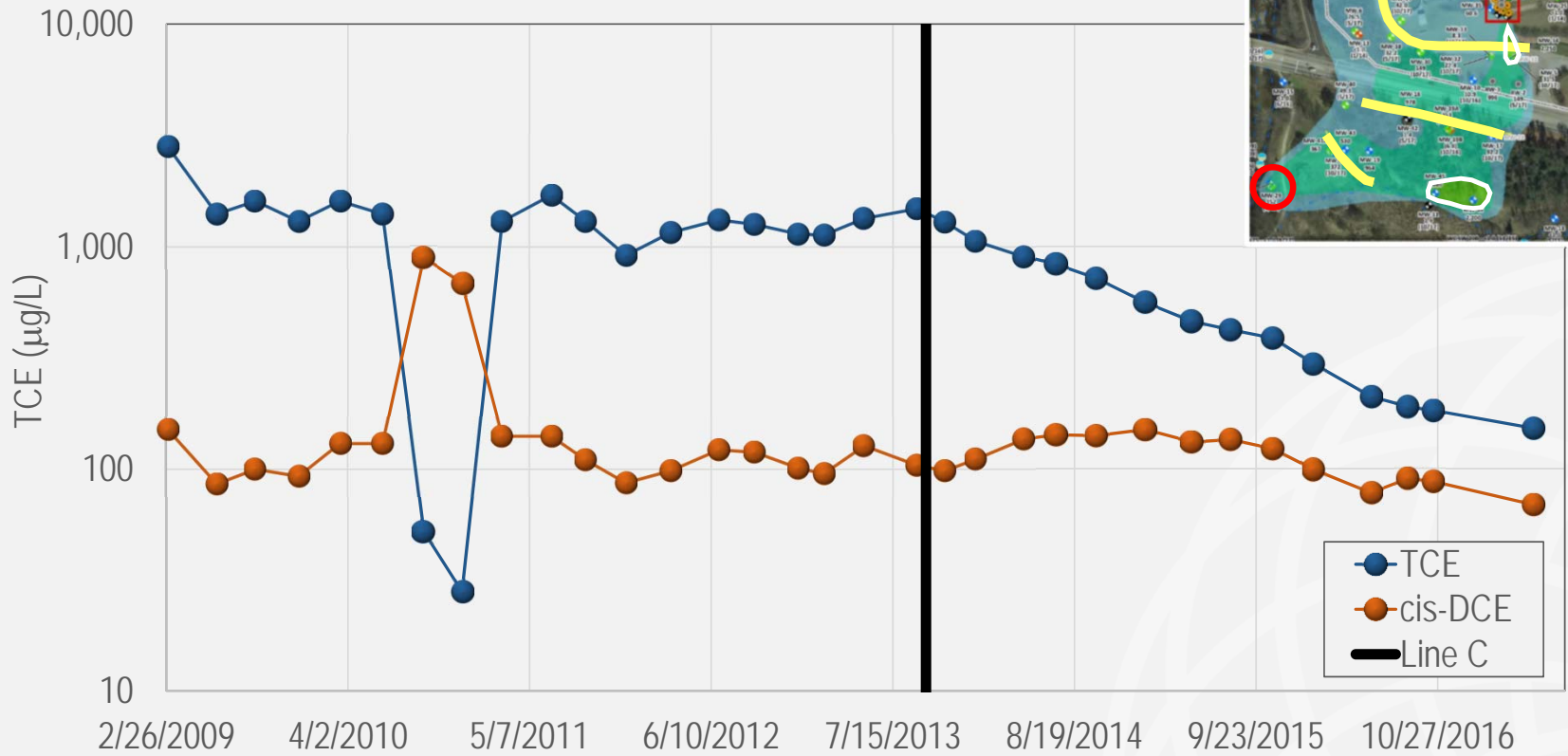
MW-39A



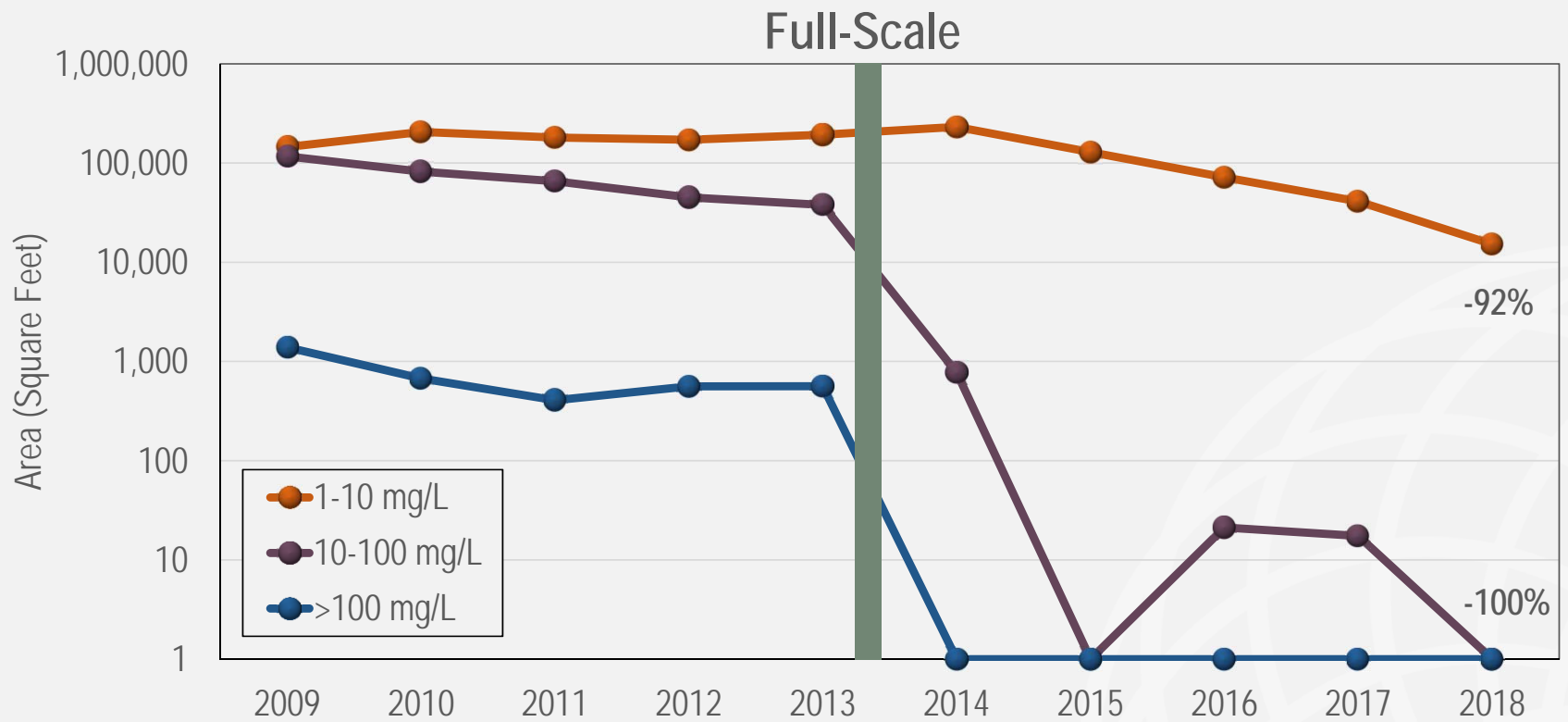
MW-41A



MW-29

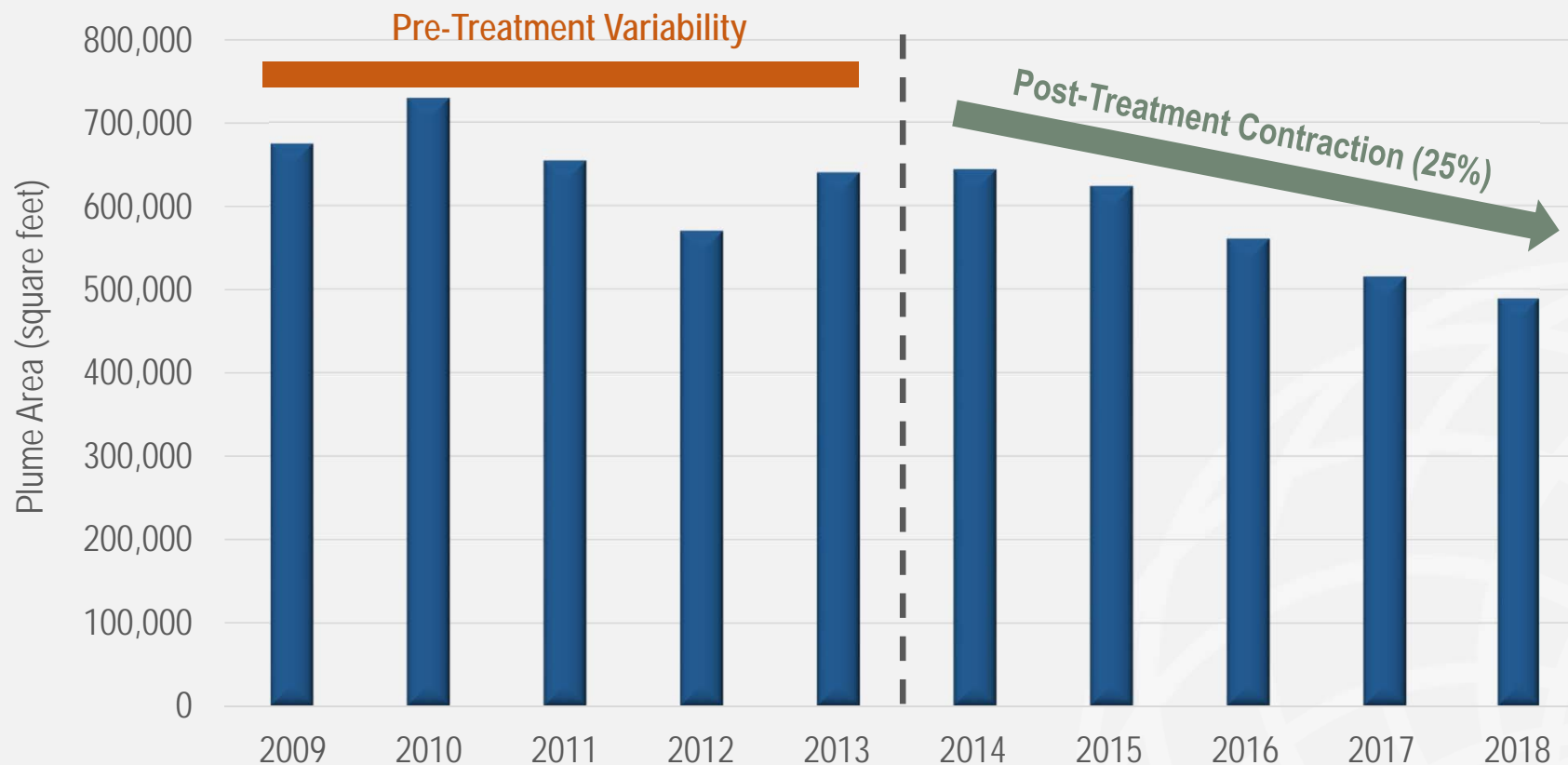


Reduced Plume Areas





Total Plume Area (>5 $\mu\text{g/L}$ TCE) Contraction



Results & Lessons Learned

- Effective hydraulic (“Controlled Jet”) installation of PRB zone
 - Long-lifetime reagents (decades)
 - Adaptable plume remedy
 - Address back-diffusion (rock and overburden)
 - Dual-porosity transport system
- Formation and degradation of cis-DCE and VC
- Nominal 100% reduction of source and plume core
 - 92% reduction in mid-range
 - 25% reduction in low-range (back-diffusion component)



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