Public Private Partnership Stimulating Sustainable Biodegradation of Chlorinated Compounds

Allison K. Stenger, Michael T. Jordan, and Casey M. Portela

Terracon, Raleigh, NC, USA

Outline

Background

- Asphalt Testing Laboratories
- COCs
- Public Private Partnership (BRP)

Site Specifics

- History/ Conditions
- Pilot Test
- Full Scale Injection

Results

- COC Concentrations
- Geochemical Conditions

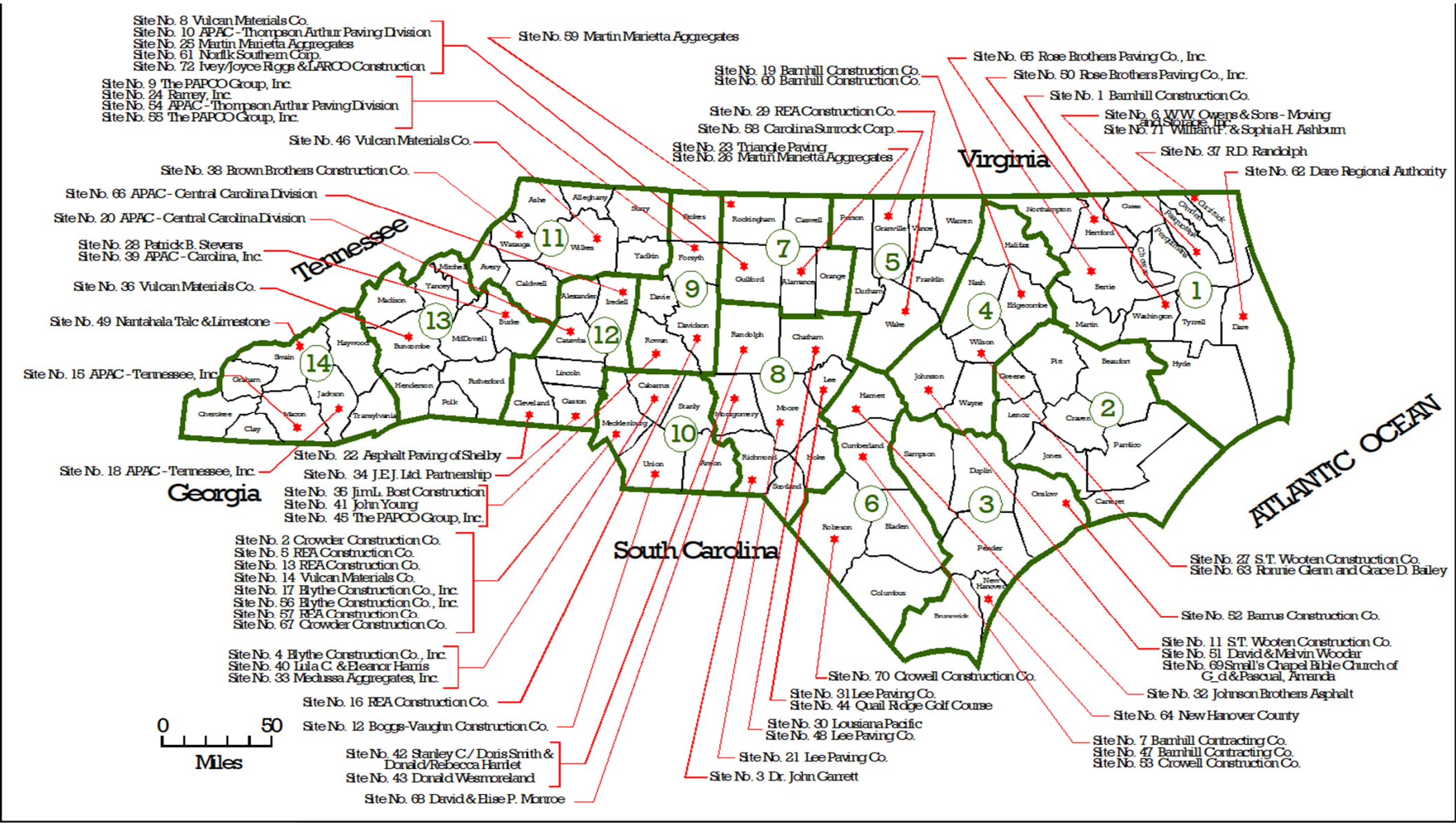
Evaluation

- Product Longevity
- Injection Methodology
- Overall Cost

Background – Asphalt Testing Laboratories

- QA/QC program
  - Asphaltic testing labs (ATLs) at privately owned asphalt plants
  - Chlorinated aliphatic compound use
- 1989 – NCDOT assessment
  - **72 potential sites**

- Target Compounds
  - Carbon tetrachloride
  - TCE
  - 1,1,1-TCA
  - Associated degradation products


Site No. 8 Vulcan Materials Co.
Site No. 10 APAC - Thompson Arthur Paving Division
Site No. 25 Martin Marietta Aggregates
Site No. 61 Norfik Southern Corp.
Site No. 72 Ivey/Joyce Riggs & LARCO Construction
Site No. 9 The PAPCO Group, Inc.
Site No. 24 Ramey, Inc.
Site No. 54 APAC - Thompson Arthur Paving Division
Site No. 55 The PAPCO Group, Inc.
Site No. 46 Vulcan Materials Co.
Site No. 38 Brown Brothers Construction Co.
Site No. 66 APAC - Central Carolina Division
Site No. 20 APAC - Central Carolina Division
Site No. 28 Patrick B. Stevens
Site No. 39 APAC - Carolina, Inc.
Site No. 36 Vulcan Materials Co.
Site No. 49 Nantahala Talc & Limestone
Site No. 15 APAC - Tennessee, Inc.
Site No. 18 APAC - Tennessee, Inc.
Site No. 59 Martin Marietta Aggregates
Site No. 19 Barnhill Construction Co.
Site No. 60 Barnhill Construction Co.
Site No. 29 REA Construction Co.
Site No. 58 Carolina Sunrock Corp.
Site No. 23 Triangle Paving
Site No. 26 Martin Marietta Aggregates
Site No. 65 Rose Brothers Paving Co., Inc.
Site No. 50 Rose Brothers Paving Co., Inc.
Site No. 1 Barnhill Construction Co.
Site No. 6 W.W. Owens & Sons - Moving and Storage, Inc.
Site No. 71 William P. & Sophia H. Ashburn
Site No. 37 R.D. Randolph
Site No. 62 Dare Regional Authority
Tennessee
Virginia
Georgia
South Carolina
ATLANTIC OCEAN
Site No. 22 Asphalt Paving of Shelby
Site No. 34 J.E.J. Ltd. Partnership
Site No. 35 Jim L. Bost Construction
Site No. 41 John Young
Site No. 45 The PAPCO Group, Inc.
Site No. 2 Crowder Construction Co.
Site No. 5 REA Construction Co.
Site No. 13 REA Construction Co.
Site No. 14 Vulcan Materials Co.
Site No. 17 Blythe Construction Co., Inc.
Site No. 56 Blythe Construction Co., Inc.
Site No. 57 REA Construction Co.
Site No. 67 Crowder Construction Co.
Site No. 4 Blythe Construction Co., Inc.
Site No. 40 Lula C. & Eleanor Harris
Site No. 33 Medussa Aggregates, Inc.
Site No. 16 REA Construction Co.
Site No. 12 Boggs-Vaughn Construction Co.
Site No. 42 Stanley C./ Doris Smith & Donald/Rebecca Hamlet
Site No. 43 Donald Wesmoreland
Site No. 68 David & Elise P. Monroe
Site No. 3 Dr. John Garrett
Site No. 21 Lee Paving Co.
Site No. 30 Lousiana Pacific
Site No. 48 Lee Paving Co.
Site No. 31 Lee Paving Co.
Site No. 44 Quail Ridge Golf Course
Site No. 70 Crowell Construction Co.
Site No. 27 S.T. Wooten Construction Co.
Site No. 63 Ronnie Glenn and Grace D. Bailey
Site No. 52 Barnus Construction Co.
Site No. 11 S.T. Wooten Construction Co.
Site No. 51 David & Melvin Woodar
Site No. 69 Small's Chapel Bible Church of G_d & Pascual, Amanda
Site No. 32 Johnson Brothers Asphalt
Site No. 64 New Hanover County
Site No. 7 Barnhill Contracting Co.
Site No. 47 Barnhill Contracting Co.
Site No. 53 Crowell Construction Co.
0
50
Miles

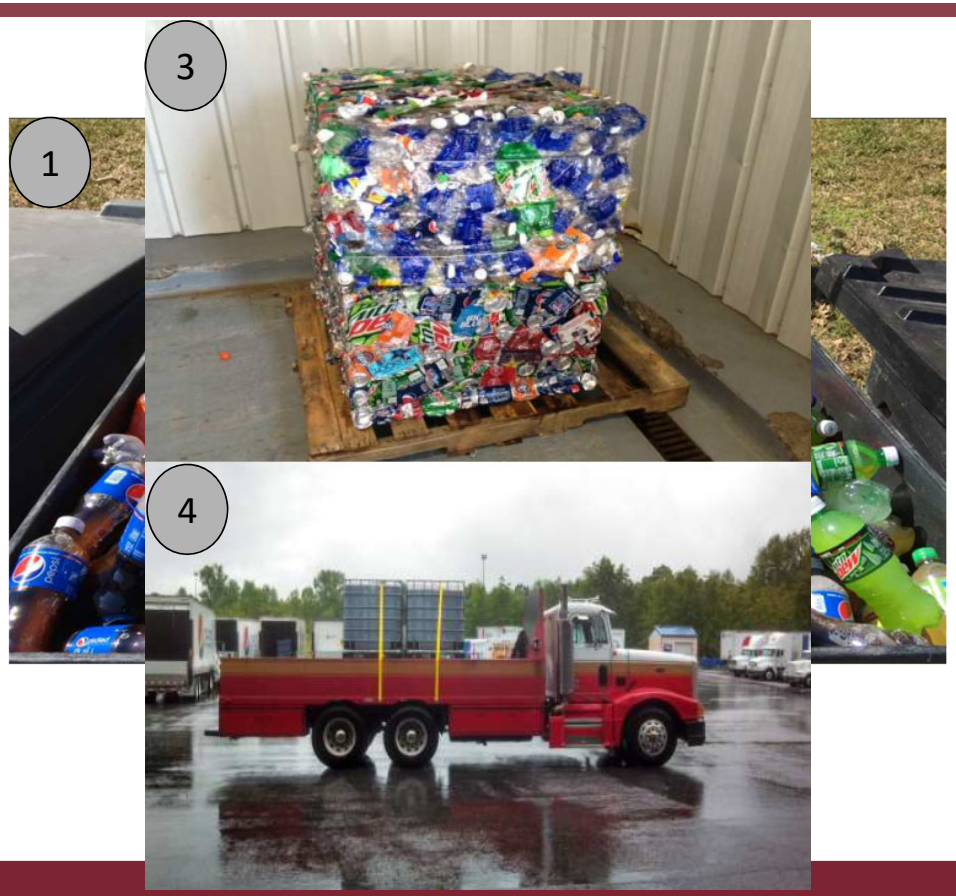
Background – Private Public Partnership

- NCDOT and NCDEQ approached Pepsi about using expired products that contain High Fructose Corn Syrup
  - Beverage Remediation Product (BRP)
- Added to the DEQ list of approved injectants in December 2014

Partner	Benefit
pepsi	Reduced waste water cost & green initiative
Raleigh	Increased capacity & saves energy
NCDOT NORTH CAROLINA DEPARTMENT OF TRANSPORTATION	Free injectant

Background – Private Public Partnership

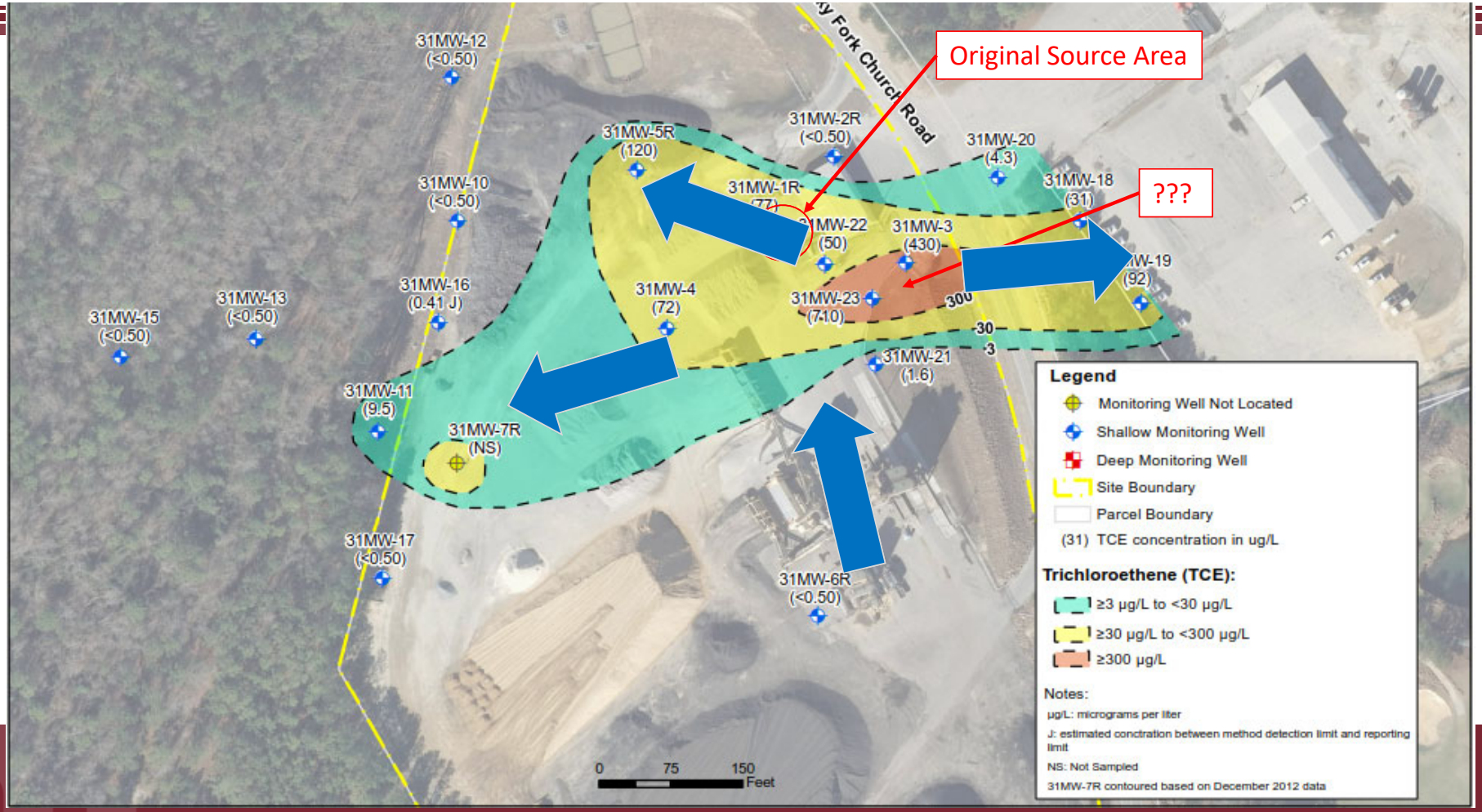
1. Pepsi Bottling Ventures uses High Fructose Corn Syrup in their products
2. Expired drinks returned and segregated based on sugar content
3. Containers are crushed and recycled
4. Capture high sugar liquid for bioremediation injections



Priority Site #31 – History/Conditions

- Initial Sampling – 1989
  - Soil – 1,042,000 µg/kg 1,1,1-TCA & 192 µg/kg TCE
  - Groundwater – 51.1 µg/L 1,1,1-TCA 90.5 µg/L TCE
- CSA – 1996
  - Soil – ND 1,1,1-TCA & 200-1300 µg/kg TCE
  - Groundwater –14-530 µg/L TCE & 270-2300 µg/L cDCE
- DPT in former source area – 2016
  - Source area not found in soil

Priority Site #31 – History/Conditions



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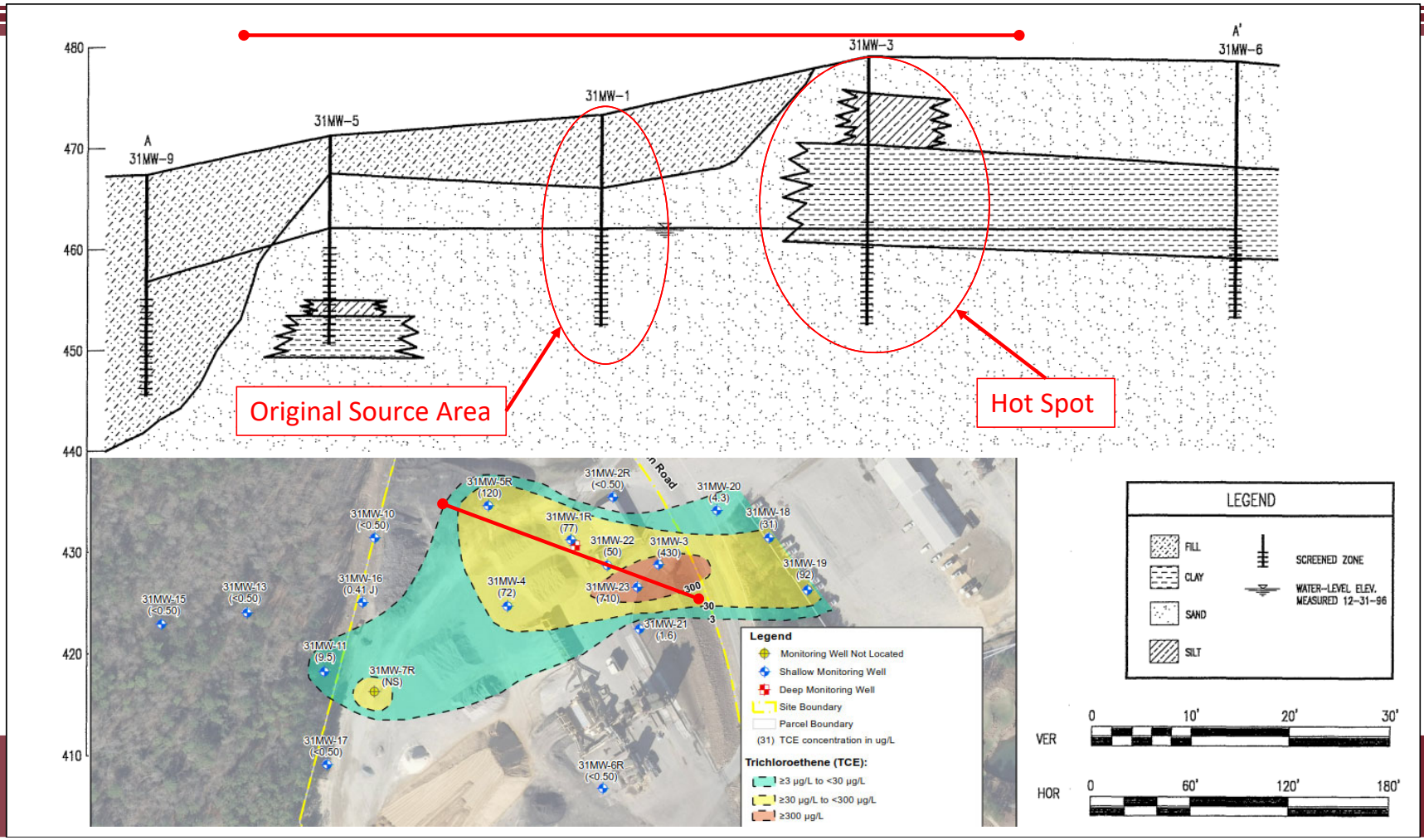

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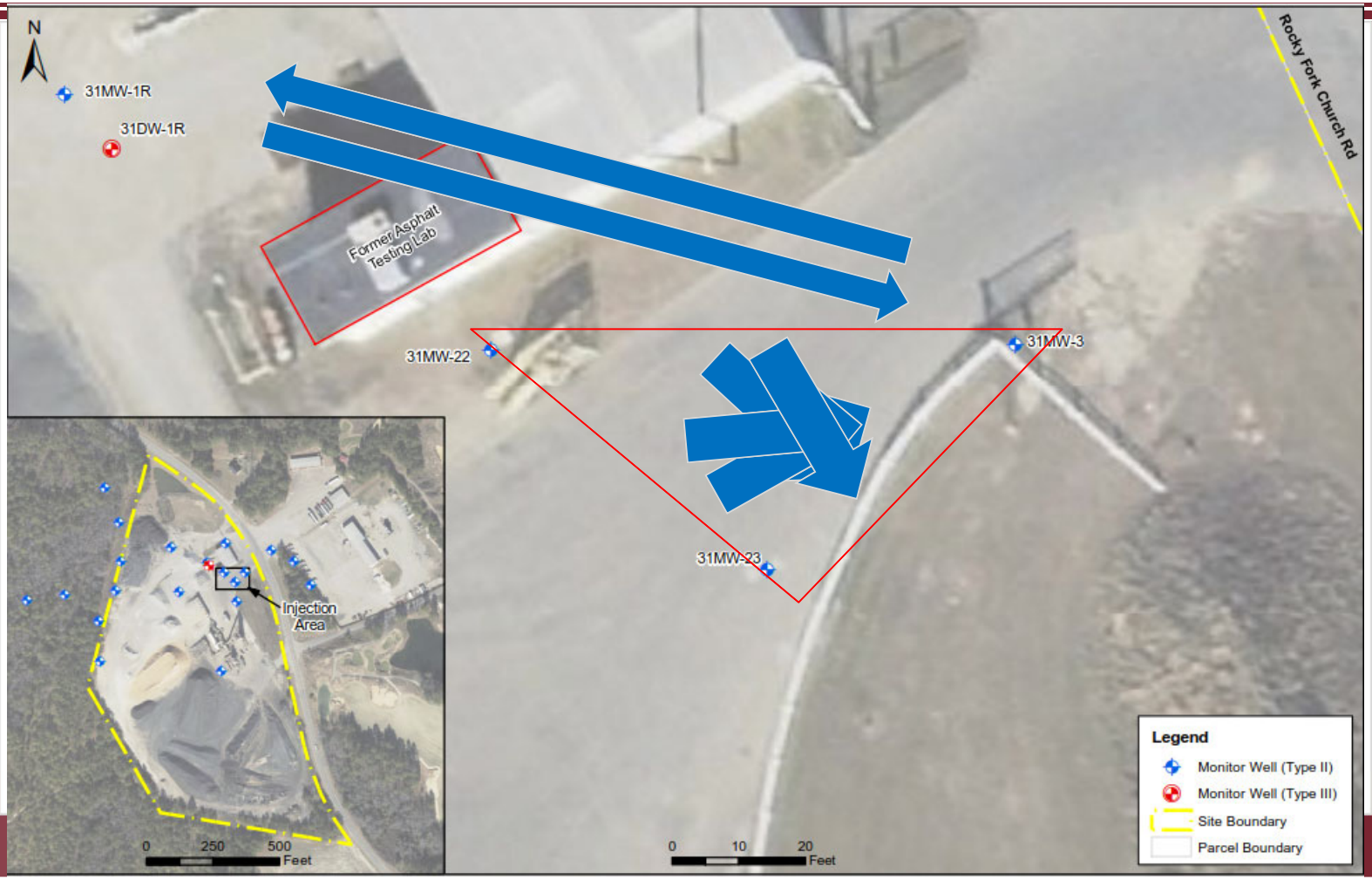

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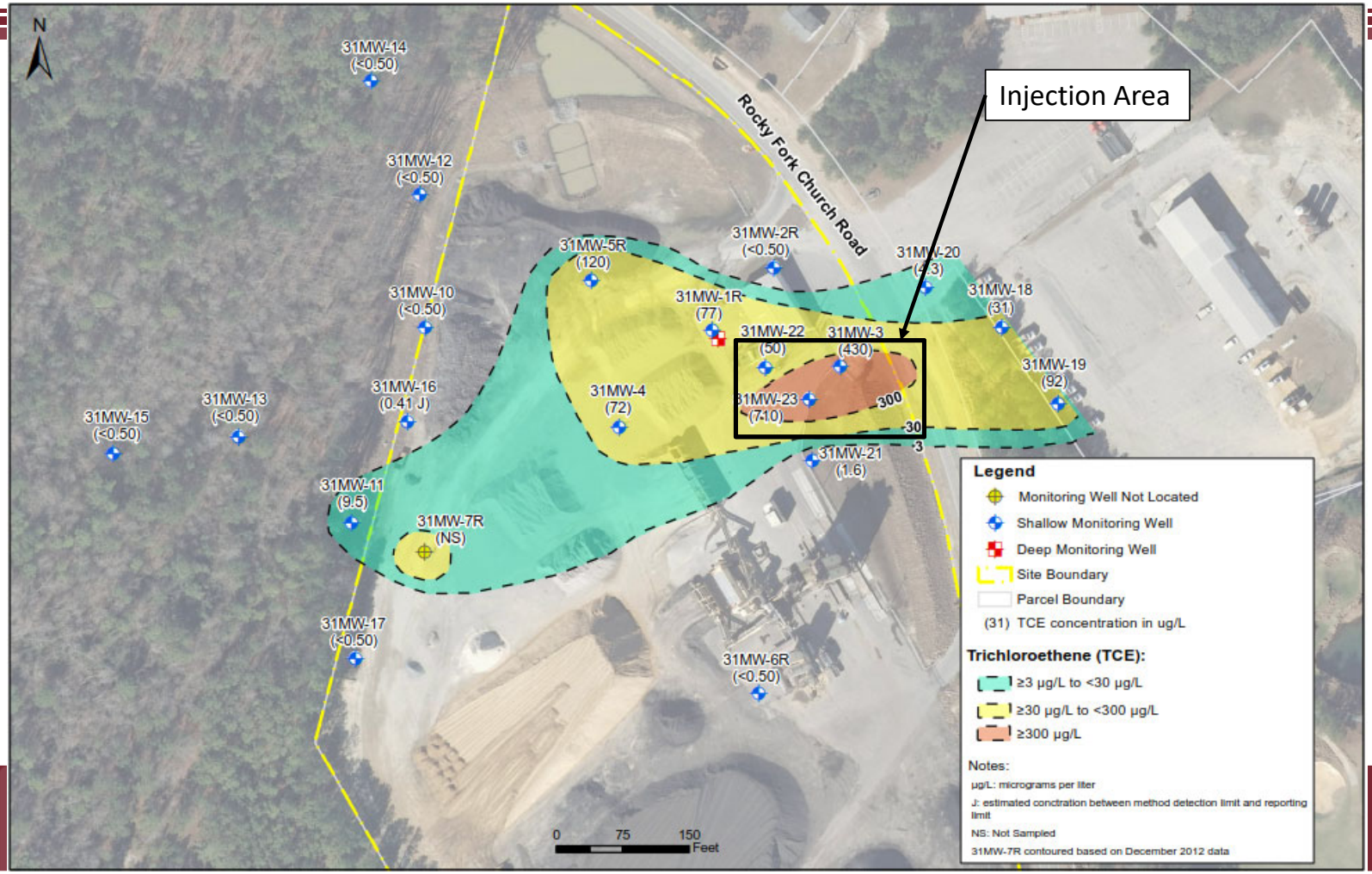
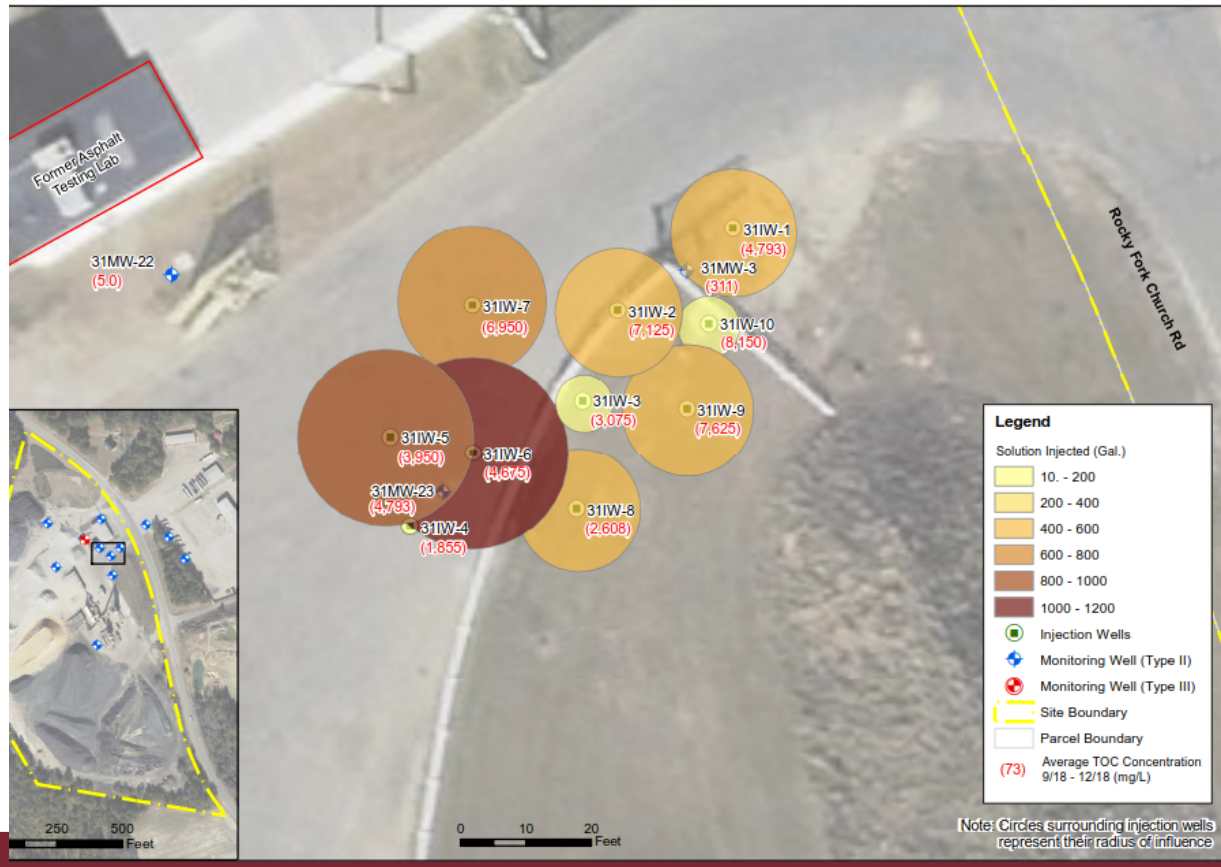


Priority Site #31 – Pilot Test (DPT)

- Mix BRP, water, sodium bicarbonate (pH adjustment) & hexametaphosphate
- Injection through DPT at various screen intervals (ranging from 21 to 32 ft bls)
- Adjusted depths based on flow rates; targeted high K zones
- Total 2,400 gal. of injectate

Priority Site #31 – Full Scale Injection

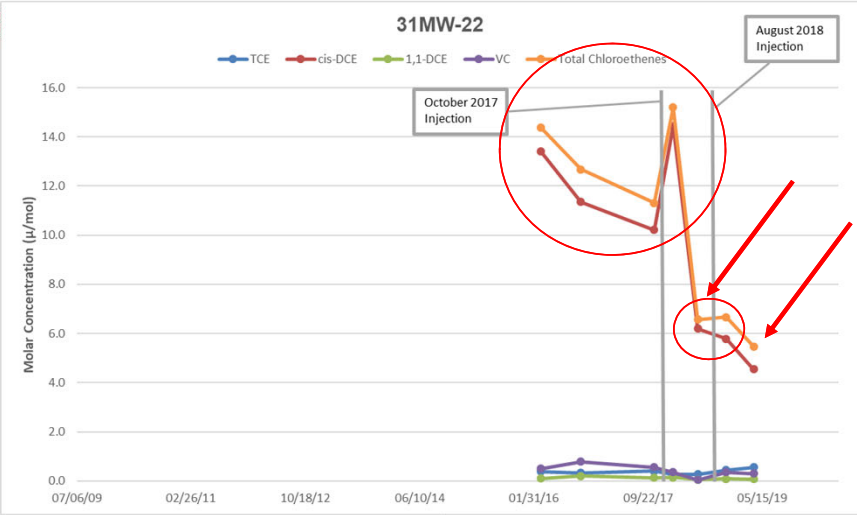
- pH adjustment & mixture procedures same as pilot
- Injection through permanent wells with 15ft screen intervals (20-35 ft bls)
- Lower flow rates, relative to pilot injection
- 11% average pore volume displacement
- Total 4,500 gal. of injectate

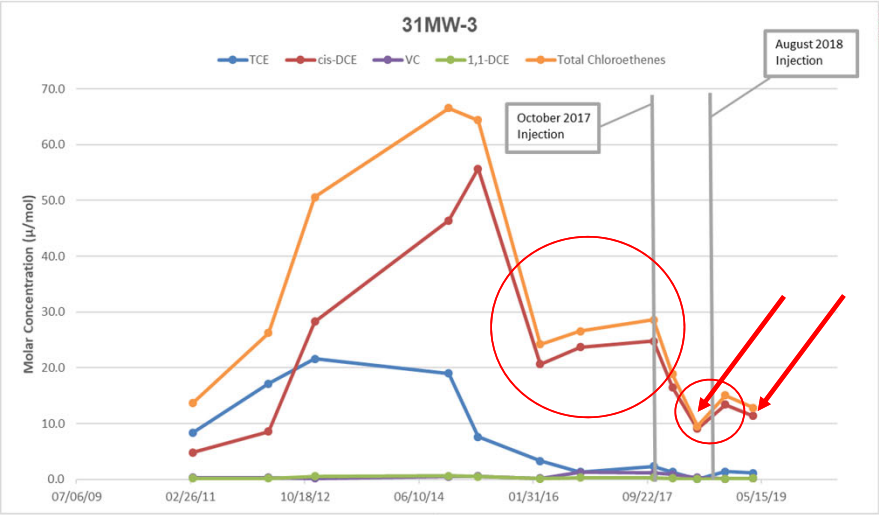


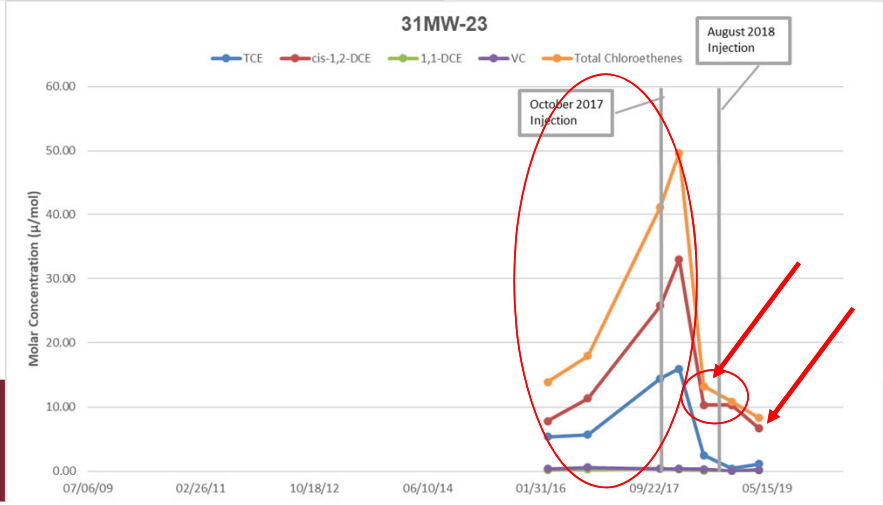
Evaluation – General (MW Averages)

	Pre Pilot (Oct '16 & Oct '17)	Post Pilot (2- & 4-Month)	Post Pilot (8-Month) / Pre Injection	Post Injection (1-, 2-, 3 & 4-Month)	Post Injection (8-Month)
Methane (mg/L)	2.6	1.4	2.2	1.2	NA
DO (mg/L)	0.49	1.18	0.30	0.35	0.25
TOC (mg/kg)	4.9	277	443	1829	604
TCE (µg/L)	538	768	123.7	99	124
Chloroethenes (µg/L)	2,347	2,860	1,014	1,073	884
pH (SU)	6.41	6.67	5.57	7.01	6.74
ORP (mV)	-25.8	-61.93	-371.1	-111.4	15.3

Evaluation – Trend Analysis







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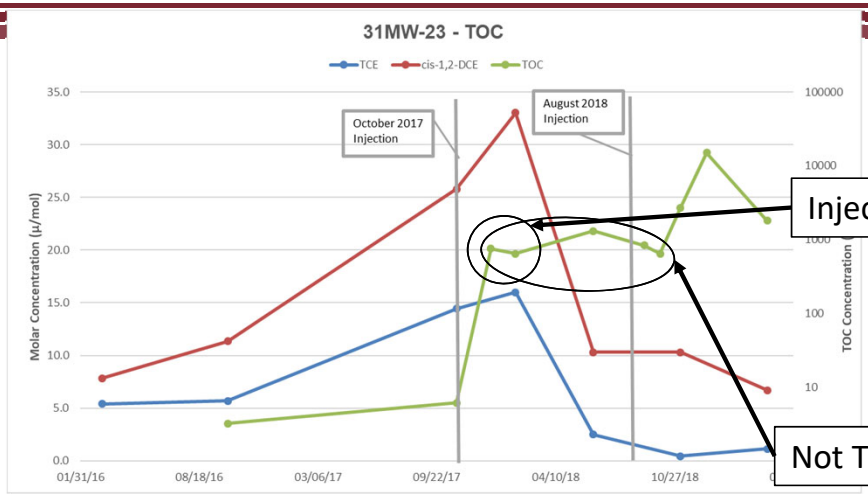
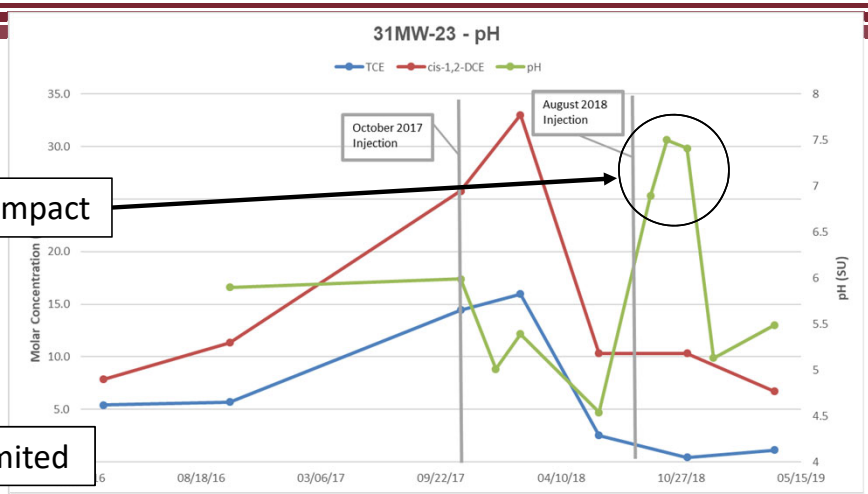
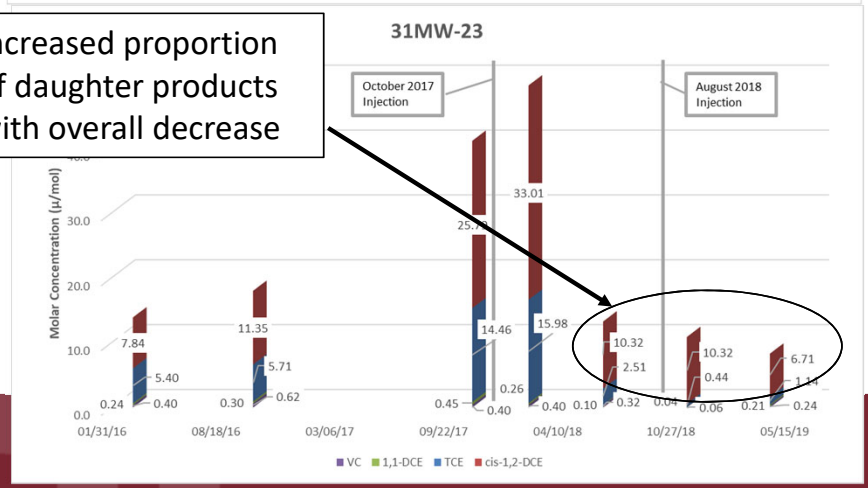


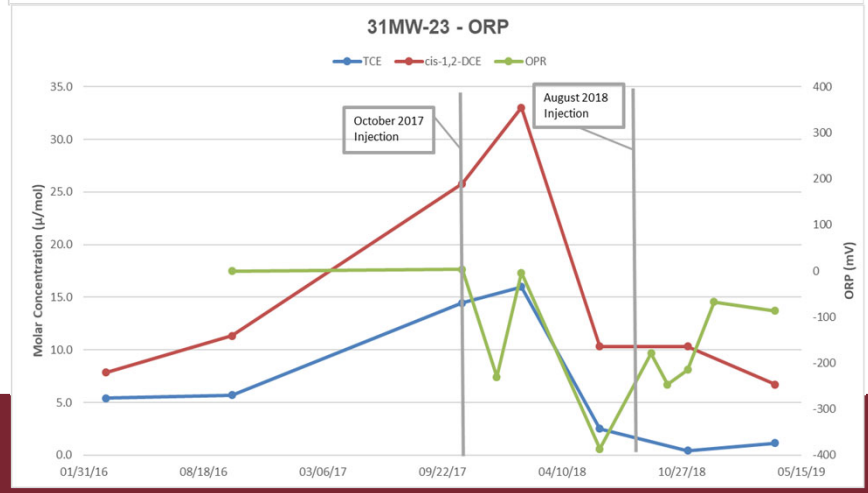


Injection impact

Not TOC limited

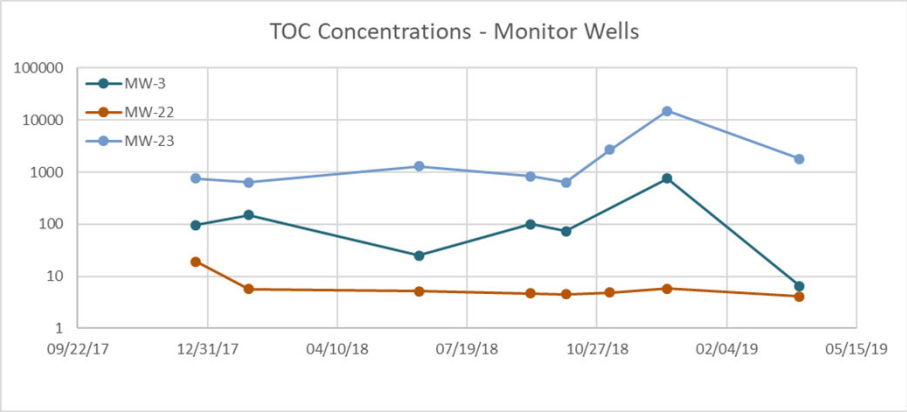
Increased proportion of daughter products with overall decrease





Evaluation – Product Longevity

- Typical Lifespan HFCS 7- 90 days*
- Calculated half-life with 2 monitor wells, another BRP site and a HFCS Site (KSP)



<u>Priority Site #45</u>

- BRP Injection
  - Half-life = 30 days (t = 39 days)

<u>Priority Site #31</u>

- BRP Injection
  - Half-life = 24 days (t = 102 days)

<u>KSP Site</u>

- HFCS Injection
  - Half-life = 40 days (t = 252 days)

* Per Principles & Practices of Enhanced Anaerobic Bioremediation of Chlorinated Solvents (2004)

Evaluation – Injection Methodology & Overall Cost

Injection Wells

- Expensive upfront cost of well install; less expensive injection cost
- Injection at our own discretion (and BRP availability);
- Subsequent injections based on TOC data

DPT

- Can make more field adjustments to target or avoid less permeable zones
- Could offset or adjust screen if encountered daylighting;
  - higher flowrates compared to injection wells
- Relative cost 2x that of the injection event using the permanent injection wells

Calculated that 3 injection events would make up the cost of the injection well install

Summary

- NCDOT has a large task at hand with 72 priority sites
- They created a partnership with PBV to receive donations of HFCS in the form of BRP
  - Does it work?
  - Product longevity?
  - Implementation methodology?
- At our site, BRP appears to be working
- Frequent follow-up injections needed due to short lifespan
- Permanent injection wells vs DPT depends on site specifics
  - Depths of injections/targeting needs
  - Anticipated total number of injections

Question?

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Terracon, Raleigh, NC, USA

Allison.Stenger@Terracon.com