

Hydraulic Emplacement of Zero-Valent Iron Coupled with In-Situ Bioremediation for VOC Treatment in a Low-Permeability Aquifer

Emily Bausher (Terraphase Engineering); Chris Voci (Terraphase Engineering); Chapman Ross (FRx, Inc.)

Background/Objectives

Historical releases of tetrachloroethene and trichloroethene at an active aircraft parts manufacturing facility in central Kansas produced two distinct dissolved volatile organic compound (VOC) groundwater plumes in a shallow low-permeability overburden aquifer. Analytical data from decades of groundwater sampling were evaluated to show that the plumes were stable, and the migration of the dissolved VOCs is controlled by intrinsic reductive dechlorination and non-transformative attenuation mechanisms at the plume margin. Over the last two years, a plan to remediate the plumes via a combined chemical reduction with zero-valent iron (ZVI) and in situ bioremediation (ISB) was developed and implemented.

Background

Two chemically distinct plumes exist on Site (verified with isotopic signatures):

- (1) The Northern Plume – contains high trichloroethene (TCE) concentrations with less degradation evident
- (2) The Primary Plume – originates from a tetrachloroethene (PCE) source and pre-dates the Northern Plume

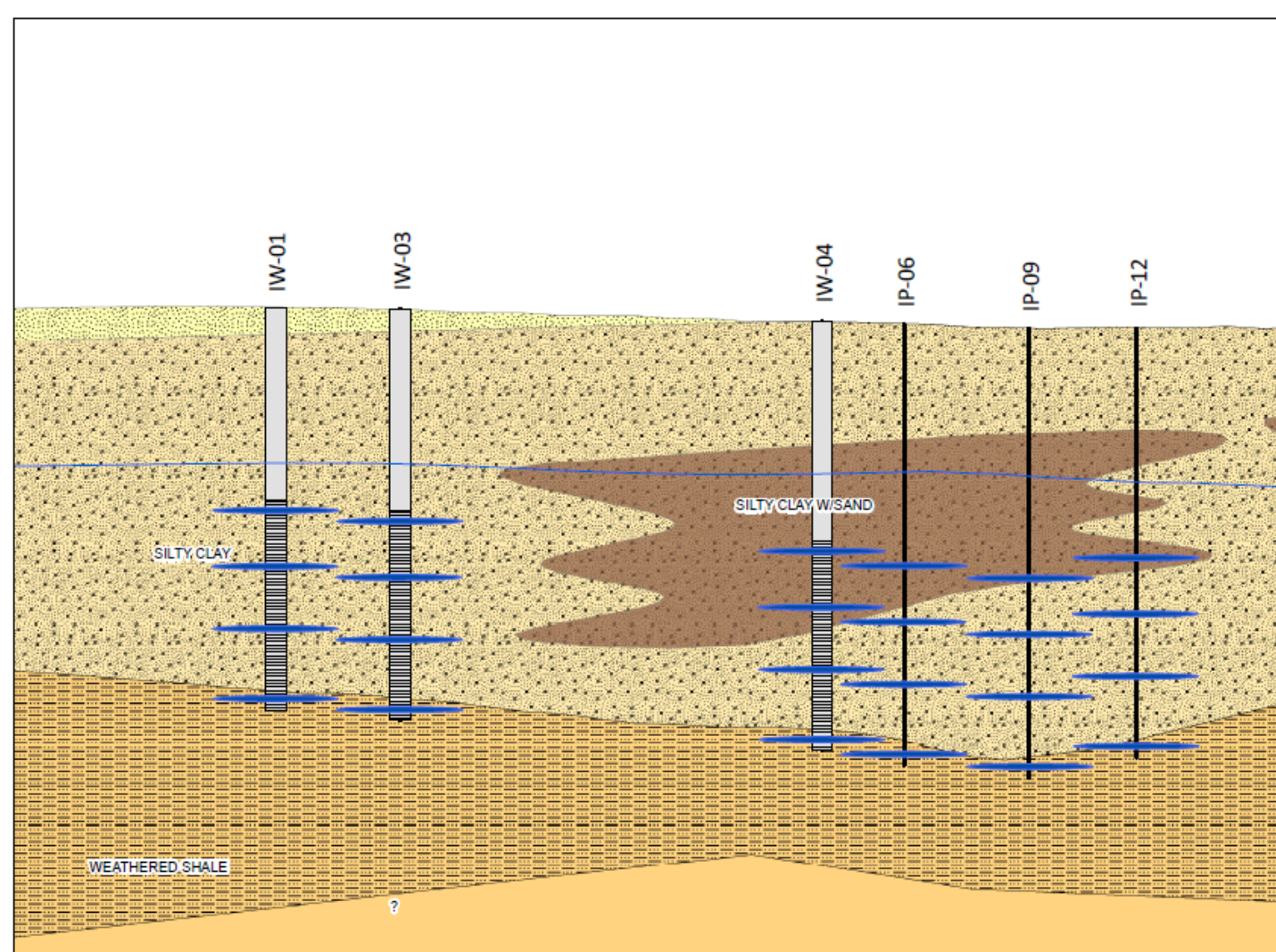
ZVI and ISB Injections

Completed in two phases: (1) Delivery of ZVI and commercial bioaugmentation culture KB-1® (2) Implementation of ISB

- (1) Installation of 13 Injection Points (IPs); 5 IPs were converted to Injection Wells (IWs)

Hydraulic Emplacement Injections

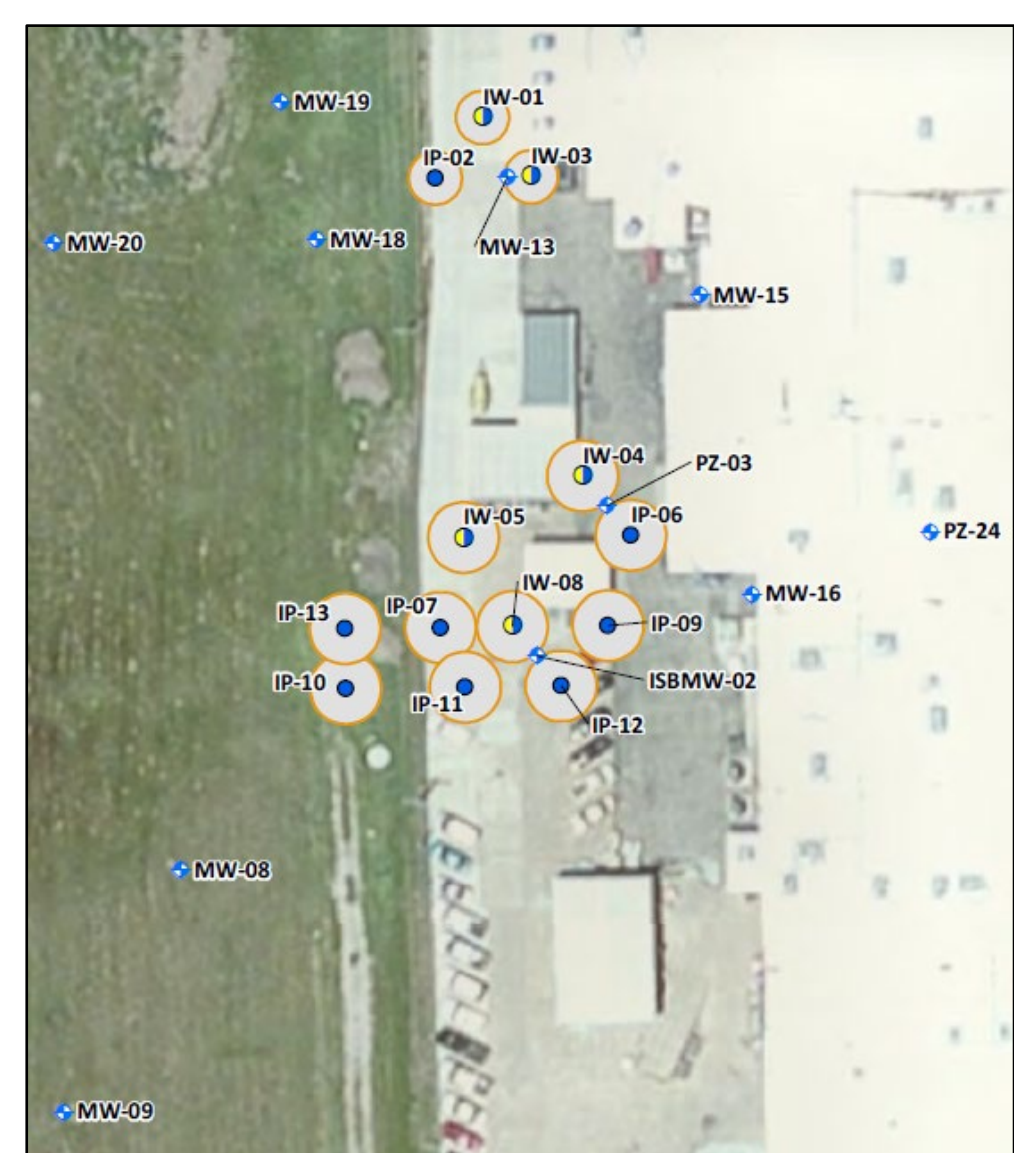
- ✓ ZVI slurry injected at 4 discrete depths per location
- ✓ KB-1® injected into all IPs
- ✓ IPs plugged and five converted to IWs
- ✓ IWs developed 10 days after installation



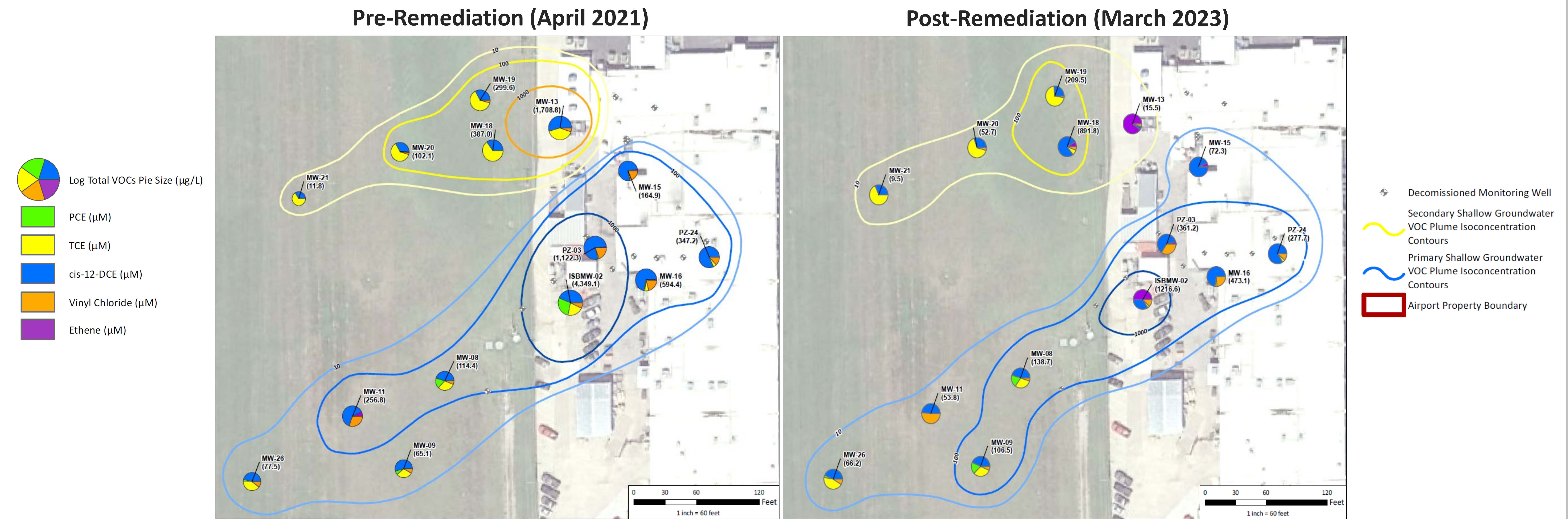
- (2) Delivery of emulsified vegetable oil (EVO) and KB-1®

ISB Injections

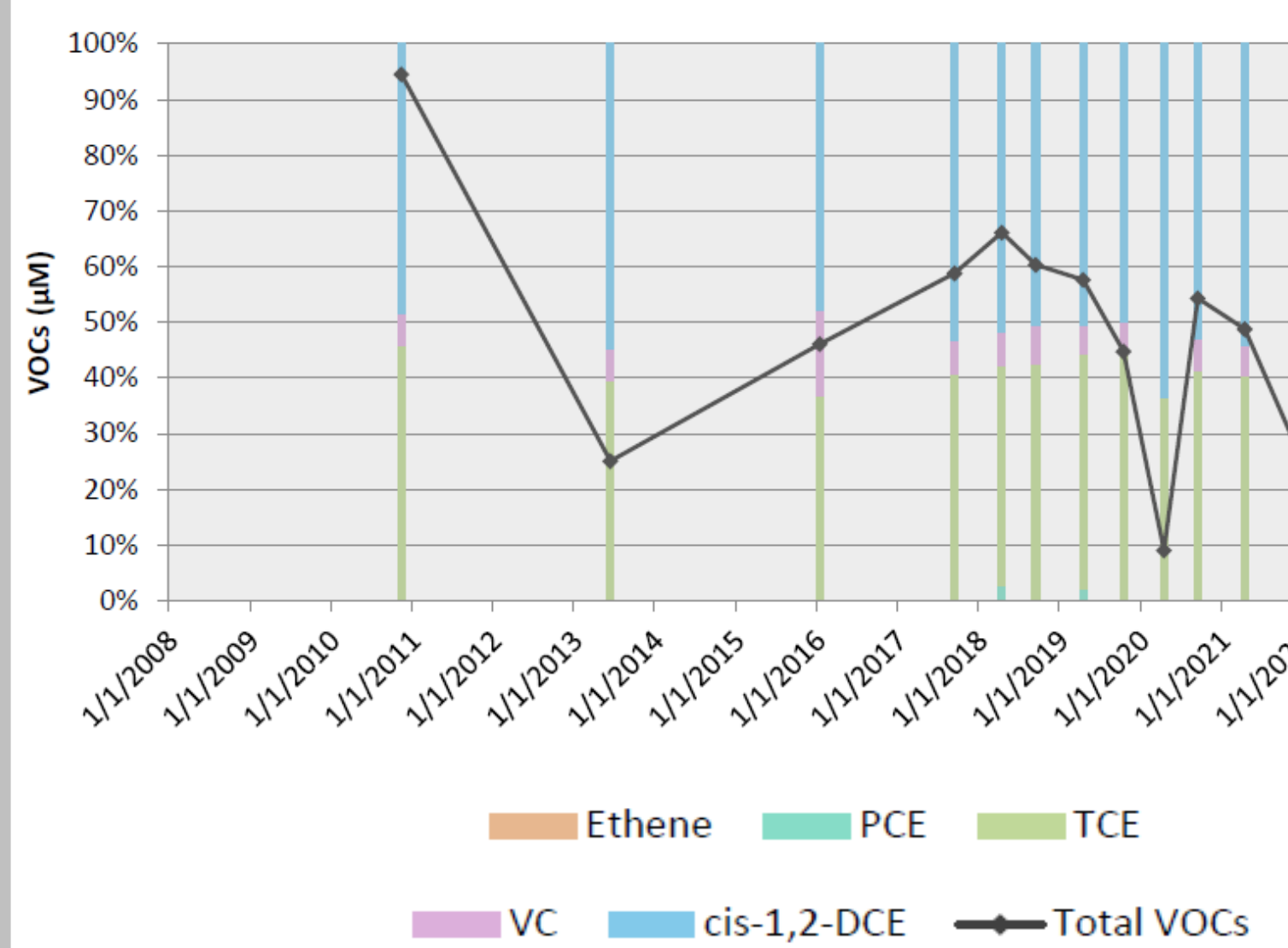
- ✓ Total of 650 gallons per IW
- ✓ Delivered via a combination of gravity-feeding and pumping
- ✓ KB-1® injected into all IWs after delivery of 325 gallons
- ✓ EVO transport visually observed in adjacent wells—measured radius of influence (ROI) of 9 feet in the northern plume, ROI of 12 feet in the southern plume



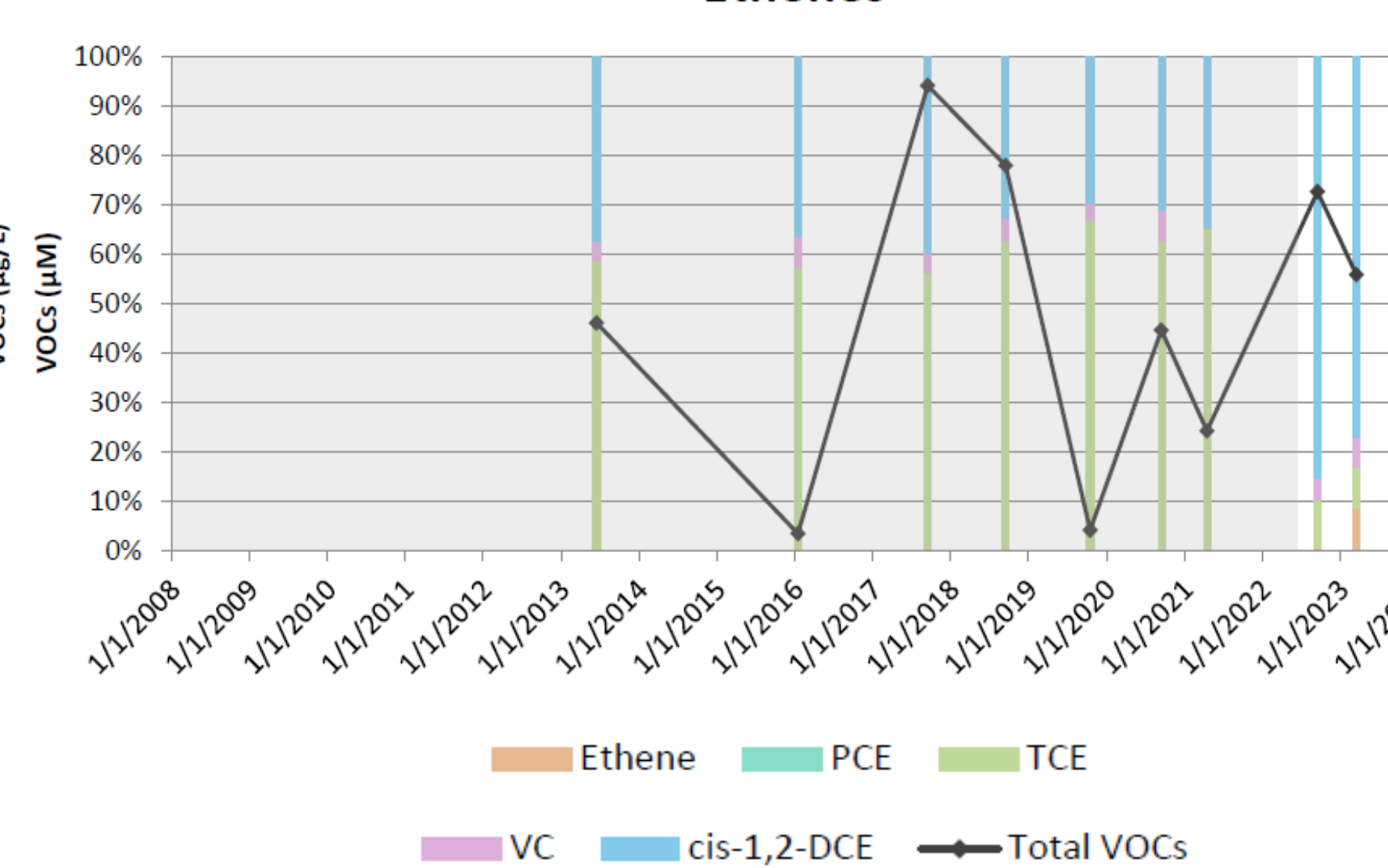
Groundwater Sampling Results



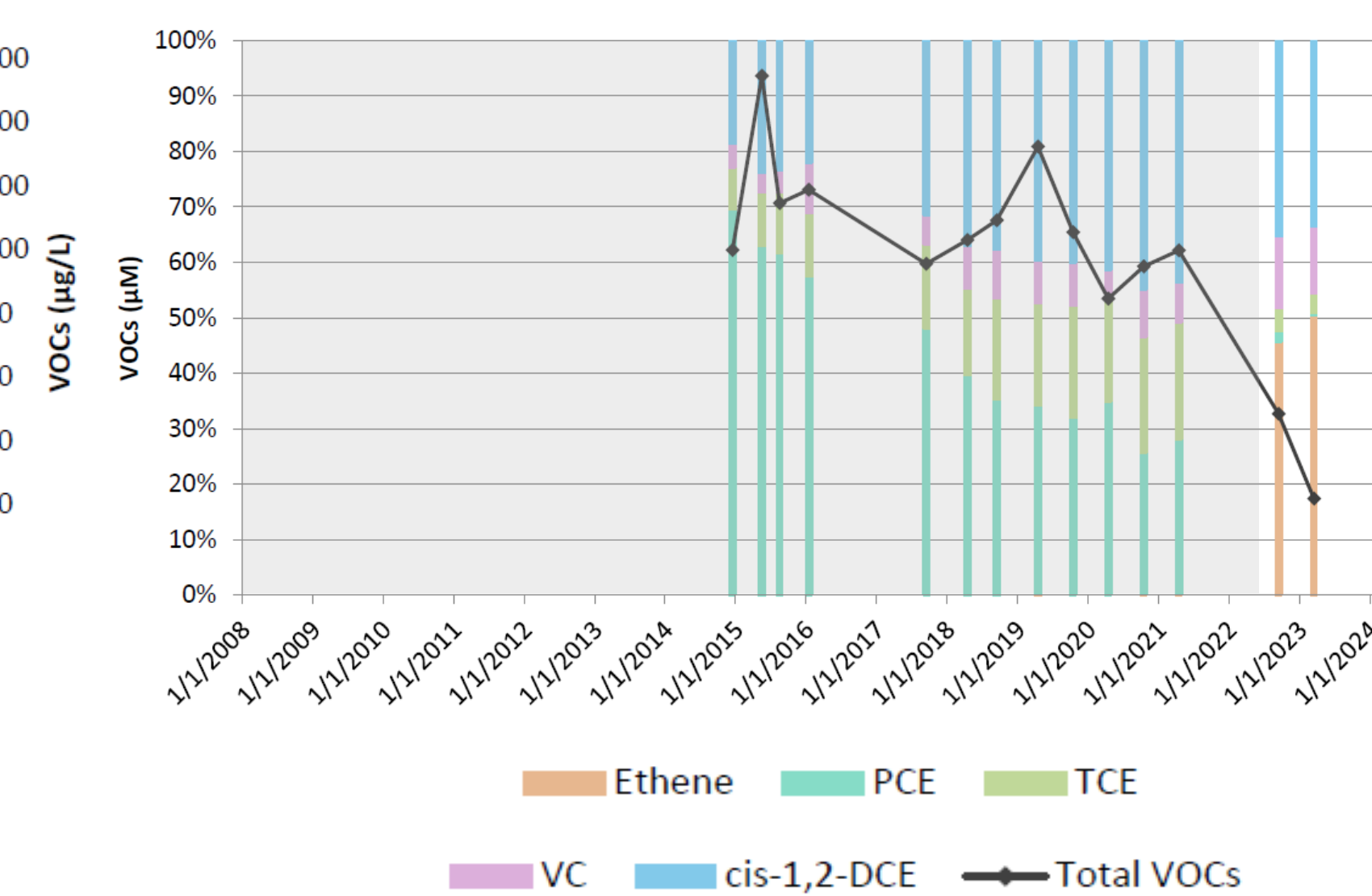
Source Area - Northern Plume - MW-13 Chlorinated Ethenes



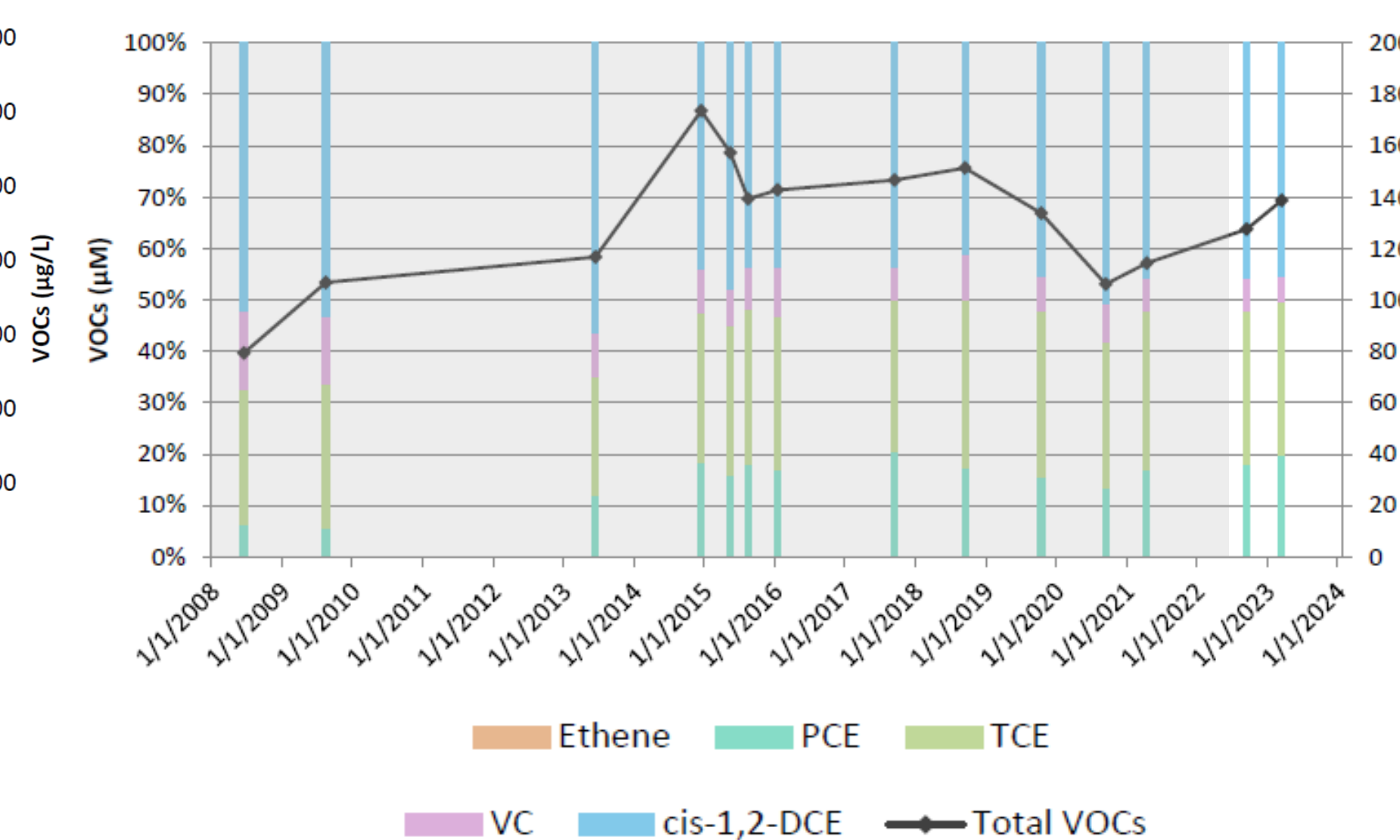
Near Source - Northern Plume - MW-18 Chlorinated Ethenes



Source Area - Primary Plume - ISBMW-02 Chlorinated Ethenes



Plume Center - Primary Plume - MW-08 Chlorinated Ethenes



Key Takeaways

- VOC concentrations in source area wells have decreased significantly, resulting in decreases in plume area and mass (~70% decrease in source mass in the primary plume).
- Abiotic transformation of VOCs and reductive dechlorination in the source areas at the Site are ongoing and sustained as confirmed by the groundwater sampling results after one year.

References

- Terraphase Engineering Inc. (Terraphase). 2017. *Voluntary Cleanup Investigation (VCI), Phase X – ISB pilot Study Addendum and Supplemental Remedial Investigation Report*, Triumph Accessory Services, Inc. Site, Wellington, Kansas. November 30.
- . 2022. *Voluntary Cleanup Plan*, Triumph Accessory Services, Inc., Site, 411 North West Road, Wellington, Kansas. February.
- . 2022. *Voluntary Cleanup Implementation Report*, Triumph Accessory Services, Inc., Site, 411 North West Road, Wellington, Kansas. October.
- . 2022. *Voluntary Cleanup Technical Memorandum 1*, Triumph Accessory Services, Inc., Site, 411 North West Road, Wellington, Kansas. December.
- Weston Solutions, Inc. (formerly Roy F. Weston, Inc.). 2013. *Phase IX – Voluntary Cleanup Investigation Report*, Triumph Accessory Services, Inc. October.