



Progressing a High Mass Petroleum Site Using In Situ Desorption/Sorption

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Antea®Group

Understanding today.
Improving tomorrow.

The Site

Former Holiday (now Circle K) Stationstore #369 in Baxter, MN

- Active gas station, important location at the edge lake country in MN
- Fuel dispense line failure led to release (2010)
- Downgradient stormwater ditch at risk
- Site in MN PetroFund
- Cleanup goals are qualitative – make progress on free product and dissolved phase impacts





More About the Site



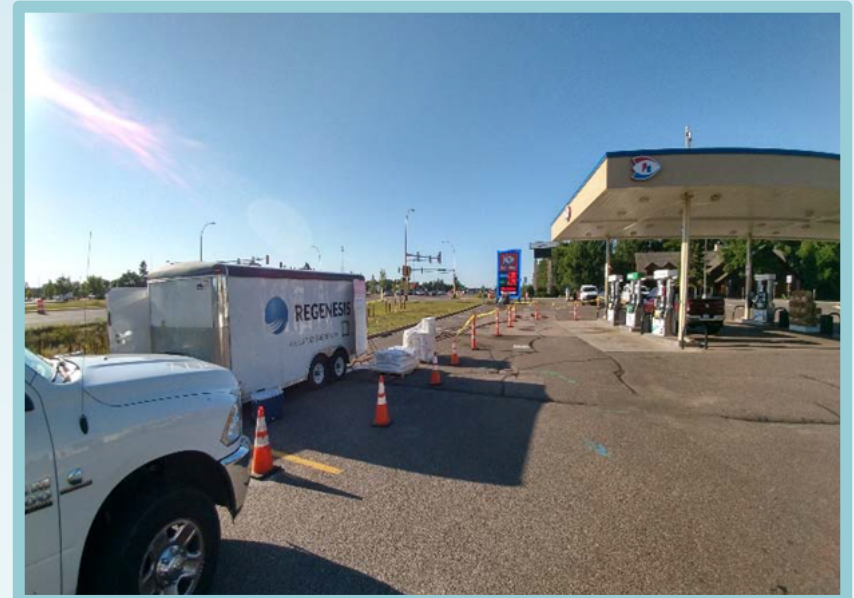
- Geology a mix of medium to fine sands
- Groundwater table at 5 ft. below ground surface on average
- Groundwater flow to the east/northeast of the site
- TPH and benzene are key analytes
- Free product found at varying thicknesses across the site well network
- Excavation not feasible in source area because of high traffic site with significant economic impact to the business. Several utilities run through the site as well.

Remediation Approach



- LIF used to map pockets of **LNAPL**
- One pilot and three subsequent ISCO events using **RegenOx[®] PetroCleanze[™]**

- Eight **High Vacuum Extraction Events (HVE)** between injection rounds
- Site polishing with **PetroFix[™]** to complete remediation



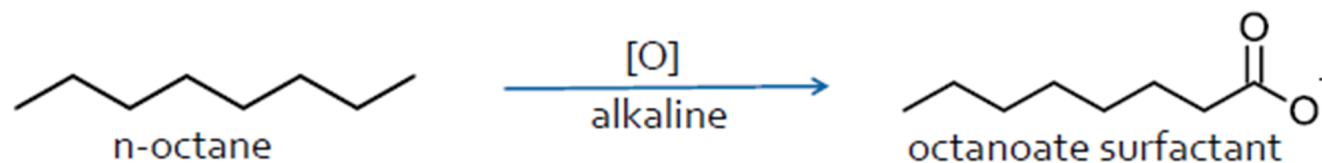
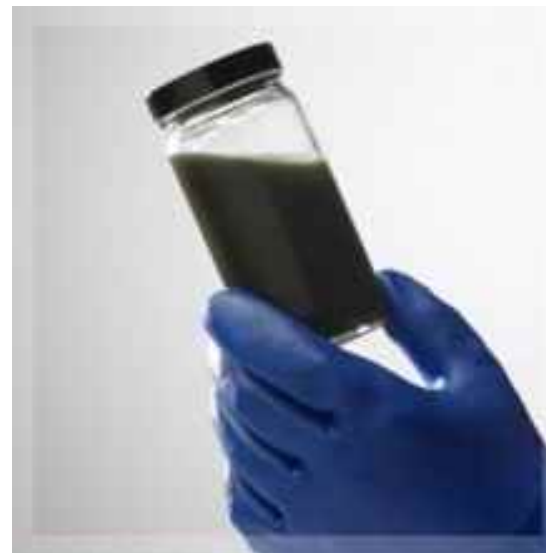
The Chemistry

PETRO CLEANZE[™]

Enhanced Desorption

Oxidation of Contaminants

- Sodium percarbonate-based oxidant
- RegenOx catalyst: sorption and destruction
- Alkaline pH favors desorption
- Partial oxidation generates surfactants



Injection Specifics – PetroCleanze™



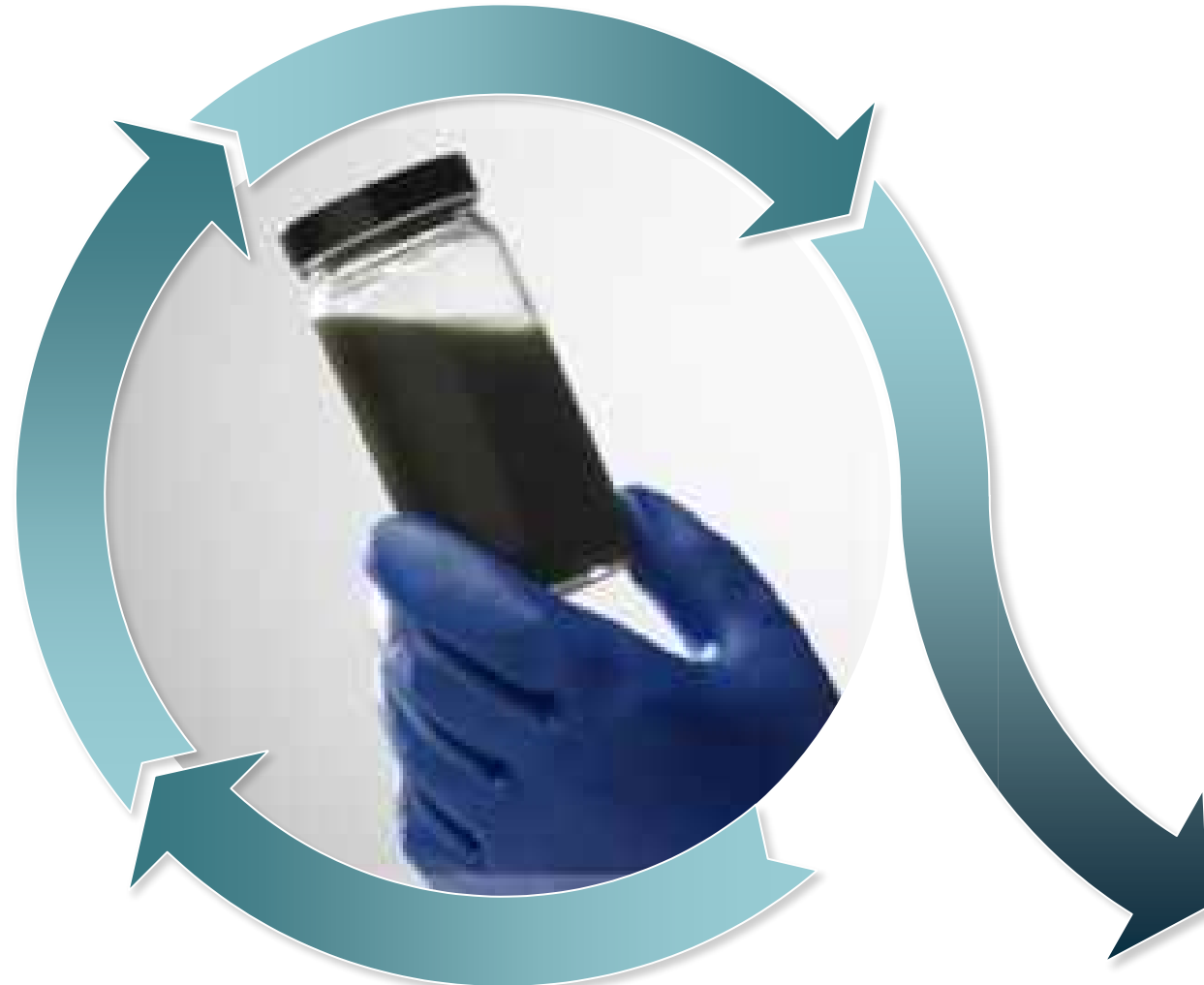
- Four total events
- 22,300 gallons of injectate applied
- Injection interval – 5 to 10 ft. bgs
- 12 ft. spacing between points, 12 ft. between rows
- 30 to 33 injection points per event
- Injection pressures 35 psi on average, flow 3 gpm on average
- Followed up with two to three days of HVE

High Vacuum Extraction Effects



PetroFix™ Sorption/Biodegradation

1. Fine-particle activated carbon (micron size)
2. Binds to aquifer solids and establishes biodegradation site coupled with nutrients
3. Regeneration occurs



Why Sulfate/Nitrate Enhancement?

- Naturally present in the subsurface
- Excellent solubility
- Sites abound with sulfate-reducing bacteria
- Nitrate can be used by both anaerobic and aerobic bacteria
- Literature suggests sulfate reducing bacteria may use nitrate when the environment becomes stressed
- Proven by case study results on numerous site types

Injection Specifics – PetroFix™

- One event
- 23,000 gallons of injectate applied
- Injection interval – 5 to 11 ft. bgs
- 12 ft. spacing between points, 12 ft. between rows
- 101 injection points
- Injection pressures 30 psi on average, flow 4 gpm on average

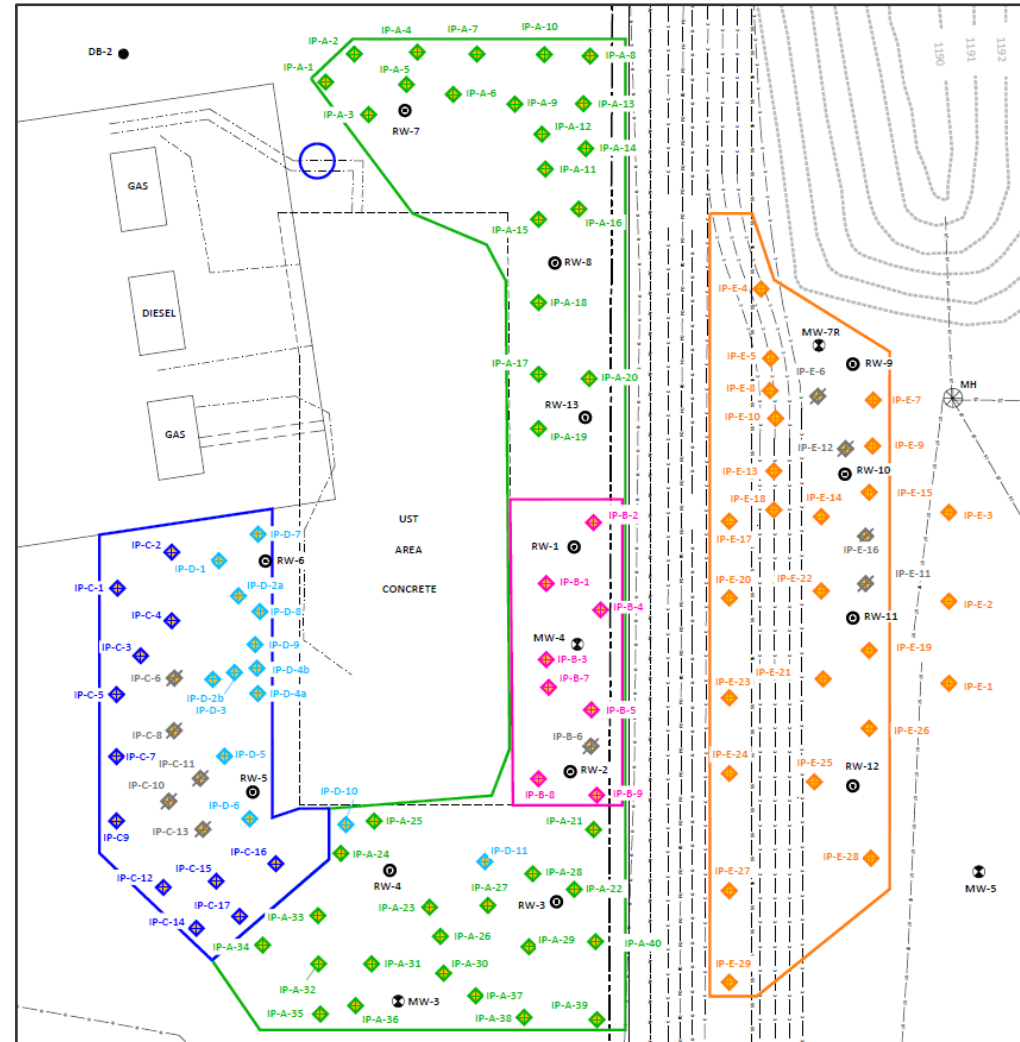


60 Days Post-PetroFix™ Injection

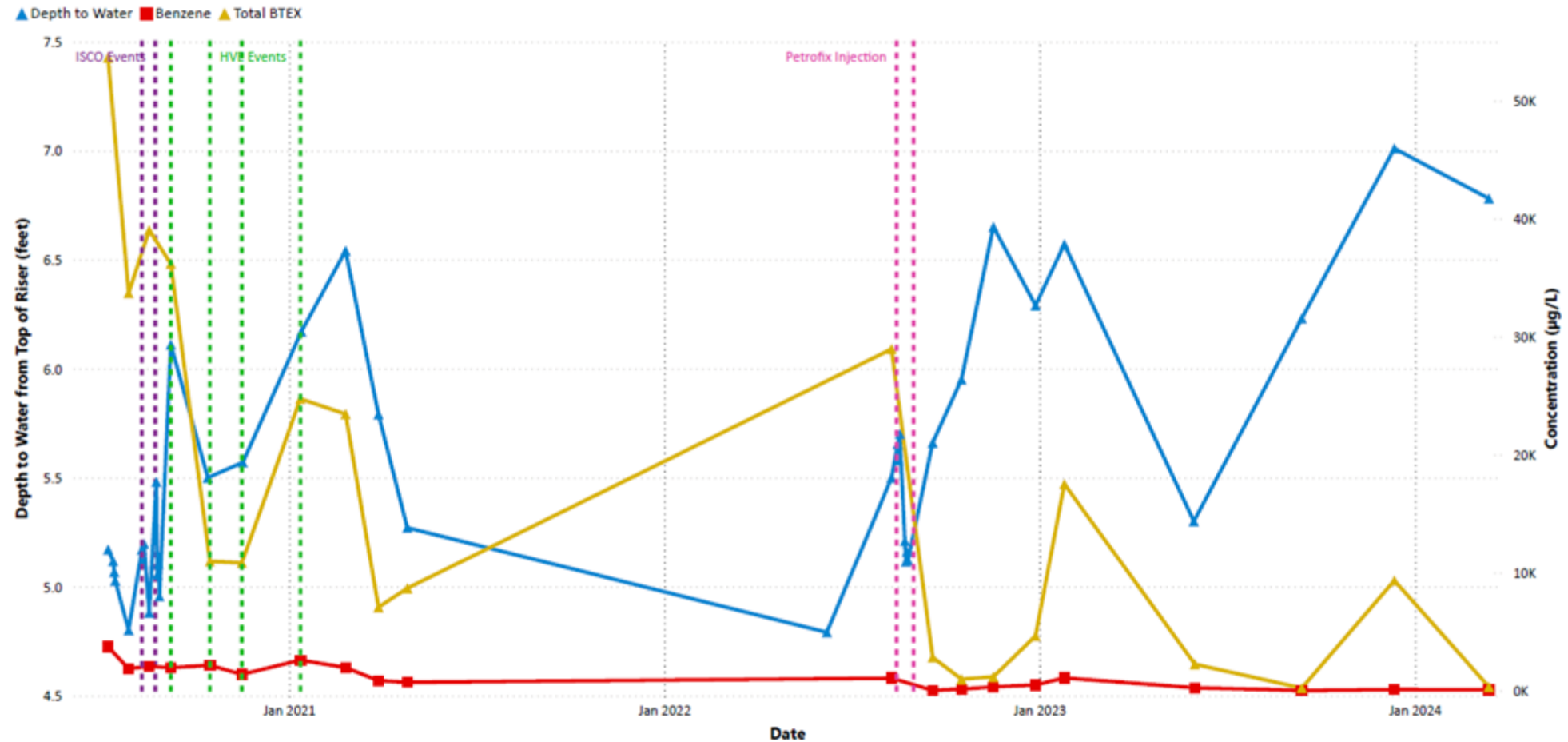
Percent Reduction for Benzene and Total BTEX

Well ID	Sample Date	Benzene (µg/L)	Pre- to Post-Injection Percent Reduction	Total BTEX (µg/L)	Pre- to Post-Injection Percent Reduction
MW-3	8/10/2022	<5.0	-	1,505.9	61.25%
	10/17/2022	<1.0		583.5	
MW-4	8/10/2022	7,040	95.53%	62,500	99.13%
	10/17/2022	315		544.4	
MW-5	8/10/2022	868	46.77%	5,743	NA
	10/17/2022	462		7,085	
MW-6	8/10/2022	2,980	5.03%	9,622	NA
	10/17/2022	2,830		13,330	
MW-7	8/10/2022	5,430	13.08%	27,290	13.05%
	10/17/2022	4,720		23,730	
RW-6/RW-6R	8/10/2022	13,800	99.96%	67,720	99.79%
	10/17/2022	<5.0		30	
RW-8/RW-8R	8/10/2022	1,050	89.05%	28,950	96.67%
	10/17/2022	115		964.8	
RW-11/RW-11R	8/10/2022	5,350	99.91%	14,113	99.79%
	10/17/2022	<5.0		30	

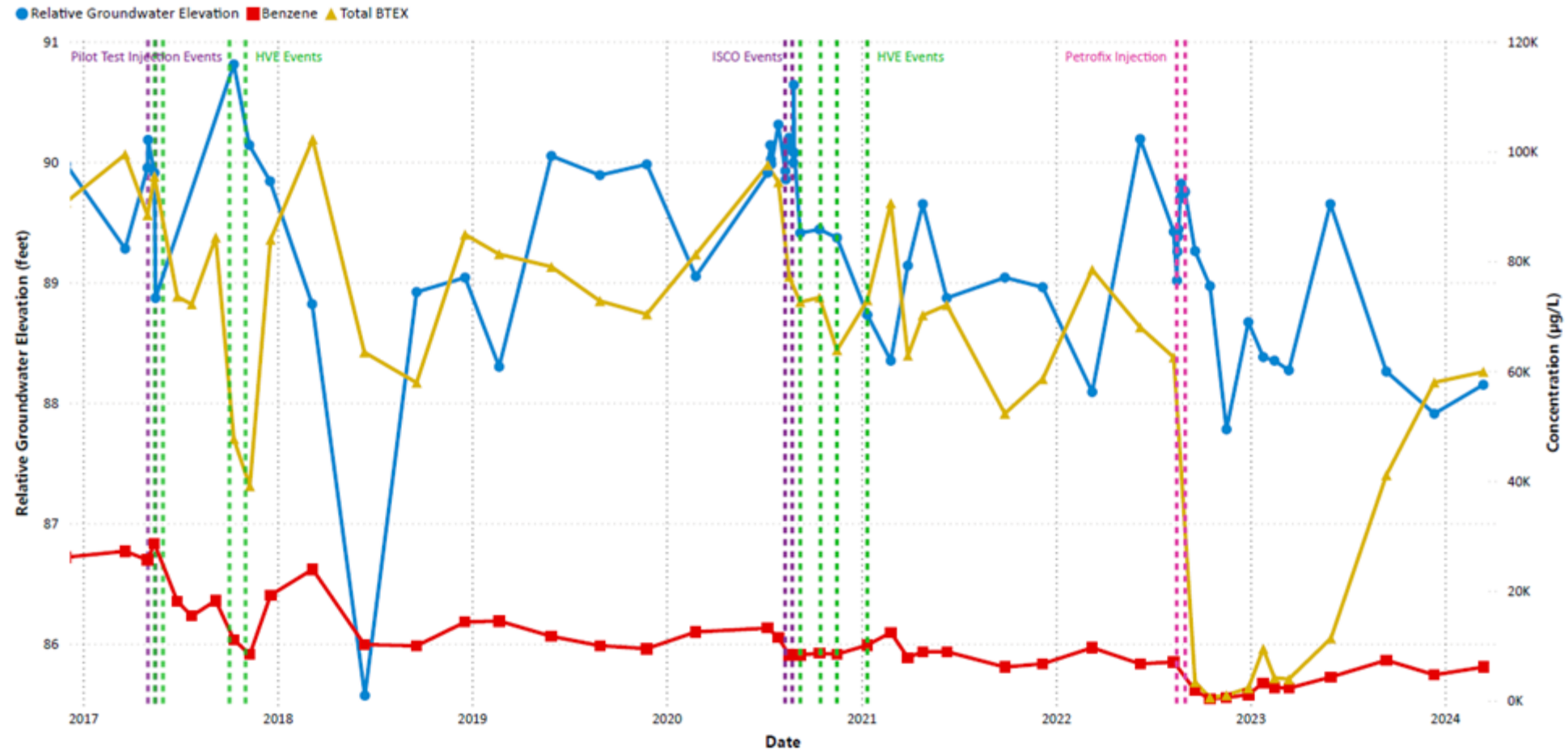
Five PetroFix™ Injection Areas



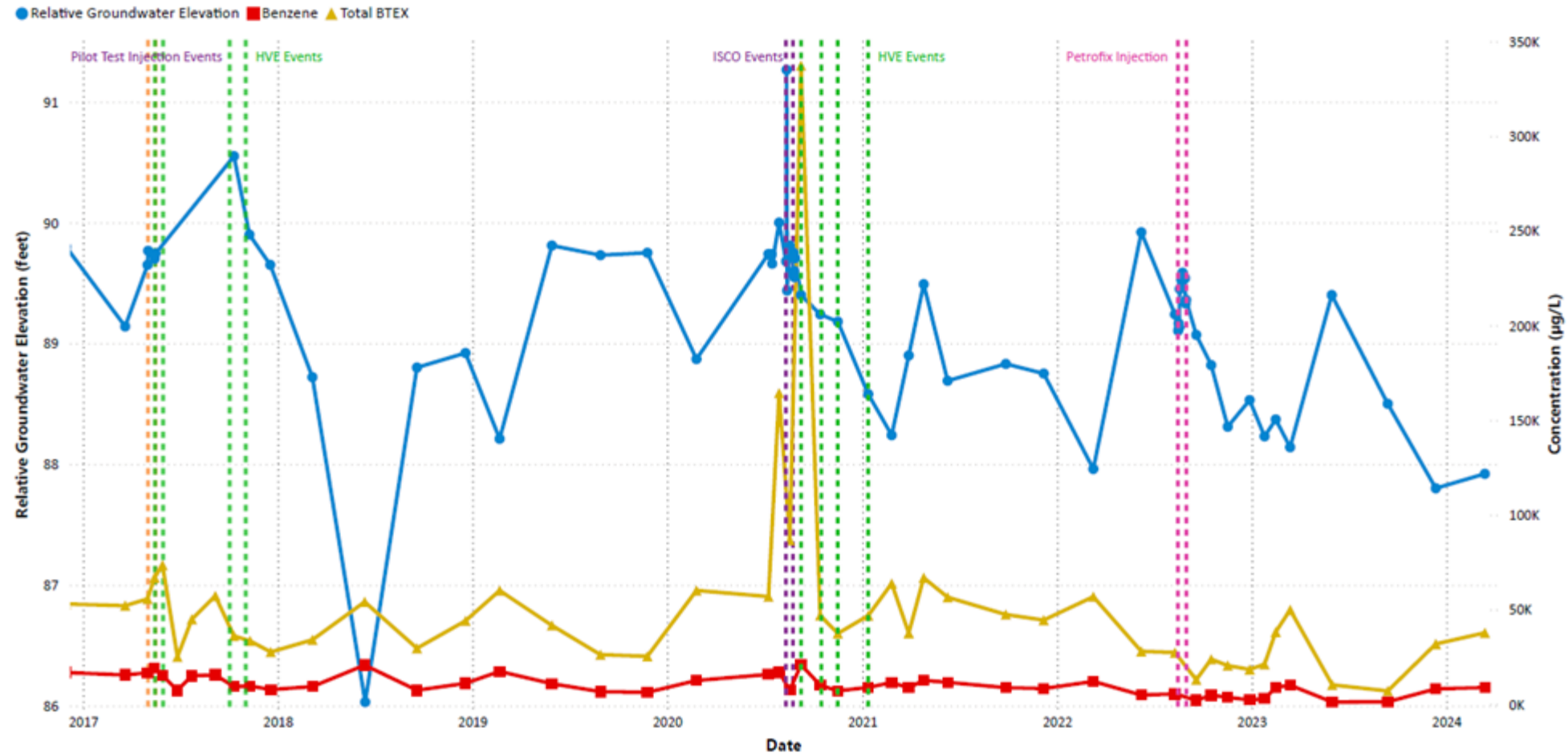
MW-4 – Northeast Side of Tank Pit



RW-8 – Southeast Side of Tank Pit



MW-7R – Near Stormwater Ditch





Lessons Learned

Even gross contamination removal at a high mass petroleum site can require substantial effort.

RegenOx[®] chemistry has desirable desorption and dissolution properties.

PetroFix[™] is a useful polishing technology that can reduce dissolved concentrations rapidly.

The UST tank basin flood technique was helpful in distributing PetroFix[™] amendment and creating a barrier to reduce mass fluxing from the tank basin.



Injection Challenges:

- *Site Traffic*
- *Protecting the Stormwater Ditch*
- *Unmarked Utilities/Lines*
- *Sugar Sands*
- *Access to Areas for Injection*



Acknowledgements:

*Chris Tufts and Molly Partridge (Antea Group)
Ryan Moore, Todd Herrington, and Tyler Harris (Regenesis)*



Thank You
If you have more questions...

Antea®Group

Understanding today.
Improving tomorrow.

We do more than effectively **solve client challenges**; we deliver **sustainable results** for a **better future**.



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