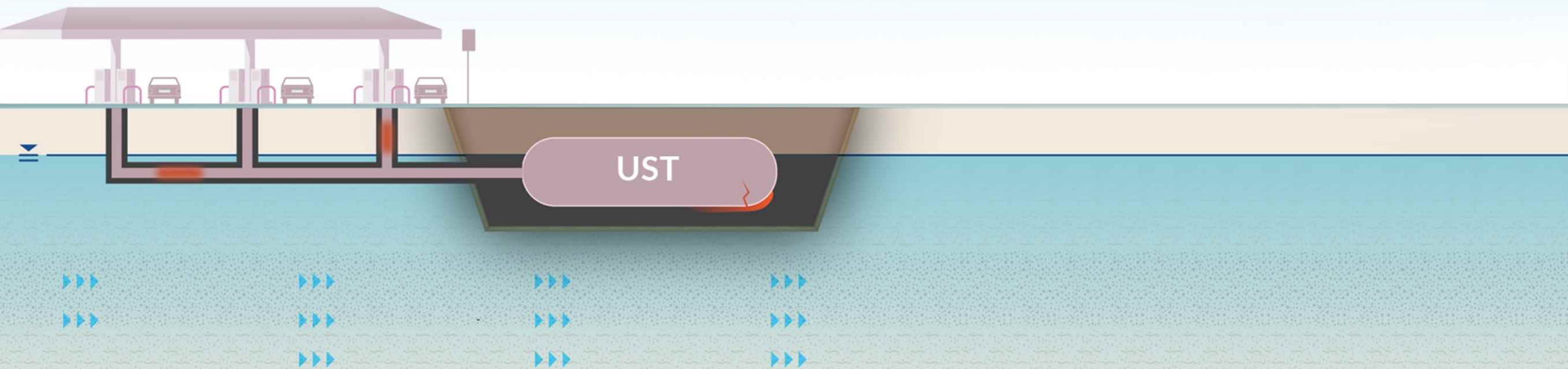


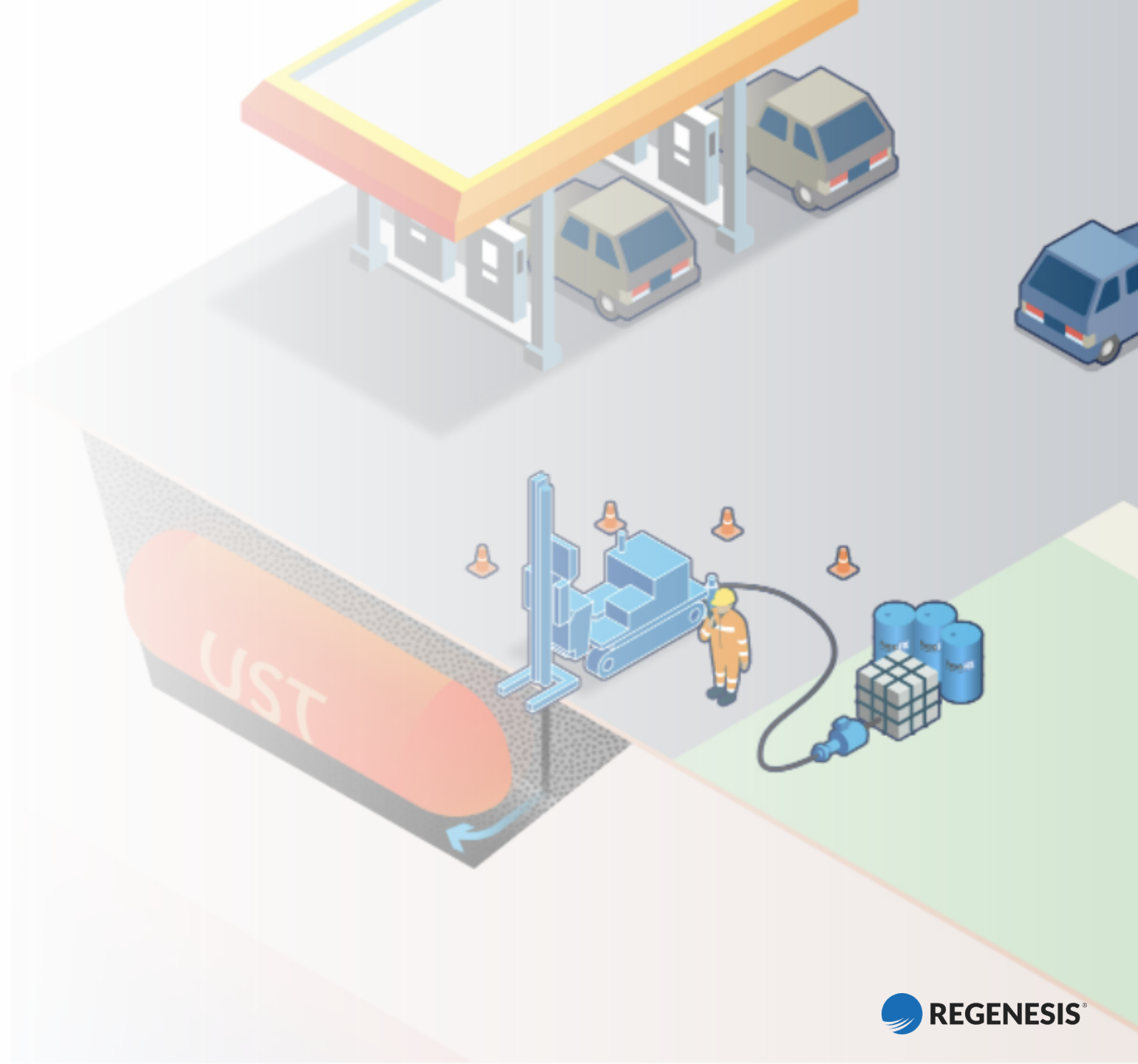
Treating and Pretreating Hard To Access Hydrocarbon Contamination In Underground Storage Tank Basins and Utility Corridors

Todd Herrington, REGENESIS, Global PetroFix Product Manager
Tyler Harris, REGENESIS, PetroFix Design Specialist



Overview

- Background
- CAC Option
- Treatment Approaches
 - Experiential
- Case Studies
- Q&A



Background



Common Hydrocarbon Collection Points

When a leak occurs, *most* mass is found near:

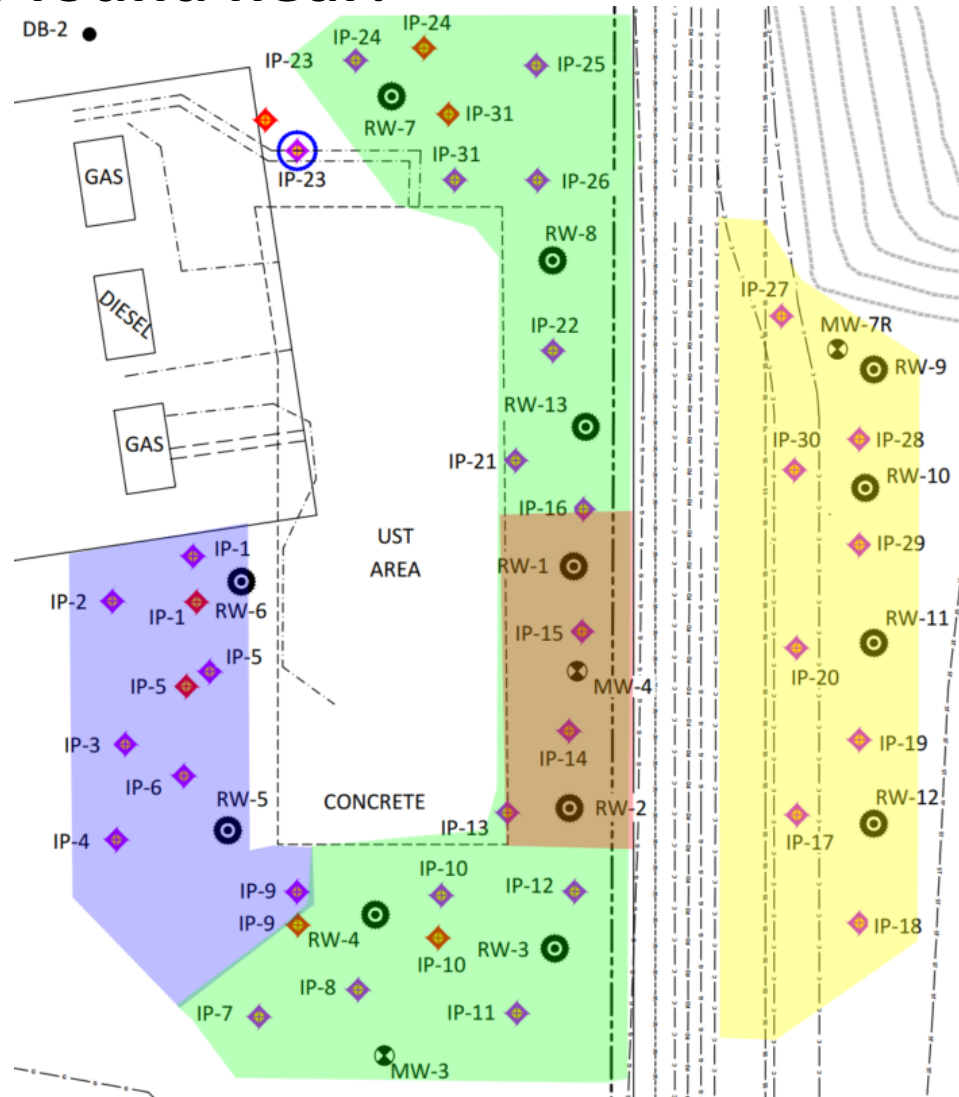
- UST Bedding
- Utility, Sewer, Water Corridors
- Fill Point – Spill Buckets
- Collection areas can be long-term issues



Management of Hydrocarbons – Risk

When a leak occurs, *most* mass is found near:

- UST Bedding
- Service Corridors (pooling of product)
- Fill Point – Spill Buckets
- Collection areas can be long-term issues



Colloidal Activated Carbon (CAC) Option



Colloidal Activated Carbon for In Situ *Hydrocarbon* Remediation

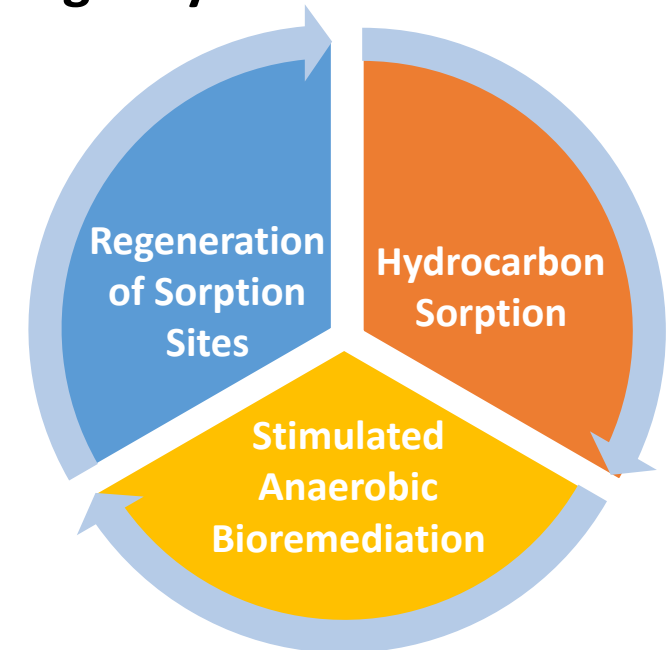
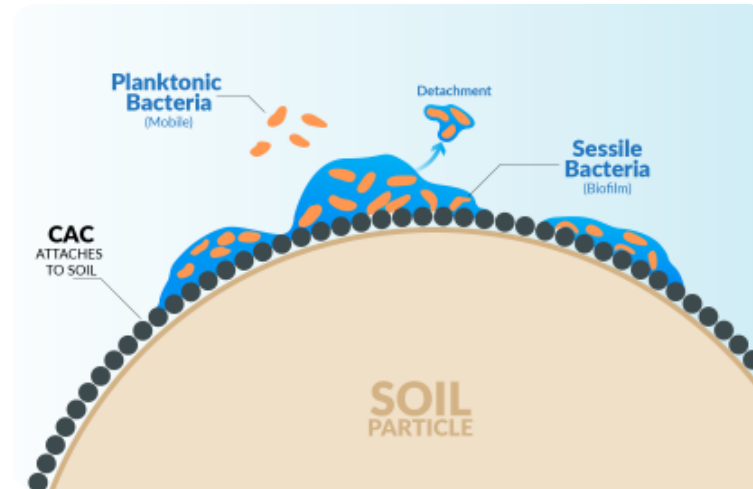
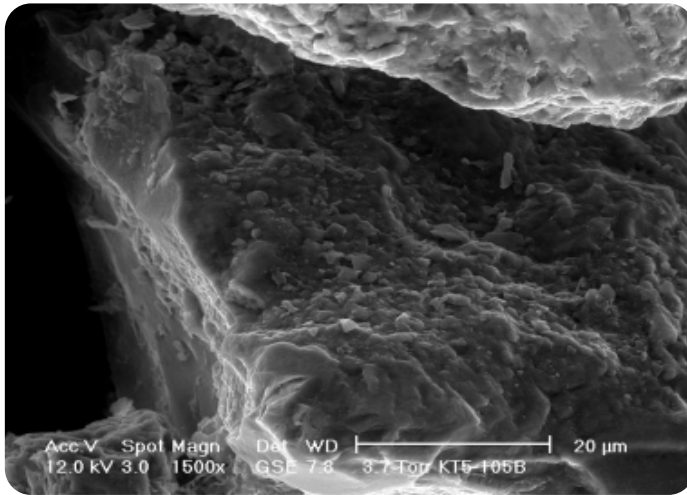
- **Micron scale activated carbon (1-2 μm \varnothing) and water suspension, +30%**
 - Shipped as viscous remedial fluid that is diluted in field
- **Ammonium sulfate (for SO_4) and sodium nitrate (for NO_3) provided in separate buckets**



Petro **FIX**[®]
Remediation Fluid

Dual Approach: Adsorption + Biodegradation

- PetroFix coats soils in flux zones with a micrometer thick layer
- Longevity – flux from upgradient or back-diffusion captured over time
- $\text{NO}_3 + \text{SO}_4$ kick-start bioremediation = biofilm formation
- *In situ* carbon regeneration = contaminant destruction and > longevity



Ease of Application



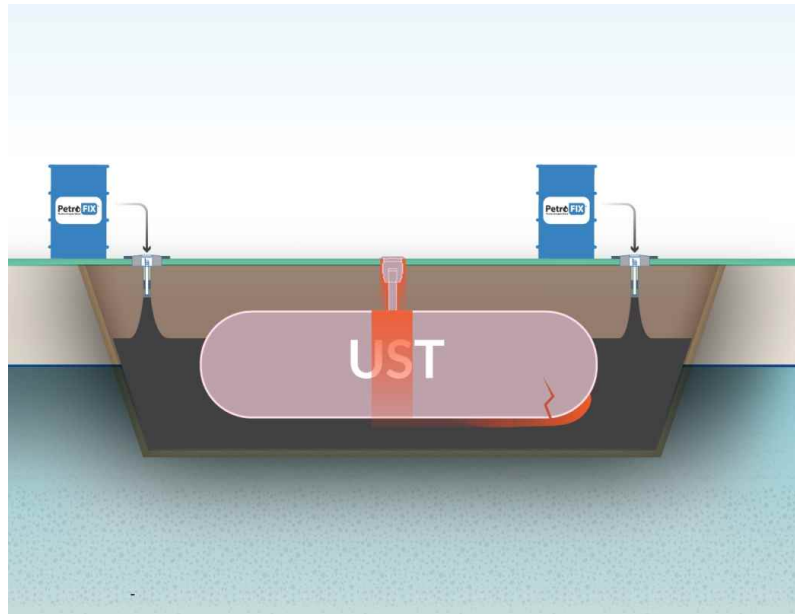
Easy to spray, pour, inject

Non-hazardous, non-corrosive

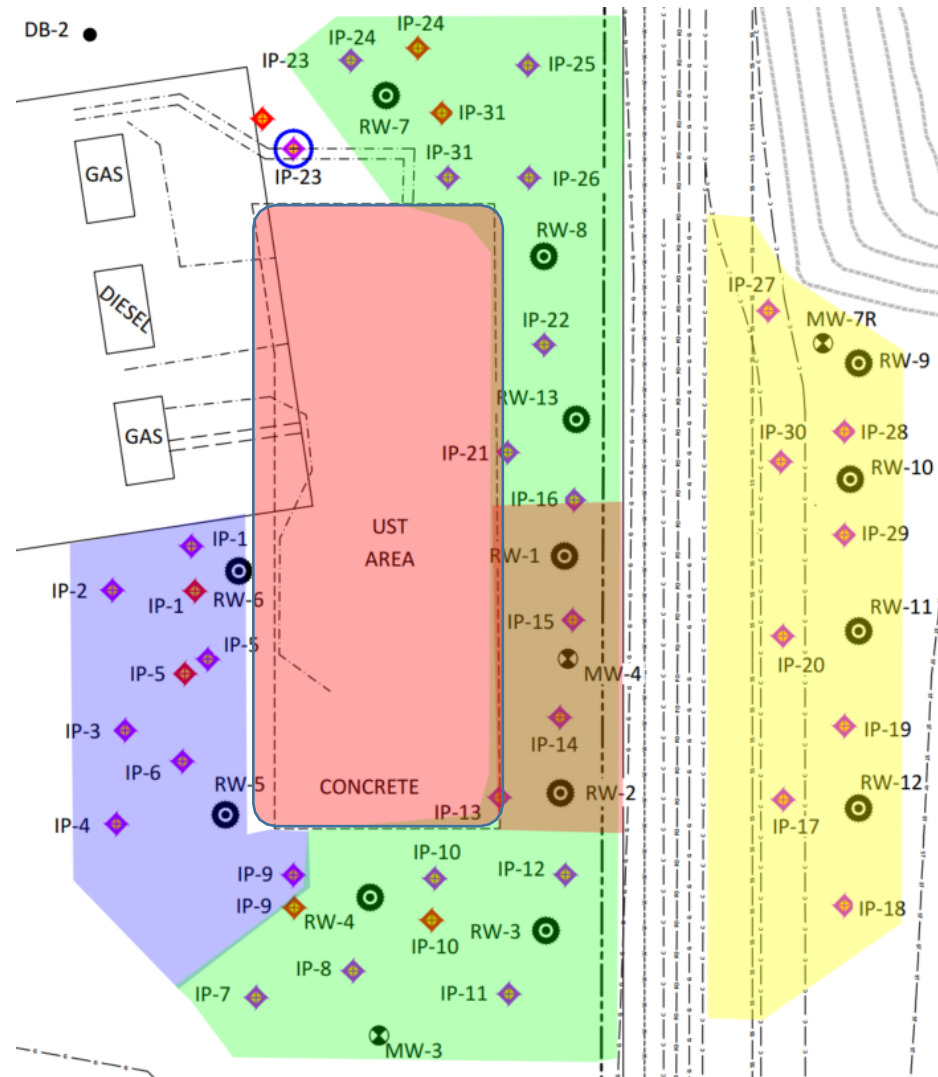
PetroFix instantly reduces contamination, treating current concentrations and preventing future movement



Spray Application Evolved To Flooding Options



Option to treat around sensitive infrastructure



Groundwater flow direction

Column Experiment

- The treated column was dosed with 29.4g of a 50% CAC solution applied to the top of the column, representative of a recommended field dose.
- The columns were fed tap water for 24hrs under gravity flow from top to bottom to emulate a natural flux of water.
- Through the top few layers of soil and ongoing 'spills' of neat diesel slugs were added at regular intervals to each column.
- No CAC eluted from the bottom of the column

The control (left) and CAC-treated (right) columns used in the study to demonstrate the ability of PetroFix to capture small diesel spills.



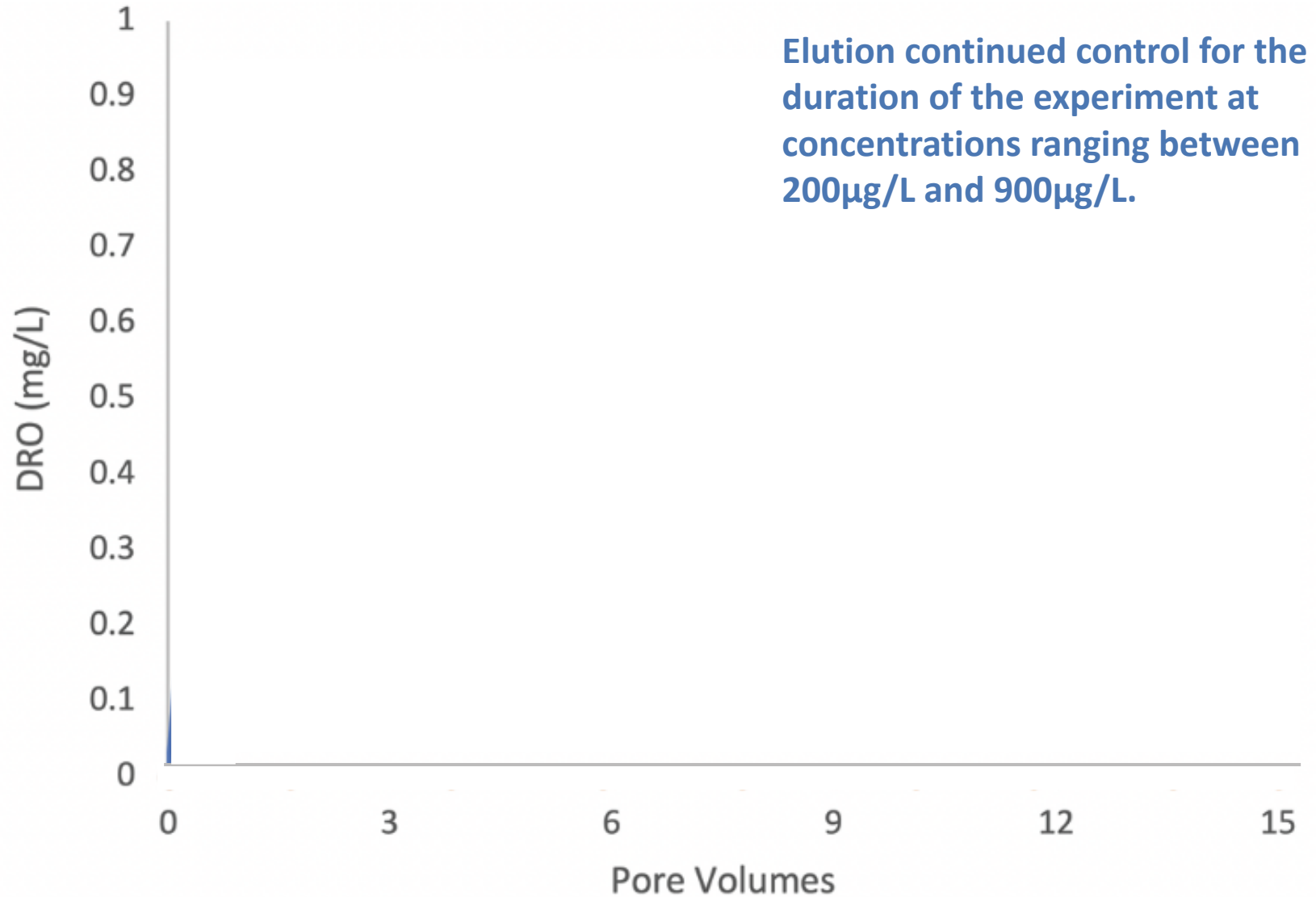
Bench Test Results

Total mass of 2.6g diesel added to each column over 14 releases

Diesel eluted through columns without CAC

PetroFix-treated column had no detectable (< 50µg/L) levels of DRO eluting from the column for 15 pore volumes.

Data show long-term ability to perform and reduce risk



Targeting UST Basins and Pipeline Corridors



Designing



Spray applications when USTs or piping are removed



UST or Utility Corridor Flood:

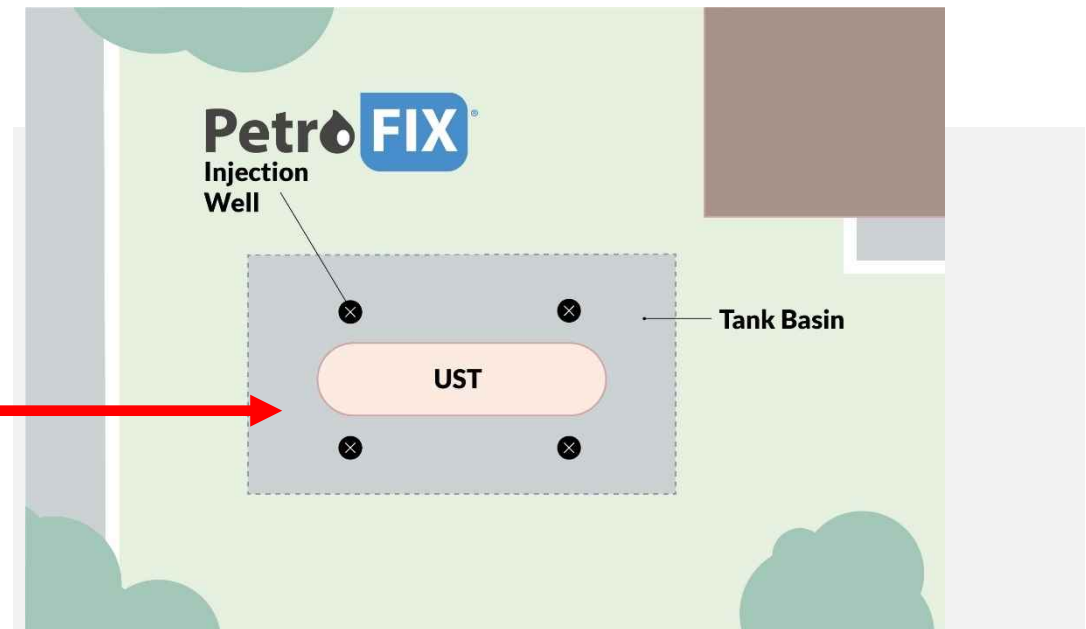
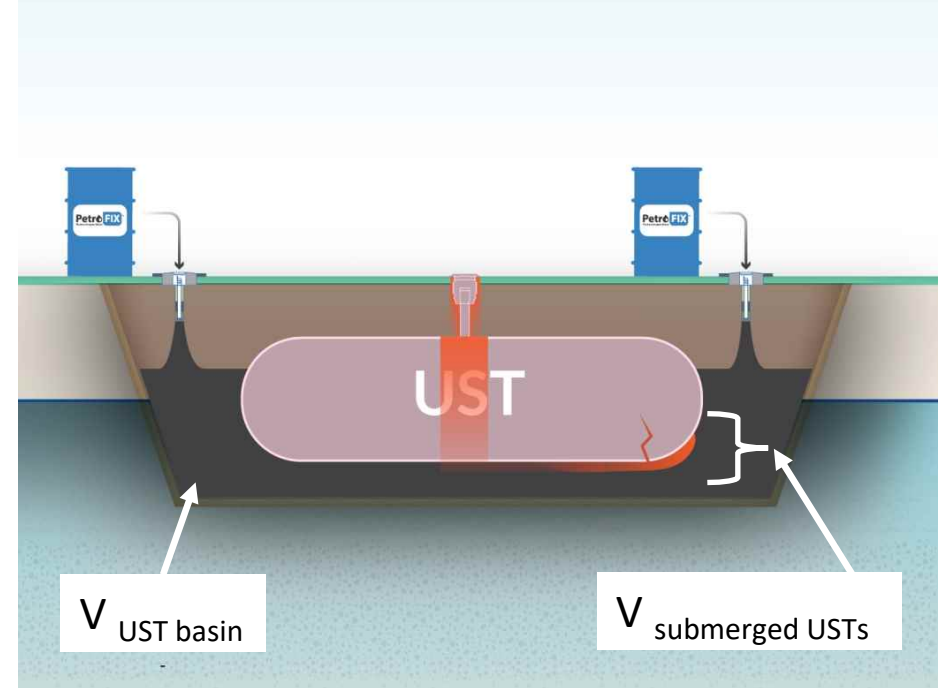
- Above tank percolation/injection
- Side of basin/corridor injection
 - Pump/pull option

Estimating

- $V_{\text{UST basin}} - V_{\text{submerged USTs}} = V_{\text{treatment}}$
- Subgrade porosity
- Starting/Anticipated dissolved mass over time
- Regeneration and/or www.petrofix.com for calcs

Considerations:

- Remove free-product first
- Lean conservative, relatively inexpensive
- App. volumes often in the 15% to 25% epsf range.
- More injection points are better for coverage.
- Slow injection rates to avoid tank movement.
- Induced current system? Sodium may require adjustment



Case Studies



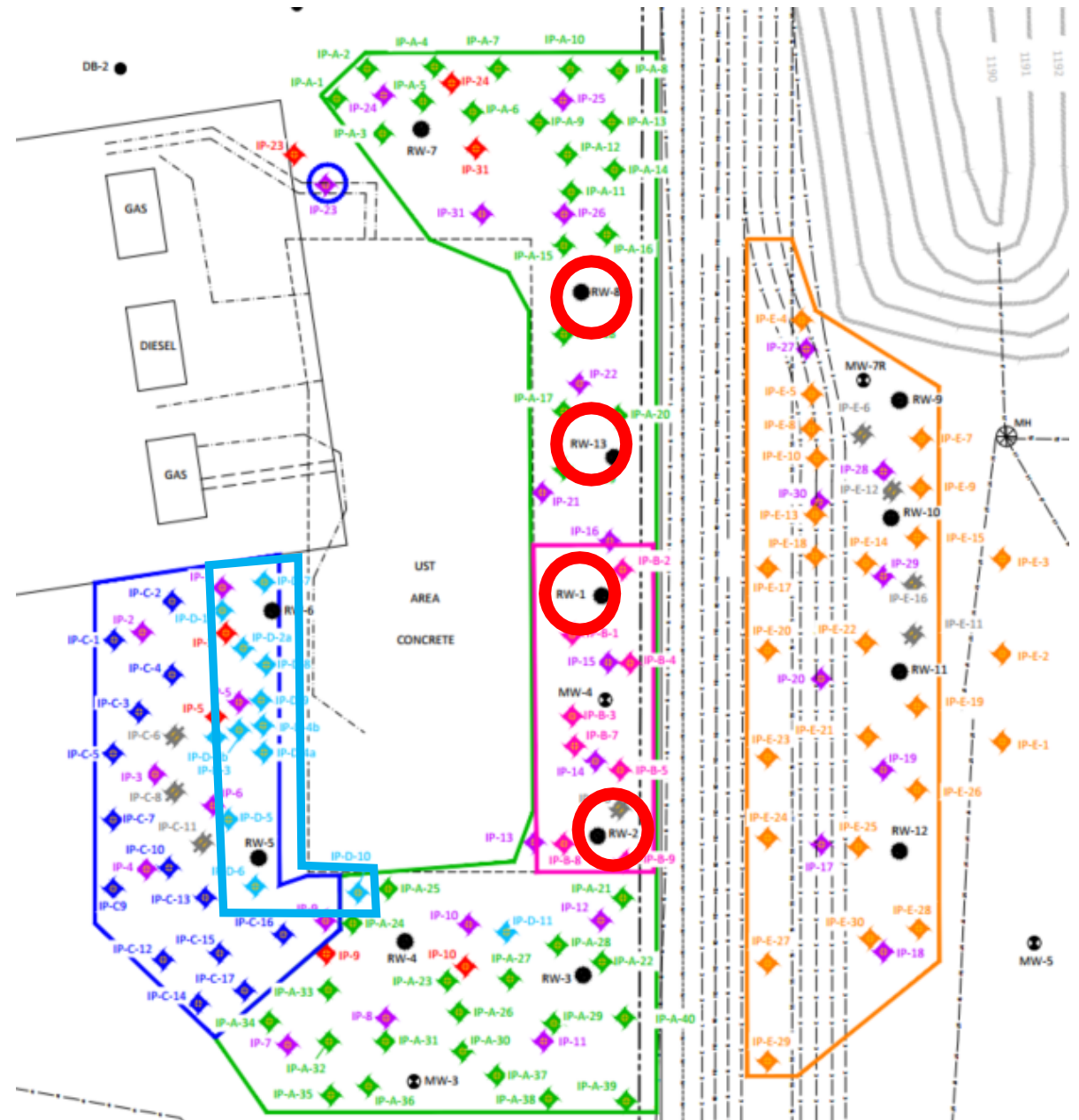
UST Basin Flood

Historic Spill - MN

UST Basin flood part of larger in situ injection – Summer 2022

13 of 102 injection points (blue) for “edge flooding” – avoid piercing infrastructure

Vacuum truck removed groundwater downgradient (red circles) to aid in distribution across basin



Credit: Antea Group, Molly Partridge and Jack Sheldon

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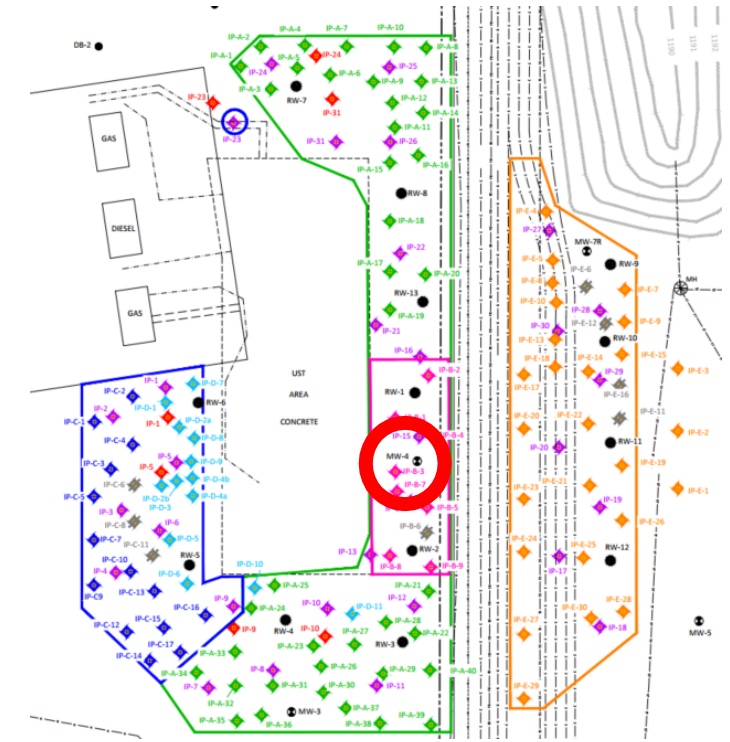
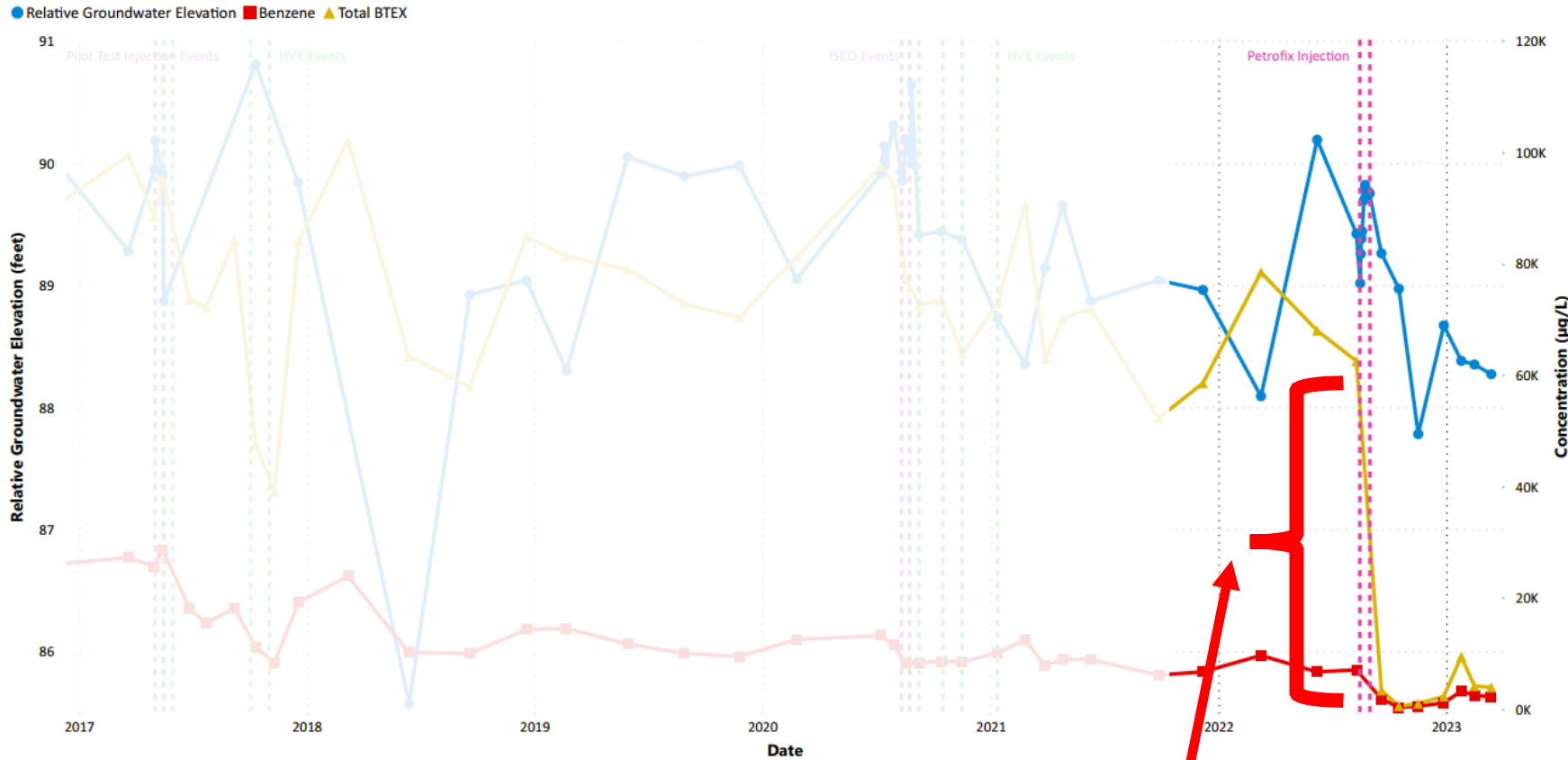
3 “flood” events to minimize surfacing at adjacent wells (Aug. 16,17,25)

- 3,725 gallons of diluted PetroFix injected
- 8,400 gallons of groundwater extracted
- 5,200 lb PetroFix
- PetroFix not observed in extraction wells during event



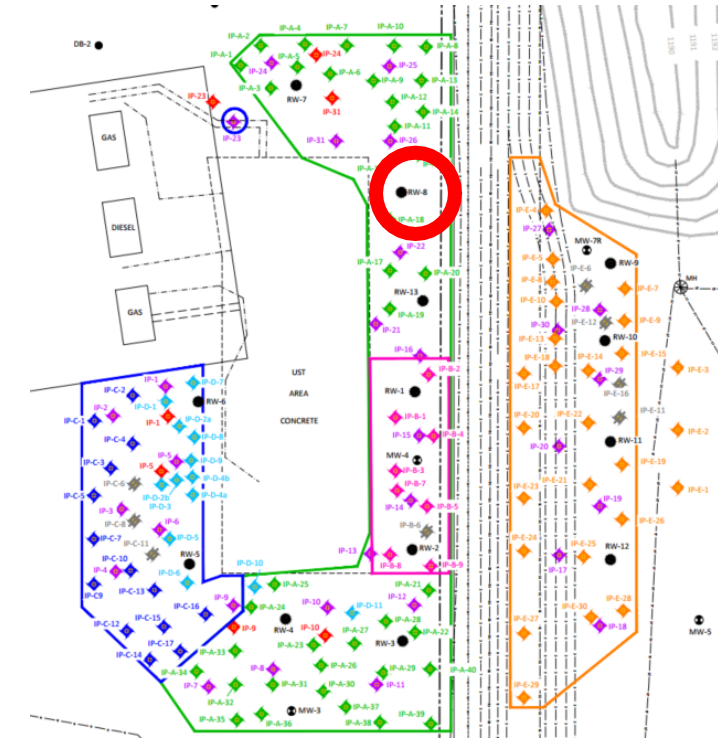
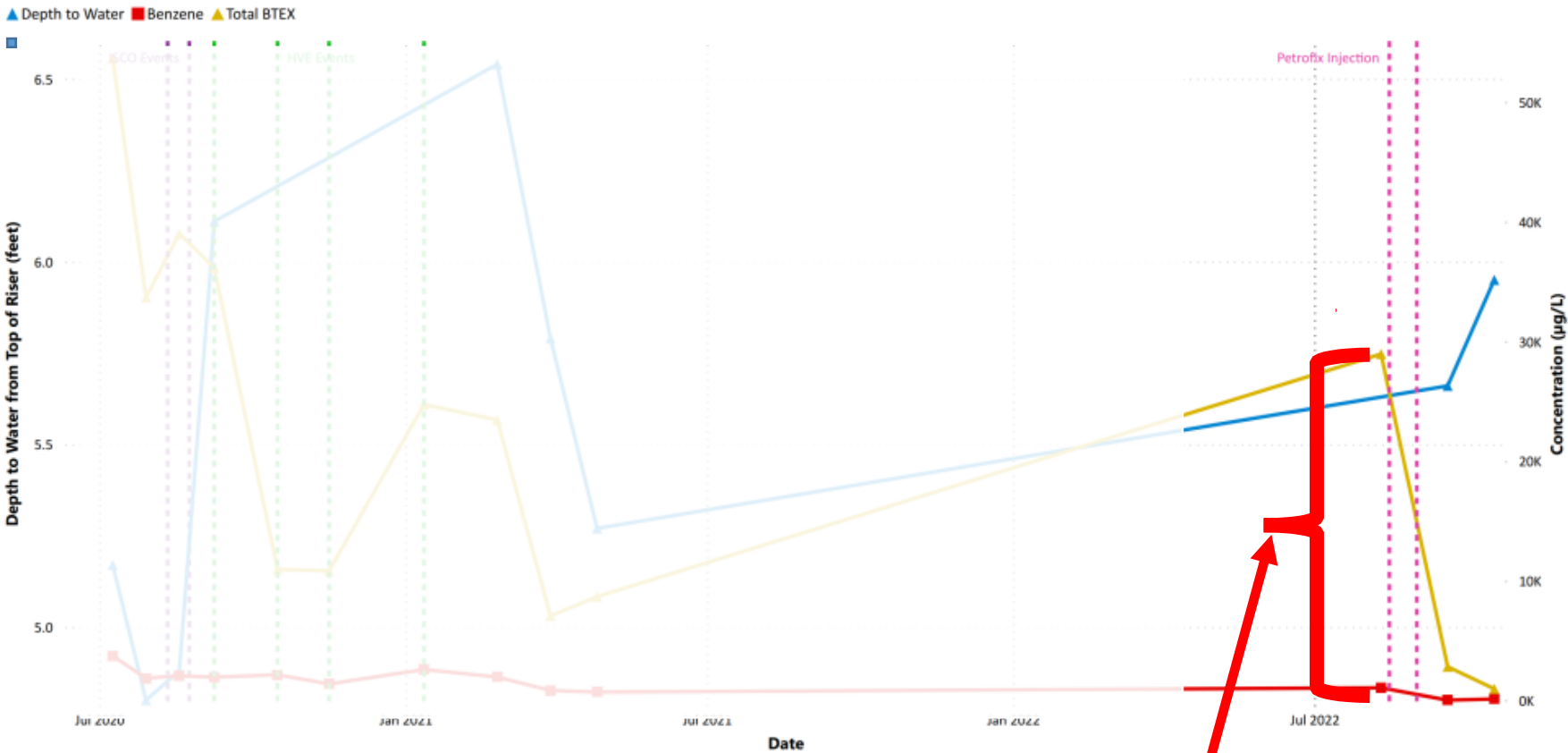
Credit: Antea Group, Molly Partridge and Jack Sheldon

Post Application - Downgradient MW-4



**2-month result:
BTEX from 69.6 mg/L to 0.54 mg/L - 99.1 % reduction
(Latest at 94.4% reduction)**

Post Application - Downgradient RW-8



**2-month result:
BTEX from 29 mg/L to 4.6 mg/L – 84 % reduction
(latest at 96% reduction)**

Tank Basin Flood

Historic CO

- **May 2017 – Stained soils discovered during replacement of spill buckets**
- **Max BTEX concentration: 6,557 $\mu\text{g}/\text{L}$**
- **3 10,000-gallon tanks and 1 12,000-gallon tank.**
- **Contaminants within tank basin and in surrounding soils (clay/sand, weathered bedrock)**

Photo: CGRS, Monica Young

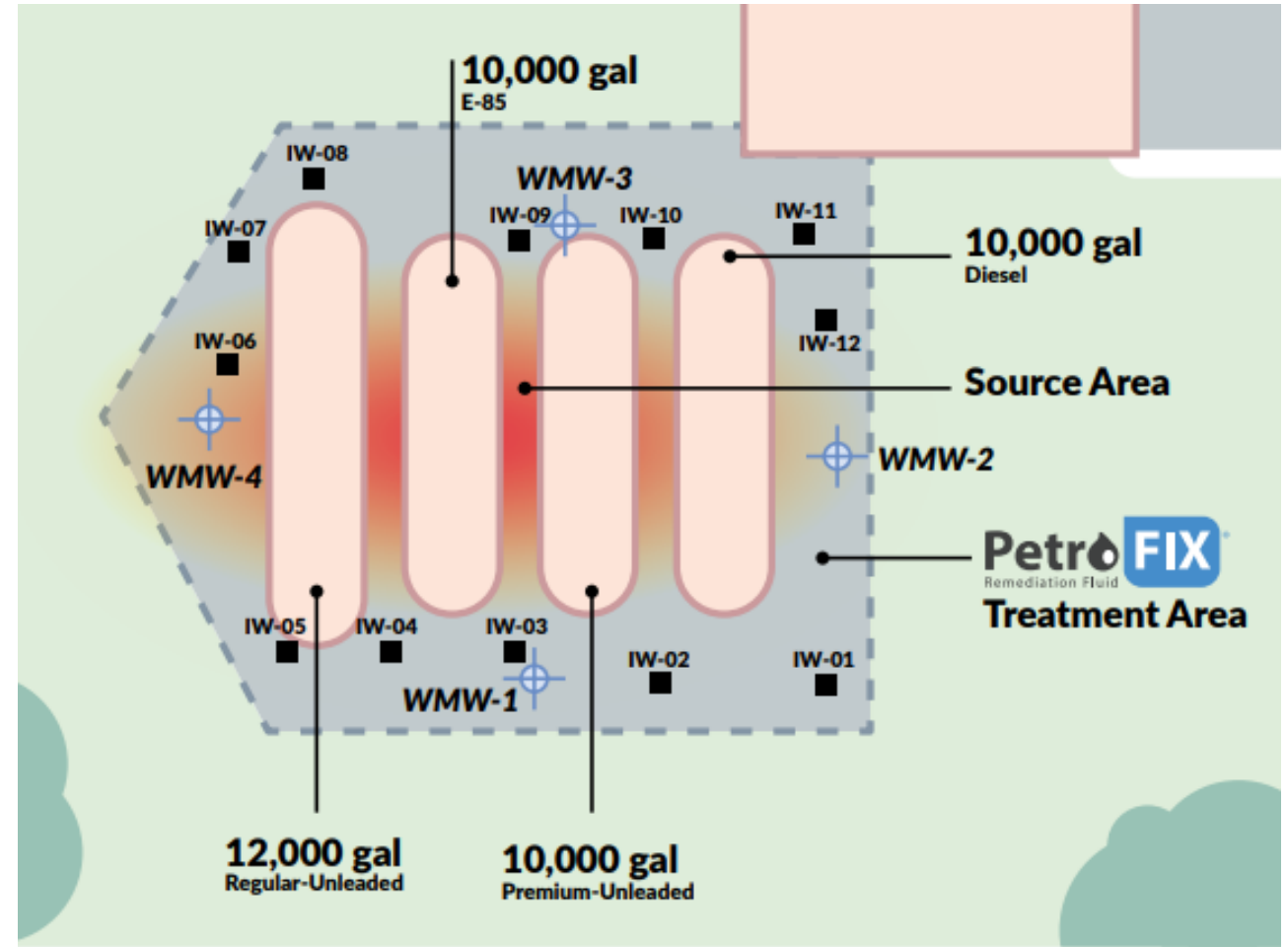
UST Basin Flood - CO

Design Dimensions:

- UST basin effective pore volume = **31,000 gallons**

Design Approach:

- Injection point installed every 250 ft²
- 12 injection points (4 ft bgs)
- Evenly spaced injection points surrounding tanks



UST Basin Flood - CO

- PetroFix was observed in all key monitoring wells by 3,000 gallons applied (<10% EPVF)
- Total volume of 4,500 gallons was applied
 - Less than 20% EPVF
- <5 PSI and <2 GPM per injection well
- DTW did not rise more than 1 ft
- **4,800 lb CAC**
 - Pilot: 400 lbs
 - Full Scale: 4,400 lbs

10,000 gal
E-95

before PetroFix Treatment
March 2020

216 ug/L

Warning indicates concentrations above Tier 1 Risk Based Screening Levels
TVPH value represents Total Volatile Hydrocarbon or gasoline

Mon. Well	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	TVPH
WMW-1	216 ug/L	2 ug/L	2,150 ug/L	89 ug/L	152 ug/L	10,800 ug/L
WMW-2	15 ug/L	<1 ug/L	50 ug/L	10 ug/L	1 ug/L	820 ug/L
WMW-3	185 ug/L	770 ug/L	828 ug/L	4,770 ug/L	<5 ug/L	30,500 ug/L
WMW-4	6 ug/L	<1 ug/L	3 ug/L	2 ug/L	15 ug/L	990 ug/L

after PetroFix Treatment
March 2021

Mon. Well	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	TVPH
WMW-1	<1 ug/L	<1 ug/L	18 ug/L	60 ug/L	<1 ug/L	700 ug/L
WMW-2	<1 ug/L	<1 ug/L	<1 ug/L	<1 ug/L	<1 ug/L	<500 ug/L
WMW-3	<1 ug/L	<1 ug/L	<1 ug/L	<1 ug/L	<1 ug/L	<500 ug/L
WMW-4	1 ug/L	<1 ug/L	<1 ug/L	<1 ug/L	1 ug/L	<500 ug/L

10,000 gal
Premium-Unleaded

PetroFix Coating of Pipeline, Germany



Background

- A new underground pipeline was installed across a chemical plant, and TPH contaminated soil and groundwater.

Remedial Strategy

- Limit recontamination of new subgrade; prevent movement of contamination across locations

PetroFix Coating of Pipeline, Germany

Risk – Rebound

- Clean fill material or groundwater being contaminated from surrounding contamination

Risk – Mobilization

- Granular pipe-bedding material creating pathway to other areas



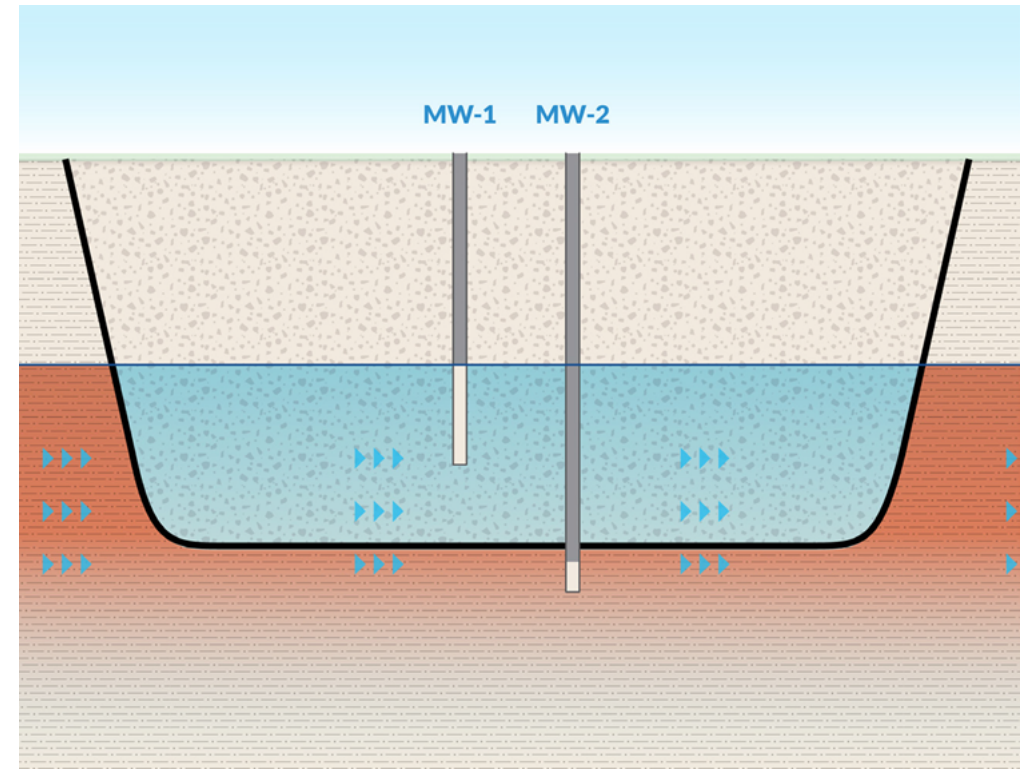
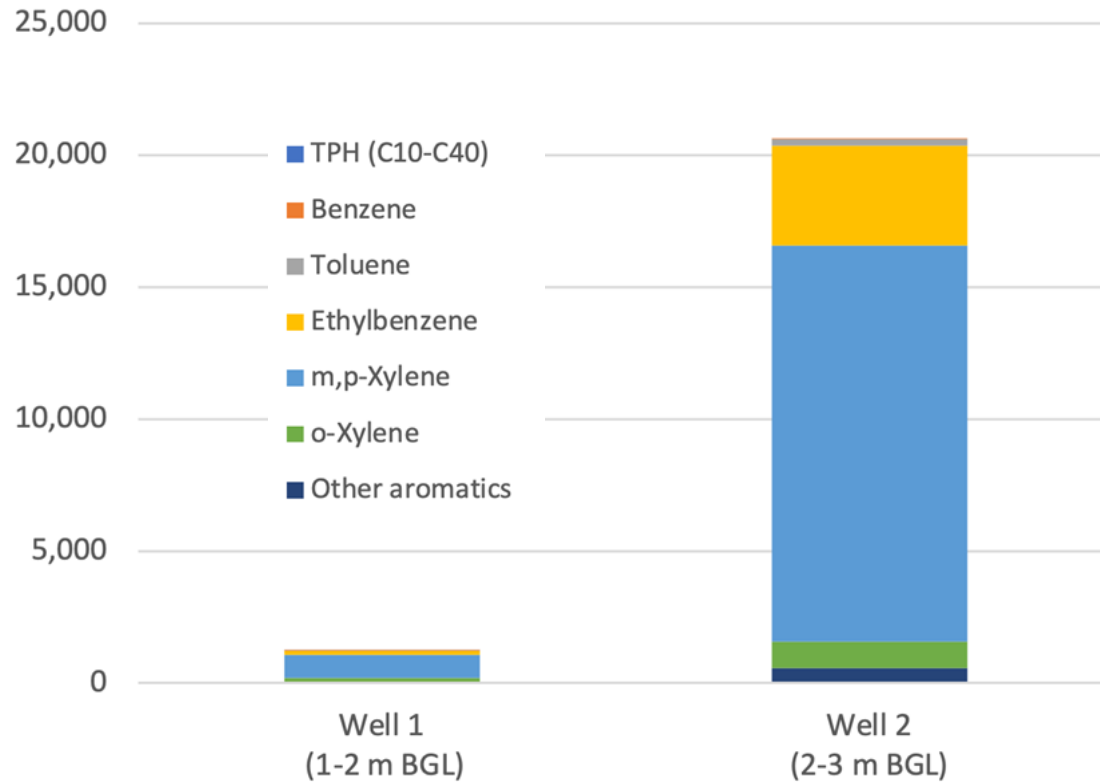
Risk Mitigation – Topical PetroFix Application

- Topical application of PetroFix® onto the excavation base and sides
- Prevent contamination of the granular backfill
- Stops the infiltration and spread of contaminated groundwater in the pipe-bedding.



Results

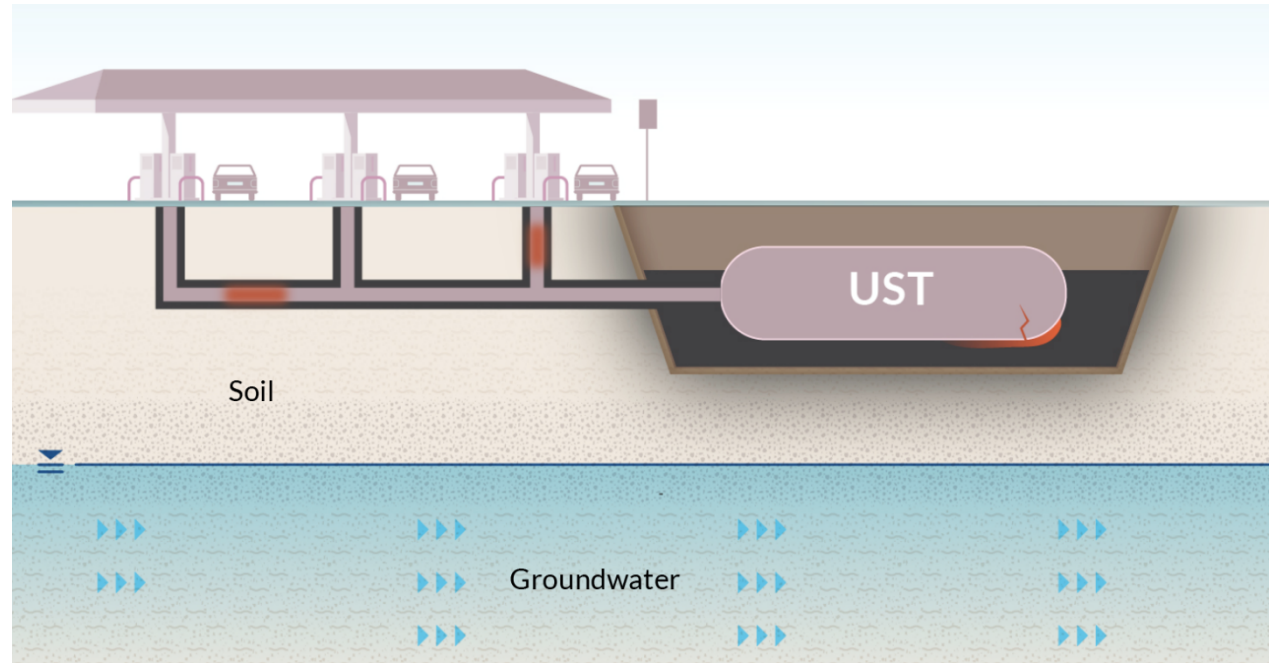
8 Months Post-Application (94% Reduction)



~17x lower concentration in pipe corridor than groundwater just below it

Conclusion

- **Easy application** - percolated, injected, or sprayed
- **Non-hazardous and non-corrosive**
- Remove LNAPL first
- results
 - Asorption + bio
- Multi-year longevity
- Reduces risk for future releases
 - Treat or pre-treat for mitigation



Questions?



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www.PetroFix.com | www.REGENESIS.com