

ENVIRONMENTAL, INC.

Summary: The subject site is an active fuel storage and dispensing site in Texas where a leaking AST created a large dissolved and NAPL plume. BOS 200+[®], a modified version of BOS 200[®], was applied over a large area during a 6 month period in 2017. Results to date indicate that NAPL levels have been eliminated or significantly reduced. In addition, Benzene and TPH-GRO (TVPH) concentrations have been reduced more than 96% and 97% respectively. A No Further Action (NFA) determination has been requested and is pending.

Project Snapshot:

- •Key Dates
- -Remedial Design Characterization February 2017
- -Injection of BOS 200+[®] Summer and Fall 2017 (6 months)
- Treatment Area: 93,000 ft²
- •The impacted lithology varied across the large area but consisted mainly of silty clay to clay over weathered shale with some sand and gravel
- Depth to groundwater was variable: 5 to 25 ft below ground surface (bgs)
- Contaminants: NAPL and TPH-GRO
- Implementation Methods: Direct push technology (DPT) and Geo-TAP injection (hollow stem auger/bentonite backfill/DPT)



Figure 1. RDC Saturated Soil Data > 500 mg/kg



Figure 2. RDC Saturated Soil Data > 2,500 mg/kg

From LNAPL to Beyond: Elimination of Significant LNAPL and BTEX Resulting from a Leaking Aboveground Storage Tank while Overcoming Refusal Using BOS 200+™

Approach:

- used to create an optimized and targeted BOS 200+ design (Figures 3-5). All samples were analyzed at the RPI Project Support Laboratory at no cost. Injection specifications
- -93,000 ft² Total Treatment Area
- -1,000+ Injection Locations
- -361,000 lbs BOS 200+ (BOS 200, gypsum, sodium sulfate, complex carbohydrates, yeast extract, and bacteria)
- The majority of the injection locations were completed using direct push injection techniques. In one area, shallow refusal was encountered (weathered shale) and the Geo-TAP technique was used to reach the target treatment depth. The Geo-TAP method involves advancing augers to the treatment total depth, backfilling with hydrated bentonite, then advancing the injection tooling using traditional direct push techniques.

Results: LNAPL

• The total number of wells with measurable LNAPL prior to remediation: 15

- Post-remediation LNAPL statistics
- -No measurable LNAPL: 12
- -Sheen: 2 -Measurable LNAPL: 1 (current max LNAPL thickness = 0.02 ft)

Dissolved Total Volatile Petroleum Hydrocarbons (Table 1)

- •The average dissolved TPH concentration in the monitoring wells prior to remediation: 20.9 mg/L
- Post-remediation average concentration: 0.38 mg/L (97% reduction)

Benzene (Table 1)

- •The average dissolved Benzene concentration in the monitoring wells prior to remediation: 0.37 mg/L
- Post-remediation average concentration: 0.012mg/L (96% reduction)





Figures 3-5. RDC Sample Result Coding and Injection Areas

Notes:

-Red circles denote wells with historic NAPL

-Red circles with white centers denote wells with historic NAPL and gw levels shallower than 5 ft bgs -Red squares denote RDC locations with TVPH in soil > 500 mg/kg and <2,500 mg/kg -Blue squares denote RDC locations with TVPH >2,500 mg/kg

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• One-thousand one-hundred and ten (1,110) soil samples were collected from 128 soil borings (approximately every 2 ft vertically) as part of a large Remedial Design Characterization in early 2017. The sample results (Figures 1 and 2) were





Technology Description: Both BOS 200 & 200+ Powdered activated carbon Supplemental electron acceptors of nitrate and sulfate Microbes (bacteria, yeast, and fungi)

BOS 200+ adds

Supplemental nitrogen for anabolic processes Supplemental carbon for energy production and anabolic processes Additional microbes to augment three characteristics 1.Breakdown the supplemental and endogenous carbons to base sugars 2.Additional sources of vitamins 3.Additional measures to ensure no H₂S build-up

Table 1. Percent Reductions After 5 Years of Monitoring				
Area	Benzene	Avg	TPH-GRO	Avg
West	99.9%	97.2%	98.9%	97.6%
	97.2%		99.6%	
	91.6%		95.0%	
	99.9%		96.8%	
East - South	98.8%	97.5%	85.8%	95.9%
	99.1%		98.2%	
	93.0%		100.0%	
	99.1%		99.5%	
East - North	65.8%	95.2%	95.0%	97.3%
	97.2%		95.2%	
	98.9%		99.4%	
	99.6%		99.3%	
	100.0%		97.1%	
	99.9%		98.8%	
	99.9%		96.4%	
	99.9%		96.9%	
Δυα	06 20/		07.00/	
Avg	90.3%		97.0%	



Figures 6-7. Baseline and Post-Injection TPH-GRO and Sulfate Groundwater Data