Combined Remedies Technologies:

Treatment of a combined CVOC and 1,4-Dioxane Plume in Urban Geology with Combined Remedy Approach

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Environmental Consulting & Remediation

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Site Background/Objectives:

Various remedial strategies have been employed at a former dry cleaner in New Jersey to mitigate combined CVOC and 1,4-Dioxane Plume migrating from overburden to bedrock aquifers.

Remedial activities have included:

In 2017 the removal of contaminated soils and an the injection of sodium persulfate for a "hot spot" area treatment of the CVOCs was conducted with limited success, the injection focused only on the overburden aquifer

In 2018 the groundwater standard for 1,4-Dioxane changed from 10 ppb to 0.04 ppb in NJ, this required the treatment of 1,4-Dioxane at the Site.

In 2020 a set of permeable reactive barriers combining electron donor (3-D Microemulsion) and Sufidated Micro Zero-Valent Iron and bioaugmentation culture (BDI Plus) were installed, these injections treated but the overburden and bedrock aquifers

In 2022 after the levels of CVOC were reduced, an in-situ treatment program for the1,4-Dioxane Plume was conducted

View of the project site and the nearby residential areas

2017

40,000 lb of PersulfOx was injected into a section of groundwater plume containing the highest levels (source material) of CVOCs.
*This injection met with *limited success and was followed up with a multi-tiered injection program in 2020...*

**The 2017 PersulfOx injections yielded CVOC reductions between 33-42%. However, PCE and TCE concentrations rebound over a 2 year period, indicating low permeability soils stored contamination, which was equilibrating with the aqueous phase through matrix back diffusion.*

2020

...which included the treatment of the shallow aquifer utilizing direct push injection of 5,000 gallons of a combination of 3-D Microemulsion and Sulfidated Micro Zero-Valent Iron and bioaugmentation culture (BDI Plus).

The deep aquifer (bedrock) was treated by injecting 4,000 gallons of remediation chemicals into12 injection wells.

2022

An in-situ bioremediation program was conducted in 2022. A bacterial culture was injected to induce metabolic biodegradation of 1,4-Dioxane. The addition of oxygen and propane induced the cometabolic biodegradation of 1,4-Dioxane.

2024

The application of the 3-D Microemulsion and Sulfidated Micro Zero-Valent Iron and bioaugmentation culture (BDI Plus) in 2020 has led to a
99% reduction in CVOCs.
The 1,4-Dioxane in-situ bioremediation program conducted in 2022 has led to a
98% reduction in 1,4-Dioxane.

TODAY

Even though significant design modifications were required to achieve desired objectives,the project was successfully completed on time and within budget.
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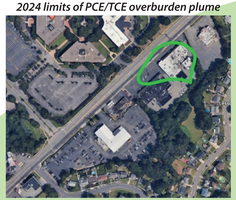
The site is reaching regulatory compliance and project closure is pending.

Injection Trailer

Drilling injection wells

2018 limits of PCE/TCE overburden plume

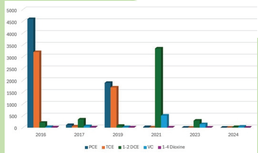
2024 limits of PCE/TCE overburden plume



Overburden Aquifer

The overburden aquifer has received three treatments the first in 2017 with the removal of impacted soil and the application of sodium persulfate, initially this treatment led to a significant reduction of contaminate mass in the shallow aquifer however within a few years the contaminate levels rebounded. The installation of the 2020 permeable reactive barriers were quite successful and decreased the contaminate levels of PCE and TCE below regulatory levels however the 1,4-Dioxane still remained significantly above regulatory standards. A third treatment focused on the 1,4-Dioxane in 2022 has shown a significant reduction in 1,4-Dioxane concentrations.

Year	PCE (ppb)	TCE (ppb)	Cis-1,2-DCE (ppb)	VC (ppb)	1-4 Dioxine (ppb)
2016	4600	5200	210	28	12
2017 Soil Removal and 40,000-pound Persulfate Injection - Overburden Aquifer					
2017	110	51	350	62	11
2019	1900	1700	79	22	10
2020 Installation of Permeable Reactive Barriers					
2021	25	10	3350	512	7.2
2022 In-situ Treatment Program for the 1,4-Dioxane Plume					
2023	3	1	300	145	3.3
2024	>1	>1	24	41	1.8

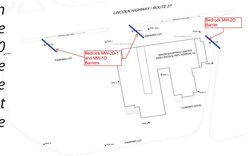
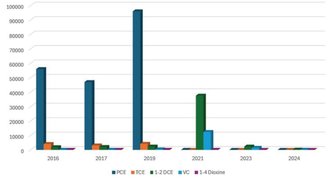


2018 limits of bedrock plume

2024 limits of bedrock plume

Bedrock Aquifer

The bedrock aquifer was not directly treated during the 2017 injection program and accordingly this treatment had limited impacts on the bedrock aquifer. The bedrock aquifer was the target of the 2020 permeable reactive barriers. That treatment decreased the contaminate levels of PCE and TCE below regulatory levels within 4 years.1,4-Dioxane still remained significantly above regulatory standards. A third treatment focused on the 1,4-Dioxane in 2022 has shown an order of magnitude reduction in 1,4-Dioxane concentrations in the bedrock aquifer.



Year	PCE (ppb)	TCE (ppb)	Cis-1,2-DCE (ppb)	VC (ppb)	1-4 Dioxine (ppb)
2016	56000	4100	1900	49	13.8
2017 Soil Removal and 40,000-pound Persulfate Injection - Overburden Aquifer					
2017	47000	3100	2000	57	12.2
2019	96000	4200	2300	350	11.9
2020 Installation of Permeable Reactive Barriers					
2021	25	5.3	37600	12400	11.6
2022 In-situ Treatment Program for the 1,4-Dioxane Plume					
2023	5	2	2300	1425	2.2
2024	ND (<1)	ND (<1)	210	84	1.4