



SODIUM PERMANGANATE OXIDATION TREATMENT

FORMER CLOTHING MANUFACTURING FACILITY NORTHERN KENTUCKY

Client: Environmental Consultant - Louisville
Contaminants: Tetrachloroethene (PCE)
Impacted Matrix: Shallow, Unsaturated Soils
Augmentations: Sodium Permanganate

PROJECT OVERVIEW:

Specialty Earth Sciences, LLC was contracted to provide the rapid reduction of PCE mass present within impacted soils beneath a former clothing manufacturing facility; with a residential closure remedial objective.

In-situ permanganate oxidation technology was selected as the preferred remedial technique based on the chemical and physical properties of PCE, concentration levels present, clay based geology, vertical and horizontal areas of impact, accessibility, and ultimate client objectives.



**CHEMICAL INJECTION
SPECIALISTS**

SITE BACKGROUND:

The property is an irregular shaped tract of land (10.1 Acres) that is developed with a single story masonry and steel-framed building. The building was constructed in 1954 by ***** as a warehouse/ distribution center for men's clothing. The area of the building is approximately 115,000 square feet. The site is surrounded by single-family housing, commercial developments and a school. The building is currently being renovated to allow for use by two commercial establishments.

From 1954 until 2004, site activities included sorting, affixing brand labels, pressing/ ironing, dry cleaning and warehousing of new garments. Prior to 1954, there was no identified use of the site based on readily available information. Commencing in 1954, a dry cleaning machine was utilized to clean new garments prior to distribution. It was reported that the dry cleaning machine, solvent storage drum(s) and a "spotting" table were located within the vicinity of the area of concern.

PERMANGANATE OXIDATION TECHNOLOGY OVERVIEW:

Permanganates are one of the most well recognized chemical oxidants within the environmental industry. They exist as salts and are traditionally available in a sodium or potassium form. Permanganates are commonly used for many industrial purposes including water and wastewater treatment operations. The use of permanganates in ground water treatment applications is a proven, well documented technology.

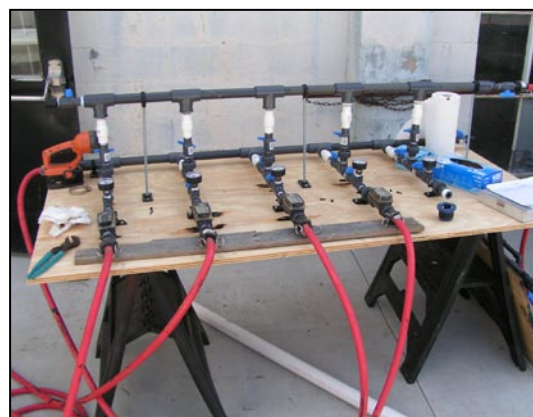
In-situ permanganate oxidation technology relies on the enhanced delivery of a permanganate oxidant compound within the subsurface providing recalcitrant contaminant (e.g. tetrachloroethene, trichloroethene, dichloroethene isomers, and vinyl chloride) remediation; with final benign reaction products of carbon dioxide, water, and inorganic salts (e.g. chlorides) via direct electron exchange processes.

Permanganate is very stable and can persist in an optimum ground water environment for months. The long lasting effects of the oxidant compound coupled with its affinity to react with chlorinated ethene compounds can provide accelerated remediation of impacted sites.

Permanganate oxidant can be successfully applied to the subsurface with minimal risk to the environment or human health and safety.



**DIRECT PUSH INJECTION POINT
WITHIN BUILDING**



**EXAMPLE OF PERMANGANATE
INJECTION MANIFOLD**

PERMANGANATE OXIDATION INJECTION EVENT:

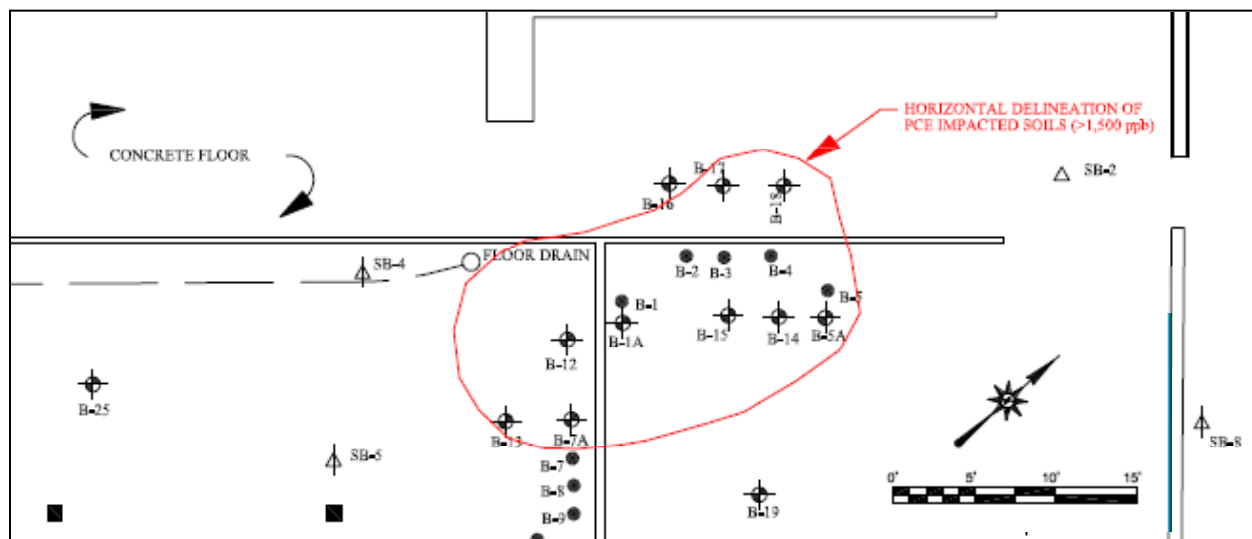
Three (3) separate chemical oxidation injection events were implemented over the course of a 6 month period (January 22, 2008 to July 25, 2008) utilizing various mixtures of sodium permanganate oxidant; in conjunction with direct push and Specialty Earth Sciences delivery techniques. Injection mixtures and concentrations were derived from historical site data, site geology, stoichiometry, chemical supplier correspondence, and experience at similar sites within the region.

A total of 1,784 lbs. of sodium permanganate was injected into the shallow subsurface formation (various vertical depths ranging from 1' - 11' below ground surface) at the former clothing facility.

- January 22, 2008 - Primary Injection Event: 1,328 lbs. of Sodium Permanganate.
- April 3, 2008 - Polishing Injection Event: 228 lbs. of Sodium Permanganate.
- July 25, 2008 - 2nd Polishing Injection Event: 228 lbs. of Sodium Permanganate.

The subsurface formation consists of stiff, dry clay, with intermittent limestone fragments, underlain by weathered bedrock at depths ranging from 8 to 11 ft. below ground surface.

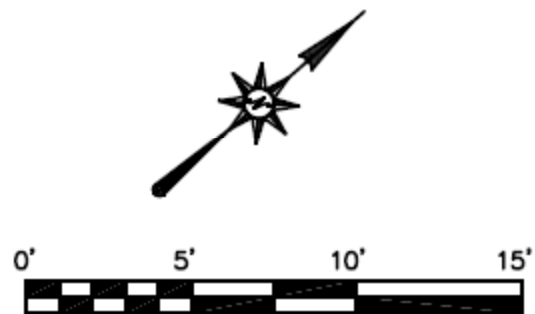
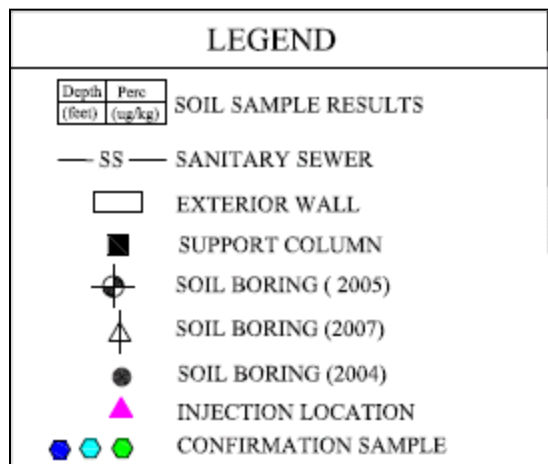
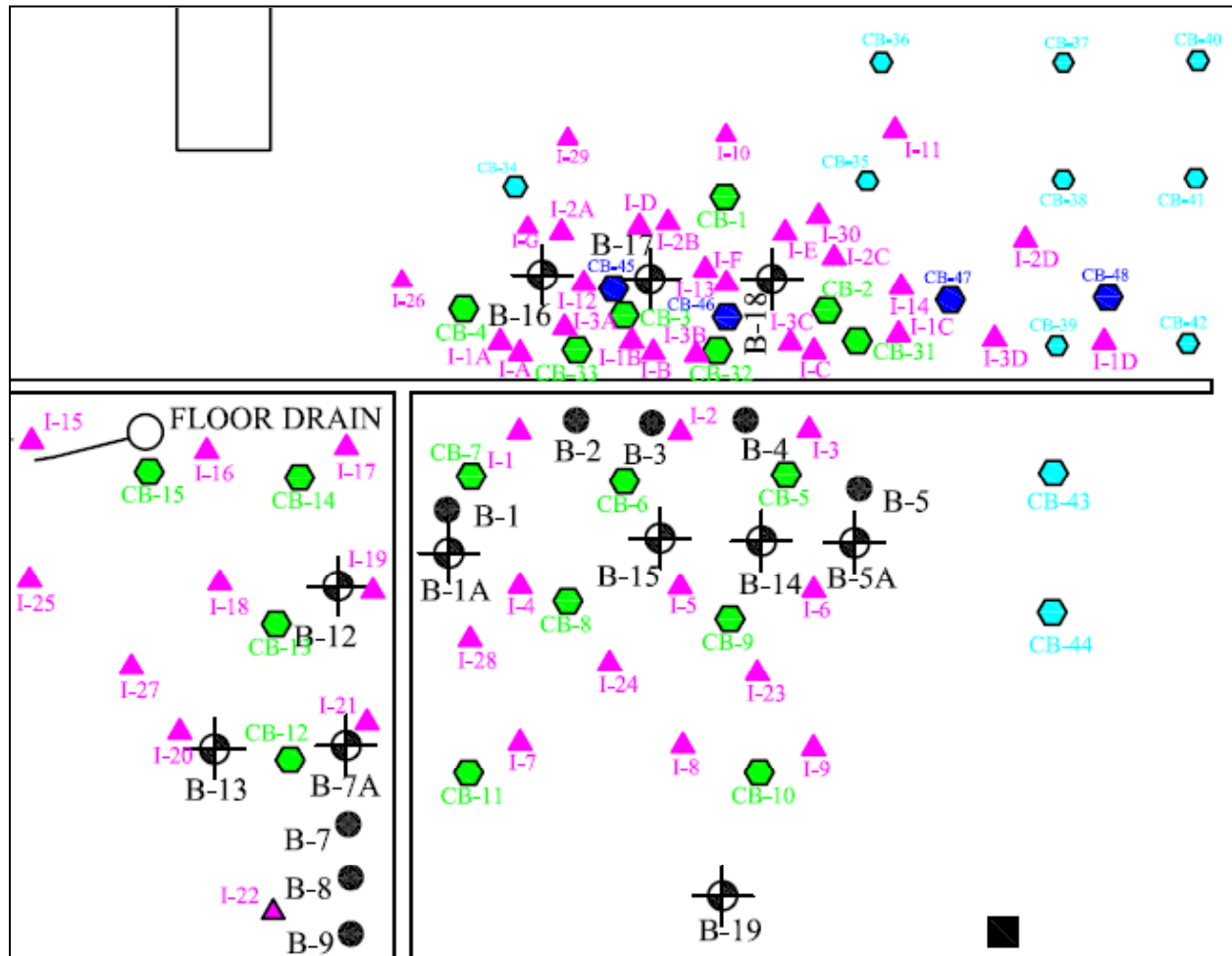
BASELINE TETRACHLOROETHENE (PCE) AREA OF IMPACT:



Boring Location	Soil Sample Date	Encountered Bedrock	Sample Depth (ft)	PCE ($\mu\text{g}/\text{kg}$)
B-1	May 2004	NE	1	32.3
B-2	May 2004	NE	1	4,750
B-3	May 2004	NE	1	4,660
			2	6,090
B-4	May 2004	NE	1	5,870
			3	6,720
B-5A	March 2005	NE	3.0	960 E
			4.0	2,130 E
			5.0	3,920
			9.0	1,710
B-7A	March 2005	NE	3.0	1,260 E
			4.0	692 E
			5.0	1,005
			9.0	5,510
B-12	March 2005	NE	3.0	922 E
			4.0	1,350 E
			9.0	6,290
B-13	March 2005	NE	3.0	753 E
			4.0	911 E
			9.0	2,440
B-14	March 2005	NE	10.8	4,160
B-18	March 2005	NE	5.0	3,560

NOTE: Cells highlighted in yellow exceed USEPA Region 9 Residential Soil Action Level = 1,500 ($\mu\text{g}/\text{kg}$).

PERMANGANATE INJECTION PTS. & CONFIRMATION SOIL SAMPLE LOCATIONS



JANUARY 28, 2008 - POST PRIMARY INJECTION EVENT ANALYTICALS:

Boring Location	Soil Sample Date	Encountered Bedrock	Sample Depth (ft)	PCE ($\mu\text{g}/\text{kg}$)
CB-1	2/29/08	10.0	3 - 4	<5
			9 - 10	52
CB-2	2/29/08	10.5	3 - 4	29
			9.5 - 10.5	4,300
CB-3	2/29/08	11.0	6 - 7	130
			10 - 11	18,000
CB-4	2/28/08	14.0	5 - 6	87
			13 - 14	31
CB-5	2/28/08	NE	2 - 3	6
			3 - 4	690
CB-6	2/28/08	NE	1 - 2	6
			3 - 4	6
CB-7	2/28/08	10.0	3 - 4	50
			8 - 9	230
CB-8	2/28/08	NE	4 - 5	170
			10 - 11	200
CB-9	2/28/08	11.0	4 - 5	340
			10 - 11	36
CB-10	2/28/08	11.0	3 - 4	11
			10 - 11	170
CB-11	2/28/08	10.5	3 - 4	20
			9 - 10	240
CB-12	2/29/08	10.5	1 - 2	<5
			9 - 10	300
CB-13	2/29/08	9.0	2 - 3	22
			8 - 9	51
CB-14	2/29/08	11.0	6 - 7	290
			8 - 10	110
CB-15	2/29/08	10.0	6 - 7	<5
			9 - 10	41

NOTE: Cells highlighted in yellow exceed USEPA Region 9 Residential Soil Action Level = 1,500 ($\mu\text{g}/\text{kg}$).

AUGUST 11, 2008 - POST 2ND POLISHING INJECTION EVENT ANALYTICALS:

Boring Location	Soil Sample Date	Encountered Bedrock	Sample Depth (ft)	PCE (µg/kg)
CB-45	8/11/08	11.0	10 - 11	1,300
CB-46	8/11/08	11.0	11 - 12	820
CB-47	8/11/08	11.0	11 - 12	3,600
CB-48	8/11/08	11.0	10 - 11	900

NOTE: Cells highlighted in yellow exceed USEPA Region 9 Residential Soil Action Level = 1,500 (µg/kg).

Post 2nd polishing injection event samples were collected from the same vertical and horizontal geological locations, as related to the January 28, 2008 confirmation samples CB-2 and CB-3. Illustrated in the confirmation sample figure found on page 5.

PERMANGANATE OXIDATION TREATMENT EFFICACY SUMMARY:

Fifty-one (51) soil samples were collected from thirty-three (33) soil borings located within the PCE area of impact. Aggressive performance sampling was considered an important project aspect, to provide sufficient data necessary in evaluating the overall permanganate oxidation efficacy.

Combined laboratory analytical results demonstrated over a 95% reduction (approx.) in the PCE area of impact as defined by USEPA action levels for residential soils.