Drycleaner Site Profiles

Contemporary Cleaners, Orlando, FL

Site Description

This is an active perchloroethylene (PCE) drycleaning facility that has been in operation since 1974. It is located in a shopping center in a commercial setting.

Site Hydrogeology

Depth to ground water: 6-8 ft. bgs.

Lithology/subsurface geology: Fine-grained quartz sand, 25-30 ft (upper surficial aquifer); clay, 1-12 ft; fine-grained silty sand and sandy clay, 20-25 ft. (lower surficial aquifer)

Conductivity: 1.3 ft/day (upper surficial aquifer); 65 ft/day (lower surficial aquifer)

Gradient: 0.01 ft/ft (upper surficial aquifer); 0.003 ft/ft (lower surficial aquifer)

Groundwater Contamination

Contaminants present: PCE, trichloroethylene (TCE), cis 1,2 dichloroethylene (cis 1,2-DCE), trans 1,2-DCE, vinyl chloride (VC)

Highest contaminant concentrations: 3300 µg/L (PCE), 4,980 µg/L (TCE), 4000 µg/L (cis 1,2-DCE), 130 µg/L (trans 1,2-DCE), 2,900 µg/L (VC)

Deepest contamination: 54 ft. bgs.

Plume size: 3.2 acres (as defined to regulatory MCLs)

DNAPLS present: N/A

Soil Contamination

Not reported

Description of Remediation Scenario

Technologies Used:
Bioremediation
Hydrogen Release Compound ® (HRC)

Cleanup goals:

Remediation technology or technologies used: *in situ* bioremediation with Hydrogen Release Compound (HRC)

Why technology or technologies used:

Final remediation scenario: Treatment area was 14,600 ft^2 (within PCE 1 mg/L isopleth) in the upper surficial aquifer. Treatment consisted of injection, using direct push technology, at 144 locations, spaced on 10-ft centers on an 80-x-180-ft grid at depths from 5-30 ft. bgs. A volume of 2.45 gal of HRC (22.5 lb Or 0.9 lb/ft) was used per injection point, resulting in use of a total of 6,810 lb of HRC.

Results

After 152 days, ground water monitoring indicated that mass reduction achieved for contaminants was:

PCE - 96% cis 1,2-DCE - 36%
TCE - 51% VC - 58%

Costs

Site Assessment:

Design and Implementation:

O&M:

Total Costs: $ 127,000, including $ 27,197 for HRC product

Lessons Learned

1. Underground Injection Control variance required.

2. Recommend requiring complete delineation of underground utilities prior to injection activities. Use of geophysical survey (GPR and electrical methods) is very helpful to ensure underground utilities are not encountered or damaged during injection.

3. A thorough understanding of site geochemistry is required to understand effect of HRC on groundwater. Acids released form the breakdown of HRC appeared to lower the pH of groundwater in certain portions of the aquifer to levels that were not conducive to continued reductive dechlorination of contaminants. The problem appears to be transient, as the pH continues to increase over time. Reformulation (reduction in concentration) of HRC should minimize this problem. The buffering capacity of the predominantly quartz sand aquifers is limited in the presence of excess acids produced from HRC. Aquifers with different sediment composition will respond differently to the HRC.

4. Prior to injection, the containers of HRC were warmed by placing them in the boiler room of the drycleaning facility. This reduced the HRC viscosity and

facilitated injection.

5. Regenesis offers design and onsite assistance and instruction during injection activities. Their guidance was very useful during the initiation of the project.

Site Specific References

Not Provided

Contacts

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This profile last updated: November 26, 2001

Drycleaner Site Profiles

Decorah Shopping Center Drycleaners, Decorah, WI

Site Description

The Decorah Shopping Center drycleaners is an active facility that has operated in a commercial setting since 1974. A different drycleaner operated on the site between 1965 and 1969. Investigations revealed the presence of chlorinated compounds in the soil and groundwater. The contamination has migrated off-site, but has not been known to impact any drinking water wells. Although the source of contamination has not been definitely identified, investigations suggest that perchloroethylene (PCE) was released through the floor drains and sewer system. PCE was likely released over 15 years ago. The underlying statutory authority for the cleanup is Chapter 292 of the Wisconsin Statutes, also known as the "Spill Law." The investigation and remediation activity at the site have qualified for financial reimbursement through the Wisconsin Drycleaner Environmental Response Program.

Site Hydrogeology

Depth to ground water: 6-10 ft. bgs.

Lithology/subsurface geology: Light brown to black sandy silt and silty sand with varying amounts of clay, grade-5 ft. bgs.
Brown to gray fine to medium grained sand, 5-11 ft. bgs.
Brown to gray fine silty sand and sandy silt with a little silty clay, 11-24 ft. bgs.
Gray silty clay, 24-28 ft. bgs.

Conductivity: about 3.7 ft/day

Gradient: Average is 0.028 ft/ft, upward

Groundwater Contamination

Contaminants present: PCE, trichloroethylene (TCE), 1,2 dichloroethylene (1,2-DCE)

Highest contaminant concentrations: 25 µg/L (PCE), 0.39 µg/L (TCE), less than 1.0 µg/L (1,2-DCE)

9-11 ft. bgs. with no significant vertical PCE migration

Plume size: About 225 ft. long and 35 ft. wide.

DNAPLs present: No

Soil Contamination

Contaminants present: PCE

Highest contaminant concentrations: 1,500 µg/kg (PCE)

Description of Remediation Scenario

Technologies Used:
Bioremediation
Natural Attenuation
Hydrogen Release Compound ® (HRC)
Capping

Cleanup goals: Remediation activities should remove the contaminant source, stabilize plume migration, and minimize long-term threats posed to human health and the environment. The ultimate cleanup goal is to reduce contaminant concentrations to the groundwater quality standards established in the Wisconsin Administrative Code, NR140. The enforcement standard for PCE in groundwater is 5 µg/L. A site-specific residual contaminant level (SSRCL) has been established for PCE concentrations in soil. The SSRCL for PCE based on the protection of groundwater is 2,864 µg/kg. (This assumes a reduction in infiltration due to the presence of an asphalt cap.) The most conservative SSRCL for PCE to minimize excess risk associated with the direct contact exposure pathway is 8,300 µg/kg.

Remediation technology or technologies used: Natural attenuation and capping (soil). Cap has yet to be installed.
Natural attenuation and Hydrogen Release Compound [HRC] (groundwater). Groundwater technologies not yet implemented.

Why technology or technologies selected: The technologies selected offer cost-effective ways to reduce solvent contamination. Contractors believe that site-specific considerations, such as the relatively wide-spread, relatively low-concentration plume and access restrictions associated with off-site residential properties, render HRC a technically sound and cost effective method.

Final remediation design: Contractors expect to install an asphalt-surface soil cap to reduce infiltration of PCE into the groundwater. This cap should, if properly maintained, minimize potential direct contact risk of PCE exposure. Upon receipt of necessary permit waivers, contractors expect to inject HRC in the upgradient portion of the plume using direct-push soil probes. Contractors currently estimate that they will need to inject about 3,000 lbs. of HRC via 20 delivery points to create anaerobic, reducing conditions that would migrate advectively with groundwater flow and dechlorinate the contaminant plume.

Results

Natural Attenuation: Six rounds of quarterly sampling data indicate that PCE concentrations have been generally stable, ranging from 2.5-18 µg/L in groundwater and from less than 25-1,400 µg/kg in soil.

The upward hydraulic gradient and relatively high horizontal gradient likely minimize the potential vertical migration of PCE. The plume has migrated to other properties, however. Contractors expect to continue remediation activities for two more years.

Costs

Site Assessment:

Design and implementation:

O&M:

Total costs:

Lessons Learned

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Site Specific References

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Contacts

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This profile last updated: November 26, 2001

Drycleaner Site Profiles

Dixie Cleaners, Jacksonville, FL

Site Description

Dixie Cleaners is an inactive perchloroethylene (PCE) drycleaning facility that operated from 1956 to 1995. The facility is located in a strip shopping center located in a commercial/
residential setting. High concentrations of PCE are located south of the southeastern corner of the facility and nearby.

Site Hydrogeology

Depth to ground water (bgs): 2 ft bgs

Lithology/subsurface geology: Silty, fine-grained sand, surface-18 ft bgs.
Clayey fine-grained sand, 18-30 ft bgs
Limestone, 30-32 ft bgs
Stiff clay, beyond 32 ft bgs

Conductivity (ft/day): (shallow sands) 0.31 ft./day; (clayey sands) 0.23 ft./day

Gradient (ft/ft): 0.009

Groundwater Contamination

Contaminants present: PCE, trichloroethylene (TCE); cis 1,2 dichloroethylene (cis 1,2-DCE); trans 1,2-DCE; vinyl chloride (VC)

Highest contaminant concentrations: 5,200 µg/L (PCE), 4,100 µg/L (TCE), 7,500 µg/L (cis 1,2-DCE), 160 µg/L (trans 1,2-DCE), 1,100 µg/L (VC)

Deepest significant ground-water contamination:
33 ft

Plume size: 175 ft x 350 ft (defined to MCLs)

DNAPLs present: PCE concentrations of nearly 3.5% of aqueous solubility indicate that residual DNAPL may be present in groundwater.

Soil Contamination

Contaminants present: PCE

Highest contaminant concentrations: 0.480 mg/kg (PCE)

Description of Remediation Scenario

Technologies Used:
Bioremediation
Hydrogen Release Compound ® (HRC)
Natural Attenuation
Bioremediation

Cleanup goals: Maximum Contaminant Levels (MCL's) - PCE= 3.0 µg /L, TCE= 3.0
µg/L, cis 1,2-DCE= 70 µg/L, trans 1,2-DCE= 100 µg /L, vinyl chloride= 1.0 µg/L

Remediation technology or technologies used: *In situ* Bioremediation using Hydrogen Release Compound (HRC™)

Why technology or technologies selected: Groundwater analytical and geochemical data indicated that natural attenuation of chlorinated compounds was occurring at the site. Conditions were amenable to injection of HRC™ as a passive low-cost enhancement to naturally occurring biodegradation of contaminants.

Date implemented: June 2000

Final remediation design: Groundwater remediation will consist of: 1) *in situ* bioremediation using HRC™, for the plume above Natural Attenuation Default Source Concentrations (NADSC), e.g. 300 µg/L PCE; and 2) monitored natural attenuation for the plume contaminant concentrations below NADSC's.

No pilot test was conducted. The technology was applied on a full-scale basis to all areas with contaminant concentrations above natural attenuation default limits. Approximately 22,000 pounds of HRC™ were injected using the following design:

175 locations injected on 10 ft centers, but injection points were shifted 5 ft on every other north-south transect
Size: 18,400 ft^2
Depth: 25 to 30 ft bgs
Volume: 5 lb/ft of vertical saturated zone
Pressure: 1,500 lb/in^2

159 injections completed to 25 ft bgs
16 injections completed to 30 ft bgs
Days to Complete: 25

In addition to existing monitoring wells, 16 micro-wells were installed to monitor the effectiveness of the remedial action. The site has a total of 30 monitoring

wells. The monitoring schedule -- one month, four months, six months, one year -- will continue.

Results

The data show that the reductive dechlorination process has accelerated in the aquifer. Approximately one year since the injection of HRC™, dissolved-phase chlorinated hydrocarbon concentrations are significantly lower. During the last sampling episode PCE was detected in two monitoring wells in the intermediate and deep zones at a concentration of 38 µg/L and 42 µg/L respectively. TCE continues to degrade in the in the shallow, intermediate and deep zones. Between April 1999 and July 2001, TCE reductions ranging from 33-99% were seen in six key monitoring wells (MW007, MW011, MW015,MW027, MW029, MW032).

Concentrations of TCE, DCE and VC within the source area still exceed regulatory standards. Downgradient migration of contaminants does not appear to have occurred. Contaminant concentrations in the intermediate zone remain high, but have noticeably decreased since application. DCE and VC continue to accumulate. Future activities may include implementing some type of *in situ* aerobic bioremediation process. An *in situ* methanotrophic bioremediation system has been recommended for this site.

Costs

Site assessment: $55,000

Design and implementation:
Well Installation & Baseline Sampling: $32,000
HRC Product: $150,000
HRC Injection (labor, drilling, & equipment): $80,000
Monitoring (1st and 2nd events), Reporting & IDW: $38,000

O&M:

Total costs (only completed sites):

Lessons Learned

1. Delineate location of underground utilities prior to injection activities using GPR and electrical methods.
2. Inform all property owners concerning the extent of injection activities and coordinate with site property owners to ensure uninterrupted access to the property.
3. A thorough understanding of site geochemistry is required to understand effect of HRC™ on groundwater.
4. Recommend utilizing HRC™ vendor for on-site supervision of injection. They bring needed experience to the job.
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Site Specific References

1. Harding Lawson Associates Contamination Assessment Report-12/97
2. Harding Lawson Associates Remedial Action Plan Detailed Design-12/99
3. Harding Lawson Associates HRC™ Injection Report-7/00
4. Harding ESE HRC™ 2nd Quarterly Report-3/01
5. Remediation Action Using HRC™ under a State Dry Cleaning Program, Watts, Jaynes, Farrell, June 2001

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This profile last updated: November 26, 2001

Drycleaner Site Profiles

Hayden Island Cleaners, Portland, OR

Site Description

This is an active perchloroethylene (PCE) drycleaning facility that has been in operation since 1975. It is located in a commercial setting adjacent to the Columbia River.

Site Hydrogeology

Depth to groundwater: 6-8 ft. bgs.

Lithology/subsurface geology:
Silty sand, 20-40 ft (upper surficial aquifer)

Conductivity: not reported

Gradient: 0.001 ft/ft (upper surficial aquifer)

Groundwater Contamination

Contaminants present: PCE, trichloroethylene (TCE), cis 1,2-dichloroethylene (cis 1,2-DCE)

Highest contaminant concentrations: 1,230 mg/L (PCE), 1 mg/L (TCE), 3.4 mg/L (cis 1,2-DCE)

Deepest contamination: Chlorinated solvents present in regional groundwater aquifer, though not attributed to site.

DNAPLs Present: none reported

Soil Contamination

None reported

Description of Remediation Scenario

Technologies Used:
Hydrogen Release Compound ® (HRC)
Bioremediation

Cleanup goals:

Remediation technology or technologies used:
In situ Bioremediaton with Hydrogen Release Compound (HRC™)

Why technology or technologies used:

Final remediation design: Treatment area was 200 ft^2 (two "treatment" walls) in the upper surficial aquifer. A total of 2,310 pounds of HRC™ were injected, using direct push technology, at 42 locations, spaced on 10-ft centers (two 2-x-80-ft grid walls) at depths of 25-40 ft. bgs. 3.2 lbs/ft of HRC™ were used at each injection point.

Results

After 1 yr and 3 mos, an 87% mass reduction in PCE was achieved. Substantial increases of daughter products TCE, cis-1,2-DCE were observed.

Costs

Site Assessment:

Design and Implementation:
HRC™ product -- $ 14,000 ($6.00/lb)
HRC™ Install -- $45,000
HRC™ Groundwater Monitoring -- $20,000

O&M:

Total Costs:

Lessons Learned

1. Location of site next to river complicated the hydrogeology of the site. River stage and tidal fluctuations accounted for flow reversals at the site. In addition, the timeframe of the injection occurred during the slowest groundwater transport period which required several months for HRC™ enhanced remediation to be noticed.

2. HRC was injected along two transects to account for groundwater flow reversals. The injections were designed to provide an engineered "treatment wall" or zone prior to off-property and surface water discharge migration.

3. A steam-cleaner is very helpful with clean-up of HRC product. Cleanup should commence the same day as injection activities. Waiting until the following day or at the end of injection event necessitated additional labor/time.

4. Analysis of acid in water sooner would have helped facilitated the amount of HRC remaining in the subsurface.

5. Regenesis offers onsite assistance and instruction during injection activities. Their guidance was very useful during the initiation of the project.

Site Specific References

Not Provided

Contacts

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This profile last updated: November 26, 2001

Drycleaner Site Profiles

Springdale Cleaners, --, OR

Site Description

Springdale Cleaners is an active dry cleaning facility located in a strip mall. The local land use is a mix of high density residential and commercial development. Residents of a neighboring apartment building observed condensed water leaking onto a landscaped planter in the area between the strip mall and the apartment complex. Subsequent investigations in 1998 revealed high levels of perchloroethylene (PCE) in the soil and groundwater at Springdale Cleaners. Additional investigations conducted in May 1999 identified high levels of PCE in the shallow groundwater. The most likely source of PCE contamination is the leaking sewer line extending out of Springdale Cleaners. Investigation officials have confirmed that the drycleaner disposed of wastewater in a floor drain, which led to the sewer line. PCE likely accumulated in low points of the sewer main and leaked into the soil and groundwater. The investigation also indicated that dissolved PCE may have come out of solution and formed DNAPL contamination. The accumulated contamination would then provide a continued source of soil and groundwater contamination even after disposal to the sewer system ceased.

Site Hydrogeology

Depth to ground water: About 20 ft. bgs.

Lithology/subsurface geology: Sandy, silty clay, about 12 ft. bgs.
Grey, silty clay, 23 ft. bgs. (maximum)

Conductivity: Very slow due to the tight soils; no value available.

Gradient: About 0.0001 ft/ft

Groundwater Contamination

Contaminants present: PCE, trichloroethylene (TCE), cis-1,2 dichloroethylene (cis-1,2-DCE), trans-1,2-DCE, vinyl chloride (VC).

Highest contaminant concentrations: 120,000 µg/L (PCE), 8,300 µg/L (TCE), 740 µg/L (cis-1,2-DCE), 390 µg/L (trans-1,2-DCE), 1,920 µg/L (VC)

Deepest significant ground-water contamination:
Not yet determined.

Plume size: About 300 ft. by 150 ft.

DNAPLs present: Although no DNAPLs have been detected or observed at the

site, extremely high concentrations of chlorinated compounds may indicate the presence of DNAPL. Groundwater sampling reveals PCE concentrations exceeding 1% saturation for pure-phase PCE.

Soil Contamination

Contaminants present: None reported

Highest contaminant concentration: None reported

Description of Remediation Scenario

Technologies Used:
Bioremediation
Hydrogen Release Compound ® (HRC)

Cleanup goals: The Oregon Department of Environmental Quality (DEQ) seeks to remove the contaminant mass from the source area and protect or mitigate threats to human health or the environment. Contractors conducted a treatability study to determine whether Hydrogen Release Compound (HRC) is a feasible technology for the site. Monitoring will occur on a quarterly basis for at least 2-3 years to evaluate technology effectiveness. DEQ will then select a final remedy that reduces VOC contamination below risk based concentration levels.

Remediation technology or technologies used: HRC (original and slow-release formulation evaluated)

Why technology or technologies selected: Technologies like soil vapor extraction would be unsuitable for this confined site because there is poor access. The Springdale site contains high concentrations of contaminants in a moderately small area. The soil is shallow and soft, and can therefore be readily probed. HRC can be applied effectively and cheaply. The slow-release HRC should provide lower concentrations of lactate over a longer period. The slow release may be ideal for sites that contain high chlorinated solvent concentrations or when remediation officials seek to decrease the number of injection events.

Final remediation design: In the treatability study, contractors injected, using direct push technology, each type of HRC in a separate area. Total quantity used was 2,310 lbs. The original HRC formulation was injected at 22 points, each at a rate of about 4 lbs/ft. The slow-release HRC was injected at 5 points, each at a rate of 10 lbs/ft.

Results

The groundwater monitoring results indicate that both slow-release and ordinary HRC injections have enhanced the degradation of PCE to daughter products. Several wells have shown significant reductions in PCE and TCE with corresponding increases in the concentrations of degradation products like cis-1,2-DCE, trans-1,2-DCE and VC. It is unknown whether PCE concentrations will

rebound when the HRC solution has been depleted. DEQ anticipates that additional HRC injections would be necessary to ensure continued degradation of the PCE and its intermediate breakdown projects.

DEQ is currently evaluating groundwater sampling results to determine whether to apply this technology to the entire plume. Groundwater monitoring is conducted on a quarterly basis to track attenuation progress and monitor potential migration of contaminants. Air sampling occurs periodically to ensure that levels of PCE, TCE and degradation products, including VC, do not reach harmful concentrations.

Costs

Site assessment: $54,900

Design and implementation: $43,700 (6 rounds of HRC pilot study monitoring in first year); $75K (second year). This includes O&M

O&M:

Total costs:

Lessons Learned

1. HRC appears to be a promising, cost-effective approach for residual DNAPL at this site.
2. Concentrations of PCE in groundwater significantly decreased within six months following injection of HRC. This may be a useful technology where moderately fast reduction of groundwater contamination (PCE) is desired.
3. HRC likely is most cost effective at sites where it can be applied using direct push technology
4. HRC is more cost effective and/or implementable then other technologies such as SVE and excavation at sites where access is limited due to adjacent structures.
5. A common concern with HRC is that while degradation of PCE and TCE may occur, the "risk-shift" to daughter products of cis-DCE and vinyl chloride may complicate cleanup and closure of sites. However, this does not appear to be problematic at Springdale Cleaners as degradation of these daughter products appears to be occurring. Also, indoor air testing has not detected vinyl chloride even though its concentration in groundwater has been detected as high as 2,870 ug/L.
6. So far during the 1.5 year duration treatment study, the PCE concentrations have not rebounded.
7. It is unclear how much time will be necessary before complete cleanup by HRC can be achieved.
8. In evaluating the cost of implementing this technology, monitoring costs should be included as these costs can be significant.

Site Specific References

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Contacts

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This profile last updated: November 26, 2001

Drycleaner Site Profiles

Washington Square Mall Dry Cleaners, --, WI

Site Description

The Washington Square Mall Dry Cleaners operated in mixed commercial and residential setting from the 1970s until 1998. The drycleaners relied on perchloroethylene (PCE) solvent as a cleaning agent in the operations. The drycleaner operations likely contributed to the chlorinated compound contamination in the soil and groundwater through releases into the floor drains.

The underlying statutory authority for the cleanup was Chapter 292 of the Wisconsin Statutes, also known as the "Spill Law." The investigation and remediation activity at the site qualified for financial reimbursement through the Wisconsin Drycleaner Environmental Response Program. Contractors completed remediation activities, and Wisconsin Department of Natural Resources (DNR) granted closure to the site in January 2001.

Site Hydrogeology

Depth to ground water: 12-13 ft. bgs.

Lithology/subsurface geology:
Uppermost Unit : Surficial top soil and small-medium-sized gravel (0.2-2.0 ft) or concrete (0.2-0.4 ft) underlain by medium, well sorted gravel (0.5-1.0 ft)

Silty clay unit: Light brown to dark brown to gray sandy clays to clayey silts, clays, and silty clays, 10-17 ft. bgs., with trace amounts of small-to-medium gravel

Conductivity: 2.83 ft/day

Gradient: About 0.015 ft/ft

Groundwater Contamination

Contaminants present: PCE, Trichloroethylene (TCE)

Highest contaminant concentrations: 2,000 µg/L (PCE), 94.9 µg/L (TCE)

Deepest significant ground-water contamination:
20 ft. bgs.

Plume size: Approximately 15,000 sq. ft. in plan size; extent of impacted groundwater, about 100 ft by 200 ft

DNAPLs present: No

Soil Contamination

Contaminants present: PCE, TCE, 1,2-dichloroethylene (1,2-DCE)

Highest contaminant concentrations: 80,000 µg/kg (PCE), 110 µg/kg (TCE), 870 µg/kg (1,2-DCE)

Description of Remediation Scenario

Technologies Used:
Removal
Natural Attenuation
Bioremediation
Reductive Dechlorination

Cleanup goals: The remedial goals include the removal of as much of the source as possible and restore groundwater quality according to the enforcement standards established NR 140 Wis. Adm. Code. A site-specific residual contaminant level (RCL) of 25 mg/kg was established for soil.

Remediation technology or technologies used:
Natural Attenuation and Removal and Off-site Disposal (soil)
Natural Attenuation, Reductive Dechlorination,
Wastewater Treatment Plant (groundwater)

Why technology or technologies selected: Most effective, feasible methods to remove the source, and to inhibit further migration of chlorinated compounds in groundwater. Access limitations and the low permeability of the silty clay unit influenced this decision. The carbon amendment technology requires little maintenance, and can be readily implemented. Carbon injection can be initiated at a slow rate, and the effects can be monitored to assess the adequacy of the injection rates utilized.

Final remediation design: PCE-impact soil, to a depth of 14 ft. bgs., was excavated and transported to a landfill.

Contactors encountered groundwater, from precipitation and surface run-in during excavation or from the sand-seam that was penetrated, during the soil removal activity and pumped and discharged it to the sanitary sewer. Contractors used carbon injections (molasses) to promote enhanced reductive dechlorination of PCE. 182 Geoprobe injection points were used in a grid-like pattern across the estimated area of impact, sited to intersect the sand seam (12-17 ft. bgs.). A Geoprobe rod was initially used as a well screen and riser for injection of the dilute molasses solution. After 15 Geoprobe borings had been completed, the rod was replaced with a 1-inch temporary PVC pipe. Bentonite pellets were then used to seal the temporary wells. 15-25 gal. of molasses and 25 gal. of water/gal. of

molasses were injected during the first event. 10 wells were installed after the first event to facilitate performance monitoring within limits of the plume. Five follow-up injections of the same size were completed over a six-month period.

Results

Soil removal: Contractors removed 3,125 tons of soil, and disposed of it in an off-site landfill. PCE concentrations were below the soil RCL of 25 mg/kg following the excavation.

Groundwater Remediation: Sampling results taken from a 20-month period following completion of soil remediation activities and the initial carbon injection event reveal PCE concentrations at non-detectable levels. An expected increase in PCE breakdown products, such as cis-1,2-DCE and vinyl chloride (VC), occurred. VC concentrations ranged from 0.37 µg/L to 88 µg/L, TCE concentrations occurred at 15 µg/L, and cis-1,2-DCE occurred at 300 µg/L. Observed concentrations of these PCE breakdown products over time suggested that residual contaminant levels would steadily decrease as the reductive dechlorination process continued. Concentrations of the non-toxic, innocuous end-products of dechlorination, ethane and ethene, were detected in four monitoring wells at approximately 1-2 orders of magnitude higher than the ethane and ethene concentrations in wells on the fringe of the plume. This was viewed as evidence that the reductive dechlorination process was going to completion.

Site is now closed.

Costs

Site assessment: --

Design and implementation: --

O&M:--

Total costs: --

Lessons Learned

1. The thorough site investigation made it easier to approve the remediation technologies. The knowledge of the plume dynamics increased the efficiency of the decision making process.
2. The source removal (soil) and active groundwater treatment facilitated a timely closure. This avoided years of groundwater monitoring.
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Site Specific References

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Contacts

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