**Site Summary**

CL-Out® bioaugmentation was implemented to remediate a mixture of chlorinated solvents in soil and ground water at a former chemical packaging company. The contamination resulted from incidental spills over many years of operations. After the extent of contamination was determined, a pump and dispose containment system was installed in 1993 to mitigate further off-property contaminant migration. CL-Out bioaugmentation was initiated in 2001 to remove the source of contamination. After six months of monthly treatment the contamination levels met the applicable drinking water standards.

**Geology and Hydrogeology**

The site is set in a complex fluvial and glacial region where tills and fluvial channel deposits are interbedded. The surface material is mainly industrial fill over silty clay till. Perched ground water is present in a sandy gravel deposit in a former fluvial channel at the base of the fill and top of the till.

The perched ground water zone is the main conduit for contaminant migration. The perched ground water zone is approximately 4 feet thick. The hydraulic conductivity of the deposits was measured as 10-4 cm/sec. The flow direction was irregular and controlled by the former channel boundaries.

**Contamination**

The volume of soil contamination in the vadose zone source area was estimated to be 2,200 tons. The main contaminants were 1,1,1-TCA, PCE and TCE. The maximum soil concentrations were: PCE 1.1 mg/kg, TCE 2.2 mg/kg, 1,1,1-TCA 1.2 mg/kg, and 1,1-DCE 0.003 mg/kg.

The ground water plume containing the solvents was estimated to be 12,000 square feet. The main contaminants and maximum concentrations were: 1,1,1-TCA 2.7 mg/L, PCE 0.11 mg/L, and TCE 0.58 mg/L, with some daughter products including 1,2-DCE 2.9 mg/L, vinyl chloride 0.17 mg/L and 1,1-DCA 0.12 mg/L.

**Remediation**

CL-Out® was applied by injecting a concentrated microbial solution into the soil and ground water in the source. Six pairs of on-inch diameter injection points were installed with one injection point competed in the shallow soil and one penetrating to the perched ground water. The CL-Out® was allowed to flush through the soil and aquifer and follow the migration path of the contaminants.

The six injections were completed between February and November 2001. The volume injected ranged between 275 and 385 gallons of CL-Out solution per event.

**Results**

Following CL-Out® bioaugmentation, ground water monitoring in an untreated monitoring well was used to track the remediation results. The concentration of all contaminants decreased quickly and steadily after the first application. In six months, all contaminants except vinyl chloride were remediated to the drinking water standard. There was an unexplained rebound in vinyl chloride concentrations, but the concentration was reduced to acceptable levels that were maintained during quarterly post treatment monitoring. The following table summarizes the ground water sampling results.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Contaminant | Pre-treatment Sampling  |  | Progress Sampling  |  |  |  | Post-Treatment Sampling |  |
|  | 2/20/01 | 2/9/01 | 3/22/01 | 6/1/01 | 8/21/01 | 10/16/01 | 12/11/01 | 2/28/01 |
| 1,1,1-TCA | 2.7 | 1.3 | 1.4 | 0.62 | 0.086 | 0.015 | 0.015 | 0.007 |
| PCE | 0.11 | 0.19 | 0.92 | 0.010 | BDL | BDL | BDL | BDL |
| TCE | 0.58 | 0.26 | 0.068 | 0.012 | BDL | BDL | BDL | BDL |
| c-1,2-DCE | 2.9 | 5.9 | 4.7 | 2.8 | 0.19 | 0.010 | 0.091 | BDL |
| 1,1-DCA | 0.12 | 0.38 | 0.28 | 0.19 | 0.15 | 0.066 | 0.059 | 0.038 |
| VC | 0.17 | 0.34 | 0.11 | 0.57 | 0.10 | 0.008 | 0.1 | BDL |

The treatment was successful in reducing the concentrations of a range of chlorinated solvents in the source area and down gradient plume. Overall, the application of bioremediation achieved the remediation goals quickly and cost effectively making the property redevelopment possible.

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