Injection Biobarrier to Remediate Perchlorate in Groundwater

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The anaerobic reduction of perchlorate via stimulated indigenous bacteria is becoming a widely accepted method for the in situ treatment of perchlorate-impacted groundwater. A full-scale, integrated containment/treatment bioremediation system was designed and constructed in August 2003 as an interim measure to address storm water and groundwater prior to migration away from a known perchlorate source area within an industrial Facility. The system includes an in situ injection biobarrier system to stimulate the indigenous bacteria to degrade perchlorate-impacted shallow groundwater prior to migration from the source area. This component of the interim measure is based on the success of a pilot test that was conducted at the same location in 2002.

Two rows of 14, one-inch injection points, are positioned on 10 to15-foot centers, thus creating an in situ permeable injection biobarrier approximately 270 feet long by 30 feet wide and 25 feet deep that effectively cuts off the plume emanating from the source area. The injection points were installed using direct-push methods. Calcium Magnesium Acetate (CMA) at a 5 to 8% solution in area pond water is injected into the points on a monthly to quarterly basis. The CMA substrate is a highly soluble and mobile substrate that is utilized to provide the largest biobarrier possible away from the injection points. Only three of the 28 total points have failed over the past 3 years as a result of short-circuiting to the surface but the overlapping configuration of the two rows compensates for the loss of those 3 points.

Monitoring of the system is accomplished with three up water table gradient monitoring wells and five down water table gradient wells. Monthly groundwater monitoring includes the following: perchlorate, chlorate, acetate, dissolved oxygen, pH, oxidation-reduction potential, dissolved organic carbon, ferrous iron and nitrate.

Field and laboratory data indicate that the injection of the substrate is maintaining an anaerobic environment in groundwater that is conducive to the reduction of perchlorate. Dissolved Oxygen (DO) is consistently below 1 mg/L in the downgradient monitoring points with the background DO level at 2-4 mg/L. Nitrate concentrations at the downgradient monitoring points are at or below the limit of detection and perchlorate concentrations at the closest monitoring point (approximately 90 feet) have been reduced from approximately 5 mg/L to about 0.1 mg/L. That indicates a 98% reduction of perchlorate in groundwater. The reduction daughter product chlorate, which is difficult to detect due to its very short half-life, has also been detected several times in that 3-year period. Acetate has also been detected at the same location, at concentrations as high as 1 mg/L, indicating that the barrier may extend at least to that monitoring location.

It is anticipated that, given the continued reduction of perchlorate in groundwater, the maintenance of the anaerobic environment will only require semi-annual to annual substrate injections until achieving risk-based perchlorate concentrations that are protective of human health and the environment.