

Enhanced bioremediation of gasoline contaminated groundwater in Finland by injection of humic acids

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A gasoline –contaminated groundwater site in Southern Finland was remediated by means of enhanced bioremediation using humic acids as enhancer. In enhanced bioremediation, it is crucial to design enhancement that is appropriate for the existing geochemical conditions. Thus the existing aerobic, iron reductive or sulfate reductive biodegradation processes are enhanced, rather than changed. At the site, ground water contamination remained after soil excavation, free phase removal and a six month long protective pumping period. During the groundwater monitoring, the hydrocarbon plume was found to be stable due to natural attenuation. The risk management options for groundwater contamination were either monitored natural attenuation (MNA) or enhanced natural attenuation (ENA). Because the site was located at a classified groundwater area, enhancement was chosen as a remediation strategy in order to achieve faster site closure. Groundwater flow modeling showed low risk for plume spreading, which was also confirmed by monitoring: The plume had spread no more than 100 m from the source area. Groundwater chemistry showed that hydrocarbons were degraded mainly under iron reductive conditions. Hence, an enhanced natural attenuation using humic acid injections was designed. This was the first case in Finland, in which enhanced natural attenuation with humic acids was used for groundwater remediation. An environmental permit for full scale remediation using humics was granted in autumn 2007. The full scale remediation was started in December 2007. Humics (1.5-30 kg/well) was mixed with anaerobic groundwater (1-5 m³/well) that was pumped from the site and reinjected to the injection wells. Regular groundwater monitoring wells were used as injection wells. During two year treatment period, contaminant concentrations decreased in most contaminated area approximately 90%. The plume area was significantly reduced. The site will be monitored for two years in order to confirm the stability the remedial result.