

## Highly Successful ERD Pilot via Simple Additive Delivery System Lead to Full-Scale Biostimulation Strategy for Destruction of Residual cVOCs

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**Background/Objectives.** The Site, a former dry cleaner in Burlington Ontario, Canada; is currently vacant, zoned commercial/residential and desirous for redevelopment. Since 2006, investigations document chlorinated volatile organic compound (cVOC) impacts to soil/groundwater. Contaminant of concern (COC), tetrachloroethylene (PCE), present at concentrations above Ministry of Environmental & Climate Change (MOECC) Table 3 Site Condition Standards (SCS). Concentrations cVOC daughter products Trichloroethylene (TCE) and Dichloroethylene (DCE) low, with Parent:Parent Daughter (P:PD) molar ratios  $\approx 100\%$ , indicative of minimal dehalorespiration.

**Approach/Activities.** A Pilot-Study approved by MOECC, using Passive Release Sock (PRS) deployment units filled with ERDenhanced™, a biostimulation additive by BioStryke®, began in March 2011 to determine if native dehalorespiring populations could be stimulated to realize enhanced reductive dechlorination. PRS units are suspended vertically within screen interval of existing 2-inch monitoring well (MW-2) passively amending the impacted saturated soil column. Units were replaced 3-times at  $\approx 8$ -week intervals; performance groundwater monitoring/sampling performed concurrently, four events completed with final additive replacement week-20 of  $\approx 26$ -week evaluation

**Results/Lessons Learned.** Performance data confirm ERDenhanced™ stimulated native dehalorespiring bacteria in treatment zone. Supportive evidence include: reductions in groundwater ORP, expedited terminal electron scavenging, expedited solubilization of residual mass (additive enhanced co-solvent effect) followed by increased bioavailability and enhanced reductive dechlorination of parent/daughter cVOCs. Specifically, [PCE] decreased 46.9% by week-8, increased 233.3% by week 14 to decrease 89.6% by week-26. Total [cVOCs] decreased 49.6%, then increased 282.6% to decrease 77.4% at week-26; reductions in P:PD ratio  $\approx 70.9\%$ , from 100% to 29.1%. In July 2013, under MOECC approval, a full-scale remediation strategy combining source removal and biostimulation with ERDenhanced™ to address residual cVOC contaminants began. Approximately 90 m<sup>2</sup> (250 m<sup>3</sup>) of slab cVOC impacted soils were removed to  $\approx 3$  meters bgs. Structural constraints limited additional excavation. An injection gallery was installed in the excavation footprint using clear stone and 6-inch slotted PVC pipe placed 2-3 meters bgs (GW elevation  $\approx 3$  meters). In March and July 2014 a  $\approx 9\%$  ERDenhanced™ slurry was gravity fed into the gallery using 990kg and 840 kg of additive, respectively, with 1,100L make-up water. Since March 2014, 5-rounds of groundwater monitoring completed (through October 2015), confirming four downgradient locations (MW-2, MW-209, MW-3 and MW-6) demonstrated positive effects from additive deployment. Each located 15-20 meters downgradient from the gallery, changes in geochemical metrics confirm enhanced reducing conditions achieved, with reduced ORP values, increased methanogenic conditions and [Total Organic Carbon] (TOC) remaining  $> 100$  mg/L. Dramatic changes in [cVOC] and P:PD were also observed. Specifically, [PCE] reduced 99.9% (MW-2), 95.0% (MW-3), and 97.9% (MW-6); total [cVOC] reduced 89.7% (MW-2), 75.8% (MW-3), and 88.1% (MW-6). No recorded [VC]. P:PD ratios reduced 99.0% (MW-2), 87.7% (MW-3), and 90.0% (MW-6) due to introduction of ERDenhanced™. CONCLUSION: The Pilot evaluation and full-scale biostimulation remediation program confirms ERDenhanced a sustainable, cost-effective and

safe in-situ cVOC remediation strategy for the destruction of cVOC contaminants in soils and groundwater; safely, sustainably and effectively.