In-Situ Remediation of Dissolved Metals Plume — From Concept to Full-Scale Remediation

Matthew Beveridge, Hemmera

Hemmera developed an innovative approach to remediate an inaccessible dissolved metals plume at an active commercial property (the "Site") that discharges to an adjacent freshwater aquatic receptor (the "Project"). The mechanism for remediation was the injection of ferrous iron, followed by in-situ oxidation to precipitate hydrous ferric oxide (HFO, or "rust"). HFO was successful in decreasing dissolved metals concentrations via coprecipitation and/or adsorption in the aquifer. Preliminary post-injection groundwater samples indicate up to a 98% decrease in dissolved metals concentrations compared to baseline.

The Project was conducted iteratively from conceptual design in 2015 to full scale implementation in 2020, with ongoing post-injection verification sampling in 2021. The various phase of work included:

Preliminary Work (2015) - Supplemental Site Investigation

- Assessment and delineation of the plume, including mineralogical assessment of the aquifer solids, porewater sampling at the aquatic receptor to determine flow path, discharge concentrations to the receptor, and toxicity testing to establish a site-specific remedial target.
- Geochemical modeling to inform future plume migration indicating that remediation was required to meet the site-specific remedial target.

Phase 1 (2018) – Bench Scale

- Initial testing of the proposed remedial approach (i.e., HFO injection) would decrease metals concentrations in Site groundwater.
- Bench Scale column tests were completed with amended aquifer solid materials (i.e., HFO added) and unamended aquifer solids (i.e., a Control), as well as Site groundwater. Results indicated up to a 99% decrease in dissolved metals in the amended columns, with minimal decrease in the control column.

Phase 2 (2019) – Pilot Scale

- Pilot Testing included drilling and installation of injection well transects parallel to groundwater flow for injection of materials to precipitate HFO in the aquifer at similar concentrations to the amended column tests. Post-injection groundwater results indicated decreased dissolved metal concentrations up to 99% downgradient of the injection wells.
- 2020 groundwater results indicated further decreases in dissolved metals one year after injection.

Phase 3 (2020-2021) – Full Scale Remediation

- Full Scale implementation with lessons learned from previous phases of work with two injection areas installed to progressively treat the plume, as well as injections to stabilize the Source Zone.
- Injection networks were designed based on detailed studies to understand the groundwater flow in the aquifer, including pumping-tracer testing to control the injected materials in the coarse, fast flowing aquifer.
- Injection methodology was designed with real-time data monitoring at downgradient wells to ensure control of the injections to prevent loss of injected materials.
- Post-injection verification groundwater analytical results indicate decreases up to 98% of dissolved metals concentrations compared to baseline.

The Project has demonstrated the efficacy of the use of HFO for decreasing metals concentrations in an inaccessible, widespread groundwater plume adjacent to a freshwater aquatic receptor. This technology is adaptable to a wide range of site conditions, limitations, and constraints and can remediate a wide suite of common metal contaminants (i.e., As, Cu, Cd, Cr, Pb, Ni, and Zn).

Matthew Beveridge

Matthew Beveridge is an Environmental Engineer with over 12 years of experience in the environmental industry conducting environmental site assessments and remediation programs in Alberta, the Northwest Territories, Nunavut, Yukon, and British Columbia. Matthew is the Business Leader for Hemmera's Site Assessment and Remediation team in Alberta. Matthew has supported clients throughout the regulatory process from initial assessment to closure and enjoys working collaboratively and iteratively to determine the best solution for each project and client. Key projects that he has been a team member on include the DEW Line Clean-Up Project at Mackar Inlet (CAM-5) and Cape Dyer (DYE-Main), the Heber Dam Remediation Project on west Vancouver Island, Rock Bay Remediation Project Stage 3 in Victoria, BC, Prophet River Remediation on the Alaska Highway, BC, and an in-situ remedial program for dissolved metals plume at a commercial property in Alberta.