

## **Pilot Testing of Groundwater Circulation Well Technology for a Caustic Groundwater Plume in a Coastal Aquifer**

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Over the past ten years, URS has been involved with remediation of a caustic groundwater plume at a chlor-alkali chemical plant. Significant pH reductions were initially achieved through operational control measures, however a residual groundwater plume persists, with pH greater than 12 in some areas. An extensive groundwater monitoring and sampling program has allowed development of a detailed database that describes stable plume conditions.

The caustic groundwater plume covers approximately four hectares and has been detected up to 20 metres deep in an unconfined sand and gravel coastal aquifer intruded by a salt water wedge. Caustic groundwater conditions exist in both the saline groundwater of the intruding wedge and the overlying fresh groundwater. A five-year pilot testing program of groundwater circulation and pump and treat technologies was conducted between January 2002 and December 2006.

The pump and treat system was initially designed as a groundwater circulation cell: extraction from an intermediate well screen, ex-situ acid treatment and re-injection into shallow and deep well screens. Over the course of four months, pumping rates decreased by a factor of five with a corresponding decrease in the size of the groundwater capture zone. Reduced pumping rates were attributed to scale build-up on the extraction well screen. Subsequent study including bench scale column tests and chemical analysis of mineral precipitates was completed to determine the cause of scale development and assess the feasibility of the groundwater circulation well technology. Two different precipitates were observed to develop: a magnesium silicate and an amorphous salt gel. The precipitates were determined to be the product of a chemical reaction occurring during pH neutralization in the saline portion of the aquifer.

A supplemental pilot test was conducted with groundwater extracted from the shallow extraction well, treated with acid and injected through a new intermediate well screen. By limiting extraction and injection to shallower depths, groundwater treatment was confined to the freshwater zone with a resulting absence of scale formation.

An adaptive management approach was required to respond to the challenges of treating high pH in a mixed saline/freshwater aquifer. Knowledge gained from the pilot testing program is being used to plan the next phase of remedial system design. Though not viable for pH treatment of saline groundwater, pump and treat technology is a feasible remedial option provided that groundwater extraction and injection wells are designed for site-specific conditions. Pilot test results suggest a promising opportunity to promote precipitate formation within the aquifer to artificially reduce hydraulic conductivity and flow within the source area of the plume.

### **Presenter Biographies**

**Lynda Smithard, P.Eng.** is a senior environmental engineer and project manager with URS with 11 years of professional experience in contaminated site assessment and remediation projects. Ms. Smithard specializes in client/regulatory agency/legal counsel liaison, detailed site investigation design, remedial options evaluation, and remedial planning and implementation. Her project portfolio includes numerous multi-stakeholder remediation projects involving large scale and complex contamination issues and provision of technical guidance for stakeholder consultation and litigation associated with these projects. Ms. Smithard has developed site

closure strategies for a variety of government and industrial clients, and has experience in the assessment and remediation of contaminated sites in the arctic and cold climates.

Ms. Smithard has expertise in the pilot testing, design and operation of in situ remediation systems including air sparging, soil vapour extraction, groundwater and free product recovery, and vacuum enhanced recovery systems. She has successfully developed and implemented a wide range of engineered remedial systems using innovative approaches. Ms. Smithard has completed over 20 such projects for clients in western Canada.