In situ stabilization/solidification (ISS) is accomplished by mixing contaminated soils with binders, such as Portland cement, to produce a monolithic material, thereby decreasing the mobility and toxicity of contaminants. While ISS has a demonstrated track record at hundreds of sites it does not typically destroy contaminants. ISS used in combination with in situ chemical oxidation (ISCO-ISS) has emerged recently as an attractive alternative to deployment of ISS alone. ISCO-ISS offers the possibility of contaminant destruction, as well as stabilization of residuals not treated by ISCO. This approach was tested for application at a gas works site in Denmark where a full-scale ISCO-ISS remedy was designed and implemented to destroy coal tar contamination, including benzene in groundwater, and to reduce hydraulic conductivity and improve soil strength.

A rigorous pre-design bench-scale test was conducted to measure the performance of ISCO-ISS in soil core and groundwater samples collected from the Site, including the impact on benzene toluene, ethylbenzene, xylene (BTEX), semi-volatile organic compounds and phenolic compounds. The bench tests determined optimum dosages of ISCO-ISS amendments, the effects of treatment on the concentration and leaching of coal tar contaminants, reduction of hydraulic conductivity, and increase of unconfined compressive strength. Based on the success of the bench-scale test and supporting published studies, the ISCO-ISS remedy proceeded to pilot test and full-scale implementation in the summer of 2018. Specific technical challenges included: interference of persulfate chemistry with cement chemistry and determining the optimal application sequence of amendments.

The onsite ISCO-ISS system was completed in October 2018, and results to date indicate that ISS combined with ISCO using base-activated (i.e., cement-activated) persulfate was a successful and cost-effective technology for treating the coal tar source area and reducing associated benzene concentrations in groundwater. The information gained from the bench-scale laboratory study was critical to the successful design of the pilot study and ultimately the full-scale implementation. Building on this successful project, guidance and recommendations for applicability of ISCO-ISS to other sites, lessons learned, and refinements for implementation in future projects will be shared.

Sandra Dworatzek, MSc

Ms. Dworatzek is an environmental microbiologist with advanced technical experience in laboratory treatability studies. Over the past 25 years she has conducted and overseen numerous bench-scale studies examining enhanced in situ bioremediation in groundwater. She has specific technical experience in the design of laboratory treatability studies, the scale up of growth of aerobic and anaerobic microbial cultures for bioaugmentation laboratory and field pilot tests, and evaluation of aerobic and anaerobic bioremediation, zero valent iron and chemical oxidation technologies in the laboratory.

Ms. Dworatzek is a Principal Scientist at SiREM, a division of Geosyntec Consultants and has been with the company for seventeen years. SiREM maintains state-of-the-art treatability, molecular testing and microbial culture production facilities. She currently oversees maintenance and culturing of KB-1® and KB-1® Plus dehalorespiring microbial cultures that have been widely used in field demonstrations to improve the rate and extent of bioremediation of chlorinated solvents in groundwater (e.g., tetrachloroethene (PCE) and trichloroethene (TCE) dechlorination to ethene), as well as the development of new bioaugmentation cultures including 1,4-dioxane, 1,2,3-trichloropropane, benzene, toluene and xylene. She provides technical oversight for treatability studies for a wide range of environmental contaminants, including halogenated organics (e.g., solvents, pesticides, etc.) and petroleum hydrocarbons both alone and in complex mixtures.