



# ADVENTUS

Proven Soil, Sediment, and Groundwater  
Remediation Technologies

## STATEMENT OF QUALIFICATIONS (May 2010)

### REMEDICATION OF TRACE METAL CONTAMINATION IN GROUNDWATER

The Adventus Group is an environmental biotechnology company that provides various remediation biotechnologies. We are NOT consultants – we support our clients' by providing unbiased design support and selection of the most cost-effective remedial solution or strategy. As appropriate, our proven products may provide significant advantages. Implementation is subsequently provided by partnering with engineering and construction firms.

Adventus has 21 years of recorded successes in using biotechnologies to solve complex environmental problems beginning in 1988 with roots in the W.R. Grace & Co. organization. ADVENTUS was founded in 2003 as a privately held, US/Canadian joint venture to provide a patented portfolio of biotechnologies designed to treat pesticides/herbicides, chlorinated solvents, organic explosives, heavy metals and petroleum-based hydrocarbons in soil and groundwater. In June 2004, EnviroMetal Technologies (ETI) became part of the Adventus Group. ETI was founded by the University of Waterloo in 1992 and has successfully implemented permeable reactive barriers (PRB) at over 150 sites worldwide. Adventus' EHC® technologies have been successfully applied at about 1000 sites, and our DARAMEND® technology has treated almost 8 million tons of soil, globally – without any failures. Our established portfolio of remediation successes enables us to uniquely guarantee the performance of our products.

The Adventus Group has considerable experience in site-specific evaluation and implementation of our technologies for trace metals and radionuclides. In addition to the numerous studies listed in Tables 1 and 2 below, our staff has reviewed designs and interpreted results from a variety of installations completed by the US Department of Energy and Atomic Energy of Canada. ETI involves academic experts in PRB technologies for treatment of trace metal and acid mine drainage sites at the University of Waterloo, in an advisory capacity as appropriate on our projects.

**Metals in Groundwater** – *In situ* chemical reduction (ISCR) using EHC-M® or granular zero valent iron (ZVI), permeable reactive barriers (PRB) with EHC-M® and/or ZVI.

**Metals in Soils** – *Ex situ*, or *in situ* treatment of soil and sediment using DARAMEND®, which integrates controlled release carbon and reduced metals (*e.g.*, ZVI).

We also have decades of experience in the area of fate and transport modeling and litigation support, including mine-related groundwater issues.

### **Representative Project Experience**

Detailed project descriptions for EHC-M applications are available at [http://www.adventusgroup.com/projects/proj\\_etc\\_m.shtml](http://www.adventusgroup.com/projects/proj_etc_m.shtml), and ZVI PRB applications can be found at <http://www.rtdf.org/public/permbarr/PRBSUMMS/>.

**TABLE 1: PRB INSTALLATIONS AND REACTIVE MATERIAL INJECTIONS FOR TREATMENT OF METALS AND CVOCS IN GROUNDWATER IMPLEMENTED WITH ADVENTUS-ETI ASSISTANCE.**

Site	Installation Date*	Remedial System	Contaminants (max conc - µg/L)	Results
US Coast Guard, NC, USA	1996	ZVI PRB	cVOCs +Cr(VI)	Sustained and complete treatment of ca. 4 mg/L TCE and ca. 3.5 mg/L Cr(VI) since installation
Industrial - Denmark	1999	ZVI PRB	TCE +Cr(VI)	Pilot-scale evaluation terminated in 2001. Results showed effective treatment of both TCE (up to 1.4 mg/L) and Cr(VI) (up to 0.11 mg/L).
Government - BC, Canada	2000	Carbon plus ZVI PRB	Ni and Cu	Consistent metal removal to date
Kelly AFB, USA	2004	ZVI PRB	cVOCs +Cr(VI)	No data available
Vancouver, WA, USA	9/2006	EHC-M** in PRB	Cr (VI) (165) + TCE	Non-detect hexavalent chromium and TCE (after 1 month) down-gradient of PRB
Industrial - Brazil	11/2007	EHC-M plume injection pilot	Pb (300)	>97% decrease in soluble Pb, and below detection limit (<10ppb) after 2 months and continuing
Industrial - Netherlands	2007	EHC-M	Zn, PCE	Complete removal of influent Zn ( up to 5 mg/L) and low levels of PCE in the site boundary PRB 2 yrs after installation
Dallas NWIRP, USA	2008	ZVI	cVOCs, Cr	
Industrial - ON, Canada	2008	EHC-M	Cu (86), Co (210), Ni (350)	Remedial objectives met for copper (within 10 days of injection); cobalt (55 days); Ni (139 days). Site closure obtained.
Lisbon - ME, USA	9/2009	EHC-M	As + VOCs	No new data.
Confidential - MI, USA	12/2009	EHC-M phased injections over years	Cr, Ni	Concentrations of As, Cr, Ni have shown decreasing trends in most wells, as expected
Delray Beach - FL, USA	12/2009	EHC-M	As	No new data.

\* ZVI – consistent PRB performance has been observed for over 14 years, with the expectation of total lifetimes in excess of 20 years.

\*\* Integrated carbon-ZVI particles; metal treatment based on sulfate reduction followed by precipitation of metal sulfides.

**TABLE 2: TREATMENT EFFICIENCIES OBSERVED IN INTERNAL EHC-M TESTS.**

<b>Compound</b>	<b>Max Influent Concentration Range (<math>\mu\text{q/L}</math>)</b>	<b>Observed Removal Efficiency (%)</b>
Antimony	24,500	>99
Arsenic	500	98
Cadmium	11	>99
Chromium	200	>99
Cobalt	210	>99
Copper	86	>99
Lead	64,000	>99
Nickel	350	>99
Zinc	50,400	92