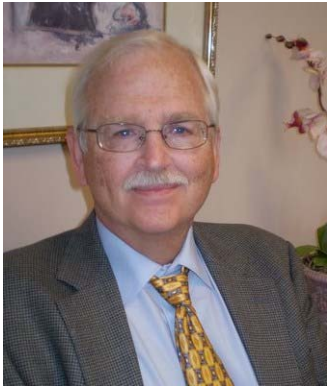




YOUR NATURAL SOLUTIONS

Patented Methods for *In Situ* Bioremediation



Dr. Robert C. Borden, P.E.

Dr. Bob Borden, PE, Joins Pollution Engineering Hall of Innovators

Dr. Robert C. "Bob" Borden is internationally recognized as an expert in natural and enhanced bioremediation of hazardous materials in the subsurface as well as non-biological remediation technologies. He has authored or co-authored dozens peer-reviewed technical publications on environmental remediation as well as many conference publications, presentations, and posters.

"This is an exciting time in environmental remediation," says Dr. Borden. "We have made tremendous advances in understanding the physical, chemical and biological processes controlling contaminant transport and fate in the subsurface. Now, we need to bring that knowledge into the marketplace and develop new, more cost-effective technologies to restore our planet's soil and groundwater. We have the expertise to make a real contribution to environmental quality-of-life, and I am excited to see us heading in that direction."

Dr. Borden was a pioneer in the development, demonstration and application of monitored natural attenuation and enhanced *in situ* bioremediation. His mathematical modeling studies have included the development and application of numerical models to simulate the natural and enhanced remediation of groundwater contaminants via aerobic biodegradation, anaerobic biodegradation and chemical oxidation. He works with private-sector interests and government research programs such as DOD's Environmental Security Technology Certification Program and Strategic Environmental Research and Development Program.

Dr. Borden has developed and evaluated protocols to assess natural attenuation of petroleum hydrocarbons, chlorinated solvents and other contaminants. He has developed instrumentation for estimating degradation rates under *in situ* conditions. He has used laboratory and field methods to demonstrate contaminant biodegradability and estimate *in situ* degradation rates at locations throughout the United States. For a project with the U.S. EPA, Dr. Borden compared rates estimated using "Protocol for estimation of anaerobic microbiological transformation rate data" (Fed. Reg. Vol. 53, No. 115) with *in situ* estimates of degradation rates and completed some of the first field studies of hydrocarbon natural attenuation.

He continues to advance the state-of-the-science by developing and patenting the use of emulsified oils for the bioremediation of groundwater, delivering significant advances to the treatment of groundwater contaminated with chlorinated solvents, energetic materials, nitrates, oxidized heavy metals and radionuclides. Dr. Borden's patented emulsified oil products have been successfully applied at sites throughout the world since commercialization in 1999.

Dr. Borden has also pioneered the use of solid alkaline materials formulated into a suspension to optimize aquifer pH for EISB. Dr. Borden has developed products that provide long-term anaerobic bioremediation through *in situ* pH adjustment. He has also developed a special formulation to enhance buffer particle distribution in aquifers. Shortly after injection, the oil droplets and buffer particles attach to the aquifer solids, providing an ideal environment for reductive dechlorination.

Dr. Borden is a Professor of Civil, Construction and Environmental Engineering at North Carolina State University and serves as Principal Engineer at Solutions-IES where he provides technical and expert witness support to many of the firm's public and private clients. Solutions-IES (www.solutions-ies.com) provides a broad range of engineering and consulting services to address environmental problems faced by industry and government. EOS Remediation (www.eosremediation.com) provides specialty bioremediation products and related services, developed by Dr. Borden, to contract engineering firms addressing *in situ* groundwater treatment.



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