# Groundwater Treatment Technologies Offer Increased Efficiency And Reduced Expense

University of Waterloo

Permeable reactive barriers developed at the University of Waterloo are two to five times less expensive than traditional pump-and-treat methods and in field tests are proving to be more effective in removing groundwater contaminants.

Contaminated drinking water is a worldwide problem, causing disease and death in developed and undeveloped countries alike. Especially troubling to remediation specialists are areas where the aquifer has become contaminated with heavy metals. These pollutants — which include mercury, arsenic, chromium and lead — are known to be toxic and difficult to extract from groundwater.

Throughout the western U.S. states, where gold and silver mines once provided abundant wealth, abandoned mine shafts have left an unexpected legacy: ground water contaminated by mine tailings.

Clean-up efforts in these areas have been notoriously expensive and frequently unsuccessful. A new class of remediation technologies, collectively known as permeable reactive barriers, or PRBs, are helping to undo the damage

done by more than a century of mining and other activities in the United States and throughout the world. These technologies, developed at the University of Waterloo in Ontario, Canada, are likely to revolutionize the way contaminated groundwater is treated in the future.

**A Relatively Simple System**

The PRB system is relatively simple, says Scott Inwood, technology transfer manager at the University of Waterloo. A typical installation involves selecting and placing a chemically reactive material into an excavated trench or chamber and positioning it to intercept the path of the contaminated groundwater plume. The PRB acts as an effective filter that removes contaminants as the groundwater flows through it. Scientists select reactive materials depending on the target contaminants that need to be treated, making the PRBs useful in a variety of applications.

The PRB technologies provide a more economical, efficient means of treating groundwater than traditional pump-and-treat methods. These conventional methods involve pumping contaminated water to the surface and treating it using filters, chemicals, electricity and manpower. The pump-and-treat approach can waste clean water and often produces contaminated byproducts. In some cases, this can cause the direction of the contaminated plume to change, increasing the risk of contaminating adjacent properties.

The mechanical pump-and-treat approach is two to five times more expensive than using the passive, unmanned, electricity-free PRB technologies, according to a 2001 report by the U.S. Environmental Protection Agency. Aside from providing the lowest-cost alternative
method, PRBs have proven to be more effective in meeting stringent regulatory criteria. And, because they are buried underground, PRBs do not create eyesores or huge surface equipment scars that may reduce property values.

**Governments, Corporations Support PRBs**

The University of Waterloo, Canadian and U.S. governments, and several multinational corporations have invested significantly in the research and development of passive remediation technologies at the University of Waterloo, resulting in the creation of more than 20 technologies and more than 100 patents and patent applications. One targets common inorganic industrial contaminants, or metals, such as chromium, uranium, copper, zinc, arsenic and mercury.

David Blowes, a professor of Earth sciences and a Canada research chair, and Carol Ptacek, an adjunct professor and research scientist with Environment Canada, invented the metals-specific PRB. While researching, they found that PRBs that use zero-valent iron or organic carbon-reactive materials could be used to treat groundwater. The two were studying dissolved metals at a mining site in New Brunswick when they realized that contaminants were being removed in some places, but not in others. That's when they began searching for practical ways of promoting chemical reactions in the aquifer that would remediate the site.

> *The metals-specific PRB is now used at several Superfund cleanup sites across the United States, as well as similar sites in Canada, Europe, South America and Australia.*

"Our system is efficient as possible and less expensive," Ptacek says. "Over the last decade, we've seen a gradual transition, from doing groundwater remediation by pumping to remediation by manipulating the aquifer."

**The Path to Licensing Has Been Difficult**

In spite of the many significant benefits this technology offers, the path to successful licensing of the technologies has been arduous. "Regulatory agencies and engineering consultants don't want to use a technology that's not proven,"

Inwood says. “We initiated a number of small-scale demonstration projects over an eight-year period to generate enough data that would provide the credibility to secure the first commercial license of the technology.”

The metals-specific PRB technology is now being field-tested at five sites in Canada and the United States, where the two governments have garnered licenses for field demonstrations. So far, 12 commercial entities have licensed the technology, including several in Canada, five in the United States and several in the European Union.

Inwood believes the technology will be widely used and accepted by the time the patent expires in 2012.

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