Use of an Alternative Paradigm to Support Optimization of In Situ Remedies for Metal and Radionuclide Contaminated Sites – The Virtual Testbed

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Plumes of contaminated groundwater beneath many sites within the DOE complex will require monitoring for tens to hundreds of years beyond the final cleanup to ensure that the system is behaving as predicted and the residual level of risk is acceptable. At many of the large complex plumes, DOE is implementing of innovative, long-lived attenuation-based remedies to deal with the complexity of the chemistry or geologic setting. For these remedies to gain regulatory approval, they must demonstrably reduce contaminant flux to compliance points for very long periods of time. The total projected cost to the Department of Energy for these monitoring activities is in excess of $2 billion. Much of this cost is associated with frequent analysis and evaluation of contaminant substances in groundwater samples from a large number of monitoring wells. Such measurements are expensive and the resulting databases are inefficient and often inadequate for meeting monitoring objectives.

One of the biggest challenges to this traditional long term monitoring paradigm is that the changes in contaminant concentrations are often lagging indicators than only alert the environmental manger that a problem has occurred rather than warning of a potential problem. It would be valuable to incorporate indications into monitoring that signal when the changes occur to major system parameters that control contaminant behavior and might cause destabilization of a plume and contaminant mobilization. We propose a monitoring strategy that shifts the focus from point source measurement of contaminant concentrations toward monitoring the physical and chemical parameters controlling contaminant movement. These are generally much less costly to measure and provide leading indicators that system changes may be conducive to contaminant mobilization. Certainly, point source measurement of contaminant concentrations will be a part of long term monitoring, yet shifting the focus as we propose would significantly reduce monitoring costs by minimizing the number of monitoring wells while providing information that leads to proactive rather than reactive responses in response to changes in residual plume dynamics.

The primary difficult in testing this monitoring strategy is that it takes years or even decades. We have overcome this challenge by testing the concepts with an extensive groundwater monitoring dataset for a mature waste site with well-documented changes. Each event in the history of the waste site produced changes to the parameter that influence contaminant behavior. Our evaluation compares measurement of the parameters to changes is contamination concentration and then we can determine whether the changes in system parameters are predictive of changes in the movement of contaminants. We can then take the strategy that was developed using the historical data, and using a fully reactive, three-dimensional groundwater model of the site that was developed by researchers at Lawrence Berkeley National laboratory to test the strategies decades into the future.