Ricker Plume Stability Method

PREMIER ENVIRONMENTAL SERVICES, INC

Evaluating plume stability is important for most remediation sites; however, it is of primary importance in the evaluation of monitored natural attenuation (MNA) sites. When characterizing groundwater contaminant plumes, there are numerous methods for evaluating concentration data. Typically, the data are tabulated and groundwater concentrations are presented on a site figure. Contaminant concentration isopleth maps are typically developed to evaluate temporal changes in the plume boundaries and plume stability is often assessed by conducting trend analyses for individual monitoring wells. However, it is becoming more important to understand and effectively communicate the nature of the entire plume in terms of its stability (i.e., is the plume growing, shrinking, or stable?).

The Ricker plume stability evaluation method described herein was developed to assist with regulatory approval of MNA as a final remedy at select sites, and to provide a definitive answer to the question posed under RCRA Corrective Action Environmental Indicator (EI) CA 750: "Has the migration of contaminated groundwater stabilized?"

The Ricker method has been accepted for use at several sites by USEPA Region 4 and its implementation is highlighted as a RCRA Showcase Pilot, accessible via this link: http://www.epa.gov/epawaste/hazard/correctiveaction/pdfs/r4_velsi.pdf. The Ricker method was also published in the Fall 2008 issue of *Groundwater Monitoring and Remediation*.

Methodology

With numerous chemicals of concern, differing analytical detection limits and cleanup standards, various source areas, and varying aquifer monitoring depths, it is often difficult to effectively answer the question "Is the migration of contaminated groundwater under control?"

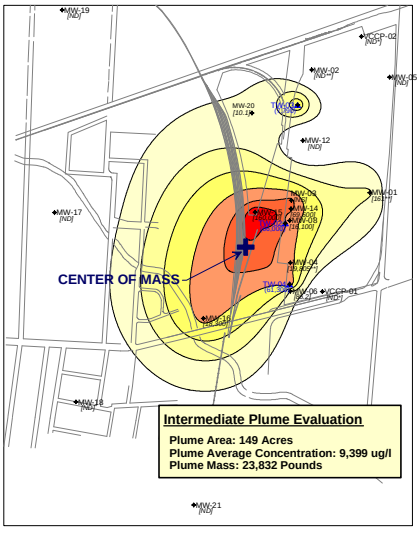
The Ricker method involves an evaluation of the overall plume in terms of area, average concentration, mass, and location of plume center of mass. The values for these plume characteristics are calculated after each sampling event and compared to previous calculations to determine underlying trends.

The plume evaluation method uses a contouring software package to generate contaminant isopleth plume maps. Mathematical features of the software allow for the calculation of plume area and average concentration and center of mass. Known or assumed values for aquifer depth and porosity are used in conjunction with the other calculated data to estimate the plume mass. Once the plume characteristics are calculated for several sampling events, statistical trend analyses may be conducted and the results of these analyses can be incorporated into future sampling and reporting.

Benefits

Although other methods of plume stability analysis exist (e.g. mass flux analysis, fate and transport modeling, etc.), the Ricker method is cost effective while being efficient and reliable. This method requires only the analytical data supplied by a laboratory to perform the assessment; whereas more complex methods (e.g. modeling) require the use of additional subjective data (e.g., hydraulic conductivity, etc.) and can be quite expensive.

When it can be demonstrated to regulatory agencies that a groundwater contaminant plume is stable in the absence of hydraulic control, such agencies have shown to be much more amenable to accepting MNA as a final remedy. This allows for either shutting down existing groundwater extraction and treatment systems, or eliminating the necessity of installing such systems, resulting in considerable cost savings.



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Expertise: Management of environmental remediation, investigations, and long-term operation and maintenance activities at CERCLA, RCRA, and other hazardous waste sites.

Mr. Ricker is a registered professional engineer who provides technical expertise in Premier's Memphis office. He has developed ambient air monitoring programs, site investigation work plans, long-term monitoring and maintenance programs, groundwater monitoring programs, and groundwater flow and contaminant fate and transport models. Mr. Ricker has provided technical support for natural attenuation projects and managed operations and maintenance for groundwater treatment plants. Mr. Ricker has a M.S. in Civil Engineering from the University of Memphis and a B.S. in Civil Engineering from Rose-Hulman Institute of Technology.

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Expertise: Environmental investigation and remediation at RCRA, CERCLA, and state agency-led sites.

Mr. Laine is a registered professional geologist and professional engineer. He is experienced in: groundwater modeling; contaminant transport; contaminant plume stability; innovative and standard remedial design and implementation; design and construction of landfill caps; and hazardous waste classification. Mr. Laine is also experienced in environmental activities pertaining to retail petroleum sites as well as the development of health and safety plans for environmental sites as well as implementation of client protocols. Mr. Laine has a B.S. and an M.S. in Geological Engineering from the University of Mississippi.

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"I am also proud of this innovative method and your "center of mass" analysis and we will continue to support this Region 4 Showcase Pilot."

- Leo Romanowski, Senior Corrective Action Specialist, USEPA Region 4

Case Study – Plume Stability

PREMIER ENVIRONMENTAL SERVICES, INC

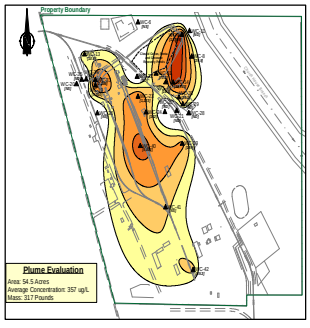
A large industrial corporation has a wood treating facility involved in an EPA-led RCRA Facility Assessment (RFA). Concurrently, this facility is involved in a State-led Corrective Action Program (CAP) to remediate groundwater beneath the facility that is contaminated with chlorophenols as a result of former unlined surface impoundments at the property. The CAP involved a groundwater pump-and-treat (P&T) system that had been in operation since 1986. Premier was retained to provide technical and regulatory assistance in guiding the property and the client through the RFA process. While Premier was not retained to assist with the groundwater CAP, a preliminary review by Premier of the site history and contaminant distributions performed in support of the RFA suggested the efficacy of the P&T system was poor. This was reported to the client, who then retained Premier to more thoroughly assess the performance of the P&T system. The assessments included performing mass calculations to evaluate the P&T system's ability to remove contaminant mass, and conducting capture zone analyses to assess the system's ability to provide hydraulic control. Premier's evaluation concluded the P&T system was ineffective in providing hydraulic control and contaminant mass removal.

Solution

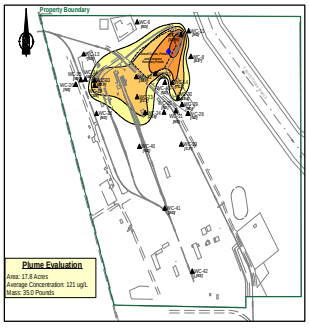
Seeking a cost effective solution, Premier conducted a Monitored Natural Attenuation (MNA) effectiveness study to evaluate the ability of naturally occurring microorganisms and natural physical processes (e.g. dispersion, sorption, etc.) to reduce contaminant concentrations in groundwater and control plume migration without the operation of the P&T system. The results of the MNA study showed clear evidence that intrinsic biodegradation of the dissolved-phase wood-treating chemical plumes is occurring and accounting for the majority of contaminant mass removal.

In addition to performing the MNA study, Premier performed a plume stability analysis to evaluate changes in the area, average concentration and mass of the plume. Below are concentration isopleth maps for creosote in 1991 and 2002, when the P&T system was shut down.

Creosote Plume in 1991



Creosote Plume in 2002



As observed in the above figures, the creosote plume has undergone significant reduction between 1991 and 2002.

Summary of Plume Stability Characteristics

Sampling Period	Area (Acres)	Average Conc. (ug/l)	Mass (lbs)
1991	54.5	357	317
1992	39.2	479	306
1993	40.7	319	212
1994	23.7	228	87.9
1995	25.1	189	77.2
1996	21.6	128	45.0
1997	19.4	134	42.4
1998	16.9	130	35.9
1999	11.4	148	27.5
2000	18.1	256	75.3
2001	23.7	106	40.8
2002	18.9	118	36.2

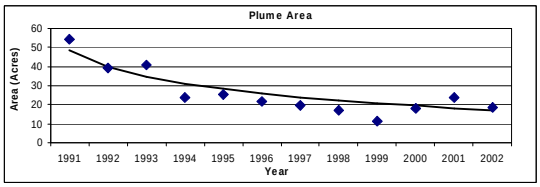
The plume has undergone the following reductions from 1991-2002:

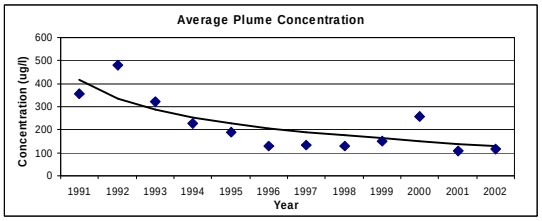
65% Reduction in Area;

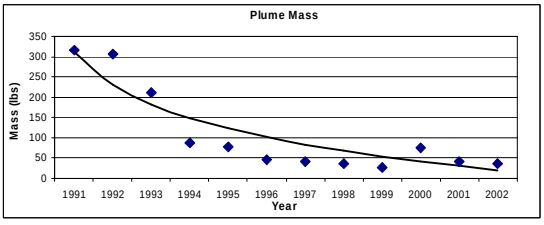
67% Reduction in Average Concentration;

88% Reduction in Mass.

As shown below, a trend analysis conducted in accordance with EPA protocols concluded that statistically significant decreasing trends occurred for all three plume characteristics. The results of the MNA study combined with the results of the plume stability evaluation were used by Premier to successfully negotiate with the State and EPA to implement MNA as an alternate remedy to the P&T system.







Results

The MNA study and the plume stability evaluation were low cost alternatives to more complex modeling efforts typically required to evaluate contaminant fate and transport. Implementation of MNA in lieu of the P&T system resulted in a cost savings of approximately $150,000/year, indefinitely.