Improving Remedial Designs Using Passive Flux Meter Studies and Plume Dimension Analysis

Chris Lee (clee@regenesis.com) (REGENESIS, Kenosha, WI)
Craig Sandefur (CSandefur@regenesis.com) (REGENESIS, San Clemente, CA)

Background/Objectives. Successful remedial designs and application requires an accurate set of input variables. Two of the most critical variables to successful implementation and performance are accurate groundwater velocity and associated contaminant flux. Accurate measurements of groundwater velocity and mass flux zones are particularly important because they largely control the size and shape of the contaminant plume. It has become generally accepted that contaminant plumes usually migrate through transport zone(s) comprising a smaller percentage of the overall aquifer thickness. Defining the contaminant mass flux and groundwater velocity in detail across the target treatment zone (TTZ) becomes crucial to the success of the project, particularly in heterogenous aquifers where contaminant mass flux is complicated by the presence of fine- and coarse- grained units.

The flux rate of contaminants is largely driven by groundwater velocity; therefore, poor estimations of groundwater velocities can lead to significant variability in designs and result in poor remedial outcomes. This presentation will address the notion of how groundwater velocity estimates are derived and introduce a novel way of obtaining more accurate velocity estimates using a method that correlates plume shape ratios to groundwater velocities obtained from passive flux meters (PFMs).

Approach/Activities. We will present data that demonstrates a strong correlation between a low-resolution analysis method referred to as a plume aspect or dispersion ratio (plume length ÷ plume width) and a higher-resolution direct measure method using passive flux meters. In this analysis we combine the two different methods to arrive at a site-specific groundwater velocity for 30 separate sites. Results demonstrate a good correlation between the two methods for a wide range of contaminant types including cVOCs, BTEX, MTBE, PCBs. In addition, early trends in the data indicate that some PFAS compounds are very likely amenable to this type of analysis. This discussion will also include analysis demonstrating significant differences between common industry methods to arrive at groundwater velocity and those methods using plume aspect ratio and passive flux meters. One of the objectives of this work is to provide the industry with an easy-to-use predictive tool that can help calibrate and reality check groundwater seepage velocity estimates for remedial designs.

Results/Lessons Learned. Mounting evidence supports the notion that a significant difference exists between traditional estimates of seepage velocity and those derived from passive flux meters. PFMs provide a higher-resolution method to accurately measure groundwater velocity and contaminant flux for remedial designs. Analysis of the PFM velocities and contaminant plume shape indicate a strong relationship (R^2 ~0.85) that can be directly correlated using a linear regression analysis. It appears that two very different lines of evidence support the underlying groundwater velocity estimates. This linear relationship creates a reasonably accurate way to validate groundwater velocity estimates as well as function as a predictive tool at sites where PFMs have not been used. The resulting groundwater velocities using the plume aspect ratio method will optimize and improve designs as well as remedial outcomes.