

Dispersion, Plumes, and Darcy's Law

Charles F. McLane and Robin Magelky, McLane Environmental LLC

In forensic investigations of ground water contamination, calculations of the travel time or arrival time of dissolved chemicals are often required. In many instances the investigator employs an advective velocity technique based on Darcy's Law. Plume arrival time at a receptor is often calculated using only the Darcy's Law ground water velocity. Similarly, plume travel time (or its corollary, the historical time of release from a known or suspected source) is sometimes estimated from the measured length of the plume. Such calculations inherently contain unquantified error. General hydrogeologic textbooks and scientific articles have, for decades, clearly presented the effects that dispersion in porous media transport can have on the arrival time of a plume front. More to the point, a warning on the misuse of Darcy's Law for these types of calculations was issued to hydrogeologic experts some time ago (Baca 1999). Yet practitioners continue to employ the overly simplified Darcy's Law approach in their forensic work. In the current study, examples are provided of the magnitude of error that can be introduced into transport time estimates for a variety of assumptions regarding aquifer dispersivity. The study demonstrates the effect of important parameters such as retardation, biodegradation, and contaminant source characteristics on plume travel time and source release time estimates. The results demonstrate that chemical fate and transport factors should be incorporated in plume travel time estimates to the extent practicable and necessary for the calculations of interest.