

**Characterization of Heterogeneous Contaminated Sites
Geometry, Geology, and Geography**

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Characterization typically requires a large number of discrete measurements to define the precise lateral and vertical distribution of source contaminants and the trajectory of the resulting plume. Discrete information (“point” monitoring from soil borings, monitoring wells and the like) is the basis for developing a detailed conceptual understanding of the site, for developing an efficient and effective remediation system, and for monitoring the performance of active remediation systems. Development of a useful conceptual model from the data relies on methods to “upscale” the point measurements to represent the heterogeneous subsurface. The most successful approaches incorporate large-scale boundary conditions and geologic considerations such as depositional environment. The importance of understanding plume geometry and the subsurface processes that control migration is exemplified by the tritium plume at the Brookhaven National Laboratory High Flux Beam Reactor, by the behavior of dense organic solvents at the Savannah River Site, and by the behavior of radionuclides beneath the waste tanks at Hanford. Themes embodied in the listed examples include: 1) the varied and creative methods that are possible to improve interpretation, 2) the importance of understanding the horizontal and vertical position of subsurface contamination to optimize remediation, and 3) the need to develop a flux based monitoring paradigm to assess the progress of long term clean up.