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An Integrated Approach to Subsurface Heterogeneity Measurement for Three-Dimensional Ground Water Flow and Contaminant Transport Modeling

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ABSTRACT

Recent improvements in computer modeling capabilities have produced several powerful, economical, three-dimensional groundwater flow and contaminant transport models. However, these models have outstripped our ability to supply the necessary subsurface characterization data from field and other methods.

Several integrating methods developed by sedimentologists can help define the most probable subsurface conditions based on limited exploration data. These methods inlcude several sedimentological facies modeling techniques. New three-dimensional geographic information system (GIS) can help model and visualize the resulting subsurface characterization data. Hydrogeologic properties can be estimated for defined litho-hydrologic units and supplied to appropriate numerical models to evaluate ground water flow and contaminant transport conditions.

These methods have been applied to a six-mile stretch of the South Platte River shallow alluvial aquifer near Platteville, Colorado. Numerous borehole and well logs were available. These were re-evaluated and combined with additional geophysical surveys to create two detailed stratigraphic profiles across the valley near the upstream and downstream test site boundaries. Facies architecture techni-

ques were used to infer sedimentary conditions between these observations and thus develop continuous cross-sections. The same techniques were then applied to project conditions, first downstream, and then upstream, to complete four intermediate transverse cross-sections and two longitudinal profiles. These steps produced twenty-one plates (maps, cross-sections, and longitudinal profiles) showing the spatial distribution of fine (clay) to coarse (sand and gravel) lenses. A three-dimensional visualization showing two merging channels demonstrated the utility of recently developed three-dimensional GIS technology. A three-dimensional finite element groundwater flow and contaminant transport model (CFEST) was used to evaluate the ground water conditions. Geohydrologic characteristics of the subsurface units were identified from the facies architecture data.

The numerical model readily produced a simulated water table which closely replicated the observed conditions and satisfied flow velocity constraints. These investigations show it is possible to obtain suitable estimates of the geohydrologic spatial trends from limited exploration data.

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