Simulation of Short Circuit Flow Paths and Transient Conditions to Understand Vulnerability of Public Supply Wells to Contamination in the High Plains Aquifer, York, Nebraska

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Abstract
The High Plains aquifer is a primary source for drinking-water supply in many areas of the High Plains. Several wells in the area are known to be screened in both the unconfined and confined portions of the aquifer which may provide a preferential pathway, or “short circuit”, for water moving from the unconfined to the confined units of the aquifer. As part of the U.S. Geological Survey National Water- Quality Assessment Program, a ground-water flow and transport model was developed to simulate processes controlling movement of contaminants to public supply wells in the layered unconsolidated deposits of the High Plains aquifer near York, Nebraska.

Water-quality samples were collected from wells screened through unconfined and confined water-bearing units. Samples also were collected from a public supply well, screened in the confined portion of the aquifer. Analytical results show that samples collected from the public supply well have chemistry and age-tracer concentrations consistent with young water derived from unconfined recharge areas mixed with relatively older waters from the confined part of the aquifer. This implies the existence of preferential flow paths that permit shallow recharge water and contaminants to move through the confining layer.

To test the conceptual model developed from the measured water-quality data, a transient ground-water flow and transport model was constructed assuming seasonal ground-water withdrawals over a 60-year period simulated using the multi-node well package, which allows water to flow

between different layers through the simulated well. A new version of MODFLOW-GWT (Ground-Water Transport) was used to simulate particle movement through the system, while also assigning ages to the particles. The simulations indicate that the transient conditions and wells screened through multiple layers can introduce shallow recharge waters and contaminants to lower layers, increasing the vulnerability of public supply wells completed in the confined system to contamination from unconfined waters.