ANALYSIS OF GROUNDWATER FLOWPATHS AND POTENTIAL FOR INTERSTATE MIGRATION OF CONTAMINANTS IN THE VICINITY OF THE SAVANNAH RIVER SITE, GEORGIA AND SOUTH CAROLINA, 2002–2020

Gregory S. Cherry

AUTHOR: Hydrologist, U.S. Geological Survey, 3039 Amwiler Road, Suite 130, Peachtree Business Center, Atlanta, Georgia 30360-2824
REFERENCE: *Proceedings of the 2005 Georgia Water Resources Conference*, held April 25–27, 2005, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. Analysis of advective particle tracking was performed to assess the potential for waterborne contaminants to migrate from the U.S. Department of Energy's Savannah River Site (SRS), beneath the Savannah River, and into Georgia (transriver flow). A variety of hazardous materials including radionuclides, volatile organic compounds, and trace metals are either disposed of or stored at several locations at the SRS (Fig. 1*A*). A previously developed U.S. Geological Survey (USGS) model simulating 1987–92 conditions (Clarke and West, 1998) was updated to reflect the observed hydrologic conditions during September 2002. Pumpage and boundary conditions were adjusted for the steady-state simulation of dry conditions during 2002. These adjustments reduced inflows from the source-sink layer and along lateral boundaries and resulted in lower simulated heads and decreased groundwater discharge to streams (Cherry, 2004).

The groundwater flow system was simulated using the USGS three-dimensional finite-difference model, MODFLOW-2000 (Harbaugh and others, 2000) and a quasi-three-dimensional approach with seven layers—six active layers and an overlying source/sink layer—that are separated by six confining units. The aquifers (represented by the layers) are, in order of decreasing depth, the Upper Three Runs aquifer (source-sink layer), Gordon, Millers Pond, upper and lower Dublin, and upper and lower Midville aquifers. Along a segment of the Savannah River between Augusta and the SRS, the seven aquifers are incised by the river, resulting in strong groundwater and surface-water interaction dominated by groundwater discharge to streams.

The previous model (Clarke and West, 1998) was used to simulate groundwater flow under 2002 conditions and a variety of future hypothetical pumping scenarios. Hydrologic conditions and groundwater pumping were extrapolated to the year 2020 based on groundwater use trends from 1980–2000 (Fanning, 2003). The following four steady-state scenarios were developed to evaluate a range of conditions affecting hypothetical solute migration from the SRS: (1) 2002 observed pumping and boundary conditions for an average year; (2) 2002 observed pumping and boundary conditions for an average year with SRS pumping discontinued; (3) projected 2020 pumping and boundary conditions for an average year; and (4) projected 2020 pumping and boundary conditions for a dry year.

The particle-tracking code MODPATH (Pollock, 1994) was used to generate advective water-particle path lines and time-of-travel based on MODFLOW simulations of the four scenarios. Simulated groundwater flowpaths for each of the four pumping scenarios indicate that time-of-travel from recharge areas originating near central SRS (D and K Areas) westward into Georgia range from about 80 years to 1,100 years (Fig. 1*B*). The shortest time-of-travel was for particles moving vertically from the base of the Upper Three Runs aquifer (layer A1) and then laterally through the Gordon aquifer (layer A2) beneath the Savannah River to discharge points in Georgia. Time-of-travel for the shortest flowpaths ranged from 80 to 415 years from recharge areas between D and K Areas (Fig. 1*A*). Based on simulated travel times, transriver flow for particles penetrating into the deeper Dublin aquifer system (layers A3–A5) was longer, ranging from 340 to 1,600 years. These particles enter the groundwater system near K Area and move downward into the Dublin aquifer system (layers A3–A5) before migrating laterally toward Georgia, where they discharge into the Gordon aquifer (layers A2). Particles entering the groundwater system north of L Area and moving laterally through the Dublin aquifer system ranged from 1,600 to 2,400 years. Travel times and particle pathways for the various pumping scenarios are similar; however, the shutdown of SRS production wells slows the downward migration of particles through the Dublin aquifer system (layers A3–A5) and median travel times for transriver flow are increased by about 50 years. These MODPATH results only represent advection and do not represent other physical, chemical or biological mechanisms of solute transport such as hydrodynamic dispersion or retardation.

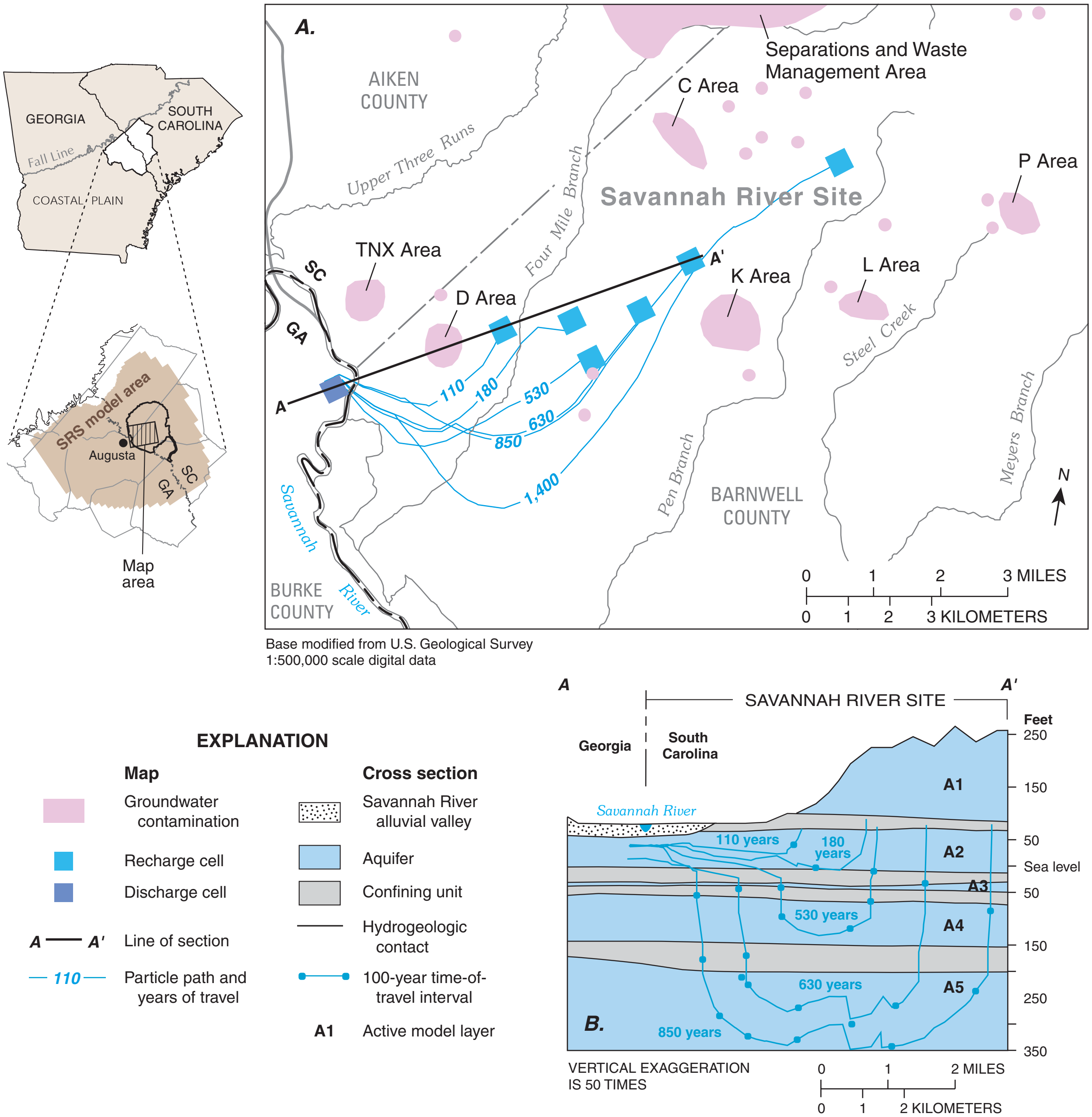

Figure 1. Simulated transriver flow areas and ground-water contamination sources on Savannah River Site (SRS).

LITERATURE CITED

Cherry, G.S. 2004. Evaluation of an existing ground-water flow model under 2002 hydrologic conditions in the vicinity of the Savannah River Site, Georgia and South Carolina. In *2003 Annual Meeting and International Conference of the American Institute of Hydrology*, "Achieving Sustainable Water Resources in Areas Experiencing Rapid Population Growth." Atlanta, Georgia, October 19–22, 2003. American Institute of Hydrology, Hydrological Science and Technology, v. 20, no. 1–4, pp. 27–38.

Clarke, J.S., and C.T. West. 1998. Simulation of ground-water flow and stream-aquifer relations in the vicinity of the Savannah River Site, Georgia and South Carolina. U.S. Geological Survey Water- Resources Investigations Report 98-4062, 134 pp.

Fanning, J.L. 2003. Water use in Georgia by county for 2000 and water-use trends for 1980–2000. Georgia Geologic Survey Information Circular 106, 176 pp.

Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald. 2000. MODFLOW-2000, The U.S. Geological Survey modular ground-water model – User guide to modularization concepts and the ground-water flow process. U.S. Geological Survey Open-File Report 00-92, 121 pp.

Pollock, D.W. 1994. Users Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U.S. Geological Survey finite-difference ground-water flow model. U.S. Geological Survey Open-File Report 94-464, 188 pp.