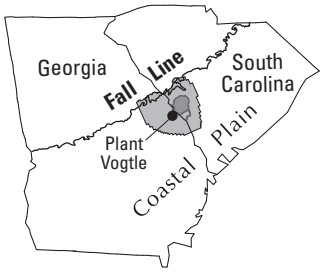
Simulation and Particle-Tracking Analysis of Selected Ground-Water Pumping Scenarios at Vogtle Electric Generation Plant, Burke County, Georgia



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Cooperator U.S. Nuclear Regulatory Commission

Year Started 2007

Problem

The Vogtle Electric Generation Plant (VEGP), in Burke County, Georgia, is one of Southern Company's two nuclear-generating facilities in Georgia. On August 15, 2006, Southern Nuclear Company applied to the U.S. Nuclear Regulatory Commission (NRC) for an early site permit (ESP) for an additional two reactors at the site. As part of the ESP permitting process, the NRC is charged with development of an environmental impact statement (EIS) to evaluate the effects of constructing and operating these new reactors on the site and surrounding area. The EIS must describe the magnitude and nature of expected effects on ground water resulting from present and potential future ground-water withdrawal. The assessment should include the area of VEGP and extend for distances great enough to cover potentially affected aquifers, including those within the boundary of the U.S. Department of Energy, Savannah River Site (SRS), located in South Carolina across the Savannah River from VEGP. The addition of two new reactors (Units 3 and 4) at VEGP will require an increase in pumping from the lower Dublin and upper and lower Midville aquifers, which currently provide the water needed for reactor Units 1 and 2. NRC would like to evaluate the effects of additional pumpage on ground-water flow in the surrounding area.

Objectives

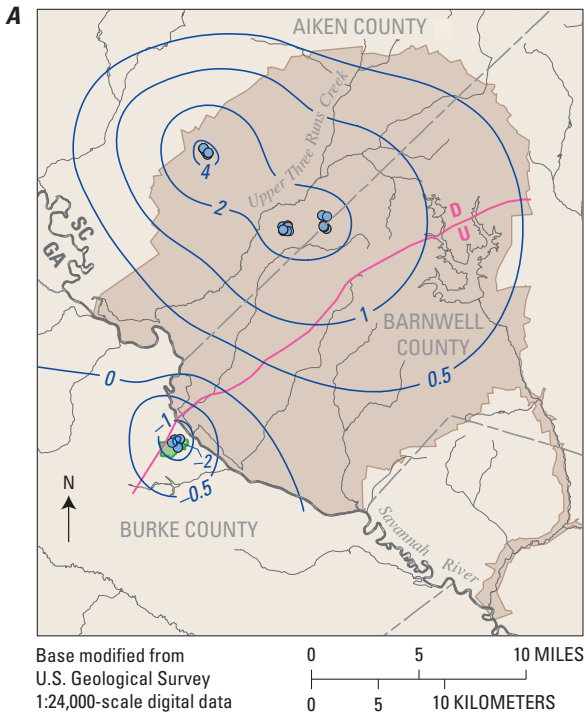
- Simulate the effect of current (2002) and potential future pumping on ground-water levels and flow paths near VEGP for three pumping scenarios in a 4,455-square-mile area near Augusta, Georgia.
- Compare simulated water levels to a Base Case representing 2002 pumping rates throughout the model area.
- Conduct a particle-tracking analysis for each scenario to determine the source of water for VEGP production wells.
- Describe the pumping distribution, simulated water-level changes, and ground-water flow paths relative to the Base Case.
- Define the limitations of the model analysis.

Progress and Significant Results, 2006–2007

- An updated and calibrated MODFLOW ground-water flow model (Cherry, 2006) was used to simulate the effect of current and potential future pumping on ground-water levels and flowpaths near VEGP for a Base Case representing year 2002 conditions and three pumping scenarios (see table). The pumping scenarios focused on pumping increases at VEGP based on projected future demands and the addition of two electrical-generating reactor units. Scenarios simulated pumping increases at VEGP ranging from 1.09 to 3.42 million gallons per day (Mgal/d), with one of the scenarios simulating the elimination of 5.3 Mgal/d of pumping at the SRS. The largest simulated water-level changes at VEGP were for the scenario whereby pumping at the facility was more than tripled, resulting in drawdown exceeding 4–8 feet (ft) in the aquifers screened in the production wells. For the scenario that eliminated pumping at SRS, water-level rises of as much as 4–8 ft were simulated in the same aquifers at SRS.
- Results of MODFLOW simulations were analyzed using the U.S. Geological Survey particle-tracking code MODPATH to determine the source of water and associated time of travel to VEGP production wells. For each of the scenarios, most of the recharge to VEGP wells originated in an upland area near the Burke and Jefferson County line. None of the recharge originated on the SRS or elsewhere in South Carolina. An exception occurs for the scenario whereby pumping at VEGP was more than tripled. For this scenario, some of the recharge originates in an upland area in eastern Barnwell County, South Carolina. Simulated mean time of travel from recharge areas to VEGP wells for the Base Case and the three other pumping scenarios was between about 2,700 and 3,800 years, with some variation related to changes in head gradients because of pumping changes (see table).

Reference

Cherry, G.S., 2006, Simulation and particle-tracking analysis of ground-water flow near the Savannah River Site, Georgia and South Carolina, 2002, and for selected water-management scenarios, 2002 and 2020: U.S. Geological Survey Scientific Investigations Report 2006–5195, 156 p.; Web-only publication available at *http://pubs.usgs.gov/sir/2006/5195/*.



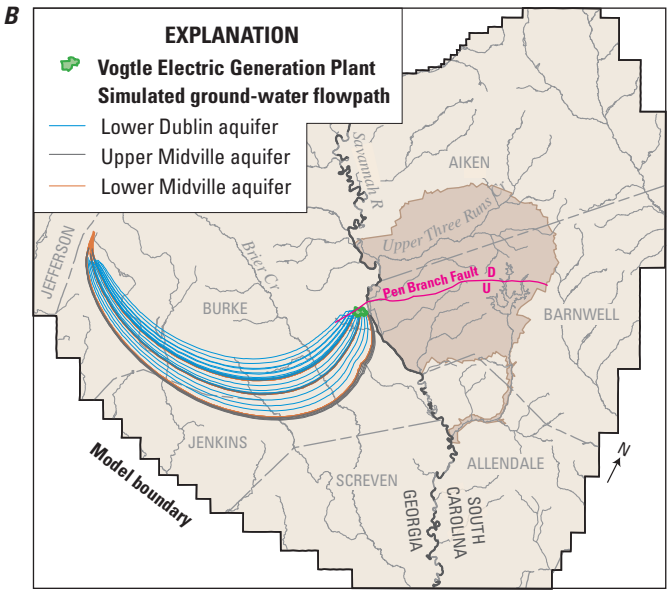
EXPLANATION

Vogtle Electric Generation Plant

D / U — **Pen Branch Fault**—Approximately located; D, downthrown side; U, upthrown side

— 1 — **Line of equal simulated water-level change**—Interval, in feet, is variable. Computed by subtracting the simulated potentiometric surface for 2002 Base Case from the simulated potentiometric surface for Scenario B

Production well—Completed in the upper Midville aquifer in which pumping was adjusted for scenario



(A) Water-level change in the upper Midville aquifer and (B) particle-tracking results. For Scenario B, the largest water-level changes were on the SRS, with maximum increases of greater than 4 ft in the Gordon aquifer, greater than 1 ft in the Millers Pond aquifer, greater than 4 ft in the upper Dublin aquifer, greater than 8 ft in the lower Dublin aquifer, and greater than 4 ft in the upper and lower Midville aquifers. The water-level rise resulting from elimination of SRS pumping reduced the effect of pumping at VEGP on ground-water levels. Maximum declines near VEGP were greater than 2 ft in the upper and lower Midville aquifers, greater than 1 ft in the lower Dublin aquifer, and greater than 0.5 ft in the upper Dublin aquifer. There was no observed change at VEGP in the overlying Gordon and Millers Pond aquifers. Simulation results for scenario B indicate that ground-water recharge is provided in an upland area near the Burke and Jefferson County line, with a mean simulated time of travel of about 2,700 years (yr) in the lower Dublin aquifer, about 3,300 yr in the upper Midville aquifer, and about 3,200 yr in the lower Midville aquifer. The fastest simulated time of travel was for a particle in the lower Dublin aquifer (about 2,100 yr), and slowest was for a particle in the upper Midville aquifer (about 5,200 yr). None of the recharge originated on SRS or elsewhere in South Carolina.

Simulated pumpage at VEGP.

[gal/min, gallons per minute; Mgal/d, million gallons per day]

Scenario	Pumping rate		Remarks
	gal/min	Mgal/d	
Base Case 2002	724	1.04	Current conditions for existing reactor units
A	1,482	2.13	Additional pumping capacity of new reactor units at average projected withdrawal rates
B	1,482	2.13	Additional pumping capacity of new reactor units at average projected withdrawal rates and elimination of 5.3 Mgal/d pumpage at Savannah River Site
C	3,099	4.46	Scenario represents a higher rate of withdrawal for the proposed new reactor units during their startup period (3.42 Mgal/d), and continuation of year 2002 pumping rates (1.04 Mgal/d) in the existing reactor units.

Summary of simulated travel time for scenarios in the VEGP model.

[For the simulation, 10 particles were assigned to each aquifer layer in 3 model cells for a total of 30 particles per layer]

Aquifer (model layer)	Statistic	Simulated time of travel in years			
		Base Case	Scenario		
		2002	A	B	C
Lower Dublin (A5)	Mean	2,700	2,700	2,700	3,800
	Median	2,700	2,600	2,700	3,000
	Maximum	3,600	3,700	3,900	12,600
	Minimum	2,100	2,100	2,100	1,800
Upper Midville (A6)	Mean	3,100	3,100	3,300	2,800
	Median	2,800	2,700	2,700	2,500
	Maximum	3,700	4,700	5,200	4,000
	Minimum	2,700	2,300	2,300	1,800
Lower Midville (A7)	Mean	3,100	3,100	3,200	2,800
	Median	2,900	2,800	2,800	2,500
	Maximum	3,800	4,200	4,600	4,000
	Minimum	2,700	2,400	2,400	2,400