

Characterization of preferential ground-water seepage from a nutrient contaminated aquifer to the Neuse River, Raleigh, North Carolina

Presenter: Kristen B. McSwain¹,
Co-authors: Richard E. Bolich², and Melinda J. Chapman³

1 U.S. Geological Survey, North Carolina Water Science Center, Raleigh, NC 27607; tel (919) 571-4022; email: kmcswain@usgs.gov 2 N.C. Dept. of Environment and Natural Resources, Div. of Water Quality, Aquifer Protection Section, Raleigh, NC 27699 3 U.S. Geological Survey, North Carolina Water Science Center, Raleigh, NC 27607

A hydrogeologic research station was installed on the site of the Neuse River Wastewater Treatment plant, in eastern Wake County, North Carolina to investigate the interaction between ground water containing elevated concentrations of nutrients and the Neuse River. Local ground-water quality has been impacted by the over application of biosolids, with shallow ground water concentrations of nitrate greater than 80 milligrams per liter (mg/L). Recent work to characterize the hydrogeologic flow conditions at the research station has revealed preferred pathways for groundwater flow into the Neuse River that bypass the established riparian buffers. Ground-water flow in the study area consists of an interconnected three-component ground-water system: a regolith/alluvium surficial aquifer, a transition zone of coarse-grained media, and a bedrock aquifer of fractured granite intruded by several near vertical tabular diabase dikes. The Neuse River has incised the regolith to the underlying transition zone, which serves as a preferential pathway for ground water flow as it has a higher hydraulic conductivity than the overlying regolith or the underlying fractured bedrock. Data collected by the USGS during previous investigations indicate that ground-water discharge to the Neuse River in the area of the research station is controlled by both the presence of the transition zone and a subsurface impermeable diabase dike that bisects the Neuse River, creating a preferential flow path of ground water discharge, or seep. To investigate the interaction between the ground water and the Neuse River, two multi-port piezometers were installed in the river bed to allow the collection of ground water and measurement of hydraulic head from depths of 10, 20, 30, 40, 50, 80, 110, and 140 centimeters beneath the bed sediments. One piezometer was installed in bed sediments upstream of the diabase dike while the second piezometer was installed downstream of the diabase dike in a seep. Hydraulic measurements indicated no measurable vertical head gradient in the upstream piezometer and an upward vertical gradient in the seep. In December 2007, water samples were collected from each port of the piezometers and from the Neuse River in the vicinity of each piezometer. Concentrations of nitrite+nitrate in samples at the up-gradient piezometer ranged from 3 to 91 mg/L with a median of 52 mg/L and were 0.4 mg/L in the Neuse River (9 samples). In samples at the down-gradient piezometer, concentrations of nitrite+nitrate ranged from 42 to 82 mg/L with a median of 79 mg/L and were 0.5 mg/L in the Neuse River (9 samples). The maximum concentration of nitrite+nitrate measured in both piezometers was comparable to concentrations measured in nearby wells tapping the regolith, indicating little immobilization or denitrification of nitrogen along the flow path. The study showed that ground-water flow and discharge are allowing the migration of nutrients from ground water to the Neuse River. The rate of ground-water discharge and nitrate flux are of particular interest during times of drought when the Neuse River discharge is primarily base flow.