Hydrologic Monitoring to Characterize Dominant Controls of Ground-Water Flow and Transport in an Area of Confined Animal Operations on a Mantled Karst Terrane, Northwestern Arkansas

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The Savoy Experimental Watershed (SEW) is a University of Arkansas property of approximately 1,250 hectares (ha) in northwestern Arkansas. The SEW occurs on a mantled (regolith-covered) karst and is the site of an integrated research effort between the University of Arkansas, Arkansas Department of Environmental Quality, Agricultural Research Service of the U.S. Department of Agriculture, and the U.S. Geological Survey. As part of the integrated research effort, a long-term, interdisciplinary field laboratory will be developed for the in-situ quantitative determination of processes, controls, and hydrologic and nutrient-flux budgets in surface-water, soil-water, and shallow ground-water environments in response to specific, near-surface confined animal operation (CAFO) activities and land uses. Comprehensive research at SEW encompasses the detailed aspects of flow and solute budgets (1) from precipitation, (2) from near-surface anthropogenic activities, (3) in runoff, (4) from within the soil zone, (5) at the epikarst, (6) from within identifiable components of the shallow karst aquifer, and (7) at spring resurgences. This presentation is limited to selected elements of budget terms (5), (6), and (7), with the objective of relating areal, stratigraphic, and temporal variations in water quality to identifiable CAFO activities and to ground-water processes and controls. Current CAFO activities in basin 1 at SEW have focused on cattle and poultry.

Continuous hydrologic monitoring at SEW includes measuring precipitation in 0.01-inch increments, and measuring interflow, epikarst flow, streamflow, water levels in selected wells, spring discharge, and appropriate water-quality parameters, all at 15-minute increments with automated probes and samplers. Discrete samples of groundwater from the previously mentioned sources are also collected throughout selected storm hydrographs (at about 1-hour increments) for analyses of water-quality constituents not easily measured by existing sensors. These data provide a wealth of information that allows mass-balance calculations, boundary-flux determinations, and water-quality evolution, all within a well-constrained areal and temporal framework amenable to numerical simulation at a site-specific scale.

Understanding gained at SEW has been applied to studies of CAFO sites elsewhere in the mantled-karst areas of the southern Ozarks, and has been used to guide data-collection rationale. Preliminary conclusions of interest are:

1) Temporally random sampling not keyed to specific hydrologic flow conditions is of little value, and does not characterize important transport features of the system;
2) Sampling from springs in karst terranes integrates the most important components of the flow system, as contrasted to sampling from wells, which typically are indicative of only a single flow component;
3) Dissolved nitrate concentrations in ground water from CAFO areas of northwest Arkansas range from 0.5 to greater than 50 milligrams per liter (mg/L). Most nitrate concentrations in ground water are less than 5 mg/L, and most of the concentrations greater than 20 mg/L have been traced to failed septic systems, and not CAFO sources;
4) Dissolved phosphorous species in ground water typically are less than 0.5 mg/L. Ground-water flow paths do not appear to be major pathways of dissolved phosphorus transport in this hydrogeologic setting;
5) Pathogen densities in ground water are dependent on flow conditions, and have been observed to range from less than 10 to greater than 500,00 colony forming units per 100 milliliters (cfu/100 mL) from the same spring. Pathogen transport in karst aquifers appears to involve resuspension of microbes from the sediment, with highest concentrations occurring at the leading edge of flood pulses; and
6) Pharmaceuticals from CAFO areas are transported in ground water, but the concentrations measured thus far in Northwest Arkansas are below the microgram per liter level.

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