Report for 2002NC1B: Hydrolgical and Biogeochemical Investigations of Riparian Buffers in the Piedmont and Blue Ridge Regions of North Carolina

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  - Allen, Donna, Craig J. Allan and Jy Wu, 2003, Hydrological and Biogeochemical Investigations of Riparian Buffers in the Piedmont and Blue Ridge Regions of North Carolina, in NC WRRI Annual Meetings, Raleigh, NC, ww2.ncsu.edu/ncsu/cil/wrri.allen.pdf.

Report Follows:

Title: Hydrological and Biogeochemical Investigations of Riparian Buffers in the Piedmont and Blue Ridge Regions of North Carolina

Problem and Research Objectives: The ongoing research project is quantifying the pollutant removal efficiency and hydrologic characteristics of vegetated riparian buffers in the western Piedmont and the Blue Ridge physiographic regions of the North Carolina. Data from the project will be used to help determine the effectiveness of riparian buffers in reducing Non Point Source (NPS) pollutant loadings to surface waters in hydrogeologic regions of the state where their use has not been fully investigated. The research will also be used to evaluate the potential of riparian buffers in controlling the NPS loadings of bacteriological contaminants to surface waters. Both aspects of the project will provide information with regard to the water quality benefits associated with vegetated riparian buffers to assist planners and resource managers when faced with decisions regarding development within floodplains. The objectives are to: 1) Define the subsurface hydrogeologic conditions at each study site through the construction of flow nets to identify subsurface flow paths, 2) Quantify subsurface flow inputs of nutrients to the receiving stream channel, and finally 3) Measure the attenuation of groundwater transported pollutants moving from field edge through the riparian buffer; and parameterize the numerical flow model.

Methodology: Two transects running from the field edge to the center of the stream channel have been instrumented at each of the two study sites. Transects at each site were sited in areas representing average slope, width and vegetative cover. Surface flow is sampled and quantified through samplers consisting of plastic bottles inserted in the ground with an opening at ground level. The objective is to quantify surface water inputs into the streamside buffer and monitor the attenuation of pollutants as they pass through the buffer. Two to three samplers are installed along each sampling transect.

Piezometers and groundwater wells have been installed at various locations along each transect including the streambed. Each piezometer is screened and water levels determined manually with an electronic depth sensor. Hydraulic conductivity is determined through Hvorslev water level recovery method (Freeze and Cherry 1979). Groundwater levels are continuously recorded at select sites with Druck Pressure transducers logged by a Campbell Scientific (CS) data logging system. Cl^- (a conservative element) and dissolved O_2 concentrations will be measured along with the pollutants of concern to delineate zones where conditions are favorable for pollutant removal. Groundwater flow through the riparian buffers will be calculated by three different methods to bracket our flow estimates. Firstly, two-dimensional flow nets will be constructed from the piezometric head data and combined with the hydraulic conductivity data to measure ground water flow (Freeze and Cherry 1979, Roulet 1990). Secondly, a series of detailed dilution gauging measurements will be made at different groundwater stages along each channel to directly quantify net ground water inputs to the stream channel. A third approach involves the use of the numeric model to predict hydrochemical transport at each site. The utility of this final approach is dependent upon a sufficient length of field data to both calibrate and test the model.

Infiltration rates are being determined with flooding ring infiltrometers. Hydraulic conductivity (K_u) in the unsaturated zone is profiled through the unsaturated zone with a Guelph Permeameter and relations established between soil moisture content and hydraulic conductivity (Reynolds and Elrick 1985). Soil moisture levels are being continuously recorded at each site with logged CS soil moisture reflectometry probes. Tension lysimeters have been installed at two

depths at each site to monitor soil solution chemistry. The purpose of this phase of the project is to quantify the transport of water and pollutants through the vadose zone of the riparian buffer and assess changes in volumetric soil moisture content to aid in the solution of the water balance. Stream flow through each buffer is monitored with an automatic water sampler/flow meter below each study area. Streamflow and water samples are recorded at the EPA downstream gauging station at the Kiser Dairy site. Stage discharge relationships are being established for the Blue Ridge site through manual gauging at different stream stages**.** All chemical and bacteriological analyses are performed at UNC Charlotte. NO_3^-, NH_4^+, Cl^- and ortho-P analyses are performed on a Dionex IC system. Total P determinations are performed colormetrically after sample digestion. Suspended sediment concentrations are determined gravimetrically after filtration. Dissolved O_2 is measured in the field with a portable O_2 meter. Dissolved organic carbon (DOC) and TN is analyzed with a Shimadzu TOC/TN analyzer. Fecal coliform are determined by method 9221 E (APHA 1998).

Progress Report: Year 1

1. Selection of Piedmont (Kiser Dairy) and Blue Ridge (Brevard) study sites (April 2002)
2. Installation of Piezometer and GW Wells at Kiser (June 2002) and (Nichols Branch (Septptember 2003)
3. Initiation of regular monitoring of Gaston County (July) and Brevard (September) sites. Monitoring is continuing on a regular schedule.
4. Analysis of Brevard and Kiser Dairy samples for major ions by IC, pH conductivity and total phosphorus is ongoing. Analyses of total nitrogen on archived subsamples will begin in June 2003.
5. Sedimentological and mineralogical analysis of Core Samples from Kiser Dairy and Brevard sites has been completed (May 2003).
6. Topographic surveys at the Kiser Dairy and the Brevard Piezometer networks have been completed and monitoring network templates have been developed.
7. The field measurement of hydraulic conductivity (K_{sat}) are ongoing at the Kiser dairy site and will begin later this summer at the Brevard site.
8. Initial results from the project were presented at the April 1, 2003 Annual NC WRRI meetings in Raleigh.

We have had a successful first year and the project is running with a regular two out of three week sampling schedule both study sites. Beyond the regular sampling the remaining field tasks involve the measurement of hydraulic conductivity for each piezometer at the Brevard location and the sampling for fecal coliform bacteria at both sites. We will also install additional piezometers at both sites to “flesh-out” our monitoring network. Sample analyses are ongoing and we expect all backlogged analyses to be completed by August 2003.