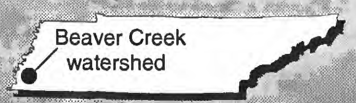
THE BEAVER CREEK STORY

Beaver Creek watershed in West Tennessee covers about 95,000 acres and includes some of the Nation's most productive farmland and most highly erodible soils. A preliminary assessment of the Beaver Creek watershed, conducted by the Tennessee Department of Environment and Conservation, indicated that agricultural activity was degrading water quality. In 1989, the Tennessee Department of Agriculture (TDA) and the U.S. Geological Survey (USGS) began a cooperative study (1) to evaluate the effect of agricultural activities on water quality in the watershed and (2) to determine the effectiveness of agricultural best management practices (BMP's) designed to improve water quality by reducing agricultural nonpoint-source (NPS) pollution.



The project gained momentum in 1990, when the Beaver Creek watershed was added to the U.S. Department of Agriculture's list of Hydrologic Unit Areas, qualifying it for educational, technical, and financial resources to improve water quality. A local coordinating committee was formed consisting of county, State, and Federal agencies, and, most importantly, local farmers. Each group had some responsibility for the Beaver Creek project, such as technical information about conservation methods, financial assistance, education, BMP implementation, or water-quality evaluation.

The following questions were considered before conducting this study:

- Where should the watershed be monitored for NPS pollution?
- What parameters should be monitored to measure NPS pollution?
- When is the most effective time to collect data that represents NPS pollution?
- What is the effect of implementing agricultural BMP's on water quality?

These questions have been answered. The results from these studies are summarized in this brochure.

WHERE TO MONITOR?

Agrichemical monitoring included testing the soils, ground water, and streams. Four farm sites ranging in size from 27 to 420 acres were monitored. Monitoring stations were operated downstream to gain a better understanding of the water chemistry as runoff moved from small ditches into larger streams and, eventually, to the outlet of the Beaver Creek watershed.

WHAT TO MONITOR?

Soil loss (suspended sediment), nutrients (fertilizers), and pesticides were monitored to determine if they were getting into the stream. Pesticides and nutrients also can percolate into the soils, therefore, agrichemical migration in the soil was evaluated to determine if ground water was affected. The biological health of the stream was measured by collecting and identifying aquatic organisms at numerous stream sites.

Information was needed to define the migration of agrichemicals in the soil and streams. The number of soil and water-quality samples was established from preliminary studies so that an adequate representation of the concentrations and loads was obtained.

WHEN TO MONITOR?

Agrichemicals can be flushed from the fields during storm runoff. Thus, stream sampling took place during rain events. Soil and ground-water samples were collected after storm infiltration to see if the agrichemicals moved downward to the water table.

MONITORING ACTIVITIES

Soil Profile Within the Fields

Five soil samples were collected between two rows and mixed together to represent a single location in the field (fig. 1). These soil composites were duplicated at several locations in a field to establish a representative distribution of pesticides over time and space. Samples were collected at different depths each time to determine if the pesticides were moving into the ground water.

Streams Draining the Fields

An optimal sampling strategy for characterizing chemicals and suspended sediment in agricultural runoff includes frequent sampling during stormflow and less frequent sampling after a storm and during periods of dry weather. A sampling interval equal to 5 percent of stormflow duration was determined to be adequate to characterize concentrations of constituents during stormflow with an error of less than 5 percent. Thus, for stormflow durations of 100 and 300 minutes, sampling intervals were 5 and 15 minutes, respectively.

The health of a stream is reflected by the number and types of bottom-dwelling organisms living in the stream (biomonitoring). Biomonitoring results varied greatly, depending on the sampling technique used. Potential biases resulting from the various sampling techniques were reduced by using several different sampling techniques.

Soil and Ground-Water Results

No-till farming techniques did not increase ground-water contamination in the Beaver Creek watershed. Horizontal dispersion of aldicarb sulfoxide, a metabolite of aldicarb, in the soil profile was negligible. The transport of aldicarb sulfoxide downward was minimal in the conventional-till and in the no-till fields. About 85 percent of this metabolite was found within the first half foot below the soil surface; none was detected below 2.5 feet. The shallow depth of transport is attributed to the low permeability of the soils, decreased amounts of rainfall, and high rates of evaporation and plant transpiration during the summer months.

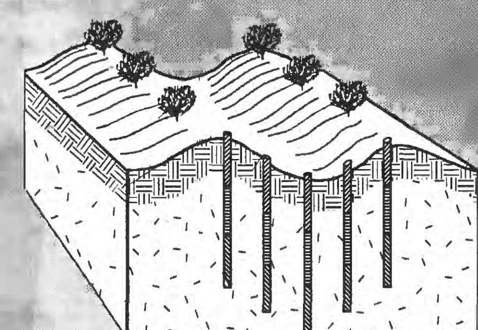


Figure 1. *Schematic of the soil sampling strategy.*

Natural, nonbiological reactions appear to be the primary mechanism for degrading aldicarb and its metabolites in the soil profile. The calculated half-lives of aldicarb metabolites in the field were much less than those derived from laboratory experiments. In the laboratory, the toxic by–product of aldicarb can last almost 3 years, but in cotton fields, it degrades to nontoxic compounds in about 2 weeks.

Pesticide contamination of ground water is not a problem in the Beaver Creek watershed. Ninety–five domestic wells in the watershed were sampled for aldicarb, atrazine, and alachlor in summer 1992. Aldicarb was not detected in any of the wells. Concentrations of atrazine detected in two wells and alachlor in three wells were less than proposed primary drinking water standards.

Significantly higher nitrate concentrations were measured in water from wells near septic tanks and confined animal facilities than from wells near fertilized fields. Wells deeper than about 150 feet were not affected by surface- or near-surface nitrate sources.

Surface-Water Results

Suspended sediment resulting from erosion is the major water-quality problem in the watershed. Runoff from no-till fields is cleaner than runoff from conventional-till fields. However, the cleaner water entering ditches and streams can become contaminated with sediment eroded from the stream channel. This process of sediment contamination is more accelerated in the channelized streams commonly found in the Beaver Creek watershed. Excessive suspended sediment interferes with biological habitat and normal decomposing of nutrients and pesticides in the streams.

Approximately 80 percent of the total nitrogen carried by storm runoff is organic nitrogen. About 75 percent of this organic nitrogen is flushed from the fields during late winter and early spring storms. Thus, BMP's that prevent field erosion during the non-growing season can help to reduce nitrogen runoff. Inorganic nitrogen (nitrate and nitrite) is only 20 percent of the total nitrogen runoff load. About 50 percent of this inorganic nitrogen is flushed from the fields during late spring storms. Only 10 percent of the inorganic nitrogen runoff occurs during the growing season probably because of assimilation and less precipitation.

From 1991 to 1995, aldicarb and its metabolites (aldicarb sulfoxide and aldicarb sulfone) were detected in runoff from the farm fields with the highest concentrations measured during a storm event only hours after aldicarb was applied. This result demonstrates the importance of weather conditions and farming activities on agricultural runoff. No aldicarb was detected in storm-runoff samples collected a few weeks after application. However, the metabolites were detected as late as 76 days after an aldicarb application.

Effectiveness Of BMP's

Prior to the implementation of BMP's at one of the farm study sites, some storms produced an average suspended-sediment concentration of 70,000 milligrams per liter (mg/L). After the implementation of BMP's, however, the average value never exceeded 7,000 mg/L, which is a tenfold reduction.

No-till crop production was the most effective BMP for conserving soil on the farm fields tested. Other studies also have found that no-till farming preserves the structure of the soil and retains the crop residues from the previous season.

A natural bottomland hardwood wetland and a constructed wetland were evaluated as instream resource-management systems. The wetlands improved water quality downstream by acting as a filter and removing a significant amount of NPS pollution from the agricultural runoff. The constructed wetland reduced the nutrient, sediment, and pesticide load by approximately 50 to 90 percent over a 4-month period (fig. 2).

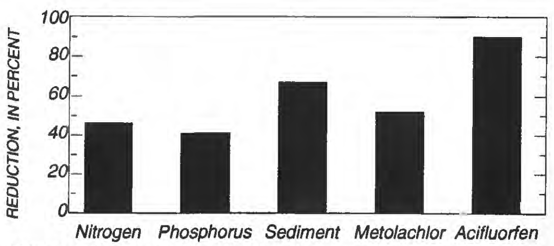


***Figure 2.** Percent reduction in constituent loads for March 27, 1995 through August 4, 1995.*

Streambanks tend to be more stable if vegetated with large trees rather than herbaceous plants; however, downcutting can still occur.

The results of the Beaver Creek watershed study have increased the understanding of the effects of agriculture on water resources. Study results also demonstrated that BMP's do protect and improve water quality. This information can help water managers, farmers, and others to protect and improve the quality of the environment for future generations.

REFERENCES

Byl, T.D., and Carney, K.A., 1996, Instream investigations in the Beaver Creek watershed in West Tennessee, 1991-95: U.S. Geological Survey Water-Resources Investigations Report 96-4186, 45 p.

Doyle, W.H., and Baker, E.G., 1995, Collection of short papers on the Beaver Creek watershed study in West Tennessee, 1989-94: U.S. Geological Survey Open-File Report 95-156, 54 p.

Organizations involved in assessment studies in the Beaver Creek area:

U.S. Department of Agriculture, Natural Resources Conservation Service
U.S. Department of the Interior, U.S. Geological Survey
Tennessee Department of Agriculture
Tennessee Department of Environment and Conservation
Shelby County Soil and Water Conservation District
University of Tennessee Agricultural Extension Service
The University of Memphis
Clemson University
The Tennessee Soybean Promotion Board

For more information contact:

District Chief	Subdistrict Chief
U.S. Geological Survey	U.S. Geological Survey
810 Broadway, Suite 500	7777 Walnut Grove Road
Nashville, Tenn. 37203	Memphis, Tenn. 38120
(615) 736-5424	(901) 766-2977
	e-mail:whdoyle@usgs.gov

Further information can be obtained by contacting your County Extension Agent. An Extension Publication Catalog can be obtained by e-mailing: SandraJ@AES.gw.utk.edu. Requests for a specific publication can also be e-mailed to this address.

In the future, Extension publications will also be available through the world wide web at http:/.funnelweb.utcc.utk.edu/utest/pubs.html.

Copies of this report may be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, Colorado 80225-0286

What does all this mean to the farm community and the people that work with them?

- Sediment from erosion, not pesticides or nutrients, is the greatest surface-water quality problem in the Beaver Creek watershed.
- No-till practices are the most effective BMP's implemented in the Beaver Creek watershed. These practices reduced soil loss within 1 year.
- No-till practices did not increase ground-water contamination in the Beaver Creek watershed, probably because the clay soils in the watershed restrict water movement and absorb the contaminants.
- Fertilizers were not major contributors to nitrogen contamination of surface water. Current fertilizer management practices are effective. Most nitrogen came from plant residues.
- Aldicarb was found in stream-water samples only when it rained soon after application. By not spraying just before a storm, farmers may save money and improve pest control in addition to protecting water quality.
- Natural wetlands and constructed wetlands reduce sediment, nutrients, and pesticides in runoff from row crops.
- Trees along streams benefit insects and other aquatic life by stabilizing the water chemistry and aquatic habitats.
- Tree preservation also helps control streambank erosion.

These investigations also provide information that may be useful to other watershed monitoring projects:

- Biomonitoring can give a measure of water quality, but the results depend on the methods. Using several different methods improves reliability and reduces chances of error.
- Taking frequent samples during storms and less frequent samples between storms and during dry periods provides accurate surface-water-quality data.
- The location of monitoring stations influences results. Clean runoff from a no-till field can pick up sediment and other contaminants from the streambed, banks, or a contaminated ditch.
- A composite soil sample from the row top, slope, and furrow position on a line at a right angle to the crop row provides representative samples for contaminant movement in the soil.
- Contaminant concentrations in soil vary both with field location and with time. Take a number of samples from the field over time for more accurate results.
- Pesticide breakdown under field conditions may be much quicker than in the laboratory.

This material is based in part upon work supported by the U.S. Department of Agriculture, Extension Service under project number 95-EHUA-1-0137.

Open-File Report 96-398

THE BEAVER CREEK STORY

By W. Harry Doyle, Jr., Bob G. Whitworth, George F. Smith, and Tom D. Byl

Prepared by the
U.S. GEOLOGICAL SURVEY

in cooperation with
THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXTENSION SERVICE

Nashville, Tennessee
1996