Maryland

Warner Creek Watershed
Section 319
National Monitoring Program Project

Figure 21: Warner Creek (Maryland) Watershed Project Location

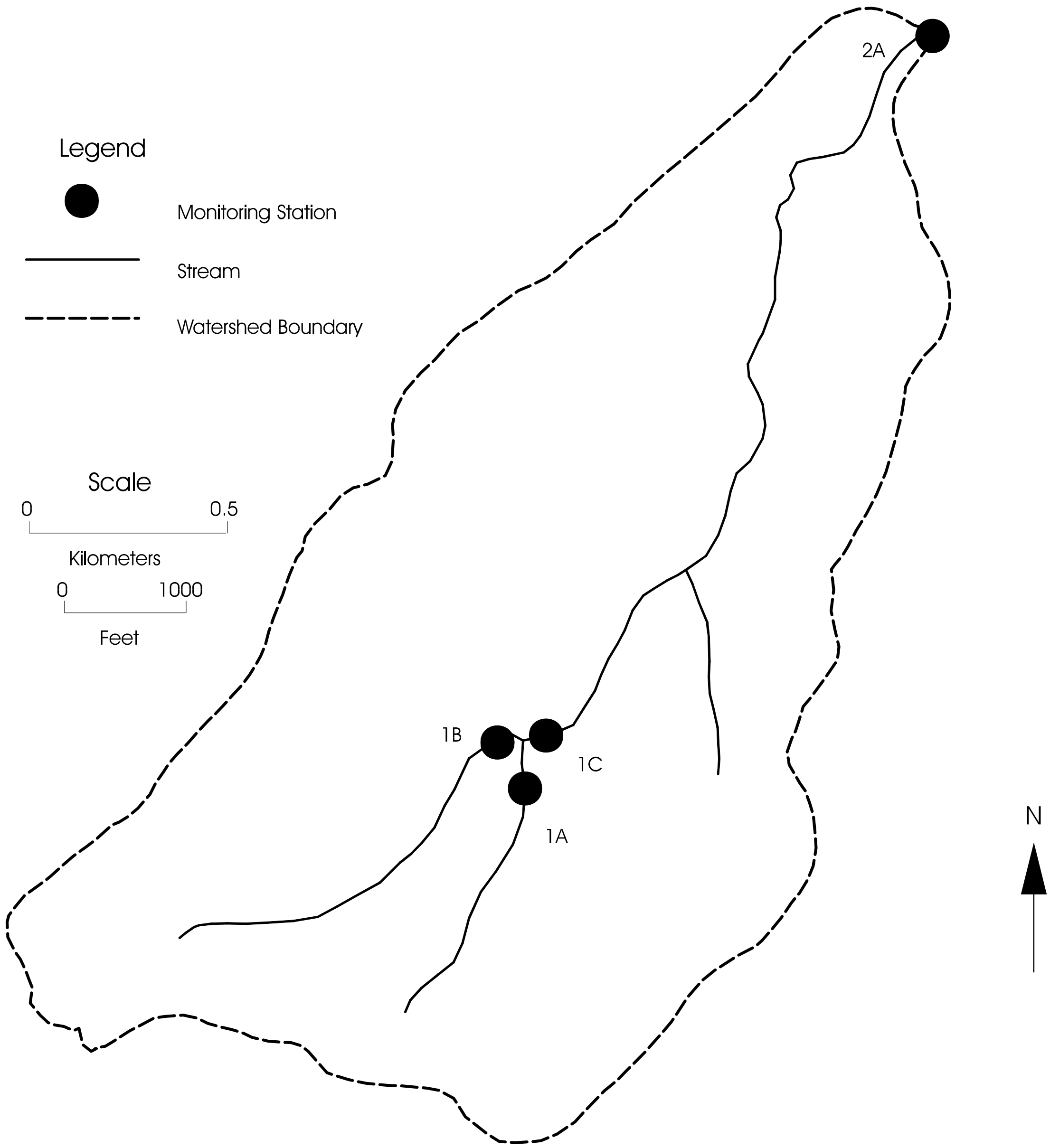

Figure 22: Water Quality Monitoring Stations for Warner Creek (Maryland) Watershed

PROJECT OVERVIEW

The Warner Creek watershed is located in the Piedmont physiographic region of northcentral Maryland (Figure 21). Land use in the 830-acre watershed is almost exclusively agricultural, primarily beef and dairy production and associated activities.

Agricultural activities related to dairy production are believed to be the major nonpoint source of pollutants to the small stream draining the watershed. A headwater subwatershed, in which the primary agricultural activity is dairy farming (treatment), was compared to another subwatershed, in which the primary agricultural activity is beef production (control).

Proposed land treatment for the treatment watershed included conversion of cropland to pasture, installation of watering systems, fencing to exclude livestock from tributary streams, and the proper use of newly constructed manure slurry storage tanks.

Water quality monitoring involved both paired watershed and upstream/downstream experimental designs. Sampling occured at the outlets of the paired watersheds (stations 1A and 1B) and at the upstream/downstream stations (1C and 2A) on a bi-weekly basis (Figure 22). Storm-event sampling by an automatic sampler occured at station 2A. Water samples were analyzed for sediment, nitrogen, and phosphorus.

Warner Creek is a subtributary of the Monocacy River basin. Monitoring data were used to evaluate the suitability of a modified version of the CREAMS and/or SWAT model for its use in the larger Monocacy River basin and elsewhere in Maryland.

Many of the BMPs in the treatment subwatershed (IB) were implemented. Post-implementation monitoring terminated December, 2003.

PROJECT BACKGROUND

Project Area

Approximately 830 acres.

Relevant Hydrologic, Geologic, and Meteorologic Factors

The watershed is in the Piedmont physiographic province. Geologically, bedrock in this area has been metamorphosed. Upland soils in the watershed belong to the Penn silt loam series with an average slope of three to eight percent. Average annual rainfall near the watershed is 44-46 inches.

Land Use

The land use in the upper portion of the watershed monitored by stations 1A, 1B, and 1C (Fig 20), is a mixture of dairy, beef, pasture, and cropland. The branch of the upper portion of the watershed, subwatershed 1A, does not have any dairy operation and that makes it very distinct from subwatershed 1B. The dominant surface cover in the upper portion of the watershed is pasture. This subwatershed (1C, sum of 1A and 1B) occupies about 324 acres. The rest of the watershed toward the downstream section (subwatershed 2A) is also under dairy, beef, pasture, and cropland. The area under subwatershed 2A is about 506 acres.

Water Resource Type and Size

Warner Creek is a small stream with a drainage area of about 830 acres, all of which are included in the study area. Its average discharge is 30 gallons per minute. Warner Creek drains into a tributary that drains into the Monocacy River basin.

Water Uses and Impairments

Other than aquatic life support, no specific uses or impairments are listed for Warner Creek. However, the watershed is characteristic of the region and impairment of Chesapeake Bay for recreation and aquatic life support by excessive nutrient loads from land runoff is a significant regional issue.

Pollutant Sources

The major sources of pollutants are thought to be the dairy operations and the associated cropland. Pastures in which cows have unlimited access to the tributary streams also contribute significant amounts of pollutants.

Pre-Project Water Quality

Seven weeks of pre-project water quality monitoring at four stations yielded the following data:

Nitrate (mg/l)	Nitrite (mg/l)	Ammonia (mg/l)	TKN (mg/l)	TKP (mg/l)	Orthophosphorus (mg/l)
3.3-6.7	.01-.05	0-23.0	0-73.0	0-6.7	0-3.6

Source: Shirmohammadi and Magette, 1993

Water Quality Objectives

The objectives of the project were to

- develop and validate a hydrologic and water quality model capable of predicting the effects of agricultural best management practices (BMPs) on water quality, both at the field and basin scale;
- collect water quality data for use in the validation of the basin-scale hydrologic and water quality model; and
- apply the validated model to illustrate relationships between agricultural BMPs and watershed water quality in support of the USDA Monocacy River Demonstration Project.

Project Time Frame

Preliminary work on the project began in May, 1993; however, the project was not approved until June, 1995.

PROJECT DESIGN

Nonpoint Source Control Strategy

Upstream/Downstream Study Area (1C and 2A):
Best management practices planned for this area included construction of watering systems for animals, fencing animals from streams, and the proper use of newly constructed manure slurry storage tanks. Conversion of cropland to pasture was also anticipated in this area.

Most of the planned BMPs for subwatershed 2A were installed in 1992 and 1993. These BMPs included conversion of cropland to pasture, installation of a watering trough(s) for the animals, fencing out the animals from the streams, and the use of the newly constructed slurry storage tanks for farms on the eastern and western portions of subwatershed 2A. The cost-shared contracts were signed in March 1995 and implementation began in July 1995. Most of the BMP implementation in this portion of the watershed was completed.

Monitoring stations for this project were carefully selected to isolate areas where a major NPS pollution problem existed that would be addressed with an individual BMP (or category of BMPs). For this project, the BMP consisted of a manure management system (two farmers have already installed a 520,000 gallons Slurry Storage system in their respective farms). Integral to such a system was a nutrient management plan that met USDA-SCS FOTG standards, as well as Cooperative Extension Service guidelines, and Maryland Department of Agriculture specifications.

BMP adoption is a voluntary process in Maryland, as it is across the U.S. The adoption process is enhanced, however, by efforts of Soil Conservation District and Cooperative Extension Service personnel. Because the Monocacy watershed, where this project was located, was a major BMP demonstration project, BMP adoption was promoted to an even greater degree.

As elsewhere, Conservation planning by the local Soil Conservation District (SCD) formed the basis of voluntary adoption in the project area. Conservation planning involved a farmstead assessment of potential and actual NPS pollution problems. Conservation plans to address such problems were written by the SCD for farms in the project area. However, implementation of these plans and the BMPs they specify was entirely voluntary and it was not possible to mandate implementation. As an example, two major farmers in the watershed have installed the Slurry Storage System (each with 620,000 gallons capacity) in their farm for managing manure as was promoted and cost-shared by SCD and USDA—Agricultural Stabilization and Conservation Service (ASCS)—in 1993. Conservation plans and BMPs proposed for the critical pollution area of the watershed, subwatershed 1B, were installed in Summer and Fall of 1995.

Impacts of nonpoint sources to ground water, and to surface water via ground water, were generally assessed by both the monitoring and modeling aspects of this project. It is beyond the scope and funding of the project to attempt a more rigorous examination of these potential impacts.

<u>Paired Watershed (1A and 1B)</u>:
The implementation of BMPs in the treatment (1B) watershed began in July 1995. Installed BMPs included waste storage structure, nutrient management, loafing at runoff management, stream crossing, water trough, livestock exclusion fencing, and critical area seeding. Additional BMPs including conservation cropping and tillage systems, crop residue, and cover crop management, interceptions/diversions around milking parlor, silage stack and loafing were installed later.

Water Quality Monitoring

The water quality monitoring component incorporated two designs:

- Upstream/downstream on Warner Creek
- Paired watersheds in the uppermost areas of the watershed

Parameters Measured

Chemical and Other

Ammonia (NH_3)
Total Kjeldahl nitrogen (TKN)
Nitrate + nitrite (NO_3+NO_2)
Nitrite (NO_2)
Orthophosphorus (OP)

Total Kjeldahl phosphorus (TKP)
Sediment

Covariates

Rainfall
Discharge: instantaneous (1A, 1B and 1C) continuous (2A)

Sampling Scheme

Upstream/Downstream Study Area (1C and 2A) (Figure 20):
Type: grab (1C and 2A); automated storm event (2A)
Frequency and season: weekly from February to June and biweekly for the remainder of the year (1993 through 1995) and biweekly since 1996.

Paired Watershed (1A and 1B) (Figure 20):
Type: grab (1A and 1B)
Frequency and season: weekly from February to June and biweekly for the remainder of the year.

Four additional sampling stations were added between sites 1C and 2A to further define nutrient levels in Warner Creek.

Monitoring Scheme for the Warner Creek Watershed Section 319 National Monitoring Program Project

Design	Sites or Activities	Primary Parameters	Covariates	Frequency of WQ Sampling	Frequency of Habitat/Biological Assessment	Duration
Paired		NH_3, NO_2 + NO_3 TKN, OP, TKP, Sediment	Rainfall discharge	Weekly Feb. to June and bi-weekly the remainder of the year (1993-1995) biweekly since 1996		3 yrs. pre-BMP 1 yrs. BMP 1 yrs. post-BMP
Upstream/ Downstream	Warner Creek	TKN, NO_3+NO_2 NO_2 OP TKP Sediment	Discharge pH			

Land Treatment Monitoring

Land use information for 1991,1992, and 1993 was compiled using information from the Soil Conservation District Office in Frederick, Maryland. Land use tracking has been performed on about 2/3 of the watershed and it will be performed for the entire watershed. Land use data was collected on each tract of land and for every field identified by a number on the aerial photos obtained from USDA-ASCS office. For each field, data such as a crop type, tillage, and acreage was recorded. Land use data have been entered into the GIS database and overlaid on topographic and soils data on the same coordinate system. BMP implementation by management area was also tracked.

The focus of much of the land treatment effort was in the drainage area to monitoring site 1B as this site had the highest loading of nitrogen and phosphorus. In 1996, an animal waste storage system, roof runoff management system, and partial fencing along a stream channel were installed; however, high nutrient export from the area continued. In 2001, the landowner installed a retention pit for milkhouse waste, interceptor tiles for silage effluent, and 9.5 acres of riparian corridor (40 ft. on either side) along stream channels.

Modifications Since Project Started

Biweekly sampling frequency was increased to weekly sampling during the wet season. Data for 1996, 1997, and portion of 1998 are in the FFY97 Annual Report (Table 3).

DATA MANAGEMENT AND ANALYSIS

Data Management and Storage

Testing of the SWAT model against monitoring data indicated that it showed good promise for predicting hydrologic and water quality response.

Monitoring data are stored and analyzed at the University of Maryland. In addition, some project data were reported using the Nonpoint Source Management System (NPSMS) software.

Project Findings

Water quality data indicate that despite long term monitoring, unusual climatic and hydrologic conditions similar to the conditions in 2003 can result in unstable watershed responses. For instance, mean nitrate-N concentrations in all four monitoring stations were unusually high (about 250 mg/L) compared to previous years with 4-8 mg/L. These high means were the consequence of wet conditions during and after hurricane Elizabeth (September 19, 2003). It is hypothesized that several storms including hurricane Elizabeth caused groundwater level to rise to near root zone area in the watershed where there may have been the abundance of nitrate-N, thus resulting in discharge of high amount of this constituent via subsurface flow into the stream.

Monitoring results documented that 70% of the total nitrate-N discharging from the watershed was carried by subsurface flow. Pollutant load reductions resulting from BMP implementation in 1996 could not be documented. Because the timing of BMP implementation could not be adequately controlled, the project was unable to isolate distinct pre-treatment and post-treatment water quality data. Thus, the project was unable to document the impacts of BMPs primarily because the statistical analyses required for paired-watershed and upstream-downstream studies could not be carried out. The primary success of the project was in calibrating and validating the SWAT model for broader use in Maryland nonpoint source projects, including TMDLs.

INFORMATION, EDUCATION, AND PUBLICITY

The project drew support from University of Maryland Cooperative Extension Service (CES) agents, the Natural Resources Conservation Service (NRCS) and Frederick Soil Conservation District offices in Frederick, Maryland, and project specialists located in the Monocacy River Water Quality Demonstration offices, several of whom have established lines of communication between watershed farmers and the local personnel of the relevant USDA agencies. Education and public awareness was conducted through the CES in the form of tours, press releases, scientific articles, and oral presentations.

TOTAL PROJECT BUDGET

Project Element	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Monitoring						
Personnel	$41,600	$32,500	$45,000	$49,000	$62,500	$67,000
Equipment	10,000	3,000	NA	NA	NA	NA
Other	26,733	35,938	37,140	34,190	39,725	39,626
TOTALS	78,333	71,438	82,140	83,190	102,225	106,626

Source: FFY94 Work Plan (6/23/94).

IMPACT OF OTHER FEDERAL AND STATE PROGRAMS

The USDA Monocacy River Demonstration Watershed Project facilitated the dissemination of information gained from the project and helped provide cost-share funds for implementing BMPs.

OTHER PERTINENT INFORMATION

Other aspects of this project dealt with the calibration and validation of the SWAT model with the measured hydrologic and water quality data. Overall results indicated that SWAT is an excellent model to be used for annual simulation of hydrologic and water quality response of mixed land use watersheds. However, its use for shorter time intervals such as daily or even monthly intervals has shortcomings. It was concluded that the SWAT model can provide an excellent management guidance on a long term basis regarding land use impacts on hydrology and water quality. Long term monitoring studies such as the one conducted in this project are very helpful in compiling proper data-base that can help to validate models such as SWAT that are being recommended for TMDL analysis by US-EPA.

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Land Treatment and Water Quality Monitoring

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