# Executive Summary and Recommendations

## USDA Great Swamp Hydrologic Unit Area Project Final Report


**April 1996**

(This Executive Summary was written and designed by Michael T. Olohan, program associate in watershed management, Rutgers Cooperative Extension, Cook College, with helpful comments and assistance from selected HUA project technical advisory committee members. This publication and its dissemination was funded by a New Jersey Department of Environmental Protection Office of Environmental Services grant (NJDEP Project #95060). Special thanks to Gregory Westfall, water resources team leader, USDA NRCS, Somerset, NJ and Kent Hardmeyer, district conservationist, USDA NRCS, Morristown, NJ for their valued input into this final document.)

# Executive Summary

Your quality of life is affected by many factors including your occupation, health, family, friends, lifestyle, neighborhood, and the watershed you live in. While you probably don't think much about it, the quality of the water around you - from the water that comes out of your tap at home to the water quality of local streams, lakes, swamps, bays, and oceans - plays a large but often unrecognized role in your day-to-day quality of life.

We all live in watersheds. Simply put, a watershed is the land area that drains to a specific waterbody or water resource. Thus, a watershed is determined by the topography of the land that controls which way the water flows. The focus of this report - the Great Swamp watershed in north-central New Jersey - includes 55.4 square miles of land area or 35,000 acres that drain portions of 10 municipalities within Morris and Somerset counties. *(See **Map 1.**)*

In order to better understand how increased quantities of stormwater from watershed towns are affecting the Great Swamp watershed and its largest natural resource, the Great Swamp National Wildlife Refuge, three U.S. Department of Agriculture agencies undertook a five-year hydrologic unit area (HUA) project in 1991. Initiated by the USDA Natural Resources Conservation Service, Rutgers Cooperative Extension, and the Consolidated Farm Services Agency, the project is guided by an interagency partnership of federal, state, county and local agencies, along with private sector and nonprofit interests.

The USDA Great Swamp Hydrologic Unit Area (HUA) Project, part of USDA's national Water Quality Initiative and New Jersey's only HUA effort, conducted in-the-field research, data analyses and interpretation, public information, education, and participation activities, and demonstration programs aimed at facilitating the adoption of best management practices (BMPs) by specific audiences.

The overall HUA project goal is to provide local decisionmakers (public officials and community leaders of the 10 Great Swamp watershed municipalities) with the tools to evaluate, recommend, and implement strategies for reducing impacts of existing and proposed development on water quantity and quality as it impacts the Great Swamp National Wildlife Refuge. Four objectives established to help meet the goal include: 1) to determine the sources of sedimentation in Great Swamp watershed; 2) to develop and transfer geographic information system (GIS) technology; 3) to implement a comprehensive public information and education program; and 4) to use biological monitoring techniques to assess watershed water quality.

Below is a summary of issues addressed by the USDA Great Swamp HUA Project, including project findings and products. The summaries provide ***only selective information***. All of these topics are described in further detail in the complete USDA Great Swamp HUA Project Final Report. The term "Great Swamp" is used throughout this summary. Generally, it refers to the Great Swamp hydrologic unit area, or watershed. Following the summaries are "Recommendations" and a list of project contacts for further information and assistance.

## Water Quantity

The *quantity* of stormwater affecting the Great Swamp watershed has increased over the last 30 years due to land use changes such as development, redevelopment, and the increase in impervious surfaces. Other concerns include rising groundwater tables that may cause septic systems to malfunction and contaminate groundwater, and the effects of stormwater detention basins on peak flows. Using two NRCS hydrologic models (TR-20 and TR-55), and a Geographic Information System (GIS) specifically developed for the HUA, calculations were developed to estimate the runoff potential from each of 21 subwatersheds that drain into the Great Swamp National Wildlife Refuge. These calculations included soil types, land use, vegetation type, hydrologic condition, amount of impervious cover and surface storage area. Data was collected during 1993 at nearly 100 sites in the field to assess the watershed's hydrology.

Products/Findings

- *41% of the watershed's soils* are in USDA NRCS hydrologic soil group "D", which have the highest runoff potential and the lowest capacity to absorb precipitation (*See **Map 2***)

- *Over 31 different types* of land use/cover were analyzed and no significant changes were predicted between 1991 and 2001

- *Water quantity* entering Great Swamp National Wildlife Refuge was predicted based upon current and projected residential, commercial and industrial development in the subwatersheds. No conclusions could be drawn from the TR-20 hydrologic model because additional data was needed.

- *Lack of proper maintenance* impairs the effective functioning of many stormwater detention basins in Great Swamp watershed

## Sediment

Quantifying the amounts of sediment (eroded soil) that enter Great Swamp National Wildlife Refuge from its watershed was an important HUA project objective. Other contaminants (such as nutrients and petroleum residues) adhere to sediment and are carried in stormwater runoff to Great Swamp. Estimating sediment from specific tributaries thus provides clues to current land-use changes and where to focus sediment-reduction efforts. Estimates were developed using a well-established formula that accounted for six relevant factors. The factors include rainfall, soil erodibility, slope of the land, length of the slope, land cover, and erosion control.

Products/Findings:

- *The greatest potential* for sediment contamination - considering present and future land uses in the watershed - is from wooded land being developed into residential or

commercial properties

- *Three* of Great Swamp's five major tributary drainage basins - the Primrose, Great and Loantaka brooks - impact the swamp with increased sediment

- *Approximately 1,963 tons* of sediment per year reach the Great Swamp National Wildlife Refuge through the three major tributaries listed above. This estimate reflects only sheet and rill erosion, or the type of erosion that occurs on broad, continuous landscapes as calculated in the USDA Universal Soil Loss Equation.

- *Streambank erosion* needs further analysis to quantify its impact as a potential source of nonpoint contamination

## Water Quality

Two types of analysis were used to identify and assess the extent of water quality problems in the Great Swamp watershed. The first was a biological survey that focused on evaluating the types and density of specific benthic (bottom-dwelling) macroinvertebrates found at 17 sampling sites in the Great Swamp's five tributaries. Each tributary had two or three sampling sites. The second was a prediction of water quality in Great Swamp's 21 subwatersheds based upon the degree of imperviousness (including roads, parking lots, sidewalks, rooftops, and other impermeable surfaces) in each watershed. Based upon the percentage of imperviousness, streams in each subwatershed were given a generic ranking. *(See **Map 3.**)* Moreover, a comparative analysis of Great Swamp watershed imperviousness and the macroinvertebrate survey results was demonstrated using the GIS.

Products/Findings

- *Passaic River and Primrose Brook*, with lightly developed, predominantly wooded watersheds, rated good to excellent water quality with the largest numbers of pollution-intolerant macroinvertebrates found

- *Great Brook*, draining a watershed that contains wooded, open areas as well as a large number of lawns, residential/commercial development, and roads had intermediate water quality

- *Loantaka and Black brooks* generally had poor water quality due to larger developed areas, lower flow rates, and possible past impacts from wastewater treatment plant effluent

- *The headwater subwatersheds* of Great and Loantaka brooks - found to contain the highest amounts of imperviousness in a GIS analysis - also contained the poorest macroinvertebrate results based on the annual macroinvertebrate survey

- *The amount of imperviousness* in Great Swamp's subwatersheds is a good indicator of the health of streams in the subwatershed

- *Great Brook* showed improvement in water quality as it flowed downstream from an urban environment into a more rural residential area

## Water Quality Modeling

Generally, a water quality model attempts to simulate specific conditions that exist within a watershed such as soil types, elevations, and particular types of land uses such as housing and farms, to predict what types of water quality impacts will occur there. Using data from earlier water quantity studies, a Rutgers University Ph.D. candidate developed a model called the Water Resources Assessment Tool (WRAT). Application of this model helped to evaluate what areas may be contributing more sediment (and attached nutrients) to the National Wildlife Refuge.

Products/Findings:

- *A WRAT simulation* corroborated the results of the USDA's stream macroinvertebrate sampling on streams that showed good to excellent water quality

- *Sediment loss* could be predicted well in the watershed using the WRAT model

- *Loantaka Brook's* water quality problems are not being caused by sediment

- *The impacts of* "point sources" and best management practices need to be taken into account when assessing the role of sediment contamination in a subwatershed

## Demonstration Projects

The purpose of demonstration projects is to show the benefits of certain types of management techniques (i.e. best management practices) that assist farmers, homeowners, and other target audiences to enhance their property in ways that will also improve and protect the water quality. The two demonstration projects undertaken focused on increasing forested buffer areas along a stream and increasing the use of low-input (less fertilizers, pesticides, and water) grass types by watershed homeowners.

A forested buffer was planted along 1,100 feet between Primrose Brook and an adjacent Harding Township farm to show the short- and long-term benefits of a streamside forested buffer on water quality and fish and wildlife habitat. Cooperating on the streamside forest buffer planting effort was a private landowner, USDA Natural Resources Conservation Service, USDA Forest Service, Morris County Soil Conservation District, and the Passaic River Coalition. The forest buffer

effort is ongoing.

A low-input lawn care demonstration site was developed and maintained at Morris County Park Commission's Frelinghuysen Arboretum by Rutgers Cooperative Extension of Morris County. Visitors learned that low-input grasses provide a green lawn with less maintenance and expense and reduce the potential for surface or ground water contamination by nutrients that may run off to streams or leach to groundwater supplies. The low-input lawn care demonstration site will be maintained through 1997.

Products/Findings:

- *Approximately 200 trees* were planted to establish a riparian buffer between adjacent farmland and the Primrose Brook
- *A tree nursery* to supply trees to continue establishing riparian forest buffers was begun at a site supplied by the Somerset County Park Commission
- *437 acres* next to Great Swamp tributaries need forested riparian buffers. *(See **Map 4.**)*
- *76% of watershed residential soil samples* were found to have high or very high phosphorus levels versus 15% for agricultural lands
- *Only 21% of watershed homeowners* surveyed had tested their soil before applying fertilizers and other soil amendments
- *Approximately 70,000 pounds of nitrogen* is applied annually by homeowners
- *Approximately 17,000 to 32,000 pounds of phosphorus* fertilizer may be unnecessarily being applied by homeowners who follow a common multi-step fertilizer program
- *"Repel" perennial ryegrass* (a low-input grass demonstrated at the low-input site) had an 80% survival rate following a drought while the fescues and bluegrass had less than 20% survival rate
- *More than 100 coupons* requesting information/assistance were returned by visitors to the HUA Project low-input lawn care site since June 1993

## Information and Education

Rutgers Cooperative Extension (Cook College) has used traditional and innovative public information, education, and marketing programs to promote the HUA project's efforts and educate its target publics. Five audiences were targeted to build a consensus for action and implementation among watershed individuals, organizations, and agencies.

Traditional methods included development of a mailing list of watershed stakeholders. A free quarterly eight-page newsletter, *Swamp Sounds*, focused on different project themes and provided timely updates to 3,100 subscribers. Return coupons in the newsletter and brochures at the low-input lawn care demonstration site measured audience interest. Other traditional techniques included two audiovisual presentations (30-minute and 10-minute) educational displays on homeowner soil testing and homeowner backyard composting, news releases on HUA project activities, and presentations and testimony at watershed forums.

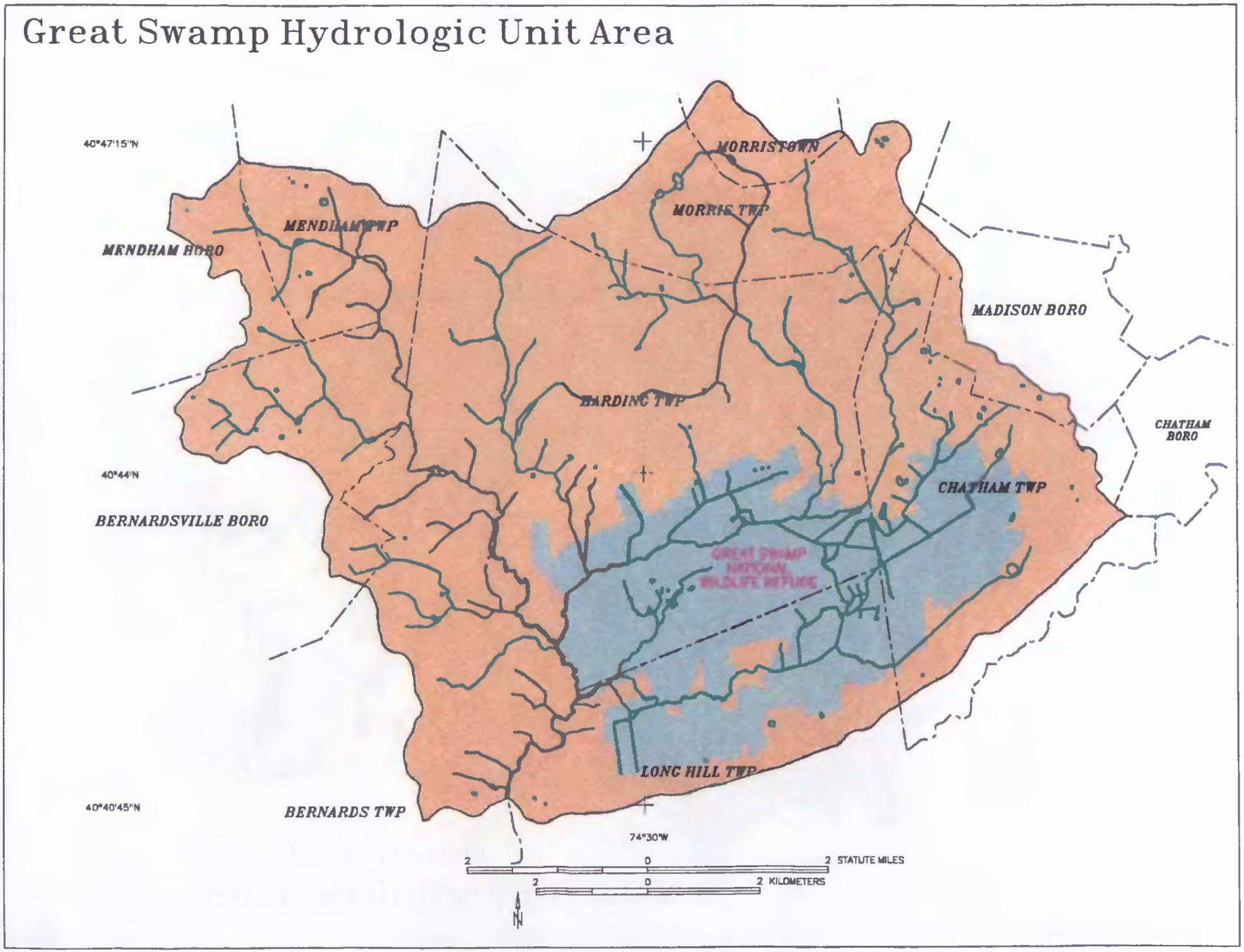
Innovative methods have included presenting 10 "Wednesday Watershed Workshops" at sites throughout the watershed that provided residents with the information, tools, and resources necessary to address local nonpoint sources of contamination; a pilot homeowner soil sampling outreach program that promoted residential soil testing and the correct application of fertilizers; a coordinated storm drain stenciling campaign that involved groups in six watershed communities; a free raffle of composting equipment at Morris County 4-H Fair; and an ongoing Great Swamp Photo Contest that highlights the Great Swamp National Wildlife Refuge's natural assets throughout the seasons.

Products/Findings:

- *16 quarterly issues of Swamp Sounds* were produced (4 more are planned in 1996)
- *An up-to-date 3,100-name mailing list* broken into 21 separate mailing categories that can be used to target specific watershed audiences
- *Audiovisual presentations* were made to approximately 2,000 citizens
- *Approximately 120 watershed homeowners* participated in the HUA pilot soil sampling outreach program in 1993 and 1994. This successful pilot program has been adapted and funded in two northern NJ watersheds that are the focus of nonpoint source prevention and management efforts by the NJ Department of Environmental Protection.
- *Individuals/organizations interested* in the HUA project grew from 200 in 1991 to 3,100 in 1995 due to effective outreach efforts at watershed events
- *Educational displays* describing the USDA Great Swamp Project were seen by approximately 300,000 people at public events/buildings from 1991 through 1995
- *Monthly workshops* on USDA Great Swamp Project initiatives were conducted in 1993 and 1994 and attended by approximately 350 citizens and community leaders
- *Conducted surveys* of septage haulers, local departments of public works, local elected officials, and watershed homeowners to evaluate related water quality concerns

(*continued on page 7 following maps*)

# Great Swamp Hydrologic Unit Area



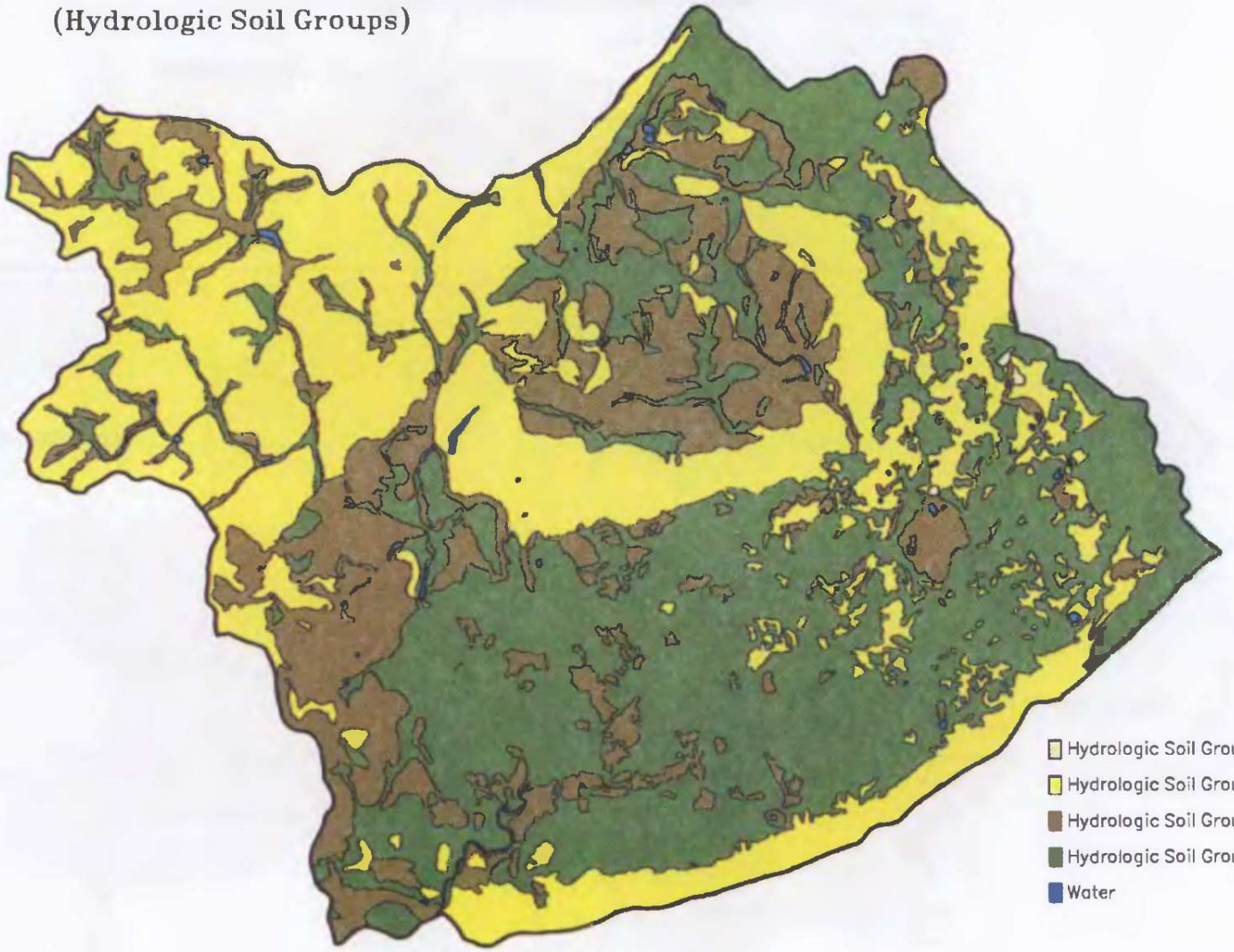

MAP 1

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

# Great Swamp Hydrologic Unit Area

## (Hydrologic Soil Groups)



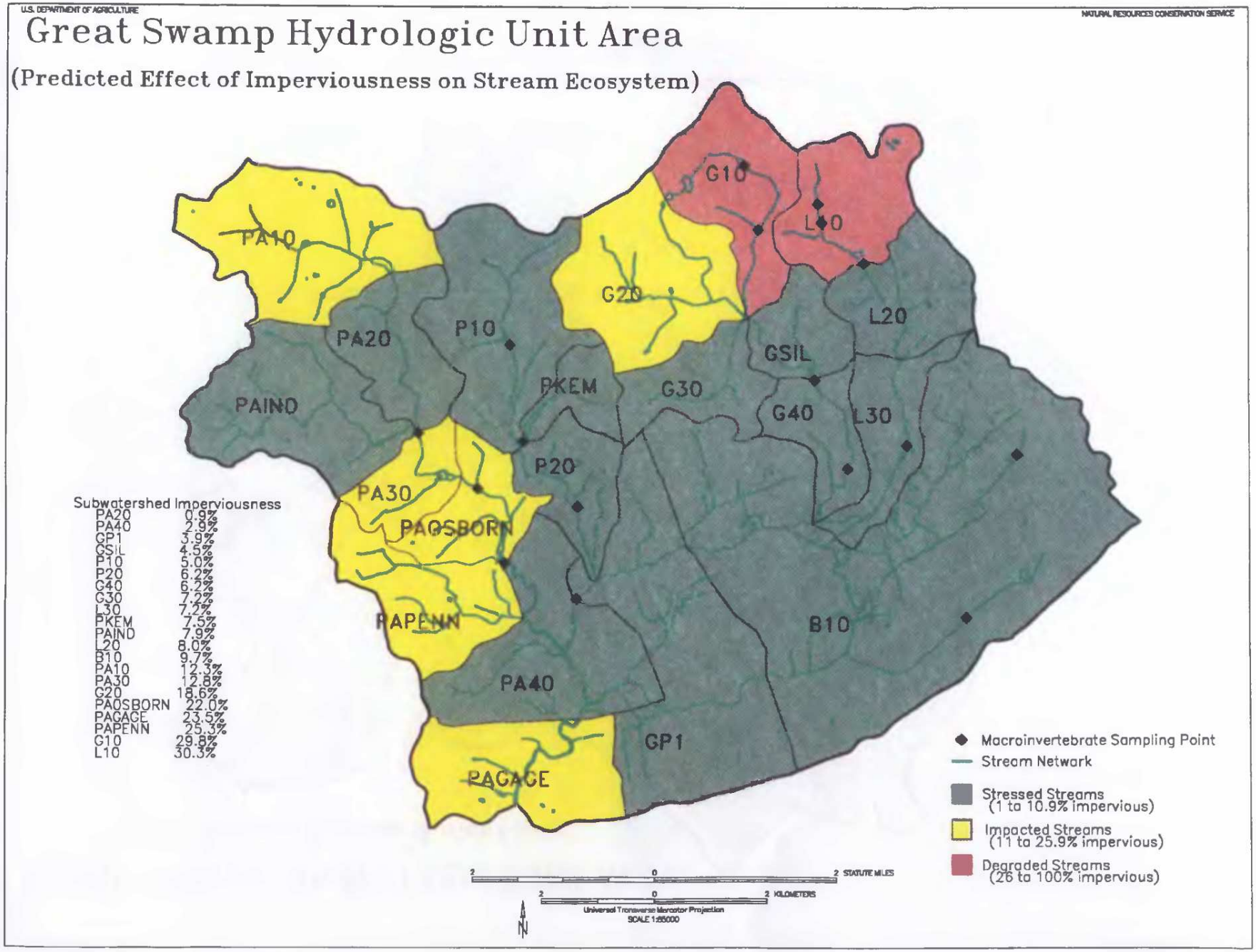

MAP 2

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

# Great Swamp Hydrologic Unit Area

## (Predicted Effect of Imperviousness on Stream Ecosystem)



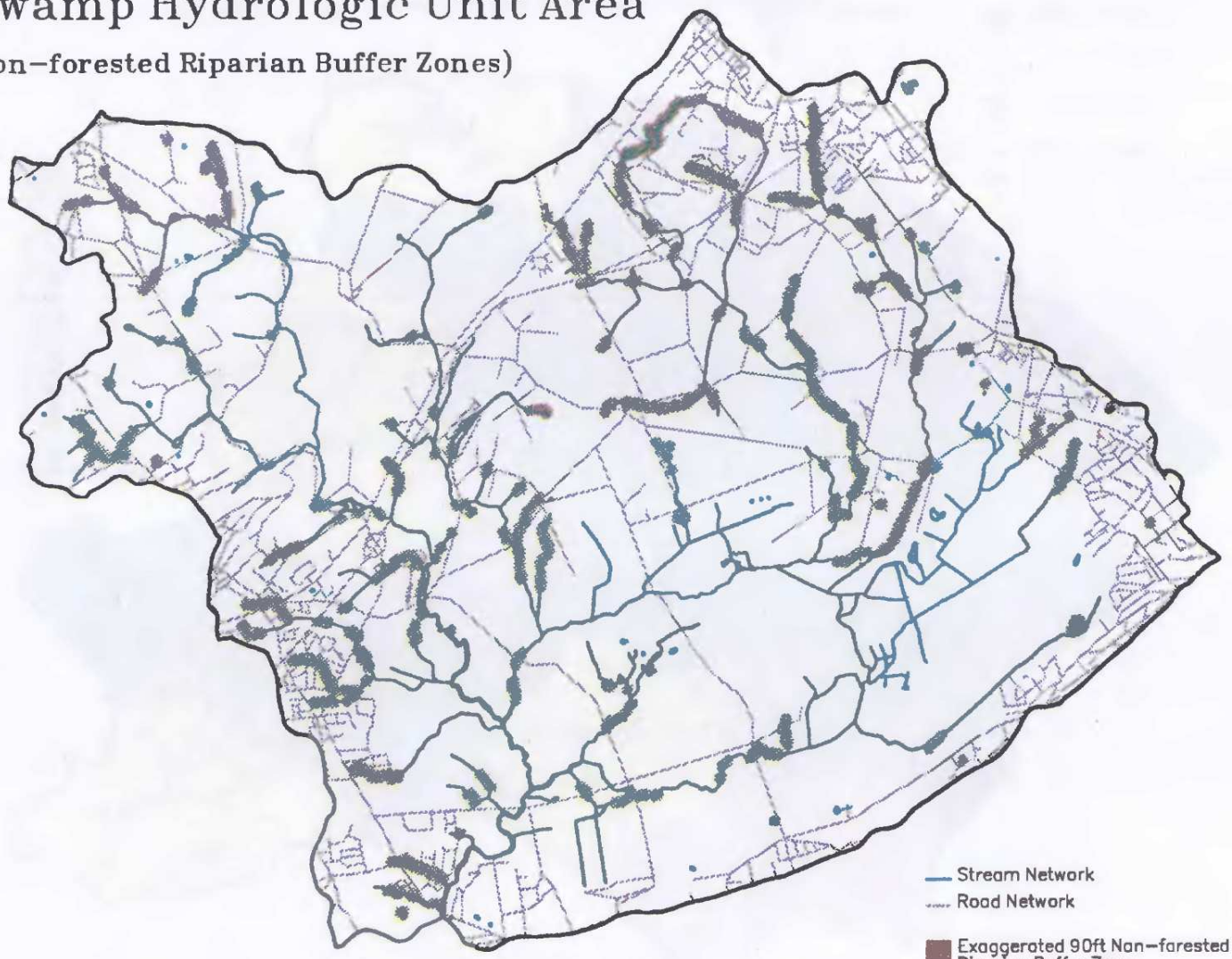

MAP 3

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

# Great Swamp Hydrologic Unit Area

## (Non–forested Riparian Buffer Zones)




MAP 4

Township, Morristown, Long Hill Township, Madison, and Bernards Township by local groups using USDA HUA stencils. The stenciling demonstrated to residents the connection between storm drains and local water quality.

- *Over 200 photographs* were submitted by outdoors photographers for the quarterly 1995 "Seasons of the Swamp" photo contest

- *Established private-sector partnerships* with a videographer, newspaper publishing company, and an environmental store to promote HUA programs to new audiences

# Recommendations

The USDA Great Swamp HUA Project recommendations were put into one of three categories: technical, institutional, or social. The recommendations are based on HUA Project study findings. The recommendations were not ranked. **The numbers were used for reference purposes only.** Prioritization of the recommendations is best left up to the watershed citizens, organizations, and agencies engaged in the continuing dialogue to improve water quality and preserve and protect the Great Swamp National Wildlife Refuge.

## Technical Recommendations

1. Develop a strategy for establishing second-level (or better) official geodetic survey monuments in the watershed for vertical control for the use of the hydrologic model and other hydrology study efforts.

2. Obtain additional stream cross-section elevation data (140 cross-sections needed) and/or topographic data to give better watershed representation and permit hydrologic modeling with greater accuracy.

3. Identify existing stormwater detention basins that may be retrofitted to improve water quality. Retrofit those basins which are feasible.

4. Plan, install and maintain best management practices with priority given to implementation on those areas with the greatest percent imperviousness.

5. Establish, preserve and enhance riparian buffers along tributaries to the Great Swamp following the best available technical information as to suggested widths, tree or other vegetative establishment and maintenance procedures.

6. Prevent/reduce potential sediment, chemical and thermal pollution from impervious surfaces through appropriate design and maintenance techniques.

7. Continue to utilize geographic information systems and biological stream monitoring to analyze the environmental and economic impacts of land use and natural resource management decisions in the watershed.

8. Encourage land use techniques that can help reduce nonpoint source pollution of the various land use types within the watershed.

9. Encourage continued water quality monitoring and upgrades in stream classifications as conditions change.

10. Establish additional stream gaging stations in the watershed to better quantify streamflow entering the Refuge.

11. Conduct an in-depth analysis of streambank erosion in the watershed.

12. Minimize imperviousness through land-use planning strategies that include reduced road widths, cluster development, shared driveways, smaller parking areas, sidewalks on one side of the street and other techniques.

## Institutional Recommendations

1. Establish an ongoing forum, led by Morris and Somerset counties, to implement the HUA project technical recommendations. Its goal is to enhance intermunicipal cooperation among land use decisionmakers to maintain and enhance water resources in Great Swamp watershed. It is recommended that this forum include USDA HUA agencies and other federal and state agencies and organizations for technical support.

2. Identify and assist local organization (s) to continue to use and update the TR-20 hydrologic model as land cover changes occur in the watershed over time.

3. Identify and assist federal, state and local agencies and organizations to develop a long-term strategy for coordination of existing water quality (such as macroinvertebrate surveys) and quantity monitoring in the watershed.

4. Address inadequate municipal enforcement of soil erosion and sediment regulations by immediately requesting the NJ Department of Agriculture State Soil Conservation Committee to assist the Morris and Somerset-Union soil conservation districts to take over the local program through a cooperative agreement or transfer of responsibility. Sediment from construction sites can be a significant nonpoint source problem.

5. Identify incentives and funding sources for providing needed cost-sharing opportunities for all agricultural operations which have the potential to cause nonpoint source pollution but do not meet various federal and state cost-sharing program eligibility criteria. (e.g. farm definition)

6. Evaluate the feasibility of establishing municipal or watershed level funding sources for managing water quality and quantity from existing as well as future development. The funding source should be capable of providing adequate funding for the coordination, installation and maintenance of best management practices.

7. Maintain existing stormwater detention basins (according to a maintenance plan)

by the responsible party.

8. Identify farmland-assessed acreage in the watershed and promote the planning and implementation of best management practices.

## Social Recommendations

1. Identify target groups and target all information and education efforts in a cost effective manner that has the best chance of reducing actual or potential contributions from a specific group.

2. Establish and maintain a demonstration educational and technical assistance program through the public, private and non-profit sectors to encourage the use of soil testing and low input lawn care practices, including the use of integrated pest management techniques.

3. Continue communications with publications, such as Rutgers Cooperative Extension's *Swamp Sounds*, the project's quarterly newsletter.

4. Provide incentives to individuals, businesses, corporations and municipalities through awards, certificates, signs and other recognition to reinforce environmentally responsible behavior.

5. Encourage the use of Home-A-Syst risk assessment technology to local health boards, environmental commissions, and others so that these groups can educate homeowners on risks to and methods of protecting their private well water supplies.

6. Promote implementation of low-input (fertilizer, pesticides and water) permanent grass species following disturbance and maintenance activities.

# USDA Great Swamp HUA Project
# List of Contacts

**Kent Hardmeyer**, *Great Swamp HUA Project Manager*
District Conservationist
USDA Natural Resources Conservation Service
Morris County Courthouse
PO Box 900
Morristown, NJ 07963-0900
**(201) 538-1552**

**Joseph Dunn**, *Great Swamp HUA Project Morris County Liaison*
District Director
Morris County Soil Conservation District
Morris County Courthouse
PO Box 900
Morristown, NJ 07963-0900
**(201) 538-1557**

**Ernest Thurlow**, *Great Swamp HUA Project Somerset County Liaison*
District Manager
Somerset-Union Soil Conservation District
308 Milltown Road
Bridgewater, NJ 08807
**(908) 526-2701**

**Michael T. Olohan**, *Great Swamp HUA Project Public Information Manager*
Program Associate in Watershed Management
Rutgers Cooperative Extension
Department of Natural Resources, PO Box 231
ENRS Building, Cook College
New Brunswick, NJ 08903-0231
**(908) 932-9634**

# USDA Great Swamp HUA Project Products' List:
## *Tools, techniques, and technology transfer*

Following is a summary of some of the new tools, techniques and applications of technical expertise that the USDA Great Swamp HUA Project has used to better identify the sources of Great Swamp watershed contamination and develop and recommend possible solutions. These HUA products are currently being used by a diversity of watershed interests for water quality improvement efforts. Contacts are listed for further information.

A **GEOGRAPHIC INFORMATION SYSTEM (GIS)** for the watershed was developed by the Great Swamp HUA Project. The GIS enables you to depict graphically the relationships between an area's natural resources (e.g. topography, soil types, and soil characteristics) and its man-made variables (e.g. present land cover, roads, and local boundaries). More than 20 separate data layers, or variables, can be displayed using the GIS. These include sewer service areas, public lands, Great Swamp tributaries, soil drainage, soil corosivity, and soil potential for pesticide leaching. The Great Swamp GIS demonstrated its value by combining appropriate data layers to determine the percent of imperviousness in subwatersheds as well as identify what areas need riparian forested buffers. GIS-produced maps have been provided to the Great Swamp Watershed Association and other watershed communities and organizations. Area residents interested in finding out how this GIS can be used to address Great Swamp natural resource issues should call Stan Jacobs at **201-538-1552**.

An annual **MACROINVERTEBRATE SURVEY** of Great Swamp tributaries is conducted by the USDA Great Swamp HUA Project during every summer. Since 1992 HUA Project staff, often assisted by volunteers from the Passaic River Coalition, Morris County Planning Board, and Chatham Township Environmental Commission, have sampled the swamp's feeder streams for biological organisms at 17 locations. Based on the diversity and density of pollution-intolerant, semi-tolerant, and pollution-tolerant organisms found along the stream's bottom, water quality at each stream location is given a numeric value using a protocol known as Beck's Biotic Index. *This biological ranking of Great Swamp's tributaries provides the only current baseline data available on watershed water quality.* A five-year grant from the NJ Department of Transportation to the HUA Project will continue the annual biological monitoring program through 1999. The annual survey reports are available by calling Kent Hardmeyer at **201-538-1552**.

A **HYDROLOGY SURVEY** to estimate the relative quantities of water potentially affecting tributaries to Great Swamp was conducted in 1993. Approximately 100 stream cross-sections were surveyed by HUA staff. The survey identified the need for establishing official geodetic survey monuments in the watershed and obtaining additional stream cross-section data before the watershed could be accurately evaluated hydrologically. For information, phone Michael Mirage at **908-246-1171 (x-135)**.

A comprehensive **INFORMATION AND EDUCATION PROGRAM** to better inform, educate, and involve the watershed's residents was coordinated by Rutgers Cooperative Extension, Cook College. Some tools included a free quarterly newsletter *Swamp Sounds*, a series of "Wednesday Watershed Workshops", a free soil sampling service to targeted audiences, audiovisual presentations, educational displays, and a photo contest highlighting the Great Swamp seasons. The soil sampling service and outreach program has been funded as an innovative BMP in two more New Jersey watersheds by NJDEP. For information, phone Michael Olohan at **908-932-9634**.

Two HUA Project **DEMONSTRATION PROGRAMS** to show the benefits of specific best management practices in the watershed are ongoing. These include the low-input lawn care demonstration site at Morris County Park Commission Frelinghuysen Arboretum, Morris Township. This site shows homeowners and "do-it-yourselfers" what types of grass require less time, watering, and fertilizing to maintain. Phone Ed Milewski at **201-285-8300** for details. A second demonstration program focused on installing streamside tree buffers to better enhance fish and wildlife habitats as well as water quality. A riparian forested buffer site was planted in 1994 on a Harding Township farm and in 1995 a volunteer tree planting program called "Trees for Streams" was initiated with assistance from Somerset County Park Commission, Passaic River Coalition, and local groups. Phone Kent Hardmeyer at **201-538-1552** for an update.