East Branch Delaware River

Stream Corridor Management Plan

December 2007

Prepared by:
Delaware County Soil and Water Conservation District
Delaware County Planning Department

In cooperation with:
The New York City
Department of Environmental Protection

~ Foreword ~

The Board of Directors of the Delaware County Soil and Water Conservation District and the Delaware County Planning, Recreation, Culture and Community Committee are pleased to present this Stream Corridor Management Plan for the East Branch Delaware River watershed. This Plan was prepared by and for the watershed residents and communities.

As a whole, the East Branch watershed has been quite well preserved. Stakeholders are interested in maintaining this preservation and further protecting the watershed for the future. The recommendations in this Plan are the result of visioning for the future by the watershed stakeholders. We encourage communities, residents, agencies and organizations to adopt this Plan, not only as a generic action plan to begin to resolve major issues and concerns, but more importantly as a road map to guide and facilitate future management and stewardship of the Pepacton Reservoir watershed.

This Plan was created in two volumes to be user friendly to watershed stakeholders. Volume 1 contains the crux of stakeholder concerns and their recommendations for enhanced stream corridor management, while Volume 2 contains more technical explanations and documentation. We sincerely hope this Plan will empower and inspire all stakeholders to comprehensively manage their valuable water resources.

Rick Weidenbach
Executive Director
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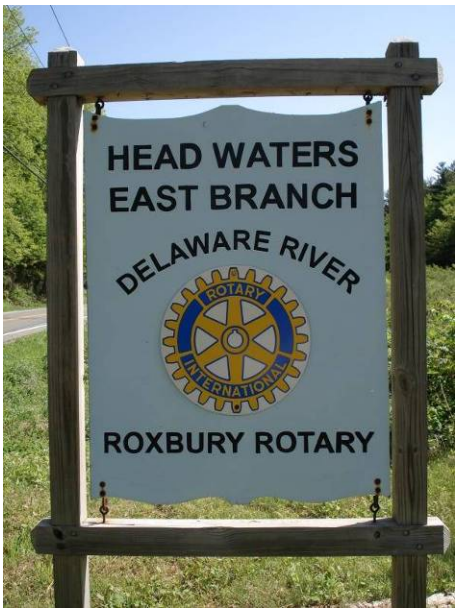

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~ Acronyms ~

ACRONYM	DEFINITION
BatK	Batavia Kill
BFE	Base Flood Elevation
BMP	Best Management Practices
BsK	Bush Kill
CCE	Cornell Cooperative Extension
CEMP	Comprehensive Emergency Management Plan
CEM	Comprehensive Emergency Management
CREP	Conservation Reserve Enhancement Program
CRISP	Catskill Region Invasive Species Partnership
CRS	Community Rating System
CWC	Catskill Watershed Corporation
DCAP	Delaware County Action Plan
DCDES	Delaware County Department of Emergency Services
DCDPW	Delaware County Department of Public Works
DCPD	Delaware County Planning Department
DCSWCD	Delaware County Soil and Water Conservation District
DFIRMs	Digital Flood Insurance Rate Maps
DoD	Department of Defense
DPW	Department of Public Works
DrB	Dry Brook
DRIPP	Delaware River Invasive Plant Partnership
EBDR	East Branch Delaware River
EBHW	East Branch Headwaters
EBMS	East Branch Mainstem
ECL	Environmental Conservation Law
EOC	Emergency Operations Center
FAD	Filtration Avoidance Determination
FC	Fall Clove
FEMA	Federal Emergency Management Agency
FIRMs	Flood Insurance Rate Maps
GCSWCD	Greene County Soil and Water Conservation District
GIS	Geographic Information System
GPS	Global Positioning System
HMGP	Hazard Mitigation Grant Program
HMPs	Highway Management Plans
ICS	Incident Command System
MB	Mill Brook
MES	Munro Ecological Services
MOU	Memorandum of Understanding
NFIP	National Flood Insurance Program
NRCS	Natural Resources Conservation Service

~ Acronyms (cont.) ~

ACRONYM	DEFINITION
NWI	National Wetland Inventory
NYCDEP	New York City Department of Environmental Protection
NYCRR	New York Code of Rules and Regulations
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSDOT	New York State Department of Transportation
NYSDOS	New York State Department of State
PAC	Project Advisory Committee
PK	Platte Kill
SBA	Small Business Administration
SCMP	Stream Corridor Management Plan
SCMPr	Stream Corridor Management Program
SEMO	State Emergency Management Office
SGAT	Stream Geomorphic Assessment Tools
SMP	Stream Management Program
SPDES	State Pollutant Discharge Elimination System
SPPP	Stormwater Pollution Prevention Plan
SWCD	Soil and Water Conservation District
TC	Terry Clove
TrK	Tremper Kill
U.S.	United States
USACOE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VlC	Vly Creek
WAC	Watershed Agricultural Council
WAP	Watershed Agricultural Program
WFP	Whole Farm Plans
WRI	Water Resources Institute

~ Executive Summary ~

Before you begin reading this Stream Corridor Management Plan, please take a moment to look out your window. The landscape you see, whether rural or urban, is part of a watershed. Within that watershed, every natural and human activity has the potential to affect:

- the quality of both ground and surface water
- the ecological health of the aquifer, pond, lake, stream, river, or reservoir that contains the water
- the enjoyment and health of those who view, recreate in, or drink the water

Over the past few centuries we have used streams for transportation, power, food, recreation and water supplies. Our past efforts at management activities to protect and preserve our streams and floodplains have been relatively uncoordinated and site specific. In recent years, efforts have started to focus on the management of the watershed as a system. Through this approach we are trying to better understand stream function, instability causes, and the effects of management practices on the entire system, not just the site. It is important to understand how a natural stream functions, and measure and document these "traits." Replicating natural stream conditions when implementing management practices allows for better stream function and health. It is equally important to understand floodplain function and that **the floodplain is part of the stream**, "…constructed by the river in the present climate and inundated during periods of high flow." (Leopold, 1997)

This Stream Corridor Management Plan focuses on the East Branch Delaware River watershed above the Pepacton Reservoir dam at Downsville. The watershed not only contains the Pepacton Reservoir, the East Branch Delaware River, and its many tributaries— it contains communities in which people live and work. The writers of this Plan strove to create a document that would take the needs and desires of watershed residents into account while outlining ways to conserve, preserve, and enhance the watershed itself. Plan development began in May 2005. A series of visioning sessions were held for the local communities, the issues and concerns of which were compiled to help with their vision of future stream stewardship and management. Outreach was also extended to the local planning boards to define stream management, solicit their input, and encourage them to consider adopting a stream management plan component into their local comprehensive plans. In other words, empower local residents and communities to take ownership of stream management.

This Plan should echo the sentiments of those who provided comments and suggestions at every planning board outreach and visioning session. And as the needs of the watershed change, this Plan will change with them. Current key findings include concerns with gravel deposition, flooding issues, need for technical assistance, lack of recreational access, and a desire for stream management education.

The Stream Corridor Management Plan should also – and most importantly – extend beyond the agencies that partnered to create it. It contains recommendations that can realistically be pursued and implemented by watershed residents and municipalities. These recommendations, driven by residents, planning board members, and the Project Advisory Committee members, will hopefully be a template and call to action for those who turn to this Plan for guidance. Key recommendations include:

- Continue and Enhance Education and Outreach
- Implement a Streamside Assistance Program (also a 2007 FAD requirement)
- Selective Stream Gravel Management
- Enhance Recreation Opportunities
- Debris Management.

This Stream Corridor Management Plan is separated into two volumes. Volume 1 contains an overview of the watershed, both from a physiographic standpoint and from that of human-environmental interactions. Community snapshots and lists of issues and concerns raised at each planning board outreach meeting are also covered. Volume 1 additionally includes a guide to living and working with streams, reprinted from "Stream Processes: A Guide to Living in Harmony with Streams" with permission by Janet Thigpen, Southern Tier Central Regional Planning and Development Board. Finally, the "meat and potatoes" of Volume 1 is the **Recommendations** section.

Volume 2, the more technical of the two volumes, is chocked full of fascinating information about the watershed. The first section is a detailed look at each of the eleven sub-basins within the East Branch Delaware River watershed. This is where specific geomorphic conditions and problem areas are documented. The "Sub-basins" section is followed by "Principles of Stream Science," from which one can obtain an education regarding the geology and fluvial geomorphology of the watershed. Descriptions of fisheries, wildlife, vegetation, water quality, flood response, and permitting processes can also be found in Volume 2.

Please note that, as you read this Plan, you may encounter re-iterations of the same content between Volume 1 and Volume 2. This is because some information presented in Volume 1 is a summarized version of that which is contained in Volume 2. These instances are marked by references to the proper section in Volume 2. Also, the definitions of acronyms and words that are *italicized* can be found in the "List of Acronyms" in Volume 1 or the "Glossary" section of Volume 2.

~ I. Introduction ~

"The rivers are our brothers. They quench our thirst. They carry our canoes and feed our children. You must give to the rivers the kindness you would give to any brother." — Chief Seattle (1854)

BACKGROUND

The waterways of upstate New York have always been vital to society. Historically, rivers and streams have provided food, drinking water, transportation, and power, so it is no coincidence that most villages and cities are located on or near a body of water. Over time, many of these waterways have become threatened by the very development they have enabled; yet, the importance of rivers and streams has not lessened. This is especially true in the East Branch Delaware River watershed. Drinking water, aesthetics, and countless recreational opportunities are provided to local citizens, tourists, and the residents of New York City over 120 miles away. The East Branch watershed is a key gem in the Catskill Mountain region that warrants protection. In order to preserve and improve water quality while protecting private property and public infrastructure, the need for a guiding document for watershed management in the East Branch has become apparent. Henceforth, the New York City Department of Environmental Protection (NYCDEP) has contracted with the Delaware County Soil & Water District (DCSWCD) to develop this Stream Corridor Management Plan (SCMP).

The DCSWCD, the Delaware County Planning Department (DCPD), and the NYCDEP recognize that local input and leadership is essential to developing and implementing the management plan. These agencies have worked with local town and village planning boards to develop a vision for each community — a critical step in the formulating stream management recommendations. It is important that the implementation of the Plan be integrated with local laws such as zoning and subdivision regulations, local floodplain laws, community comprehensive plans, town Highway Management Plans, the county-wide Delaware County Action Plan (DCAP), and the Delaware County Multi-jurisdictional All-Hazards Mitigation Plan. The purposes of the Plan were presented to each town planning board within the watershed, promoting discussion about local concerns and specific problematic areas. In addition, a Project Advisory Committee (PAC) was formed of local stakeholders, municipal representatives and businesses to help develop, guide, and implement the Plan's objectives. The PAC met numerous times during the course of developing this Plan and their input is reflected in its recommendations. A PAC sub-committee was formed to review potential project sites and recommend the demonstration project site.

Since 1993, New York City's water supply system has met the criteria for filtration avoidance as determined by the United States Environmental Protection Agency (USEPA). With every Filtration Avoidance Determination (FAD) renewal, ideas and techniques evolve that have the potential to enhance watershed protection. In support of the 2002 FAD, the NYCDEP and the DCSWCD agreed to partner to write this management plan. Since effective watershed management requires community and land use planning components in addition to technical research and implementation, the DCSWCD subcontracted with the DCPD to help bring these components to the Plan. Targeted at communities and agencies within the watershed, this Plan is focused on education as well as stream management recommendations and practices.

The final framework that the SCMP needs to dovetail with is the Delaware County Action Plan (DCAP). Created in 1999 to address water quality issues in the New York City watershed, DCAP was originally written in response to the designation of the Cannonsville Reservoir watershed as a phosphorus-restricted basin. DCAP coordinates public and private agencies to develop water quality initiatives and seek funding for implementation. Current components of the Action Plan include management programs for stormwater and flooding, highway runoff, on-site septic systems, precision livestock feeding, forage management, the Stream Corridor Management Program, and the assessment of phosphorus reduction by monitoring best management practices (BMPs).

This Stream Corridor Management Plan (SCMP) has been developed to achieve the following goals for the East Branch Delaware River above the Pepacton Reservoir Dam, the reservoir itself, and their contributing tributaries.

GOALS OF THE PLAN

- Offer the public opportunities for involvement in visioning and taking ownership of future watershed management
- Create a better understanding of stream processes and promote a stream stewardship ethic among watershed stakeholders
- Study and evaluate streams and their effects on local stakeholders, and ensure continued protection and preservation of East Branch watershed while maintaining economic sustainability
- On a watershed-wide scale, create a multi-objective, community-based approach for stream management in the East Branch by promoting and applying the principles of fluvial geomorphology as the scientific basis of the approach
- Implement a community-based restoration project demonstrating entrepreneurial approaches for stream and floodplain protection
- Develop a comprehensive “living” Stream Corridor Management Plan with recommendations to guide future stream stewardship

PLAN OBJECTIVES

- Develop a Project Advisory Committee to guide the process
- Identify the issues and needs in the basin
- Perform assessments to obtain necessary data
- Provide educational opportunities for watershed stakeholders
- Promote the importance of the creation, enhancement, and protection streamside buffers
- Explain the importance of biodiversity and habitat protection
- Review stream-related regulations – implementation, enforcement, and funding
- Promote the importance of floodplains and their function
- Review planning options to manage floodplain development
- Prioritize areas in need of restoration
- Develop a set of stewardship recommendations

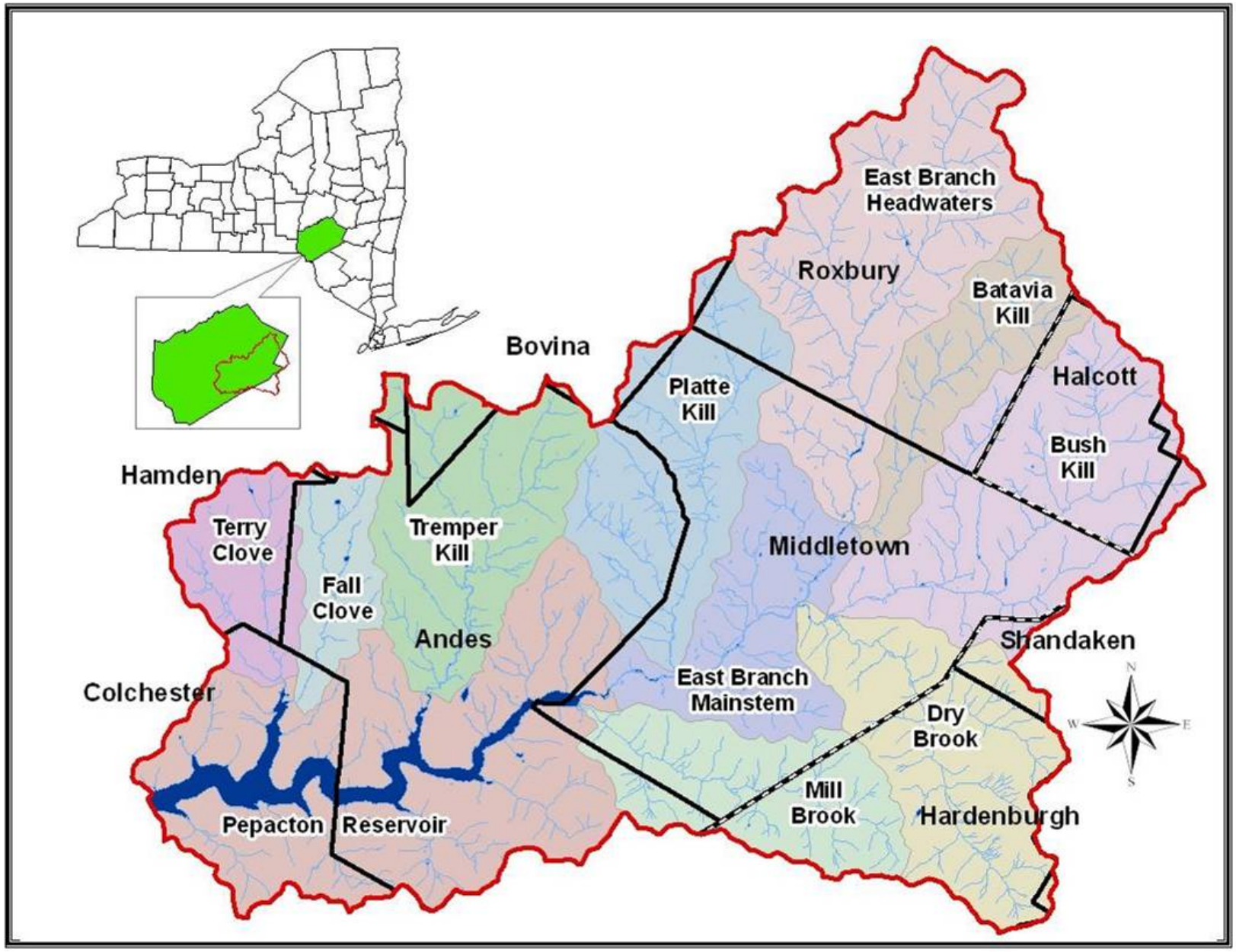
~ II. Watershed Overview ~

PHYSICAL CHARACTERISTICS

Physiography

The East Branch Delaware River is located in the eastern portion of the Allegheny Plateau physiographic province, which is the northern part of the Appalachian Plateaus that extend from southern New York to central Alabama. The East Branch Delaware River, along with eight additional sub-basins, contributes water to the Pepacton Reservoir. The total drainage area of the East Branch Delaware River watershed above the Pepacton Reservoir Dam is 371 square miles with 644.4 total stream miles. The entirety of the watershed is situated among rolling hills. The eastern portion of the watershed becomes rather steep, with portions of the Mill Brook and Dry Brook sub-basins bordering on the high peak region of the Catskills. Elevations within these sub-basins approach 3500 feet above sea level.

The watershed lies within the borders of three counties and at least portions of eleven townships. The location of the watershed and its sub-basins is indicated on **Map 1** (following page)**.** The majority of the watershed lies within Delaware County, with relatively smaller portions in Ulster and Greene County. The majority or entirety of the following towns are within the project area: Andes, Colchester, Halcott, Hardenburgh, Middletown, and Roxbury. These are all contiguous to the main stem of the East Branch and the mainstems of the sub-basins. Parts of the Towns of Bovina, Delhi, Hamden, Shandaken, and Lexington are also within the watershed. The only incorporated villages within the East Branch Delaware River watershed are Margaretville and Fleischmanns, while the remaining population centers are the recognized Hamlets of Arkville, Roxbury, Halcottsville, New Kingston and Andes.



Map 1. Pepacton Reservoir Watershed

Climate

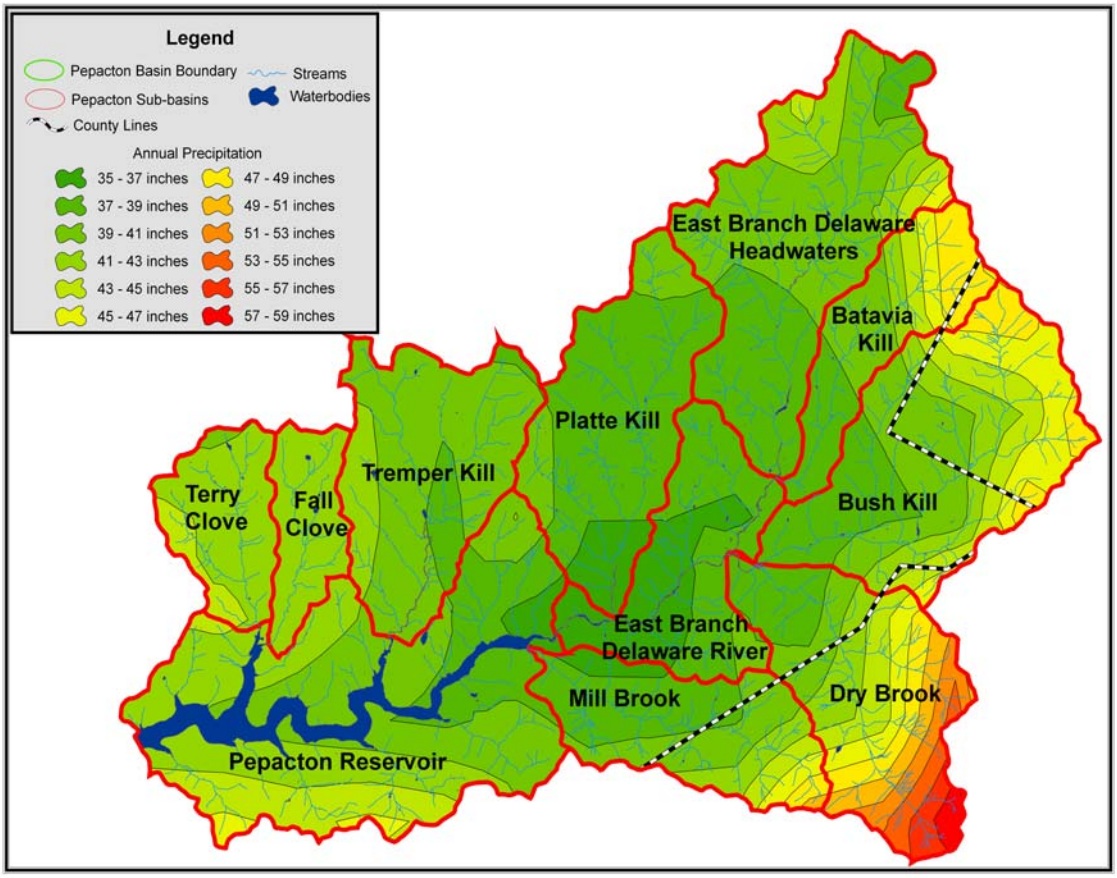
The climate of Delaware County is considered "humid continental." Cool, dry air masses generally move eastward throughout the year, while warm, humid maritime air masses from the south move northeastward during the summer (Lumia, 1991). Relatively few hot days are experienced during the otherwise normally cool summers. Cold winter temperatures prevail whenever Arctic air masses flow southward from central Canada. Mean daily temperatures range from the low 20's in winter to the upper 60's in summer. Rainfall is usually adequate during the growing season (May – September), but deficiencies of precipitation sometimes occur.

Map 2 (following page) depicts the average annual precipitation distribution for the entire watershed. The legend at the right of the map shows the annual precipitation amounts. Note that Dry Brook and Mill Brook sub-basins are particularly prone to heavy rainfall, often sudden and brief, in their headwaters.

Increased rainfall has been experienced over the entire watershed over the past 100 years, with an additional 5.9 inches falling per year mostly due to extreme rain events. The topography of the East Branch Delaware watershed also has a significant effect on rainfall within the basin. Moisture-laden air is advected up the eastern slopes of the Catskills during northward-moving storms, causing heavier precipitation than is received on the western slopes. On the other hand, the western slopes receive more precipitation from eastern-moving storms[1]. This explains the heavier precipitation in the eastern portion of the watershed, since these areas lie on the western slopes of the Catskills.

Climate change models predict continued increases in precipitation over the next 50 years[2], with earlier ice off dates for streams in the spring and the likelihood of more frequent severe storm events and mid-summer droughts. These changes would likely impact the character of the streams, the landscape, the vegetation and the aquatic and terrestrial wildlife of the region.[3] Such changes would also affect the hydrology of the watershed (see next Section).

[1] Information obtained from "A Prospectus by the Cornell University Hydrologic Sciences Working Group."
[2] Burns, D.A., Klaus, J., McHale, M. R., 2007, Recent climate trends and implications for water resources in the Catskill Mountain region, New York, USA, Journal of Hydrology, 336, pg. 155-170, Elsevier.
[3] Climate change in the U.S. Northeast; A Report of Northeast Climate Impacts Assessment, The Union of Concerned Scientists, October 2006



Map 2. Average Annual Precipitation

Hydrology

Streams in the East Branch watershed are primarily perennial streams—they flow year round except in smaller headwater streams or in extreme drought conditions. The drainage pattern is generally dendritic (a branching, tree-like form), which is typical of watersheds in the Catskill Mountain region geology (see **Map 1** in the Physiography section).

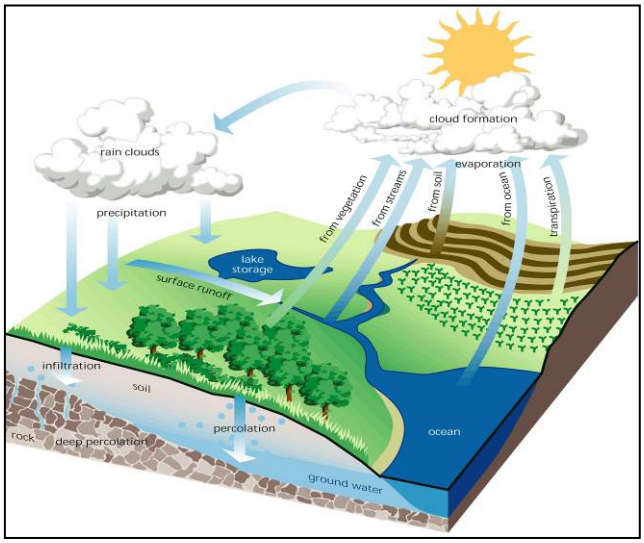


Figure 1. The Hydrologic Cycle

Understanding the hydrology of a drainage basin is important to stream management because the rate of runoff affects flood behavior, water quality and quantity, *aquatic habitat*, and recreational use (Referring to the above Climate Section, increased runoff would likely result in changes in valley

characteristics, stream channel dimensions, and stream sediment transport (see next Section) which could significantly affect how people live and work around streams and the surrounding landscape). Although it may not be obvious, the water flowing through the East Branch Delaware River drainage system reflects the integrated net effect of all the watershed characteristics that influence the hydrologic cycle (**Figure 1**). See **Volume 2, Section 3** for a more complete description.

The United States Geological Survey (USGS) maintains seven *continuous-recording stream gages* in the East Branch watershed and three inactive gages. These gages measure the stage, or height, of the water surface at a specific location, updating the measurement every 15 minutes. By knowing the stage, we can calculate the discharge (the volume of water flowing by that point every second) using a rating curve relationship developed by USGS. In this way, the discharge can be predicted for any stage of interest. We can also use the historic record of constantly changing stage values to evaluate stream response to rain storms, snow melt, extended periods of drought, to analyze seasonal patterns or flood characteristics. The gages in the East Branch basin have long enough periods of record to prepare hydrographs for their individual streams.

Table 1. USGS Stream Gages

Station ID	Station Name	Drainage Area (Mi^2)	Period of Record
01413088	East Branch Delaware River at Roxbury	13.5	June 2000 - present
01413398	Bush Kill Near Arkville NY	46.7	Oct 1997 - present
01413408	Dry Brook at Arkville NY	82.2	Dec 1996 - present
01413500	East Branch at Margaretville NY	163	Feb 1937 - present
01414000	Platte Kill at Dunraven NY	34.9	Oct 1941 - Sept 1962, Dec 1996 - present
01414500	Mill Brook Near Dunraven NY	25.2	Feb 1937 - present
01415000	Tremper Kill Near Andes NY	33.2	Feb 1937 - present
01415500	Terry Clove Kill Near Pepacton NY	13.6	Inactive
01416000	Fall Clove Kill Near Pepacton NY	11.3	Inactive
01416500	Coles Clove Kill Near Pepacton NY	28	Inactive

For example, information gathered from the gage at Margaretville shows that most of the runoff for the watershed above Margaretville occurs between mid March and mid May, with a second period of runoff in the fall in November and December. This is a period when the ground is often bare and *evapo-transpiration* from plants is low. The precipitation that falls during this period quickly runs off and the streams are full.

The USGS posts this information on their web site and it can be found at this address: http://waterdata.usgs.gov/ny/nwis/current/?type=flow (Verified September 11, 2007)

Stream Characteristics

In the course of transporting water from the tops of mountains to the ocean, streams also transport sediment scoured from their own beds and banks. Streams and rivers are never constant, and it is important to understand how and why streams change. This understanding will help ensure that human activities do not inadvertently accelerate the rate of change.

Natural streams vary from steep to flat, wide to narrow, and relatively straight to a bending (or *sinuous*) flow pattern. The slope of a section of stream or "reach" largely depends on its position within a watershed. Streams are typically straighter and steeper in the headwaters where the valley is narrow and the slope is steep. As distance increases from the headwaters and the slopes begin to level in the lower, wider sections of the valley, the stream begins to meander. This is illustrated in **Figure 2**, where slope generally decreases from left to right and stream form is seen from both a cross-sectional and "aerial" view.

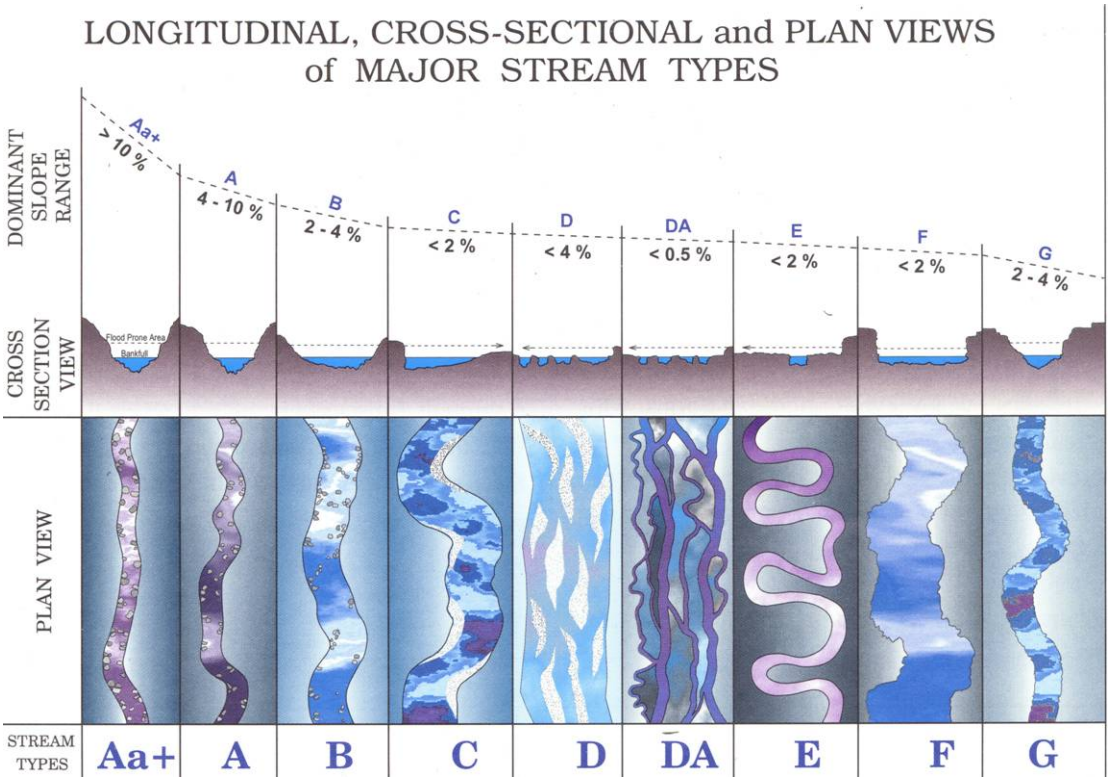


Figure 2. Views of Major Stream Types

Streams are constantly changing. During a storm event, the power or energy of water flowing in a stream is very noticeable. A large amount of sediment is moved during the peak flow of a high water event and that sediment is deposited as the water subsides. When there are low flow periods, the stream does not have enough energy to carry significant amounts of sediment. The sediment deposits in the form of gravel bars.

Under natural, undisturbed conditions, changes in the channel will be gradual. Where human development actions have changed conditions near the stream, the rate of change may be greatly accelerated or constrained. Streams that are in balance with their landscape can adapt a form that passes both the water and *bedload* (such as sediment, debris, etc.) associated with floods, regaining their previous form after the flood passes. These streams are considered to be stable, having a dimension and slope that is in balance with the location in the valley setting. In many situations, however, sections of stream can become *unstable* when human activities (such as bridge construction) have upset that balance, altering the stream's ability to move its water and bedload effectively.

Efforts to improve water movement during flood events have led people to make stream channels too wide, armor the stream banks, build berms or otherwise limit the extent of the floodplain. Increasing channel capacity by dredging to deepen or widen the stream provides only temporary relief and typically results in upstream and downstream channel instability. Armoring the bank with riprap can accelerate stream velocity and result in transferring erosion problems to downstream landowners. Berming the floodplain to protect development concentrates and accelerates flood flows and results in changes to the elevation of the stream bed[4]. Past stream interventions and channel alterations, such as dredging, channelization, straightening, berming, and rip-rapping, still affect the channel function today. For in-depth information on stream function and form in detail, refer to **Section 3** located in **Volume 2**.

During the assessments of the East Branch Delaware River watershed, the Delaware County Soil and Water Conservation District Stream Corridor Management Program (SCMPr) staff focused on trying to determine the relative stability of the streams in the watershed. They

- identified areas where the streams eroded their banks and deposited excess gravel
- examined the extent of streamside buffers to assess whether the streambank was protected with vegetation
- mapped and visited the location of bridges and culverts to assess whether the stream encountered problems flowing through these structures.

From these assessments the team described their findings in on a reach-by-reach basis for the East Branch Delaware mainstem and its tributaries. The complete description of the findings is located in **Section 1** of **Volume 2**.

Geology

In landscapes unchanged by human activities, streams reflect the regional climate, biology and geology. Climate was discussed in the preceding section, while biology, especially streamside vegetation, will be discussed in **Section 5** of **Volume 2**. The following section describes the basic geology of Delaware County and the East Branch basin.

Bedrock Geology

The bedrock underlying all of Delaware County is of sedimentary origin. Geologic research indicates that the *sediments* resulted from the *erosion* of a large mountain range that once existed to the east during the upper Devonian Period, some 370 million years ago. Westward flowing rivers carried the eroded sediments into the "Catskill Delta," a vast marshy plain that was developing at the time. There the waters deposited layers of *sand*, *gravel, silt* and *clay* that eventually became the beds of sandstone, conglomerate (sandstone with pebbles), siltstone and shale rocks of today. The thickest and most uniform beds of certain sandstones are now valuable for local "bluestone" quarries.

[4]2002, Riparian Areas: Functions and Strategies for Management, National Academy of Sciences, Washington, DC, pg. 155.

Important rock groups and some of their component rock formations in the East Branch watershed are shown in **Table 2**. None of these formations contain beds of limestone, but rather contain much silica; they are therefore considered to be "acidic" rocks, and spring water arising from bedrock cracks and fissures tends to be low in dissolved calcium and magnesium carbonates ("soft" water).

Some 330 to 250 million years ago, long after the sedimentary rocks had been formed, mountain-building forces began raising the large Appalachian mountain chain to the south. Being at the northern end of these rising mountains, the plateau that we know as the Catskill region was uplifted, acquiring vertical fractures in its rock layers during this time. Long periods of weathering and erosion wore down this plateau and created a drainage network along joints or fractures in the bedrock – an early version of the stream valleys we have today. Thus, the Catskill Mountains were created both by forces of erosion as well as those that build mountains upward. However, the shapes of the landscape have also been significantly remolded by glacial events, as described below.

Table 2. Bedrock Types in the East Branch Basin*

Geologic Group	Rock Formation	Type of Rocks Included
West Falls	**Honesdale**	Sandstone & shale
West Falls	**Slide Mountain**	Sandstone, shale & conglomerate
West Falls	**upper Walton**	Shale, sandstone & conglomerate
Sonyea	**lower Walton**	Shale, sandstone & conglomerate
Genesee	**Oneonta**	Shale, sandstone & conglomerate

* Like the bedrock formations themselves occur, the oldest rocks are listed on the bottom, the youngest at the top of the table.

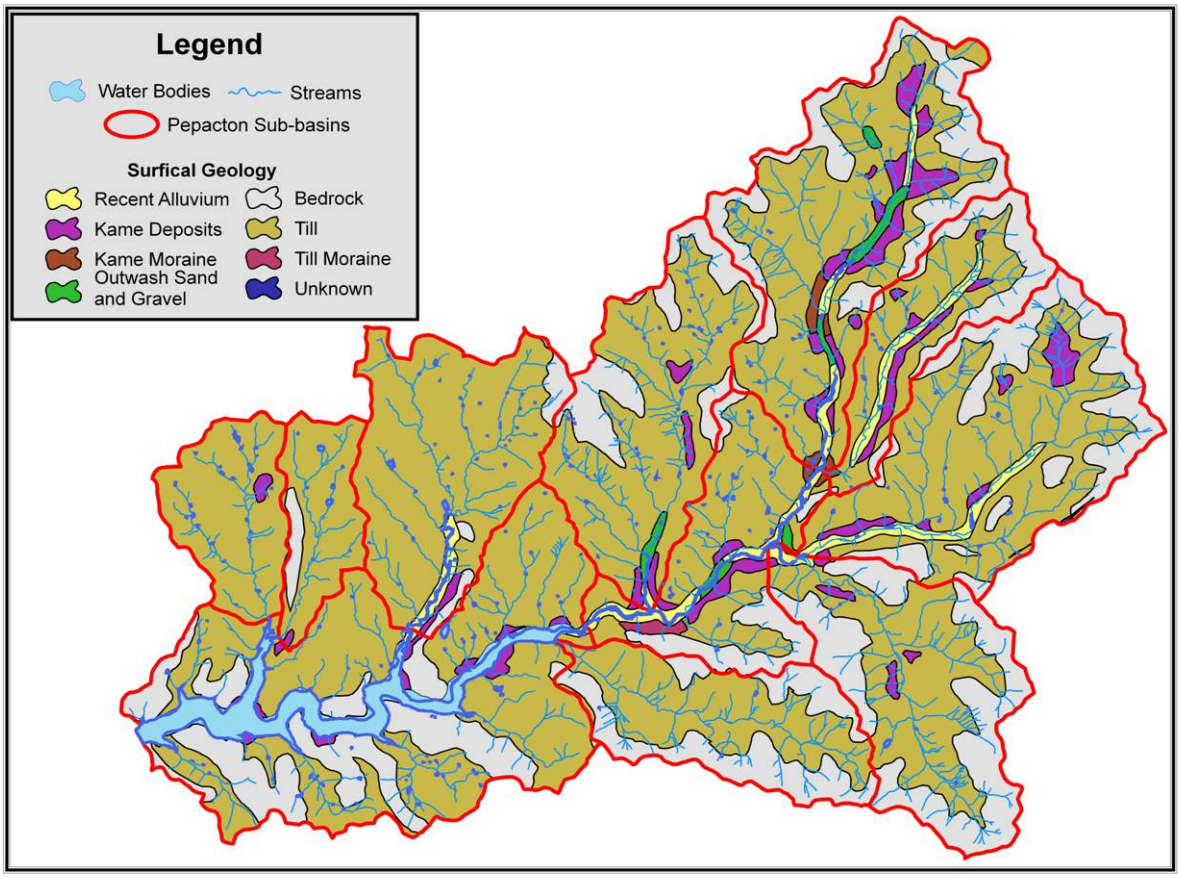
Glacial Geology

The most recent glaciation to leave this area (the Wisconsin glaciation) did so only some 10 to 12 thousand years ago. The processes of glacial erosion crushed and fragmented rocks into a slurry of *boulders*, angular stones and *gravel*, sand, silt and clay. This mixture was transported beneath, within and on top of the glacier, sometimes for many miles before being deposited by the ice or its meltwaters. Called glacial till, most uplands in the East Branch basin are covered with this kind of deposit (**Map 3**)[5]. For example, about 95% of Dry Brook's watershed is covered by varying thicknesses of glacial till.

In locations where washed and sorted debris was deposited, usually the margins of major valleys such as the mouth of the Platte Kill along the East Branch, gravelly terraces and kame deposits occur (**Map 3**). These give such parts of the landscape a somewhat lumpy and bumpy appearance. Such deposits are often valuable sources of sand and gravel, although they typically

[5] Map 3 is based in part on the work of Rich and others. Isachsen and others (1991, pp. 161-193) discuss the glacial epoch and its effects on NY landscapes. Reynolds (2004), Titus (1996) and Rich (1935) give more detailed descriptions of glacial landforms in the Catskills Region than the summary provided here.

contain more silt and clay than is desirable. Sand and gravel deposits can also store considerable amounts of ground water, which is released gradually to form the base flow of streams. By contrast, the extensive glacial till deposits contribute only a minor amount of ground water to base flow (Reynolds, 2004).



Map 3. Surficial Geology

The stagnating remains of the valley glaciers blocked off the outlets of some meltwater streams, creating lakes until the dams of ice could melt, which took many years. In the quiet waters of deeper lakes, silts and clays settled out and accumulated while in shallower, more agitated lakes fine sand and silt was deposited. The finest-textured (clayey) sediments formed relatively small deposits. Coarser lake-laid deposits occur in the East Branch and other valleys, although more recent floodplain deposits often overlie them. The river itself winds through the relatively flat surface of accumulated sediments over the much deeper valley carved into the bedrock. Reynolds (2004) reported about 150 feet of sediment filling the valley floor where the Pepacton Reservoir's Downsville dam was constructed.

Where relatively fast-flowing tributary streams enter major valleys, water velocity slows as they flow across the flatter river floodplain. The abrupt slowing of the stream's velocity causes it to drop its bedload of sand and gravel on the floodplains as a subtle fan or delta-shaped alluvial fan deposit. This process has been continuing since the waning stages of glaciation, and alluvial fans

are commonplace in larger valleys. Because these deposits are fairly level and well drained, they make good farmland and building sites; the center of many villages and hamlets, including parts of Margaretville and Roxbury, are on alluvial fan landforms.

The glacial deposits described above are the parent materials in which the soils of today have developed. In terms of geology and soil formation, the Epoch since the glaciers left their deposits on the Delaware County landscape is a short period of time. Processes of erosion and sediment accumulation continue to affect the landscape, although their rates can be greatly accelerated by man's activities.

Applied Geology

Probably one of the least known but most appreciated aspects of geology in this region of the Catskills is closely related to maintaining fish habitat. It is well known that various sport fish, including trout, require relatively clean and cold water for their survival and especially for spawning. The best trout streams tend to have a steady supply of baseflow from cool groundwater. This requires a means of water storage and release, either natural or man-made, especially through the warm summer months. As mentioned before, the glacial till that covers over 90% of the East Branch watershed contributes little groundwater to maintain base flows between precipitation events, largely producing runoff instead. The primary soil materials that can store and steadily release groundwater are extensive areas of sand and gravel, due to their porosity. But the entire East Branch basin has only minor amounts of these deposits (5 to 7%) as kame, kame moraine, outwash and alluvium (**Map 3**).

The answer to this puzzle was first alluded to by a geologist from Binghamton University (Coates, 1971) and was more recently deduced by the United States Geological Survey (USGS) (Reynolds, 2000 & 2004). It turns out that of the sandstone, siltstone and shale bedrock types of the Catskill Mountains, sandstone is the most permeable, due primarily to its extensive joints and other fractures. A bedrock aquifer underlies the entire East Branch watershed, with the most massive sandstone occurring in the Mill Brook and Tremper Kill sub-basins. While all of the East Branch exhibits unusually high base flows for the small amount of sand and gravel deposits, these two sub-basins have the capacity to store and slowly release relatively large amounts of groundwater to stream baseflow — capacities greater than nearly all other basins in the Catskills (exceeded only by the Beaver Kill and Willowemoc Creek to the south). Stored groundwater is thus released from sandstone by springs and subsurface seepage into streams for extended periods through the summer, which maintains favorable trout habitat for most of the year.

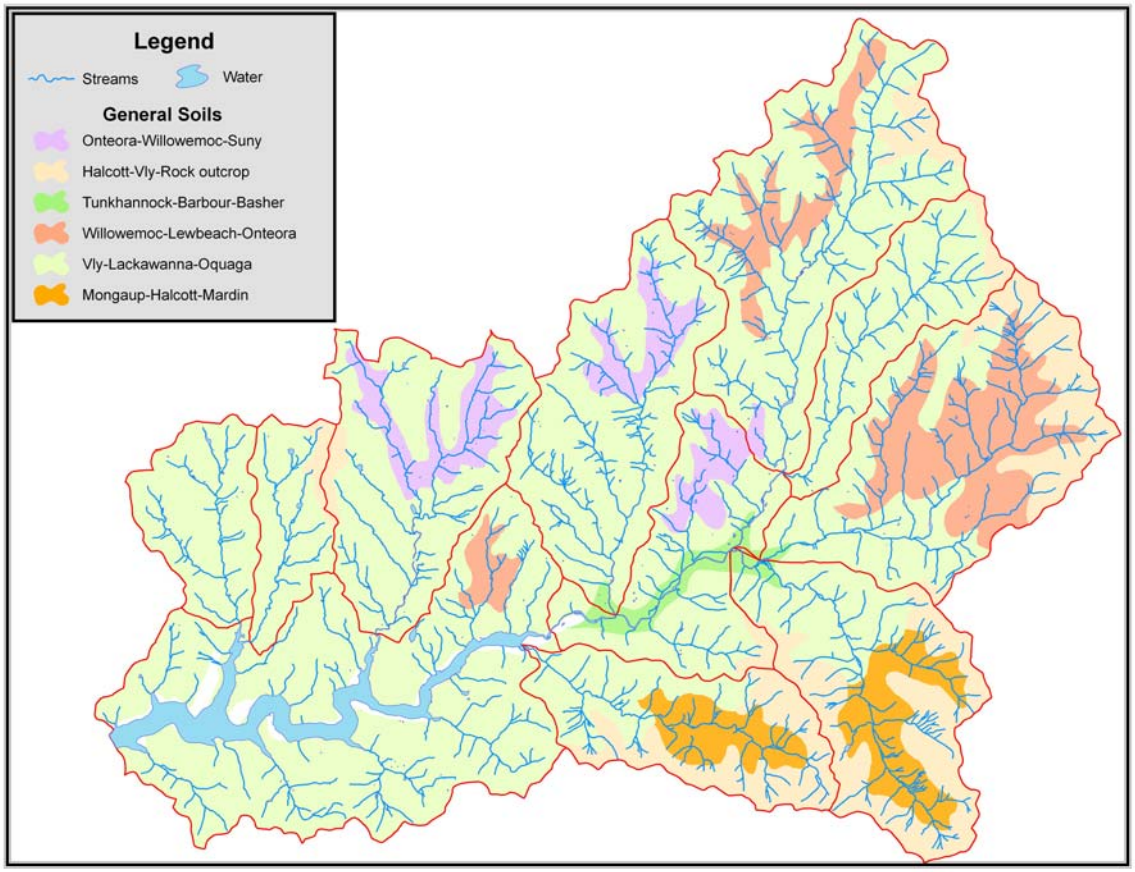
Soils

Over the 10,000 years or so since the glacial deposits were exposed to the elements, the influences of physical weathering and plant and animal life have been at work. The surface layer down to a depth of about 6 feet is generally considered to be “soil,” and the materials below this closely reflect the original geologic deposit in which the soils of today have developed. The study of soil is useful for this discussion primarily due to two aspects: a) water movement as runoff and infiltration, and b) as a source of nutrients and sediment that reach surface waters.

The United States Department of Agriculture (USDA)-Natural Resources Conservation Service (NRCS) has mapped soils in Delaware County through their soil survey program. **Map 4** shows a generalized view of soils mapping in the study area, using only six map units instead of the 129 recognized in the detailed soil survey (for full detail see http://websoilsurvey.nrcs.usda.gov verified September 26, 2007).

Agriculture is a significant land use in the East Branch watershed, and it is linked to the land management changes that may be needed in the future to enable successful stream corridor management. Soil characteristics must be evaluated in order to design conservation practices that limit the loss of excess *nutrients* and eroded sediments from farmland and keep them from entering surface water.

The most extensive map unit along streams is Vly-Lackawanna-Oquaga, which consists of reddish brown soils that developed in upland glacial till. The sand and gravel "bottomland" soils of Tunkhannock-Barbour-Basher extend from Arkville and Margaretville along the East Branch main stem to the Pepacton Reservoir. The remaining soils are all variations of glacial till, the variations based mainly on either depth to bedrock, wetness or parent material color. For readers that are interested, these soil groups are further described on the following page (**Table 3**).



Map 4. General Soils

Table 3. General Soils

Soil Type	*Onteora-Willowemoc-Suny*	*Halcott-Vly-Rock Outcrop*
Slope (Range)	Strongly steep – level	Moderately steep – very steep
Depth (Range)	Very deep – bedrock	Moderately deep – shallow or exposed bedrock
Drainage (Range)	Moderately well drained – poorly drained	Somewhat excessively drained
Texture	Medium	Medium
Elevation	Uplands >1750 ft.	Uplands >1750 ft.
Suitability for Ag.	Fair	Unsuitable
Components	60% Onteora 21% Willowemoc 5% Suny 14% other	40% Halcott 25% Vly 13% Rock Outcrop 22% other

Soil Type	*Tunkhannock-Barbour-Basher*	*Willowemoc-Lewbeach-Onteora*
Slope (Range)	Steep – nearly level	Gently sloping - steep
Depth (Range)	Very deep – bedrock	Very deep - bedrock
Drainage (Range)	Moderately well drained – somewhat droughty	Well drained – somewhat poorly drained
Texture	Medium to moderately coarse	Medium
Elevation	Valleys <1750 ft.	Uplands >1750 ft.
Suitability for Ag.	Excellent (for slopes <15%)	Good (for slopes <15%)
Components	53% Tunkhannock 11% Barbour 6% Basher 30% other	41% Willowemoc 30% Lewbeach 10% Onteora 19% other soils

Soil Type	*Vly-Lackawanna-Oquaga*	*Mongaup-Halcott-Mardin*
Slope (Range)	Strongly sloping – very steep	Gently sloping – strongly sloping
Depth (Range)	Moderately deep – bedrock	Moderately deep – shallow – bedrock
Drainage (Range)	Somewhat excessively drained – well drained	Somewhat excessively drained – moderately well drained
Texture	Medium	Medium
Elevation	Uplands	Uplands
Suitability for Ag.	Fair	Fair to poor
Components	35% Vly 31% Lackawanna 26% Oquaga 8% other	55% Mongaup 16% Halcott 15% Mardin 14% other

Wetlands

Wet portions of the landscape such as marshes, wet meadows, swamps (forested wetlands), bogs, the shallow margins surrounding ponds, lakes or reservoirs, and seasonally-flooded floodplains are generally known as "wetlands". Over the last few decades, society and the scientific community have increasingly become aware of the functions of wetlands, their values to society, and the variety of forms they take. Differences arise from variation in vegetation, soils, hydrology, and position in the landscape, all of which can make some wetlands more "valuable" than others. In their natural condition, wetlands provide flood control, erosion control, water quality protection, fish and wildlife habitats, and opportunities for recreation, aesthetic appreciation and education.

The U.S. Fish and Wildlife Service published their inventory of wetlands for the entire New York City watershed in 1996. The data is available as printed maps and is also in digital format as a spatial and tabular database. The analysis of this information (without considering the shorelines and deepwater habitat of the Pepacton Reservoir itself) produced the following noteworthy wetland characteristics in the East Branch watershed:

1) The East Branch Headwaters contain more wetlands than other sub-basins in the watershed. However, at a total of only 359 acres, wetlands comprise a very small proportion of the land area. This acreage equals 1.1% of the sub-basin and is close to the maximum for all those contributing to the East Branch.

2) Most wetlands in each sub-basin are relatively small, with median wetland size ranging from 0.64 to 1.48 acres.

3) The most extensive wetland type is small marshes with *emergent* vegetation (such as cattails). The next most common type is small ponds, followed by scrub-shrub swamps and lower portions of perennial streams.

4) Wetlands seem to occur in patterns that roughly follow surface drainage channels (as opposed to being randomly scattered across the landscape).

The ability of wetlands in the East Branch watershed to abate flooding and perform other valuable functions is limited by their small aerial extent. However, it is more important than ever to protect existing wetlands for the functions they do provide. For a more in-depth discussion of wetlands in the watershed, please refer to **Volume 2** of the SCMP**, Section 2**.

HUMAN-ENVIRONMENTAL INTERACTIONS

Historical Land Use

In the early days of settlement, Delaware County was a veritable treasure trove of valuable natural resources. Originally blanketed by a forest including maples, oaks, beeches, elms, black cherries, white pines, hemlocks, hickories, spruces, and the now-rare chestnut, the county was largely cleared to make way for agriculture. While much of the wood was used for construction, tools, wagons, and furniture, certain tree species served more specialized purposes. The hard, uniquely colored wood of black cherry trees was superb for the manufacture of fine furniture. The tannins in the bark of hemlock trees were utilized for tanning leather, and the abundance of hemlock supported the multitudes of tanneries in Delaware County[6]. Tanneries also used water in their processing of the hides, which contributed to the pollution of the waterways at the time. Sugar maples, the sweet sap of which flows heavily during the cold nights and warm days of early spring, provided syrup and sugar to those who tapped the trees[6].

As the forests fell, man and horse alike strained and struggled to pick rocks, pull stumps, and plow the virgin soil. Given the steep terrain and thin topsoil of much of Delaware County, productive land was limited to the lowlands (often the floodplain). Buckwheat, rye, corn, oats, and some wheat was grown by local farmers, although rye was by far the best suited for poor soils. The necessity for milling facilities grew out of these crops, leading to the construction of grist mills across the county. Between sawmills and grist mills, most waterways were utilized for water power.

Upon the arrival of the railroad, the importance of growing breadstuffs for personal use lessened as grains could be shipped from other, more productive locations. The local abundance of water and cold-hardy grasses instead supported dairying as the primary agricultural focus. Eastern Delaware County was home to a booming dairy industry, boasting both farms and creameries. Milk was shipped by rail as far as New York City, with butter traveling as far as California. Later, in the 1900s, cauliflower began to accompany dairy products on the transportation routes. Bringing high prices, cauliflower was important to small farms until larger operations began to dominate the market mid-century[7].

The East Branch Delaware River was highly important to local residents. Providing a means of transportation and trade, commerce was made possible with other municipalities. Many families relied on fish caught in the river or its numerous tributaries for food, with the shad fishery in Colchester being exceptional. The East Branch Delaware River could also occasionally wreak havoc, with floods destroying homes, infrastructure, and crops. In the 1890s, an October flood washed away a cemetery containing the remains of prominent pioneers and Revolutionary War soldiers[8].

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[6] Griffin, Ira Mae. *The History of the Town of Roxbury.* Reprint 1975. page 4
[7] Galusha, Diane. *As The River Runs: A History of Halcottsville, New York.* Catskill Mountain Publishing Corp. Arkville, NY. 1990. pages 24-38 and pages 1, 17, 21
[8] W.W. Munsell & Co. *History of Delaware County, NY with Illustrations, Biographical Sketches, and Portraits of Some Pioneers and Prominent Residents.* W.E. Morrison & Co. Ovid, NY. Rep ublished 1976 (orig. 1880). page 137

The construction and operation of railroads had a significant impact on the East Branch Delaware. The Ulster and Delaware Railroad crossed the Bush Kill and East Branch Delaware at numerous locations and the rail bed affected flood flows and redirected stormwater through an extensive network of ditches and box culverts. Railway washouts in storm events frequently required expensive repairs that involved protecting the rebuilt streamside track sections and structures with large rock and concrete.

In the early 1800s, a dam was erected on the mainstem of the river within the township of Middletown at Halcottsville. Thirty-eight-acre Lake Wawaka was formed, which for over 125 years provided power for mills and industry, ice for farms and creameries, and later, electricity for the residents of Halcottsville. Enlarged in the early 1900s, the lake became the focus of a lawsuit after it allegedly inundated part of a local farm. This controversy would be mirrored — on a much larger scale — upon the construction of the Pepacton Reservoir downstream in the 1950s. Damaged by a flood in 1987, the Lake Wawaka dam was never repaired and the impoundment has since decreased in size[7].

The only other dam on the mainstem of the East Branch is that of the Pepacton Reservoir at Downsville. The priority of the East Branch watershed became the provision of drinking water to New York City residents when thousands of acres of land were flooded in 1955. Four communities were inundated (Arena, Pepacton, Shavertown, and Union Grove), and 974 people were displaced. The largest reservoir by volume in the New York City system, the Pepacton contains 140.2 billion gallons at full capacity and provides the City of over 8 million people with 25% of its drinking water[9].

Current Land Use

Today, the forests have regained much of their original extent as agriculture has dwindled across the watershed. Dairy farming and forestry, however, remain the predominant active land uses within the basin. The trees are still used for lumber, furniture, pallets, and pulp, and people are still tapping the sweet resource of the sugar maples. The rural character of the East Branch Delaware River watershed makes it attractive to tourists and second-home buyers alike, which has increased recreational use of lands and waterways. Fishing, canoeing, kayaking, hiking, birding, and other pastimes are frequently enjoyed in, on, or near the East Branch and its tributaries. Prime trout fishing is legendary, both in the Pepacton Reservoir itself and in the East Branch Delaware. In winter, ample snowfall allows snowmobiles to travel the 354 miles of New York State-funded trails in Delaware County, many of which lie within watershed boundaries. Skiers and snowboarders descend upon resorts such as Plattekill Mountain in the town of Roxbury and Belleayre Mountain, which straddles the line between the East Branch Delaware River / and the Esopus Creek watershed. Tourism is now an integral part of the economy for communities within the watershed. The Delaware and Ulster Railroad – complete with its extensive streamside infrastructure - continues to function as an excursion train between Arkville and Roxbury and also provides hiking opportunities on sections of the railbed along the stream from the Village of Roxbury.

[9] Information obtained from http://nyc.gov/html/dep/html/watershed_protection/html/pepactoninfo.html Verified on November 28, 2007.

Real estate prices have soared over the last thirty years, which in combination with the abandonment of many farms, has led to the parcelization of previously large tracts of land. This parcelization presents a challenge to unified stream management. An additional challenge is the fact that most villages and hamlets are located on or quite near waterways, increasing the amount of impervious surface and therefore the possibility of pollution. However, the communities within the East Branch watershed have adopted local land use laws including zoning, site plan review, subdivision regulations, and floodplain management laws. These tools are used by the local municipalities to protect the safety, health and general welfare of the residents. This includes protecting the environment and all natural resources.

Our activities have affected the landscape as previous generations cleared forests for pastures and cropland, or straightened stream channels to accommodate agriculture and/or development. The conversion of forest land for agriculture two centuries ago resulted in more frequent and severe flooding. The streams and associated erosion rapidly changed the landscape. The impact of these changes on the landscape is visible today as numerous small terraces along headwater streams indicating the process of bed degradation. The regeneration of the forest cover in the recent decades has helped moderate the runoff and changes in the stream channels. Unfortunately, the return of the forests is countered by trends in residential development. **Figure 3** illustrates what happens to a watershed after it is developed and green space is converted to impervious surfaces such as roads, parking areas and roof tops. Note that peak flow (discharge) increases. Also note that this increased discharge takes less time to reach its maximum. This double effect of a higher discharge occurring in less time usually initiates erosion and the destabilization of the drainage basin.

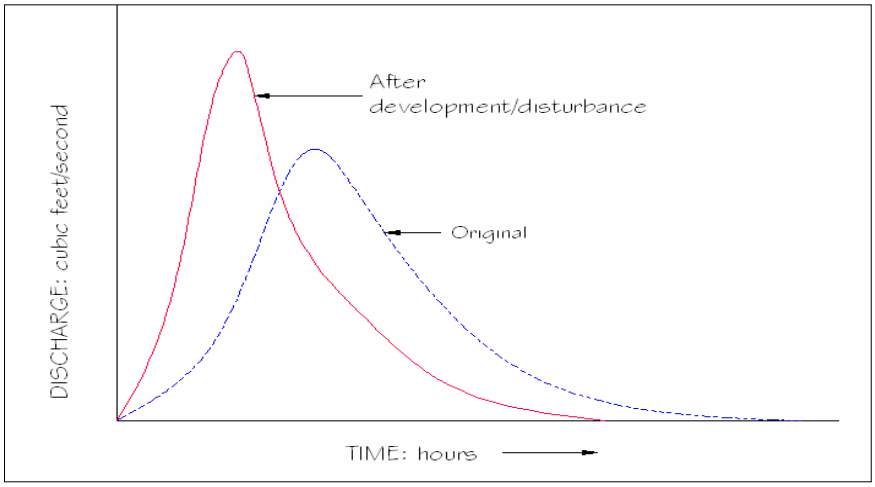


Figure 3. The Effect of Disturbance on Stream Discharge

Infrastructure

In the basin there are two villages and five hamlets which serve as commercial centers for the surrounding towns. Village and hamlet tax parcels are primarily residential and commercial in nature, with the lot sizes substantially smaller. These smaller lots can be accommodated because of the use of municipal sewer and water systems.

The major municipal water supplies *within* the Pepacton Reservoir's contributing basin are for the Andes Water District, the Arkville Water District, the Village of Fleischmanns, the Halcottsville Water District, the Village of Margaretville, the Roxbury Water District, and the Denver Water District. There are numerous additional water supplies within the watershed, most

supported by groundwater. These water supplies – often simple wells – sustain schools, hospitals, housing developments and mobile home parks, camps, hotels / inns, and businesses. Thousands of private residences and seasonal homes add to the number of springs and wells utilized for potable water.

The New York City Department of Environmental Protection operates two sewage treatment plants within the watershed, one located in Margaretville and one in Grand Gorge. Other municipal wastewater treatment plants serve the hamlet of Andes, the Village of Fleischmanns, and Denver / Roxbury Run. Like water supplies, there are many other wastewater treatment facilities for schools, housing developments, camps, hotels / inns, and businesses.

Linking the towns of the East Branch basin is a network of highways and bridges under three separate ownership and maintenance categories: New York State, Delaware County, and townships. They are all part of an infrastructure system on an inventory maintained by the New York State Department of Transportation (NYSDOT). Highways are inventoried according to political jurisdiction with subcategories including pavement type. All bridge structures with a span of 20 feet or greater are inventoried, numbered, rated, and periodically inspected for condition and safety by NYSDOT. In Delaware County, bridges on town highways with a 20 foot span and greater are inventoried, numbered (in addition to the NYSDOT inventory and numbering system), maintained, and periodically inspected for maintenance or repair scheduling by the county. On county highways, all structures with a span of 5 feet or greater are managed as bridge structures. Structures on town highways with less than 20 feet of span are the individual town's responsibility and are not inventoried by the county or state.

Highways

As depicted by **Map 5,** there are two state highways within the East Branch basin: 28 and 30. These are the major routes in the watershed. State Highway 28 enters the watershed from Delhi, travels through Andes, Margaretville, and Fleischmanns, and exits at the eastern bound of the basin. State Highway 30 enters the southeastern edge of the watershed from Downsville, runs along the southern edge of the Pepacton, and then crosses to the northern shore. Going through the Village of Margaretville, State Highway 30 continues on to Roxbury and leaves the watershed after passing through Grand Gorge. State Highways 28 and 30 intersect west of the Village of Margaretville.

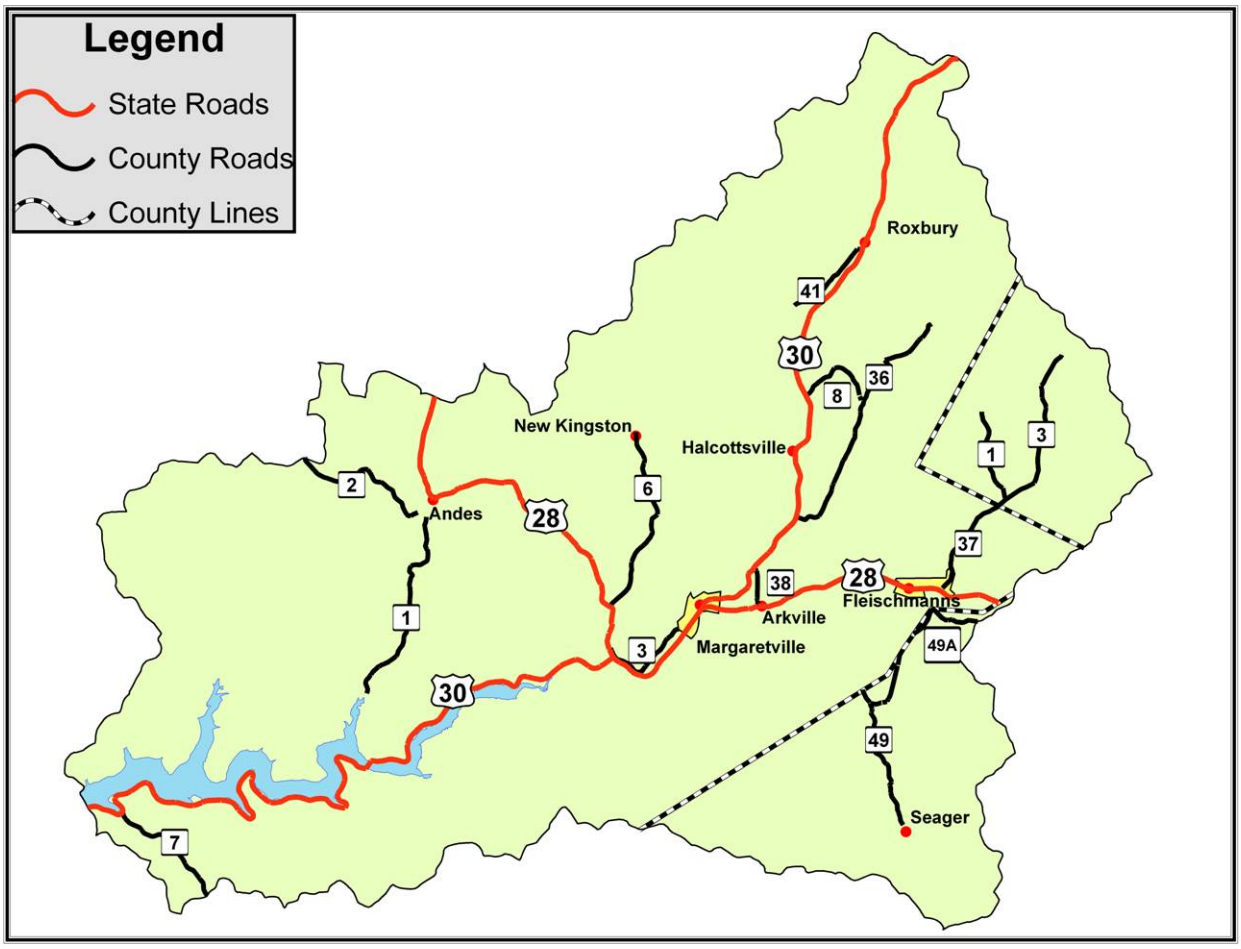
Portions of nine county highways traverse the watershed, five of which lie completely within the basin. In the eastern portion of the watershed are:

- County Route 41 in Roxbury
- County Route 36 between State Highway 30 and Vega
- County Route 8 connecting State Highway 30 and County Route 36
- County Route 37 from Fleischmanns to the Town of Halcott in Greene County
- County Route 38 connecting State Highway 30 and State Highway 28 east of Margaretville

In the central portion of the watershed are:

- County Route 6 between State Highway 30 and New Kingston
- County Routes 1 and 2 in Andes

County Route 7 lies in the western portion of the watershed, connecting State Highway 30 with Roscoe in Sullivan County.



Map 5. Watershed Highways

Most of the highway mileage in the watershed is divided among the jurisdictions of the eleven townships, although the townships with little land area within the watershed contain negligible road mileage. These roads run along streams, over mountaintops and connect with each other and the state and county highways. Town highways are constructed to various standards, with many having been constructed or rehabilitated to the Erwin and Donovan standards developed and financially supplemented by New York State from the period of 1952 through 1982. Town highways feature a variety of surfaces including improved dirt, gravel, or oil and stone. Most town highway mileage is a public right-of-way by usage according to the NYS Highway Law.

Stream Impacts from Highways

Many of these highways are in close proximity to streams and rivers, often crossing them. Highway maintenance can affect stream dynamics and water quality as a result of roadside drainage management, road surface repairs, bridge rehabilitation or replacement, snow and ice removal, and bank stabilization (which may be between the road and the stream). Road encroachment has already impacted many streams, ultimately leading to stream instability — rapid bank erosion, impaired water quality and stream health. Worse yet, these local changes can spread upstream and downstream, causing great lengths of stream instability. Roads near streams can also introduce pollutants or garbage from stormwater runoff, which negatively impacts aquatic habitat. Stormwater runoff is recognized as a significant water quality concern in Delaware County. As overland flow from impervious surfaces such as roads, rooftops and parking areas, it contains contaminants and nutrients that are delivered directly into stream systems. A good streamside buffer along roads could help minimize excess pollutants and garbage from entering the stream system.

Roadside ditches collect stormwater runoff and carry it away from the road, sometimes diverting it directly into the streams. However, getting the water to the streams faster can have negative impacts such as contaminated stormwater, excess sediment, and excess water entering the stream system without any filtration. Increased flooding can occur, due in part to more frequent, extreme rain events, but there are other factors at work. Impervious surfaces and drainage ditches do not allow water enough time to infiltrate the soil, resulting in excess water entering stream systems. Ditch maintenance without re-seeding can increase sediment and turbidity into the stream system, adding to gravel deposition problems. Proper culvert installation is important for stream stability as well, since incorrect culvert installation can increase streambank erosion and/or gravel deposition upstream and downstream of the culvert.

Stream Impacts from Bridges

Bridge design has become a complex issue between highway infrastructure and stream management. Of the 42 bridges in the East Branch Delaware watershed, 20 belong to New York State DOT[10] and 22 are county-owned bridges. The individual towns maintain an additional 42 stream crossing structures. Under many circumstances, bridges were built without any consideration given to stream system impacts, as long as a certain amount of water from a predicted flood event would pass under the bridge. Bridges that are built too wide for the stream will start to deposit sediment upstream or downstream of the structure during periods of low flow or base flow. Bridges that are built too narrow for the stream to pass under may cause streambank erosion upstream and/or downstream of the structure. Gradual rises in the highway leading up to a bridge (i.e. the bridge approach) typically fill a portion of the floodplain; during floods this constriction can force water that is normally on the wider floodplain through the narrow opening under the bridge. This concentrates the energy of the floodwaters, potentially causing erosion problems downstream and under the bridge.

[10] According to Timothy Giblin, NYSDOT Region 9

Current Stream Impact Mitigation Efforts

Work is currently underway to address stormwater issues as related to development-related runoff and highway management. By following recommendations of the Delaware County Action Plan (DCAP) the county is developing and implementing programs for better stormwater and highway management. In addition, the Delaware County Planning Department (DCPD) and Department of Public Works (DPW) are answering the call for proper local stormwater management with Highway Management Plans, individually tailored for each town. Creating these plans helps identify existing infrastructure as well as historical or repetitive problems areas. Recommendations for road improvement and maintenance plus stormwater infrastructure at the township level are included.

Citizen Flood Response

Floods are an act of nature and, unfortunately, they can at times create immense damage to our homes and infrastructure. There are well documented events in 1942, 1955 (when the Pepacton Reservoir filled up for the first time), 1987, 1996, 2005, and 2007 to name a few. When floods occur, flow exceeds the "normal" rate, stream banks overtop, and water flows onto the floodplain. It is important to remember "*The floodplain is defined as the flat area bordering a stream, constructed by the river in the present climate and inundated during periods of high flow*" (Leopold, 1997). Flood flows over floodplains accomplish three natural functions: energy reduction, deposition of finer sediments (which enhances plant growth), and deposition of woody debris.

It is important to recognize that much of the property damage suffered during floods is directly related to development on the floodplain. For those who live in a flood-prone area, several practical steps can be taken to protect a home or business in preparation for future floods. Irreplaceable valuables should not be stored in the cellar and first floor. If an oil tank exists in the basement, it should be securely anchored according to code to prevent it from floating and spilling during a flood. Electrical components, including the washer and dryer, within the house should be raised above the level of potential flood waters. Consideration should be given whether to raise the furnace and water heater above the level of potential flood waters. These suggested actions could help avoid the common repairs homeowners may have to undertake after a flood. Propane tanks should also be secured in a manner that they will not float downstream in the event of a flood.

In the event of a flood, FEMA recommends the following actions to make sure a family stays safe until the water levels recede:

- **Fill bathtubs, sinks, and jugs with clean water in case water becomes contaminated.**
- **Listen to a battery-operated radio for the latest storm information.**
- **If local authorities instruct the community to do so, turn off all utilities at the main power switch and close the main gas valve.**
- **If told to evacuate your home, do so immediately.**

- **If the waters start to rise inside a house before evacuation, retreat to the second floor, the attic, and if necessary, the roof.**
- **Floodwaters may carry raw sewage, chemical waste and other disease-spreading substances; wash hands with soap and disinfected water.**
- **Avoid walking through floodwaters. As little as six inches of moving water can knock a person off their feet.**
- **Don't drive through a flooded area. If you come upon a flooded road, turn around and go another way. A car can be carried away by just 2 feet of flood water, the depth of which can be very hard to judge.**
- **Electric current passes easily through water, so stay away from downed power lines and electrical wires.**

Following a flood, individuals should take special care to document their damages and losses. Receipts for repairs and materials as well as photographs of damages should all be kept by home and business owners.

June 2007 Flood Event

A very localized and devastating flood occurred on June 19, 2007. An intense storm dropped over eight inches of rain in two hours, causing severe flash flooding in a few small tributaries that discharge directly into the Pepacton Reservoir. Holliday Brook and Beech Hill were hardest hit (see **Map 6** below).

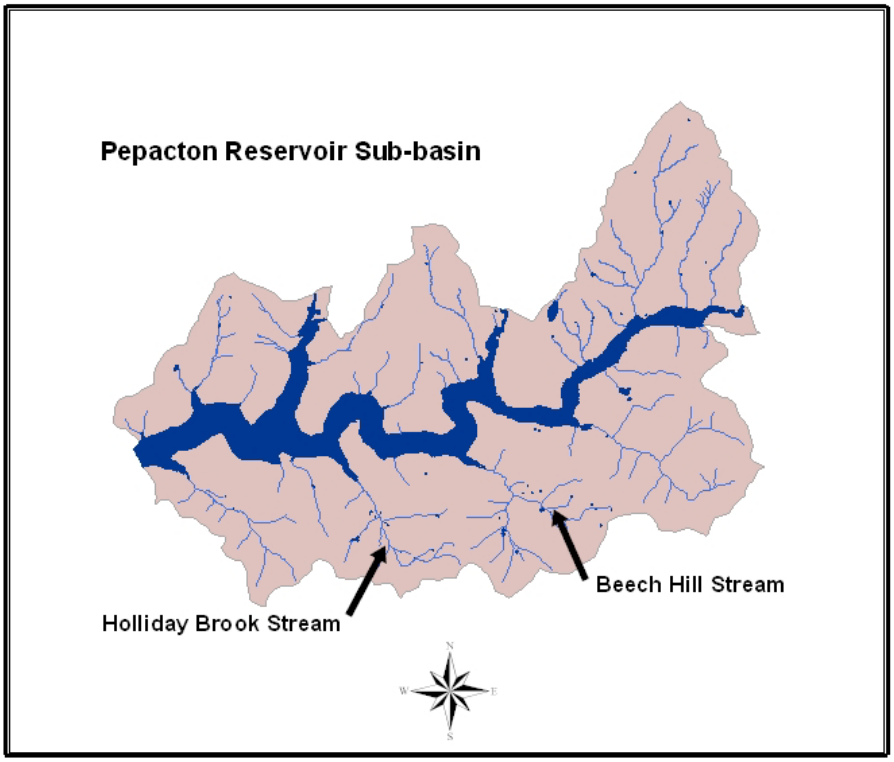
Holliday Brook

Along Holliday Brook, one house was completely washed away, one private bridge was obliterated, and another bridge disabled. Approximately three quarters of one mile of road – both Town of Colchester and New York City jurisdictions – was completely washed out, made both unrecognizable and impassable. An entire mile of stream upstream from the reservoir was significantly altered. Damage included channel avulsion (re-location), severe down-cutting, and debris deposition, all of which were most significant at the demolished private bridge. The impacts to water quality and aquatic habitat were severe.

Since the Holliday Brook Road is a connector road to a New York State Scenic Highway Corridor, the New York State Department of Transportation (NYSDOT) assisted the Town of Colchester and City of New York with flood response and recovery efforts. The Army National Guard was also made available to assist. At the request of NYSDOT, DCSWCD staff was dispatched to guide the National Guard with emergency stream restoration. DCSWCD staff protocol involved assessment of the stream reach, removal of large woody debris, returning the stream to its original channel, and establishment of adequate channel cross-sectional area. Approximate cross-sectional area was calculated from the DCSWCD Regional Hydraulic Relationship Curves (see **Volume 2, Section 3**). DCSWCD staff provided channel alignment, stream grade, and cross-section stakeout to guide National Guard operators.

Beech Hill

Impacts to the Beech Hill and Mary Smith Hill tributary were less significant, but still resulted in damage to public infrastructure in the form of failed highway embankments, temporary road closures, and impacts to water quality and aquatic habitat. DCSWCD staff assisted the USDA Natural Resources Conservation Service Emergency Watershed Protection Program with designs at two locations to repair approximately 1200 feet of stream channel and embankments.



Map 6. Location of Holliday Brook and Beech Hill

Delaware County's System for Flood Response

On July 21, 2004, the Delaware County Comprehensive Emergency Management Plan (CEMP) was adopted by the Delaware County Board of Supervisors. The CEMP resulted from recognition on the part of local government and state officials that a comprehensive plan was needed to enhance the county's ability to manage emergency/disaster situations. It was prepared by county officials working as a team in a planning effort recommended by the State Emergency Management Office (SEMO). The CEMP constitutes an integral part of a statewide emergency program and contributes to its effectiveness. It describes in detail the centralized direction of requests for assistance and the understanding that the governmental jurisdiction most affected by an emergency is required to involve itself prior to requesting assistance. The development of the CEMP included an analysis of potential hazards that could affect the county and an assessment of the capabilities existing in the county to deal with potential problems. Authority to undertake

this effort was provided by both Article 2-B of the State Executive Law and New York State Defense Emergency Act.

Dealing with disasters is an ongoing and complex undertaking. However, lives can be saved and property damage minimized by reducing risk before a disaster occurs. Timely and effective response from appropriate officials and volunteers during an event helps provide both short and long term recovery assistance.

This process is called Comprehensive Emergency Management (CEM). CEM emphasizes the interrelationship of activities, functions, and expertise of local, county, state and federal departments and agencies necessary to deal with emergencies. The CEMP contains three sections to deal separately with each part of this ongoing process. The emergency management responsibilities of various county officials, departments and agencies are outlined in the CEMP. Assignments are made within the framework of the present county capability and existing organizational responsibilities. The Department of Emergency Services is designated to coordinate all emergency management activities of the county during the event and assist with coordination of all local efforts to respond.

Once the immediate response to an event is over and recovery efforts are under way the Delaware County Hazard Mitigation Coordinator becomes responsible for all county and local efforts to clean up and prepare long term mitigation programs. The designated Hazard Mitigation Coordinator is the Delaware County Planning Director to ensure all mitigation and recovery efforts are properly coordinated with all agencies and local entities.

County responsibilities are closely related to the responsibilities of the local officials within the county (cities, towns and villages). The county emergency management coordinator must officially open the county's Emergency Operations Center (EOC) and contact all partners involved in management phases of an emergency. Once the EOC is operating the municipalities have a location to send information and request additional support. The EOC is manned by all members of the emergency response team including emergency personnel, police, public works representatives, planning staff and administrative staff as well as any other essential personnel called upon. The county has the responsibility to assist the local governments in the event that they have fully committed their resources and are still unable to cope with disaster. Similarly, New York State is obligated to provide assistance to the county after resources have been exhausted and the county is unable to cope with the disaster.

Delaware County uses the Incident Command System (ICS) to respond to emergencies. The ICS is a management tool for the command, control and coordination of resources and personnel in an emergency. Specific emergency management guidance for situations requiring special knowledge, technical expertise, and resources may be addressed in separate annexes attached to the CEMP. Examples of this type of situation are emergencies resulting from floods, hazardous chemical releases, dam failure, and power outage. The CEMP provides general all-hazards management guidance—using existing organizations—to allow the county to meet its responsibilities before, during and after an emergency.[11]

[11] Delaware County, *Delaware County Comprehensive Emergency Management Plan*, July 2004, pages i-ii, paraphrased.

Although the CEMP addresses all emergency/disaster situations, flooding has been the most prevalent in the East Branch watershed. During major flood events and other disasters that can cause road and bridge closures, the Delaware County Department of Emergency Services (DCDES) activates its emergency operations center and ICS. All emergency response agencies including Federal Emergency Management Agency (FEMA), SEMO, the NYS Office of Fire Prevention Control, law enforcement agencies, and fire departments are contacted and put on alert. The Department of Emergency Services monitors all emergency situations and provides for emergency evacuations, if necessary.

~ III. Stream Restoration Projects ~

"I have never seen a river that I could not love. Moving water…has a fascinating vitality. It has power and grace and associations. It has a thousand colors and a thousand shapes, yet it follows laws so definite that the tiniest streamlet is an exact replica of a great river." — Roderick Haig-Brown, fisherman and conservationist

Stream restoration is an effort to restore the function of a stream by returning it to the appropriate size, shape, and condition which will allow it to reach a stable form. In other words, the replication of a stable stream is attempted. Restoration differs from "stream bank stabilization" (or other interventions that typically address only a limited problem area) in that restoration looks at an entire reach of stream. Before a restoration project is implemented, a series of important watershed characteristics are studied. Data is gathered in order to design for the proper conditions prior to implementing the project.

Those that embark on a restoration project typically look to ensure that the stream's slope is not too steep or too flat, and that it has a proper width, depth, and access to its floodplain. This can vary from stabilizing a streambank at a critical location to a full restoration that may include stream re-location. In all situations, streamside vegetation management plays an integral role.

EAST BRANCH DELAWARE RIVER DEMONSTRATION PROJECT

$300,000 of the project funding in the NYCDEP contract was earmarked for a demonstration project within the watershed. Assessments and investigations narrowed potential projects to four sites in the watershed. A subcommittee of the Project Advisory Committee was appointed to rank all four sites, select the site most in need of restoration and that would fit the NYCDEP contractual requirements for a demonstration project, and report back to the full committee. The Margaretville Village Park site was selected.

Margaretville Village Park

Project Goal

The purpose of this project was to reduce stream bank instability and resulting turbidity in the New York City water supply, and protect public infrastructure and adjoining private property. The existing conditions are characterized by excessively eroding stream banks and stream bed scour during a range of flow conditions.

The plan for restoration consisted of placement of three rock vane structures with rock toe protection. These measures were designed to minimize sedimentation and facilitate a riparian buffer enhancement. This was not a flood control project.

Project Location

The project is located adjacent to the village park in Margaretville, Town of Middletown, Delaware County, New York.

Project Description

This project was to stabilize streambank erosion. Techniques involved installation of 3 single arm rock vanes with upstream rock toe protection to stabilize an eroding stream bank and control bed scour where a failed boiler plate and railroad rail retaining was been removed. The existing riparian buffer will be enhanced and expanded and live willow stakes will be placed in the voids of the existing riprap – in the spring of 2008.

As constructed, the work completed at this site was designed to be a self maintaining streambank stabilization project based on natural stream channel design principles. The project design was based on observations and measurements taken at the project site and upstream and downstream of the project site.

Project Cost - $293,694
Project Funding – NYCDEP, NYSDEC

OTHER RESTORATION PROJECTS

$400,000 in of project in the NYCDEP contract was earmarked for facilitating Conservation Reserve Enhancement Program (CREP) projects in both the East Branch and West Branch Delaware River watersheds. These funds are used where streambanks are not stable enough to implement CREP according the CREP guidelines. In the East Branch watershed, the Joy Tuttle farm was selected for a streambank stabilization project. This is the first farm upstream (approximately 0.5 miles) of the Pepacton Reservoir. By stabilizing this streambank, the producer is assured of a minimized risk of further damage to the field and has agreed to place the entire farm into CREP. This project is in cooperation with the Watershed Agricultural Program (WAP) Small Farms Program.

Joy Tuttle Streambank Restoration

Project Goal

The purpose of this project was to reduce stream bank instability and resulting turbidity in the New York City water supply, and protect public infrastructure and adjoining private property. The existing conditions were characterized by excessively eroding stream banks during a range of flow conditions.

The plan for restoration consisted of placement of 250 linear feet of live log crib-wall and live willow staking along the top of the streambanks for approximately 1100 feet on both sides. These measures were designed to minimize sedimentation and facilitate a riparian buffer and livestock exclusion. This was not a flood control project.

Project Location

The project is located approximately 300 feet downstream from Delaware County bridge 1-2 on County Route 1 in the Town of Andes.

Project Description

This project was to stabilize streambank and floodplain erosion. Techniques involved installation of approximately 250 linear feet of live log crib-wall where the stream continually broke out onto the left (looking downstream) floodplain and had excessively eroded the streambank. Existing gravel berms were removed from the site. Live plant material staking was installed on both streambanks for a distance of approximately 1100 feet.

As constructed, the work completed at this site was designed to be a self maintaining streambank stabilization project based on natural stream channel design principles. The project design was based on observations and measurements taken at the project site.

Project Cost - $71,718
Project Funding – NYCDEP, NYSDEC

~IV. Communities~

"When we try to pick out anything by itself, we find it hitched to everything else in the universe." — John Muir

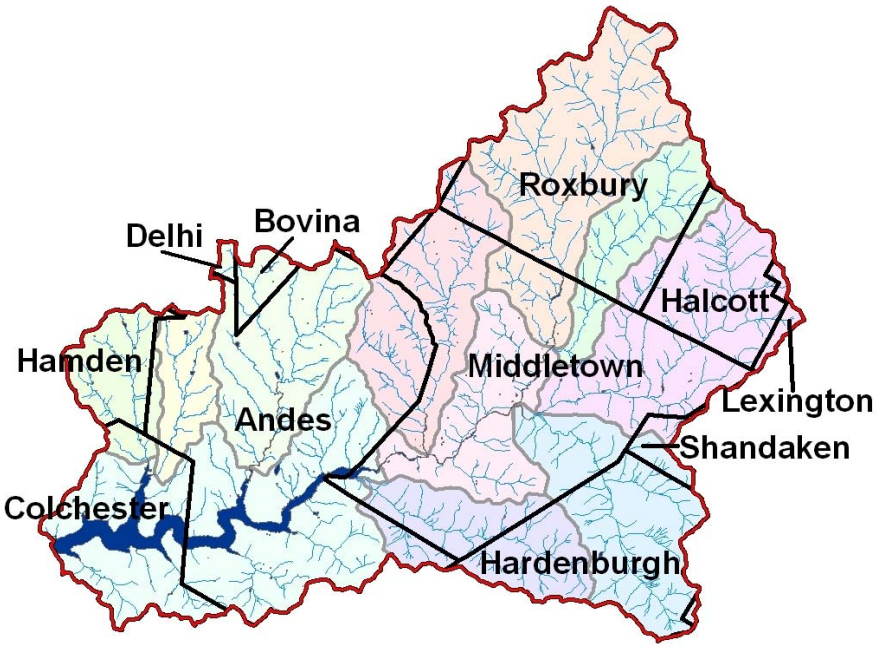
The towns and villages within the East Branch Delaware River watershed share many characteristics that range from rural landscapes to a common concern regarding stream management. Many communities utilize tools — such as comprehensive plans or subdivision regulations — to manage land use within their borders. These tools vary across the watershed, however, making each community unique in their approach to stream management. The following table highlights the guidelines and regulations adopted by each town and village within the watershed.

Table 4. Land Use Regulations in Watershed Communities*

	Comprehensive Plan	Ready for Comp. Plan update	Subdivision Regulations	Site Plan Review**	Zoning	Dump Control Law	Mobile Home Regulations	Critical Environmental Areas	Sourcewater Plan	Highway Management Plan	Stormwater Management Plan
TOWNS											
Andes	**2003**	**X**	**2006**	**2007**	**2007**	**X**	**X**			**IP**	
Bovina	**2003**	**X**	**1997**	**X**	**1996**	**X**	**X**			**IP**	
Colchester	**2003**	**X**	**2004**			**X**				**IP**	
Delhi	**2002**	**X**	**1989**	**X**	**2002**	**X**	**X**			**IP**	
Halcott	**2003**	**X**	**2002**	**X**		**X**					
Hamden	**2000**	**X**	**2006**	**2001**		**X**	**X**			**IP**	
Hardenburgh			**X**		**2007**						
Lexington											
Middletown			**1989**	**X**	**2000**	**X**	**X**			**IP**	
Roxbury	**2002**	**X**	**1988**			**X**		**X**	**2004**	**IP**	
Shandaken	**2005**		**X**		**X**						
VILLAGES											
Fleischmanns	**E/U 2008**				**E/U 2008**		**X**		**2004**		
Margaretville	**E/U 2007**			**X**	**2005**	**X**	**X**		**2004**		**2003**

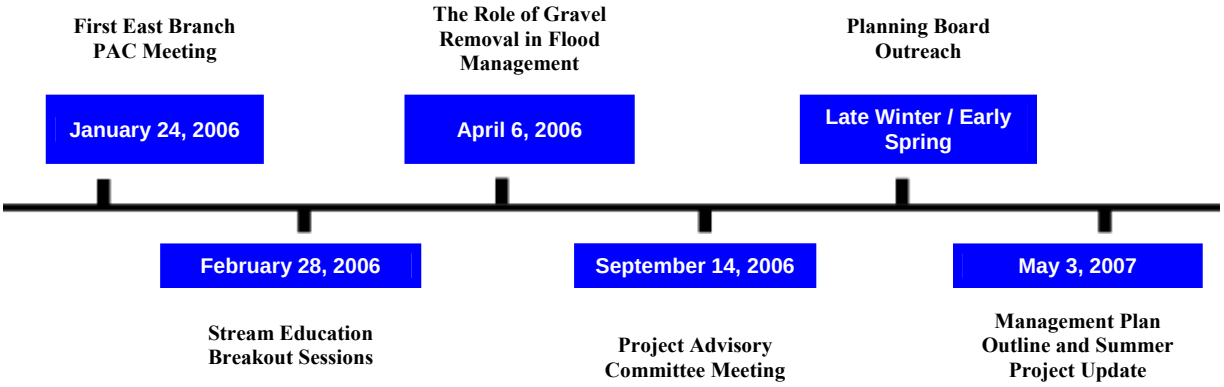
Date = Year of Adoption or Amendment X = Adopted IP = In Progress
E/U = Existing regulation, update in progress

*Note: Delaware County also has a "Right to Farm" law that applies to each community within its borders.
** Many communities' site plan review is part of their zoning regulations.



Map 7. Town Locations

As stated in the Introduction to Volume 1, "The DCSWCD, the Delaware County Planning Dept. (DCPD), and the NYCDEP recognize that local input and leadership is essential to developing and implementing the management plan." These agencies worked with the PAC and local town and village planning boards in order to develop a vision for each community — a vision critical to formulation of stream management recommendations. The purposes of the Plan were discussed with and presented to the PAC and each board within the watershed, promoting discussion about local concerns and specific problematic areas.



In addition, a survey regarding stream management issues was provided to many of the planning boards. Nine surveys were returned and the results showed that gravel deposition/removal, debris removal, erosion, stormwater/highway management, floodplain issues, and invasive species are nearly universal problems in communities throughout the watershed. Also common

were concerns about funding for stream management, the lack of stream-related knowledge, and permit accessibility. While many communities have existing stream protection tools in the form of local laws and comprehensive plans, these tools are due for updates and enhancements. Education — both municipal and public — is desired across the watershed, along with assistance with permit applications. Some communities want help in drafting local laws and comprehensive plan revisions, and some are interested in stream clean-ups and watershed associations. Others are interested in involving their local chambers of commerce in an active watershed management role.

Overall, there is a distinct concern about stream management within the East Branch watershed. Both the comments received at the meetings and the survey results have helped shape the management plan to fit the communities. On the following pages are demographic profiles of the watershed communities, issues and concerns raised by planning board members at the outreach meetings, and community-specific action plans.

ANDES

Located along the southeastern border of Delaware County, Andes is a predominantly rural township. Adjacent townships consist of Colchester, Hamden, Delhi, Bovina, and Middletown. Covering 112.5 square miles (89.4% within the East Branch watershed), the town's population consisted of 1,356 people as of the 2000 U.S. Census. There were 1,326 housing units within the town, 722 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $86,600.

Planning Board Issues and Concerns:

- Tree/debris removal from streams on state or "forever wild" lands?
- Debris inventory
- Permit accessibility municipalities and private landowners

Suggested Town of Andes Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work with NYSDEC and other private land trusts to develop a method to manage debris removal from state-owned and other "forever wild" lands.	Town Board
Develop a process to inventory stream debris and its removal	Town Board/Town Highway Department
Work with regulatory agencies to streamline the permitting process	Town Board

BOVINA

Located in the east-central portion of Delaware County, Bovina is a largely rural township. Adjacent townships consist of Delhi, Hamden, Andes, Middletown, Roxbury, and Stamford. Covering 44.5 square miles (13.4% within the East Branch watershed), the town's population consisted of 662 people as of the 2000 U.S. Census. There were 521 housing units, 244 of which were seasonal or vacant. Owner-occupied housing units exhibited a median value of $92,900.

Planning Board Issues and Concerns:

- The highway department needs technical assistance with maintenance and improvements
- Gravel removal
- Streambank erosion within the hamlet of Bovina Center
- There is the general feeling that "we can only fix 20 years' worth of problems during a flood" because that seems to be the only time people are allowed in the stream
- NYSDEC permitting process is too slow and needs to be streamlined
- Funding for restoration and maintenance is needed for projects on private property

Suggested Town of Bovina Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work with partners to facilitate a scientifically-based method to efficiently remove excess gravel from streams	Town Board/Town Highway Department
Develop a process to inventory, assess, and stabilize erosion within Bovina Center	Town Board/Town Highway Department
Locate funding sources to offset private landowner stream maintenance expenses	Town Board
Work with regulatory agencies to streamline the permitting process	Town Board

COLCHESTER

Located on the southern border of Delaware County, Colchester is mostly rural. Adjacent townships consist of Hancock, Walton, Hamden, and Andes. Covering 142.2 square miles (20.5% within the East Branch watershed), the town's population consisted of 2,042 people as of the 2000 U.S. Census. There were 1,587 housing units in the town, 750 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $73,500.

Planning Board Issues and Concerns:

- Support and education is necessary outside watershed boundaries to ensure protection of tailwaters below the dam
- Permitting and approval for the construction of a stream crossing needs to be made easier
- General frustration with the permitting system; it needs to be streamlined
- Early warning system for flooding along the East Branch.
    - This is an action item in the Delaware County Multi-jurisdictional All-Hazard Mitigation Plan.

Suggested Town of Colchester Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work in conjunction with the County All Hazard Mitigation Plan to develop an "early warning system" to be used in the event of stream flooding	Town Board/Emergency Services
Involve the Town with any watershed activities that are relevant to the tailwater region below the Pepacton Dam	Town Board/Town Highway Department
Work with regulatory agencies to streamline the permitting process	Town Board
Consider setback requirements specific to separation distances of structures from watercourses	Planning Board

DELHI

Located in the central portion of Delaware County, the majority of the township of Delhi is rural. Adjacent townships consist of Hamden, Andes, Bovina, Stamford, Kortright, Meredith, and Franklin. Covering 64.6 square miles (1.6% within the East Branch watershed), the town's population consisted of 4,629 people (2,583 within the village of Delhi) as of the 2000 U.S. Census. There were 1,818 housing units, 325 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $86,300.

The Town of Delhi faces the same issues addressed by many other communities, although the majority of the town lies within the West Branch Delaware River watershed.

Suggested Town of Delhi Action Plan
Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board

HALCOTT

Halcott, with its pastoral view and rolling hills, is located in the western portion of Greene County. Adjacent townships consist of Roxbury and Middletown in Delaware County, and Lexington in Greene County. Covering 23 square miles (95.1% within the East Branch watershed), the town's population consisted of 193 people as of the 2000 U.S. Census. There were 288 housing units, 204 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $82,500.

Planning Board Issues and Concerns:

- Willows growing in the stream create problems
- Gravel deposition
- Japanese knotweed
- An abundance of vegetation is negatively viewed as 1.) limiting access and 2.) clogging the stream
- Water encroachment on property causing erosion issues
- Culvert at Elk Creek needs to be properly sized and brought up to standard
- More education is needed regarding debris removal rights during flood events

- Stream management education is needed for second homeowners
- Informal watershed association is being developed and should be supported by the local community
- Seemingly fewer fishermen
- Very little development pressure to impact local streams

Suggested Town of Halcott Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work with partners to facilitate a scientifically-based method to efficiently remove excess gravel from streams	Town Board/Town Highway Department
Develop a program to address invasive species such as Japanese Knotweed	
Examine need to rehabilitate Elk Creek stormwater infrastructure	Town Highway Department
Develop a process to inventory stream debris and its removal	Town Board/Town Highway Department
Develop educational outreach materials that can be sent to second homeowners	Town Board
Work with regulatory agencies to streamline the permitting process	Town Board
Keep apprised of watershed association activities and strive to keep them up to date on town practices to avoid duplication or conflicting efforts	Town Board/Town Highway Department

HAMDEN

Located in the central portion of Delaware County, Hamden is predominantly rural. Adjacent townships consist of Delhi, Andes, Colchester, Walton, and Franklin. Covering 59.9 square miles (19.3% within the East Branch watershed), the town's population consisted of 1,280 people as of the 2000 U.S. Census. There were 902 housing units, 361 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $76,300.

Planning Board Issues and Concerns:

- Interested in assisting with an update to the West Branch Stream Corridor Plan to ensure uniform management and protection of streams within the community
- Education is needed so that contractors can avoid disturbing the streams and creating more problems
- Platner Brook has gravel issues

Suggested Town of Hamden Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work with partners to facilitate a scientifically-based method to efficiently remove excess gravel from streams such as Platner Brook	Town Board/Town Highway Department
Educate contractors on streambank construction and maintenance practices to avoid further problems that may result from improper stream excavation	Town Board

HARDENBURGH

Located in the western corner of Ulster County, Hardenburgh is a largely rural township. Adjacent townships consist of Andes and Middletown in Delaware County, Shandaken and Denning in Ulster County, and Rockland in Sullivan County. Covering 81.5 square miles (43.4% within the East Branch watershed), the town's population consisted of 208 people as of the 2000 U.S. Census. There were 275 housing units, 180 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $89,000.

Planning Board Issues and Concerns:

- Work with NYSDEC to develop gravel removal protocol and criteria
- There are gravel deposition and flooding problems
    - Below confluence of Dry Brook and Mill Brook
    - Below Haynes Hollow and Kelly Flats
- Safety for human life becomes a concern for developments when one road is the ONLY road in and out and it is threatened by flood waters
- Mill Brook is a problem up by the schoolhouse and requires rehabilitation and management

Suggested Town of Hardenburgh Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work with partners to facilitate a scientifically-based method to efficiently remove excess gravel from streams	Town Board/Town Highway Department
Increase level of caution regarding the safety of all town roads threatened by flood damage	Town Board/Town Highway Department

LEXINGTON

Located along the southwestern border of Greene County, Lexington is a rural township. Adjacent townships consist of Halcott, Prattsville, Ashland, Jewett, and Hunter in Greene County, Shandaken in Ulster County, and Roxbury in Delaware County. Covering 79.7 square miles (2.6% within the East Branch watershed), the town's population consisted of 830 people as of the 2000 U.S. Census. There were 854 housing units, 479 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $80,800.

The Town of Lexington faces many of the same stream management issues that were raised in other watershed communities.

Suggested Town of Lexington Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board

MIDDLETOWN

Located in the southeast corner of Delaware County, Middletown is a largely rural township. Adjacent townships consist of Andes, Bovina, and Roxbury. Covering 97.3 square miles (99.8% within the East Branch watershed), the town's population consisted of 4,051 people as of the 2000 U.S. Census. Of these, 643 resided within the Village of Margaretville and 351 lived in Fleischmanns. There were 3,013 housing units (350 Margaretville, 287 Fleischmanns) in the town, 1,341 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $83,600.

Planning Board Issues and Concerns:

- What about cleaning out our streams?
  - Monitor, control, and "triggers"…do it scientifically
- Who would do the work of a watershed association?
- We need education regarding people's rights and limitations when it comes to stream management.
- Issues where the river may change dramatically and due to ownership changeover, nobody knows
- Gravel deposition problem "across from Alta"
- Issues with recreation access and misuse/abuse of access privileges
- What is the responsibility of the landowner to the quality of the watercourse running through his/her property?

The Village of Margaretville

Located in the Town of Middletown, Margaretville is one of two small villages within the East Branch Delaware River watershed. As of the 2000 U.S. Census, 643 people resided within the Village. There were 350 housing units and a large business district. The Village is considered the main commercial district for Middletown and is the site for the local school.

Planning Board Issues and Concerns:

- Bull Run is an ongoing problem, especially at the "slide"
- Ice jams create flooding that jeopardizes homes and businesses along Main Street
- The creation of a protocol for debris removal prior to, during, and after a flood is essential to ensuring the safety of Village residents, businesses, and highway infrastructure

The Village of Fleischmanns

Located in the Town of Middletown, Fleischmanns is one of two villages in the East Branch Delaware River watershed. The population of Fleischmanns consisted of 351 people as of the 2000 U.S. Census. There were 287 housing units in the village, many of which are seasonal or second homes.

Planning Board Issues and Concerns:

- The Village would like to acquire old Lake Switzerland, harvest topsoil, and restore it as a lake
- The Village comprehensive plan being developed should incorporate goals from the EBSCMP
- Tourism is large part of the economy and is reliant on fishing and other recreational opportunities along the streams
- The protection of fish habitat is important

Suggested Town of Middletown Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work with partners to facilitate a scientifically-based method to efficiently remove excess gravel from streams	Town Board/Town Highway Department
Educate private landowners on their rights, limitations, and responsibilities regarding stream management on their property	Town Board
Monitor recreational access points and address any misuse/abuse with rigid enforcement	Town Board
Margaretville	
Develop a strategy to address ice jams and the resulting damage	Village Board/Village Highway Department
Examine the conditions of the “slide” at Bull Run and determine a strategy to address the ongoing problem.	Village Board
Incorporate principles of stream stewardship into the Village Comprehensive Plan.	Village Board/Planning Board
Fleischmanns	
Incorporate principles of stream stewardship into the Village Comprehensive Plan.	Village Board/Planning Board

ROXBURY

The eastern-most township in Delaware County, Roxbury is mostly rural. Adjacent townships consist of Stamford, Bovina, and Middletown. Covering 87.6 square miles (72.4% within the East Branch watershed), the town's population consisted of 2,509 people as of the 2000 U.S. Census. There were 2,026 housing units in the town, 948 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $78,200.

Planning Board Issues and Concerns:

- Update local comprehensive plan to incorporate stream management
- Vega Mountain Rd. in the hamlet: debris gets clogged under the bridges and gravel in the stream causes water to flow over the hay field
- Highway superintendents would benefit from stream management education
- More development is leading to increased stormwater runoff
- Stream impacts should be considered prior to subdivision approval
- Should get gravel out of the stream as a temporary relief/fix and use that gravel as a resource
- Concerned with stormwater and highway impacts
- Concerned with stormwater impacts associated with wind towers and their access roads

Suggested Town of Roxbury Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board
Work with partners to facilitate a scientifically-based method to efficiently remove excess gravel from streams in bridge areas such as Vega Mountain Road	Town Board/Town Highway Department
Educate highway department on streambank construction and maintenance practices to avoid further problems that may result from improper stream management	Town Board/Town Highway Department

SHANDAKEN

Located along the northern border of Ulster County, Shandaken is a rural township. Adjacent townships consist of Hardenburgh, Denning, Olive, and Woodstock in Ulster County, Lexington and Hunter in Greene County, and Middletown in Delaware County. Covering 119.8 square miles (3.2% within the East Branch watershed), the town's population consisted of 3,235 people as of the 2000 U.S. Census. There were 2,666 housing units, 1,203 of which were seasonal or vacant. Owner-occupied housing units within the town exhibited a median value of $91,200.

The Town of Shandaken experiences many of the same stream management concerns that were raised by other watershed communities.

Suggested Town of Shandaken Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

RECOMMENDATION	PARTY RESPONSIBLE
Adopt the EBDR SCMP at the local level	Town Board/Town Planning Board
Review floodplain regulations to ensure that the most up to date management techniques are being followed	Town Board
Develop local codes to include stream management practices in the local review processes	Town Board/Planning Board/Code Enforcement Officer
Update Comprehensive Plan to include BMPs for stream management	Town Board/Planning Board

~ V. Working and Living with Streams ~

STREAM STEWARDSHIP

Once one understands the basic principles of stable, healthy streams and how human activities affect those streams, the question of "What next?" usually arises. This section will outline some general principles of stream stewardship that can be adopted at the personal, municipal, or regional agency level.

- Work toward the protection and/or restoration of
  - the environmental services provided by streams and floodplains
  - the health of stream and floodplain ecosystems
  - the naturally effective channel form and function of streams
  - floodplains as part of the natural stream system
  - riparian buffers
- In the process of managing streams to protect public safety and infrastructure, avoid threatening
  - stream health upstream or downstream
  - the upland ecosystem through which the stream runs
  - the streambank stability of neighboring properties

Many stewardship and/or management practices require permits from regulatory agencies. Permitting is further described as follows:

PERMIT REQUIREMENTS[12]

If you plan to alter a stream or floodplain, it is important to understand the applicable regulations and what permits, if any, are required. A proposed project that does not conform with environmental regulations will probably be rejected by the regulatory agencies. Rather than fight a losing battle, ask the county Soil and Water Conservation District (SWCD) to help develop a project that meets your stream management objectives without an adverse impact on the stream system. Once you've got a good design, the SWCD can assist with obtaining any necessary permits. A stream project may require approval by one or more of the following agencies:

NYSDEC: The NYS Department of Environmental Conservation (NYSDEC) is responsible for preserving and protecting lakes, rivers, streams, and wetlands in New York State. Activities that may require a permit include:

- Disturbance of the bed or banks of a 'protected stream' or other watercourse.
- Construction and maintenance of dams.
- Excavation or filling or both in 'navigable waters.'
- Disturbance within or adjacent to a 'state regulated wetland.'

[12] Reprinted from "Stream Processes: A Guide to Living in Harmony with Streams" with permission by Janet Thigpen, Southern Tier Central Regional Planning and Development Board.

To determine if a state permit is required, it is recommended that you contact the NYSDEC early in the planning process. More information can be found in Section 8 of Volume 2.

U.S. Army Corps of Engineers: Under the Clean Water Act, the Corps of Engineers is responsible for ensuring that projects in the 'waters of the United States' do not adversely affect such waters. In addition, activities 'in, under, or over a navigable water or wetlands adjacent to navigable waters of the United States' are regulated under the Rivers and Harbors Act. Examples of regulated activities include but are not limited to: dredging, filling, excavating, land clearing using mechanized equipment, ditching, stream channelization and relocation, shore protection, and dock construction. It is recommended that you consult with the Corps of Engineers regarding federal permit requirements for any project in or near a river, stream, or wetland. If the project also requires a permit from NYSDEC, a joint application process can be used to obtain the state and federal permits. More information can be found in **Section 8** of **Volume 2**.

Floodplain development permit: Most municipalities regulate development within the area mapped as the 100-year floodplain according to the standards established by the National Flood Insurance Program. These regulations apply to in-stream activities, as well as those in adjacent floodplains. The requirements for floodplain development are intended to ensure that new development in flood-prone areas is adequately protected from flood damages and does not cause damage to other properties. This permit may require engineering analysis to determine if a project will result in an increase in the height of flooding during a 100-year flood event. Regulated floodplain areas are delineated on federally prepared floodplain maps. Permits for development activities within the designated floodplain are obtained from the city, village, or town.

Local land use regulations: In order to prevent the problems that inevitably arise when development interferes with streams, some municipalities have adopted additional land use regulations for stream corridors. These may take the form of steam setback provisions for buildings, site plan review requirements, or additional development standards within a stream corridor overlay district.

Property owner: Unless you are operating under an emergency authorization, landowner permission is required for any work on property that you do not own.

Easement or Right-of-Way: If a proposed stream project is located within an easement or highway right-of-way, additional permission may be required to insure that the proposed project does not interfere with highway safety or the purpose of the easement. Agencies that build or maintain flood control projects (U.S. Army Corps of Engineers or NYSDEC) generally hold easements requiring that any project on flood control lands obtain prior approval. The NYSDEC also holds easements for fishing access along some streams. Some property is protected by conservation easements.

Although the overlapping jurisdictions of various government agencies may be confusing and frustrating, keep in mind that the underlying regulations were enacted to protect public safety and the quality of the environment. A project that is consistent with these objectives should be

granted the necessary permits. The county Soil and Water Conservation District is a valuable resource in helping you to navigate the regulatory waters and obtain permit coverage.

Even if no permit is required, you may still be responsible for any water quality violations that result from a stream project. It is always a good idea to talk with your county Soil and Water Conservation District if you are unsure of how to proceed.

FREQUENTLY ASKED QUESTIONS[12]

Who owns the streambed?

New York State is the sovereign owner of the beds of "navigable waters" in the state. This ownership gives the state the right to control the bed and to ensure that navigable waterways shall forever remain public highways. A stream and any contiguous wetlands may be classified as "navigable" if it is large enough for operation of a canoe or larger boat. For information about state ownership of a waterway and the activities for which state approval is required, contact the Lands Underwater program of the NYS Office of General Services (http://www.ogs.state.ny.us/realEstate/permits/luwfaq.html, verified May 23, 2007).

As a general rule, the ownership and therefore control of the bed of non-navigable streams or other non-navigable bodies of water is vested in the proprietors of the adjoining uplands, unless their deed provides otherwise. In other words, if you own the bank of a non-navigable stream, you probably own the streambed and are referred to as a riparian owner.

Regardless of who owns a stream, various government entities retain police power over activities that may impact navigation, public safety, the environment, or the rights of other property owners. **Owning a stream does not give you the right to do whatever you please with it.**

Who owns the water in a stream?

In New York State, water in a stream is not "owned" by anyone. The relevant question is:

Who has the right to use water in a stream?

Water rights and water laws vary from state to state. New York follows the riparian rights doctrine developed under common law. Common law means that the rules were not enacted by the legislature, but were developed by the courts through the decisions they hand down. Riparian rights doctrine allows the owners of land bordering on a watercourse to withdraw a "reasonable" amount of water. The courts have generally held that domestic use or use on the land is "reasonable," while removal of water from the riparian property is "unreasonable." Because all landowners along a stream have "riparian rights," none can use the water so as to deprive the others of their rights. If a water use interferes with the "reasonable" use of another riparian owner, the aggrieved party must go to court to protect his/her rights.

Do river basin commissions grant water rights?

In some New York watersheds (such as the Susquehanna, Delaware, and Great Lakes Basins), multi-state commissions may have the authority to regulate water use. These agencies can protect other water users and the environment by reviewing and approving a proposed water withdrawal. Although there may be fees associated with water withdrawal permits, this approval is a police power function and does not confer a property right or "ownership."

Who is responsible for the stream?

Restoration of stream problems is **generally the responsibility of the private landowner**. Although various government agencies have regulatory jurisdiction over how a stream is managed, it is not their job to come and "fix" your stream. Government highway departments are limited in the extent of their stream work to that needed for protection of roads, bridges, and culverts. Other government resources are more likely to be available to assist with a project that restores a degraded stream system, rather than one designed for localized protection of private property. For information about stream maintenance and restoration assistance, contact the county Soil and Water Conservation District.

Responsibility for a stream does not give you the right to do whatever you consider necessary to "fix" its problems. Assume that every stream is regulated unless you determine otherwise.

If flooding occurs or gets worse after a stream has been modified (by diverting flow, modifying the channel, constructing a bridge, etc.), is the person who made the modification liable for damages?

Yes, quite possibly. Courts have, according to common law, followed the adage "use your own property in such a manner as not to injure that of another." This means that no landowner, public or private, has a right to use his/her land in a way that substantially increases flood or erosion damages on adjacent lands. A municipality or property owner may thus be liable for construction, improvements, or modifications that they should reasonably have anticipated to cause property damage to adjacent property. The lack of proper planning, design, and execution thereof, may be considered a clear indication of the lack of good faith and hence negligence with regard to damages that subsequently occurred.

May someone be held liable for failing to remedy a natural hazard that damages adjacent property?

Sometimes. Courts have generally not held governmental units and private individuals responsible for naturally occurring hazards such as stream flooding or bank erosion that damage adjacent lands. In keeping with this principle, a municipality would not be liable for failure to restrain waters between banks of a stream or failure to keep a channel free from obstruction that it did not cause. However, a small number of courts have held that government entities may need to remedy hazards on public lands that threaten adjacent lands. In addition, land owners and governments are liable if they take actions that increase the hazards.

Can liability arise from failure to reasonably operate and maintain a bridge, drainage structure, dam, or flood control structure?

Possibly. The owner of a dam or other water control structure is responsible for inspecting and maintaining it. Where there is a duty to act and the risk of not acting is reasonably perceived, then failure to take appropriate actions may be considered negligent conduct.

May a regulatory agency be liable for issuing a regulatory permit for an activity that damages other private property?

Yes, quite possibly. In fact a careful analysis of hundreds of cases in which the lawsuit involved permitting indicates that a municipality is vastly more likely to be sued for issuing a permit for development that causes harm than for denying a permit based on hazard prevention regulations. The likelihood of a successful lawsuit against a municipality for issuing a permit increases if the permitted activity results in substantial flood, erosion or physical damage to other private property owners.

How safe is safe enough?

Municipalities regularly issue permits for activities that are in compliance with existing laws, but might still be at risk of damage. For example, floodplain development regulations generally apply only to areas mapped as the 100-year floodplain. Yet significant flooding and erosion damages can and do occur outside of these regulated flood-prone areas. Some municipalities address this additional risk by attaching conditions to their approvals for those projects with identified risks. These conditions can clearly state that the municipality is **not obligated** to fix personal property in the event of damage. One Town granted approval for a driveway bridge that met all applicable standards, but attached material clearly warning the applicant about the hazards of driving through floodwaters, the risk that emergency vehicles may be unable to reach the house during floods, the potentially high maintenance costs, and the potential liability for the owner if the project results in damage to other property.

May governmental units be held liable for refusing to issue permits in floodways or high-risk erosion areas because the proposed activities could damage other lands?

No. In general, landowners have no right to make a "nuisance" of themselves. Courts have broadly and consistently upheld regulations that prevent one landowner from causing a nuisance or threatening public safety.

What precautions can be taken to avoid liability?

Be "reasonable." The overall issue, in most instances, is the "reasonableness" of an action by the community or property owner. Due to advances in technology and products, there is an increasingly high standard of care for "reasonable conduct." The "act of God" defense is seldom successful because even rare flood events are now predictable. As a precaution, technical assistance from stream professionals should be obtained prior to implementing any stream project. Because a well-designed project is less likely to damage other lands, this reduces the

potential basis for legal action. And if you are sued, the best defense is a well-documented record showing "due diligence." That is, that you have done sufficient analysis and design to demonstrate the adequacy of the project with "a reasonable degree of certainty."

SELF-ASSESSMENT[12]

Q: "That gravel bar takes up most of the stream channel—that's why the stream floods. If we could only remove that gravel bar, then this stream would stay in its banks."

(a) All of the gravel deposited above the low water level should be removed to solve the flooding problem.

(b) The gravel should be removed to a level below the low water level so that the stream channel is deeper and wider.

(c) Although gravel bar removal may provide temporary relief in some situations, the gravel bar is likely to return during the next high flow event.

(d) The gravel bar is part of the stream system and should be planted with vegetation to stabilize it.

A: ***(c)*** *In many streams, gravel bars are an integral part of the stream and floodplain system. They are comprised of sediment that will be carried farther downstream during the next high flow event and replaced by a fresh supply of gravel. If the gravel is stabilized, as recommended in answer (d), then the stream is likely to erode somewhere else to obtain the necessary sediment load and flooding at the site will continue.*

Q: "If they would dredge this stream, it would be deeper and we wouldn't have all of these problems with flooding and erosion."

(a) A larger stream channel would hold all of the water and solve the flooding problems.

(b) Dredging results in increased erosion.

(c) Dredging results in increased sediment build up, which may make flooding problems even worse.

(d) Dredging can result in increased erosion and/or increased sediment deposition, so both (b) and (c) may be correct.

A: ***(d)*** *Because dredging alters the shape and slope of the channel and disconnects the stream from its floodplain, it destroys those features that naturally dissipate the stream's energy. This frequently results in severe erosion problems. In addition, the shape of the dredged channel is generally not conducive to sediment transport, resulting in a buildup of eroded sediment within the channel. Past disturbance of stream channels has resulted in some of the stream problems we see today.*

Q: "We need to straighten the stream to keep it from washing out that bank. And if the water flows through here faster, it won't flood my neighbor's house."

(a) Straightening a channel may temporarily solve a localized bank erosion or flooding problem.

(b) When a stream is straightened, it becomes steeper and faster, which results in a greater potential for erosion of streambanks and streambeds.

(c) After a channel is straightened, water will get to downstream areas faster and increase the risk of flooding.
(d) All of the above.

A: ***(d)*** *Stream straightening or "channelization" can have adverse impacts and is not generally recommended. Because the bends in a stream channel dissipate energy, a straightened stream has more energy available to erode its channel. In addition, channelization may increase the downstream flood risks.*

Q: "You should use a bulldozer to build up that streambank for flood protection."
(a) Floodplain soil in usually poorly suited for levee construction.
(b) Floodplain soil is usually ideal for levee construction.
(c) By cutting off the stream's access to its floodplain, an elevated streambank will increase the stream's energy and thus the potential for erosion.
(d) Both (a) and (c).

A: ***(d)*** *A berm made of local materials pushed up on a streambank is not true flood protection. Although it may withstand the forces of small flood events, these structures are prone to failure during major floods.*

Q: "I've owned this land for 10 years and it's never been flooded. But they say it's floodplain, so I can't build the house I'd planned."
(a) No building is allowed in the mapped 100-year floodplain.
(b) Floodplain development may be allowed if rules are followed to minimize the flood risk.
(c) If the last flood didn't touch the building site, it's probably safe to build there.
(d) Government has no authority to restrict what can be done on private property—whether it's in the floodplain or not.

A: ***(b)*** *Courts at all levels have upheld the validity of floodplain regulations that prevent damage from hazardous development in locations where flooding is anticipated. Most municipalities have enacted standards that allow some development in the floodplain if it meets flood protection criteria and will not cause damage to adjacent properties. However, it is safer to locate new development outside of the floodplain.*

Q: "I remember when you could step across this creek. Nobody has done anything to it, but now trees are falling in and the banks are over my head. What happened?"
(a) The speaker's memory is faulty—the stream hasn't changed.
(b) The speaker forgot about the time that his neighbor bulldozed the creek to make it deeper.
(c) It is likely that development or other changes in the watershed have increased stream flow, which triggered erosion of a larger channel.
(d) It is natural for all streams to get bigger and deeper with time.

A: ***(c)*** *Although it is possible that the creek is adjusting to a channel disturbance, the reason for increased flooding or erosion can often be found in the watershed that drains into a stream. The general hydrologic symptoms of forest clearing, agriculture, and urbanization are increased peak flows and decreased base flows, resulting in more frequent flooding,*

increased bank erosion, sediment buildup, and other effects. Sometimes it only takes a few new houses or a new access road to cause problems in a stream.

Q: "This !*$!#*! creek is eating away my property. I pay taxes. Who is going to fix it?"

(a) New York State regulates streams, so they are responsible for maintenance.
(b) The County Soil and Water Conservation District takes care of the streams.
(c) In New York, our home rule laws make municipalities responsible for stream maintenance.
(d) The landowner is ultimately responsible for stream and water problems.

A: (d) The land along a stream belongs to the landowner and any necessary work, such as erosion or flood control, is therefore their responsibility. Landowners that have chosen to own land along a stream have assumed stream maintenance responsibilities, much the same as mowing the lawn or fixing the roof. However, responsibility for the stream does not allow a property owner to work in the stream without a permit. Nor does it protect them from liability if they cause damage to another property.

Q: "This is my property. I own the creek. Nobody can tell me what I can or can't do with it."

(a) A permit from New York State is required for any disturbance within 50 feet of some streams.
(b) A U.S. Army Corps of Engineers permit may be required for disturbance of "waters of the United States."
(c) A floodplain development permit must be obtained from the municipality for any development, including fill or grading, within the mapped floodplain.
(d) All of the above.

A: (d) *Although the riparian property owner does own the stream, various government agencies have police powers regulating what can be done within and adjacent to the stream channel. This regulatory authority is based on public health and safety concerns, the potential for adverse impacts to other property, and potential impacts to aquatic habitat. In addition, irresponsible alteration of natural drainage patterns can result in a lawsuit if it results in damage to neighboring property.*

Q: "My driveway bridge washed out. Who is going to pay for it?"

(a) Federal disaster assistance is available to pay for all flood damages, including washed out driveways.
(b) Flood insurance on the house will cover bridge damage.
(c) The Town or County will help me out.
(d) All maintenance and repair costs for private stream crossings are the responsibility of the landowner.

A: (d) *Federal disaster assistance is not available unless the flood is declared a federal disaster, doesn't cover all damages, and may be limited to a low interest loan. The National Flood Insurance Program only offers policies for buildings and building contents. Damage to bridges, culverts, driveways, lawns, etc. is not covered by flood insurance. While local governments may be helpful, your private property is not their responsibility.*

~ V. Recommendations ~

INTRODUCTION

"The traditional engineering approach to river development has failed to incorporate the practical, physical, aesthetic and financial advantages of approaching river management as maintenance of natural tendencies in river channel behavior." — Luna Leopold

Traditional stream management practices typically focus on single objectives such as bank stabilization or flood threat reduction. While dumped stone, riprap and other hard armoring techniques may achieve the goal of localized bank *stability* or protection, the application of these techniques generally do not consider potential causes or effects downstream or outside the immediate project area. Additionally, other stream functions such as stream and *floodplain* ecology, *sediment* transport and water quality are rarely considered. In many instances, ongoing evolutionary changes in stream form are interrupted by localized stabilization techniques. These interruptions may cause stream *instability* to shift upstream or downstream. Work undertaken to address one form of instability may create a domino effect of instability elsewhere.

Our understanding of how healthy streams function is still growing. As the science of stream ecosystems and best management practices to protect and restore them continue to evolve, this improved understanding needs to be incorporated into our day-to-day stewardship and management activities. The NYCDEP is committed to using the DCSWCD as a technical advisor, information clearinghouse, and funding source for implementation of SCMP recommendations. The following recommendations are suggested guidelines to help and improve stream management in the East Branch basin.

RECOMMENDATION #1

Scientifically-Based Post-Flood Emergency Stream Intervention

The SCMPr should work cooperatively with the NYCDEP and the Project Advisory Committee to improve immediate post-flood emergency intervention capabilities by demonstrating and training contractors and local municipalities in scientifically-based stream principles, procedures and methods.

Delaware County has had a number of floods in the last eleven years that have left varying degrees of damage in their aftermath, including loss of life. The June 2006 and June 2007 floods caused significant damage, both recurring and new. The June 2006 flood clearly demonstrated the need for improved flood response. It is clear and obvious that municipalities and contractors need to have scientifically-based knowledge including proper channel dimensions, floodplain function and the negative impact of berms. Much immediate post-flood mitigation performed to date has led to additional problems or left some areas vulnerable to recurring damage. In many areas post-flood work has unraveled stream systems more than any other non-flood work combined. Many streams are poised to further damage public and private property, put lives at risk, and impair water quality and aquatic habitat.

Municipalities, resource agencies, private contractors and landowners are overwhelmed with post-flood triage and obtaining necessary permits, and are significantly challenged with knowing

how to perform scientifically based mitigation. Regulatory agencies are equally overwhelmed with permit issuance. This will continue unless post-flood response can be enhanced.

DCSWCD has received Round 9 Water Quality Improvement Project, Non-agricultural Non-point Source Abatement and Control funding to begin to pro-actively address post-flood emergency intervention issues before the next flood happens. With this and matching funding the DCSWCD proposes a new and innovative approach for post-flood emergency intervention in preparation for future floods to:

- Scientifically and environmentally address stream channel avulsions (course changes) and compromised channel capacity
- Initiate a process whereby local contractors and highway superintendents obtain a knowledge base with training and certification in:
  - Use of DCSWCD Regional Hydraulic Relationship curves to properly size stream channels
  - Re-connecting floodplains
  - Natural stream restoration principles and techniques
  - Identification and prioritization of stream reaches for post-flood intervention
  - Best Management post-flood intervention techniques

Having a trained and knowledgeable contractor and highway superintendent base will significantly enhance future post-flood emergency intervention and efforts in the watershed.

RECOMMENDATION #2

Provide Technical Assistance To Local Highway Departments

> ***The SCMPr, in cooperation with the Delaware County Department of Public Works (DCDPW) and the NYCDEP, should enhance communication with local highway departments. These efforts should be developed and implemented in cooperation with the PAC and the DCPD, and utilize Catskill Watershed Corporation (CWC) program funds for stormwater retrofits and other practices as appropriate.***

The SCMPr follows the Delaware County Action Plan (DCAP) and works with the Delaware County Department of Public Works (DCDPW) to manage streams in proximity to county roads. The DCPD and DCDPW also work with town highway departments to develop Highway Management Plans (HMPs). The HMPs are intended to be a long term management tool for highway superintendents to prioritize projects and better estimate costs of repairs on an annual basis. In addition, the plans will encourage are more comprehensive maintenance program incorporating similar design standards throughout the county. These practices will ensure local roads can meet the enhanced standards for road construction as well as the management of stormwater systems and flow of runoff associated with highway infrastructure. Opportunities exist to help local highway departments reduce maintenance costs by orienting and sizing culverts and bridges to better accommodate stream flow patterns.

The SCMPr should work in cooperation with other interested parties such as the DCDPW and DCPD to enhance its technical assistance to local highway departments. This could include:

- A protocol to evaluate existing culverts and bridges following geomorphic principles, and work collectively to prioritize and design culverts for retrofitting or replacement where necessary
- Use DCSWCD Regional Hydraulic Relationship Curves (see **Volume 2, Section 3**) and Draft Stream Maintenance Protocol (on a pilot basis where applicable) to appropriately manage streams in proximity to local roads
- Work with local municipalities to assess areas in need of periodic stream maintenance around public infrastructure, following DCSWCD's Draft Stream Maintenance Protocol
- Work with local municipalities to procure funding for prescriptive measures

This technical assistance could be provided through recommendations in individual Highway Management Plans. The SCMPr should also work in cooperation with the New York State Department of Transportation to assess, mitigate and maintain problem areas along state highways.

RECOMMENDATION #3

Implement the Streamside Assistance Program

> ***The SCMPr should implement the Streamside Assistance Program as defined in the 2007 Filtration Avoidance Determination. This effort should be developed and implemented in cooperation with the PAC.***

The development of an individual Whole Farm Plan for agricultural producers and a Forestry Plan for forest landowners has been essential to improving and maintaining water quality in the East Branch watershed. These plans inventory and assess soil, water, and forest resources and provide a clear plan of action by recommending both structural and managerial Best Management Practices that meet both landowner and water quality objectives.

As with agricultural and forestry practices, certain activities by streamside landowners may contribute to stream and streamside buffer degradation. Most streamside property (approximately 96.8%) in the East Branch watershed is non-agricultural land. In the West Branch Delaware River SCMP, the SCMPr recommended development of a program to provide non-agricultural streamside landowners with an individual Stream Corridor Management Plan. The 2007 Filtration Avoidance Determination provides for such an initiative, entitled the Streamside Assistance Program.

An individual SCMP would be provided at the request of the landowner. This may require a small refundable deposit by the landowner but will ultimately be free of charge. The Plan would address floodplain function, stream processes (including streambank and stream channel maintenance), invasive species control with Japanese knotweed management as a primary focus (see **Section 5** of **Volume 2**), and the importance of desirable native streamside vegetation and its function.

Streamside landowner stewardship is essential to proper stream corridor management. Efforts by individual streamside landowners to improve and maintain proper stream processes and streamside buffers can be substantial, especially with the control of invasive species and the management of desirable native vegetation. Well informed streamside landowners can also be instrumental in maintaining floodplain function in addition to stream channel and streambank functions. Many times, streambank erosion and stream channel degradation begin as small problems that could have been minimized or corrected—without public funding assistance—by well-informed streamside landowners. The preparation of individual Stream Corridor Management Plans will also provide SCMPr staff with opportunities to proactively monitor stream health, identify emerging issues and/or problems in the watershed, and develop greater rapport with streamside landowners.

RECOMMENDATION #4

Continue with and Enhance Education and Outreach Efforts

> ***The SCMPr should cooperate with the NYCDEP and the PAC to better inform and educate all stakeholders regarding stream stewardship, the importance of floodplain function, stream processes, and the importance of streamside vegetation. Education and outreach efforts should be developed and implemented in cooperation with the PAC, with cooperation from the Catskill Watershed Corporation's (CWC) Education Program.***

The success of any program is a function of its education and outreach efforts. Government programs such as the SCMPr are no substitute for genuine stewardship by watershed residents and stakeholders. Stream stewardship should be every resident's responsibility, and participation by all stakeholders is the preferred objective. To accomplish this, all stakeholders need to better understand stream processes such as streambank erosion, sediment transport and the function of floodplains, streamside vegetation, and wetlands. Improved understanding will help guide stakeholders as they adopt practices to protect streams and improve overall stream stability. Likewise, stream managers need to understand and incorporate the perspectives and priorities of stakeholders as they direct future stewardship and management efforts.

Enhance education and outreach efforts to include:

- Streamside landowner rights
- Stream gravel management (See **Recommendation #9**)
- Stream, floodplain, and streamside vegetation functions
- Invasive species identification and management (See **Recommendation #16**)
- Highway management and its streamside effects (See **Recommendation #2**)
- Flood response/flood hazard mitigation (See **Recommendation #'s 1 & 17**)
  - Education and training for municipalities and contractors
  - Municipal education regarding the Delaware County Multi-jurisdictional All-Hazards Mitigation Plan
  - Improved correspondence regarding funding available to municipalities and individuals for declared flood events
- Formation and function of community groups

- Providing educational sessions for local planning boards
- Use of mass mailings
- Use of websites and links to others
- Collaboration of various organizations/municipalities/landowners for the development of a strategic plan for recreational and educational use of East Branch Deleware River (EBDR) corridor
- Collaboration with the Water Discovery Center of the Catskills

RECOMMENDATION #5

Provide Annual Floodplain Development Permit Training for Municipal Officials

> ***The SCMPr, in cooperation with the NYSDEC, NYCDEP, DCPD and PAC should work toward providing annual Floodplain Development Permit training for local municipal officials.***

Floodplain development permits are required for any floodplain development in New York State as part of the National Flood Insurance Program (NFIP). Local laws authorize designated municipal officials to accept floodplain development applications, review their completeness, require hydrology studies, issue permits and issue compliance certificates. Compliance with the NFIP is what enables landowners to purchase flood insurance backed by the Federal government, and keeps rates reasonable as well.

These laws and requirements are in place to prevent structural damage and loss of life during major flood events. It is not a question of if another large flood will occur, but when. Better understanding of flood damage potential, stormwater implications, the NFIP, and use of Federal Insurance Rate Maps will empower local officials to make informed decisions, including local Comprehensive Plan implementation. Knowing how to properly manage our floodplains is crucial to our continued safety and economic sustainability. Further, demonstrating excellence in implementing the NFIP through the Community Rating System (CRS) can achieve reduced flood insurance rates for our communities.

RECOMMENDATION #6

Enhance Local Land Use Laws and Ordinances

> ***The SCMPr, in cooperation with the DCPD, NYCDEP, PAC and other interested stakeholders, should work toward including a stream management component in local Comprehensive Plans, local laws and local management practices as may be appropriate.***

The Towns within Delaware County through participation in the Town Planning Advisory Service (TPAS) can work with the Delaware County Planning Department to develop a process to incorporate stream stewardship and maintenance into local planning initiatives. The continued revision and updating local plans and local laws can be a source to incorporate criteria for

protection as well as encourage development in areas that mitigate impacts to streams to the greatest extent possible.

Projects that municipal leaders may consider to meet the objectives of this goal could include the following:

- Update local Comprehensive Plans to reflect the importance of stream corridor management and the protection and preservation of the streams within the municipalities.
- Develop tools that can be used to support planning initiatives for stream rehabilitation projects such as Source Water Protection Plans and Open Space or Recreation Plans.
- Adopt and maintain local Highway Management Plans to address stormwater and infrastructure impacts associated with roads and bridges.
- Update local Floodplain Laws to include limits for floodplain development and protect stream banks from encroachment.
- Update local zoning laws and subdivision regulations to include best stream management practices.
- Support annual stream clean-up days.
    - Coordinate efforts with the Delaware County Solid Waste Coordinator to ensure proper disposal of debris (see **Recommendation #12**).
- Support local groups that wish to develop watershed associations that would work toward stream management practices and assist SWCD and NYCDEP monitor the health of individual stream reaches,

Local communities should also work with the Delaware County Soil and Water Conservation District and the Delaware County Planning Department to regularly update and manage the SCMP.

RECOMMENDATION #7

Adopt Principles of Stream Stewardship at the Municipal Level

> ***Local legislative boards should incorporate principles of stream stewardship into the creation and/or revision of their town or village comprehensive plans and local land use regulations.***

Scientifically-based stream management practices (see below) are essential to the long-term health and stability of all waterways flowing through the towns and villages of the East Branch Delaware River watershed. Following the principles of proper stream stewardship will not only ensure the preservation of stream health, aesthetics, recreational opportunities, water quality, and aquatic habitat, but will also reduce or prevent costly restoration and repairs stemming from damages caused by unstable stream systems.

If the principles of stream stewardship are incorporated into the goals and objectives of a local comprehensive plan, land use regulations such as subdivision, site plan review, and zoning laws may be created and/or revised to afford additional protection to waterways. From that point

forward, development activities within that municipality would be reviewed with an eye toward improved and enhanced stream stewardship.

STREAM STEWARDSHIP

Once one understands the basic principles of stable, healthy streams and how human activities affect those streams, the question of "What next?" usually arises. This section will outline some general principles of stream stewardship that can be adopted at the personal, municipal, or regional agency level.

- Work toward the protection and/or restoration of
  - the environmental services provided by streams and floodplains
  - the health of stream and floodplain ecosystems
  - the naturally effective channel form and function of streams
  - floodplains as part of the natural stream system
  - riparian buffers
- In the process of managing streams to protect public safety and infrastructure, avoid threatening
  - stream health upstream or downstream
  - the upland ecosystem through which the stream runs
  - the streambank stability of neighboring properties

RECOMMENDATION #8

Streamline Stream Work Permitting

The Stream Corridor Management Program (SCMPr) proposes that the permitting process for stream work be simplified and streamlined. It is proposed that an interagency working group composed of representatives from the NYSDEC, U.S. Army Corps of Engineers, DCSWCD, NYCDEP, neighboring Soil & Water Conservation Districts, DCDPW, and local community leaders, identify ways to delegate, simplify and streamline the permitting process for the benefit of all agencies and stakeholders.

The purpose of this recommendation is to enhance the permitting process so that necessary stream stabilization efforts may be made in a timely and efficient manner.

The following goals are suggested:

- In sub-basins with approved watershed management plans, enhance delegated permitting authority to the DCSWCD by NYSDEC for implementation of approved stream management practices under its current General Permit
- Enhance the process for permitting federal flood response and recovery programs such the USDA Emergency Watershed Program
- Work with United States Army Corps of Engineers (USACOE) to provide guidance documents for landowners
- Local planning board review of stream permits in economic development areas with the goal of working on future guidance documents

RECOMMENDATION #9

Selective Stream Gravel Management

> ***The SCMPr, NYCDEP, and the Delaware County Department of Watershed Affairs should work with the NYSDEC and U.S. Army Corps of Engineers to identify and fund an independent stream scientist or engineer to create a guidance document with recommendations on how, when and where to scientifically manage problematic gravel deposits within the East Branch Delaware River system . Such a document might require a study. In this interim, the Delaware County SCMPr Draft Stream Maintenance Protocol would be employed.***

Throughout the development of this management Plan, several members of the public and local government leaders stated their belief that certain gravel deposits have had a harmful effect on streambank stability and flooding over the years. Numerous concerns have been expressed regarding current policies and regulations restricting gravel removal. The Stream Corridor Management Program has the responsibility to investigate these issues and respond to these concerns by advancing discussion with the appropriate regulatory agencies.

The DCSWCD wishes to create an informed dialog among stakeholders about gravel and stream processes in the East Branch Delaware River (EBDR) watershed. This dialog would share perceptions of and explore common goals between stream managers and the general public regarding sediment and woody debris mobilization, transport, and deposition. The goal would be to identify the information required to determine if and when an appropriate level of response should be exercised. The DCSWCD recognizes that in order to successfully advocate a specific plan of action regarding scientific gravel management, it must involve key regulatory agencies while developing a science-based understanding of local stream processes.

The Draft Stream Maintenance Protocol is attached as Appendix A.

RECOMMENDATION #10

Provide Assistance to Community Watershed Groups/Associations and Government Entities

> ***The SCMPr, working with the PAC and NYCDEP, should provide technical assistance and general direction to community watershed groups/associations and government entities that are actively engaged in grassroots stream stewardship/management activities.***

Jurisdictions adjacent to the EBDR watershed have met with success when local watershed associations have taken ownership of the stewardship/management of their particular sub-basin. These stakeholders play a significant role by providing historical information, assisting with data collection, and developing and implementing localized stream management plans. In so doing, stream health, streamside buffers, and upland and aquatic habitat are locally managed for the long-term.

The DCSWCD, in cooperation with the PAC and NYCDEP, can provide valuable guidance to community watershed groups/associations and government entities. The ultimate goal is to empower these groups to manage their streams in a manner that is consistent with their own visions for the future, proper principles of stream stewardship, and the EBDR SCMP. Guidance can range from that which is administrative in nature (suggesting watershed association structure and identifying funding sources) to the more technical (providing education on stream science and assisting with design/selection of mitigation and stewardship activities.)

RECOMMENDATION #11

Participation with the Delaware County Action Plan (DCAP)

> ***The Stream Corridor Management Program will continue to work closely with all DCAP participants to integrate the East Branch Delaware River Stream Corridor Management Plan and its recommendations into all relevant components of the Delaware County Action Plan.***

DCAP is a local initiative that comprehensively evaluates water quality issues and coordinates and facilitates local, state, and federal efforts to improve water quality in Delaware County (see **Section 10** of **Volume 2**). Integrating the Stream Corridor Management Plan and its recommendations into DCAP programs will maximize water quality benefits by ensuring multi-departmental review and county-wide awareness.

RECOMMENDATION #12

Debris Management

> ***The SCMPr should cooperate with the Project Advisory Committee, Delaware County Solid Waste Coordinator and NYCDEP to develop a protocol for inventorying floodplain debris and assist municipalities and communities with developing appropriate action plans for debris management.***

Throughout many areas in the watershed, a plethora of debris can be found on floodplains in the form of uprooted trees, stumps, garbage dumpsters, propane and/or oil tanks, lumber, sheds, yard items or anything else that can float. During a flood, such debris can easily travel downstream and collectively has the potential to clog a bridge or culvert, often with devastating effects. It is also a threat to water quality.

The SCMPr can assist this effort by:

1. Assisting with local efforts to ensure responsible floodplain management including maintenance and annual clean up efforts.
    - Developing a protocol for municipalities and communities to use to inventory floodplain debris and assist with annual clean-up efforts. This should be coordinated with the Delaware County Solid Waste Coordinator to ensure proper disposal of debris.

- Helping interested municipalities and communities develop individual debris management action plans that may include clean-up efforts as well as policing efforts to ensure local areas known for illegal dumping are monitored and people are prosecuted for illegal dumping on private property in streams and along floodplains.
- Holding a series of educational workshops on debris management for streamside stakeholders. This should be coordinated with the SWCD, Delaware County Solid Waste, NYS DEC and NYCDEP.

2. Working with the Delaware County Solid Waste Management Facility, NYC DEP, local communities and Delaware County Emergency Services to assist with debris removal and inventory after a catastrophic flood event.
    - Assist with a plan for debris removal and management after a flood event to reduce impacts to the health and safety of flood victims and other residents of the communities. Actively participate in clean-up and debris removal efforts to reduce costs to county tax payers for removal after a flood event.
    - Participate during the operation of the Emergency Operations Center (EOC) to retrieve, sort and dispose of debris in an appropriate manner, including household waste, contaminated materials, woody debris, etc. This coordinated effort should be overseen by the Solid Waste Coordinator and the DPW Commissioner to ensure proper disposal of all forms of waste.
    - Coordinate with local transfer stations to properly sort and dispose of debris after a flood event.

RECOMMENDATION #13

Prioritization of Identified Stream Intervention Projects

The SCMPr, working with the PAC and NYCDEP, should prioritize potential restoration reaches, including the type and level of intervention needed.

Stream reaches in need of management vary both in the magnitude of the problem and level of intervention needed. Water quality, property, and aquatic habitat protection will be the main concerns for all reaches prioritized for intervention. Level of intervention will be based on the current need and condition of the stream as well as the type of existing and future land uses. Streamside properties having development potential based on location, accessibility, size, soils, and local land use controls will be deemed as more critical for intervention. With all levels of intervention listed below, it is important to use native plant materials for the restoration and to continue to achieve the goal of a naturalistic look and character. Identified projects are listed in the DCSWCD two-year Action Plan.

Preservation – This intervention level should be considered when stream and surrounding floodplain are in excellent condition with low flooding and erosion threats, good water quality, and sustainable functioning aquatic and terrestrial habitat. These sections should be identified as valuable anchor points for stable stream morphology and good habitat, as well as helping to preserve and/or enhance water quality and flood and floodplain dynamics.

Passive – Passive intervention should be considered when a stream reach and surrounding floodplain are in generally good condition, exhibiting apparent stability and sustainable function without further need for intensive management or changes. These reaches may not be in the most stable condition but may recover unassisted over time. Some visual monitoring or inspection of certain features or areas may be warranted, but generally no active management is recommended.

Assisted Recovery – Partial intervention, or "assisted recovery," involves direct management intervention on a small scale. Assisted recovery must be done carefully and with a good understanding of the stream type and setting to avoid further instability. Assisted recovery may be as simple as planting streamside vegetation to maintain bank stability, or as complicated as designing comprehensive stormwater management retrofits or reconstructing sections of streambank.

Full Geomorphic Restoration – This intervention level, very costly and requiring the most intensive management, should be reserved for the most severe locations of stream instability with the greatest adverse impact on management goals. This level of management requires much greater time, financial resources, and technical expertise to ensure stability restoration is consistent with both management goals, stream type, and setting that will ensure project success and longevity.

RECOMMENDATION #14

Enhancement of East Branch Watershed Fisheries

The SCMPr, in cooperation with the NYSDEC, the NYCDEP, and the PAC, should provide support to local grass-roots efforts, watershed associations, and fisheries organizations to enhance existing fisheries in the East Branch Delaware River watershed.

The East Branch Delaware River and its tributaries are noted for their trout fishery, with many reaches providing excellent habitat. However, there are some impacted reaches and good reaches that could be enhanced, particularly by increasing streamside vegetation. Suggestions for enhancing fisheries (and water quality) include:

- Working with landowners around Lake Wawaka (Halcottsville Pond) to reduce negative thermal effects on trout and to enhance trout migration in this reach of the East Branch Delaware River
- Continue to work with all stakeholders, the NYSDEC, and identified legislators to bring the No-Kill fishing proposal to fruition, extending from the Village of Margaretville to the New York City property line downstream of the village
- Work with the landowner to restore the reach of the Platte Kill avulsed during the June 2006 flood.
- As may be identified by **Recommendation #9**, consider the influence of certain gravel deposits on fish passage.

To address PAC concerns, and in cooperation with the PAC, the SCMPr should assist the PAC in seeking qualified professionals and matching funds to research the following:

- Thermal effects on streams and suggest mitigation options
- Cumulative thermal effects of ponds and lakes on streams, their effects on local water tables, and suggest mitigation options
- Mitigation options for those pollutants identified by the USGS in their study (Part 3, 2004) of water quality in the Pepacton Reservoir basin
- Expand on mercury contaminant level research that is being conducted in the basin

RECOMMENDATION #15

Enhance Recreation Opportunities

The SCMPr, in cooperation with the PAC and NYCDEP, should assist communities to enhance streamside recreational opportunities where possible. These efforts should be developed and implemented in cooperation with the PAC and with assistance with the DCPD.

Little public access exists along the main stem of the East Branch Delaware River and its major tributaries. This limits use of the waters for angling, canoeing and kayaking. These activities augment tourism and are relaxing means of recreation for all residents who choose to take part. Some areas could be revitalized or enhanced with streamside walkways to accommodate a greater cross-section of tourists and residents.

The SCMPr, in cooperation with NYCDEP and the PAC, should:

- Work with DCPD and other appropriate organizations and agencies to facilitate recreation and revitalization plans. These plans could include:
    - Public access points for angling, canoeing and kayaking that do not compromise streambank integrity
    - Revitalization of existing public access points and streamside walkways
    - Creation of new streamside walkways to establish outdoor classrooms
- Collaborate with various organizations/municipalities/landowners for the development of a strategic plan for recreational and educational use of EBDR corridor

RECOMMENDATION #16

Invasive Species Management

The SCMPr, in cooperation with NYCDEP, PAC, TNC, Catskill Region Invasive Species Partnership (CRISP), and other interested stakeholders, should continue its involvement with invasive species management, following and promoting all invasive plant programs in the East Branch watershed. These efforts should be developed and implemented in cooperation with the PAC.

Sometimes attempts to beautify a property with new and different plants will introduce a plant that aggressively spreads out of control. These "invasive" plants present a threat when they alter the ecology of the native plant community. Their impact may even alter the landscape should the invasive plant destabilize the geomorphology of the watershed (Malanson, 1993). Japanese knotweed, an invasive plant gaining a foothold in the East Branch basin, is an example of a plant capable of causing such disruption. Although others exist, other invasive plants of note along the East Branch corridor include common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and garlic mustard (*Alliaria petiolata*)[13]. Current control efforts include a pilot Japanese knotweed management project in Halcott Center and stakeholder education.

The SCMPr, in cooperation with NYCDEP, PAC should:

- Continue the Halcott Center Japanese knotweed management pilot project
- Expand Japanese knotweed management projects throughout the watershed
- Expand and enhance invasive species education efforts, particularly through websites
- Work with and promote all invasive plant programs in the East Branch watershed
- Assist communities with applying for CWC funds where appropriate
- Consider emphasis on native replacement vegetation

RECOMMENDATION #17

Flood Hazard Mitigation and Flood Response and Recovery

The SCMPr should continue to work with the Delaware County Planning Department and Emergency Services to implement the county-wide, multi-jurisdictional, All-Hazards Mitigation Plan. The SCMPr should continue to work with the Delaware County Board of Supervisors, the NYCDEP, the NYSDEC, and the State Emergency Management Office (SEMO) to revise the FEMA flood study and floodplain maps.

Hazard mitigation is any sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects. Flood recovery is federal and state assistance available through FEMA and SEMO, the agencies that administer their respective hazard mitigation programs for declared flood disasters. Flood Studies and Flood Insurance Rate Maps (FIRMs) provide vital information to communities considering flood hazard mitigation and stream management options.

The DCPD has completed preparation of a county-wide, multi-jurisdictional, All-Hazards Mitigation Plan that will enable communities to apply for funding through hazard mitigation programs. Plans are also under way in cooperation with the Delaware County Board of Supervisors, NYCDEP, and NYSDEC to update current floodplain maps. Stream Corridor Management Program staff will continue to support both efforts. These efforts could include but are not limited to:

[13] The Nature Conservancy, *Invasive Plant Species Inventory and Assessment of the Beaverkill Forest Matrix Block in the Catskill Mountains in Southeast New York*, January 2006, pages 14 & 17.

- Implementation of early flood warning systems
- Development of community flood preparation and flood response action plans
  - Use of DCSWCD Regional Hydraulic Relationship Curves to restore flood-damaged channels
  - Assistance with trained personnel to assess post-flood stream conditions
  - Use of trained personnel to perform post-flood stream work
  - Engage the Delaware River Basin Commission
  - Engage Trout Unlimited
- For declared disasters
  - Outreach to communities with information regarding available funding to municipalities and individuals
  - Assist communities with FEMA/SEMO work orders
  - Cooperation with Trout Unlimited

RECOMMENDATION #18

Utilize Existing Funding Sources

> ***The SCMPr should cooperate with the NYCDEP to explore opportunities for existing funding sources to enable implementation of recommendations identified in this Stream Corridor Management Plan.***

Proper stream stewardship and management is crucial to meet water quality goals and objectives. This Stream Corridor Management Plan provides a variety of recommendations, the implementation of which will require an equal variety of funding amounts. For example, enhanced management techniques may incur relatively few costs; by contrast, mitigation measures that seek to maintain water quality while ensuring economic sustainability may require substantial funding. It is important to take full advantage of funding opportunities through established, local, not-for-profit organizations like the CWC and the Watershed Agricultural Council (WAC). These development corporations have the dual goals of protecting water resources in the New York City watershed while preserving and strengthening communities within the region. Both corporations are logical choices to fund stream corridor management projects and programs identified in each West-of-Hudson County's stream management plans, thereby reducing the need to establish new funding mechanisms and governing boards. Opportunities exist to enhance their current programs and/or establish new programs to assist the SCMPr in meeting stewardship and management needs.

The SCMPr and CWC, in cooperation with NYCDEP, should:

1. Explore opportunities to enhance existing CWC **stormwater programs** through:
   a. Cooperative public outreach efforts to educate businesses, municipalities and residents regarding stormwater impacts on streams.
   b. Enhanced public outreach efforts to include funding for stream management education and stream stewardship training, such as invasive species identification and management for landowners, local planning boards and highway departments, contractors, schools, community groups, and other interested stakeholders.

c. Funding for retrofitting selected culverts that pose stormwater and fish passage issues.
d. Funding for solutions at bridges experiencing storm flow problems.

2. Investigate existing program opportunities while exploring new programs for **stream and stormwater management** to include funding for:
   a. Mitigation of stream alignment issues at roadways, bridges, and culverts
   b. Stream maintenance according to the DCSWCD protocol
   c. Debris inventories and local action plans
   d. Invasive species management
   e. Enhancement of recreational opportunities in the watershed, such as the creation of access and recreation use plans
   f. Rehabilitation and establishment of educational streamside pathways
   g. Local match for early flood warning systems and development of community flood response action plans
   h. Assistance for the 2007 FAD Streamside Assistance Program
   i. Stream contaminant research
   j. Stream thermal impact research

The SCMPr and WAC, in cooperation with NYCDEP, should:

1. Explore opportunities to **enhance the WAC's Watershed Agricultural and Forestry Programs** to include funding that:
   a. Trains staff to identify stream issues and their possible causes during preliminary review processes.
   b. Develops "Stream Stewardship Plans" that outline economical measures for farmers to maintain stream stability.
   c. Locates matching funds to assist with stream and streambank stabilization measures on farms.

RECOMMENDATION #19

Develop a Process for Updating the East Branch Delaware River Stream Corridor Management Plan

> ***In cooperation with the PAC and the NYCDEP, the Stream Corridor Management Program should develop a process for updating the East Branch Delaware River Stream Corridor Management Plan.***

It is expected that as this Plan and its recommendations are addressed and implemented, additional information and data will be collected and other management issues identified. In order to keep the Plan a "living document," it should be updated as needed using the biennial Action Plans as required by the 2007 Filtration Avoidance Determination (FAD). Action Plans outline SCMP implementation schedules, with a two-year plan being submitted each year. The DCSWCD, NYCDEP and the PAC will meet each year by April 1 to review the status of the Action Plans and make modifications as necessary. The SCMP will be updated accordingly. It is also recommended that the Action Plans be shared annually with the DCAP partners.

APPENDIX A

Stream Maintenance Pilot Program for Removal of Selected Gravel Deposits

DRAFT June 8, 2006

Stream Corridor Management Program

Stream Maintenance Pilot Program for Removal of Selected Gravel Deposits

Introduction

Throughout the past century, many streams, particularly tributaries to the East and West Branches of the Delaware River, have been re-located or otherwise manipulated to accommodate development, agriculture and other land-uses. Although well intended, these intervention measures have, to varying degrees, disrupted natural stream function. As a result, many of these stream reaches exhibit an excessive amount of deposition, particularly near their confluences with the larger rivers. During base flow conditions, excessive deposition at these confluences may be restrictive to fish passage. In some instances gravel deposits may have a deleterious effect on stream bank stability and flooding may be exacerbated.

During the past few decades municipalities and others easily obtained permits to clean out certain stream reaches where infrastructure or property was threatened. However, permitting for gravel removal in streams has reasonably become more restrictive perhaps with the exception of emergency situations. Currently, gravel can only be removed to an elevation six inches above the ambient waterline.

The Delaware County Soil & Water Conservation District (DCSWCD) Stream Corridor Management Program (SCMPr) is investigating stream gravel issues. The SCMPr continues to expand its science-based understanding of gravel and natural stream processes and share that knowledge to improve both the professional manager's and general public's understanding of the mobilization, transport and deposition processes of stream gravel and sediment. With an enhanced understanding of these natural relationships, informed decisions can be made regarding if and where an appropriate level of response and intervention can or should be exercised.

The following proposed procedure is based on this science.

Proposed procedure

Note: All administrative and technical work to be performed by the DCSWCD and/or Delaware County Department of Public Works (DCDPW). Excavation work to be performed by municipal forces or a hired excavating contractor.

1. Select location based on threat to public infrastructure and safety, site history and/or fish passage issues.
   a. Selection to be mutually agreed on by the DCSWCD and DCDPW. Where fish passage issues are a concern, obtain consensus from Trout Unlimited.

2. Establish a minimum of two cross-sections through the area of the stream to be excavated. Additional cross-sections are to be established as a given situation may require, as determined in the field by DCSWCD Stream Program staff.
   a. Establish permanent monuments on both sides of the stream at each cross-section.
      i. Monuments shall be beyond the top of the stream bank in a location where they cannot be disturbed.
   b. Survey existing topography at cross-sections in accordance with the Rosgen Level II procedure.
   c. Survey existing thalweg profile a reasonable distance upstream and downstream of the cross-sections, as determined in the field by DCSWCD Stream Program staff, in accordance with the Rosgen Level II procedure and also as follows:
      i. At a confluence, the profile shall extend to the opposite bank of the intersecting stream.
      ii. If a significant gravel load is present in the intersecting stream, a profile along the intersecting stream thalweg shall be taken a reasonable distance upstream and downstream of the gravel deposit, as determined in the field by DCSWCD Stream Program staff.
      iii. Additional cross-sections will be taken in the intersecting stream, as determined in the field by DCSWCD Stream Program staff.
3. Determine site drainage area in square miles
   a. Use Digitial Elevation Model (DEMs) where available
      i. Currently available at DCSWCD for West of Hudson watershed
   b. Use other acceptable methods where DEMs not available

4. Using appropriate Regional Hydraulic Relationship Curves, determine a design cross-sectional area, average width and average depth as follows:
   a. West Branch and Susquehanna basins
      i. Calculate bankfull cross-sectional area using $A_{bf} = 10.02*DA^{0.81}$
      ii. Calculate average bankfull width using $W_{bf} = (18 * A_{bf})^{0.5}$
      iii. Calculate average bankfull depth (d_{bf}) using $d_{bf} = W_{bf} \div 18$

   b. East Branch basin

i. Calculate bankfull cross-sectional area using $A_{bf} = 7.01*DA^{0.93}$
ii. Calculate average bankfull width using $W_{bf} = (18 * A_{bf})^{0.5}$
iii. Calculate average bankfull depth (d_{bf}) using $d_{bf} = W_{bf} \div 18$

Note: the calculated bankfull cross-sectional area will be hereafter referenced as the designed channel capacity.

5. Determine Baseline Channel Dimensions
   a. Design a channel using the bankfull cross-sectional area and width as calculated above. The top width of the channel shall be the calculated average bankfull width. Channel bottom width shall be determined by using appropriate side slopes as may fit the situation while maintaining the cross-sectional area, top width and average depth as calculated above.
   b. If conditions permit, a parabolic channel may be designed that maintain the bankfull cross-sectional area, top width and average depth as calculated above.

6. Estimate volume of gravel to be removed using the difference between existing conditions and the calculated baseline channel dimensions.

7. Establish a Threshold Channel Capacity
   a. A threshold channel capacity is needed to determine when the channel is to be excavated back to the baseline channel dimensions. Current data suggests a reasonable threshold to be 70% of the designed channel capacity (see attached memo dated 1/11/06).

8. Obtain all necessary permits from regulatory agencies:
   a. NYSDEC Article 15, Protection of Waters
   b. US Army Corps of Engineers
      i. Nationwide 3, Maintenance and/or
      ii. Nationwide 27, Stream & Wetland Restoration Activities and/or
      iii. Nationwide 33, Temporary Construction, Access and Dewatering and/or
      iv. Nationwide 37, Emergency Watershed Protection & Rehabilitation
   c. NYSDEC Stormwater Pollution Prevention Plan
   d. NYCDEP Stormwater Pollution Prevention Plan
   e. Local Floodplain Development Permits
   f. This work is being performed to improve stream sediment characteristics, minimize impacts from future floods and improve fish passage. This work would be of short duration. De-watering operations could significantly increase mitigation time and create as much turbidity as the mitigation process itself. Consequently, it seems reasonable to assume that an appropriated de-watering protocol could be developed or a de-watering variance issued for work of this nature.
   g. Since this will be a permanent maintenance situation, permits should be renewed or extended with written notification by the DCSWCD to the NYSDEC when the threshold channel capacity has been reached.

9. Establish excavation limits in the field at all cross-sections and the upstream and downstream ends of all profiles.

10. Excavate the channel to the baseline channel dimensions under the direction of DCSWCD or DCDPW.

11. Monitoring – Established sites shall be monitored by DCSWCD or DCDPW as follows:
    a. Frequency
        i. After every flow event of bankfull discharge or greater
        ii. Annually if no bankfull flow events occur
    b. Data to be collected
        i. Re-survey established cross-sections
        ii. Re-survey thalweg profile(s)
    c. Analyses required
        i. Compare current channel capacity with the designed channel capacity
        ii. Determine if the threshold channel capacity has been reached

12. Re-excavate the channel to the baseline channel dimensions under direction of DCSWCD or DCDPW when a maintained channel becomes filled to the threshold channel capacity.

13. Benefits
    a. Increased channel capacity and provision for a more free flowing channel
    b. Improved streambank stability where impacted by deleterious gravel depositions
    c. Decreased localized flooding because sufficient channel capacity is maintained
    d. Improved fish passage, particularly at base flow conditions
    e. Minimized emergency situations
        i. Decreased need for emergency management funding

APPENDIX B

Delaware County Partners Action Plan

Delaware County Partners Action Plan

Supported by the text of the East Branch Delaware River Stream Corridor Management Plan

√	RECOMMENDATION	PARTY RESPONSIBLE	TIME FRAME TO BE COMPLETED	APPROXIMATE COST	POTENTIAL FUNDING SOURCE
	Provide workshops and educational documentation to better inform and educate all stakeholders regarding stream stewardship, the importance of floodplain function, stream processes, and the importance of streamside vegetation.	SWCD/NYC DEP/Delaware County Board of Supervisors	Ongoing	Dependent upon specific needs for education.	CWC, NYC DEP, FEMA, NYS DOS, NYS DEC, and other programs per specific educational needs
	The Stream Corridor Management Program (SCMPr) should implement the Streamside Assistance Program as defined in the 2007 Filtration Avoidance Determination.	PAC/Town Boards/ SWCD/DCAP Partners/ Delaware County BOS	Ongoing	Dependent upon specific projects defined.	CWC. NYCDEP, NYS DEC, Safe Drinking Water Act Funds, and other programs per specific project
	The SCMPr should cooperate with the Project Advisory Committee, Delaware County Solid Waste Coordinator, and NYCDEP to develop a protocol for inventorying floodplain debris and assist municipalities and communities with developing appropriate action plans for debris management after a catastrophic flood event.	SWCD/PAC/ DCAP Partners/ Delaware County Hazard Mitigation Coordinator/ Delaware County Solid Waste Management	Ongoing	Minimal	NYC DEP/ Delaware County
	Assist communities in developing a process for sponsoring annual stream clean-up projects.	SWCD/ Delaware County Solid Waste Management/ Town and Village Boards	Ongoing	Minimal	Town Boards/ Delaware County
	The SCMPr, NYCDEP, and the Delaware County Department of Watershed Affairs should work with the NYSDEC and U.S. Army Corps of Engineers to identify and fund an independent stream scientist or engineer to create a guidance document with recommendations on how, when and where to scientifically manage problematic gravel deposits within the East Branch Delaware River system.	NYS DEC/ NYC DEP/ DCAP Partners/ SWCD/ ACOE/ Local stakeholders	Ongoing	To be determined per project.	CWC/ NYS DOS/ Safe Drinking Water/ NYS DEC

	The SCMPr, in cooperation with PAC and NYCDEP, should assist communities to enhance streamside recreational opportunities where possible.	NYS DEC/ PAC/ NYC DEP/ Local communities/ private stakeholders	Ongoing	N/A	N/A
	Local Communities and the Delaware County Chamber of Commerce should work to promote existing recreational opportunities along streams for economic enhancement of the watershed area.	Local communities/ local stakholders/ NYS DEC/ Delaware County Chamber of Commerce	Ongoing	N/A	N/A
	The Stream Corridor Management Program (SCMPr), in cooperation with the NYS Department of Environmental Conservation, the New York City Department of Environmental Protection (NYCDEP), Trout Unlimited and other organizations, and local stakeholders, should work to enhance existing fisheries in the East Branch Delaware River watershed.	NYS DEC/ NYC DEP/ Trout Unlimited/ local stakeholders	Ongoing	N/A	N/A
	The SCMPr, in cooperation with Delaware County Department of Public Works and NYCDEP, should enhance communication with local highway departments.	PAC/ DC DPW/ DC Planning/ Town Highway Superintendents	Ongoing	N/A	N/A
	The Delaware County Board of Supervisors and local Delaware County municipalities should work to complete and adopt Highway Management Plans for each Town.	DC DPW/ DC Planning/ Local Towns	Ongoing	$60,000 per community	NYS DEC/ CWC/ Safe Drinking Water Act/ Delaware County
	The SCMPr, in cooperation with the Delaware County Planning Department, NYCDEP, PAC and other interested stakeholders, should work toward including a stream management component in local comprehensive plans, local laws and local management practices as may be appropriate.	Local town and village boards/ NYC DEP/ PAC/ DC Planning	Ongoing	N/A	N/A
	The Towns and Villages should work to update local floodplain laws to incorporate more restrictive development criteria for projects within the 100-year floodplain.	DC Planning/ Local Towns and Villages/ FEMA	Ongoing	N/A	N/A

	The SCMPr, in cooperation with NYCDEP, PAC, CWC and other interested stakeholders, should continue its involvement with invasive species management, following and promoting all invasive plant programs in the East Branch watershed.	Local stakeholders/ PAC/ SWCD/ NYCDEP/ NYSDEC	Ongoing	N/A	N/A
	A protocol for developing an interagency working group composed of representatives from the New York State Department of Environmental Conservation, U.S. Army Corps of Engineers, Delaware County Soil & Water Conservation District (DCSWCD), New York City Department of Environmental Protection, neighboring Soil & Water Conservation Districts, Delaware County Department of Public Works (DCDPW) and local community leaders to identify ways to delegate, simplify, and streamline the permitting process for the benefit of all agencies and stakeholders.	NYS DEC/ US ACOE/ DC SWCD/ NYC DEP/ neighboring SWCD offices/DCDPW/local community leaders	2010	N/A	N/A
	Integrate the East Branch Delaware River Stream Corridor Management Plan and its recommendations into all relevant components of the Delaware County Action Plan.	DC BOS/ DCAP Partners/ DC Watershed Affairs/ SWCD	Ongoing	N/A	N/A
	The SCMPr should cooperate with the NYCDEP to explore opportunities for local funding sources to enable implementation of recommendations identified in this Stream Corridor Management Plan.	SWCD/ DC BOS/ NYCDEP/ CWC/ WAC	Ongoing	N/A	N/A
	The SCMPr should continue to work with the Delaware County Planning Department and Emergency Services to implement the county-wide, multi-jurisdictional, All-Hazards Mitigation Plan.	Local communities/ DC Planning Department/ DC Emergency Services	2010	N/A	N/A
	The SCMPr should continue to work with the Delaware County Board of Supervisors, the NYCDEP, the NYSDEC and the State Emergency Management Office (SEMO) to revise the FEMA flood study and floodplain maps.	DC BOS/ NYC DEP/ SEMO	Ongoing	N/A	N/A
	The SCMPr, working with the Project Advisory Committee and New York City Department of Environmental Protection, should prioritize potential restoration reaches, including the type and level of intervention needed.	PAC/ NYCDEP/ NYS DEC/ SWCD	Ongoing	Costs will vary per project prioritized.	N/A

	The SCMPr should work cooperatively with the NYCDEP and the PAC to improve immediate post-flood emergency intervention capabilities by demonstrating and training contractors and local municipalities in scientifically-based stream principles, procedures, and methods.	PAC/ NYCDEP/ SWCD	Ongoing	Dependent upon specific needs	
	The SCMPr, working with the PAC and NYCDEP, should provide technical assistance and general direction to community watershed groups/associations and government entities that are actively engaged in grassroots stream stewardship/management activities.	PAC/ NYCDEP/ SWCD	Ongoing	Dependent upon specific needs	
	In cooperation with the Project Advisory Committee and New York City Department of Environmental Protection, the Stream Corridor Management Program should develop a process for updating the East Branch Delaware River Stream Corridor Management Plan.	PAC/ SWCD/ Delaware County Planning/ local communities/ NYC DEP	2012	N/A	N/A