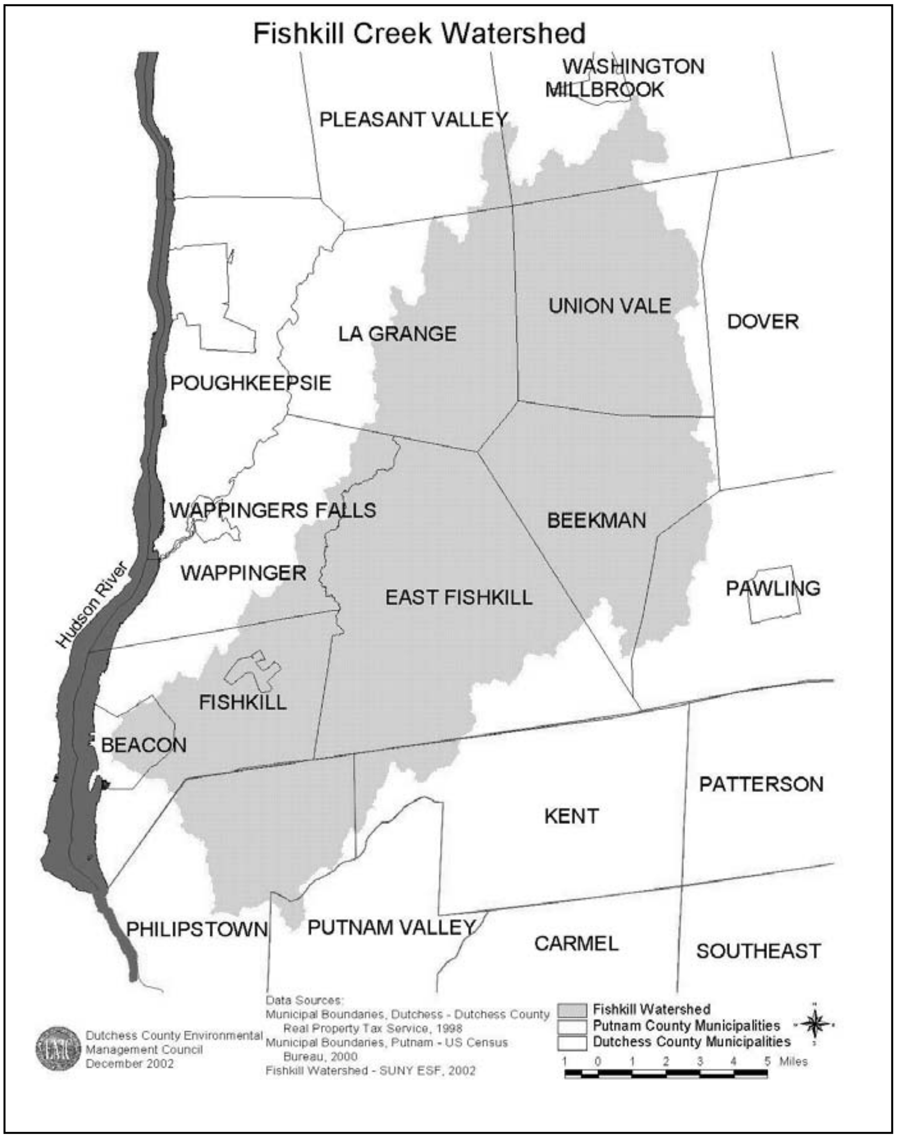
Natural Resources Management Plan For The Fishkill Creek Watershed

A Natural Resources Inventory and Conservation Strategy



Fishkill Creek in Tymor Park, Union Vale

Fishkill Creek near Carpenter Road in East Fishkill

Fishkill Creek in Beacon, NY

A Project of the Fishkill Creek Watershed Committee, May, 2005

FishkillCreekWatershed.org

Natural Resource Management Plan

for the

Fishkill Creek Watershed

June 2005

Prepared by the:

Dutchess County
Environmental Management Council
and
Fishkill Creek Watershed Committee

Primary support provided by:

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Acknowledgements

The *Natural Resources Management Plan for the Fishkill Watershed* was accomplished as a collaborative effort between several agencies, municipalities, non-governmental organizations, and most importantly, the citizens of the watershed. Upon completion of the *Natural Resources Management Plan for the Wappinger Creek Watershed* in October of 2000, municipal officials in the Fishkill Creek watershed began expressing interest in a watershed planning effort focused in Southern Dutchess County. Utilizing financial support from the Hudson River Estuary Program, the Dutchess County Environmental Management Council (EMC) and Dutchess County Soil and Water Conservation District (SWCD) hosted a Fishkill Watershed Symposium in May of 2002. Special thanks should be extended to our host, the Town of East Fishkill, and our symposium presenters: Barbara Kendall (Hudson Valley Greenway), Scott Cuppett (Hudson River Estuary Program), and Dr. Karin Limburg (State University of NY, Environmental School of Forestry). Following the symposium, a dedicated group of citizens, agency representatives, non-governmental organizations, and municipal representatives formed the Fishkill Creek Watershed Committee.

The following members of the Fishkill Creek Watershed Committee provided important information and news, valuable insights, and innovative ideas: Tim Sweeney, Carolyn Plage, Jane Geisler, Robert Hoose, Paul Wise, Marion Wise, Peter Rostenberg, Dan Troge, Kerri Brady, Noreen O' Rourke, Denis Callinan, Judy Lacombe, Candace Coates, Diana Hesse, Janet Swentusky, Jeff Green, Karen Bard, Sonja Sjoholm-DeHaas, Mary Schmalz, Cliff Schwark, Peter Idema, Camile Price, George Hanson, Bernard Ruf, Ellen and Robert Delocis, Rich Taylor, Tom Farmer, John Morabito, Dorothy Bermann, Marshall Seddon, Louis Chara, Malcolm Mills, Joan Pagones, Donald Groff, Marlene Woodason, Verna Wren, Laura Heady, Ed Heiser, Gretchen Stevens, Vincent Fabiano, Gerry Iagallo, Dennis Zach, Joe Ruggiero, Richard Nunez, Amanda Long, Joel Sholtes, Scott Cuppett, Sky Shook, Ryan Palmer, Rebecca Hale, Cathy Weick, and Becky Thornton.

Lynn Robbins, the first Chair of the Fishkill Watershed Committee, demonstrated the value of strong and compassionate leadership in leading a fledgling watershed group through their initial trials and tribulations. Rick Oestrike chaired the Committee through its second and into its third year and accomplished many projects such as the stream walk, a public service announcement, and many public presentations, to name a few. We further acknowledge Ed Hoxsie and Brian Scoralick from the Dutchess County Soil and Water Conservation District for providing technical support. Additionally, the committee's listserv and web page wouldn't have come to fruition if not for Fred Robbins, the web master. Lou Sebesta and Rick Oestrike provided invaluable resources for the forestry and geology sections of this management plan. Jesse Sayles and Barbara Kendall (Hudson River Estuary Program, NYSDEC) each contributed to the plan by writing sections on dams and the NYS Stormwater Program, respectively. Russell Urban-Mead offered insights and contributed to the groundwater section. Finally, special thanks are due Dan Shapley for his timely and educational environmental articles that provides a means for more public involvement in the watershed planning process.

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Background

The Fishkill Creek Watershed Committee developed the *Natural Resources Management Plan for the Fishkill Creek Watershed* over a three-year period. The plan is designed as a comprehensive review of existing Fishkill watershed characteristics, data and maps compiled in a single document. Ultimately, the plan is meant to assist the fourteen watershed municipalities in planning for a sustainable future for their water and biological resources. Ensuring the health of the watershed's environmental resources will also help secure a future of prosperous economic growth and a good quality of life for watershed residents.

The Fishkill Creek watershed, located in Dutchess and Putnam Counties, NY drains approximately 193 square miles (123,627 acres) in eleven Dutchess County and three Putnam County municipalities. The main stem of the Fishkill Creek begins in the center of Union Vale and flows southwest, entering the Hudson River in Beacon. Located less than 90 miles from New York City, the watershed has experienced intense growth over the past thirty years. Land uses in the watershed are diverse, ranging from predominantly residential and forested land in the eastern portion, with mixed agricultural in the northern sections, to urban and commercial in the western half. During the period between 1990 and 2000 the population of Dutchess County increased by eight-percent (U.S. Census Bureau, 2001). As the population of Dutchess County rapidly increases it is imperative that measures are taken to protect the health of our water and maintain community resources.

Due to the complicated composition of the rural/urban land use interface of Southern Dutchess/Northern Putnam Counties, and the rapid rate of change, a broad range of challenges face the watershed. The primary sources of pollutants in the Fishkill Creek watershed are from nonpoint sources. Nonpoint source pollutants arise from a number of sources rather than just one (i.e. parking lot runoff, stormwater, septic system effluent, agriculture or construction runoff). Impacts from nonpoint source pollution threaten the quality of the recreational fishery, boating, and swimming in the Fishkill watershed streams, lakes, and ponds. Water supply wells and wildlife in watershed communities can also be negatively affected. Water quality impairment has been documented by several studies and detailed in the following plan. In addition to surface water problems, a portion of southern Dutchess County's groundwater was contaminated by organic chemicals.

The Fishkill Creek Watershed Committee (FCWC) benefited by the experiences and outcomes of the Wappinger Creek Watershed Planning Committee (WCWPC). The WCWPC was formed in 1995, conducted numerous research projects and trainings, and completed a watershed management plan in 2000. Since 2000, a watershed-based Intermunicipal Council has been formed and adopted measurable goals to be accomplished on a watershed scale. Many of the municipalities in the Wappinger Creek watershed also contain a portion of the Fishkill Creek watershed. However, a few municipalities outside the Wappinger watershed, or predominantly in the Fishkill, expressed an interest in starting an intermunicipal council to address issues specific to the Fishkill Creek watershed. In May of 2002, in collaboration with the Town of East Fishkill and the New York State Department of Environmental Conservation's Hudson River Estuary Program, the Dutchess County Environmental Management Council (DCEMC) and Dutchess County Soil and Water Conservation District (SWCD) hosted a symposium to initiate the Fishkill watershed planning process. Following the symposium, a group of watershed citizens, municipal representatives, and agency personnel started the Fishkill Creek Watershed Planning Committee (FCWC) in an attempt to address the threats identified at the symposium.

Water Quality Analysis of the Fishkill Creek Watershed

Water quality of the Fishkill Creek and its major tributaries was assessed between 1973 and 2002 by different scientific research groups including, Neuderfer (1977), Schmidt and Kiviat (1985), Bode et al. (1991), Bode et al. (1999), Stainbrook (2001), and Bode (2004). The primary component of these studies was an analysis of biological communities, including benthic macroinvertebrates and fish. In addition to the biological analysis, water samples were collected and analyzed for chemical and physical parameters.

Comprising 42% of the Fishkill Creek watershed, the Fishkill Creek main stem subwatershed encompasses 52,783 acres in the towns of Union Vale, Beekman, East Fishkill, Fishkill and Wappinger. The watershed's major stream is the main stem of the Fishkill Creek, originating in the town of Union Vale and flowing southwest until it empties into the Hudson River in the City of Beacon. Based on previous studies of the Fishkill Creek (1973 through 2001), it seemed the stream water quality improved slightly in the downstream portions of the stream since 1973. These improvements can most likely be accounted for by the passage and implementation of the Clean Water Act in 1972, and the subsequent reduction of point (end-of-pipe) source discharges. Upstream of the Route 9 Bridge (FC 6.9), the Fishkill Creek remained in good ecological health throughout the period of study (1973 through 2001). In this section, the primary impact to biological communities appeared to be the many dams in the creek, but this does not necessarily translate into water quality degradation. From the Route 9 bridge (FC 6.9) to its confluence with the Hudson River, the Fishkill Creek was impacted by various sources of pollution including sewage inputs, construction and historical industrial inputs.

The Sprout Creek watershed encompasses 29,342 acres representing 24 percent of the Fishkill Creek Watershed. This subwatershed is located within five municipalities including the towns of Washington, Pleasant Valley, Union Vale, La Grange, East Fishkill and Wappinger. The Sprout Creek appeared to be in good (non- to slightly-impacted) shape throughout the period of study (1973-2002). However, at various points throughout the period of study there were pollution sources that acted to slightly degrade the stream. The most likely sources of nutrient enrichment were sewer treatment plant effluents, faulty septic systems, and agricultural operations that weren't following best management guidelines.

Clove Creek watershed encompasses an area of approximately 12,960 acres in the town of Fishkill in Dutchess County, and the towns of Philipstown and Putnam Valley in Putnam County, representing 10 % of the Fishkill Creek Watershed. The major stream in the subwatershed is the Clove Creek, which originates in Putnam County on the east side of Route 9 and continues to flow northward to the town of Fishkill. The Clove Creek flows parallel to the Fishkill Ridge on the northern side, and continues west, where it empties into the Fishkill Creek near the intersection of Route 9 and Interstate 84. Clove Creek aquifer is a significant feature located in the northwest corner of Putnam and southwest corner of Dutchess Counties'. Designated as a critical environmental area by the town of Fishkill, the Clove Creek aquifer is underlain by sand and gravel, and is a very permeable and productive aquifer with wells yielding an average of 189 gallons of water per minute (Snavely, 1980). Macroinvertebrate analysis indicated the Clove Creek was a good (non- to slightly-impacted) quality stream, and fish sampling indicated the fish community of the Clove Creek hadn't changed since a previous sampling in 1936 (Schmidt and Kiviat, 1985). The researchers also found reproducing brown trout populations, which can also be an indicator of good water quality.

Jackson Creek watershed encompasses an area of 5,524 acres in the towns of Union Vale, La Grange and Beekman. The watershed encompasses 4 percent of the total area of the Fishkill Creek Watershed. Schmidt and Kiviat (1985) assessed the fish populations of Jackson Creek and found naturally reproducing trout populations. Healthy brook and brown trout populations were also documented in 2001, despite poor physical conditions due to the lack of flow and only pockets of water (Stainbrook, 2004). Finally, in the summer of 2002, Bode et al. (2004) found the Jackson Creek fauna dominated by clean-water mayflies, and based on macroinvertebrate metrics assessed the water quality as nonimpacted.

Whaley Lake Brook watershed encompasses 11,481 acres, accounting for 9 percent of the Fishkill Creek watershed area. This watershed is located within three municipalities including the towns of Union Vale, Beekman and Pawling. Researchers visited Whaley Lake Brook in 1988 through 1989 at river mile WL 0.4. According to Stevens et al. (1994), Whaley Lake Brook had substantially higher chloride concentrations than existed in the 1985 analysis. Despite the increase in chloride concentrations, Whaley Lake Brook had good water quality (slightly impacted), a substantial fish community, and clean-water diatoms (Stevens et al., 1994). Additionally, spawning brown trout were documented in 1988 and 1989, again indicating good water quality.

The Whortlekill Creek watershed encompasses approximately 4,269 acres, accounting for 3 percent of the total Fishkill Creek watershed area. The Whortlekill Watershed is located in three municipalities including the towns of Beekman, La Grange and East Fishkill. Researchers visited Whortlekill Creek in 1988 through 1989 at river mile WK 0.35. According to Stevens et al. (1994), the stream contained a diatom community that was dominated by pollution sensitive species, especially in the fall and winter. Additionally, the stream contained the best fish community of all the Fishkill Creek sampling stations (Stevens et al., 1994). The researchers found a reproducing population of brook trout, which are very pollution sensitive. Combined, these factors indicated good (non- to slightly-impacted) water quality. In 2001, the brook trout populations were still present despite a large increase in developed land (Stainbrook, 2004).

Wiccopee Creek watershed (H-95-8) encompasses 7,267 acres, accounting for 6 percent of the Fishkill Creek watershed area. This Fishkill Creek subwatershed is located within four municipalities including the towns of East Fishkill and Fishkill in Dutchess County and the towns of Kent and Philipstown in Putnam County. The stream was assessed in 1985 when Schmidt and Kiviat found the Putnam County headwaters contained healthy brown trout and slimy sculpin populations. Slimy sculpins require clean and clear streams for survival, and thus their presence indicated good (non-impacted) water quality in the headwaters of the Wiccopee. The researchers went as far as to compare the headwaters to pristine Catskill streams, particularly due to the cold-water temperatures (Schmidt and Kiviat, 1986). Overall, Wiccopee fish populations appeared not to have changed significantly since a previous fish study in 1936 (Schmidt and Kiviat, 1986).

Researchers visited the Wiccopee Creek again in 1988 through 1989 at river mile WC .82 (Route 52 bridge). They found the macroinvertebrate community indicated high water quality (non-impacted) in the summer, but mediocre (slightly impacted) in other seasons (Stevens et al., 1994). The fish communities were the poorest in the Fishkill basin with only two species collected in 1988, and by 1991 the fish communities hadn't recovered (Stevens et al., 1994). Although the lower portions of the Wiccopee appeared to have been damaged, the headwater portion remained pristine. Despite the poor fish community, the water chemistry parameters measured as good (non- to slightly-impacted).

Management Strategies for Achieving Watershed Conservation Goals and Objectives

To protect the Fishkill Creek watershed for future generations, efforts need to be made to protect the stream corridor through the establishment of effective forested stream buffers. The stream buffers will function to offer some measure of protection against encroaching land uses. Additionally, watershed groundwater withdrawals for the expansion of suburban land uses need to be balanced to protect in-stream flows. In conjunction with this, a watershed-wide approach should be employed to determine the amount of regulated discharges that can be added to the various streams during low-flow periods without causing degradation. Stormwater run-off, from parking lots, roads, and subdivisions, should be treated before reaching the streams. In addition, serious investments should be made into impervious surface alternatives.

Water quality monitoring should continue to be conducted to track changes in biological community structure and water chemistry. Dissolved oxygen, temperature, conductivity, nitrate, phosphate, sulfate and chloride are water quality constituents of particular interest for tracking human-induced changes. Finally, failing and out-of-date sewage systems need to be upgraded to protect water quality and human health.

Following these guidelines should allow the Fishkill Creek to thrive along with the communities it touches. Ignoring the water quality of the Fishkill Creek during this period of extensive expansion will act to erode the health of the Fishkill Creek, and ultimately the surrounding communities. In depth recommendations developed by the Fishkill Creek Watershed Committee include:

Watershed Conservation Objectives

1) The Dutchess County Environmental Management Council and various environmental organizations should collect, organize, evaluate and make public existing data on the Fishkill Creek watershed.

2) Municipalities, government agencies and environmental organizations should continue to monitor water quality and quantity, biodiversity, land use, stream flow regime and other parameters within the watershed with the objective of identifying areas of concern to its integrity. Wherever possible this new data should be incorporated into the database mentioned in objective number one.

3) Municipalities, residents and businesses (i.e. property owners) should work toward remediation of the problems identified through analysis of the database developed through objectives one and two. Environmental groups should assist with the remediation efforts.

4) Businesses, municipalities, environmental groups and residents (the stakeholders) should collaborate to protect the watershed.

5) Environmental organizations, residents, businesses and municipalities should encourage locally based water resource education.

6) All stakeholders should help maintain a good quality-of-life within the watershed by protecting the health of the watershed.

Specific Recommendations

- Efforts should be made to protect the stream corridor through the establishment of effective forested stream buffers. The stream buffers will offer some measure of protection against encroaching land uses.
- Groundwater withdrawals for the expansion of suburban land uses need to be balanced with groundwater recharge to protect in-stream flows. In conjunction with this, a watershed-wide approach should be employed to determine the amount of regulated discharges that can be added to the stream during low-flow periods without causing degradation.
- Stormwater run-off, from parking lots, roads, and buildings, should be treated before reaching the stream. This can be accomplished by replacing old infrastructure with modern systems that remove many pollutants (see additional watershed protection measures section).
- In addition, serious investments should be made into impervious surface alternatives and ordinances to limit the amount of impervious surfaces in new developments.
- Water quality monitoring should continue to be conducted to track changes in biological community structure and water chemistry. Macroinvertebrate studies should be repeated approximately every 5 years. Dissolved oxygen, temperature, conductivity, nitrate, phosphate,

sulfate, and chloride are water quality constituents of particular interest for tracking human-induced as well as natural changes in the drainage.

- Mapping of riparian and in-channel habitats should be completed. The remote-sensing based mapping should be updated on a 5 year basis in order to track changes.
- Identify streams routinely use for swimming and check to see if NYSDEC classifies them as B (suitable for primary contact recreation). If necessary, request a classification upgrade to class B.
- Cumulative impacts should be considered before issuance of state pollution discharge (SPDES) permits.
- Best Management Practices (BMPs) issued by the NYSDEC, NYSDOT, USEPA and others should always be followed.
- Many of the dams within the watershed are no longer in use. These dams should be systematically evaluated and removed where practical.

Implementation of the Plan

The Fishkill Creek Watershed Committee is committed to accomplishing the recommendations set forth in this management plan. To this end, the Committee members will concentrate their collective efforts in identifying funding opportunities to move implementation forward. In addition, resource partners (agencies and non-governmental agencies) should identify the goals and objectives that they can move forward under the pretext of their operational mandate.

One of the primary components necessary for the success of this planning project is public involvement. To this end, the Committee has already had a good start with the watershed symposium, watershed plan, education grant to complete watershed-based lesson plans, completion of the streamwalk project, numerous publications, presentations, and displays, creation of the listserv and the watershed website (FishkillCreekWatershed.org). In addition to continuing these efforts, the Committee should work towards formal intermunicipal cooperation, including the municipal adoption of measurable watershed conservation goals.

For more information on the Fishkill Creek Watershed Committee, please visit FishkillCreekWatershed.org.

I. Introduction

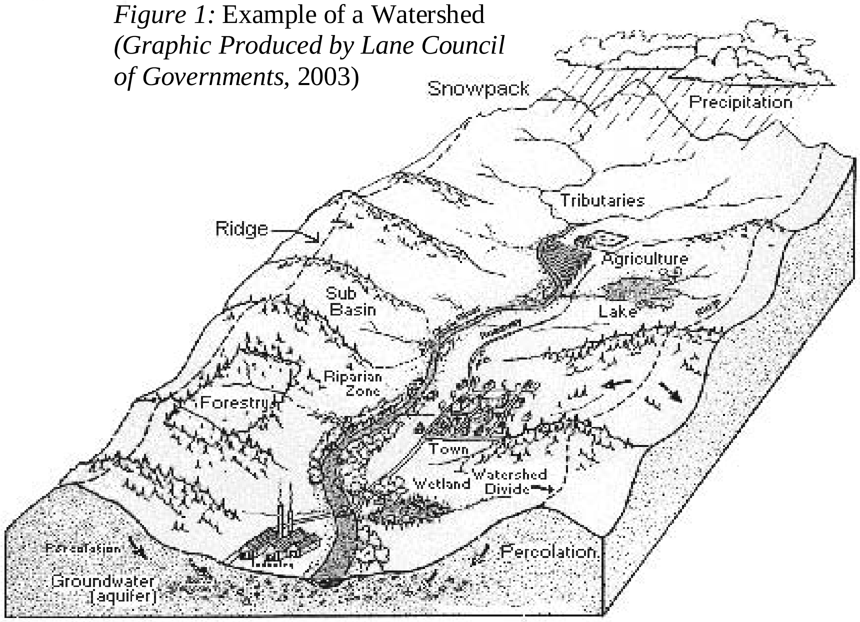
Purpose of Fishkill Watershed Plan

The *Natural Resources Management Plan for the Fishkill Creek Watershed* is designed as a comprehensive review of existing Fishkill watershed characteristics, data and maps compiled in a single document. Subject areas addressed in the plan include wetland information, subwatershed characteristics, water quality data, land use information, and natural resources. A watershed protection plan is also included, and potential funding sources are identified. Ultimately, the plan is meant to assist the fourteen watershed municipalities in planning for a sustainable future for their water and biological resources. Ensuring the health of the watershed's environmental resources will also help secure a future of prosperous economic growth and a good quality of life for watershed residents.

The Fishkill Creek and its Watershed

A watershed can be defined as the land area that water flows across (surface water), and under (groundwater), on its way to a stream, river, or lake (Figure 1). Watersheds vary in size, from the Atlantic Ocean, to the Hudson River, to the Fishkill Creek, down to small tributaries that drain into the Fishkill Creek. Basically, a watershed is an area of land that drains to a single outlet. Everyone lives in a watershed.

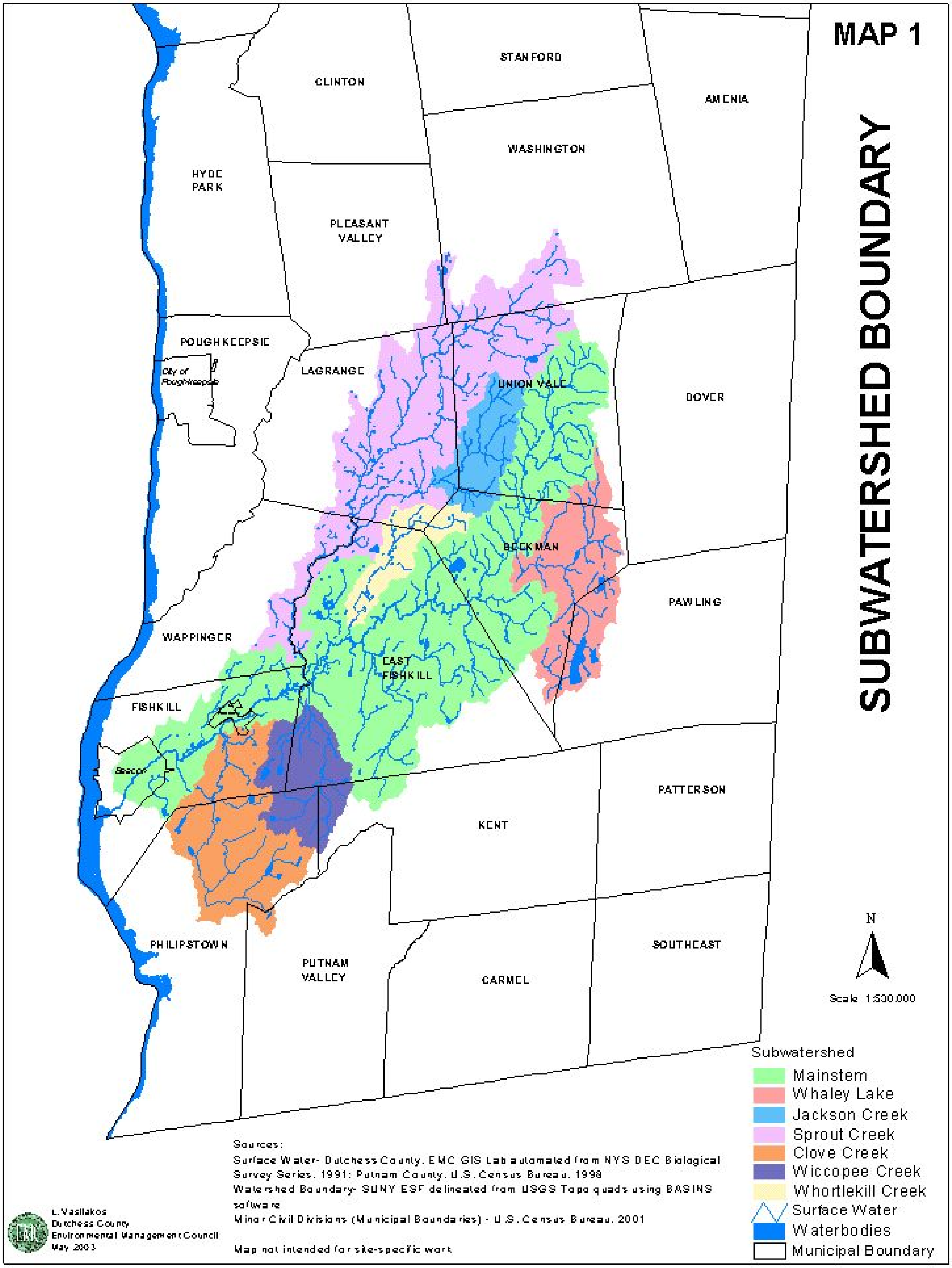
Figure 1: Example of a Watershed
(Graphic Produced by Lane Council of Governments, 2003)



The Fishkill Creek watershed, located in Dutchess and Putnam Counties, NY drains approximately 193 square miles (123,627 acres) in eleven Dutchess County and three Putnam County municipalities (Map 1). The main stem of the Fishkill Creek begins in the center of Union Vale and flows southwest, entering the Hudson River in Beacon (Map 1). In between, through its various tributaries, it drains large sections of Union Vale, Beekman, East Fishkill, and Fishkill, along with smaller portions of western Pawling, southeastern Pleasant Valley, northwestern Kent, northern Philipstown, and southwestern Washington (Map 1). The Sprout Creek, Fishkill Creek's largest tributary, drains major sections of La Grange, and Union Vale, and smaller portions of Wappinger and East Fishkill. In Putnam County, the Clove Creek drains a large section of Philipstown, and a very small section of northwest Putnam Valley. Finally, Wiccopee Creek drains a small portion of western Kent.

Elevations in the watershed vary from a high of approximately 1,610 feet above sea level on Mount Beacon, to almost sea level at the confluence of the Fishkill Creek and Hudson River. The average elevation of the watershed is approximately 635 feet above sea level. In the upper reaches of the basin the stream drops slightly more than 200 feet in 10 miles. In the lower portion, where the Fishkill Creek flows over shale and limestone ledges, the gradient is 200 feet in 5 miles. The main stem of the Fishkill Creek ranges from 420 feet above sea level in the four corners region of Union Vale, La Grange, Pleasant Valley, and Washington to sea level at the confluence of the Fishkill Creek and Hudson River.

Located less than 90 miles from New York City, the watershed has experienced intense growth over the past thirty years. Land uses in the watershed are diverse, ranging from predominantly residential and forested land in the eastern portion, with mixed agricultural in the northern sections, to urban and commercial in the western half. During the period between 1990 and 2000 the population of Dutchess County increased by eight-percent (U.S. Census Bureau, 2001). As the population of Dutchess County rapidly increases it is imperative that measures are taken to protect the health of our water and maintain community resources. If we fail to incorporate environmental protections during this period of rapid urbanization and sub-urbanization, the future integrity of our water and environmental resources may be severely compromised. Additionally, the increases in sub-urbanization will lead to extremely large and costly infrastructure projects to replace the natural drinking water filtration and sewage disposal functions currently performed for free by nature. Watershed and environmental health also depend on a healthy and vibrant economy. Knowing this, watershed communities must develop and implement plans that combine environmental protections, economic growth, and healthy communities. Ultimately, the health of our local environment drives the quality of life of our residents. In the following management plan, recommendations are proposed to assist in maintaining a healthy environment, while promoting sustainable community development.


MAP 1
SUBWATERSHED BOUNDARY
STANFORD
CLINTON
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
SOUTHEAST
CARMEL
N
Scale 1:530,000
Subwatershed
Mainstem
Whaley Lake
Jackson Creek
Sprout Creek
Clove Creek
Wiccopee Creek
Whortlekill Creek
Surface Water
Waterbodies
Municipal Boundary
Sources:
Surface Water- Dutchess County, EMC GIS Lab automated from NYS DEC Biological Survey Series, 1991; Putnam County, U.S. Census Bureau, 1998
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software
Minor Civil Divisions (Municipal Boundaries) - U.S. Census Bureau, 2001
Map not intended for site-specific work
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003

How we are connected to the Fishkill Creek Watershed and *Why you should care*

Wherever you live in the watershed, what you do at your home and its surroundings can have a direct impact on your neighbor's water resources. As Fishkill Creek watershed land uses evolved over the last 200 years, the natural water balance has been altered. Natural forest cover and wetlands have been replaced with roads, driveways, parking lots, and buildings. These hard surfaces, or impervious surfaces, increase the amount of rainfall that flows over land and reduce the amount of rainfall that percolates into the soil or is consumed by plants and trees. Increasing the amount of rainfall that runs off the land leads to flooding, and as water flows over these paved surfaces, it collects soil, pet wastes, salt, fertilizers, oils, and other pollutants. Increased impervious surfaces can lead to increased storm flow intensity that can exacerbate flooding and stream erosion. It doesn't matter if your house does not border a stream or river, local rainwater flows down the street into a catch basin. Storm sewers often carry this runoff from your neighborhood directly to the nearest body of water, taking dirt and pollutants along with it. In order to meet both surface and groundwater planning needs, both quality and quantity, a comprehensive watershed approach is required to document the magnitude of potential impairment, and involve watershed stakeholders in recommending strategies for remediation and management.

What are the primary concerns in the Fishkill Creek Watershed?

Due to the complicated composition of the rural/urban land use interface of Southern Dutchess/Northern Putnam Counties, and the rapid rate of change, a broad range of challenges face the watershed. To understand the threats to the Fishkill Creek watershed we must differentiate between point and nonpoint source pollutants. Point sources of pollution can usually be traced to a specific source or pipe that is discharging effluent to a receiving water body (i.e. sewage or industry discharges). The State Pollution Discharge Elimination System (SPDES) permitting program was designed to address point source pollution (Map 5). In 1972 approximately 2000 miles of streams and rivers were impaired by point source pollution (NYSDEC, 1996). However, by regulating industrial and sewage discharges, the number of stream and river miles impaired by point source pollutants had been reduced to approximately 300 miles by 1996 (NYSDEC, 1996).

The primary sources of pollutants in the Fishkill Creek watershed are from nonpoint sources. Nonpoint source pollutants arise from a number of sources rather than just one (i.e. parking lot runoff, stormwater, septic system effluent, agriculture or construction runoff) (Figure 2). Impacts from nonpoint source pollution threaten the quality of the recreational fishery, boating, and swimming in the Fishkill watershed streams, lakes, and ponds. Water supply wells and wildlife in watershed communities can also be negatively affected. Water quality impairment has been documented by several studies. Based on 1991, 1997, and 1998 biological monitoring data of the Fishkill Creek, the New York State Department of Environmental Conservation (NYSDEC) found that the reach from Fishkill to Beacon is considered slightly impacted, probably by sewage and heavy metal wastes (NYSDEC, 1999). This same study also suggested that agricultural activity in the upper watershed might be contributing to elevated nutrient loads (NYSDEC, 1999).

Additionally, in a 1994 study, Hudsonia, Ltd. found a strong upstream-to-downstream pollution gradient in the Fishkill system, with pollution increasing as you moved downstream (Stevens et al., 1994). Based on these studies and local observation, the lower five miles of the Fishkill Creek were placed on the NYSDEC's Priority Water List (PWL) in 1996 due to impairments from runoff.

Anything dumped into the stormdrain may eventually end up in the local stream, lake, or wetland (University of Wisconsin. 1999).

In a recent intensive study by the NYSDEC, the Fishkill Creek was identified as one of four streams in the Hudson Basin with a “medium” need for remediation from multiple urban nonpoint sources of pollution (Bode et al., 2001). Only two streams in the Hudson Valley, receiving point source pollutants, ranked higher for remediation. Bode et al. (2001) also demonstrated through tissue analysis of aquatic organisms, that there were elevated levels of polycyclic aromatic hydrocarbons (PAHs) at Hopewell Junction and Beacon monitoring sites in the Fishkill Creek, elevated levels of lead and selenium at a Beacon site, and high levels of lead in crayfish at the Beacon site. PAHs result as a by-product of combustion from sources such as incineration of municipal and solid waste, burning fossil fuels, forest fires, and other industrial processes (USGS, 1998). Finally, Hillside Lake, a small lake surrounded by development in the town of East Fishkill, has also been placed on the NYSDEC Priority Water List due to nutrient loading from failing on-site septic systems and urban runoff (NYSDEC, 1999).

Surface water reservoirs in Fishkill, Philipstown and Beekman have been relatively clean to date, but long-term land use planning is needed to protect these important resources. In addition, Hudsonia (1994) researchers demonstrated that the Fishkill Creek provided a variety of aquatic habitats, comprised of a diverse array of fishes ranging from upland cold water forms (slimy sculpin and brook trout) to slow-moving water forms (banded killifish and largemouth bass). In a study of the estuarine portion of the Fishkill Creek, researchers theorized that increased urbanization in the Fishkill watershed caused a decrease in the amount of Hudson River fish spawning in the creek (Schmidt and Limburg, 1989). The recommendations proposed in chapter four are intended to protect the unaffected fishery and may help restore the degraded fishery.

In addition to surface water problems, a portion of southern Dutchess County’s groundwater was contaminated by organic chemicals. The chemical solvents trichloroethylene (TCE), trichloroethane (TCA), and perchloroethylene (PCE) were discharged into the aquifer. PCE and TCE were commonly used to degrease metal parts, and PCE was also used in the dry cleaning process. TCA was used as an ingredient in degreasers, paints and glues until being banned in 1996 because it contributes to the depletion of the earth's ozone layer. In 2003, there were 141 private wells contaminated by either TCE, TCA, PCE, or a combination of the three. Additionally, wells throughout Dutchess County have been contaminated with methyl tertiary-butyl ether (MTBE). MTBE is a chemical that was a component of gasoline since 1979, when it was introduced to take the place of lead as an octane enhancer. However, it was not until 1992 that the chemical became a large part of gasoline by volume. In 1992, the amendments to the Clean Air Act mandated that non-attainment areas for the ambient standards set by the Act use reformulated gasoline. MTBE turned out to be such a threat to drinking water because of its chemical properties. It is hydrophilic and fast moving, meaning it is attracted to water, and as such moves more quickly through the ground than other components of gasoline. Most people can smell MTBE in contaminated water at levels as low as 100 parts per billion (ppb). On May 24, 2000, legislation banning the use, sale or importation of fuels containing MTBE in New York State was signed into law. The ban on MTBE went into effect in the beginning of 2004.

In conclusion, it is extremely important that the citizens of the Fishkill Creek watershed work collaboratively with government agencies, non-governmental agencies, and businesses to design a plan for a sustainable watershed future. The plan should address the surface and ground water contamination issues outlined above. In addition, the plan should ensure that sufficient quantities of water are available to sustain the unique biodiversity, and wide-ranging habitats, of the watershed. The *Natural Resource Management Plan for the Fishkill Creek Watershed* is designed as a guide to initiate and sustain the planning process.

Goals and Objectives of the Fishkill Creek Watershed Committee

The Fishkill Creek Watershed Committee developed a mission statement and goals in 2002 (Table 1).

Table 1. Mission Statement and Goals of the Fishkill Creek Watershed Committee

Mission Statement(s)

- To involve individuals, groups and other interested entities, both public and private, within the Fishkill Creek watershed for the long-term planning of sustainable communities and protection of our natural environment including but not limited to ground and surface water quality and quantity.

  and/or

- To encourage individuals and entities, both public and private to work for the protection of the natural environment within the Fishkill Creek watershed.

Goals

- Protect wetlands and aquifers, and protect and restore naturally vegetated forested stream buffers.
- Identify and encourage financial incentives to residents and businesses that conserve and protect the watershed.
- Identify human activities taking place in the watershed that could damage the aquifer. Assign generally accepted levels of risk to them, then work with businesses and residences to reduce those risks.
- Promote awareness and education within the watershed.
- Educate and empower local landowners.
- Identify and remediate problem areas and future issues that arise within the watershed.
- Promote biodiversity.
- Maintain water quality where it is currently satisfactory.
- Start water quality monitoring program to identify existing water quality problems in the watershed.

Past, Current, and Future Activities

The Fishkill Creek Watershed Committee (FCWC) benefited by the experiences and outcomes of the Wappinger Creek Watershed Planning Committee (WCWPC). The WCWPC was formed in 1995, conducted numerous research projects and trainings, and completed a watershed management plan in 2000. Since 2000, a watershed-based Intermunicipal Council has been formed and adopted measurable goals to be accomplished on a watershed scale. Many of the municipalities in the Wappinger Creek watershed also contain a portion of the Fishkill Creek watershed. However, a few municipalities outside the Wappinger watershed, or predominantly in the Fishkill, expressed an interest in starting an intermunicipal council to address issues specific to the Fishkill Creek Watershed. In May of 2002, in collaboration with the Town of East Fishkill and the New York State Department of Environmental Conservation's Hudson River Estuary Program, the Dutchess County Environmental Management Council (DCEMC) and Dutchess County Soil and Water Conservation District (SWCD) hosted a symposium to initiate the Fishkill watershed planning process. Following the symposium, a group of watershed citizens, municipal representatives, and agency personnel started the Fishkill Creek Watershed Committee (FCWC) in an attempt to address the identified threats (Table 2). The following is a list FCWC activities that have been either accomplished or are on-going.

- Hosted a watershed symposium, formed planning committee, adopted mission and goals, and hold monthly meetings (often with speakers).
- Received funding for the development of the Natural Resources Management Plan for the Fishkill Creek Watershed, and for an education campaign.
- Received support from watershed municipalities through board appointed representatives.
- Completed a Fishkill watershed land use analysis based on year 2000 digital orthophotos.
- Collaborated with the DCEMC and State University of New York, Environmental School of Forestry on an ecological health assessment of watershed.
- Started an education subcommittee that received funding for a watershed education program from the Hudson River Estuary Program.
- Completed physical assessments of 16-miles of the Fishkill Creek.
- Started a watershed internet/email group and a web-based education campaign (Table 3).
- Worked with Hudsonia Ltd. to incorporate a biodiversity component in the watershed planning process.

Table 2. Top Ten Threats To The Fishkill Watershed Identified By Participants Of The May 9, 2002 Symposium

1.	High rate of development
2.	Quantity of groundwater
3.	Lack of enforcement of existing regulations
4.	Public health (due to groundwater contamination)
5.	Surface water reductions (due to over withdrawal)
6.	Land uses with potentially hazardous by-products in close proximity to residential areas
7.	Land use regulations that don't necessarily protect water quality
8.	Sewage discharges to creek
9.	Lack of research
10.	Lack of cooperation

Table 3. Website & Online Discussion Group Information

(by Fred Robbins, December, 2004)

The Fishkill Creek Watershed Committee's Website provides an introduction to watersheds, maps, pictures, results of Streamwalk 2004, tips for watershed care, meeting information, and links to many other websites. Visit FishkillCreekWatershed.org.

The Committee's **Online Discussion Group** (sometimes called a "listserv") is a service that provides an email "bulletin board" which we can all use to exchange information and thoughts. Any member can "post" a message that will be seen by all other members. Joining the group will also enable you to view the email archive (letters, media articles, meeting minutes, email from other members), as well as to control your message viewing preferences.

Just go to groups.yahoo.com/group/Fishkillwatershed and click on "Join this Group!" Then you can post messages by sending email to Fishkillwatershed@yahoogroups.com.

II. Description of the Watershed

Watershed Boundary

The Fishkill Creek watershed encompasses fourteen municipalities within Dutchess and Putnam counties (Map 1, Table 4). Within Dutchess County, the watershed covers sections of the towns of Beekman, East Fishkill, Fishkill, La Grange, Pawling, Pleasant Valley, Union Vale, Wappinger, Washington, City of Beacon and Village of Fishkill. Within Putnam County, the watershed covers portions of the towns of Kent, Philipstown and Putnam Valley.

Table 4. Municipalities in the Watershed

Municipality	Percent of Municipality in the Watershed (%)	Percent of Watershed in the Municipality (%)
BEACON (C)	57.4	1.4
BEEKMAN	92.5	14.7
EAST FISHKILL	84.1	25.1
FISHKILL (T)	54.9	8.9
FISHKILL (V)	100.0	0.4
KENT	7.6	1.7
LAGRANGE	56.9	11.9
PAWLING	11.4	2.5
PHILIPSTOWN	33.7	9.0
PLEASANT VALLEY	4.8	0.8
PUTNAM VALLEY	1.5	0.3
UNION VALE	86.4	16.7
WAPPINGER	22.7	3.3
WASHINGTON	10.5	3.1

Subwatersheds

The Fishkill Creek watershed is made up of seven subwatersheds including the Fishkill Creek Main stem, Clove Creek, Jackson Creek, Sprout Creek, Whaley Lake Creek, Wiccopee Creek, and Whortlekill Creek (Map1, Table 5). The State University of New York School of Environmental Science and Forestry (SUNY ESF) delineated the subwatersheds from the United States Geological Survey (USGS) topographic quadrangles using BASINS software. Biological, physical and chemical data were collected from 16 sites within these subwatersheds during the 2001 sampling season (June-August) (Map 11).

Land Use

Land use in the Fishkill Creek watershed is diverse consisting of agriculture, urban/commercial, extractive,

Table 5. Subwatershed Acreage

Subwatershed	Total Area (Acres)
Fishkill Creek Mainstem	52,783
Clove Creek	12,960
Jackson Creek	5,524
Sprout Creek	29,342
Wiccopee Creek	7,267
Whaley Lake	11,481
Whortlekill Creek	4,270
TOTAL	**123,627**

forest, industrial, outdoor recreation, public, residential, transportation, inactive, and water resources as defined using the New York State Land Use and Natural Resources Inventory (LUNR) (CLEARS, 1995) (Map 2). In the LUNR classification system, agricultural land includes orchards, vineyards, horticulture or floriculture, high intensity cropland, cropland and cropland pasture, pasture and specialty farms. Commercial land is categorized as areas predominately connected with the sale of products and services including central business districts, shopping centers, resorts and strip development. Extractive land consists of surface and subsurface material extraction including stone quarries, sand and gravel pits, underground mining, oil and gas wells, salt mining and other areas for both open and underground mining. Forest land consists of forest brushland (i.e. regenerating forest with more than 10 % brush cover), forest lands (land areas with natural stands where 50 % or more of the trees are over 50 years old and over 30' high) and plantations.

Industrial lands are characterized as areas used for product manufacturing and research including light manufacturing and industrial parks and heavy manufacturing. Outdoor recreation areas are predominantly utilized for outdoor recreation including golf courses, ski areas, swimming areas, marinas, yacht clubs and boat launch sites, public and private campgrounds, fairgrounds, public parks, etc. Public land provides services to the public including educational institutions, religious institutions, health institutions, military bases, solid waste disposal, cemeteries, water supply treatment facilities, sewage treatment plants, road and street equipment centers, etc. Residential land consists of high, medium and low density residential areas, strip developments, rural hamlets, farm labor camps, rural estates, cluster housing, cottages and vacation homes, apartment buildings, mobile homes, and rural non-farm residences. Transportation is categorized as highways, railways, airports, barge canals, marine shipping areas, and communication and utilities. Inactive land consists of an area that is not being utilized as a particular land use including inactive agricultural land and urban inactive. Water resources are categorized as lakes and ponds, streams and rivers, wetlands, marine lakes, rivers and seas and the Hudson River.

In 2003, a study was conducted by the DCEMC, with funding from the Hudson Valley Regional Council (HVRC), designed to analyze the land use and land cover characteristics of the Fishkill watershed. The final product of the study was the development of a land use/land cover data layer in the LUNR classification system that was based upon the Dutchess County's Year 2000 aerial photography. Using this layer, land use was aggregated into 11 categories and calculations were made to determine percent land use for the entire watershed. The completed layer was also compared with a LUNR layer that was developed from 1995 aerial photography to determine land use change over the five-year period for the Dutchess County portion of the Fishkill Creek watershed.

In 2000, the dominant land use in the Fishkill Creek watershed was forest cover comprising nearly 50 % of the watershed (Table 6, Map 2). The second largest category was residential land uses encompassing approximately 21 percent. Other land use categories included agriculture (10.7%), water/wetlands (8.9%), outdoor recreation (2.4%), inactive land (1.8%), transportation (1.5%), urban/commercial (1.3%), public/semipublic (1.2 %), extractive (0.7 %) and industrial (0.6%) (Table 6). In the Dutchess County portion of the watershed, the major land use types were forest cover (45.8 %), residential (22.7 %) and agriculture (11.8 %) (Table 7). In the Putnam County portion of the watershed, the major land use types were forest cover (82.4 %), residential (8.5 %) and water/wetlands (5.1 %) (Table 8). In the Fishkill Creek watershed from 1995 to 2000, the largest percentage increase was in urban land use with a 111 percent change (Table 9). There were also considerable percent increases over the five-year period in commercial and outdoor recreation land uses with 52 and 46 percent change, respectively (Table 9). Finally, there was a 21 percent decrease in the percentage of agricultural land uses (Table 9).

Table 6. Land Use in the Fishkill Creek Watershed.
(Source: DCEMC GIS Lab digitized from March 2000 Aerial Photography, 2003)

Land Use Category	Percentage (%)
Agriculture	10.7
Urban/Commercial	1.3
Extractive	0.7
Forestland	49.8
Industrial	0.6
Outdoor Recreation	2.4
Public/Semipublic	1.2
Residential	21.1
Transportation	1.5
Inactive	1.8
Water/Wetlands	8.9
TOTAL	**100**

Table 7. Land Use in the Dutchess County Portion of Fishkill Creek Watershed.
(Source: DCEMC GIS Database, Derived from Fishkill Creek Watershed
Land Use Cover, Based on Dutchess County Aerial Photography, 2003)

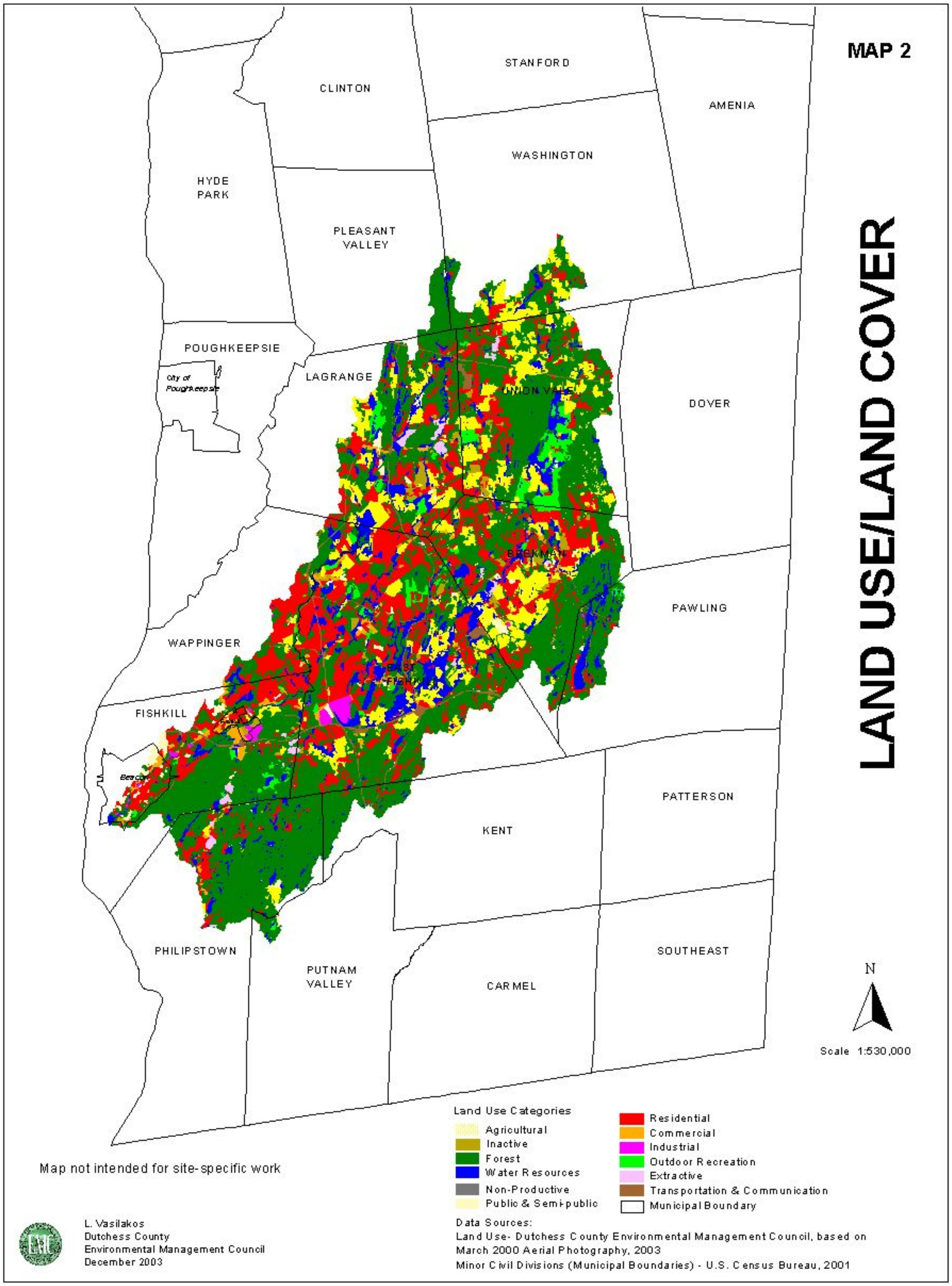
Land Use Category	Percentage (%)
Agriculture	11.8
Urban/Commercial	1.4
Extractive	0.7
Forest	45.8
Industrial	0.6
Outdoor Recreation	2.7
Public	1.2
Residential	22.7
Transportation	1.7
Inactive	2.0
Water/Wetlands	9.3
TOTAL	**100**

Table 8. Land Use in the Putnam County Portion of Fishkill Creek Watershed. (Source: DCEMC GIS Database, Derived from Fishkill Creek Watershed Land Use Cover, Based on Putnam County Aerial Photography, 2003)

Land Use Category	Percentage (%)
Agriculture	1.5
Urban/Commercial	0.8
Extractive	0.7
Forest	82.4
Outdoor Recreation	0.2
Public	0.6
Residential	8.5
Transportation	0.2
Inactive	0.1
Water/Wetlands	5.1
TOTAL	**100**

Table 9. Land Use Comparison for the Fishkill Creek Watershed from 1995 to 2000. (Source: Dutchess County Environmental Management Council, 2003)

LAND USE CATEGORY	ACRES 1995	ACRES 2000	ACRES DIFF	PCT 1995 (%)	PCT 2000 (%)	PCT DIFF (%)	PCT CHANGE (%)
Agricultural	16585	13139	-3446	15.0	11.8	-3.2	-20.8
Commercial	999	1518	519	0.9	1.4	0.5	51.9
Extractive	583	764	182	0.5	0.7	0.2	31.2
Forest	52652	50839	-1813	47.6	45.8	-1.8	-3.4
Industrial	654	701	47	0.6	0.6	0	7.2
Outdoor Recreation	2016	2946	931	1.8	2.7	0.9	46.2
Public & Semi-public	1234	1384	150	1.1	1.2	0.1	12.2
Residential	21850	25177	3327	19.8	22.7	2.9	15.2
Transportation & Communication	1800	1885	85	1.6	1.7	0.1	4.7
Urban (Transitional)	1051	2216	1165	0.9	2.0	1.1	110.9
Water & Wetlands	11169	10354	-815	10.1	9.3	-0.8	-7.3


MAP 2
LAND USE/LAND COVER
STANFORD
CLINTON
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
FISHKILL
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
N
Scale 1:530,000
Land Use Categories
Agricultural
Inactive
Forest
Water Resources
Non-Productive
Public & Semi-public
Residential
Commercial
Industrial
Outdoor Recreation
Extractive
Transportation & Communication
Municipal Boundary
Map not intended for site-specific work
L. Vasilakos
Dutchess County
Environmental Management Council
December 2003
Data Sources:
Land Use- Dutchess County Environmental Management Council, based on March 2000 Aerial Photography, 2003
Minor Civil Divisions (Municipal Boundaries) - U.S. Census Bureau, 2001

Surface Water

The Fishkill Creek is the watershed's major stream beginning in the town of Union Vale and flowing ~ 35 miles southwest until it empties into the Hudson River in the City of Beacon. The Fishkill Creek is fed by approximately 338 miles of tributaries including Sprout Creek, Jackson Creek, Whortlekill Creek, Whaley Lake Stream, Wiccopee Creek, and Clove Creek (Maps 1, 3). The Sprout Creek is a major tributary of the Fishkill Creek draining large sections of La Grange, Union Vale, and small portions of Wappinger and East Fishkill. Jackson Creek drains a large portion of Union Vale and small portions of La Grange and Beekman. The Whortlekill Creek, located in the central part of the watershed, drains sections of La Grange, Beekman and East Fishkill. Whaley Lake Stream drains sections of Union Vale, Beekman and Pawling. The Wiccopee Creek drains the towns of East Fishkill, Fishkill and Kent. The Clove Creek drains a section of the town of Fishkill in Dutchess County and the towns of Philipstown and Putnam Valley in Putnam County.

Fishkill Creek discharge at Beacon, NY ranged from a high of 6,970 cubic feet per second on August 20, 1955 to a low of 1.1 cubic feet per second on September 12, 1964 (USGS, 2003). Annual discharge at the Fishkill Creek gauging station in Beacon decreased during the gauge's period of operation, 1945 through 1967 (Figure 3). However, discharge from the Fishkill Creek gauging station in Hopewell Junction showed an increase in average annual discharge during the period of operation between 1964 through 1975 (Figure 4).

Figure 3: Fishkill Creek Average Annual Discharge, Beacon - 1945-1967

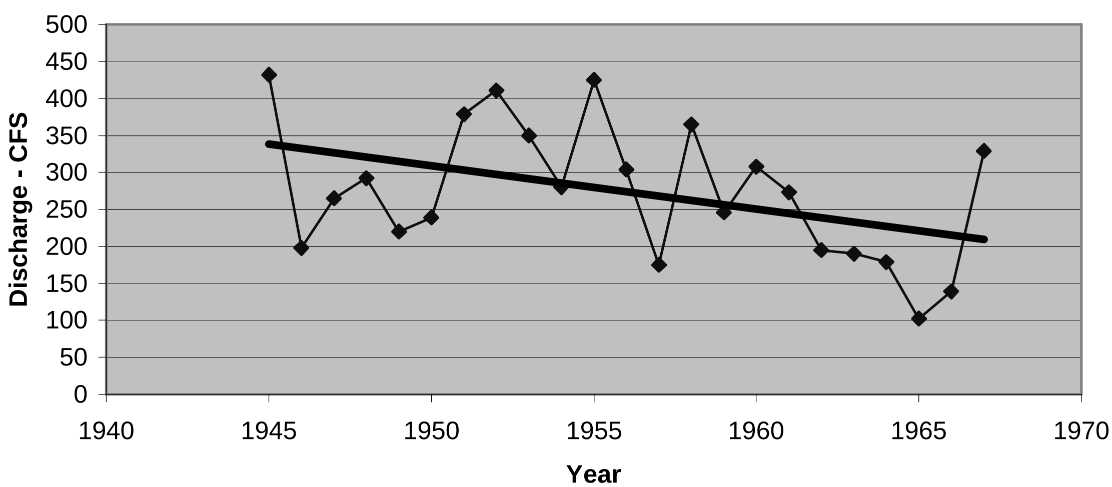
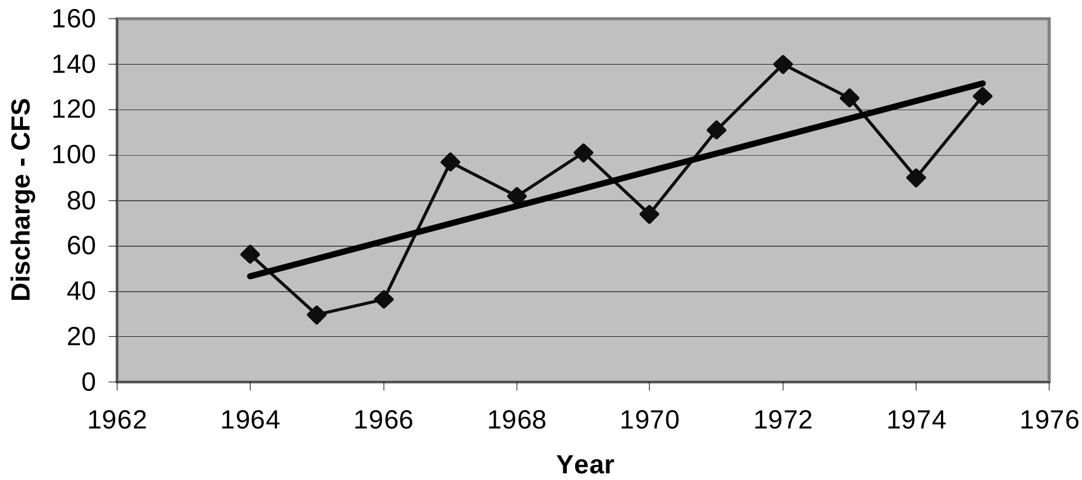
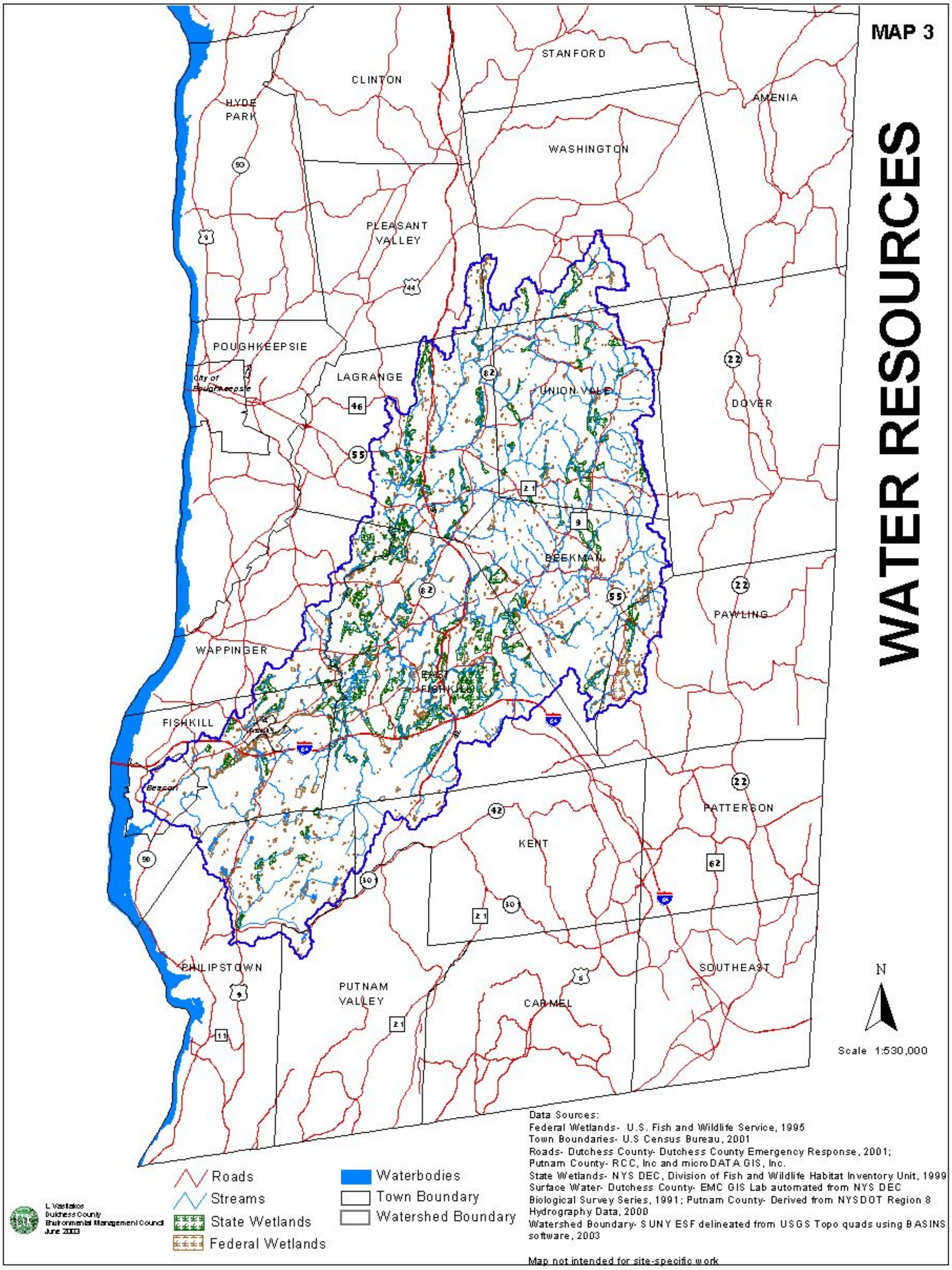


Figure 4: Fishkill Creek Average Annual Discharge, Hopewell Junction - 1964-1975



Figures 3 and 4 are meant to demonstrate the fluctuations that naturally occur in stream discharge. The discharge is primarily driven by precipitation, but land uses can dramatically alter the hydrologic cycle. Unfortunately, the United States Geological Survey removed the last gauge in the Fishkill watershed in 1975, so tracking the impacts of increasing development and impervious surfaces will be difficult. Precipitation will remain the primary driver of stream discharge, but increasing water withdrawals, increasing impervious surfaces and resulting infrastructure, and global climate change will undoubtedly affect the Fishkill Creek in coming years. Impacts of global warming on stream flows are poorly understood, but will vary over space and time. Due to seasonal changes in precipitation and temperature, stream flows may decrease during some months and increase during others (Tung and Haith, 1995). In any case, climate change due to increases in atmospheric CO_2 and other gases are likely to substantially impact water resources. Predictions have been made, based on hydrologic and demographic statistics, that the Sprout and Fishkill basins will experience zero flow periods of seven consecutive days with a ten year occurrence interval by the year 2035 (Horsley and Witten, 1992). These impacts are predicted to occur due to large withdrawals for water supply and export of wastewater for discharge to the Hudson River. It would be prudent to update this study based on current demographics and water supply plans.

The discharge in the Fishkill ranges from 2 to 11 cubic meters/second (Stevens et al., 1994), and the average Hudson River discharge below the Federal Dam at Troy is approximately 392 cubic meters/second (Limburg et al., 1986). Knowing this, the Fishkill Creek contributes approximately 0.5 to 2.8 percent of the freshwater flow to the Hudson River. The percentage of freshwater flow may not be significant, but the transported pollutants could impact the Hudson River ecosystem.


MAP 3
WATER RESOURCES
STANFORD
CLINTON
AMENIA
HYDE PARK
WASHINGTON
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
N
Scale 1:530,000
Roads
Streams
State Wetlands
Federal Wetlands
Waterbodies
Town Boundary
Watershed Boundary
L. Vasilakos
Dutchess County
Environmental Management Council
June 2003
Data Sources:
Federal Wetlands- U.S. Fish and Wildlife Service, 1995
Town Boundaries- U.S Census Bureau, 2001
Roads- Dutchess County- Dutchess County Emergency Response, 2001;
Putnam County- RCC, Inc and microDATA GIS, Inc.
State Wetlands- NYS DEC, Division of Fish and Wildlife Habitat Inventory Unit, 1999
Surface Water- Dutchess County- EMC GIS Lab automated from NYS DEC
Biological Survey Series, 1991; Putnam County- Derived from NYSDOT Region 8
Hydrography Data, 2000
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS
software, 2003
Map not intended for site-specific work

The watershed has approximately 1,575 acres of lakes and ponds ranging in size from one-tenth of an acre to 252 acres (Map 3). The New York State Department of Environmental Conservation classifies surface waters based on their best usages (Table 10 and appendix IV). Waterbodies exceeding 20 acres (smallest to largest) include Beacon Reservoir (Town of Fishkill), Deer Lake, Hillside Lake, Lake Valhalla (Town of Philipstown), Lake Walton, Beaver Lake, Little Whaley Lake, Nuclear Lake, Tyrell Lake, Sylvan Lake and Whaley Lake (Table 11).

Table 10. Water Quality Classifications and Standards of Quality and Purity (Source: NYSDEC, 1991)

Part 701- Classification (freshwater)	
N	Natural – Drinking (no disposal of sewage allowed)
AA-S	Drinking (no disposal of sewage allowed)
A-S	Drinking (International boundary waters)
AA	Drinking (disinfection required)
A	Drinking (coagulation, sedimentation, filtration and disinfection required)
B	Bathing – primary contact recreation
C	Secondary contact recreation – fishing and boating; will support fish propagation
D	Fishing; will not support fish propagation
Part 703 - Standards of Quality and Purity	
(T)	indicates a waterbody that will support trout survival
(TS)	indicates a waterbody that will support trout spawning
	Chemicals, pH, bacteria, and turbidity are also regulated

Table 11. Waterbodies Greater Than 10 Acres in the Fishkill Creek Watershed (with the exception of Furnace Pond) (Source: Dutchess County Environmental Management Council GIS Database- Dutchess County data for waterbodies automated from NYS DEC Biological Survey Series, 1991; Putnam County data derived from NYSDOT Region 8 Hydrography data, 2000)

Waterbody Name	DEC Code	Area (acres)	Municipality	DEC Classification
Unnamed Pond or Lake	unknown	10.17	Philipstown	Unknown
McKinney Pond	H-95-P357	10.26	Unionvale	C(T)
Jordan Pond	unknown	11.06	Philipstown	Unknown
Pray Pond	H-95-P359	11.19	Unionvale	C(T)
Tributary of Wiccopee Creek	H-95-13-1a-P350aa	11.32	East Fishkill	D
Christie Pond	H-95-24-P358a	11.48	Unionvale	C
Tributary of Wiccopee Creek	H-95-13-2-2-P350e	17.84	East Fishkill	D
Tributary of Whaley Lake Brook	H-95-19-3-P351h	18.39	Beekman	A
Barrett Pond	unknown	18.49	Philipstown	Unknown
Beacon Reservoir	H-95-2-P345	20.25	Fishkill	A
Beacon Reservoir	H-95-2-P-345	23.09	Philipstown	A
Unnamed pond	H-95-7-P5237	23.42	Fishkill	Unknown
Hillside Lake	P345g	26.36	East Fishkill	B
Tributary of Fishkill Creek, unnamed pond	H-95-11a-1-P345w	27.44	East Fishkill	D
Lake Valhalla	H-95-5-2-P345k	29.15	Philipstown	A
Unnamed pond of Wiccopee Creek	H-95-10-13-P5695	32.85	Unionvale	Unknown
Lake Walton	H-95-11a-P345y	41.31	East Fishkill	B
Unnamed pond	H-P5235	41.55	Fishkill	Unknown
Little Whaley Lake	H-95-19-P353-1-P354	44.1	Pawling	B
Unnamed pond of Whaley Lake Brook	H-95-19-4a-P5222	49.27	Pawling	D
Tyrell Lake	H-95-10-10-P348o	49.44	Pleasant Valley	C
Furnace Pond	H-95-P356	8.7	Unionvale	C(T)
Sylvan Lake	P352	116.09	Beekman	B
Whaley Lake	H-95-19-P353	252.04	Pawling	B

Beacon Reservoir

This 20.2-acre reservoir is located adjacent to Mount Beacon Monument Road in the town of Fishkill. Beacon Reservoir is located less than one-tenth of a mile from the Dutchess/Putnam County boundary. In 2004, the reservoir was surrounded entirely by forest. This reservoir provides drinking water for the City of Beacon and may provide ideal habitat for many plants and animals due to its intact-forested surroundings.

Deer Lake

Deer Lake is a 23.4-acre man-made lake on the Sharpe Reservation property in the town of Fishkill. Totaling 227.3 acres, the lake's watershed is surrounded primarily by forest with some recreation and residential land uses. The elevation of the lake is 732 feet above sea level. A water quality study conducted by Grim (1996) indicated high turbidity with visibility up to 6.5 feet (maximum lake depth- 26 ft). Water chemistry tests revealed concentrations of nitrate, total phosphorus and total dissolved solids of 0.09

mg/L, 0.12 mg/L, and 142 mg/L, respectively (Grim, 1996). Deer Lake exhibited a neutral pH of 7.0, and dissolved oxygen levels ranging from 2.0 to 10.0 mg/L. The lake's fish population was diverse consisting of largemouth bass, brown bullhead, pumpkinseed, bluegill and yellow perch (Grim, 1996). Phytoplankton and zooplankton were prevalent in the lake and consisted of diatoms, filamentous cyanobacteria, chlorophytes, chrysophytes, rotifers, cladocerans, cyclopoid copepodids and copepod nauplii (Grim, 1996).

Hillside Lake

Hillside Lake is a 26.4-acre lake in the Town of East Fishkill that is the centerpiece of a park district. In 2000, the lake's surrounding land use was predominantly residential with some forested land south of the lake. The lake is in close proximity to two state-regulated wetlands including HJ-73, a Class 3, 85.2-acre wetland and HJ-9, a Class 2, 40.5-acre wetland. The NYS DEC has designated this lake as a priority water body and has placed it on the State's priority water body list due to water quality problems. Efforts are ongoing to remediate the problems in the lake.

Lake Valhalla

Lake Valhalla is a 29.1-acre lake located in the Town of Philipstown. In 2003, the lake was surrounded by two federally regulated wetlands consisting of lacustrine unconsolidated bottom and palustrine forest. The lacustrine unconsolidated bottom wetland totaled 31.1 acres, and is diked/impounded and permanently flooded. The palustrine-forested wetland is 4.6 acres and is seasonally flooded.

Lake Walton

Lake Walton is a 41.3-acre lake located in the Town of East Fishkill. In 2000, land use surrounding the lake was quite diverse consisting of primarily forest (251.2 acres) with some recreation (14.2 acres), and residential (34.7 acres) land uses. Sections of a state-regulated wetland classified as HJ-15 (200-acres, Class 1) are located northeast and south and southwest of the lake. Ranging in size from 0.21 to 21.8 acres, federally regulated wetlands overlap HJ-15. The wetlands consist of palustrine scrub shrub, palustrine forested, palustrine emergent marsh and palustrine unconsolidated bottom. There is also a small section of agricultural land northeast of lake Walton. The lake is characterized as eutrophic and has a high abundance of native and invasive aquatic plants. Recently, most of the land was purchased and plans are underway to subdivide the area to possibly construct homes.

Beaver Lake

Beaver Lake is a 41.5-acre man-made lake on the Sharpe Reservation property in the town of Fishkill. In 2000, the lake's watershed, totaling 177.4 acres, was surrounded by forest and recreation land uses. The lake contained a variety of fish species including largemouth bass, brown bullhead, white perch, banded killifish, and bluegill (Grim, 1996). Plankton communities were comprised of both phytoplankton and zooplankton species. The dominant phytoplankton species consisted of diatoms, chlorophytes and the chrysophyte dinobryon (Grim, 1996). The dominant zooplankton species included rotifers, ciliated protists and dinoflagellates (Grim, 1996). Turbidity of the lake was 7.2 feet (maximum lake depth- 33 feet) indicating low water clarity. Water quality analyses indicated a nitrate concentration of less than 0.05 mg/L, total phosphorus concentration of less than 0.05 mg/L and total dissolved solids of 180 mg/L (Grim, 1996). Beaver Lake also exhibited a pH of 7.1 and dissolved oxygen levels ranging from 3 to 9 mg/L (Grim, 1996).

Little Whaley Lake

Refer to Significant Area section for description

Nuclear Lake

Nuclear Lake is a 49.3-acre lake located on a 1,137-acre parcel in the towns of Pawling and Beekman. The National Park Service owns the entire parcel. The lake's watershed is located in the eastern section of the Fishkill Creek drainage basin with the west and north edges of the property draining into Gardner Hollow Brook. An outlet stream flows from the southern end of the lake in a westerly direction passing through several wetlands. These wetlands form a connection with wetlands in the Whaley Lake watershed. The bedrock geology of the lake property is primarily schist and gneiss. Soils within the area are mostly derived from glacial till and are acidic with the exception of wetland and calcareous soils (Nuclear Lake Management Site Clearance Subcommittee, 1982). The wetland soils are composed of fine material and more plant organic material than the till soils. In the southwestern section of the property, calcareous soils derived from carbonate rock outwash and alkaline are present in small areas (Nuclear Lake Management Site Clearance Subcommittee, 1982). The lake surface elevation is 758 feet with steep slopes greater than 15% throughout most of the area (Nuclear Lake Management Site Clearance Subcommittee, 1982).

This lake is recognized locally for its scenic beauty, diversity of plant life, and public access. The terrestrial vegetation is comprised predominantly of hardwood forest supporting white oak, red oak, hemlock, tulip tree, black birch, flowering dogwood, witch-hazel, mountain laurel and other trees and shrubs (Nuclear Lake Management Site Clearance Subcommittee, 1982). Wetland vegetation includes, but is not limited to red maples, yellow birch, alder, royal fern, skunk cabbage, and tussock sedge. Purple loosestrife, cattail and alder occur along the lake shoreline. The lake also serves as an ideal habitat for birds, mammals, reptiles, amphibians and fish. Mammals that utilize this area include beaver, eastern chipmunk, woodchuck, bobcat and whitetail deer. Reptiles and amphibians include snapping turtles, painted turtles and spring peepers. Fish commonly found include northern pike, chain pickerel, creek chub sucker, brown bullhead, white perch, pumpkinseed, bluegill, largemouth bass, yellow perch, and possibly brown and brook trout (Nuclear Lake Management Site Clearance Subcommittee, 1982). The lake is prime habitat for migratory waterfowl in the early spring and late fall. The Ralph T. Waterman Bird Club sited sixty-four bird species including great blue heron, black-capped chickadee, belted kingfisher, warblers, woodpeckers, water thrushes, and sparrows. The lake is a prime recreational area for hikers due to the presence of the Appalachian Trail along the lakeshore.

In December of 1972, two chemical explosions accidentally occurred in the Plutonium Laboratory Building located on the property. The explosions resulted in the release of small amounts of plutonium and uranium material to the atmosphere, building's interior, and surrounding soils (National Park Service, 1993). Following a clean up of the radioactive contamination, the facility ceased operations, and in 1979 the National Park Service purchased the property as part of the Appalachian Trail. In 1993 the National Park Service recommended further nuclear decontamination and site restoration so the entire site could be opened to the public. In 1994, the final clean up was completed and the park was opened to the public.

Tyrell Lake

Tyrell Lake is a 49.4-acre lake located in the town of Pleasant Valley. In 2000, the surrounding land use was primarily forestland, with some residential use (15.5 acres) in the northeast corner and recreation (13.8 acres) land use in the northwest corner. VB-43, a 21.2-acre, Class 2 designated New York State regulated wetland is contiguous to the lake and extends southward. United States Fish and Wildlife Service wetland classification types adjacent to the lake include lacustrine unconsolidated bottom, palustrine scrub shrub, palustrine forested, and palustrine emergent marsh. Pond Gut Creek, a perennial Class C(t) designated stream flows from the southern outlet of the lake connecting to subtributaries of the Sprout Creek. This lake is located in close proximity to the Taconic-Hereford State Forest, a 909-acre multiple use area. It is also less than a mile from Innisfree Gardens, which includes 200 acres of landscaped gardens inspired by Chinese concepts.

Sylvan Lake

Located in the town of Beekman, Sylvan Lake is the second largest lake in the Fishkill Watershed. The lake covers 116-acres with a watershed of 0.81 square miles. It is also the deepest lake in Dutchess County with a maximum depth of 140 feet. In 2000, land uses surrounding the lake were mixed, consisting of residential, outdoor recreation, and interspersed forestland. HJ-13, a Class 2, state-regulated wetland totaling 91.4 acres is adjacent to the lake. Eighteen smaller federally regulated wetlands overlap HJ-13 and continue south forming a connection with the main stem of the Fishkill Creek. The types of federally regulated wetlands consist of lacustrine unconsolidated bottom, palustrine forested, palustrine unconsolidated bottom, palustrine scrub shrub and palustrine aquatic bed. The lake supports fish species including largemouth bass, chain pickerel, cisco (lake herring), and panfish.

Whaley Lake

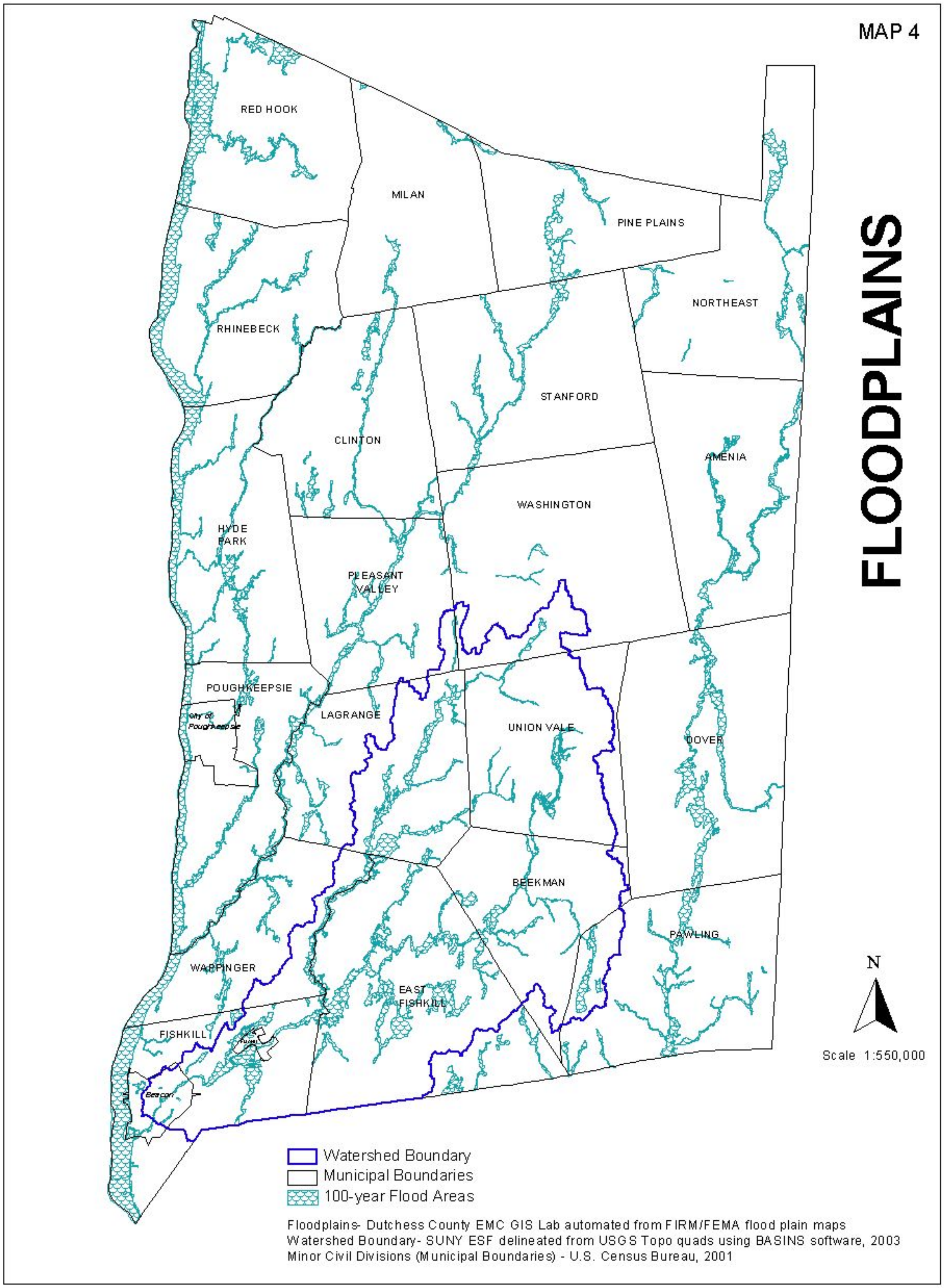
Located in the town of Pawling, the 252-acre Whaley Lake is the largest lake in the Fishkill Creek watershed and Dutchess County. A dam was constructed between 1837 and 1838 (Johnson, 2000) to enclose the pond that was already present. The dam was used to impound water used by several mills located downstream on the Fishkill Creek. The mills, which benefited from the dam, were Brandley Dye Works, the Groveville Mill, the Dutchess Hat Works and the New York Rubber Company (Johnson, 2000). In 2000, the surrounding land uses consisted of residential (~200 acres) and public/semipublic (~20 acres) land interspersed with forest. Whaley Lake's watershed encompasses 3.7 square miles and includes Little Whaley Lake, Sunset Lake and Willow Lake.

The aesthetic and ecological health of Whaley Lake was assessed through the Citizens Statewide Lake Assessment Program (CSLAP) from 1998 to 2001, a volunteer lake monitoring program conducted by the NYSDEC and NYS Federation of Lake Associations. Water quality parameters were measured in order to characterize the trophic state of the lake. The mean concentrations for total phosphorus, chlorophyll a concentrations and sechi depth clarity were 0.013 mg/L, 7.8 ug/L, and 3.2 m, respectively (Kishbaugh, S. and B. Hohenstein, 2000). Based on these water quality measurements, Whaley Lake was characterized as a mesotrophic or moderately productive lake. Other water quality parameters measured included pH, conductivity, color and nitrate. These parameters indicated that the lake continued to support most aquatic organisms. Animals that utilized the area included beaver, muskrat, turtles and frogs. Fish species included largemouth bass, chain pickerel, yellow perch, brown bullhead and panfish. Aquatic plants included Eurasian watermilfoil (invasive), coontail, Illinois pondweed, Robbins' pondweed and large leaf pondweed. Since 1998, recreational perception improved from slightly impaired to closer to excellent, probably coinciding with the decrease in weed densities (Kishbaugh, S. and B. Hohenstein, 2000). However, the recent introduction of two invasive species including Eurasian watermilfoil and curly-leaf pondweed are cause for concern.

Floodplains

Floodplains perform many important functions, including the temporary storage of floodwaters, the moderation of peak flows, the maintenance of water quality, the recharge of groundwater, and the prevention of erosion. Floodplains also provide habitat for wildlife, recreational opportunities, and aesthetic benefits. The preservation of floodplains and associated wetlands is very important for watershed health.

The Federal Emergency Management Administration (FEMA) Flood Insurance Rate Maps (FIRM) provides detailed floodplain data. Floodplain maps show areas within a 100-year flood boundary, as defined as an area that has a 1 percent chance or greater probability of the flood stage being reached, or exceeded, in any given year. Floodplains within the Dutchess County portion of the Fishkill watershed consist of A zone (A, AE, and AO zones) floodplains (Map 4). Floodplains characterized as zone A are commonly found along lakes, streams, rivers or other watercourses and subject to 100-year floods. In addition, zone A floodplains are areas with base flood elevations and flood hazard factors not determined. Zone AE are subject to 100-year floods with known base flood elevations. Zone AE include non-tidal floodplain areas that consist of floodway (high velocity water) or floodway fringe (low velocity water) along streams or rivers. Zone AO are subject to 100-year shallow flooding. Within the Dutchess County portion of the watershed, there are 227.4 square miles of floodplains (Map 4). Digital data was not available for the Putnam County portion of the watershed.


MAP 4
FLOODPLAINS
RED HOOK
MILAN
PINE PLAINS
RHINEBECK
NORTHEAST
STANFORD
CLINTON
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
N
Scale 1:550,000
Watershed Boundary
Municipal Boundaries
100-year Flood Areas
Floodplains- Dutchess County EMC GIS Lab automated from FIRM/FEMA flood plain maps
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software, 2003
Minor Civil Divisions (Municipal Boundaries) - U.S. Census Bureau, 2001

State Pollution Discharge Elimination System (SPDES)

Under Article 17 (Water Pollution Control) of the Environmental Conservation Law (ECL), the State Pollution Discharge Elimination System (SPDES) permit program was instituted to work towards the elimination of pollution and maintain the highest quality of New York's water resources. The goals of instituting the program were to protect public health, enhance public enjoyment of water resources, protection and propagation of fish and wildlife and industrial development. Regulated activities under the program include construction or use of an outlet or discharge pipe ("point source") that discharges wastewater into the surface waters or ground waters of the state. Additionally, construction or operation of a disposal system, such as a sewage treatment plant, and discharge of stormwater require a SPDES permit. Permits are required for discharges of more than 1,000 gallons per day to surface and ground waters. Discharges to groundwater containing sewage, non-sewage or non-industrial wastes fewer than 1,000 gallons per day require approval from city, county or state health departments.

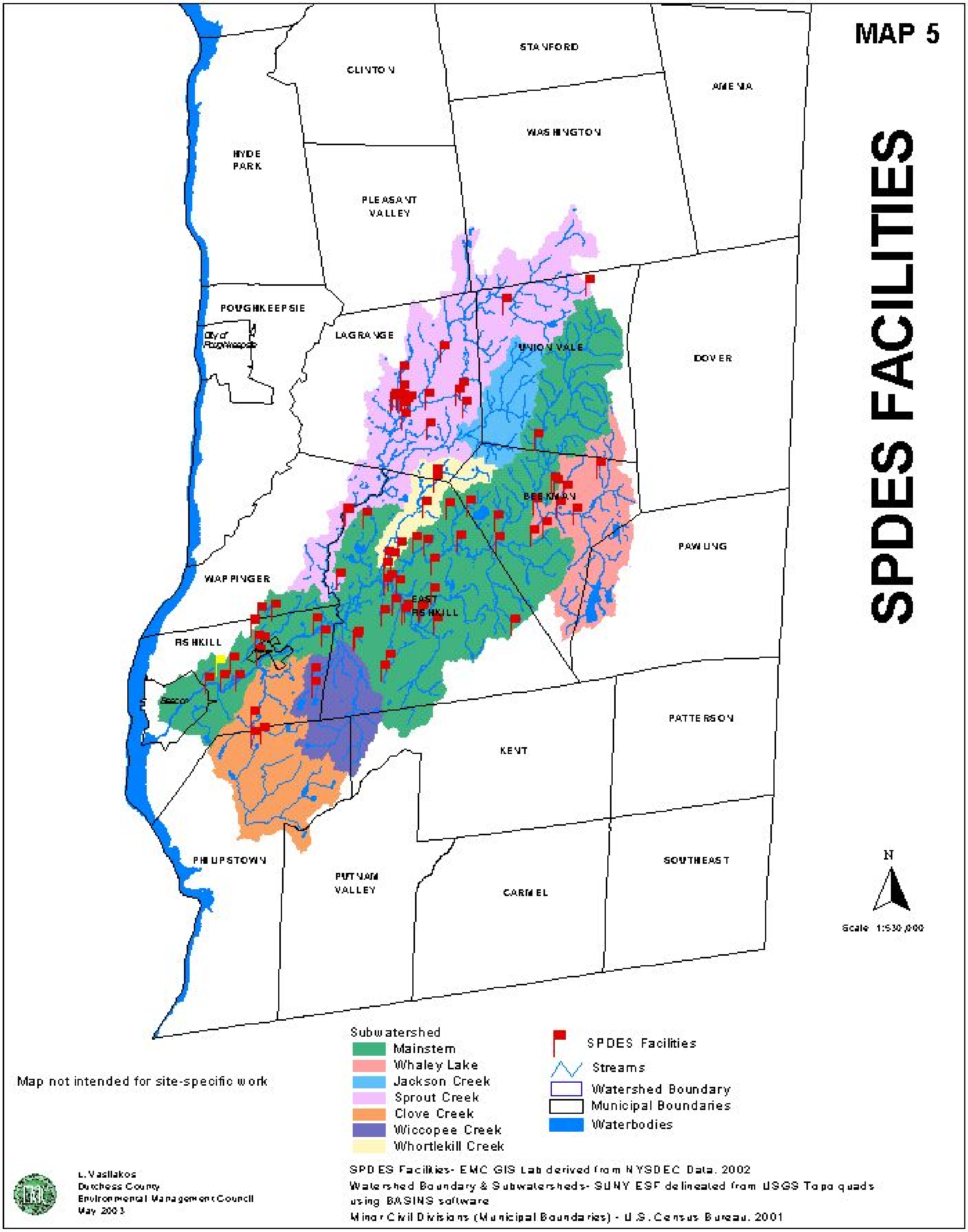
In 2002, the Fishkill Creek watershed contained 25 SPDES regulated facilities discharging to surface water and 64 facilities to ground water (Map 5, Tables 12 & 13). The location of SPDES facilities was determined using Geographic Information System (GIS) software. Surface water discharging facilities were geographically located by latitude and longitude information provided by the NYSDEC. Ground water facilities were determined by comparing NYSDEC data (permittee name, permittee address, contact information) with parcel information provided by the Dutchess County Real Property Tax Service and Putnam County Department of Planning.

Table 12. Fishkill Creek Watershed *Surface* Water SPDES Discharge Sites
(Source: DCEMC GIS Database, Developed from NYSDEC SPDES data layer, 2002)

SPDES Number	Facility Name	Municipality	Waterbody Name	DEC Classification
0032972	Chelsea Cove WWTP	Beekman	Sylvan Lake Outlet (H-95-14)	B
0164933	Dover Ridge Estates- Sections 1 & 2	Beekman	Gardiner Hollow Bk Trib (H-95-19-3-3)	A
0214531	Dalton Farms Sewage Treatment Plant	Beekman	Whaley Lake Brook (H-95-19)	C(TS)
0071153	Green Haven Correctional Facility	Beekman (T)	Fishkill Creek (H-95)	C(T)
0005096	IBM East Fishkill Facility	East Fishkill	Wiccopee Creek (H-95-8)	C(T)
0035939	Stormville/East Fishkill Rest Areas	East Fishkill	Wiccopee Creek Trib (H-95-13-2)	C
0037281	Beekman Country Club Subdiv Sewage TP	East Fishkill	Fishkill Creek Trib (H-95-13A)	C
0207888	Twin Creeks Development	East Fishkill	Fishkill Creek (H-95)	B(T)
0208299	Wildflower Hills Stp	East Fishkill	Wiccopee Creek (H-95-13)	C(T)
0249815	East Fishkill Facility	East Fishkill	Wiccopee Creek (H-95-13-1)	C
0263982	Sagamor WWTP	East Fishkill	Sylvan Lake Outlet (H-95-14)	B
0084301	Hopewell Inn	East Fishkill (T)	Whortlekill Creek (H-95-12)	C(TS)
0090093	Royal Inn	East Fishkill (T)	Wiccopee Creek (H-95-13)	C(T)
0005754	Texaco at Beacon	Fishkill (T)	Fishkill Creek (H-95)	C
0024848	Mountain View Apts.	Fishkill (T)	Fishkill Creek Trib. (H-95-3B)	C
0084298	Bardo's Fishkill Motor Inn	Fishkill (T)	Forge Brook (H-95-4)	C
0208400	Resident Subhqtrs.- Fishkill	Fishkill (T)	Clove Creek (H-95-5)	C(TS)
0264237	Fishkill/East Fishkill Joint Landfill	Fishkill (T)	Bloomer Creek Trib (H-95-7-2)	C
0060992	Fishkill (V) Sewage Treatment Plant	Fishkill (V)	Fishkill Creek (H-95)	B(T)
0105457	Service Station- Rt. 55 & Taconic	LaGrange	Sprout Creek (H-95-10)	C(T)
0250031	Ryan Oil, Inc.	LaGrange	Jackson Creek Trib (H-95-10-2-5B)	C
0248282	Billings Plant	LaGrange	Sprout Creek Sub Trib (H-95-10-70-1)	C(TS)
0219002	Tymor Park	Union Vale	Fishkill Creek (H-95)	C(T)
0103829	Cooper Road Trailer Park	Wappinger	Fishkill Creek Trib (H-95-4-1)	C
0076066	182 Old Rt. 9 Warehouse	Wappinger (T)	Fishkill Creek Subtrib (H-95-4-1)	C

Table 13. Fishkill Creek Watershed *Groundwater* SPDES Discharge Sites
(Source: DCEMC GIS Database, Developed from NYSDEC SPDES data layer, 2002 and parcel data from the Dutchess County Real Property Tax Service and Putnam County Department of Planning)

SPDES	Parcel Number	Facility Name	Municipality	Waterbody Name
0207977	6161-08-837825	Roseview Farms/Mursellos Food Market	Beekman	GW-Gardner Hollow Brook
0250015	6558-03-262285	Town Plaza	Beekman	Groundwater
0142174	6759-04-685204	Claudio's Restaurant Inc	Beekman	Groundwater
0079847	6759-00-876096	Pine Grove Motel	Beekman	Groundwater
0076015	6758-02-725770	Beekman Fire Dist Fire House	Beekman	Groundwater
0249891	6658-00-507504	Lake Plaza	Beekman	Groundwater
0208469	6758-00-203186	Lime Ridge Farms	Beekman	Groundwater
0234354	6758-00-421355	Sugar Maple Farm	Beekman	Groundwater
0073121	6259-02-635855	Hopewell Gardens Inc.	East Fishkill	Groundwater
0207543	6559-03-327315	Arthursburg Plaza	East Fishkill	Groundwater
0185027	6558-01-098780	Hopewell Precision	East Fishkill	Groundwater
0248312	6558-02-547736	Swiss Hamlet Recreation Area	East Fishkill	GW-Sylvan Lake Brook
0250643	6358-02-561646	Lot 3-376 Business Park	East Fishkill	GW-Sprout Creek
0250490	6358-02-533640	Lot 1 - 376 Business Park	East Fishkill	GW-Sprout Creek
0250635	6358-02-535612	Lot 2 - 376 Business Park	East Fishkill	GW-Sprout Creek
0250651	6358-02-562615	Lot 4 - 376 Business Park	East Fishkill	GW-Sprout Creek
0063959	6358-02-911567	Super Seven Plaza	East Fishkill	Groundwater
0185604	6458-04-887068	Clove Branch Apts.	East Fishkill	GW-Fishkill Creek
0095800	6457-01-371939	Red Wing Park Wastewater Disposal Facility	East Fishkill	Groundwater
0145467	6457-02-591969	A Kessler Mobile Homes	East Fishkill	Groundwater
0145688	6457-01-470744	Stockyard Restaurant	East Fishkill	GW-Whortlekill
0250236	6557-01-235639	Muscoot Restaurant North	East Fishkill	Groundwater
0185426	6457-01-328570	Grand Union Plaza	East Fishkill	GW-Fishkill Creek
0165654	6357-03-385343	Tots n Us	East Fishkill	GW-Fishkill Creek Tributary
0164917	6557-03-242048	Lechambord Restaurant & Inn	East Fishkill	GW-Fishkill Creek Tributary
0248444	6456-01-249613	Cinnamon Tree Day Care	East Fishkill	GW-Pennywater Pond
0247880	6455-00-300810	Maintenance Facility- East Fishkill	East Fishkill	GW-Fishkill Creek Tributary
0215481	6556-01-036716	Concord Office Park	East Fishkill	GW-Wiccopee Creek Tributary
0219037	6456-02-988681	Taconic Plaza	East Fishkill	Groundwater
0142026	6456-02-680640	Probst Stores	East Fishkill	Groundwater
0142352	6456-01-463820	East Fishkill Corporate Park	East Fishkill	Groundwater
0068471	6158-10-260574	BGB Mobile Homesites	Fishkill (T)	Fishkill Creek Subtributary
0066656	6256-04-931444	Fishkill Bowling Alley	Fishkill (T)	Groundwater
0250678	6156-04-717443	Splash Down Park	Fishkill (T)	GW-Wetland WF-11
0142638	6156-04-718417	Southern Dutchess Derby Inc	Fishkill (T)	GW-Green Fly Swamp
0165875	6356-03-107207	Administration Bldg	Fishkill (T)	Groundwater
0078417	6055-01-182629	Glenham Elementary School	Fishkill (T)	Groundwater
0185779	6155-01-306679	Professional Office Bldg.	Fishkill (T)	Fishkill
0185817	6255-00-885170	Sharpe Reservation	Fishkill (T)	GW-Fishkill Creek Tributary
0149284	6154-00-683590	Snow Valley Mobile Home Park	Fishkill (T)	Clove Brook
0207870	6160-04-801372	Billings Plaza	LaGrange	GW-Sprout Creek Tributary
0249874	6261-04-868334	Manchester Shopping Center	LaGrange	Groundwater
0235431	6460-01-480927	LaGrange Town Center	LaGrange	Groundwater
0248321	6460-02-678933	Villa Marissa Restaurant	LaGrange	Gw-Sprout Creek
0185051	6460-02-611894	The Full Gospel Center	LaGrange	Groundwater
0143588	6460-02-702756	Elliott Apts	LaGrange	Groundwater
0081035	6260-02-510715	Freedom Park (Rest Rooms)	LaGrange	Groundwater
0235181	6460-02-701540	Arlington High School	LaGrange	GW-Sprout Creek
0250783	6460-04-877280	Coach House Restaurant	LaGrange	GW-Southorly Pond
0248142	6559-03-316413	LaGrange Commons Shopping Center	LaGrange	GW-Whortlekill Creek
0235199	6461-04-668121	Arlington High School	LaGrange	GW-Sprout Creek Tributary
0166588	6460-02-521968	Freedom Business Center	LaGrange	Groundwater
0207560	6460-02-604956	Lexington Park	LaGrange	GW-Sprout Creek Tributary
0235245	6560-03-185350	LaGrange Elementary School	LaGrange	GW-Sprout Creek Tributary
0093017	6461-04-713516	James Baird State Park	LaGrange	GW-Sprout Creek
0185396	6163-04-600353	IBM Building #930	LaGrange	Groundwater
0149004	6171-00-912250	Country Side Restaurant	Philipstown	GW-Pond
0219053	5955-02-798930	Pemm Corp.	Philipstown	Groundwater
0008591	no parcel info.	Brookside Trailer Park	Philipstown	GW- Highland Creek
0214914	6662-00-716842	Union Vale Community Residence	Union Vale	GW-Willow Brook
0219592	7164-00-039612	Verbank Ira	Union Vale	Groundwater
0088986	6161-54-192393	Fountains at Millbrook	Union Vale	GW-Sprout Creek Tributary
0145432	6359-03-056187	Mid-Hudson Castle Ltd.	Wappinger (T)	GW- Sprout Creek Tributary
0023931	6258-03-100235	John Jay High School Sewage Treatment Plant	Wappinger (T)	Gildersleeve Brook


MAP 5
SPDES FACILITIES
CLINTON
STANFORD
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
N
Scale 1:530,000
Map not intended for site-specific work
Subwatershed
Mainstem
Whaley Lake
Jackson Creek
Sprout Creek
Clove Creek
Wiccopee Creek
Whortlekill Creek
SPDES Facilities
Streams
Watershed Boundary
Municipal Boundaries
Waterbodies
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003
SPDES Facilities- EMC GIS Lab derived from NYSDEC Data, 2002
Watershed Boundary & Subwatersheds- SUNY ESF delineated from USGS Topo quads using BASINS software
Minor Civil Divisions (Municipal Boundaries) - U.S. Census Bureau, 2001

Dams

The following section, Knowledge flow: a Hudson River Estuary Watershed citizens' tool for ecological discussions about stream barriers and barrier removal, was written by Jesse S. Sayles from the NYSDEC, Hudson River Estuary Program as an overview of the function of dams within stream systems. This section also outlines the rationale and challenges behind restoring the natural flow of a stream.

Introduction

There are at least 350 known dams and many more unknown dams, culverts, and buried stream segments in the Hudson River Estuary watershed (Personal Communication, NYSDEC, March 2005). The Hudson River Estuary Action Plan of 2001 strives to promote local community stewardship of estuary tributaries. As community groups discuss stream barriers they will need supporting information for decision-making. Recently, authors have published many literature reviews about the ecological and geomorphic effects of dams and removal (Bednark, 2001; Hart et al., 2002; Pizzuto, 2002; Poff and Hart, 2002; Shafroth et al., 2002; Stanely and Doyle, 2002; Larke et al., 2003). This article is not intended as another literature review. Instead it will: (1) differentiate between the restoration, rehabilitation, enhancement, protection and conservation studies (2) discuss the ecological effects of barriers and (3) their removal on the stream ecosystem, and (4) conclude with how to use this information for community discussion about barrier mitigation. Important concepts for proceeding from discussion to research and action will be put forward.

Generally there are two types of dams, run of the river and impounding. Run of the river dams store little or no water, have short residence times and little or no control over water release rate (Poff and Hart, 2002). Storage dams have large hydraulic heads and storage volume, long hydraulic residence times and controlled release rates (Poff and Hart, 2002). Culverts are enclosed pipes through which stream flow is directed, and are often used in road crossings or development over a streambed. In buried streams, the stream has been paved or developed over, but stream interactions with soils may still exist.

Field of study differentiation

The concepts of restoration, rehabilitation and enhancement aim at some level of site improvement, while protection and conservation try to maintain what is present (Hambler, 2004). Restoration and rehabilitation have a historic reference point in mind (Shields et al., 2003; Hampler, 2004). In the strictest sense, restoration is achieved only if an original historical reference ecosystem is produced; a partial return to such a reference point, either in form or function, is rehabilitation (Hampler; 2004). In most cases it is not feasible to completely return a site back to an historic reference point due to complex interactions of changes, large-scale environmental change, or species extinction (Ormerod, 2004). Often, even in scientific literature, when one talks about restoration it is actually rehabilitation. Enhancement involves alteration of a site to a non-preexisting state (Lewis, 1989; Gwein et al., 1999).

Ecological effects of stream barriers

Barriers affect river systems; the river, river bed, riparian zone, flood plain, associated ecosystem communities, and temporal legacy, in many ways (Bednark, 2001; Hart et al., 2002). For conceptual facilitation, the affects of barriers will be discussed in four dimensions: longitudinal (up-to-down-stream interactions), lateral (river channel, riparian and floodplain interactions), vertical (benthos, water column, atmosphere and riparian canopy cover interactions) and temporal (biotic and abiotic changes). The literature used in this analysis primarily pertains to dams, but, in most cases, the discussion can be inferred to culverts and buried streams.

Longitudinal interaction effects

Dams impede or prevent movement or dispersal of anadromous fish, riparian species, and plant propagules (Poff and Hart, 2002; Boedeltje et al., 2004). Sediment flow downstream is reduced due to deposition behind both dam types (Bednark, 2001; Stanely and Doyle, 2002), and dramatic temperature changes upstream and downstream of dams are often created (Bednark, 2001). In addition, nutrient and oxygen regimes are altered in the river due to temperature stratification in many reservoirs (Bednark, 2001; Poff and Hart, 2002). Nutrients settle out of the water column above both dam types reducing downstream delivery (Stanely and Doyle, 2002). Furthermore, changes in water flow rate above and below dams alter species and food web composition (Bednark, 2001; Suren et al., 2003a, Suren et al., 2003b), and lake ecosystems are created behind many dams (Bednark, 2001). Overall, the integrity of the river as a continuous functioning system is altered (Bednark, 2001; Pejchar and Warner, 2001; Clark et al., 2003). The interactions and disturbances of dams associated with tidal areas are even more complex (Bednark, 2001) because water flows in multiple directions. Culverts and buried streams that are too small to accommodate stream flow may have small reservoirs behind them causing some of the above-mentioned affects. If there were a vertical drop upon discharge, the barrier would again have similar affects.

Lateral interaction effects

Reduced flooding to riparian zones due to flow reduction associated with impounded water (Poff and Hart, 2002) and deepening and widening of the river channel from sediment erosion due to behind dam deposition (Moffat, 2003) alters nutrient deposit to, and delivery from, riparian zones (Haberstock et al., 2000; Dodds, 2002), seed dispersal (Boedeltje et al., 2004), and necessary habitat moistening for many organisms (Bednark, 2001). Bank erosion (Moffat, 2003) may also harm riparian plant stability. Changes to groundwater tables, due to reservoirs, can affect sensitive species and alter community patterns and composition (Shafroth et al., 2002). Above dams, riparian communities are transformed often resulting in decreased biodiversity (Nilsson, et al., 1997). Culverts, depending on length, would eliminate such interactions entirely. Finally, interactions of buried streams may be limited to ground seepage.

Vertical interaction effects

Sediment deposition above dams smothers important microhabitats (Bednark, 2001), and sediment erosion below dams also results in a loss of microhabitats (Poff and Hart, 2002). Flow rate changes effect benthic invertebrate and algal community compositions (Suren et al., 2003a; Suren et al., 2003b). In-stream woody debris could be decreased from dam retention resulting in a loss of detrital food webs (Hauer et al, 2003), feeding grounds, and habitat for many species (Crook and Robertson, 1999). Any riparian canopy cover loss would allow greater light infiltration, altering algal and macroinvertebrate community composition (Bunn and Davies, 2000; Suren et al., 2003a, Suren et al., 2003b). Culverts and buried streams would virtually eliminate any vertical interactions, with the exception of downward ground seepage associated with buried streams.

Temporal interaction effects

Stream channels naturally meander and change because of normal sediment movement (Dodds, 2002). In time scales of river morphology, a dam's lifetime, 50-120 years (Pejchar et al., 2001; Doyle et al., 2003) is short. It is unknown how long and to what extent the physical impacts of dams will affect river morphology. Dams alter biotic composition and trajectories of river systems (Poff and Hart, 2002), and may promote invasive or non-native species (Pejchar et al., 2001). Presumably culverts and buried streams have similar affects.

Ecological effects of stream barrier mitigation or removal

Unimpeded longitude, lateral and vertical interactions are vital to proper long-term functioning of river systems (Jungwirth et al., 2002). Proper barrier mitigation or removals allow these interactions to occur. However, there is the potential for negative impacts during dam removal. If PCB, heavy metal or other contaminated sediments are built up behind dams there is a large potential negative ecological impact of dam removal (Bednark, 2001) and appropriate management must take place prior to removal. With or without contaminants, sediment discharge associated with dam removal acts like a sand blaster, damaging invertebrates, fish, and riparian root structures (Bednark, 2002). Sediment discharge may, but not always (Stanley et al., 2002), destroy in-stream habitat (Bednark, 2001), and bury riparian plants (Shafroth et al., 2002). The time it takes for stored sediments to be mobilized varies with dam size, natural sediment load of the river and flow rate (Bednark, 2001). Changes to water tables during dam removal can negatively impact sensitive species (Stanley and Doyle, 2003) that may have developed in association with the long-term presence of the dam (Bednark, 2001). Barrier removal can act as a source or sink for species invasion (MCA/WCS, 2002, Shafroth et al., 2002), and facilitate movement of pollutants downstream via current or upstream by contaminated fish and other organisms.

Barrier removal decision

Though there are negative impacts associated with dam removal most are relatively short-term in duration, and the benefits of removal are thought to outweigh the adverse impacts (Hart et al., 2002). Contaminated sediments pose a big problem to removal operations, and should be dredged and moved. This relocation of contaminated sediments raises a new problem. It is important to analyze habitat conditions above and below barriers because the upstream and downstream communities, good or bad, will be able to interact following dam removal. The past century has seen a loss of 54% of wetland acreage in the U.S. (Dodds, 2002). It could be argued that some dams, in the upper reaches of watersheds, replace some of this lost wetland habitat. It is important to consider whether these reservoirs are rapidly filling with sediment, or if they behave like natural wetlands (Hammer, 1997). There are also economic, legal, safety, recreational, and aesthetic reasons for and against removing barriers (Bowman, 2002; Johnson and Graber, 2002; Whitelaw and MacMullan, 2002).

Information for consideration before proceeding with mitigation or removal

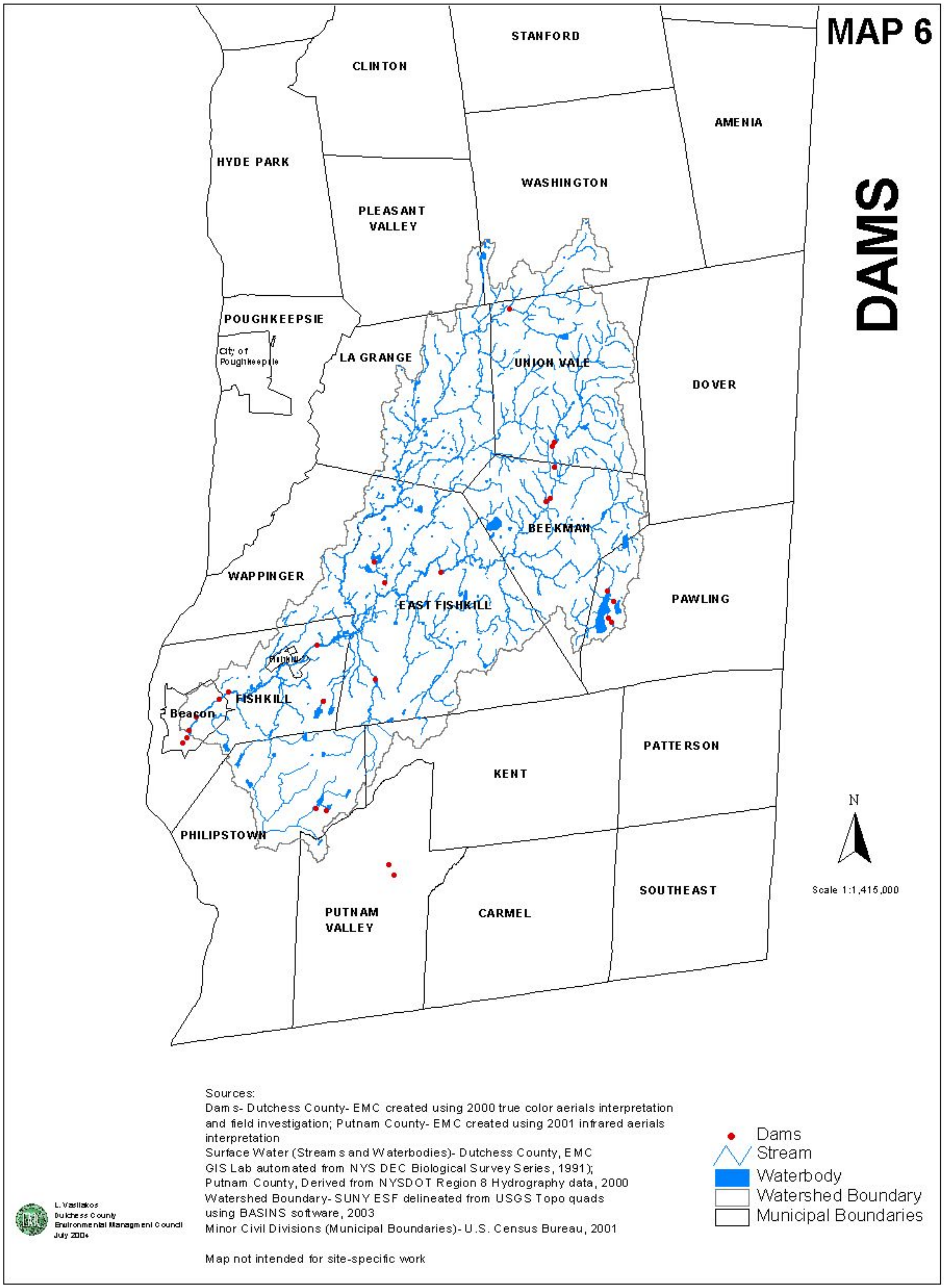
Barrier mitigation and removal is just one of many strategies for river restoration (Hart et al., 2002). It is important to look at the context of a given barrier within the overall system. It may make more ecological sense to address issues of surface or storm water runoff in the barrier site catchments, or riparian buffer quality downstream, before thinking about mitigation or removal of the dam. For impounding dams it is also important to look at any human structures downstream, such as small bridges, which are not designed for increased flows. Though this section illustrates ecological effects of stream barriers and removal, each barrier entering decision-making discussions must be treated individually. For example, downstream sediment deposition from removal may be detrimental to riparian communities because of burial, or it may benefit them by creating new alluvial surfaces depending on community succession levels (Shafroth et al., 2002).

There are numerous examples of successful and beneficial dam removals. The Edwards Dam removal on the Kennebeck River, Maine, enabled fish species migration (Stanley and Doyle, 2003). A dam removal on the Baraboo River, Wisconsin, saw rapid and desired upstream changes in macroinvertebrate communities, and no detrimental effect on healthy downstream communities (Stanley et al., 2002). There are also examples of negative impacts from removal. The Fort Edwards Dam on the Hudson River, Upstate New York, discharged PCB laden sediments downstream (Shuman, 1995). Dam removal on the Kettle River, Minnesota, resulted in downstream mussel population declines, but did restore fish access (Hart et al., 2002).

Monitoring and research must be part of the removal/mitigation and restoration/rehabilitation decision process, and must precede action (Hart et al., 2002). Preliminary research is somewhat proportional to the size of the barrier (primarily dam in this case) and its reservoir (Babbitt, 2002). Barrier mitigation or removal discussions should take climatic, hydrologic, ecologic and biologic variability into account (Bilby et al., 2003; Edmonds et al., 2003; Hauer et al., 2003; Montgomery and Bolton, 2003; Wissmar et al., 2003), as well as potential random events. There are 26 documented dams in the Fishkill watershed (Table 14, Map 6). Each dam should be analyzed on an individual basis, with an individual context. However, the dams also need to be considered collectively, as dams have cumulative impacts on river systems.

Table 14. Dams in the Fishkill Creek Watershed
(Source: DCEMC developed using 2000 aerial photography)

Dam Name	Municipality	Waterbody Name
Glenham Dam (Groveville Mill)	Beacon	Fishkill Creek
Braendly Fishkill Dam	Beacon	Fishkill Creek
Tuck Dam	Beacon	Fishkill Creek
New York Rubber Co. Dam	Beacon	Fishkill Creek
Unnamed Dam (Wolcott Ave.)	Beacon	Fishkill Creek
McKinney Dam	Beekman	Fishkill Creek
Furnace Pond Dam	Beekman	Fishkill Creek
Unnamed Dam	Beekman	Pond- Fishkill Creek
Unnamed Dam	Beekman	Constructed Pond
Unnamed Dam	Beekman	Fishkill Creek
Greenburg Henderson Dam	East Fishkill	Fishkill Creek
Fishkill Farms Pond	East Fishkill	Wiccopee Creek
Lake Walton Dam	East Fishkill	Lake Walton
Unnamed Dam	East Fishkill	Tributary of FC-H95-11A
Texaco Dam	Fishkill	Fishkill Creek
Sydeman Dam (Brinkerhoff Dam)	Fishkill	Fishkill Creek
Sunset Lake Dam	Pawling	Subtributary of Whaley Lake Creek
Little Whaley Lake Dam	Pawling	Little Whaley Lake
Willow Lake Dam	Pawling	Willow Lake
Whaley Lake Dam	Pawling	Whaley Lake Creek
Perkins Estate Pond Dam	Philipstown	Clove Creek
Jordan Pond Dam	Philipstown	Clove Creek
Lower (South) Wiccopee Dam	Putnam Valley	Wiccopee Creek
Upper (North) Wiccopee Dam	Putnam Valley	Wiccopee Creek
Unnamed Dam	Union Vale	Fishkill Creek
Verbank Village Dam	Union Vale	Sprout Creek


MAP 6
DAMS
STANFORD
CLINTON
AMENIA
HYDE PARK
WASHINGTON
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LA GRANGE
UNION VALE
DOVER
BEEKMAN
WAPPINGER
EAST FISHKILL
PAWLING
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
N
Scale 1:1,415,000
Sources:
Dams- Dutchess County- EMC created using 2000 true color aerials interpretation and field investigation; Putnam County- EMC created using 2001 infrared aerials interpretation
Surface Water (Streams and Waterbodies)- Dutchess County, EMC GIS Lab automated from NYS DEC Biological Survey Series, 1991); Putnam County, Derived from NYSDOT Region 8 Hydrography data, 2000
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software, 2003
Minor Civil Divisions (Municipal Boundaries)- U.S. Census Bureau, 2001
Map not intended for site-specific work
Dams
Stream
Waterbody
Watershed Boundary
Municipal Boundaries
L. Vasilakos
Dutchess County
Environmental Managment Council
July 2004

Wildlife and Fisheries

The Fishkill Creek watershed is literally crawling with life. An amazing variety of habitats, people, plants, and animals are all interconnected in a fragile web of life, often called "biodiversity". Every member is essential to keeping this web in balance. For example, the list of species required for the life cycle of a single tree may be in the hundreds or thousands. Moreover, the list of animals that will utilize a single fallen tree is in the thousands, but a few of the more well known creatures include squirrels, woodpeckers, grouse, bears, foxes, skunks, mice, and shrews as well as worms, salamanders, beetles, ants, centipedes, sowbugs, and insect larvae. There are twice as many species of beetles that live on dead and dying wood as there are species of mammals, birds, reptiles, and amphibians in the entire world (Kyker-Snowman, 2003). The fallen tree also provides critical habitat, steady moisture, and food for a multitude of mosses, fungi, trees, and vascular plants. If our fallen tree had been removed either during land use changes or during "clean up" after falling, the ramifications would reverberate throughout the web. Certainly, this doesn't preclude us from taking a few trees for firewood, but if enough fallen trees are removed, the structure of the overall community would likely change.

The fallen tree example was meant to demonstrate the complexity of the web of life, and how eliminating one organism will ultimately affect many. It is very difficult to predict the consequences of removing individual pieces from the web of life. Therefore, as an integral piece of the web, humans should work toward protection and preservation of the functions necessary for our survival. There are many ecosystem functions we receive from nature including cleaner air through vegetation, cleaner water through soil and wetland filtration, soil formation from forests, pollination of food crops from our native insects, natural flood water retention/groundwater recharge, and pest control from our native bats, birds, and insects (i.e. dragonflies/damselflies). For example, bees pollinate about a trillion apple blossoms each year in New York State, micro-organisms biodegrade much of our garbage as well as fallen leaves and other dead animal and plant matter, earthworms turn over soil and keep it aerated, soil bacteria turn nitrogen into nitrate fertilizer and plants use up carbon dioxide and produce oxygen, thereby slowing global warming. LoGiudice et al. (2003) demonstrated that maintaining healthy biodiversity and community structure can reduce the incidence of Lyme disease; and Allan et al. (2003) suggested that forest fragmentation can increase white-footed mouse populations which in turn increases the human risk of exposure to Lyme disease. Therefore, the benefits of a healthy and diverse ecosystem extend far beyond clean air and water and into the fabric of human health and quality of life.

In the United States the economic services provided by a vibrant/healthy biological web of life (biodiversity) contribute an estimated $319 billion per year, or 5% of the gross domestic product (Pimentel et al., 1997). The worldwide benefits are estimated to be $2,928 billion per year, or approximately 11% of the world economy (Pimentel et al., 1997). Closer to home, the economic impact of recreational use of the Wappinger Creek exceeds 1.2. million in a normal season (Black and Winne, 1998). It is important to note that the Wappinger Creek contributions to the Dutchess County economy were only calculated for recreation uses. Clearly, our economic vitality depends on maintaining healthy biodiversity.

The plants and animals that inhabit the Fishkill Creek watershed are suited to the habitats provided by our temperate climate. The other major factor is human alteration of the landscape. Pre-colonization Dutchess County was predominantly forested, but by the mid-1800s much of the county had been converted to farmland. By 2004 much of the farmland had been converted to residential, commercial, and forested landscapes.

The reaction of wildlife has varied to the changing land use. A few, such as the timber wolf and passenger pigeon have gone extinct in this region (passenger pigeon is extinct worldwide). Beaver, pileated woodpeckers, and bald eagles were once gone from this region due to over hunting, habitat loss, and pesticide poisoning respectively, but have since returned with reduced hunting pressure, an increase in second-growth forests, and a ban on DDT. Some species, such as the bobcat, black bear, osprey, and Atlantic sturgeon are less common than they were prior to European colonization. However, other species, such as the white tailed deer, raccoon, skunk, red fox, robin, and painted turtle have thrived in our suburban landscape (Kiviat, 1984).

According to the New York State Natural Heritage Program (2003 and 2004; Reschke 1990), the list of endangered (imminent threat of extirpation) animal and plant species that occur, or once occurred, in the Fishkill watershed include the bog turtle (Clemmys muhlengergii), Northern Cricket frog (*Acris crepitans* - possibly occurred), wild hydrangea (Hydrangea arborescens), and live-forever (Sedum telephioides). The list of threatened (likely to become an endangered species within the foreseeable future) animal and plant species includes the timber rattlesnake (Crotalus horridus), blandings turtle (Emydoidea blandingii), bald eagle (Haliaeetus leucocephalus), least bittern (Ixobrychus exilis), pied-billed grebe (Podilymbus podilymbus), stiff-leaf goldenrod (Solidago rigida), swamp cottonwood (Populus heterophylla), and blazing star (Chamaelirium luteum). Species of special concern that may also inhabit the watershed include the wood turtle (Clemmys insculpta), spotted turtle (Clemmys guttata), eastern box turtle (Terrapene carolina), jefferson salamander (Ambystoma jeffersonianum), and marbled salamander (Ambystoma opacum). Finally, rare communities in the watershed include the acidic talus slope woodland, Appalachian oak-hickory forest, chestnut oak forest, floodplain forest, oak-tulip tree forest, pitch pine-oak heath rocky summit, red cedar rocky summit, rich shrub fen, and the rich sloping fen. For more in-depth information on the endangered and threatened plants and communities please see the vegetation section of this plan.

In Dutchess County, human-induced land use changes are currently the dominant factor in habitat and natural landscape changes. However, many wildlife species in the Fishkill watershed also influence the landscape. Heavy deer browsing of seeds, seedlings, and saplings can dramatically alter the composition of a forest to encourage the growth of species that deer find less palatable (Curtis, 2004). Species imported from other areas that thrive in our region, often called invasive species, can also have dramatic effects on the landscape. For example, Eurasian water milfoil (*Myriophyllum spicatum*) is native to Europe and Asia, but has run rampant in Dutchess County waterbodies choking out native species. Eurasian water milfoil spreads rapidly since it can reproduce by seed or fragmentation (one small clipping can grow into an entire plant), and in our nutrient rich lakes it flourishes. The wooly adelgid (*Adelges tsugae*), a small aphid-like insect pest native to China and Japan, is threatening to decimate our eastern hemlock (*Tsuga canadensis*) populations. Once infested, hemlock mortality rates range between 50%-99% (Orwig, 2002). The plant species most likely to replace hemlocks are hardwood tree species and possibly other invasive species. Ultimately, this will have a dramatic effect on the structure of these communities. For example, the distribution and abundance of brook trout and diversity of aquatic insects will likely decline with the hemlock forests (Evans, 2002). Hemlock forests maintain stable, lower water temperatures and more stable hydrologic regimes (i.e. they don't dry up as much) than the hardwood forests that will likely replace them (Snyder et al., 2002). These are just a few examples of how, in a global society, careless actions can import and release species that can drastically change our ecological communities.

The Fishkill Creek watershed contains cold (headwater) and warm (closer to Hudson) water habitats. Many sections of the Fishkill are stocked with brown trout, and a few sections maintain reproducing populations. The lower creek has largemouth and smallmouth bass populations, along with a variety of other warm water species. Tables 15 and 16 contain the fish species collected throughout the watershed in 1988 (Stevens et al., 1994) and 2001 (Stainbrook, 2004). Tables 15 and 16 are meant as a general guide to some of the species present in those time periods, but shouldn't be compared due to inconsistencies in habitats and sites sampled. According to the 1994 researchers, the Whortlekill, Clove Creek, and Whaley Lake Creek had the highest quality fish habitat (Stevens et al., 1994). In general, the watershed contains good potential habitats, but is threatened primarily by sediment and thermal pollution brought on by increased intrusion into the stream's immediate riparian area. This intrusion not only includes the destruction of the forested buffer areas surrounding the main stem of the Fishkill, but also the many miles of tributaries that supply water to the main stem. Protection and/or restoration of the forested buffer zones surrounding the Fishkill and its tributaries is crucial to the survival of a robust fishery that includes cold water species (sculpins/trout) as well as warm water species (bass).

Benthic Macroinvertebrates are organisms without backbones that live at least a portion of their lives on the bottom of a water body. Typically, these invertebrates are large enough to see with the naked eye, but a working technical definition could be large enough to not pass through a number 30 sieve. Benthic macroinvertebrates include aquatic insects such as mayflies (ephemeroptera), stoneflies (plecoptera), caddisflies (tricoptera), true flies (black flies, crane flies, midges, deer flies, etc.)(diptera), dobson flies (megaloptera), dragonflies and damselfiles (odonata), and beetles (coleoptera). Additionally, crayfish, worms, clams, and snails are benthic macroinvertebrates. These organisms live year-round in the streams and lakes of Dutchess County, and with limited mobility, are fairly restricted in their individual geographic range. The assemblage of macroinvertebrates found living in a section of river or stream can directly reflect the quality of the water of that segment. Tables 17 and 18 list the macroinvertebrates identified in the Fishkill Creek in 1991 and 1999, respectively.

Table 15: Fish Collected in the Fishkill Basin in July and October 1988 (Stevens et. al, 1994)

Common Name	**Scientific Name**
Redfin Pickeral	*Esox americanus*
Blacknose Dace	*Rhinichthys atratulus*
Brown Trout	*Salmo trutta*
Rock Bass	*Ambloplites rupestris*
Largemouth Bass	*Micropterus salmoides*
Longnose Dace	*Rhinichthys cataractae*
Fallfish	*Semotilus corporalis*
Tessellated Darter	*Etheostoma olmstedi*
Common Shiner	*Luxilus cornutus*
Creek Chub	*Semotilus atromaculatus*
White Sucker	*Catostomus commersoni*
Blue Gill	*Lepomis macrochirus*
Cutlips Minnow	*Exoglossum maxillingua*
American Eel	*Anguilla rostrata*
Goldfish	*Carassius auratus*
Redbreast Sunfish	*Lepomis auritus*
Pumpkinseed	*Lepomis gibbosus*
Striped Bass	*Morone saxatilis*
Smallmouth Bass	*Micropterus dolomieu*
Yellow Perch	*Perca flavescens*
Spotfin Shiner	*Cyprinella spiloptera*
Golden Shiner	*Notemigonus crysoleucas*
Banded Killifish	*Fundulus diaphanus*
Brook Trout	*Salvelinus fontinalis*

Table 16: Fish Collected in the Fishkill basin during summer, 2001 (Stainbrook, 2004)

Common Name	**Scientific Name**
Redfin Pickeral	*Esox americanus*
Blacknose Dace	*Rhinichthys atratulus*
Brown Trout	*Salmo trutta*
Rock Bass	*Ambloplites rupestris*
Largemouth Bass	*Micropterus salmoides*
Longnose Dace	*Rhinichthys cataractae*
Fallfish	*Semotilus corporalis*
Tessellated Darter	*Etheostoma olmstedi*
Common Shiner	*Luxilus cornutus*
Creek Chub	*Semotilus atromaculatus*
White Sucker	*Catostomus commersoni*
Blue Gill	*Lepomis macrochirus*
Cutlips Minnow	*Exoglossum maxillingua*
American Eel	*Anguilla rostrata*
Sclupin	*Cottus cognatus*
Rainbow trout	*Oncorhynchus mykiss*
Pumpkinseed	*Lepomis gibbosus*
Spot tail shiner	*Notropis hudsonius*
Smallmouth Bass	*Micropterus dolomieu*
Yellow Perch	*Perca flavescens*
Spotfin Shiner	*Cyprinella spiloptera*
Golden Shiner	*Notemigonus crysoleucas*
Banded Killifish	*Fundulus diaphanus*
Brook Trout	*Salvelinus fontinalis*
Brown bullhead	*Ameiurus nebulosus*
Yellow bullhead	*Ameiurus natalis*
Blunt nose	*Pimephales notatus*
Fathead minnow	*Pimephales promelas*
Black crappie	*Pomoxis nigromaculatus*
Green sunfish	*Lepomis cyanellus*

Table 17: Fishkill Creek Macroinvertebrate Community present in 1991. Samples collected and data combined from Clove Valley above Dorn Rd., Hopewell Junction below Augusta Dr. bridge, Sarah Taylor Park in Fishkill and Main St. in Beacon (Bode et. al, 1991).

STREAM SITE:	Fishkill Creek	
DATE:	August 29-30, 1991	
SAMPLE TYPE:	Kick sample	
SUBSAMPLE:	100 individuals	
PLATYHELMINTHES	Undetermined Turbellaria	
TURBELLARIA		
NEMERTA	*Prostoma graecense* (=rubrum)	
ANNELIDA		
OLIGOCHAETA	Undetermined Lumbricina	
ARTHROPODA		
CRUSTACEA		
AMPHIPODA	Gammaridae	*Gammarus* sp.
MOLLUSCA		
GASTROPODA	Lymnaeidae	Undetermined
	Planorbidae	Undetermined
	Ancylidae	*Ferrissia rivularis*
	Hydrobiidae	*Amnicola* sp.
	Spaeriidae	*Sphaerium sp.*
PELECYPODA		
INSECTA		
EPHEMEROPTERA	Baetidae	*Acentrella* sp.
		Baetis intercalaris
		Baetis flavistriga
		Baetis sp.
	Oligoneuriidae	*Isonychia bicolor*
	Heptageniidae	*Stenonema* sp.
		Stenomema modestum
		Stenacron interpunctatum
	Ephemerellidae	*Serratella deficiens*
	Caenidae	*Caenis* sp.
ODONATA	Aeschnidae	*Boyeria* sp.
PLECOPTERA	Perlidae	*Paragnetina media*
COLEOPTERA	Elmidae	*Optioservus* sp.
		Optioservus trivittas
		Oulimnius latiusculus
		Stenelmis concinna
		Stenelmis crenata
		Stenelmis sp.
	Psephenidae	*Psephenus* sp.
TRICHOPTERA	Philopotamidae	*Chimarra aterrima(?)*
	Hydropsychidae	*Cheumatopsyche* sp.
		Hydropsyche betteni
		Hydropsyche bronta
		Hydropsyche morosa
		Hydropsyche sparna
	Hydroptilidae	*Hydroptila* sp.
		Hydroptila consimilis(?)

Table 17 cont'd.

		Leucotrichia sp.
	Psychomyiidae	*Psychomyia flavida*
DIPTERA	Simuliidae	*Simulium venustum*
		Simulium jenningsi
		Simulium sp.
	Tipulidae	*Antocha* sp.
		Limonia sp.
	Rhagionidae	*Atherix* sp.
	Chironomidae	
	Tanypodinae	*Thienemannimyia gr.* spp.
	Orthocladiinae	*Cricotopus trifascia gr*
		Limnophyes sp.
		Orthocladius carlatus
		Rheocricotopus robacki
		Tvetenia vitracies
	Chironominae	
	Chironomini	*Dicrotendipes neomodestus*
		Microtendipes rydalensis gr
		Parachironomus frequens
		Phaenopsectra flavipes
		Polypedilum illinoense
		Polypedilum convictum
		Polypedilum aviceps
	Tanytarsini	*Rheotanytarsus distinctissimus gr*
		Rheotanytarsus exiguus gr
		Tanytarsus glabrescens gr.
		Tanytarsus guerlus gr

Station 1: Clove Valley, NY, 10 m above Dorn Rd. bridge
Station 3: Hopewell Junction, NY, 150 m below Augusta Dr. bridge
Station 5: Fishkill, NY, access through Sarah Taylor Park
Station 7: Beacon, NY, 100 meters above Main St. bridge

Table 18: 1999 Macroinvertebrate data from the Fishkill Creek at Sarah Taylor Park in Fishkill (Station 5) and Main Street in Beacon (Station 7) (Bode et al., 2001)

STREAM SITE:	Fishkill Creek			
DATE:	July 14, 1999			
SAMPLE TYPE:	Kick sample			
SUBSAMPLE:	100 individuals			
			Sta. 5	Sta. 7
PLATYHELMINTHES				
TURBELLARIA		Undetermined Turbellaria	1	3
ANNELIDA				
OLIGOCHAETA		Undetermined Lumbricina		1
ARTHROPODA				
CRUSTACEA				
ISOPODA	Asellidae	Caecidotea communis		6
AMPHIPODA	Gammaridae	Gammarus sp.		1
INSECTA				
EPHEMEROPTERA	Baetidae	Acentrella ampla		1
		Baetis brunneicolor		8
		Baetis flavistriga	3	6
	Heptageniidae	Stenonema sp		1
	Perlidae	Paragnetina media	2	
	Elmidae	Optioservus sp.	2	6
		Promoresia elegans	2	
		Stenelmis sp	1	24
	Philopotamidae	Chimarra obscura	1	
	Hydropsychidae	Cheumatopsyche sp.	18	
		Hydropsyche betteni	1	17
		Hydropsyche bronta	5	1
	Hydroptilidae	Hydroptila sp.		2
	Simuliidae	Simulium fibrinflatum		9
		Simulium jenningsi	38	
	Chironomidae	Thienemannimyia gr. spp.	1	
		Diamesa sp.		1
		Cardiocladius obscurus	3	
		Cricotopus bicinctus		2
		Tvetenia vitracies	9	2
		Polypedilum convictum	1	
		Polypedilum illinoense	1	
		Rheotanytarsus distinctissimus gr.	1	
		Rheotanytarsus exiguus gr.	3	6
		Tanytarsus glabrescens gr.	1	
		Tanytarsus guerlus gr.	1	
		SPECIES RICHNESS	19	20
		BIOTIC INDEX	4.72	5.4
		EPT RICHNESS	5	8
		MODEL AFFINITY	50	60
		ASSESSMENT OF IMPACT	slight	slight

Vegetation

Prior to European settlement, oak-dominated forests and white pine probably covered approximately fifty to seventy-five percent of Dutchess County (Kiviat, 1984a). During the 19th century more than ninety percent of the county was cleared for agricultural purposes (Kiviat, 1984). As agricultural land uses changed and declined through the twentieth century forest cover began to increase. In 2000, based on a land use analysis conducted by the DCEMC employing the land use for natural resources classification system, the Fishkill Creek watershed was dominated by six land use/vegetation types including wooded wetlands, marshes and bogs, plantations, brush lands and agriculture, forest, and developed land.

Bottomlands, floodplains, riparian zones, marshes, bogs and wooded wetland forests offer a diversity of plant species due to different hydrologic regimes ranging from dry to permanently wet. Within these habitats, common species consist primarily of hardwoods including, but not limited to, red and silver maple, pin and swamp white oaks, green ash, red or slippery elm, tulip tree, sycamore, American basswood, bitternut and shagbark hickory, eastern cottonwood, black and weeping willows. American elm can occasionally be found in the less disturbed areas where isolated survivors of Dutch elm disease exist. In drier areas, sugar maple, red oak and white ash may be found. Butternut may be present in areas isolated from the canker, which has devastated the species elsewhere. Common understory trees include spicebush, American hornbeam, gray and red osier dogwoods, hawthorn and buckthorn. Common plants found in marshes include purple loosestrife, marsh marigold, bulrushes, rushes, tussock sedge, cattail, and reed. Other plants commonly found in non-tidal wetlands include spicebush, silky dogwood, pickerelweed, jewelweed, buttonbush, cinnamon fern, and skunk cabbage.

Plantations are comprised of stands of planted trees, consisting of pure stands or alternating patches of conifers. Conifers may include eastern white pine, eastern or Canada hemlock (which is being devastated by the alien hemlock wooly adelgid insect) as well as plantations of non-native Norway spruce and larch. Brushlands, commonly referred to as old agriculture fields, may contain gray dogwood, red cedar, gray birch, staghorn sumac, black locust, white pine, quaking aspen, black cherry, red maple, arrowwood, and American prickly ash in the canopy layer. Beneath the canopy layer, typical plants found include little bluestem (grass), goldenrods, asters, dewberry, blackberry, sassafras, sweet fern, chokecherry and common juniper.

Upland forests are primarily composed of northern hardwoods, including but not limited to sugar maple, red maple, red, white, black and chestnut oaks, black cherry, black locust, American beech, black and yellow birch, white and green ash, shagbark and pignut hickory, tulip tree, hackberry, black gum, black walnut, and eastern hophornbeam. Alien invasives like ailanthus and buckthorn are proliferating on more disturbed, exposed sites. Developed land typically contains landscaped vegetation and nonnative grasses.

According to the New York Natural Heritage Program (2004), there are eight plant species of rare, endangered, or threatened status in the Fishkill watershed. These plant species include live-forever, swamp cottonwood, blazing star, heartleaf plantain, seaside goldenrod, stiff-leaf goldenrod, spongy arrowwood and wild hydrangea. In addition, there are ten plant communities of special concern in the watershed including floodplain forest, rocky summit grassland (Scofield Ridge), acidic talus slope woodland, Appalachian oak-hickory forest, chestnut oak forest, oak-tulip tree forest, pitch pine-oak-heath rocky summit, red cedar rocky summit, rich shrub fen and rich sloping fen.

Acidic Talus Slope Woodland

Acidic Talus Slope Woodland consists of an open or closed canopy and forms on talus slopes composed of non-calcareous bedrock such as granite, quartzite, or schist (Reschke, 1990). Common trees include sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), chestnut oak (*Quercus montana*), red oak (*Q. rubra*), white oak (*Q. alba*), striped maple (*Acer pensylvanicum*) and mountain maple (*A. spicatum*). Many species of ferns are found in the ground layer including bulblet fern (*Cystopteris bulbifera*), fragile fern (*Cystopteris fragilis*), Christmas fern (*Polystichum acrostichoides*), marginal wood fern (*Dryopteris marginalis*), silvery spleenwort (*Athyrium thelypteroides*), and maidenhair fern (*Adiantum pedatum*) (Reschke, 1990). Other herbs commonly found in this type of woodland are ricegrass (*Oryzopsis racemosa*), bloodroot (*Sanguinaria canadensis*), blue cohosh (*Caulophyllum thalictroides*), ginseng (*Panax quinquefolius*) and zig-zag goldenrod (*Solidago flexicaulis*). Two snakes found in this habitat are the copperhead (*Agkistroden contortrix*) and timber rattlesnake (*Crotalus horridus*) (Reschke 1990).

Appalachian Oak-Hickory Forest

Appalachian Oak-Hickory forests are comprised of hardwoods that occur on well-drained sites, predominately on ridge tops, upper slopes, or south and west-facing slopes. Soils within this community are primarily loams and sandy loams. Trees that dominate this community include red oak (Quercus rubra), white oak (Q. alba) and black oak (Q. velutina). Other trees that occur in this community include pignut hickory (Carya glabra), shagbark hickory (C. ovata), sweet pignut hickory (C. ovalis), white ash (Fraxinus americana), red maple (Acer rubrum), and Eastern hop hornbeam (Ostrya virginiana) (Reschke, 1990). Flowering dogwood (Cornus florida), witch hazel (Hamamelis virginiana), shadbush (Amelanchier arborea) and choke cherry (Prunus virginiana) are commonly found in the subcanopy (Reschke, 1990). Smaller shrubs include maple-leaf viburnum (Viburnum acerifolium), blueberries (Vaccinium angustifolium, V. pallidum), red raspberry (Rubus idaeus), gray dogwood (Cornus foemina ssp. racemosa), and beaked hazelnut (Corylus cornuta) (Reschke, 1990). The ground layer is also composed of many herb species including wild sarsaparilla (Aralia nudicaulis), false Solomon's seal (Smilacina racemosa), Pennsylvania sedge (Carex pensylvanica), tick trefoil (Desmodium glutinosum, D. paniculatum), black cohosh (Cimicifuga racemosa), rattlesnake root (Prenanthes alba), white goldenrod (Solidago bicolor) and hepatica (Hepatica americana) (Reschke, 1990). Animals that are commonly found in this community include red-bellied woodpecker (Melanerpes carolinus), whip-poorwill (Caprimulgus vociferous), and wild turkey (Meleagris gallopavo) (Reschke, 1990).

Chestnut Oak Forest

Chestnut Oak Forest is a hardwood forest that is found on well-drained soils in glaciated portions of the Appalachians, and on the coastal plain. Trees that dominate the canopy layer are chestnut oak (*Quercus montana*) and red oak (*Q. rubra*) (Reschke, 1990). Other trees commonly found in this community include white oak (*Q. alba*), black oak (*Q. velutina*) and red maple (*Acer rubrum*) (Reschke, 1990). Plants found in the shrub layer include black huckleberry (*Gaylusscia baccata*), mountain laurel (*Kalmia latifolia*) and blueberry (*Vaccinium palladium*) (Reschke, 1990). The ground layer contains Pennsylvania sedge (*Carex pensylvanica*), wild sasparilla (*Aralia nudicaulis*), wintergreen (*Gaultheria procumbens*) and the moss *Leucobryum glaucum* (Reschke, 1990). The decimation of American chestnut (*Castanea dentate*) by disease has reduced its presence in this community.

Floodplain Forest

A floodplain forest is comprised of hardwoods that occur on mineral soils on low terraces of river floodplains and river deltas. The flooding regime consists of annual flooding in the spring within the low areas, and irregular flooding in the high areas. The plant community in the floodplain forest is variable but may exhibit a high diversity. Canopy tree species include silver maple (*Acer saccharinum*), red maple (*A. rubrum*), sycamore (*Platanus occidentalis*), cottonwood (*Populus deltoides*), butternut (*Juglans cinerea*), black willow (*Salix nigra*), bitternut hickory (*Carya cordiformis*), swamp white oak (*Quercus bicolor*), white ash (*Fraxinus americana*), black ash (*F. nigra*), and basswood (*Tilia americana*) (Reschke, 1990). The white willow (*Salix alba*), an introduced tree, is often present in floodplain forests. In the ground layer, common species include sensitive fern (*Onoclea sensibilis*), white snakeroot (*Eupatorium rugosum*), Canada goldenrod (*Solidago canadensis*), jewelweed (*Impatiens capensis*), jumpseed (*Polygonum virginianum*), and spicebush (*Lindera benzoin*) (Reschke, 1990). Bird species that utilize the floodplain forest as habitat include yellow-throated vireo (*Vireo flavifrons*), tufted titmouse (*Parus bicolor*), red-bellied woodpecker (*Melanerpes carolinus*), and pileated woodpecker (*Dryocopus pileatus*) (Reschke, 1990).

Oak-Tulip Tree Forest

Oak-Tulip Tree Forest is a hardwood forest that is found on moist, well-drained sites. The community is composed of plants that are adapted to a moderately moist environment. Trees which dominate the canopy layer include red oak (*Quercus rubra*), tulip tree (*Liriodendron tulipifera*), beech (*Fagus grandifolia*), black birch (*Betula lenta*), red maple (*Acer rubrum*), scarlet oak (*Quercus coccinea*), black oak (*Q. velutina*), and white oak (*Q. alba*) (Reschke, 1990). Beneath the canopy, the dominant species is flowering dogwood (*Cornus florida*). Other species in the subcanopy layer include witch-hazel (*Hamamelis virginiana*), sassafras (*Sassafras albidum*), red maple (*Acer rubrum*), and black cherry (*Prunus serotina*) (Reschke, 1990). The shrub layer is comprised of maple-leaf viburnum (*Viburnum* *acerifolium*), northern blackberry (*Rubus allegheniensis*) and blueberries (*Vaccinium angustifolium*, *V. pallidum*) (Reschke, 1990). The ground layer is comprised of herb species including white wood aster (*Aster divaricatus*), New York fern (*Thelypteris noveboracensis*), Virginia creeper (*Parthenocissus quinquefolia*), jack-in-the-pulpit (*Arisaema triphyllum*), wild geranium (*Geranium maculatum*), solomon's seal (*Polygonatum biflorum*), and false solomon's seal (*Smilacina racemosa*) (Reschke, 1990).

Pitch-Pine-Oak-Heath Rocky Summit

This community forms on warm, dry, rocky ridge tops and summits composed of non-calcareous bedrock such as quartzite, sandstone, or schist. The plant community may be sparse but tolerates acidic soils. Plant species commonly found include pitch pine (*Pinus rigida*), chestnut oak (*Quercus montana*), scrub oak (*Q. ilicifolia*), common juniper (*Juniperus communis*), blueberry (*Vaccinium angustifolium*), sweet fern (*Comptonia peregrina*), black huckleberry (*Gaylussacia baccata*), Pennsylvania sedge (*Carex pensylvanica*), poverty-grass (*Danthonia spicata*), common hairgrass (*Deschampsia flexuosa*), three-toothed cinquefoil (*Potentilla tridentata*) and cow-wheat (*Melampyrum lineare*) (Reschke, 1990). Two lichens commonly found in this community are *Cetraria arenaria* and *Cladonia* spp. (Reschke, 1990)

Red Cedar Rocky Summit

This community forms on warm, dry, rocky ridge tops and summits where bedrock is calcareous, such as limestone or dolomite. Vegetation may be sparse or patchy with many rock outcrops. Very little data is available on the species commonly found in this community. Known species include eastern red cedar (*Juniperus virginiana*), shagbark hickory (*Carya ovata*), eastern hop hornbeam (*Ostrya virginiana*), serviceberry (*Amelanchier* spp.), little bluestem (*Schizachyrium scoparium*), sedge (*Carex eburnea*), and everlasting (*Antennaria plantaginifolia*) (Reschke, 1990).

Rich Sloping Fen

A rich sloping fen is a small, gently sloping, mineral-rich wetland, with shallow peat deposits that occurs in a shallow depression on a slope composed of calcareous glacial deposits (Reschke, 1990). Rich sloping fens are headwater wetlands that are fed by small springs or ground water seepage. The vegetation community is comprised of trees and shrubs, and a ground layer of herbs and bryophytes. This habitat may occur upstream from, and transition into, hemlock-hardwood swamps. The species diversity is high including a variety of shrubs, herbs, and mosses. Common shrubs include red osier dogwood (Cornus sericea), willows (Salix discolor, S. sericea, S. bebbiana), dwarf raspberry (Rubus pubescens), northern gooseberry (Ribes hirtellum), alder-leaf buckthorn (Rhamnus alnifolia), arrowwood (Virburnum dentatum var. lucidum), highbush blueberry (Vaccinium corymbosum), red maple (Acer rubrum), eastern red cedar (Juniperus virginiana), and hemlock (Tsuga canadensis) (Reschke, 1990). Herb species include the sedges (Carex flava, C. interior, C. sterilis, C. leptalea, C. lacustris, C. hystericina and C. aquatilis), cottongrass (Eriophorum viride-carinatum), cattail (Typha latifolia), marsh fern (Thelypteris palustris), crested wood fern (Dryopteris cristata), cinnamon fern (Osmunda cinnamomea), common horsetail (Equisetum arvense), black-eyed Susan (Rudbeckia laciniata), marsh marigold (Caltha palustris), roundleaf sundew (Drosera rotundifolia), and skunk cabbage (Symplocarpus foetidus) (Reschke, 1990). Rich sloping fens also include various species of mosses including Aulacomnium palustre, Sphagnum warnstorfii, Tomenthypnum nitens, Campylim stellatum and Cratoneuron filicinum (Reschke, 1990).

Wetlands

Wetlands are very important features in the Fishkill Creek watershed providing valuable functions including water quality protection, flood control, wildlife and fish habitat, nutrient cycling, and groundwater storage. They also provide visual and aesthetic quality and offer recreational and educational opportunities. Many wetlands are designated as significant natural areas supporting habitat for threatened or endangered species or unusually diverse plant and animal communities. They also act to enhance the quality of life in Dutchess County. In 2000, wetlands covered approximately 10,753 acres (DCEMC GIS Laboratory, 2003) in the watershed (Map 3). This included a total of 10,092 wetland acres in Dutchess County and 661 acres in Putnam County (DCEMC GIS Laboratory, 2003). A list of federally regulated wetlands exceeding 50 acres is provided in Table 19, and state regulated wetlands exceeding 100 acres is provided in Table 20.

Within the Fishkill watershed, some towns have developed wetland and watercourse protection ordinances in an effort to provide for the protection, preservation, proper maintenance and use of wetlands, waterbodies and watercourses. Protection measures in the ordinance may include preventing damage from erosion and siltation, minimizing disturbance, protecting forested buffer zones, preserving natural habitats and protecting against flood and pollution through the establishment of a water control commission. As of 2004, towns in the watershed that adopted wetland protection ordinances included La Grange, Fishkill, Pleasant Valley, Pawling and Wappinger.

Table 19. Federal Wetlands over 50 acres in the Fishkill Creek Watershed
(Source: (DCEMC GIS Database, Derived from U.S. Fish and Wildlife Service Data, 1995)

Wetland Type	Acreage	Municipality	Description	Access Roads
PFO1E	185.6	East Fishkill	Tributary of Wiccopee Creek	Rt. 52, Cosmo Dr.
L1UBHh	112.6	East Fishkill	Slyvan Lake	Slyvan Drive
PFO1E	98.7	East Fishkill	Tributary of Wiccopee Creek	Rt. 52, Shenandoah Rd., Schlueter Rd.
PFO1A	77.2	East Fishkill	Fishkill Creek, Tributary of Fishkill Creek	New Hackensack Rd.
PFO1E	67.0	East Fishkill	Tributary of Wiccopee Creek	TSP South and Rt. 52
PFO1A	60.2	East Fishkill	Fishkill Creek Mainstem	New Hackensack Rd. & Carpenter Rd.
PFO1E	56.4	East Fishkill	Fishkill Creek Mainstem	I-84, Old Town Rd., Greenwood Dr.
PFO1E	56.3	East Fishkill	Subtributary of Wiccopee Creek	I-84, Townsend Rd.
R2UBH	50.8	East Fishkill	Fishkill Creek Mainstem	I-84, Old Town Rd., Greenwood Dr.
L1UBHh	248.4	Pawling	Waterbody- Whaley Lake	Rt. 292
PFO1Ed	54.9	Wappinger	Tributary of Whaley Lake Brook	Rt 9, Cedar Hill Rd.

Table 20. New York State Regulated Wetlands over 100 acres in the Fishkill Creek Watershed
(Source: DCEMC GIS Database, Derived from NYSDEC, Division of Fish and Wildlife Habitat Inventory Unit, 1999)

Wetland ID	Area (Acres)	Municipality	Description- Streams and Waterbodies	Access Roads
HJ-15	173.3	East Fishkill	Stream- tributary of Fishkill Creek	Lake Walton Rd.
HJ-20	112.4	East Fishkill	Fishkill Creek Mainstem	TSP North, Stormville Rd, Carpenter Rd.
HJ-37	540.2	East Fishkill	Fishkill Creek Mainstem	Rt. 52, Palen Rd.
HJ-44	121.1	East Fishkill	Tributary of Fishkill Creek and Penneywater pond	Harrigan Rd.-off Rt. 52
HJ-49	552.5	East Fishkill	none	I-84 and Rt. 52
HJ-49 UPL	165.2	East Fishkill	Tributaries of Wiccopee Creek	I-84 and Rt. 52
HJ-53	128.0	East Fishkill	Tributary of Wiccopee Creek	Blue Hill Rd., Rt. 52, Shenandoah Rd.
HJ-54	209.6	East Fishkill	Wiccopee Creek, Tributaries of Wiccopee Creek	I-84, Townsend Rd., Shenandoah Rd.
HJ-73	144.7	East Fishkill	Sprout Creek	Robinson Lane, Hillside Lake Rd.
PQ-10	119.4	Beekman, Pawling	Whaley Lake,outlet and tribs of Whaley Lake	RT. 292, Old Rt. 55 and Rt. 55
PQ-8	262.8	Beekman, East Fishkill	Fishkill Creek, Tributaries of Fishkill Creek	Benton Moore Rd., New Hacksensack Rd
PV-53	204.2	LaGrange	Sprout Creek, subtributary of Sprout Cr., Jackson Cr.	Noxon Rd., Hillside Lake Rd., Robinson Ln.
PV-57	101.0	LaGrange	Tributaries of Sprout Creek	Robinson Lane, Diddell Rd.
VB-16	176.3	Union Vale	Clove Valley Cr., Sweezy Cr., Pray Pond, Tribs of Clove Valley and Sweezy Creeks	Clove Rd. and North Clove Rd.
VB-26	231.7	Union Vale	McKinney Pond, Trib of Fishkill Cr.and Clove Valley Cr.	Bruzgul Rd.,West Clove Mountain Rd.
VB-3	141.1	Washington	Sprout Creek, tributary of Sprout Cr., Tyrell Lake	Oak Summit Road
VB-37	121.7	Beekman	Tributary of Whaley Lake Brook	Rt. 55, Hynes Rd., Clove Valley Rd.
WF-12	111.5	Fishkill, Wappinger	Tributary and Subtributaries of Whaley Lake Brook	Smithtown Rd., Cooper Rd., Rt. 9

Description of Selected Fishkill Watershed wetlands

(NWI and DEC wetland classifications are detailed in appendix III)

HJ-49

HJ-49 is a 552-acre wetland bordered by Route 52, the Taconic State Parkway, Hosner Mountain Rd., and Interstate 84 in the Town of East Fishkill. Upland areas in this wetland total 165 acres, and the wetland is entirely in private ownership. This New York State designated class 2 wetland is characterized as an emergent marsh serving as prime wildlife habitat. According to a field survey conducted by the Dutchess County Environmental Management Council (1977), wetland plants present included dogwood, purple loosestrife, willow, red maple, false nettle, stinging nettle, jewelweed, slippery elm and New York ironweed. Rare plants included cardinal flower and arrowhead. Wildlife present included frogs, ducks, catbirds, and bluejays. The wetland contains a class C (suitable for secondary contact recreation), perennial stream that is a subtributary of Wiccopee Creek. A total of 42 US Fish and Wildlife Survey classified wetlands overlap HJ-49. The wetland types include palustrine scrub shrub, palustrine forested, palustrine emergent and palustrine unconsolidated bottom wetland types (PFO1E, PSS1E, PEM1E, PEM1C, PEM1C, PSS1/EM1E, PEM1A, PEM1Cd, PFO1Cd, PFO1C, PSS1C, PUBHh, and PUBHx) with permanent, temporary or seasonal flooding regimes. The total acreage of wetland identified by the US Fish and Wildlife service in the National Wetland Inventory was 470.7 acres (DCEMC, 1995).

HJ-37

This 540-acre wetland is located near Route 52, Rt. 82 and Palen Rd. in the Town of East Fishkill. Ownership within this wetland is primarily private, with IBM Corporation owning multiple parcels totaling 185 acres. The Town of East Fishkill owns a small portion totaling 16.5 acres. The wetland is designated by the state as a class 2 wetland and an environmentally significant area due to the presence of a rare plant species. The wetland contains the Fishkill Creek main stem, classified as B(T), which is suitable for primary contact recreation and trout survival. It also contains tributaries to the Fishkill Creek including Sprout Creek, Gildersleeve Brook, Trout Creek, and Bloomer Brook. In 1995, a total of 67 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped HJ-37. The wetland types consisted of lacustrine limnetic unconsolidated bottom, palustrine emergent marsh, palustrine forested, palustrine scrub shrub, palustrine unconsolidated shore, and riverine lower perennial unconsolidated bottom (L1UBHh, PEM1/SS1C, PEM1E, PFO1A, PFO1C, PFO1Cd, PFO1Ch, PFO1E, PSS1E, PUBHx, PUSCh, and R2UBH) with permanent, temporary or seasonal flooding regimes. The federally identified wetlands ranged in size from 0.2 to 40 acres, totaling 225 acres. HJ-37 provides a linkage to other wetlands in the watershed including HJ-56 (Class 2, 43 acres), HJ-69 (Class 3, 22 acres), HJ-70 (Class 4, 29 acres), HJ-57 (Class 2, 21 acres), HJ-43 (Class 3, 15 acres), HJ-41 (Class 2, 38 acres), and HJ-33 (Class 2, 41 acres).

PQ-8

This wetland located in the Towns of East Fishkill and Beekman encompasses 263 acres. A portion (94 acres) of this wetland is owned by the NYS Green Haven Prison, and the remaining portion is in private ownership. PQ-8 is located near New Hackensack Road (Rt. 216), Phillips Road, Benton Moore Road and Moonlight Drive. It is designated as a class 2 wetland and regulated entirely by the state government. The upper portion is characterized as a sensitive site. The Fishkill Creek and a tributary to the creek flow through this wetland. The stream is capable of supporting trout and other fish species. In 1995, a total of 23 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped PQ-8. The wetland types included palustrine emergent marsh, palustrine forested, palustrine scrub shrub and palustrine unconsolidated bottom with artificial, seasonal, semi permanent and temporary flooding regimes. The federal wetlands ranged in size from 0.1 to 77 acres, totaling 154 acres.

VB-26

VB-26 is a state-regulated, class 2 wetland totaling 232 acres that are entirely in private ownership. The wetland is located in close proximity to Bruzgul Rd (CR. 21), West Clove Mountain Rd. and Clove Rd (CR. 9) in the Town of Unionvale. The Fishkill Creek (Class C(T)) and a tributary to Clove Valley Creek (Class C) flow through this wetland. McKinney Pond is also located within this wetland. In 1995, a total of 52 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped VB-26. The wetland types consisted of palustrine emergent marsh, palustrine forested, palustrine scrub shrub and palustrine unconsolidated bottom with temporary, permanent, seasonal, and semi permanent flooding regimes. The national wetland inventory wetlands ranged in size from 0.13 to 42 acres, totaling 290 acres. According to a field survey conducted by the Dutchess County Environmental Management Council (1977), wetland plants consisted of red maple, dogwood, willow, alder, tussock sedge, bulrush, water plantain, cattail, buttonbush, false nettle, jewelweed, white ash, spicebush, and skunk cabbage. Three rare plants were present including royal, lady and cinnamon ferns. Wildlife present on the wetland included deer, fox sparrow, red-winged blackbird, blue jay, white-throated sparrow, catbird, gold finch, rabbit and grouse.

HJ-54

HJ-54, commonly known as Townsend Swamp, is a class 1 wetland in the Town of East Fishkill designated as New York Significant Habitat. This wetland encompasses 210 acres in close proximity to I-84, Townsend Rd. and Shenandoah Road. In 1995, a total of 24 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped HJ-54. The wetland types consisted of palustrine forested, palustrine scrub shrub, palustrine emergent, and palustrine unconsolidated bottom with temporary, seasonal, semi permanent, and permanent flooding regimes. The total acreage of national wetland inventory wetlands was 187 acres, with the three largest federal wetlands characterized as palustrine forested. Streams that flow through this wetland include Wickopee Creek (HR-95-13) (Class C(T)) and tributaries to Wickopee Creek. (Note, Wickopee Creek (HR-95-13) and Wiccopee Creek (HR-95-8) are different streams).

PV-53

PV-53 is a 204-acre wetland located adjacent to Robinson Lane and Hillside Lake Road (CR. 33) in the towns of La Grange, East Fishkill and Wappinger. This class 1 wetland is designated as a sensitive site by the state due to the presence of a NYS threatened animal (the name of which remains classified for its safety). Sprout Creek (Class C(T)), a subtributary to Sprout Creek (Class C) and Jackson Creek (Class C(TS)) flow through this wetland. According to a Dutchess County Environmental Management Council survey (1977), vegetation present in this wetland included red maple, dogwood, spicebush and purple loosestrife. In 1995, a total of 22 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped PV-53, totaling 111 acres. The wetland types present included palustrine emergent, palustrine forested, palustrine scrub shrub and palustrine unconsolidated bottom with temporary, seasonal, semi-permanent and permanent flooding regimes. This wetland is surrounded by residential development owned by private landowners.

VB-16

VB-16 is a 176-acre, NYSDEC class 2 wetland located near Clove Rd., North Clove Rd. and West Clove Mountain Rd in the Town of Union Vale. In 1995, a total of 17 U.S. Fish and Wildlife Service National

Wetlands Inventory classified wetlands overlapped VB-16, totaling 115 acres. The wetlands types included palustrine forested, palustrine scrub shrub, palustrine emergent marsh and palustrine unconsolidated bottom with temporary, seasonal, and permanent flooding regimes. Streams that flow through this wetland include Clove Valley Creek and Sweezy Creek, both classified as C(T), offering suitable habitat for trout. This wetland also contains Pray Pond (11 acres), which flows into a stream that connects to a larger state wetland (VB-26) made up of three sections totaling 232 acres. The wetland complex and various streams form the headwaters of the Fishkill Creek. According to a survey conducted by the Dutchess County Environmental Management Council (1977), wetland plants consisted of red maple, black ash, swamp white oak, tussock sedge, cattail, elm, speckled alder, willow and dogwood. Other plants (either rare, endangered, unique or protected) included purple-fringed orchis, New York fern, Massachusetts fern, ground pine, cardinal flower, grass of parnassis and stargrass. Wildlife included painted turtles, house wren, deer, minnows, black-capped chickadees, redwing blackbirds, catbirds, cedar waxwings, blue jays, green heron and brook trout.

HJ-44

This NYSDEC, class 2 wetland consists of two separate wetlands totaling 121 acres in the Town of East Fishkill. HJ-44 is adjacent to Harrigan and Binnewater Rds., both off of Rt. 52. In 1995, a total of 14 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped HJ-44, totaling 84 acres. Ranging in size from .36 to 37 acres, the wetland types included palustrine emergent, palustrine forested and palustrine unconsolidated bottom with temporary, seasonal, semi permanent and permanent flooding regimes. Streams and waterbodies within this wetland include a tributary of Wickopee Creek and Penneywater pond (8.3 acres).

PQ-10

PQ-10 is a NYSDEC, class 2 wetland made up of 8 wetland areas totaling 119 acres in the Town of Pawling. The portion of this wetland south of Route 55 was designated an environmentally sensitive area by the town of Pawling. In 1995, a total of 15 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped PQ-10. Ranging in size from 0.2 to 33 acres, the wetland types included palustrine forested and palustrine scrub shrub with seasonal flooding regimes. At the southern end of this wetland is Whaley Lake (NYSDEC Class B), which totals 252 acres and is designated as a critical environmental area. Flowing through this wetland is a perennial stream, Whaley Lake Brook (Class C (TS)) that is the outflow of Whaley Lake. At the northern end of the wetland is Nuclear Lake, which drains into a tributary of Whaley Lake Brook. The Appalachian Trail runs north of this wetland. Ownership is both public and private with the northern half, and adjacent area, owned by the National Park Service and the southern half and adjacent area owned by private landowners.

VB-3

VB-3 is a NYSDEC, class 2 wetland consisting of two wetland areas totaling 141 acres in the Town of Union Vale. In 1995, a total of 15 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped VB-3, totaling 107 acres. Wetland types included palustrine emergent marsh, palustrine forested, palustrine unconsolidated bottom and palustrine scrub shrub with seasonal and permanent flooding regimes. Streams that flow through this wetland include Sprout Creek and a tributary to Sprout Creek. The Sprout Creek tributary continues to flow through a network of streams into wetland VB-43 (13 acres), eventually reaching Tyrell Lake (49 acres). The southern portion of this wetland is designated an environmentally sensitive area that extends to VB-43.

HJ-73

This wetland is located between Robinson Lane and Hillside Lake Rd (CR. 33) in the Towns of East Fishkill and Wappinger. HJ-73 is a NYSDEC, class 3 wetland consisting of three areas totaling 145 acres. The upper portion of this wetland is within an environmentally significant area that connects to PV-53 and PV-57 (101 acres). Sprout Creek flows through this wetland, which then continues to flow to nearby wetlands including HJ-6 (32 acres), HJ-72 (33 acres), HJ-33 (40 acres), and HJ-37 (540 acres). Hillside Lake is also in close proximity to HJ-73. In 1995, a total of 18 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped HJ-73, totaling 115 acres. Wetland types included palustrine forested, palustrine scrub shrub, palustrine emergent marsh and palustrine unconsolidated bottom with temporary, seasonal and permanent flooding regimes.

VB-37

This 122-acre wetland is located in the Town of Beekman, with the upper portion between Hynes Rd. and Rt. 55 and the lower portion off of Beekman-Poughquag Rd. VB-37 is a NYSDEC, class 2 wetland that provides a connection to various wetlands in the town of Union Vale, as well as Whaley Lake in the town of Pawling. Streams that flow through this wetland include a tributary of Whaley Lake Brook and a subtributary of the Fishkill Creek. The tributary of Whaley Lake Brook continues to flow through interconnected streams to PQ-10 in the Town of Pawling. A subtributary of the Fishkill Creek flows from VB-37 to VB-33, a 21-acre, class 3 designated wetland and VB-36, a 13-acre, class 2 designated wetland. The subtributary of the Fishkill Creek flows into a tributary of Clove Valley Creek, which reaches its terminus below the southern portion of VB-26, a 232-acre, class 2 wetland. In 1995, a total of 18 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped VB-37, totaling 66 acres. Ranging in size from 0.1 to 13 acres, wetland types included palustrine emergent marsh, palustrine forested, palustrine scrub shrub, and palustrine unconsolidated bottom with temporary, seasonal and permanent flooding regimes.

WF-12

This 111-acre, class 2 designated wetland is located in the towns of Fishkill and Wappinger. It is located adjacent to Smithtown Rd., Cooper Rd. and Route 9 and is entirely in private ownership. WF-12 is designated as an environmentally significant area due to the presence of a rare plant. Stephens Brook (Class C(T)) flows through this wetland, into a national wetland inventory wetland classified as PFO1Ed (14 acres) and continues until it empties into the Fishkill Creek. In 1995, a total of 15 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped WF-12, totaling 85 acres. Wetland types included palustrine forested and palustrine scrub shrub with seasonal flooding regimes.

HJ-15

This 173-acre, class 1 designated wetland is located off of Lake Walton Rd. in the town of East Fishkill. The wetland is made up of 7 areas with the lower portion (94 acres) designated as an environmentally significant area. Private landowners primarily own HJ-15 with the exception of a 3-acre parcel (adjacent to Lake Walton) owned by the Town of East Fishkill. Streams, which flow through this wetland, consist of two unnamed tributaries of the Fishkill Creek. Lake Walton, a 41-acre, NYSDEC, class B designated lake and five unnamed ponds are also within the wetland system. The unnamed tributaries of the Fishkill Creek flow southward connecting to HJ-18, a 35-acre, NYSDEC class 2 designated wetland, which then connects to HJ-77. HJ-77 is a 29-acre, class 2 designated wetland that connects to HJ-37 (class 2, 540-acres), which connects to many wetlands in the Town of East Fishkill (for further information, refer to description above). In 1995, a total of 22 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped HJ-15, totaling 138 acres. Wetland types included lacustrine unconsolidated bottom, palustrine forested, palustrine scrub shrub and palustrine unconsolidated bottom with seasonal, semi permanent and permanent flooding regimes.

HJ-20

HJ-20 is a NYSDEC class 3, 112-acre wetland in the Town of East Fishkill. It is located adjacent to New Hackensack Rd. between Stormville Rd. and Carpenter Rd. Ownership within the wetland is primarily private, with the exception of a 17-acre parcel owned by the Town of East Fishkill. A tributary of Wickopee Creek flows through HJ-20, and continues to flow through other wetlands including HJ-29 (class 2, 16 acres), HJ-40 (class 3, 88 acres), HJ-48 (class 3, 34 acres) and HJ-54 (231 acres). In 1995, a total of 11 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped HJ-20, totaling 110 acres. Wetland types included palustrine emergent marsh, palustrine forested, palustrine scrub shrub and palustrine unconsolidated bottom with temporary, seasonal and permanent flooding regimes.

HJ-53

This NYSDEC, class 3 wetland encompasses 128 acres in the Town of East Fishkill. HJ-53, located between Rt. 52 and Shenandoah Rd, is entirely in private ownership. A tributary of the Wiccopee Creek flows through this wetland connecting it to national wetlands inventory wetlands including PEM1/SS1Cd (4 acres), PFO1A (27 acres), PFO1A (17 acres), and PUBHh (12 acres). In 1995, a total of 6 U.S. Fish and Wildlife Service National Wetlands Inventory classified wetlands overlapped HJ-53, totaling 110 acres. Wetland types included, palustrine forested, palustrine emergent marsh and palustrine scrub shrub with seasonal flooding regimes.

Geology and Groundwater

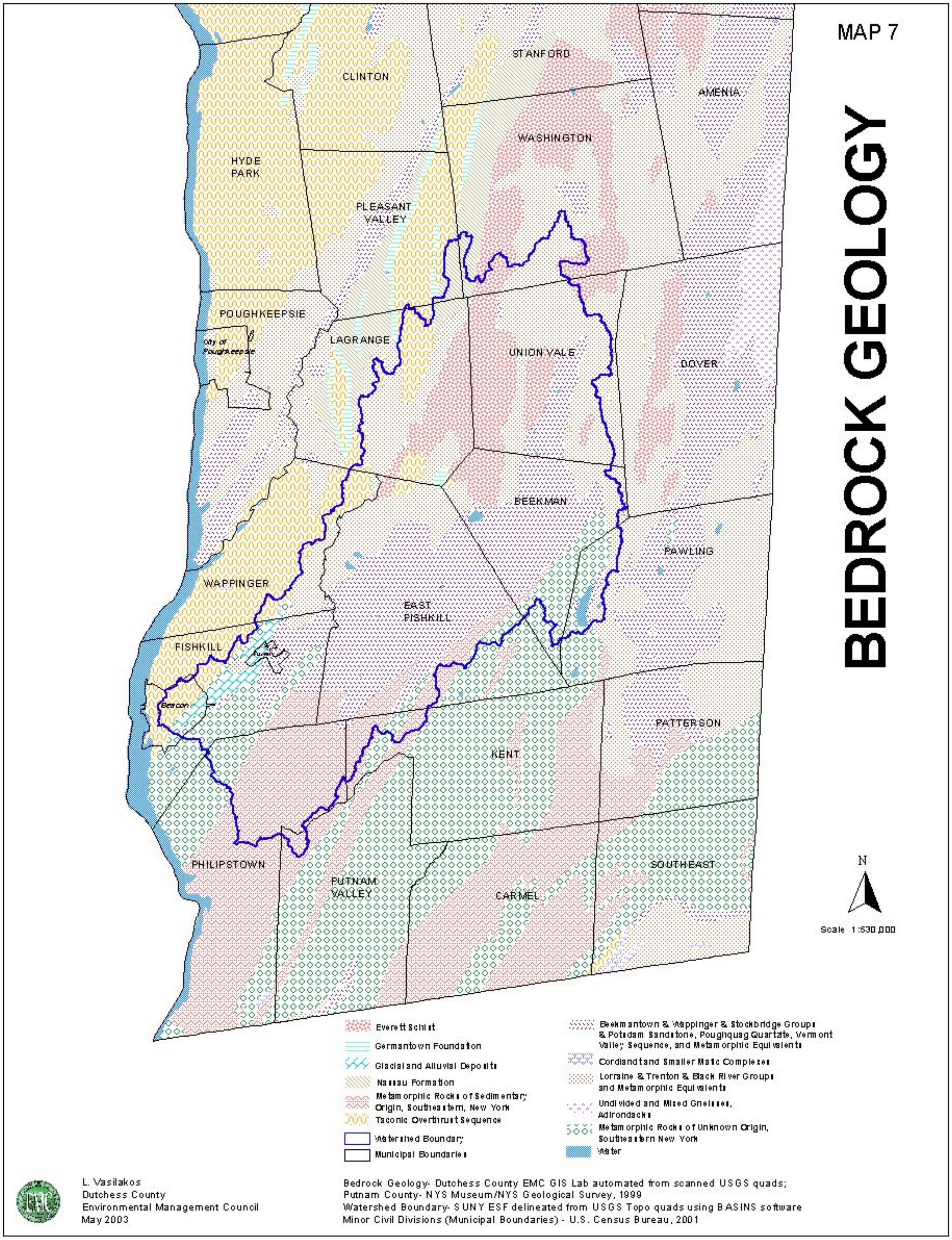
Bedrock Geology

The Fishkill Creek watershed covers portions of two physiographic regions including the Hudson Highlands and Mid-Hudson Valley. Distinctly different types of bedrock dominate each physiographic region. Most of the watershed covers a portion of the Mid-Hudson Valley and is underlain by sedimentary and meta-sedimentary rocks formed in the early Paleozoic Era (540 million years old to 450 million years old). The remainder of the watershed covers part of the Hudson Highlands where the bedrock is predominantly high temperature and pressure metamorphic gneisses of Pre-Cambrian age (more than 1 billion years old).

The bedrock exposed in the Mid-Hudson Valley was formed as shales, siltstones, sandstones and dolomitic limestones during the Cambrian and Ordovician Periods within the early Paleozoic Era (NYS Museum, 1991). These rocks include the Everett Schist, Germantown Formation, Nassau Formation and the Taconic Overthrust Sequence units shown in Map 7. These rocks were modified by metamorphism and a series of large faults during the formation of the Appalachian Mountains. Metamorphism by higher and higher temperatures and pressures can be observed as one travels eastward across Dutchess County (Barth, 1936). What occurs as shale in western Dutchess County has been modified to the rock phyllite in central Dutchess County and schist in the east. The limestones of western Dutchess County become marbles as you move eastward. Finally, sandstone in the west becomes quartzite in the eastern part of the county. According to the Geologic Map of New York (1986), large thrust faults cross the area and trend roughly northeast-southwest. Enormous masses of rock were displaced along these thrust faults toward the northwest during the formation of the Appalachian Mountains. Bedrock categorized as the “Taconic Overthrust Sequence” was moved great distances along the thrust faults (Map 7).

The limestones and marbles within the watershed are significant because these rocks may create better aquifers than the shales, which are very common in the Mid-Hudson Valley. These rock units are designated by the Beekmantown, Wappinger and Stockbridge Groups (Map 7). A comparison of the Bedrock Geology map with the Aquifer Map (Map 9) shows that most of the aquifer within the watershed is underlain by limestone and marble.

The bedrock of the Hudson Highlands is dominated by ancient and very high temperature and pressure metamorphic gneisses with lesser amounts of granite, amphibolite, etc. The gneisses have been sub-divided according to mineralogy (e.g. “biotite-quartz-plagioclase gneiss” and “garnet-biotite-quartz-feldspar gneiss”). Minor amounts of granite, amphibolite and mafic composition igneous rocks also occur in the Hudson Highlands. The Poughquag Quartzite is Cambrian in age and often located along the margins of the Hudson Highlands on topographically high ground.


MAP 7
BEDROCK GEOLOGY
STANFORD
CLINTON
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
SOUTHEAST
PUTNAM VALLEY
CARMEL
N
Scale 1:530,000
Everett Schist
Germantown Foundation
Glacial and Alluvial Deposits
Nassau Formation
Metamorphic Rocks of Sedimentary Origin, Southeastern, New York
Taconic Overthrust Sequence
Watershed Boundary
Municipal Boundaries
Beekmantown & Wappinger & Stockbridge Groups & Potsdam Sandstone, Poughquag Quartzite, Vermont Valley Sequence, and Metamorphic Equivalents
Cordlandt and Smaller Mafic Complexes
Lorraine & Trenton & Black River Groups and Metamorphic Equivalents
Undivided and Mixed Gneisses, Adirondacks
Metamorphic Rocks of Unknown Origin, Southeastern New York
Water
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003
Bedrock Geology- Dutchess County EMC GIS Lab automated from scanned USGS quads;
Putnam County- NYS Museum/NYS Geological Survey, 1999
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software
Minor Civil Divisions (Municipal Boundaries) - U.S. Census Bureau, 2001

Surficial Geology

Surficial deposits are loose sand, gravel, silt and mud that often overlie the bedrock of our region (Map 8). These deposits can be divided into glacial deposits left behind by the glaciers during the Ice Ages, and alluvial deposits, which were left by flowing water after the retreat of the glaciers. Alluvial deposits are usually confined to stream and river valley bottoms. Alluvial fans are cone-shaped piles of sediment deposited when a fast flowing mountain stream abruptly slows down upon leaving the mountains. Glacial deposits can be sub-divided into many different categories such as till, outwash, kames and lake (lacustrine) deposits. Some of the glacial deposits make good aquifers, while others do not.

Till is the most abundant surficial deposit within the watershed (Map 8) and is characterized by a great variety of different particle sizes ranging from boulders through sand to microscopic clay particles mixed together. Till is deposited directly from glacial ice. Outwash deposits usually consist of layered sand and gravel, which were left behind by streams as the glaciers melted. As the glaciers melted, temporary lakes were also created. Sediments deposited in these lacustrine environments can range from sand to silt to clay. Lacustrine deposits usually have only one-grain size in a given location. Kame deposits consist of layered sand and gravel that form near the edge of the glacier. Outwash, kame and lacustrine sand deposits are sometimes utilized as aquifers. Glacial till and lacustrine silt and clay are rarely used as aquifers because they do not have the necessary water storage characteristics.

Aquifer Characteristics

Three important characteristics of aquifers are porosity, permeability and recharge. Porosity is simply the amount of pore space within the material. A material with abundant pore space can hold a large amount of groundwater. Permeability is the ease with which water can move through the material. Its value depends upon how interconnected and large the pore spaces are. An aquifer with high permeability can have water pumped out of it rapidly. Recharge is the process whereby precipitation (rain and snow) replenishes the water in the aquifer. Fortunately, in this region there is adequate rainfall to recharge our aquifers except during prolonged periods of drought.

Outwash, kame and lacustrine sand deposits usually have both high porosity and high permeability and therefore can be used as aquifers. However, these same characteristics mean that any contamination will spread rapidly through the aquifer. The limestones and marbles of the Mid-Hudson Valley had rather low porosity and permeability originally. However, limestone slowly dissolves in water so thin fractures widen over time. This can create a series of interconnected openings (even caverns) through which groundwater travels rapidly. Limestone deposits that have these solution features make excellent aquifers but are at risk of contamination similar to the aforementioned surficial deposits.

Generally speaking, the shales of the Mid-Hudson Valley and the gneisses of the Hudson Highlands make mediocre to poor aquifers. However, these can often be utilized by individual homes especially if the well intersects a fracture containing water.

The Groundwater Connection

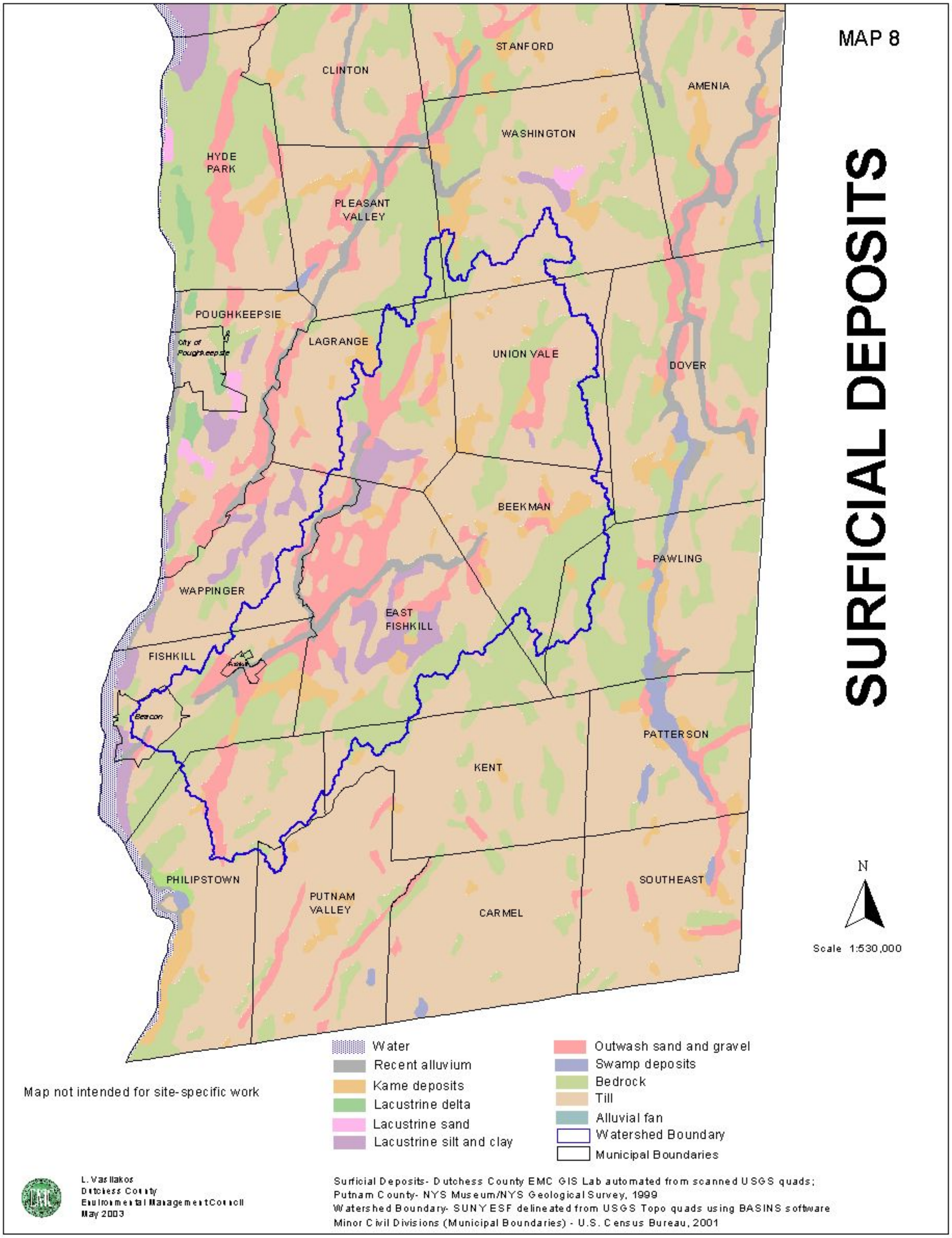
1. During dry periods, water in the Fishkill Creek consists solely of groundwater discharging from aquifers in the watershed, and treated wastewater returns from wastewater treatment plants.
2. Under 10-year drought conditions, Fishkill Creek flows measured at Beacon drops to approximately 4 million gallons per day (gpd).
3. The Watershed above Beacon contains 190 square miles, or 121,600 acres.
4. This means that during drought periods, the aquifers under each acre in the watershed contribute approximately 33 gallons per day to the Fishkill Creek or its tributaries.
5. Since the average person consumes 20 or more gallons per day*, wherever population equals 2 persons per acre and local wells are in use, groundwater no longer reaches the Fishkill Creek during droughts.
6. And wherever populations using local wells exceed 2 persons per acre, deficit withdrawals are occurring and stream flow is reduced, affecting fish survival, wildlife habitat, swimming, boating, and water quality.

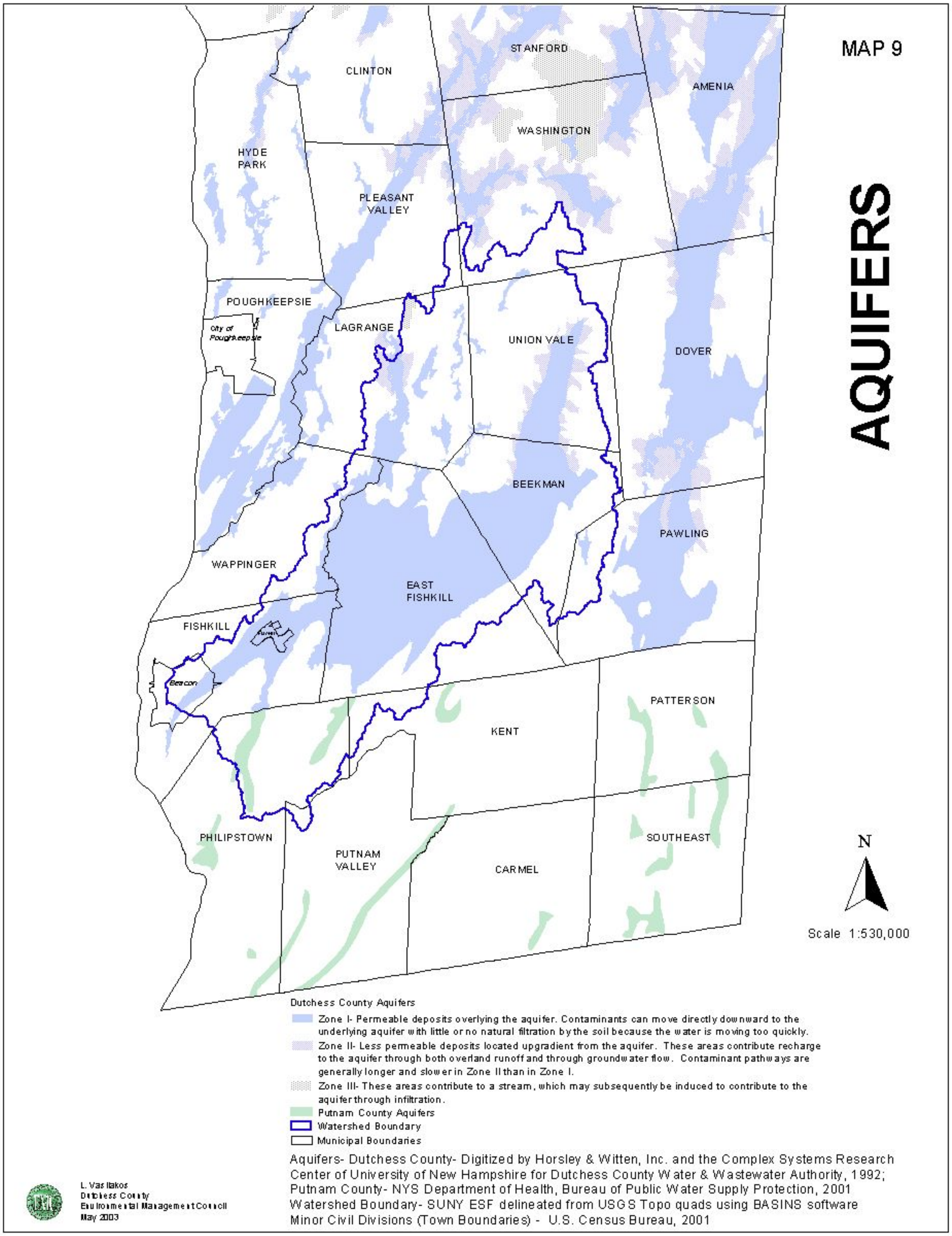
*Consumption is the difference between water entering the home and water returned to nature through septic systems or sewage treatment plants. Per capita water consumption for individuals using septic systems is probably higher than 20 gpd due to evapotranspiration losses off leaching fields.

Other Groundwater Factors

1. Where individual wells and septic systems are used, a USGS model predicts that groundwater quality suffers if average lot sizes drop below 3 acres where soils contain clay or silt or below 1.5 acres in areas with sandy soils.
2. Road salt can locally harm groundwater quality if melting snow-salt mixture drains to low areas near wells.
3. A Dutchess County Water & Wastewater Authority study shows that E-coli levels in private wells can increase during extended drought periods, potentially as a result of proximity to septic systems.
4. The Dutchess County Water & Wastewater Authority monitors groundwater levels in a network of groundwater wells across Dutchess County.
5. Phase II stormwater regulations offer an opportunity to preserve groundwater recharge if synergies are sought between soil conservation and groundwater preservation objectives.

Provided by Russell Urban-Mead, Hydrogeologist, The Chazen Companies


MAP 8
SURFICIAL DEPOSITS
STANFORD
CLINTON
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
N
Scale 1:530,000
Water
Recent alluvium
Kame deposits
Lacustrine delta
Lacustrine sand
Lacustrine silt and clay
Outwash sand and gravel
Swamp deposits
Bedrock
Till
Alluvial fan
Watershed Boundary
Municipal Boundaries
Map not intended for site-specific work
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003
Surficial Deposits- Dutchess County EMC GIS Lab automated from scanned USGS quads;
Putnam County- NYS Museum/NYS Geological Survey, 1999
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software
Minor Civil Divisions (Municipal Boundaries) - U.S. Census Bureau, 2001


MAP 9
AQUIFERS
STANFORD
CLINTON
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
SOUTHEAST
PUTNAM VALLEY
CARMEL
N
Scale 1:530,000
Dutchess County Aquifers
Zone I- Permeable deposits overlying the aquifer. Contaminants can move directly downward to the underlying aquifer with little or no natural filtration by the soil because the water is moving too quickly.
Zone II- Less permeable deposits located upgradient from the aquifer. These areas contribute recharge to the aquifer through both overland runoff and through groundwater flow. Contaminant pathways are generally longer and slower in Zone II than in Zone I.
Zone III- These areas contribute to a stream, which may subsequently be induced to contribute to the aquifer through infiltration.
Putnam County Aquifers
Watershed Boundary
Municipal Boundaries
Aquifers- Dutchess County- Digitized by Horsley & Witten, Inc. and the Complex Systems Research Center of University of New Hampshire for Dutchess County Water & Wastewater Authority, 1992;
Putnam County- NYS Department of Health, Bureau of Public Water Supply Protection, 2001
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software
Minor Civil Divisions (Town Boundaries) - U.S. Census Bureau, 2001
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003

Climate

The Fishkill Creek watershed has a humid continental climate with strong seasonal temperature variability and periods of unusually warm or cold weather (Mackenzie, 2001). Coldest weather occurs when Arctic air masses from Canada cover the region. Warmest weather generally occurs when a stationary high-pressure region forms over the Atlantic Ocean and the circulation around the high draws warm air into our region from the south or southwest for extended periods of time. The presence of the Atlantic Ocean nearby tends to moderate temperature fluctuations somewhat and provide a source of moisture for precipitation (DCDPD and DCEMC, 1985). Weather data was recorded at the Dutchess County Airport, Wappinger, NY and in Millbrook, NY. The airport station is located a few miles west of the Fishkill Creek watershed, while the Millbrook station is located just north of the watershed.

At the Dutchess County Airport, the average annual temperature for a 30-yr period was 49.3 °F, with monthly mean temperatures ranging from 24.7 °F in January to 72.4 °F in July (Mackenzie, 2001). Average annual precipitation was 43.8 inches, and varies from a minimum monthly mean of 2.6 inches in February to 4.8 inches in May (Mackenzie, 2001). Average annual snowfall was 34.5 inches, with the maximum monthly mean snowfall of 10.6 inches occurring in January (Mackenzie, 2001). The average annual heating degree-days was 6,267, while the average annual cooling degree days was 645 (Mackenzie, 2001). Similar statistics have been generated for the Dutchess County Airport station over a twenty-nine year period from 1951 to 1980 (NOAA, 1985). At the airport, the average annual temperature was 47.4 F, and average annual precipitation was 40.6 inches (NOAA, 1985). A weather station at the Institute of Ecosystem Studies (IES) in Millbrook has measured pH (acidity) of precipitation since 1984. The average pH of precipitation was 4.27, with monthly averages ranging from 4.00 in July to 4.54 in November (Kelly et al., 2002). In 2003, the average pH of precipitation was 4.52, ranging from 4.18 in July to 4.87 in January. The pH of precipitation in Dutchess County is 10 times more acidic than natural precipitation, which typically has an average pH of 5.2.

Comparison of Precipitation and Stream flow

Stream flow within the watershed was measured by the United States Geological Survey (USGS) at several locations: Fishkill Creek at Bridge Street in Beacon (station #01373500) from 1944 to 1968, Fishkill Creek at Hopewell Junction (#01372800) from 1964 to 1975, East Mt. South on Clove Creek (#01372950) from 1956 to 1962 and the Highway Department on Clove Creek on various days from 1962 to 1973. The USGS also measured stream flow during the passage of Tropical Storm Floyd in September of 1999 at the Beacon station. Finally, base flow of the Fishkill Creek was measured at the Beacon station on three days in 2001 and 2002 by The Chazen Companies (Chazen Companies, 2003). The total volume of stream flow depends in part on the amount of surface runoff due to precipitation, and in part on base flow due to discharge of groundwater into the stream in a "gaining" stream. If water from the stream percolates downward into the ground it is called a "losing" stream. In a losing stream, the stream flow is determined by the amount of surface runoff minus the water lost downward.

The average annual discharge from the Beacon gauging station (1945-1967) showed a downward trend over time with an R-squared value of 0.183 (Figure 5). This equation suggests that stream flow at Beacon should decrease to zero late in the year 2002. This has not been observed, in fact, the Chazen Companies (2003) measured base flow in the same location in 2001 and 2002, which ranged from 13.5 cubic feet per second (cfs) to 26.7 cfs (these are minimum flows, the average annual discharge would be significantly higher). Unfortunately, there isn't any data from 1967 until 2001 to resolve the discrepancy. Possible reasons include, the 22-year USGS data could be unrepresentative of the long-term trend, conditions in the watershed may have changed since 1967, and/or precipitation patterns or measurement methodology were different in the 1945 to 1967 study period. For example, a very significant drought occurred in the mid-1960s and may have biased the USGS data set. Land use has also changed significantly since 1967 in the Fishkill Creek watershed. Deforestation and increased amounts of impervious surfaces tend to increase the proportion of precipitation running off into streams. Since 1967, the construction of several sewage treatment plants may have contributed to stream flow additions to the Fishkill Creek. It remains to be verified, which if any of these changes account for the discrepancy mentioned above. While the minimum discharge measured was 13.5 cfs in September 2002, the maximum monthly stream flow was 1,075 cfs in October 1955 when a hurricane traveled across the area.

The annual average discharge at the Beacon station versus the annual precipitation measured at the Millbrook weather station results in a best-fit trendline with the equation - $Y = 10.775X – 141.45$; R squared = 0.698 (Figure 6). This equation is a simple mathematical model of the stream flow response to variations in precipitation. The equation suggests that the Fishkill Creek is a losing stream with approximately 140 cfs of water disappearing. The best-fit trendline also suggests that stream flow would fall to zero if annual precipitation dropped to about 13 inches.

Based on USGS discharge measurements recorded between 1964 and 1975, annual discharge of the Fishkill Creek near Hopewell Junction, about 20 miles upstream of the Beacon station showed an increase in stream flow (Figure 7). The best-fit trendline to this data follows the equation – Y = 7.7238X – 15123; R squared = 0.626. This data set only spans twelve years, and the first three data points are unusually low due to the drought in the mid-1960s, thus the data set may be unrepresentative of a long-term average. The apparent increase in stream flow over time may be due to deforestation, increased amount of impervious surfaces, the construction of sewage treatment plants that discharge into the Fishkill Creek upstream or an unusual set of weather data. In September of 1999, the USGS measured the discharge at this location as 2,370 cfs during the passage of Tropical Storm Floyd.

Figure 5: Average Annual Fishkill Creek Discharge, Beacon - 1945-1967

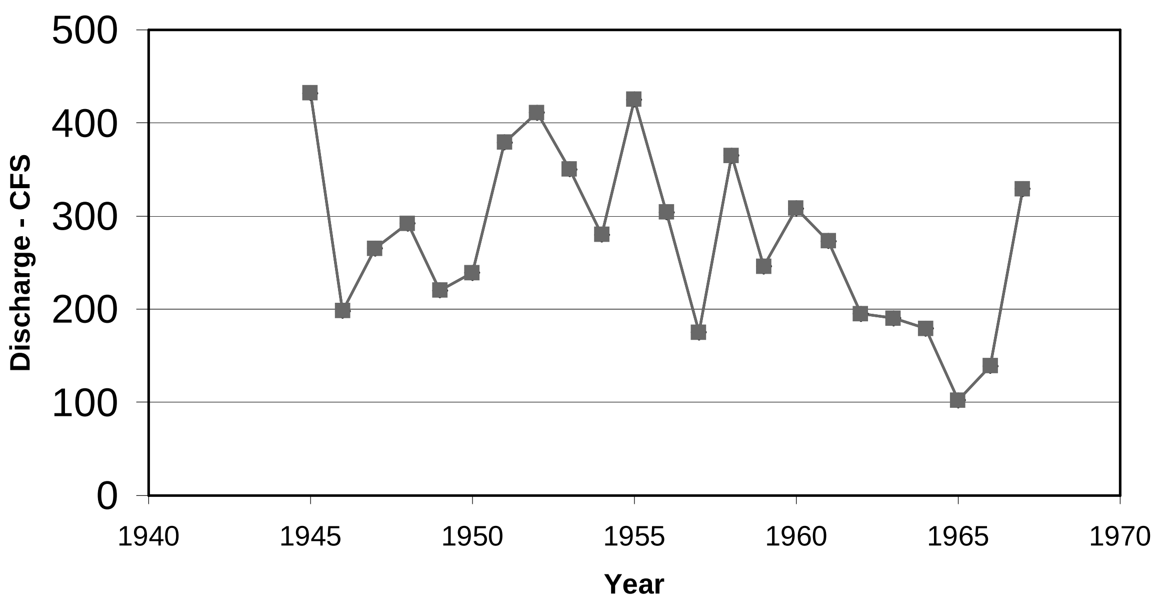


Figure 6. Mean Annual Precipitation vs. Annual Discharge for Beacon, NY - 1950-1967

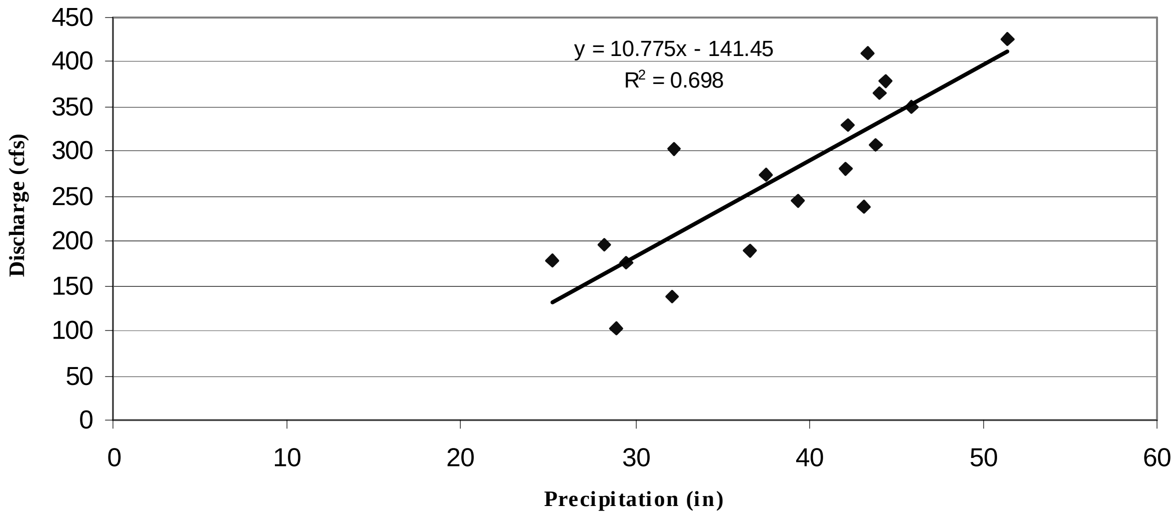
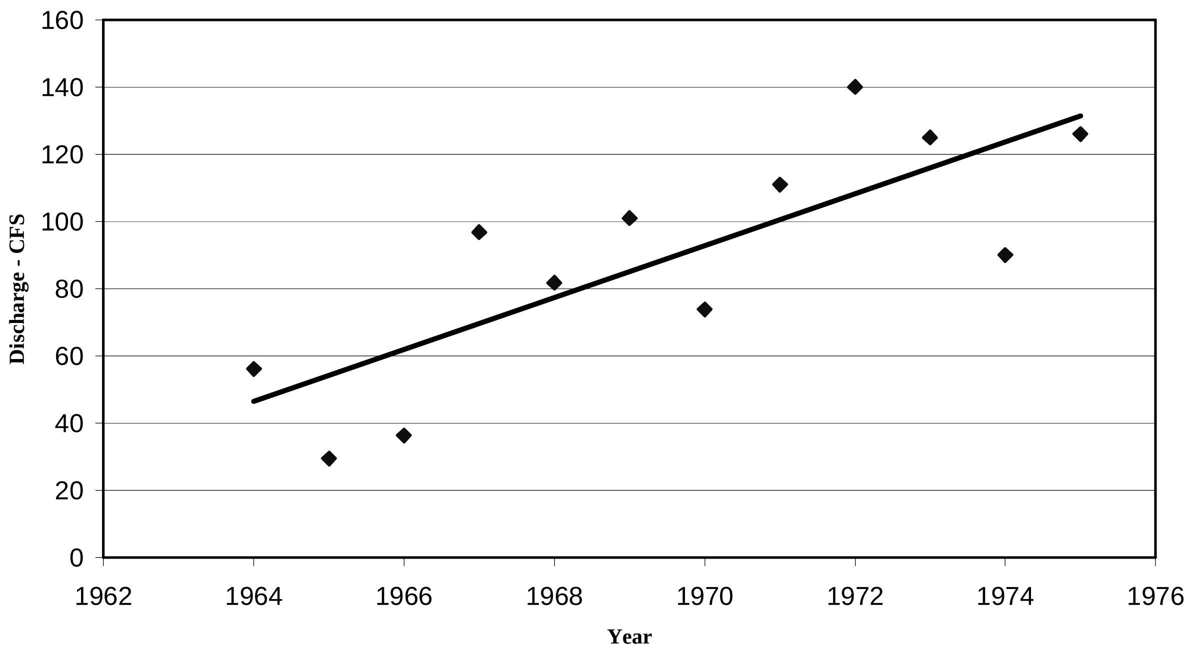


Figure 7. Average Annual Fishkill Creek Discharge, Hopewell Junction - 1964 - 1975



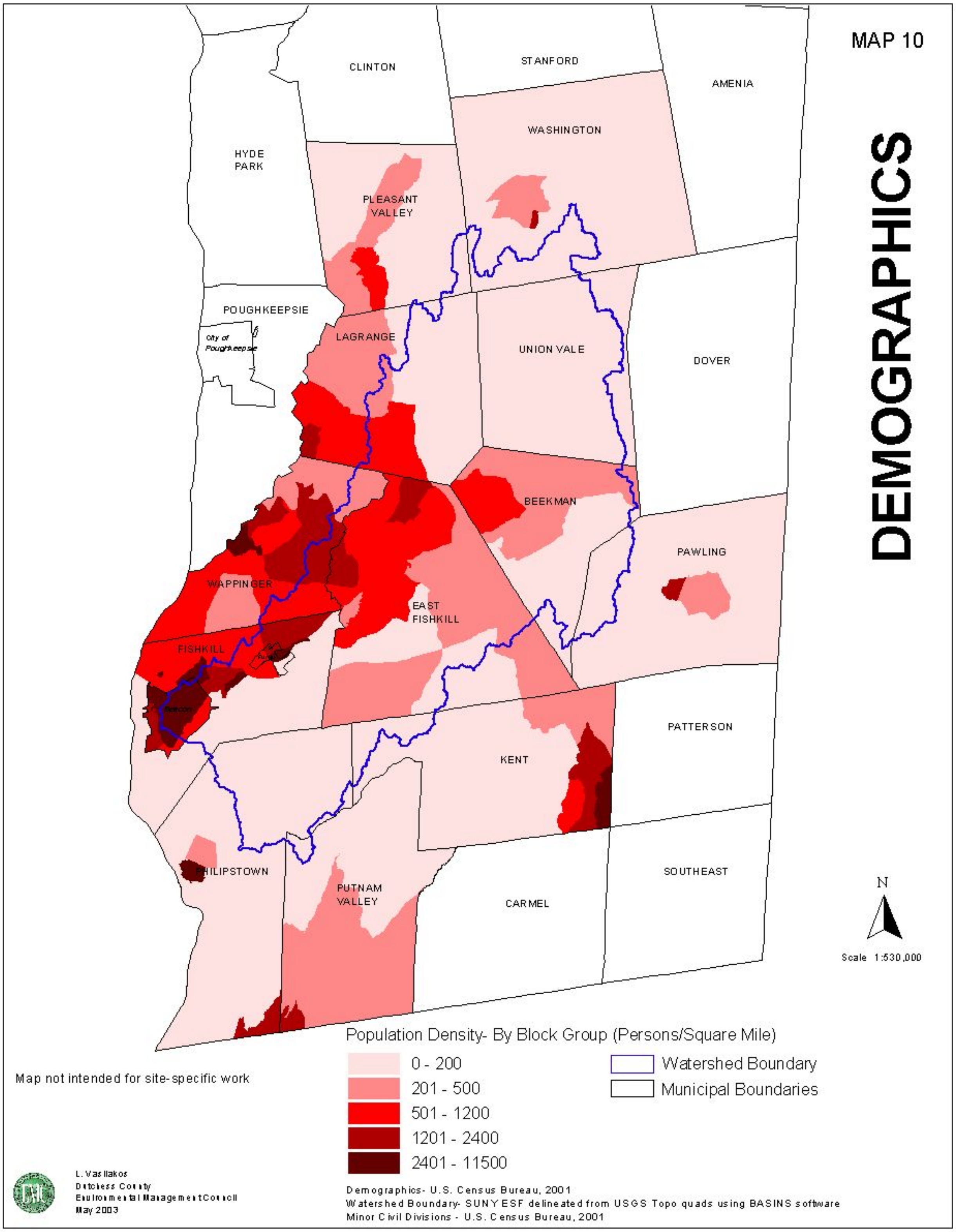
Demographics

In 2000, the population of watershed municipalities ranged from 1,735 in the Village of Pawling to 26,274 in the Town of Wappinger (Table 21). The City of Beacon had the highest population density with 2,892 persons per square mile, while the Town of Washington had the lowest with 80 persons per square mile (Table 21, Map 10). The southern portion of the watershed has experienced the most growth, with the towns of Fishkill, East Fishkill and Wappinger exceeding 20,000 people. The population growth in these towns has contributed to intense development, which can greatly impact the quality and quantity of water in the watershed.

Table 21. Demographics for Municipalities in the Fishkill Creek Watershed.
(Source: Census 2000 Summary File 1 (SF1) [New York]/prepared by U.S. Census Bureau, 2001)

Municipality	Total Population	Population Density (persons/square mile)
BEACON (C)	13,808	2,892
BEEKMAN	11,452	382
EAST FISHKILL	25,589	450
FISHKILL (T)	20,258	625
FISHKILL (V)	1,735	608
KENT	14,009	345
LA GRANGE	14,928	376
PAWLING	7521	167
PHILIPSTOWN	9422	183
PLEASANT VALLEY	9,066	275
PUTNAM VALLEY	10,686	258
UNION VALE	4,546	121
WAPPINGER	26,274	919
WASHINGTON	4,742	80

Note: Town of Fishkill, Town of Pawling, Town of Philipstown, Town of Wappinger and Town of Washington were adjusted to account for population within the town without the incorporated villages (e.g. The Town of Pawling population does not include the Village of Pawling)


MAP 10
DEMOGRAPHICS
CLINTON
STANFORD
AMENIA
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LAGRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
N
Scale 1:530,000
Population Density- By Block Group (Persons/Square Mile)
0 - 200
201 - 500
501 - 1200
1201 - 2400
2401 - 11500
Watershed Boundary
Municipal Boundaries
Map not intended for site-specific work
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003
Demographics- U.S. Census Bureau, 2001
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software
Minor Civil Divisions - U.S. Census Bureau, 2001

Recreation

Within the Fishkill Creek watershed, there are many recreational areas composed of state and town parks, state forests, and private preserves (Table 22). These areas offer many recreational opportunities including hiking, swimming, fishing, mountain biking, horseback riding, boating, picnicking, cross-country skiing, and snowshoeing. Many towns in the watershed also have athletic fields and playgrounds that are less than an acre in size and therefore do not appear in Table 22. The Appalachian Trail also passes through the watershed, covering approximately 20 miles from Pawling to Philipstown.

Table 22. Recreation Areas in Fishkill Creek Watershed

Name	Municipality	Acreage	Description
Madam Brett Park	City of Beacon	12	private park
Memorial Park	City of Beacon	4.53	municipal park
Hammond Field	City of Beacon	0.80	playground
Depot Hill Multi-Use Area	Beekman, Pawling	260	public, state land, Appalachian Trail
Beekman Recreation Area	Beekman	2.42	park
Hopewell Complex Park	East Fishkill	1.83	municipal park
Brettview Acres	East Fishkill, Wappinger	2.96	municipal park
Slyvan Lake Beach Park	East Fishkill	95	public
Red Wing Park	East Fishkill	2.04	municipal park
Soccer Complex Park	East Fishkill	3.28	municipal park
Wiccopee Park	East Fishkill	0.38	municipal park
Jean Van Pelt Park	Fishkill (T)	1.80	public, town park
Maurer/Geering Park	Fishkill (T)	24.80	public, town park
Doug Phillips Memorial Park	Fishkill (T)	10.00	public, town park
Bob Shepheard Memorial Park	Fishkill (T)	16.30	public, town park
Dutchess Park Lake	Fishkill (T)	11.30	public
Dutchess Junction Park	Fishkill (T)	NA	state park, town use
Sharpe Reservation	Fishkill (T)	3000	private preserve, camps
Fishkill Ridge Conservation Area	Fishkill (T)	1030	private preserve
Sarah Taylor Park	Fishkill (T)	3.95	municipal park
Mt. Beacon	Fishkill (T)	17.59	hiking, scenic views
Freedom Park	LaGrange	91.26	public, swimming
Stringham Park	LaGrange	6.28	public, town park
LaGrange Park	LaGrange	1.54	public, town park
James Baird State Park	LaGrange	50.59	state park
NYS Taconic Hereford State Forest	LaGrange	909	state forest, multi-use area
Edward R. Murrow Park	Pawling	65	town park
Clarence Fahnstock State Park	Philipstown, Putnam Valley & Kent	12,000	state park, Appalachian Trail
Innisfree Gardens	Pleasant Valley,Washington	160	private park, picnicking
Tymor Park	Union Vale,Beekman	500	town park
Frederick E. Godfrey Memorial Park	Union Vale	12	town park
Firefighter's Memorial Park	Union Vale	1.00	town park
Robinson Lane Park	Wappinger (T)	4.77	athletic field
Rockingham Park	Wappinger (T)	1.08	municipal park
Ye Old Apple Orchard Pond Park	Wappinger (T)	0.40	park

Significant Areas in the Fishkill Creek Watershed

Significant natural areas consist of geological formations (i.e. mountains, steep ravines), hydrologic features (rivers, lakes, wetlands) and other areas of special importance such as critical habitat for threatened, endangered or rare species. These areas provide several environmental benefits such as sustaining the quantity and quality of water, offering habitat for plant and animal communities, providing recreational and educational areas, and providing scenic view sheds. The significant areas described were designated by the Dutchess County Environmental Management Council to encourage their protection and sustain the environmental benefits they provide.

Hosner Mountain

Hosner Mountain is a rocky ridge area located in the Town of East Fishkill that provides open space, scenic beauty, wildlife habitat and recreational opportunities. A section of the Appalachian Trail is accessible via Hosner Mountain Road, which is owned and maintained by the U.S. Department of Interior. At the top of Hosner Mountain, there are views of the Hudson Highlands, Shawangunks, and Catskills. There are also scenic vistas that overlook the Taconic State Parkway and I-84 along with pristine wilderness and countryside within the Hudson River Valley.

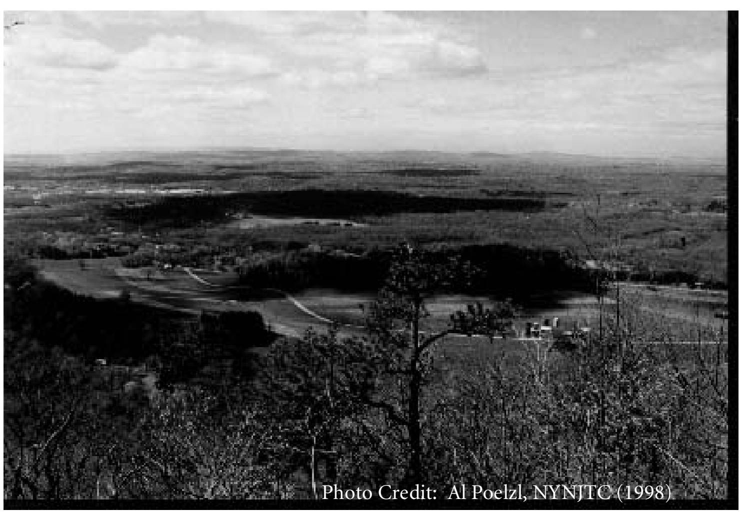


Figure 8. View of Hosner Mountain taken from the Appalachian Trail

Little Whaley Lake

Little Whaley Lake is a 45-acre natural lake that lies about 1 mile east of Whaley Lake (252 acres) and about 2 miles south of Route 55 in the Town of Pawling. The property was formerly owned by the Boy Scouts of America, Greater New York Council, but in 2004 was shared by both private and corporate landowners. In the 1990s, the surrounding land use consisted of mixed deciduous-hemlock forest with an understory of mountain laurel representative of a transitional plant community, vernal pools, wooded wetlands, steep slopes and limy bedrock outcroppings (National Audubon Society, 1998). At the northern end of the lake, a perennial stream (class C) flows into Whaley Lake. The elevation of the lake is 917 feet, with it reaching 1,130 feet at the top of the ridge, contributing to the highest elevation in the town of Pawling (Gilbert, 1989). The area is comprised of soils that are highly susceptible to erosion including Charlton-Chatfield complexes and Hollis-Chatfield Rock Outcrops.

The area is characterized as an important bird area (IBA), containing significant habitats for the survival and conservation of bird species. Little Whaley Lake and surrounding lakes (Whaley Lake, Nuclear Lake) and wetlands provide habitat for waterfowl including kingfishers, green herons and great blue herons (Gilbert, 1989). Breeding species include Northern Goshawk, Cooper's Hawk, Osprey, Golden-winged Warbler, Cerulean Warbler, Blackburnian Warbler, Canada Warbler, Swainson's Thrush and Hermit Thrush (National Audubon Society, 1998). Other birds that utilize the lake for breeding habitat include Canada geese, mallard and wood ducks (Gilbert, 1989). The 1982-83 Atlas Breeding Bird Survey indicated the use of the lake by 90 bird species during the nesting season. The lake and its surrounding watershed was designated as a Critical Environmental Area in September 1985 by the Town of Pawling, and a Significant Natural Area by Dutchess County due to its special characteristics, its value as a water resource and its extreme vulnerability. The site is also designated as one of the 123 priority sites in the 1997, New York State Open Space Plan.

Townsend Swamp

Townsend Swamp is a 210-acre, NYSDEC, class 1, regulated wetland (HJ-54) located in the Town of East Fishkill. It is designated as a sensitive site/significant area by New York State due to the presence of a rare animal. It is also designated as a significant natural area by the Dutchess County Environmental Management Council. Ownership of this wetland is entirely private, but was recommended for preservation by the Nature Conservancy (DCDPD and DCEMC, 1985). According to the United States Fish and Wildlife Service National Wetland Inventory, Townsend Swamp contains four different wetland types including palustrine forested, palustrine emergent, palustrine scrub shrub and palustrine unconsolidated bottom, totaling 187 acres. Wiccopee Creek and its subtributaries flow through this wetland providing suitable habitat for fish.

Sharpe Reservation

Sharpe Reservation encompasses 3,000 acres of land in the Towns of Fishkill and East Fishkill in Dutchess County and the Town of Philipstown in Putnam County. It is owned by the Fresh Air Fund and utilized as a recreational camp and environmental education facility. The property contains forests, wetlands and three lakes. In 1995, the Sharpe Reservation contained nineteen wetlands identified in the National Wetlands Inventory. Wetland types included palustrine unconsolidated bottom, palustrine emergent marsh, palustrine forested, palustrine scrub shrub, and lacustrine unconsolidated bottom. Tributaries of the Fishkill Creek on this property include Bloomer Brook and a tributary to Clove Creek, both perennial, class C streams suitable for secondary contact recreation. The property also contains numerous trails, which provide scenic vistas. Sharpe Reservation has historical significance due to the presence of charcoal pits that predate the Revolutionary War (DCDPD and DCEMC, 1985).

Figure 9. Deer Lake at Sharpe Reservation, Fishkill, NY

III. Status of the Fishkill Creek Watershed

Introduction

Water quality of the Fishkill Creek and its major tributaries was assessed between 1973 and 2002 by different scientific research groups including, Neuderfer (1977), Schmidt and Kiviat (1985), Bode et al. (1991), Bode et al. (1999), Stainbrook (2001), and Bode (2004). The primary component of these studies was an analysis of biological communities, including benthic macroinvertebrates and fish. In addition to the biological analysis, water samples were collected and analyzed for chemical and physical parameters. The following summaries provide the rationale for the studied parameters.

Nitrogen

Nitrogen is found in various forms in ecosystems including organic forms, nitrate (NO_3^-), nitrite (NO_2^-) and ammonium (NH_4^+). The majority of nitrogen is in the form of a gas (N_2), which makes up approximately 80% of our air. Nitrogen is converted into organic matter by some types of terrestrial plants (legumes) that have nitrogen-fixing bacteria, lightning and microbes in the water and soil. Nitrate, the most mobile form of nitrogen, can either be assimilated by vegetation to make protein, leach into groundwater or surface water, or be converted to nitrogen gas in the process of denitrification (Welsch et al. 1995). Nitrites (NO_2^-), ammonia (NH_3) and ammonium (NH_4^+) are intermediate forms of nitrogen in aquatic systems and are quickly removed from the system by being converted to another form of nitrogen (NO_3^- or N_2) (Behar, 1996). Ammonium is released into the system during animal or plant decomposition or when animals excrete their wastes. Through the process of nitrification, ammonium is oxidized to nitrates by nitrifying bacteria ($NH_4^+ \rightarrow NO_2^- \rightarrow NO_3^-$). Nitrate concentrations in water can serve as an indicator of sewage or fertilizer in surface or ground water.

Based upon average concentrations found in water samples from 85 sites across the United States, in relatively undeveloped watersheds the median concentrations of nitrate-nitrogen and total nitrogen were .087 and .26 mg/L respectively (Clark et al., 2000). However, due to present and past land uses, the undeveloped watershed concentrations (below .26 mg/L) of total N rarely occur in Dutchess County in 2004. Major sources of nitrate (most mobile form of nitrogen) in streams are municipal and industrial wastewater discharges and agricultural and urban runoff. In addition, deposition from the atmosphere of the nitrogenous material in automobile exhaust and industrial emissions are a source (Smith et al., 1991).

Nitrate in excessive amounts can accelerate eutrophication of surface waters, and can present a human health concern in drinking water. Any water that contains nitrate concentrations of 44 mg/L (equivalent to 10 mg/L nitrate-nitrogen for EPA and NYSDOH standards) or higher has the potential to cause methemoglobinemia, or "blue baby" disease in children, and the excess nitrate can indicate serious residential or agricultural contaminants (McCasland et al., 1998). Although the human health standard for nitrate consumption has little correlation with stream health, high levels of nitrate in both surface and groundwater usually indicate widespread nonpoint source pollution. Figures ten and eleven provide a general idea of total nitrogen and nitrate-nitrogen concentrations in the Fishkill Creek basin during low-flow in the summer of 2001.

Figure 10. Mean total nitrogen and nitrate-nitrogen concentrations (mg/L) from a limited set (4) of Fishkill Creek water samples collected in summer 2001 and 2002 (Stainbrook, 2004). Data are arranged from downstream (river mile 4.1) to upstream (river mile 25.7).

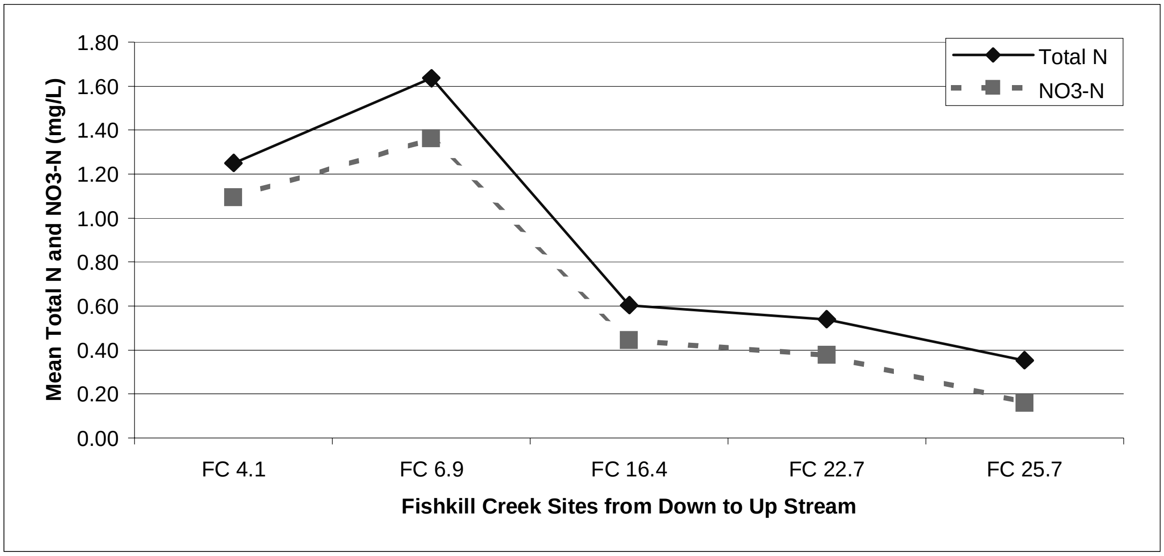
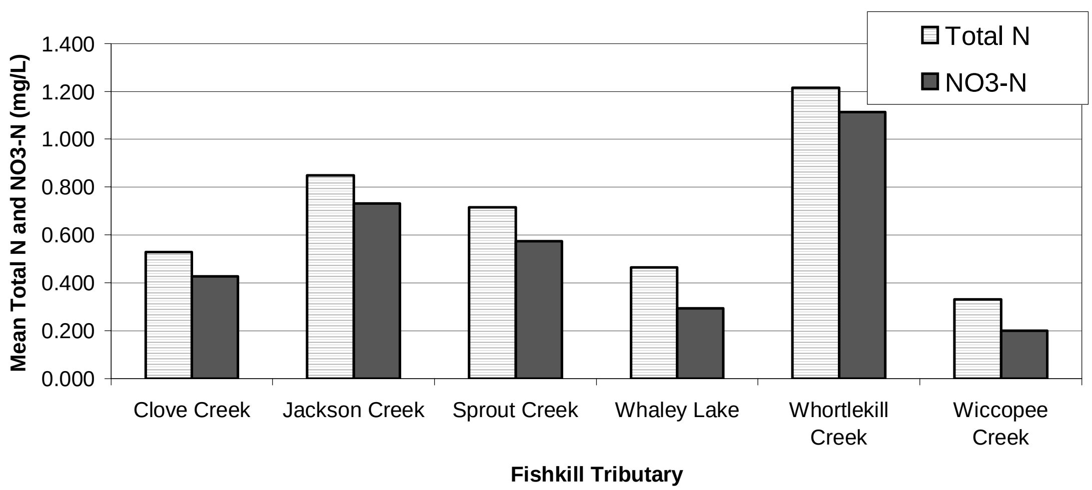


Figure 11. Mean total nitrogen and nitrate-nitrogen concentrations (mg/L) from a limited set (4) of water samples collected close to the confluence of the major tributaries to the Fishkill Creek and the Fishkill Creek proper in the summer of 2001 and 2002 (Stainbrook, 2004).



Phosphorus

Phosphorus is a nutrient essential to plant growth. In aquatic ecosystems phosphorus occurs primarily in the form of organic phosphorus. Organic phosphorus is bound in plant and animal tissue and is unavailable for plant uptake. Phosphate (orthophosphate) is in a form that is available and needed by plants. Plants assimilate orthophosphate from the surrounding water and convert it to organic phosphorus. In freshwater ecosystems phosphate tends to be the nutrient that is least available for plant growth. Consequently, phosphate is the limiting factor, and small additions to surface waters can result in large amounts of plant growth and eutrophication.

Phosphate binds to soil particles, which slows its transport. Often, the soil-attached particles will settle out in standing water (ponds/lakes), which can lead to excessive vegetation growth. The most likely sources of phosphate inputs include animal wastes, human wastes, fertilizer, detergents, disturbed land, road salts (anticaking agent), and stormwater runoff. Based upon the average concentrations found in water samples from 85 sites across the United States in relatively undeveloped watersheds, the median concentrations of total phosphorus and orthophosphate as P were .022 and .010 mg/L respectively (Clark et al., 2000). In general, any concentration over 0.05 mg/L of orthophosphate will likely have an impact on surface waters (Behar, 1996). However, in many streams and lakes concentrations of PO_4 as low as 0.01 mg/L can have a significant impact on water resources by causing a proliferation of aquatic vegetation and phytoplankton. In order to control eutrophication, the USEPA recommended limiting phosphate concentrations to .05 mg/L in waters that drain to lakes and ponds, and .1 mg/L in free flowing rivers and streams (USEPA, 1996). Figures twelve and thirteen provide an idea of low flow summer concentrations of phosphorus, in the year 2001, from the Fishkill Creek basin.

Figure 12. Mean total phosphorus concentrations (mg/L) from a limited set (4) of Fishkill Creek water samples collected in summer 2001 and 2002 (Stainbrook, 2004). Data are arranged from downstream (river mile 4.1) to upstream (river mile 25.7).

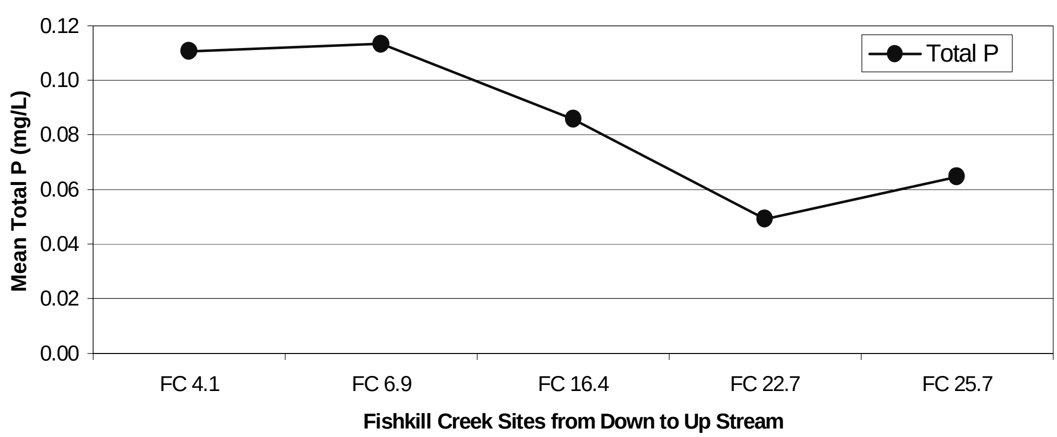
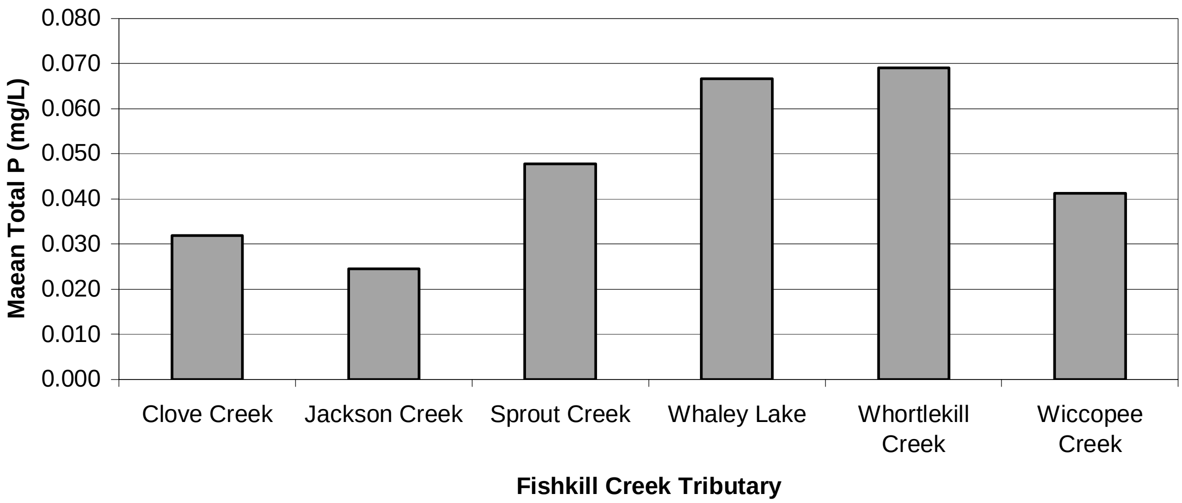


Figure 13. Mean total phosphorus concentrations (mg/L) from a limited set (4) of water samples collected close to the confluence of major tributaries to the Fishkill Creek and the Fishkill Creek proper in the summer of 2001 and 2002 (Stainbrook, 2004).



Other Chemical and Physical Parameters

Dissolved oxygen is the presence of oxygen gas (O_2) molecules in the water. The molecules are naturally consumed and produced in aquatic systems, and necessary for almost all aquatic organisms. If dissolved oxygen levels fall below a certain threshold, biologic integrity will be compromised. For example, on a scale of 0 to 14 mg/L, a concentration of 7 mg/L to 11 mg/L is very good for most stream fish (Behar, 1996). Dissolved oxygen can be measured as the concentration of milligrams O_2 per liter (mg/L) or as percent saturation of O_2. Percent saturation is the amount of oxygen in a liter of water relative to the total amount of oxygen the water can hold at a given temperature. In cold water systems, a percent saturation of 60% to 79% is acceptable for most stream animals (Behar, 1996).

The pH of water is important because most species of aquatic organisms prefer a pH in the range of 6.5 to 8.0, and variance outside of this range can stress or kill organisms. Due to the acidity of rainfall, maintaining this level is of concern in New York State. According to the NYSDEC (2004), the average rainfall acidity in NY ranges in pH from 4.0 to 4.5. However, Dutchess County contains large amounts of calcium carbonate bedrock, which acts to raise the alkalinity and hardness of surface and ground water, and provides a buffer for acidic inputs.

Sulfates (SO4--) can be naturally occurring as a result of the decomposition of leaves that fall into the stream, water passing through rock or soil containing gypsum and other common minerals, or from atmospheric deposition. They also can be indicators of municipal sewer treatment plant discharges, fertilized agricultural runoff, or industrial discharges. The combustion of fossil fuels releases large amounts of sulfur to the atmosphere. Sulfur in the atmosphere is oxidized and eventually deposited by precipitation, or other means, as sulfate. Sulfate is highly mobile and often ends up in our local streams and lakes. Therefore, monitoring levels of sulfate in surface waters may provide a means of tracking impacts of fossil fuel consumption.

Conductivity is the measure of the ability of water to carry an electric current, and is determined primarily by bedrock geology. High conductivity is created by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a conductivity range of 150 to 500 µmhos/cm (USEPA, 1997).

Macroinvertebrate Sampling Rationale

Benthic macroinvertebrates (BMI) can be simply defined as animals without backbones that are larger than ½ millimeter and live at least a portion of their life cycles in or on the bottom of a body of water (Dates and Byrne, 1996). In freshwater systems these animals may live on rocks, logs, sediment, debris and aquatic plants during their various life stages. A few common examples of BMIs include crustaceans such as crayfish, mollusks such as clams and snails, aquatic worms, and the immature forms of aquatic insects such as stoneflies, caddisflies, mayflies and true flies.

BMIs function at the lower levels of the aquatic food chain, with many feeding on algae, detritus, and bacteria. Some shred and eat leaves and other organic matter that enters the water, and others are predators. Because of their abundance and position in the aquatic food chain, BMIs play a critical role in the natural flow of energy and nutrients through the aquatic system (Covich et al., 1997). For example, Sweeney (1993) demonstrated in a second order stream, that leaf litter and woody debris were primarily consumed in the forested woodlot where the debris originated, rather than being washed downstream. Also, as organisms die, they decay, leaving behind nutrients that are reused by aquatic plants and other animals in the food chain. Insects fill the roles of predators, parasites, herbivores, saprophages, and pollinators, among others, which indicate the pervasive ecological and economic importance of this group of animals in both aquatic and terrestrial ecosystems (Rosenberg et al., 1986).

Biological monitoring appears to be an attractive methodology for documenting water quality for several reasons. First, the community collected at a given site reflects the water quality at that site over several weeks, months, or years. The alternative methodology of grabbing a water sample reflects the water quality at the instant the sample is collected (i.e. a snap shot image). Second, the community-based approach protects the biological integrity of the water body, and doesn't focus on a limited number of chemical parameters. Third, samples can be preserved in reference libraries for future application; this provides a convenient routine of summer collection and winter analysis. Finally, biological assessments tend to be much more cost effective than chemical analysis. Table 23 lists the rationale for biomonitoring in New York State (Bode et al., 2002).

Biological assessments have been used by many states to evaluate the effectiveness of water quality programs, particularly for nonpoint source impact determinations (USEPA, 2002). For example, biological assessment models have been tested with field data and the results suggested that macroinvertebrate data collected for establishing the degree of water quality impairment can also be used to identify the impairment source with reasonable accuracy (Murray et al., 2002). In addition, it has been suggested that the percentage of chironomids (Diptera larvae) in samples may be a useful index of heavy metal pollution (Winner et al., 1980). Furthermore, the Ohio EPA employs biological response signatures, based on biological, chemical, physical, bioassay, pollution source, and watershed characteristic, that consist of key response components of the biological data that consistently indicate one type of impact over another (Yoder, 1991). In New York State, the first recorded biological monitoring effort dates from 1926-1939, but the regulatory role of stream biological monitoring did not begin in New York until after the passage of the Federal Water Pollution Control Act Amendments of 1972 (Clean Water Act). The primary objective of New York State's program was to evaluate the relative biological health of the state's streams and rivers through the collection and analysis of macroinvertebrate communities (Bode et al., 2002).

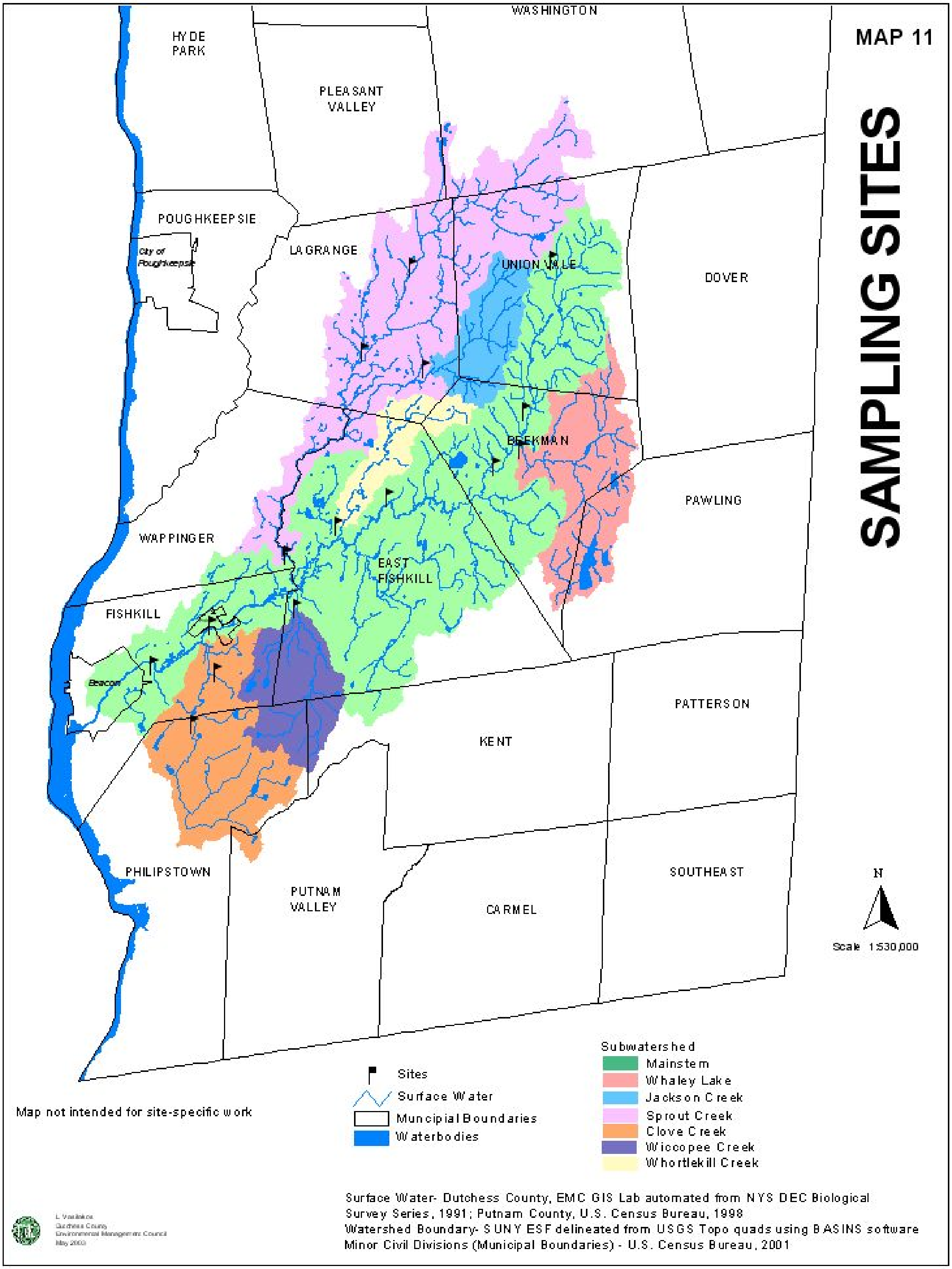
Table 23: Rationale for the analysis of macroinvertebrate communities to determine water quality of streams and rivers in New York State (Bode et. al., 2002).

1. BMIs are sensitive to environmental impacts;
2. BMIs are less mobile than fish, and thus can avoid discharges;
3. They can indicate the effects of spills, intermittent discharges, and lapses in treatment;
4. They are indicators of overall, integrated water quality, including synergistic effects and substances lower than detectable limits;
5. They are abundant in most streams, and are relatively easy and inexpensive to sample;
6. They are able to detect non-chemical impacts to the habitat, such as siltation or thermal change;
7. They are readily perceived by the public as tangible indicators of water quality;
8. They can often provide an on-site estimate of water quality;
9. They bioaccumulate many contaminants to concentrations that analysis of their tissues is a good monitor of toxic substances in the aquatic food chain;
10. They provide a suitable endpoint to water quality objectives.

Standardized protocols for benthic macroinvertebrate monitoring were developed in the mid-1980s due to the need for cost-effective habitat and biological survey techniques (Plafkin et al., 1989). The primary driver of the development was limited economic resources available to states with miles of unassessed streams. It was also recognized that it was crucial to collect, compile, analyze, and interpret environmental data rapidly to facilitate management decisions and resulting actions for control and/or mitigation of impairment. Therefore, the conceptual principles of rapid bioassessment protocols (RBPs) were as follows, cost-effective, yet scientifically valid procedures, provisions for multiple site investigations in a field season, quick turn-around of results for management decisions, easily translated to management and the public, and environmentally benign procedures (Barbour et al. 1999).

Subwatershed Summaries

The following summaries are based on the subwatersheds of the Fishkill Creek watershed. In other words, the entire Fishkill Creek watershed was divided into the seven major tributary watersheds for the following analysis (Map 1). Approximately the same watershed sites were sampled in the Schmidt and Kiviat (1986), Stevens et al. (1994), and Stainbrook (2004) studies (Map 11). Within the subwatershed summaries, assessment site names are based on river mileage from the Fishkill Creek's confluence with the Hudson River, or the tributaries confluence with the Fishkill Creek. The complete New York State Department of Environmental Conservation's stream classification definitions are available in appendix four, and all state pollution discharge elimination system (SPDES) permits issued prior to August 2002 for the Fishkill basin are available in tables 12 and 13 of this document.


MAP 11
SAMPLING SITES
WASHINGTON
HYDE PARK
PLEASANT VALLEY
POUGHKEEPSIE
City of Poughkeepsie
LA GRANGE
UNION VALE
DOVER
BEEKMAN
PAWLING
WAPPINGER
EAST FISHKILL
FISHKILL
Beacon
PATTERSON
KENT
PHILIPSTOWN
PUTNAM VALLEY
CARMEL
SOUTHEAST
N
Scale 1:530,000
Sites
Surface Water
Muncipial Boundaries
Waterbodies
Subwatershed
Mainstem
Whaley Lake
Jackson Creek
Sprout Creek
Clove Creek
Wiccopee Creek
Whortlekill Creek
Map not intended for site-specific work
Surface Water- Dutchess County, EMC GIS Lab automated from NYS DEC Biological Survey Series, 1991; Putnam County, U.S. Census Bureau, 1998
Watershed Boundary- SUNY ESF delineated from USGS Topo quads using BASINS software
Minor Civil Divisions (Municipal Boundaries) - U.S. Census Bureau, 2001

Fishkill Creek Main Stem

Comprising 42% of the Fishkill Creek watershed, the main stem subwatershed encompasses 52,783 acres in the towns of Union Vale, Beekman, East Fishkill, Fishkill and Wappinger (Map 12). The watershed's major stream is the main stem of the Fishkill Creek, originating in the town of Union Vale and flowing southwest until it empties into the Hudson River in the City of Beacon. In 2000, land uses in the main stem watershed consisted of 44.2% forest, 23.9% residential, 10.4% water/wetlands, 9.7% agriculture, 3.5% outdoor recreation, 2.1% transportation, 1.7% commercial, 1.7% public/semipublic, 1.5% inactive, 1.1% industrial and 0.2% extractive (Table 24). The percentage of lake, ponds and wetlands in the main stem subwatershed was the highest in the Fishkill Creek watershed.

Table 24. Fishkill Creek Mainstem Land Use

Land Use Category	Acreage	Percentage (%)
Agriculture	5081.3	9.7
Commercial	891.2	1.7
Extractive	124.1	0.2
Forestland	23037.4	44.2
Industrial	572.5	1.1
Outdoor Recreation	1807.2	3.5
Public/Semipublic	877.2	1.7
Residential	12462.8	23.9
Transportation	1071.2	2.1
Inactive	788.8	1.5
Water/Wetlands	5440.2	10.4
	52153.97	**100.00**

The dominant soil types in this watershed were Hollis-Chatfield-Rock outcrop complex (13.8%), Hoosic gravelly loam (8.6%) and Stockbridge silt loam (8.3%) (Table 25). Hollis-Chatfield-Rock outcrop complex is comprised of 35% Hollis soils, 30% Chatfield soils, 15% folded schist, granite, or gneiss rock outcrop and 20% other soils. Hollis soils are shallow, well drained and somewhat excessively drained loamy soils formed in till underlain by folding schist, granite or gneiss bedrock. Chatfield soils are moderately deep, well drained and somewhat excessively drained loamy soils formed in till underlain by folded schist, granite, or gneiss bedrock. Well-drained soils comprised 64.5% of the watershed, while hydric (wet) soils comprised 11.9%. Soils prime for farmland represented 5.7% of the total, while 3% of soils were designated as farmland of statewide importance.

The New York State Department of Environmental Conservation classified the Fishkill Creek main stem as C from its mouth to its confluence with the Clove Creek (FC 5.9 or 1,690' upstream of Route 84), C(T) from the confluence with Clove Creek (FC 5.9) upstream to river mile 9.6 (4,752' upstream of Route 52 crossing near East Fishkill/Beekman town line), B(T) from river mile 9.6 to 1,221' above the intersection of the main stem and Clove Branch Road in Beekman (FC 16.4), and C(T) from 1,221' above the intersection of the main stem and Clove Branch Road (FC 16.4) to its source in the Town of Unionvale, where the stream crosses Chestnut Ridge Road (FC 35.1).

The largest bodies of water included Sylvan Lake (116.1 acres), Lake Walton (41.3 acres), Beacon Reservoir (20.2 acres), Christie Pond (11.5 acres), Pray Pond (11.2 acres), McKinney Pond (10.3 acres), Furnace Pond (8.7 acres) and Penneywater Pond (8.3 acres). The Fishkill Creek main stem watershed is comprised of 144 miles of tributaries and subtributaries. Named tributaries that drain into this subwatershed include Gidneytown Brook, Sprout Creek, Whortlekill Creek, Wiccopee Creek, Sylvan Lake Outlet, Ivy Hollow Brook (Frog Hollow Brook), Whaley Lake (Brook or Stream), Dry Brook (Melzingah or Beacon Reservoir), Clove Creek, Clove Valley Creek, Sweezy Creek, Seely Creek, Bloomer Brook, Trout Creek and Gildersleeve Brook. In August of 2002, there were forty-two State Pollution Discharge Elimination System (SPDES) permitted facilities that discharged into surface water (19) or groundwater (23) within the subwatershed.

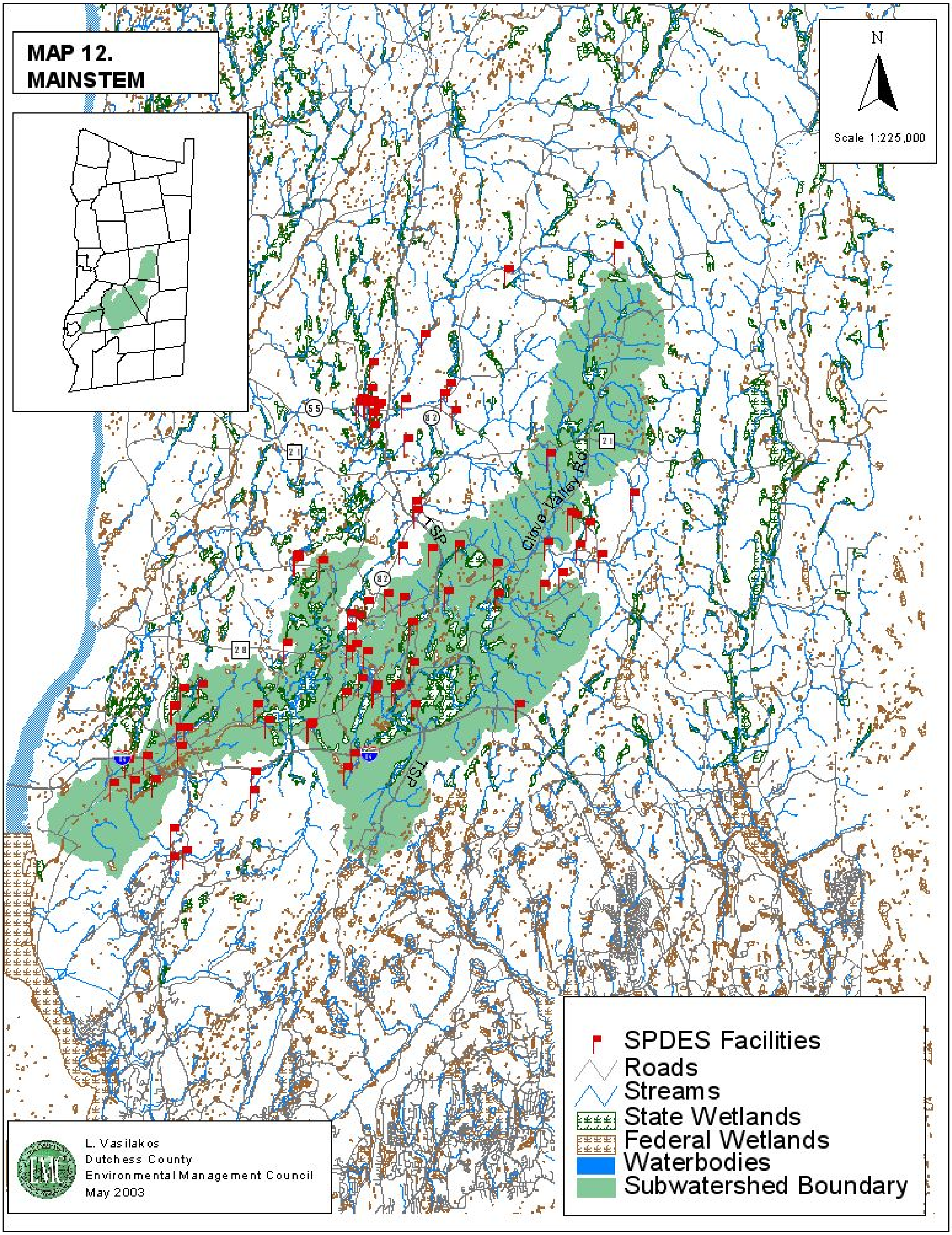

MAP 12.
MAINSTEM
N
Scale 1:225,000
55
82
21
TSP
Clove Valley Rd
28
SPDES Facilities
Roads
Streams
State Wetlands
Federal Wetlands
Waterbodies
Subwatershed Boundary
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003

Table 25. Soils in the Fishkill Creek Mainstem

Soil Name	Percentage (%)	Soil Description
Bernardston silt loam	4.57	0.63% prime farmland, well-drained
		2.96 % farmland of statewide importance
Bernardston-Urban land complex	0.21	well-drained/urban
Canandaigua silt loam	0.90	hydric
Carlisle muck	2.17	hydric
Charlton loam	2.62	well-drained
Charlton-Chatfield complex	2.66	well-drained
Chatfield-Hollis complex	2.40	well-drained/somewhat excessively drained
Copake, gravelly silt loam	2.59	0.89% prime farmland, well-drained
Copake, channery silt loam	0.05	all prime farmland, well-drained
Dutchess silt loam	1.71	well-drained
Dutchess-Cardigan complex	4.20	well-drained
Dutchess-Cardigan-Urban land complex	0.59	well-drained/urban
Farmington-Galway complex	3.19	well-drained
Farmington-Rock Outcrop	0.57	well-drained
Fluvaquents-Udifluvents complex	1.53	hydric/well to excessively drained
Fredon silt loam	1.20	somewhat poorly drained
Galway-Farmington complex	4.96	well-drained
Galway-Farmington- Urban land complex	0.53	well-drained/urban
Georgia silt loam	1.38	well-drained
Halsey mucky silt loam	0.20	hydric, poorly-drained
Haven loam	0.67	prime farmland, well-drained
Hollis-Chatfield-Rock Outcrop complex	13.81	well-drained
Hollis-Rock Outcrop complex	0.21	well-drained
Hoosic gravelly loam	8.56	somewhat excessively drained
Hoosic channery loam	0.75	somewhat excessively drained
Hoosic-Urban land complex	0.50	somewhat excessively drained/urban
Kingsbury and Rhinebeck soils	0.10	somewhat poorly drained
Knickerbocker fine sandy loam	0.50	somewhat excessively drained
Knickerbocker-Urban land complex	0.20	somewhat excessively drained/urban
Leicester loam	0.15	somewhat poorly drained
Linlithgo silt loam	0.21	somewhat poorly drained
Massena silt loam	1.40	somewhat poorly drained
Nassau-Cardigan complex	3.00	somewhat excessively drained/well-drained
Nassau-Rock outcrop complex	1.74	somewhat excessively drained/rock
Palms muck	0.79	hydric, poorly-drained
Pawling silt loam	1.70	well-drained
Paxton fine sandy loam	0.01	well-drained
Pits, gravel	0.24	N/A
Pittstown silt loam	1.44	well-drained
Punsit silt loam	0.60	somewhat poorly drained
Raynham silt loam	0.51	somewhat poorly drained
Scio silt loam	0.02	well-drained
Sun loam	0.03	poorly drained (hydric)
Stockbridge silt loam	8.13	3.2% prime farmland, well-drained
Stockbridge Farmington complex	5.34	well-drained
Stockbridge-Urban land complex	0.35	well-drained/urban
Sun silt loam	2.24	hydric, poorly-drained
Udorthents	2.11	well-drained
Urban land	1.17	N/A
Water	1.00	N/A
Wappinger loam	0.21	prime farmland, well-drained
Wayland silt loam	4.07	hydric, poorly-drained
TOTAL	100	

Biological Community Analysis

Based on recent assessments (1991, 1999, and 2001), the main stem of the Fishkill Creek ranges from non-impacted in its upstream reaches, to slightly impacted towards its confluence with the Hudson River (Map 13) (Table 26). In the following text, assessment site names are based on river mileage from the Fishkill Creeks confluence with the Hudson River (see introduction for biological water quality assessment rationale).

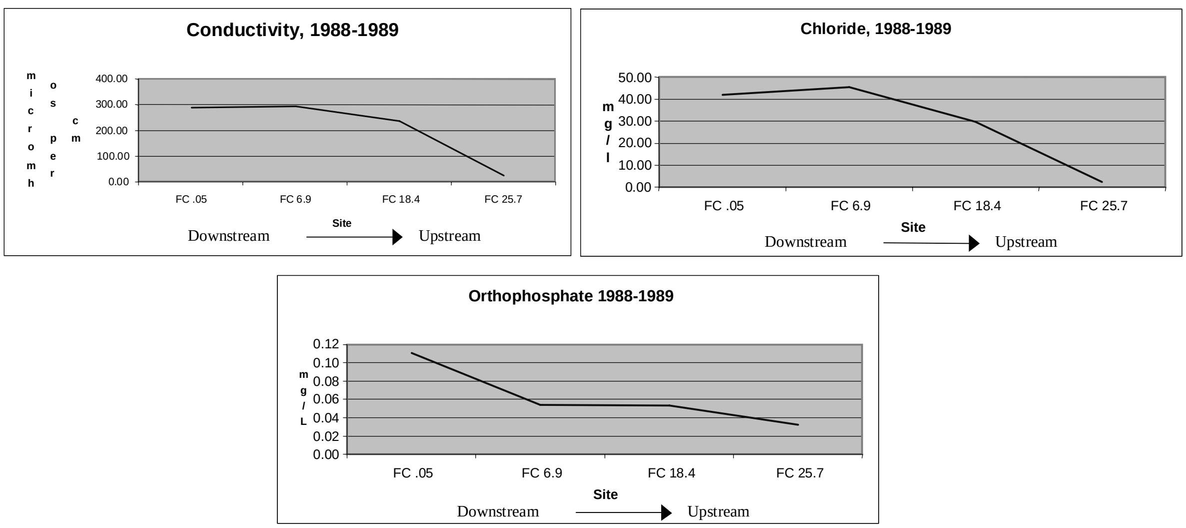
In July of 1973, fifteen stations in the main stem of the Fishkill Creek were assessed (Neuderfer, 1977). Based on the macroinvertebrate community, the water quality of the Fishkill Creek from river mile 23.4 (200' downstream of Greenhaven Rd. bridge) to river mile 12.8 (1000' downstream of the Palon Rd. bridge) was found to be in good condition (non-impacted) (Neuderfer, 1977). River mile 9.7 (end of McGrath Terrace road) through river mile 6.5 (2500' downstream of Route 9 bridge) demonstrated satisfactory (slightly impacted) water quality (Neuderfer, 1977). In this section, nutrient enrichment and the resulting eutrophication were apparent, and drastically altered the biological community towards an unbalanced population (Neuderfer, 1977). Water quality at river mile 3 (250' downstream of Beacon Dye and Texaco Research facility) through river mile 2.7 (30' downstream of Bridge street) appeared to have been grossly degraded (severely impacted) by toxic pollutants (Neuderfer, 1977). However, by river mile 1.8 (300' downstream of the East Main St. bridge in Beacon) water quality appeared to have improved to satisfactory (slightly impacted) (Neuderfer, 1977). Neuderfer (1977) identified several point sources of pollution to the Fishkill Creek including, the Greenhaven State Prison, Dutchess Park and Merrit Brooklands sewer treatment plants, Texaco Research waste treatment effluent, discharges from Beacon and Braendly Dye, and Bobrich Products Company.

In conclusion, based on the 1973 study, the Fishkill Creek main stem was non-to-slightly impacted by siltation and nutrient enrichment in it upper reaches through river mile 6.5. Below river mile 6.5, toxic pollutants were drastically impacting water quality, but the creek's communities seemed to recover by river mile 1.8 (300' downstream of East Main Street bridge in Beacon).

Approximately a decade after the 1973 study, researchers again visited the Fishkill Creek for an overall assessment of stream health. In 1985, Schmidt and Kiviat found the Fishkill Creek system in good health. However, the main stem of the Fishkill Creek, from Hopewell Junction to the confluence with the Hudson River, was slightly-to-moderately impacted from municipal and industrial discharges, dams and channelization (Schmidt and Kiviat, 1986). Additionally, in 1988, a separate research group found the Fishkill Creek in Beacon and downstream of the Route 9 bridge in the Town of Fishkill to contain poor macroinvertebrate community representation (Stevens et al., 1994). The suspected causes for the poor communities varied from industrial and organic (sewage) pollutants in Beacon, to channelization and the resulting degraded habitat that accompanied the construction of the Route 9 bridge (FC 6.9) (Stevens et al. 1994). Communities at Hopewell Junction (~FC 16.4) and upstream of the Route 55 crossing (~FC 25.7), were assessed as moderately impacted (Stevens et al., 1994).

In 1985, the Fishkill Creek, upstream of approximately river mile 10.3 (1.4 miles upstream of Rte. 52 bridge) had healthy fish populations and contained substantial sport fish populations (trout, smallmouth and largemouth bass, and rock bass) (Schmidt and Kiviat, 1986). Near river mile 10.3 and in Beacon, fish populations were dominated by warmwater and pollution tolerant fish species (Schmidt and Kiviat, 1986). Finally, the Fishkill Creek demonstrated a prominent upstream to downstream pollution gradient (Stevens et al., 1994). The analysis of water chemistry further demonstrated the upstream to downstream pollution gradient (Figure 14)(Stevens et al., 1994).

Figure 14. Water chemistry data averaged from monthly samples collected May 1988 through April, 1989 (Stevens et al., 1994). Graphs demonstrate the gradient of ion concentrations in the Fishkill Creek from Beacon (stream mile FC .05) to Clove Valley (stream mile FC 25.7).



The New York State Department of Environmental Conservation's Stream Biomonitoring Unit assessed the Fishkill Creek at four sites in 1991. Sites ranged from approximately river mile 26 (Clove Valley) to river mile 1.4 (Beacon). Based on macroinvertebrate community analysis, FC 26 (Clove Valley), FC 6.9 (Route 9), and FC 1.4 (Beacon) all rated as slightly impacted, and FC 16.9 rated as non-impacted. The FC 26 community was most likely affected by an upstream dam, and did not necessarily indicate degraded water quality (Bode et al., 1991). Communities at FC 6.9 and FC 1.4 showed indications that sewage and heavy metal pollutants may have been negatively affecting the macroinvertebrate community (Bode et al., 1991).

The final study in the Fishkill Creek was conducted in 2001 by researchers from the State University of New York, Environmental School of Forestry and the Dutchess County EMC. Results indicated a similar upstream (non-to-slightly impacted) to downstream (slightly-to-moderately impacted) gradient of stream health that was present since the 1973 study. However, Stainbrook (2004) also suggested that the health of the Fishkill Creek improved slightly from 1988 to 2001.

Conclusion – Status of Fishkill Creek Main Stem

Based on previous studies of the Fishkill Creek (1973 through 2001), it seemed the stream water quality improved slightly in the downstream portions of the stream since 1973. These improvements can most likely be attributed to the passage and implementation of the Clean Water Act in 1972, and the subsequent reduction to point (end-of-pipe) source discharges. Upstream of the route 9 bridge (FC 6.9), the Fishkill Creek remained in good ecological health throughout the period of study (1973 through 2001). In this section, the primary impact to biological communities appeared to be the many dams in the creek, but this does not necessarily translate into water quality degradation. Rather, it may be an indicator of habitat degradation.

From the Route 9 bridge (FC 6.9) to its confluence with the Hudson River, the Fishkill Creek was impacted by various sources of pollution. The Route 9 (FC 6.9) area seemed to have been drastically impacted by stream channelization caused by construction of a new bridge in the early 1980s, but the community recovered somewhat since that time. In 2001, little change from 1991 was detected in the macroinvertebrate communities living in the Fishkill Creek near Sarah Taylor Park in Fishkill (close to Rte. 9 or FC 6.9) (Bode et al., 2001). In addition, little change was noticed at the site approximately 328-feet above the East Main Street bridge in Beacon (FC 1.4) (Bode et al., 2001). Tissue analysis of organisms from these two sites showed elevated levels of polycyclic aromatic hydrocarbons (PAHs), and elevated levels of lead and selenium at the Beacon site (Bode et al., 2001). PAHs result from the incomplete combustion of organic carbon (including wood), municipal and solid waste, and fossil fuels, as well as from natural anthropogenic introduction of uncombusted coal and oil (USGS, 1998). The level of lead in crayfish at the Beacon site was high, and likely attributable to unknown urban sources of pollution (Bode et al., 2001). It is not known whether there are new sources of lead, or the crayfish are being exposed to lead stored in sediments from historical discharges.

Biological communities also demonstrated impacts from sewage inputs. The source of these inputs was most likely sewer overflows following heavy rains and the aging sewage infrastructure in the City of Beacon. There is no doubt, that the many dams from Route 9 south impacted biological communities, both fish and macroinvertebrates, but their associated waterfalls also acted to add dissolved oxygen to the water column. This addition of oxygen may have helped the stream maintain healthy levels of dissolved oxygen through stressful low flow periods. Table 26 offers a decade-based summary of the studies that were completed in the Fishkill Creek.

Table 26. Comparison of Fishkill Creek, Macroinvertebrate-Based, Aquatic Community Health Results 1973, 1985, 1991 and 2001.

	1973 (Neuderfer, 1977)	1985 (Schmidt and Kiviat, 1986)	1991 (Bode et al., 1991)	2001 (Bode et al., 2001)
Clove Valley	Non-to-slightly impacted; EPT present	Slightly-to-Moderately impacted; but mayflies and caddis present	Slightly impacted; EPT present	No Data
Hopewell Junction	Non-to-slightly impacted; EPT present	Slightly-to-Moderately impacted; no mayflies	Non-impacted; dominated by mayflies	No Data
Fishkill	Slightly impacted; caddis and mayflies present	Severely impacted; no mayflies	Slightly impacted; EPT present	Slightly impacted; Elevated levels of PAHs
Beacon	Moderately impacted; dominated by caddisflies	Severely impacted; dominated by caddisflies	Slightly impacted; dominated by caddisflies	Slightly impacted; Elevated levels PAHs, lead, and selenium

New York State Department of Environmental Conservation Biomonitoring Unit's Levels of Water Quality Impacts in Streams (Bode et al., 2001).

Non-Impacted – Indices reflect very good water quality. The macroinvertebrate community is diverse, usually at least 27 species in riffle habitats. Water quality should not be limiting to fish survival or propagation. This level of water quality includes both pristine habitats and those receiving discharges that minimally alter the biota.

Slightly Impacted – Indices reflect good water quality. The macroinvertebrate community is slightly but not significantly altered from the pristine state.

Moderately Impacted – Indices reflect poor water quality. The macroinvertebrate community is altered to a large degree form a pristine state. Water quality is often limiting to fish propagation, but usually not to fish survival.

Severely Impacted – Indices reflect very poor water quality. The macroinvertebrate community is limited to a few tolerant species. The dominant species are almost all tolerant, and are usually midges and worms. Often 1 or 2 species are very abundant. Water quality is often limiting to both fish propagation and survival.

Sprout Creek Watershed

The Sprout Creek watershed encompasses 29,342 acres representing 24 percent of the Fishkill Creek watershed (Map 13). This subwatershed is located within five municipalities including the towns of Washington, Pleasant Valley, Union Vale, La Grange, East Fishkill and Wappinger. In 2000, the dominant land uses in the Sprout Creek watershed were forest (43%), residential (21%) and agriculture (17%). Land uses representing a smaller portion of the watershed area included water/wetlands (9.5%), inactive (2.0%), outdoor recreation (2.0%), transportation (1.9%), extractive (1.4%), public/semipublic (0.98%), urban/commercial (0.8%), and industrial (0.01%)(Table 27). The Sprout Creek watershed ranked second for total acreage of agricultural land, and third for acreage of water/wetlands relative to the other subwatersheds in the Fishkill Creek watershed.

The dominant soil types in this watershed include Dutchess-Cardigan complex (27.6%), Nassau-Cardigan complex (17.8%), Hoosic gravelly loam (11.5%), and Nassau-Rock outcrop complex (7.0%) (Table 28). Well-drained soils comprise 39.7 %, while hydric soils comprise 14.6%. Approximately 35 percent of soils are classified as farmland of statewide importance, while 7 percent are classified as prime farmland.

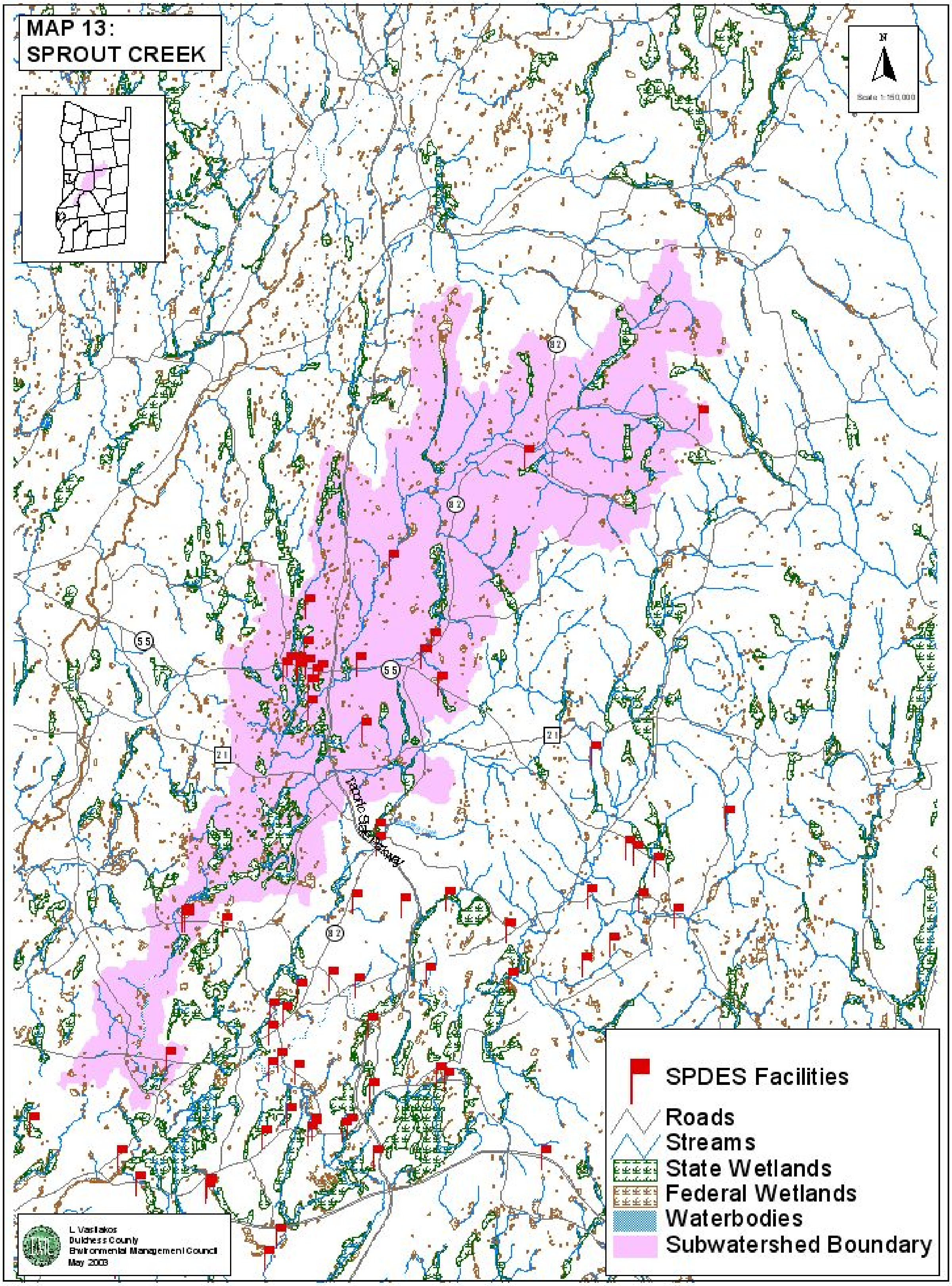
The Sprout Creek watershed contains many tributaries totaling 77 miles in length, with the Sprout Creek itself contributing 18.5 miles of the total. The main stem of the Sprout Creek is classified as a C(T) stream by the New York State Department of Environmental Conservation. This classification means the stream should be suitable for fishing, fish propagation and survival, and primary and secondary contact recreation. The watershed also contained approximately 332 acres of ponds and lakes. The largest lakes were Tyrell Lake (Class C, 49.4 acres) and Hillside Lake (Class B, 26.4 acres). In August of 2002, there were 24 SPDES facilities that discharged into surface water (3) or groundwater (21).

Table 27. Land Use in Sprout Creek Subwatershed

Landuse Category	Acreage	Percentage (%)
Agriculture	4947.97	17.00
Urban/Commercial	236.36	0.81
Extractive	396.62	1.36
Forestland	12562.02	43.17
Industrial	2.69	0.01
Outdoor Recreation	578.84	1.99
Public/Semipublic	284.17	0.98
Residential	6180.08	21.24
Transportation	555.70	1.91
Inactive	586.82	2.02
Water/Wetlands	2768.97	9.52
Total	**29100.24**	**100.00**

Table 28. Soils in the Sprout Creek Watershed

Soil Type	Percentage (%)	Soil Description
Bernardston silt loam	3.78	1.55 % prime farmland, 1.95% farmland of statewide importance, well-drained
Bernardston- Urban land complex	0.07	well-drained/urban
Canandaigua silt loam	0.84	hydric
Carlisle muck	2.37	hydric
Charlton-Chatfield complex	0.34	0.22 % farmland of statewide importance, well-drained
Dutchess silt loam	3.52	1.08 % prime farmland, 1.96 % farmland of statewide importance, well-drained
Dutchess-Cardigan complex	27.58	23.14% farmland of statewide importance, well-drained
Farmington-Galway complex	0.05	well-drained
Fluvaquents-Udifluvents complex	0.80	hydric
Fredon silt loam	1.04	farmland of statewide importance, hydric inclusion
Galway-Farmington complex	0.02	farmland of statewide importance, well-drained
Georgia silt loam	0.67	0.64 % prime farmland, 0.03 farmland of statewide importance well drained
Halsey mucky silt loam	0.40	hydric
Haven loam	0.42	prime farmland, well-drained
Hollis-Chatfield Rock Outcrop complex	0.62	well-drained
Hoosic gravelly loam	11.49	somewhat excessively drained
Hoosic channery loam	0.57	somewhat excessively drained
Hoosic-Urban land complex	0.06	somewhat excessively drained/urban
Linlithgo silt loam	0.39	farmland of statewide importance, hydric inclusion
Massena silt loam	1.00	somewhat poorly drained
Nassau-Cardigan complex	17.81	somewhat excessively drained/well-drained (mix)
Nassau-Rock Outcrop complex	6.98	somewhat excessively drained
Palms muck	0.73	hydric
Pawling silt loam	1.70	well-drained
Pits, gravel	0.34	N/A
Pittstown silt loam	3.47	2.51% prime farmland, 0.96 % farmland of statewide importance well-drained
Punsit silt loam	1.18	farmland of statewide importance, somewhat poorly drained
Stockbridge silt loam	0.23	0.02 % prime farmland, 0.21% farmland of statewide significance well-drained
Stockbridge-Farmington complex	0.01	well-drained
Sun silt loam	3.65	farmland of statewide importance, hydric
Udorthents, smoothed	0.35	well-drained
Urban land	0.00	N/A
Water	0.92	N/A
Wappinger loam	0.84	prime farmland, well-drained
Wayland silt loam	5.77	hydric
TOTAL	100.00	


MAP 13:
SPROUT CREEK
N
SPDES Facilities
Roads
Streams
State Wetlands
Federal Wetlands
Waterbodies
Subwatershed Boundary
L Vasilakos
Dutchess County
Environmental Management Council
May 2003

Biological Community Analysis

In July of 1973, two stations in the main stem of the Sprout Creek were assessed. Based on this assessment, water quality appeared to have been very good (non-impacted) at stream mile 3.2 (downstream of George Brown Bridge on Brown Road) with no evidence of recent organic pollution (Neuderfer, 1977). River mile 2.5 (upstream of the Old Hopewell Rd. (Cty Rte. 28) bridge) also appeared to have good water quality (slightly impacted). However, there were indications of a slight amount of nutrient enrichment from the Rockingham Farms sewage treatment plant effluent (Neuderfer, 1977).

In 1985, researchers again visited the Sprout Creek and assessed water quality at river mile 10.6 (Todd Hill Road bridge) and river mile 1.3 (Route 82 bridge). Based on the macroinvertebrate community, the Sprout Creek was assessed as the least affected by pollution of all the Fishkill Creek tributaries (Schmidt and Kiviat, 1986). Another indicator of clean, cold water in the Sprout Creek was the presence of reproducing brown trout, and when compared to historical data it appeared the fish community hadn't changed significantly since 1936 (Schmidt and Kiviat, 1986). Finally, based on chemical and physical parameters, the Sprout Creek appeared healthy (non-to-slightly impacted)(Table 29).

Once again the Sprout Creek was studied in 1988-1989 at the same sites (SC 10.6 and SC 1.3) with more somber results. Researchers found healthy macroinvertebrate populations in the winter, but poor in the remaining seasons, and speculated the closed Town of La Grange landfill and bank modifications may have negatively impacted the system around SC 1.3 (Stevens et al., 1994). In general, water quality at SC 10.6 and SC 1.3 was good (slightly impacted)(Table 29). However, the water at SC 1.3 had high phosphorus and low dissolved oxygen levels in July, possibly due to the Rockingham Farms sewage treatment plant effluent which has since been sent to the Beacon sewer treatment plant (Stevens et al., 1994).

Table 29. Yearly mean water chemistry data from Sprout Creek 10.6 and Sprout Creek 1.3 from 1985, 1989, and 2001. Sample collection in 1985 ranged from January through December, 1989 collection ranged from May 1988 through April 1989, and 2001 data is limited to summer 2001 and 2002 (Schmidt and Kiviat, 1986; Stevens et al., 1994; Stainbrook, 2004).

Sprout Creek 10.6						
			Year			
	1985		**1989**		**2001**	
Parameter						
pH	7.6	s.d. .37, N = 11	7.5	s.d. .47, N = 9	8.01	s.d. .20, N = 4
Dissolved Oxygen (mg/L)	10.8	s.d. .54, N = 11	8.2	s.d. .87, N = 10	9.22	s.d. .99, N = 4
Alkalinity (mg/L)	60	s.d. 16, N = 11	ND		ND	
Temperature C	9	s.d. 7.3, N = 11	10.2	s.d. 7.9, N = 12	19.45	s.d. 6.2, N = 4
Chloride (mg/L)	18.1	s.d. 2.6, N = 10	22.6	s.d. 3.4, N = 12	ND	
PO4-P (mg/L)	ND		0.01	s.d. .007, N = 12	ND	
SO4 (mg/L)	ND		18.2	s.d. 3.5, N = 12	ND	
Conductivity (µmhos/cm)	ND		157	s.d. 47, N = 12	382.5	s.d. 129.4, N = 2
Sprout Creek 1.3						
			Year			
	1985		**1989**		**2001**	
Parameter						
pH	7.4	s.d..22, N = 11	7.5	s.d. .37, N = 9	7.8	s.d. .32, N = 4
Dissolved Oxygen (mg/L)	9.9	s.d. 1.6, N = 11	8.1	s.d. 1.8, N = 10	8.8	s.d. 2.1, N = 4
Alkalinity mg/L)	69	s.d. 10.8, N = 11	ND		ND	
Temperature C	10.8	s.d. 7.7, N = 11	10.7	s.d. 7.9, N = 12	18.25	s.d. 3.4, N = 4
Chloride (mg/L)	23.6	s.d. 3.2, N = 11	30.2	s.d. 5.1, N = 12	ND	
PO4-P (mg/L)	ND		0.04	s.d. .03, N = 12	ND	
SO4 (mg/L)	ND		21.1	s.d. 3.9, N = 12	ND	
Conductivity (µmhos/cm)	ND		205	s.d. 57, N = 12	479	s.d. 66.5, N = 2

Finally, in 2002, the New York State DEC Biomonitoring Unit assessed the Sprout Creek. At similar locations to the previous studies, they found the stream to be slightly impacted from nonpoint source nutrient enrichments.

In conclusion, the Sprout Creek appeared to be in good (non-to slightly-impacted) shape throughout the period of study (1973-2002). However, at various points throughout the period of study there were pollution sources that acted to slightly degrade the stream. The most likely sources of nutrient enrichment were sewer treatment plant effluents, faulty septic systems, and agricultural operations that weren't following best management guidelines. In their 1994 report, Stevens et al. recommended all new increases to nutrient load and/or reduction in dissolved oxygen need to be carefully evaluated. It would be prudent to follow this advice as development occurs throughout the Sprout Creek watershed. Cumulative impacts should be assessed prior to the issuance of permits to discharge to the waters of the Sprout Creek, and in the design of septic systems within 200 feet of the stream. In addition, agricultural operations that aren't following best management practice guidelines should be identified and encouraged to follow the guidelines.

Clove Creek Watershed

Clove Creek watershed encompasses an area of approximately 12,960 acres in the town of Fishkill in Dutchess County, and the towns of Philipstown and Putnam Valley in Putnam County, representing 10 % of the Fishkill Creek watershed (Map 14). The major stream in the watershed is the Clove Creek, which originates in Putnam County on the east side of Route 9 and continues to flow northward to the town of Fishkill. The Clove Creek flows parallel to the Fishkill Ridge on the northern side, and continues west, where it empties into the Fishkill Creek near the intersection of Route 9 and Interstate 84. In 2000, the dominant land use in the watershed was forest totaling 79%, the highest percentage among all Fishkill Creek subwatersheds (Table 30). The remaining Clove Creek watershed land uses were residential (8%), water/wetlands (5%), commercial (1.9%), agricultural (1.6%), extractive (1.6%), public/semipublic (0.7%), outdoor recreation (0.6%), transportation (0.6%), industrial (0.4%), and inactive land (0.3%) (Table 30).

The predominant soils are Charlton-Chatfield soils (17%), Hollis-Chatfield (16.2%), and Charlton Loam (13.4%)(Table 31). Charlton-Chatfield soils are comprised of 50% Charlton soils, 30% Chatfield soils and 20% other soils. Charlton soils are very deep, well-drained loamy soils formed in till. Chatfield soils are moderately deep, well drained to somewhat excessively drained loamy soils formed in till underlain by folded schist, granite, or gneiss bedrock. Charlton-Chatfield soils are recognized as farmland of statewide importance. In addition, soils characterized as prime farmland, or are suitable for farming and/or cultivating crops, represent 4.6 percent of the Clove Creek watersheds' soil area. Soils designated as farmland of statewide importance represent 16.9 percent. Finally, well-drained soils encompass 84.7% of the subwatershed, while hydric soils comprise 6.5% of the subwatershed.

The New York State Department of Environmental Conservation classified the Clove Creek as a C(TS) stream, suitable for trout spawning, from its confluence with the Fishkill Creek to the inlet of an unnamed pond (p345c) in the town of Philipstown. From the unnamed pond to the Fishkill's source the stream it is classified as a C stream. The best usage of Class C(TS) waters is fishing, but they are also suitable for trout propagation and survival. The water quality should also be suitable for primary and secondary contact recreation. A number of water bodies that enter Clove Creek have higher stream classifications. Lake Valhalla, Cargill Reservoir, and the headwaters of Hell Hollow Stream are designated as Class A streams, which are suitable for drinking water. In August of 2002, there were three SPDES facilities that discharged into groundwater within this watershed. Two of these facilities also discharged into Clove Brook and Highland Creek.

Clove Creek aquifer is a significant feature located in the northwest corner of Putnam and southwest corner of Dutchess Counties'. Designated as a critical environmental area by the town of Fishkill, the

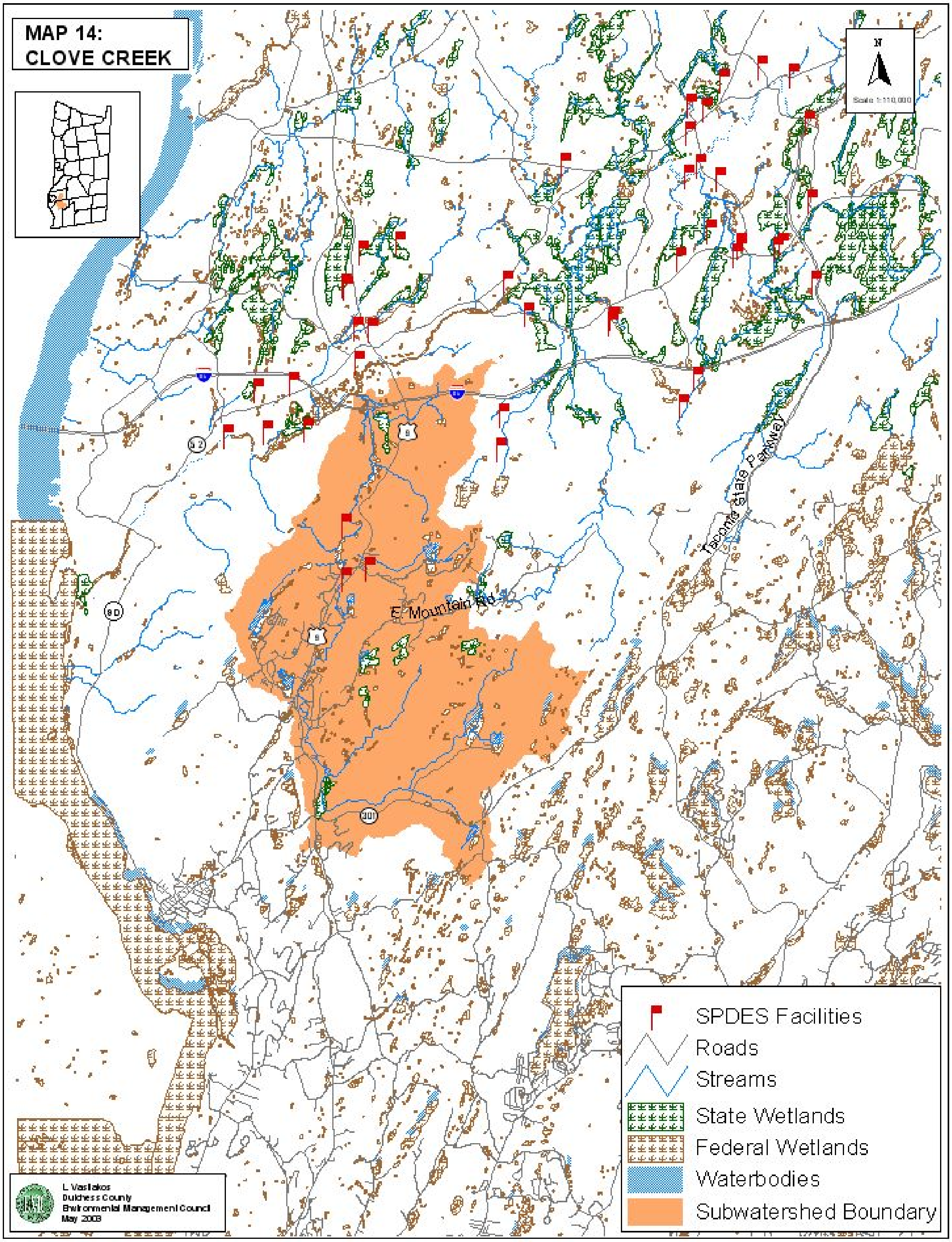
Clove Creek Aquifer is underlain by sand and gravel, and is a very permeable and productive aquifer with wells yielding an average of 189 gallons of water per minute (Snavely, 1980).

Table 30. Clove Creek Land Use

Land Use Category	Acreage	Percentage (%)
Agriculture	209.09	1.61
Commercial	243.56	1.88
Extractive	204.43	1.58
Forest	10230.39	78.93
Industrial	56.99	0.44
Outdoor Recreation	81.44	0.63
Public/Semipublic	95.00	0.73
Residential	1052.64	8.12
Transportation	81.69	0.63
Inactive	44.37	0.34
Water/Wetlands	661.52	5.10
TOTAL	**12961.13**	**100.00**

Table 31. Soils in the Clove Creek Subwatershed

Soil Type	Percentage (%)	Soil Description
Canandaigua	0.01	Hydric
Carlisle Muck	0.54	Hydric
Charlton-Loam	13.38	Well-Drained, 2.71 prime farmland, 2.34 farmland of statewide importance
Charlton-Chatfield (rolling)	16.97	Well-Drained, 11.53 farmland of statewide importance
Chatfield-Hollis (rolling)	10.84	Well-Drained
Copake GR-SIL,hilly	10.43	Well-Drained
Fluvaquents-Udifluvents	1.90	hydric/well-drained
Fredon SIL	0.35	poorly drained, farmland of statewide importance, hydric inclusion
Galway-Farmington	0.25	Well-Drained, farmland of statewide importance
Georgia SIL	0.11	Well-Drained, 0.09 prime farmland, 0.01 farmland of statewide imp.
Haven L, nearly level	0.05	Well-Drained, prime farmland
Hinckley gravelly loamy sand	0.29	excessively drained
Hollis-Chatfield, rolling	16.21	well-drained
Hollis Rock Outcrop, very steep	6.71	well-drained
Hoosic GR-L	0.62	somewhat excessively drained, farmland of statewide importance
Knickerbocker FSL, nearly level	1.18	somewhat excessively drained, 0.84 prime farmland 0.34 farmland of statewide importance
Leicester loam, stony	2.96	poorly drained, drained
Linlithgo SIL	1.16	somewhat poorly drained, farmland of statewide importance
Palms muck	0.41	very poorly drained, hydric
Palms and Carlisle Soils	0.10	very poorly drained, hydric
Paxton fine sandy loam	3.72	well-drained
Pits	1.25	somewhat excessively drained
Pompton silt loam	0.14	well-drained to poorly drained, suitable for farming
Pittstown SIL	0.05	Well-Drained, prime farmland
Raynham SIL	0.09	somewhat poorly drained, farmland of statewide importance
Ridgebury Loam	0.61	poorly drained, hydric, suitable for farming
Riverhead	2.56	well-drained
Sun loam	1.02	poorly drained, hydric
Sun SIL	0.17	poorly drained, hydric inclusion, farmland of statewide importance
Sutton Loam	0.79	well drained
Udorthents	1.53	well drained
Urban land-Charlton complex	0.09	urban/well-drained
Urban land	0.71	impermeable
Water	1.39	n/a
Woodbridge loam	0.89	well-drained
Wappinger	0.13	Well-Drained, prime farmland
Wayland SIL	0.37	poorly drained, hydric
TOTAL	**100.00**	


MAP 14:
CLOVE CREEK
E. Mountain Rd
Taconic State Parkway
SPDES Facilities
Roads
Streams
State Wetlands
Federal Wetlands
Waterbodies
Subwatershed Boundary
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003

Biological Community Analysis

The Clove Creek was not sampled during the 1973 assessment of Neuderfer. However, Schmidt and Kiviat assessed the Clove Creek in 1985 at approximately river mile CC .75 (behind Route 9 plaza). Macroinvertebrate analysis indicated the Clove Creek was a good (non-to-slightly impacted) quality stream, and fish sampling indicated the fish community of the Clove Creek hadn't changed since a previous sampling in 1936 (Schmidt and Kiviat, 1985). The researchers also found reproducing brown trout populations, which can also be an indicator of good water quality.

In 1988 and 1999, researchers sampled water chemistry, fish, diatom and macroinvertebrate communities at three sites in the Clove Creek watershed. All the sites were located in Putnam County at approximately river miles 3.1, 4.6, and 6.2. The researchers found the Clove Creek contained the best water quality in the entire Fishkill system (Stevens et al., 1994) (Table 32). They also found reproducing brown trout at CC 3.1 and CC 4.6, and pollution sensitive diatoms dominated at various times throughout the year (Stevens et al., 1994). Finally, in 2002 the New York State Department of Environmental Conservation's Stream Biomonitoring Unit assessed the Clove Creek as non-impacted based on the macroinvertebrate assemblage near CC .75 (Bode et al., 2004).

In 1985, Schmidt and Kiviat recommended upgrading the NYSDEC classification of the Clove Creek to B due to the amount of primary contact recreation that occurs in the stream. Recently, the stream was upgraded from class C to class C(TS) in recognition of the trout spawning that occurs in the stream. If the stream is being utilized for primary contact recreation (swimming), as observed by Kiviat and Schmidt, it should be afforded the protections' that accompany a B classification. Also, as pointed out by Stevens et al. (1994), the Clove Creek watershed is under intense residential, commercial, and industrial development pressure. Therefore, land use proposals should be scrutinized with the intention of maintaining the high biotic quality present during the period of study.

Table 32. Yearly mean water chemistry data from Clove Creek at various sampling points from 1985, 1989, and 2001. Sample collection in 1985 ranged from January through December, 1989 collection ranged from May 1988 through April 1989, and 2001 data is limited to summer 2001 and 2002 (Schmidt and Kiviat, 1986; Stevens et al., 1994; Stainbrook, 2004).

Clove Creek								
	Year				**Year**			
	1985				**1989**			
Location	**CC .75**		**CC 3.1**		**CC 4.6**		**CC 6.2**	
Parameter								
pH	7.5	s.d. .34, N = 11	7.6	s.d. .51, N = 8	7.3	s.d. .62, N = 8	7.1	s.d. .69, N = 8
Dissolved Oxygen (mg/L)	10.4	s.d. 1.7, N = 11	9.3	s.d. 1.7, N = 10	9.6	s.d. 1.8, N = 10	8.9	s.d. 2.3, N = 10
Alkalinity (mg/L)	56.5	s.d. 18.6, N = 11	ND	ND	ND	ND	ND	ND
Temperature C	10	s.d. 7.8, N = 11	10.5	s.d. 7.5, N = 12	12	s.d. 9.9, N = 12	11.3	s.d. 8.2, N = 12
Chloride (mg/L)	18.5	s.d. 3.7, N = 10	25.6	s.d. 11, N = 12	21.9	s.d. 12.8, N = 12	17.9	s.d. 10.5, N = 12
PO4-P (mg/L)	ND	ND	0.007	s.d. .0009, N = 12	0.007	s.d. .003, N = 12	0.005	s.d. .003, N = 12
SO4 (mg/L)	ND	ND	14.4	s.d. .58, N = 12	13	s.d. 3.0, N = 12	10.9	s.d. 2.6, N = 12
Conductivity (µmhos/cm)	ND	ND	171.7	s.d. 112, N = 12	114	s.d. 87, N = 12	77	s.d. 36.4, N = 12
			Year					
			2001					
Location			**CC .75**		**CC 6.5**			
Parameter								
pH			7.5	s.d. .24, N = 4	7.9	s.d. .26, N = 4		
Dissolved Oxygen (mg/L)			7.8	s.d. 3.5, N = 4	8.7	s.d. 1.6, N = 4		
Alkalinity (mg/L)			ND	ND	ND	ND		
Temperature C			18.1	s.d. 4.0, N = 4	17.2	s.d. 2.6, N = 4		
Chloride (mg/L)			ND	ND	ND	ND		
PO4-P (mg/L)			ND	ND	ND	ND		
SO4 (mg/L)			ND	ND	ND	ND		
Conductivity (µmhos/cm)			417.5	s.d. 109.6, N = 2	359	s.d. 154.1, N = 2		

Jackson Creek Watershed

Jackson Creek watershed encompasses an area of 5,524 acres in the towns of Union Vale, La Grange and Beekman (Map 15). The watershed encompasses 4 percent of the total area of the Fishkill Creek watershed. In 2000, the dominant land use in the watershed was forest representing 42 percent of the total Jackson Creek watershed land use. Residential and agricultural land uses were the next highest categories representing 27 and 19 percent, respectively. Jackson Creek watershed had the highest percentage of agricultural land relative to all the subwatersheds in the Fishkill Creek basin. Other land uses in the watershed included inactive land (5%), water/wetlands (4%), outdoor recreation (2%), public/semipublic (0.3%), urban/commercial (0.1%) and extractive (0.07%) (Table 33).

The dominant soils in the Jackson Creek watershed are Nassau-Cardigan complex (21%), Dutchess Cardigan complex (20%), and Pittstown silt loam (15 %) (Table 34). Nassau-Cardigan complex is comprised of 40% Nassau soils, 40% Cardigan soils and 20% other soils and rock outcrop. Nassau soils are shallow, somewhat excessively drained loamy soils formed in till underlain by folded shale bedrock. Cardigan soils are moderately deep, well-drained loamy soils formed in till underlain by folded shale bedrock. Sixty-nine percent of watershed soils are well drained, and hydric soils comprise ten percent. Five percent of soils are classified as farmland of statewide importance, while three percent are classified as prime farmland.

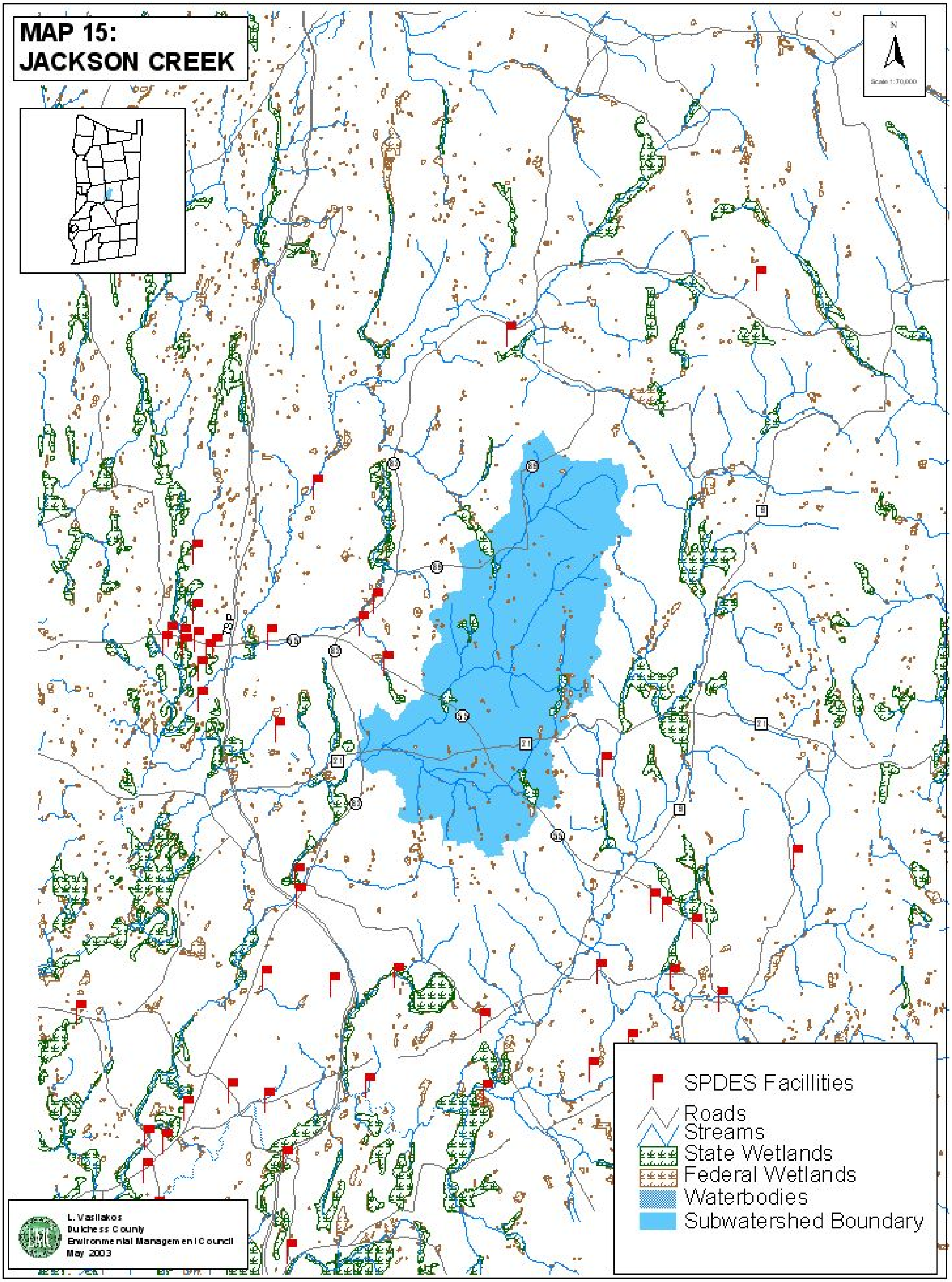
Jackson Creek watershed contains at least 20 lakes and ponds totaling 6 acres. The waterbodies range in size from 0.02 to 1.9 acres, and the watershed contains 24 tributaries totaling 23 miles. Jackson Creek is classified C(TS) from its confluence with the Sprout Creek to river mile 4.5 (317' upstream of East Noxon Rd. crossing), and class C(T) from JC 4.5 to its source. The classification means the stream should be suitable for primary and secondary contact recreation, and it should support trout spawning and survival. Finally, as of August 2002, there were no SPDES facilities present in the watershed.

Table 33. Jackson Creek Subwatershed Landuse

Landuse Category	Acreage	Percentage (%)
Agriculture	1055.50	19.01
Urban/Commercial	6.62	0.12
Extractive	3.74	0.07
Forestland	2340.60	42.15
Outdoor Recreation	119.63	2.15
Public/Semipublic	18.23	0.33
Residential	1498.32	26.98
Inactive	291.89	5.26
Water/Wetlands	218.70	3.94
Total	**5553.23**	**100.00**

Table 34. Soils in the Jackson Creek Subwatershed

Soil Name	Percent (%)	Description
Bernardston silt loam	5.15	1.4% prime farmland, well-drained
		3.1% farmland of statewide importance
Carlisle Muck	0.00	hydric
Dutchess silt loam	3.31	1 % prime farmland, well-drained
		2.3 % farmland of statewide importance
Dutchess-Cardigan complex	20.16	well-drained
Fluvaquents-Udifluvents complex	3.93	hydric/well to excessively drained
Fredon silt loam	0.75	somewhat poorly drained
Georgia silt loam	3.03	well-drained
Halsey mucky silt loam	0.17	hydric, poorly-drained
Hoosic gravelly loam	7.97	somewhat excessively drained
Hoosic channery loam	1.25	somewhat excessively drained
Massena silt loam	4.16	somewhat poorly drained
Nassau-Cardigan complex	20.66	somewhat excessively drained/well-drained
Nassau-Rock outcrop complex	3.23	somewhat excessively drained/rock
Palms muck	0.73	hydric, poorly-drained
Pawling silt loam	0.51	well-drained
Pits, gravel	1.30	N/A
Pittstown silt loam	15.32	well-drained
Punsit silt loam	1.90	somewhat poorly drained
Stockbridge silt loam	0.63	prime farmland, well-drained
Sun silt loam	5.25	hydric, poorly-drained
Udorthents	0.04	well-drained
Water	0.22	N/A
Wayland Silt Loam	0.31	hydric, poorly-drained
TOTAL	100.00	


MAP 15:
JACKSON CREEK
N
Scale 1:70,000
SPDES Facilities
Roads
Streams
State Wetlands
Federal Wetlands
Waterbodies
Subwatershed Boundary
L. Vasilakos
Dutchess County
Environmental Management Council
May 2003

Biological Community Analysis

Jackson Creek was not sampled during the 1973 or 1989 assessments because it is a tributary to the Sprout Creek, and not directly to the Fishkill Creek. However, Schmidt and Kiviat (1985) assessed the fish populations of Jackson Creek and found naturally reproducing trout populations. High brook and brown trout populations were also documented in 2001, despite poor physical conditions due to the lack of flow and only pockets of water (Stainbrook, 2004). Water chemistry data were collected in the summers of 2001 and 2002, but it is limited to four dates (Table 35). Finally, in the summer of 2002, Bode et al. (2004) found the Jackson Creek fauna dominated by clean-water mayflies, and based on macroinvertebrate metrics assessed the water quality as non-impacted.

Jackson Creek has been subjected to intense development pressures in the past four years (2000-2004). It is imperative to the health of the biotic communities that water quality and quantity issues be considered during the approval of development proposals. The geomorphic stability of the stream needs to be assessed to determine the impact of an increasing number of stream crossings and land contour changes for development, particularly in the steep sloped areas upstream of the route 55 crossing. Finally, further chemical water quality analysis may be warranted to establish base line chemical parameters for the stream.

Table 35. Yearly mean water chemistry data from Jackson Creek, collected at river mile 4 (720' downstream of Rte 82 crossing). Data is limited to summer 2001 and 2002 (Stainbrook, 2004).

Jackson Creek		
	Year	
	2001	
Location	**JC 4.0**	
Parameter		
pH	7.9	s.d. .21, N = 4
Dissolved Oxygen (mg/L)	9.8	s.d. 1.66, N = 4
Alkalinity (mg/L)	ND	ND
Temperature C	18.75	s.d. 6.25, N = 4
Chloride (mg/L)	ND	ND
PO4-P (mg/L)	ND	ND
SO4 (mg/L)	ND	ND
Conductivity (µmhos/cm)	412.5	s.d. 78.5, N = 2

Whaley Lake Brook Watershed

Whaley Lake Brook watershed encompasses 11,481 acres, accounting for 9 percent of the Fishkill Creek watershed area (Map 16). This watershed is located within three municipalities including the towns of Union Vale, Beekman and Pawling. In 2000, the dominant land uses in the watershed were forest (58%), residential (18%) and water/wetlands (10%) (Table 36). The remaining land uses included agriculture (8.9%), inactive (2.8%), public/semipublic (0.81%), outdoor recreation (0.80%), transportation (0.59%), urban/commercial (0.52%), extractive (0.11%), and industrial (0.08%) (Table 36). Relative to other Fishkill Creek subwatersheds, Whaley Lake Brook watershed ranked second in total area of water/wetlands and third for forestland.

The dominant soil type in Whaley Lake Brook watershed is Hollis Chatfield Rock outcrop complex comprising 36.4% (Table 37). Hollis and Chatfield soils are well drained to somewhat excessively drained loamy soils formed in till which is underlain by folded schist, granite or gneiss bedrock. The major difference between the two soil types is their depth, with Hollis soils characterized as shallow (10 to 20 inches) and Chatfield considered moderately deep (20 to 40 inches). Another portion of this complex is rock outcrop consisting of exposures of folded schist, granite or gneiss bedrock. The second most abundant soil type is Stockbridge silt loam at 14.6%. Stockbridge silt loam is a well-drained loamy soil formed in till which ranges in slope from 3 to 45 percent.

The Whaley Lake Brook watershed contains ~32 miles of streams, and ~393 acres of lakes and ponds. Whaley Lake Brook is approximately 5.6 miles in length from its beginning at the outfall of Whaley Lake, to its confluence with the Fishkill Creek. The brook is classified as a C(T) stream from its confluence with the Fishkill Creek upstream to its confluence with tributary 4 (river mile 4.5), and a C(TS) stream from tributary 4 to the outlet of Whaley Lake. According to the New York State Department of Environmental Conservation, the best usage of Class C (TS) waters is fishing, but they are also suitable for trout propagation and survival. The water quality should also be suitable for primary and secondary contact recreation. Gardner Hollow Brook (tributary H-95-19-3/river mile 4.5) has an A classification for half its length, indicating it could provide a source of drinking water, along with the uses listed above. The remainder of Gardner Hollow Brook is classified C(T). Tributary H-95-19-1 (WL 1.48) and H-95-19-2 (WL 1.5) are classified as C(T), and the remainder of the Whaley tributaries have C designations.

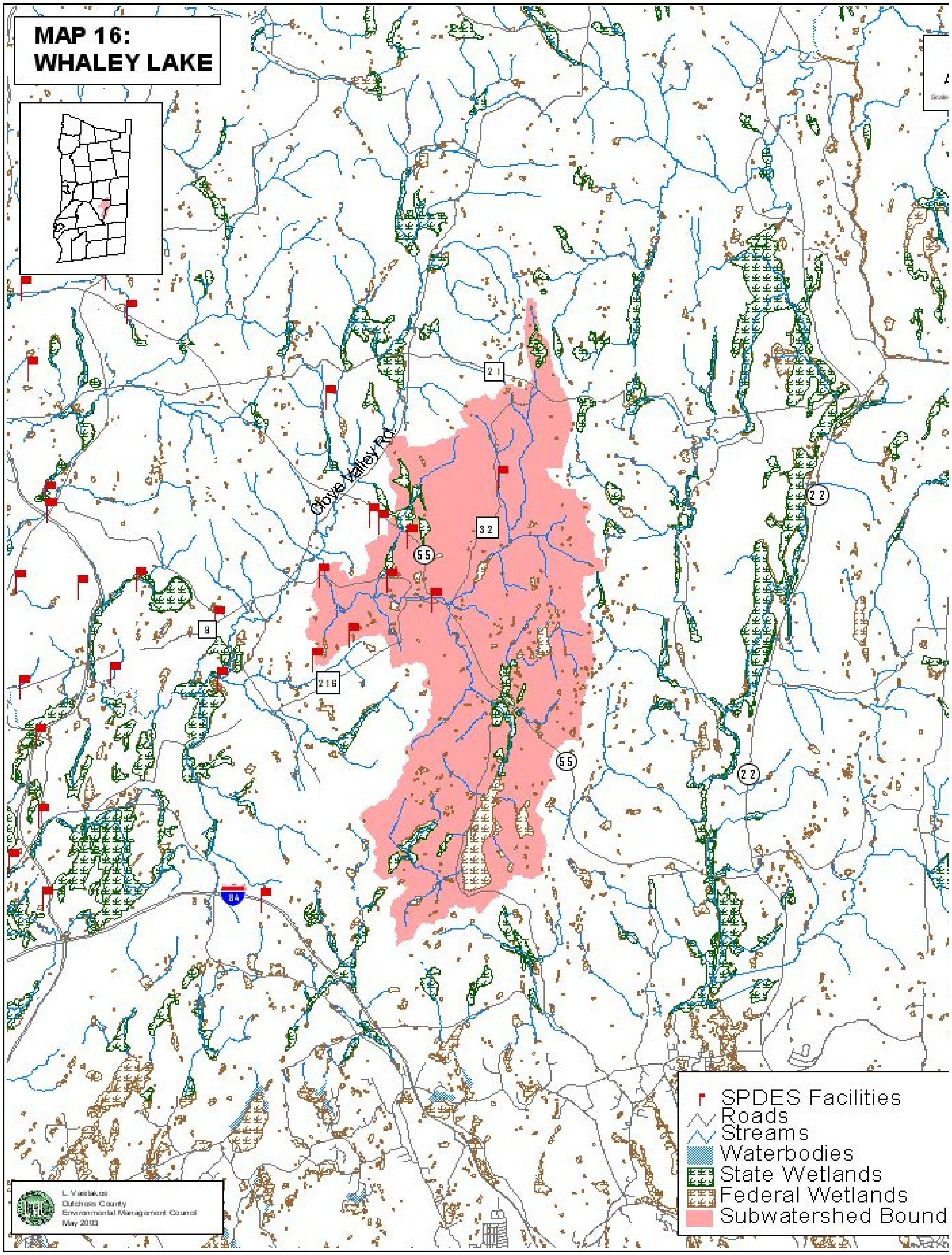
The largest lakes in the watershed are Whaley Lake (252-acres, class B), Little Whaley Lake (44.1 acres, class B), and Nuclear Lake (50 acres, class C). There is more in-depth discussion of these lakes in the Surface Water section of this plan. Finally, as of August of 2002, there were 7 SPDES facilities that discharged to surface water (2) or groundwater (5).

Table 36. Land Use in the Whaley Lake Subwatershed

Land Use Category	SUM_ACRES	Percentage (%)
Agriculture	1008.94	8.86
Urban/Commercial	58.66	0.52
Extractive	12.79	0.11
Forestland	6554.40	57.58
Industrial	8.83	0.08
Outdoor Recreation	91.36	0.80
Public/Semipublic	92.66	0.81
Residential	2014.73	17.70
Transportation	67.13	0.59
Inactive	321.19	2.82
Water/Wetlands	1152.67	10.13
Total	**11383.37**	**100.00**

Table 37. Soils in the Whaley Lake Subwatershed

Soil Name	Percentage (%)	Soil Description
Carlisle Muck	1.35	hydric
Charlton loam	3.76	0.48 prime farmland, 3.04 farmland of statewide importance, well-drained
Charlton-Chatfield complex	8.31	5.45 % farmland of statewide importance well-drained
Chatfield-Hollis complex	11.88	well-drained
Copake gravelly silt loam	4.34	2.92% prime farmland, 1.32 farmland of statewide importance, well-drained
Copake channery silt loam	0.91	0.91 % prime farmland, well-drained
Farmington-Galway complex	0.27	well-drained
Farmington-Rock outcrop	0.03	well-drained/rock (mix)
Fluvaquents-Udifluvents complex	0.20	hydric/well-drained (mix)
Fredon silt loam	0.40	farmland of statewide importance, hydric inclusion
Galway-Farmington complex	0.27	well-drained
Georgia silt loam	2.52	1.93% prime farmland, 0.59 farmland of statewide importance, well-drained
Halsey mucky silt loam	0.15	hydric
Hollis-Chatfield Rock outcrop complex	36.36	well drained and somewhat excessively drained
Hoosic gravelly loam	0.44	0.38 farmland of statewide importance somewhat excessively drained
Hoosic channery loam	0.09	farmland of statewide importance, somewhat excessively drained
Linlithgo silt loam	0.11	farmland of statewide importance, hydric inclusion
Massena silt loam	1.78	farmland of statewide importance, hydric inclusion
Palms muck	1.64	hydric
Pawling silt loam	0.13	prime farmland, well-drained
Pits, gravel	0.49	N/A
Stockbridge silt loam	14.56	3.35 prime farmland, 8.03 farmland of statewide importance well-drained
Stockbridge-Farmington complex	2.05	farmland of statewide importance, well-drained
Sun silt loam	2.77	farmland of statewide importance
Udorthents	0.10	somewhat excessively drained to well-drained
Urban land	0.07	N/A
Water	3.46	N/A
Wappinger loam	0.15	well-drained
Wayland silt loam	1.38	hydric
TOTAL	**100**	


MAP 16:
WHALEY LAKE
Clove Valley Rd
21
32
55
9
216
22
84
SPDES Facilities
Roads
Streams
Waterbodies
State Wetlands
Federal Wetlands
Subwatershed Bound
Dutchess County
Environmental Management Council
May 2003

Biological Community Analysis

Whaley Lake Brook wasn't sampled in Neuderfer's 1973 watershed assessment. The stream was assessed in 1985 at river mile WL 0.4, where Schmidt and Kiviat found that Whaley Lake Brook had a substantial effect on the water quality of the upper Fishkill creek (Schmidt and Kiviat, 1986). Additionally, the researchers documented brown trout holding over throughout the summer, but didn't find evidence that they were successfully reproducing at that time (Schmidt and Kiviat, 1986).

Researchers visited Whaley Lake Brook again in 1988 through 1989 at river mile WL 0.4. According to Stevens et al. (1994), Whaley Lake Brook had substantially higher chloride concentrations than existed in the 1985 analysis (Table 38). Despite the increase in chloride concentrations, Whaley Lake Brook had good water quality (slightly impacted), a substantial fish community, and clean-water diatoms (Stevens et al., 1994). Additionally, spawning brown trout were documented in 1988 and 1989, again indicating good water quality.

Due to the chloride concentrations in Whaley Lake Brook, further chemical examinations may be warranted to track potential sources. In addition, as noted by Stevens et al. (1994), the effects of increased sewage inputs on stream flora and fauna need to be evaluated in order to determine the required level of sewage treatment necessary to minimize impacts for the rapidly developing area.

Table 38. Yearly mean water chemistry data from Whaley Lake Brook 0.4 from 1985, 1989, and 2001. Sample collection in 1985 ranged from January through December, 1989 collection ranged from May 1988 through April 1989, and 2001 data is limited to summer 2001 and 2002 (Schmidt and Kiviat, 1986; Stevens et al., 1994; Stainbrook, 2004).

Whaley Lake Brook						
	Year		**Year**		**Year**	
	1985		**1989**		**2001**	
Location	**WC 0.4**		**WC 0.4**		**WC 0.4**	
Parameter						
pH	7.9	s.d. .28, N = 11	8	s.d. .31, N = 8	8.2	s.d. .24, N = 4
Dissolved Oxygen (mg/L)	10.7	s.d. 1.6, N = 11	9.8	s.d. 2.1, N = 10	9.7	s.d. 1.3, N = 4
Alkalinity (mg/L)	93.2	s.d. 42.2, N = 11	ND	ND	ND	ND
Temperature C	11.2	s.d. 8.8, N = 11	12.7	s.d. 9.3, N = 12	20.2	s.d. 4.8, N = 4
Chloride (mg/L)	25.8	s.d. 9.1, N = 10	35.3	s.d. 16.5, N = 12	ND	ND
PO4-P (mg/L)	ND	ND	0.011	s.d. .005, N = 12	ND	ND
SO4 (mg/L)	ND	ND	15.8	s.d. 2.9, N = 12	ND	ND
Conductivity (µmhos/cm)	ND	ND	239.2	s.d. 114.9, N = 12	444.5	s.d. 201.5, N = 2

Whortlekill Creek Watershed

The Whortlekill Creek watershed encompasses approximately 4,269 acres, accounting for 3 percent of the total Fishkill Creek watershed area (Map17). The Whortlekill watershed is located in three municipalities including the towns of Beekman, La Grange and East Fishkill. In 2000, the dominant land uses in the watershed were residential (42%), forest (31%) and agricultural (9.6%)(Table 39). The remaining land uses included water/wetlands (8%), urban/commercial (3%), outdoor recreation (2%), inactive (2%), transportation (1%), public/semipublic (0.47%), extractive (0.37%), and industrial (0.06%). Developed land (urban/commercial, industrial, residential and public/semipublic land uses) accounted for 45.5% of the land area in the watershed, ranking it the highest relative to all other subwatersheds of the Fishkill Creek.

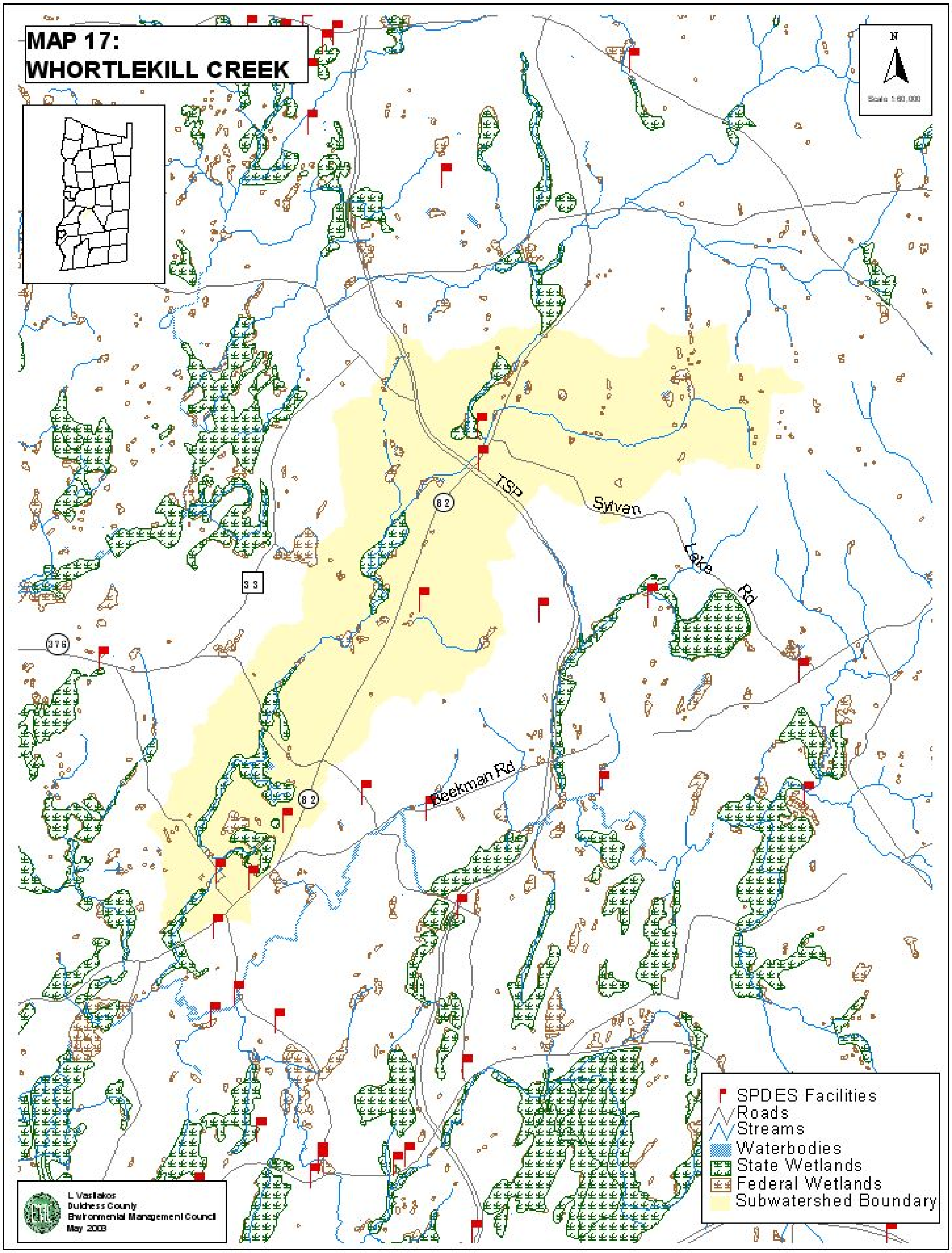
The dominant soil types in the Whortlekill watershed are Hoosic gravelly loam (29.1%) and Dutchess-Cardigan complex (19.1%)(Table 40). Hoosic gravelly loam is very deep and somewhat excessively drained sandy over gravelly soil formed in outwash. Hoosic gravelly loam has a slope ranging from 0 to 45 percent, and a permeability that is rapid to moderately rapid in the surface layer and subsoil and very rapid in the substratum. Dutchess-Cardigan complex consists of about 40 percent Dutchess soils, 30 percent Cardigan soils, and 30 percent other soils and rock outcrop. Dutchess soils are very deep, well-drained loamy soils formed in till with a moderate permeability. Cardigan soils are moderately deep, well-drained loamy soils formed in till underlain by folded shale bedrock with moderate permeability. Well-drained soils comprise 49.5% of soils in the watershed, while hydric soils comprise 8.9%. In 2004, soils characterized as farmland of statewide importance comprised 61.8% while prime farmland comprised 7 percent of the Whortlekill land area.

The Whortlekill Creek watershed contains approximately 52.7 acres of ponds and lakes, and 11.7 miles of streams. The Whortlekill Creek measures approximately 8.3 miles in length. From its confluence with the Fishkill Creek to tributary H-95-12-1a (WK 5.6), the stream is designated a Class C(T) stream. From tributary 1a (WK 5.6) to its source the stream is classified as C(TS). The best usage of the Whortlekill Creek is fishing, while it should also be suitable for fish propagation and survival along with primary and secondary contact recreation. Additionally, the upper portions should support trout reproduction. The remaining tributaries of the Whortlekill Creek are classified as C. As of August 2002, the watershed contained 6 SPDES facilities that discharged to groundwater.

Table 39. Land Use in the Whortlekill Subwatershed		
Land Use Category	**Acreage**	**Percentage (%)**
Agriculture	410.92	9.59
Urban/Commercial	135.79	3.17
Extractive	16.01	0.37
Forestland	1340.03	31.26
Industrial	2.45	0.06
Outdoor Recreation	86.00	2.01
Public/Semipublic	19.94	0.47
Residential	1784.43	41.63
Transportation	48.71	1.14
Inactive	95.81	2.24
Water/Wetlands	346.35	8.08
Total	**4286.43**	**100.00**

Table 40. Soils in the Whortlekill Subwatershed

Soil Name	Percentage (%)	Soil Description
Bernardston silt loam	7.58	1.45 % prime farmland, 5.81 % farmland of statewide importance, well-drained
Carlisle muck	1.05	hydric
Dutchess silt loam	0.22	prime farmland, well-drained
Dutchess-Cardigan complex	19.12	18.53 farmland of statewide importance, well-drained
Fluvaquents-Udifluvents complex	2.38	hydric
Fredon silt loam	2.10	farmland of statewide importance, hydric inclusion
Galway-Farmington complex	0.21	well-drained
Georgia silt loam	0.79	0.20 prime farmland, 0.59 farmland of statewide importance; well-drained
Halsey mucky silt loam	0.17	hydric
Haven loam	0.37	prime farmland, well-drained
Hoosic gravelly loam	29.09	28.56 farmland of statewide importance somewhat excessively drained
Hoosic channery loam	0.75	farmland of statewide importance, somewhat excessively drained
Hoosic-Urban land complex	0.70	somewhat excessively drained/urban
Massena silt loam	2.04	farmland of statewide importance, hydric inclusion
Nassau-Cardigan complex	14.97	well-drained to somewhat excessively drained
Nassau-Rock outcrop complex	1.34	somewhat excessively drained/urban
Palms muck	0.10	hydric
Pits, gravel	0.96	N/A
Pittstown silt loam	4.60	4.5 % prime farmland, 0.09 farmland of statewide importance, well-drained
Punsit silt loam	1.26	farmland of statewide importance, hydric inclusion
Stockbridge silt loam	0.31	0.13 % prime farmland, 0.18 % farmland of statewide importance, well-drained
Stockbridge-Farmington complex	0.28	farmland of statewide importance
Sun silt loam	1.62	farmland of statewide importance, hydric inclusion
Udorthents, smoothed	1.45	0.32 hydric inclusion, somewhat excessively drained to moderately well-drained
Urban land	0.56	N/A
Water	0.67	N/A
Wappinger loam	0.14	prime farmland, well-drained
Wayland silt loam	5.16	hydric
TOTAL	100.00	


MAP 17:
WHORTLEKILL CREEK
N
TSP
Sylvan
Lake
Rd
82
33
376
Beekman Rd
SPDES Facilities
Roads
Streams
Waterbodies
State Wetlands
Federal Wetlands
Subwatershed Boundary
L Vasilakos
Dutchess County
Environmental Management Council
May 2003

Biological Community Analysis

Whortlekill Creek was not sampled in Neuderfer's 1973 or Schmidt and Kiviat's 1985 watershed assessment.

Researchers visited Whortlekill Creek in 1988 through 1989 at river mile WK 0.35. According to Stevens et al. (1994), the stream contained a diatom community that was dominated by pollution sensitive species, especially in the fall and winter. Additionally, the stream contained the best fish community of all the Fishkill Creek sampling stations (Stevens et al., 1994). The researchers found a reproducing population of brook trout, which are very pollution sensitive. Combined, these factors indicated good (non-to slightly-impacted) water quality. However, sulfate and chloride concentrations and conductivity levels were high relative to other subwatersheds (Table 41). In 2001, the brook trout populations were still present despite a large increase in developed land (Stainbrook, 2004).

The high chloride and sulfate concentrations can be considered indications of impacts from urbanizing land uses. Therefore, it would be warranted to conduct further research in order to determine if land use impacts have damaged biological communities.

Table 41. Yearly mean water chemistry data from Whortlekill Creek 0.35 from 1989 and 2001. Sample collection in 1989 ranged from May 1988 through April 1989, and 2001 data is limited to summer 2001 and 2002 (Schmidt and Kiviat, 1986; Stevens et al., 1994; Stainbrook, 2004).

Whortlekill Creek				
	Year		**Year**	
	1989		**2001**	
Location	**WK .35**		**WK .35**	
Parameter				
pH	7.8	s.d. .5, N = 8	8.05	s.d. .29, N = 4
Dissolved Oxygen (mg/L)	8.3	s.d. 1.6, N = 10	9.4	s.d. .90, N = 4
Alkalinity (mg/L)	ND	ND	ND	ND
Temperature C	11.3	s.d. 8, N = 12	19.7	s.d. 4.8, N = 4
Chloride (mg/L)	23.7	s.d. 14, N = 12	ND	ND
PO4-P (mg/L)	0.009	s.d. .007, N = 12	ND	ND
SO4 (mg/L)	14.4	s.d. 3.1, N = 12	ND	ND
Conductivity (µmhos/cm)	188.6	s.d. 68, N = 12	621	s.d. 76.4, N = 2

Wiccopee Creek Watershed

Wiccopee Creek watershed (H-95-8) encompasses 7,267 acres, accounting for 6 percent of the Fishkill Creek watershed area (Map 18). This Fishkill Creek subwatershed is located within four municipalities including the towns of East Fishkill and Fishkill in Dutchess County and the towns of Kent and Philipstown in Putnam County. According to reference materials the Wiccopee is also called Trout Creek. In 2001, the dominant land uses in the Wiccopee Creek watershed were forest (71.2%) and residential (13.4%) (Table 42). The remaining land uses included agriculture (4.8%), water/wetlands (4.5%), outdoor recreation (2.1%), extractive (1.4%), transportation (0.82%), inactive (0.80%), industrial (0.56%), and commercial (0.37%). Wiccopee Creek watershed had the second highest percentage of forested land relative to the other subwatersheds of the Fishkill Creek watershed.

Comprising 27% of watershed soils, Copake gravelly silt loam is the dominant soil type (Table 43). Copake gravelly loam is a very deep, well-drained gravelly loam soil over sand and gravel that is formed in outwash. Copake gravelly loam ranges in slope from 0 to 45%. Eighty-seven percent of watershed soils can be characterized as well drained, and approximately 5% are classified as hydric. In addition, 19.4% of soils are characterized as farmland of statewide importance, while the prime farmland classification characterizes 10.5%.

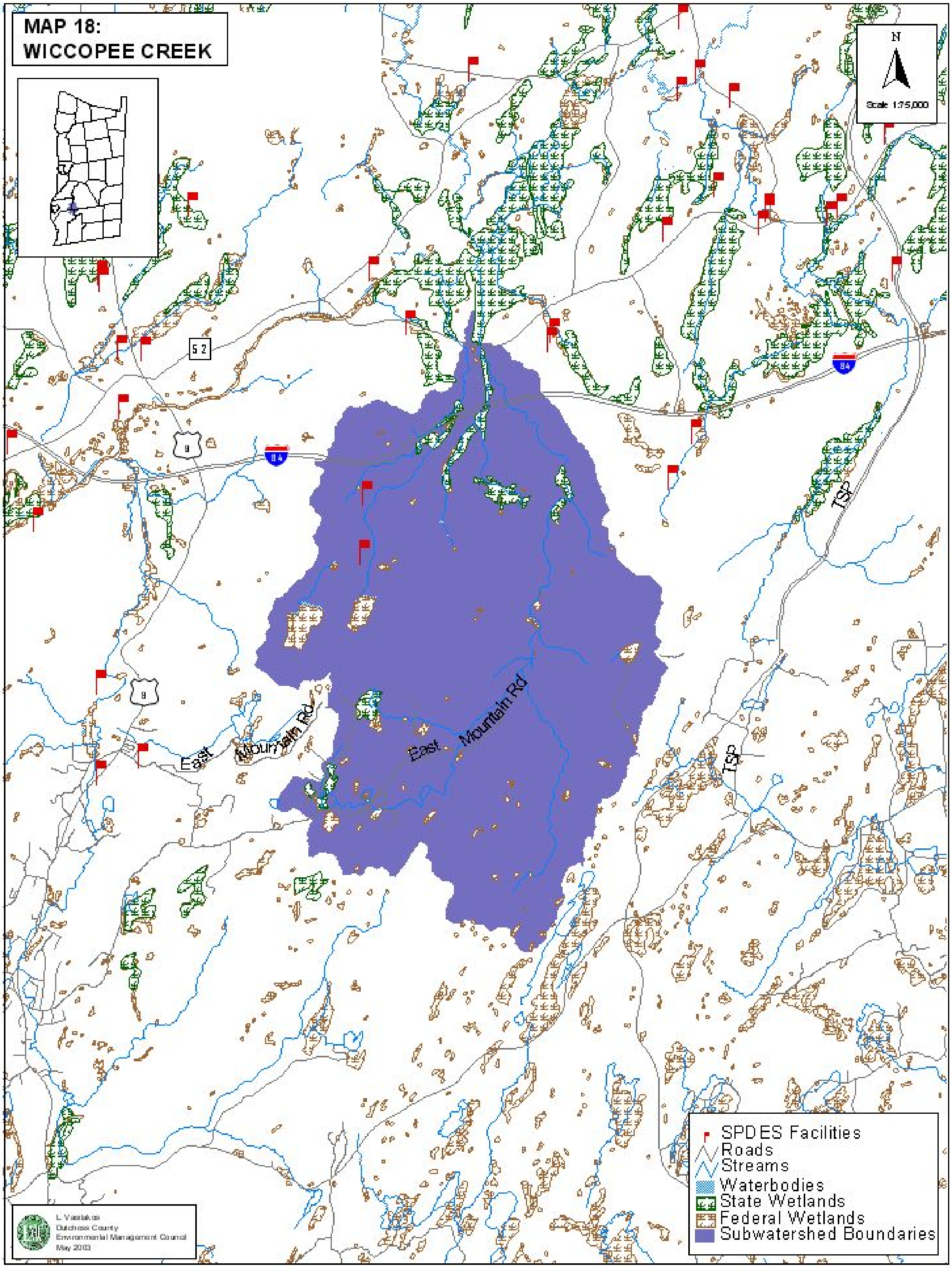
The Wiccopee Creek watershed contains 13.7 miles of streams, and 86 acres of lakes and ponds. In addition, the Wiccopee Creek main stem totals approximately 6 miles, and the majority of lakes and ponds were classified as New York State regulated wetlands. Wiccopee Creek (H 95-8), a Class C(T) stream, should be suitable for trout survival, and it should support primary and secondary contact recreation. Tributary H 95-8-6, which is located in Putnam County, is classified to support trout survival and spawning (C(TS)). The remainder of the perennial tributaries in the watershed have been assigned a C classification. Finally, the Wiccopee Creek watershed contains 2 SPDES facilities that discharged to surface water (1) or ground water (1).

Table 42. Land Use in the Wiccopee Creek Subwatershed

Land Use Category	Acreage	Percentage (%)
Agriculture	347.53	4.78
Commercial	27.20	0.37
Extractive	104.01	1.43
Forestland	5180.18	71.23
Industrial	40.44	0.56
Outdoor Recreation	154.30	2.12
Residential	977.49	13.44
Transportation	59.93	0.82
Inactive	58.23	0.80
Water/Wetlands	323.33	4.45
TOTAL	**7272.66**	**100.00**

Table 43. Soils in the Wiccopee Creek Subwatershed

Soil Type	Percentage (%)	Soil Description
Bernardston silt loam	2.45	0.15 % farmland of statewide importance,well-drained
Carlisle muck	0.34	hydric
Charlton loam	7.49	0.55% prime farmland, well-drained
Charlton-Chatfield complex	12.20	9.03 % farmland of statewide importance, well-drained
Chatfield-Hollis complex	12.31	well drained and somewhat excessively drained
Copake gravelly silt loam	26.58	6.86 % prime farmland, 2.59% farmland of statewide importance, well drained
Farmington-Galway complex	0.95	well drained and somewhat excessively drained
Fredon silt loam	0.64	farmland of statewide importance, hydric inclusion
Galway-Farmington complex	0.80	0.30 % farmland of statewide importance, well drained
Georgia silt loam	0.99	prime farmland, well drained
Halsey mucky silt loam	0.12	hydric
Hollis-Chatfield Rock outcrop complex	12.87	well drained and somewhat excessively drained
Hollis-Rock outcrop complex	3.33	well drained and somewhat excessively drained
Hoosic gravelly loam	0.15	farmland of statewide importance, somewhat excessively drained
Leicester loam	1.63	poorly drained, hydric
Massena silt loam	0.17	farmland of statewide importance, hydric inclusion
Palms muck	0.14	hydric
Pawling silt loam	2.09	prime farmland, moderately drained
Paxton fine sandy silt loam	0.98	well-drained
Pits, gravel	0.82	N/A
Pompton silt loam	0.11	moderately well-drained and somewhat poorly drained
Ridgebury loam	0.03	hydric inclusion
Riverhead loam	0.45	well-drained
Sun loam	0.90	farmland of significant importance, hydric
Stockbridge silt loam	3.07	2.38 % farmland of significant importance, well-drained
Stockbridge-Farmington complex	3.33	2.94 % farmland of significant importance well-drained and somewhat excessively drained
Sutton loam	0.02	well-drained
Udorthents	1.30	somewhat excessively drained to moderately drained
Urban land	0.42	N/A
Water	1.55	N/A
Wappinger loam	0.19	well-drained
Wayland silt loam	1.56	hydric
TOTAL	**100.00**	


MAP 18:
WICCOPEE CREEK
N
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52
9
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East Mountain Rd
East Mountain Rd
TSP
TSP
SPDES Facilities
Roads
Streams
Waterbodies
State Wetlands
Federal Wetlands
Subwatershed Boundaries
Dutchess County
Environmental Management Council
May 2003

Biological Community Analysis

The Wiccopee Creek wasn't sampled in Neuderfer's 1973 watershed assessment. The stream was assessed in 1985 when Schmidt and Kiviat found the Putnam County headwaters contained healthy brown trout and slimy sculpin populations. Slimy sculpins require clean and clear streams for survival, and thus their presence indicated good (non-impacted) water quality in the headwaters of the Wiccopee. The researchers went as far as to compare the headwaters to pristine Catskill streams, particularly due to the cold-water temperatures (Schmidt and Kiviat, 1986). Overall, Wiccopee fish populations appeared not to have changed significantly since a previous fish study in 1936 (Schmidt and Kiviat, 1986).

Researchers visited the Wiccopee Creek again in 1988 through 1989 at river mile WC .82 (Route 52 bridge). They found the macroinvertebrate community indicated high water quality (non-impacted) in the summer, but mediocre (slightly impacted) in other seasons (Stevens et al., 1994). The fish communities were the poorest in the Fishkill basin with only two species collected in 1988, and by 1991 the fish communities hadn't recovered (Stevens et al., 1994). Although the lower portions of the Wiccopee appeared to have been damaged, the headwater portion remained healthy. Despite the poor fish community, the water chemistry parameters measured as good (non-to-slightly impacted)(Table 44).

In 1988 and 1991, Stevens et al. (1989) noted a black substance on the rocks that wasn't present in the 1985 study of Schmidt and Kiviat. The substance tested high in manganese, and the researchers contemplated whether there was a relationship between the substance and the high stream turbidity observed by Schmidt and Kiviat (1986). The 1986 report noted that following a rainstorm the Wiccopee Creek at Route 52 was as "turbid as the Mississippi River", and suggested the high turbidity may have been caused by construction site runoff (Schmidt and Kiviat, 1986). In any case, proper erosion and sediment controls should be required during construction if the healthy fish populations documented in 1985 are to be restored and/or maintained. In addition, other potential impacting land uses, such as gravel mining and orchards, should be investigated for water quality improvement potential (Schmidt and Kiviat, 1986). Finally, the stream should be assessed to determine potential impacts, and a possible source, of the unidentified black substance noted by Stevens et al., (1994)

Table 44. Yearly mean water chemistry data from Wiccopee (Trout) Creek .82 from 1985, 1989, and 2001. Sample collection in 1985 ranged from January through December, 1989 collection ranged from May 1988 through April 1989, and 2001 data is limited to summer 2001 and 2002 (Schmidt and Kiviat, 1986; Stevens et al., 1994; Stainbrook, 2004).

Wiccopee Creek						
	Year		**Year**		**Year**	
	1985		**1989**		**2001**	
Location	**WC .82**		**WC .82**		**WC .82**	
Parameter						
pH	7.6	s.d. .22, N = 11	7.8	s.d. .5, N = 8	7.9	s.d. .27, N = 4
Dissolved Oxygen (mg/L)	10.4	s.d. 1.86, N = 11	8.3	s.d. 1.6, N = 10	9.5	s.d. 1.55, N = 4
Alkalinity (mg/L)	76.8	s.d. 22, N = 11	ND	ND	ND	ND
Temperature C	9.7	s.d. 7.7, N =11	11.3	s.d. 8, N = 12	18.7	s.d. 4.6, N = 4
Chloride (mg/L)	14.4	s.d. 3.7, N = 11	23.7	s.d. 14, N = 12	ND	ND
PO4-P (mg/L)	ND	ND	0.009	s.d. .007, N = 12	ND	ND
SO4 (mg/L)	ND	ND	14.4	s.d. 3.1, N = 12	ND	ND
Conductivity (µmhos/cm)	ND	ND	188.6	s.d. 68, N = 12	355	s.d. 1.4, N = 2

Conclusion

Looking towards the future

To protect the Fishkill Creek watershed for future generations, efforts need to be made to protect the stream corridor through the establishment of effective forested stream buffers. The stream buffers will function to offer some measure of protection against encroaching land uses. Additionally, watershed groundwater withdrawals for the expansion of suburban land uses need to be balanced to protect in-stream flows. In conjunction with this, a watershed-wide approach should be employed to determine the amount of regulated discharges that can be added to the various streams during low-flow periods without causing degradation. Stormwater run-off, from parking lots, roads, and subdivisions, should be treated before reaching the streams. In addition, serious investments should be made into impervious surface alternatives.

Water quality monitoring should continue to be conducted to track changes in biological community structure and water chemistry. Dissolved oxygen, temperature, conductivity, nitrate, phosphate, sulfate and chloride are water quality constituents of particular interest for tracking human-induced changes. Finally, failing and out-of-date sewage systems need to be upgraded to protect water quality and human health.

Following these guidelines should allow the Fishkill Creek to thrive along with the communities it touches. Ignoring the water quality of the Fishkill Creek during this period of extensive expansion will act to erode the health of the Fishkill Creek, and ultimately the surrounding communities. In depth recommendations developed by the Fishkill Creek Watershed Committee are available in Chapter 4.

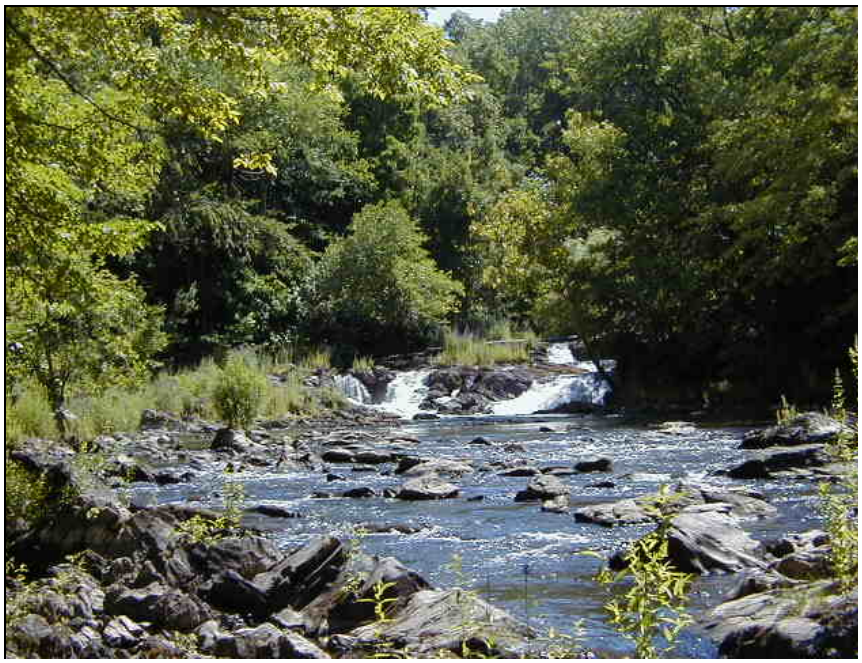

Figure 15. Fishkill Creek rapids near Maddam Brett Park in Beacon, NY.

IV. Management Strategies for Achieving Watershed Conservation Goals and Objectives

Introduction

The previous three chapters outlined many of the natural resources of the Fishkill Creek watershed. Chapter four contains objectives and recommendations that are designed to protect and/or restore the Fishkill Creek watershed. Following these guidelines should allow the Fishkill Creek, and its watershed, to thrive along with the communities it touches.

This chapter is divided into three parts. The first section includes *Watershed Conservation Objectives* that can be applied to the entire watershed. In the second section there are *Subwatershed Specific Recommendations* for the main stem and each subwatershed that include recommendations from previous scientific studies. The third part of this chapter contains *Additional Watershed Protection Measures* identified as important by the Fishkill Creek Watershed Committee. Finally, Chapter five outlines various *Best Management Practices* developed by the New York State Department of Environmental Conservation and other organizations that can be utilized to mitigate for the effects of various development and land use activities on water quality and quantity within a watershed.

Watershed Conservation Objectives

1) The Dutchess County Environmental Management Council and various environmental organizations should collect, organize, evaluate and make public existing data on the Fishkill Creek watershed.

2) Municipalities, government agencies and environmental organizations should continue to monitor water quality and quantity, biodiversity, land use, stream flow regime and other parameters within the watershed with the objective of identifying areas of concern to its integrity. Wherever possible this new data should be incorporated into the database mentioned in objective number one.

3) Municipalities, residents and businesses (i.e. property owners) should work toward remediation of the problems identified through analysis of the database developed through objectives one and two. Environmental groups should assist with the remediation efforts.

4) Businesses, municipalities, environmental groups and residents (the stakeholders) should collaborate to protect the watershed.

5) Environmental organizations, residents, businesses and municipalities should encourage locally based water resource education.

6) All stakeholders should help maintain a good quality– of– life within the watershed by protecting the health of the watershed.

Subwatershed Specific Recommendations

The following recommendations focus on environmental concerns pertaining to the Fishkill Creek watershed and its subwatersheds (major tributaries), as identified in current and previous investigations conducted in the various streams within the watershed.

Entire Fishkill Creek Watershed

Efforts should be made to protect the stream corridor through the establishment of effective forested stream buffers. The stream buffers will offer some measure of protection against encroaching land uses.

Groundwater withdrawals for the expansion of suburban land uses need to be balanced with groundwater recharge to protect in– stream flows. In conjunction with this, a watershed– wide approach should be employed to determine the amount of regulated discharges that can be added to the stream during low–flow periods without causing degradation.

Stormwater run– off, from parking lots, roads, and buildings, should be treated before reaching the stream. This can be accomplished by replacing old infrastructure with modern systems that remove many pollutants (see additional watershed protection measures section).

In addition, serious investments should be made into impervious surface alternatives, and ordinances to limit the amount of impervious surfaces in new developments.

Water quality monitoring should continue to be conducted to track changes in biological community structure and water chemistry. Macroinvertebrate studies should be repeated approximately every 5 years. Dissolved oxygen, temperature, conductivity, nitrate, phosphate, sulfate, and chloride are water quality constituents of particular interest for tracking human– induced as well as natural changes in the drainage.

Mapping of riparian and in–channel habitats should be completed. The remote– sensing based mapping should be updated on a 5 year basis in order to track changes.

Identify streams routinely use for swimming and check to see if NYSDEC classifies them as B (suitable for primary contact recreation). If necessary, request a classification upgrade to class B.

Cumulative impacts should be considered before issuance of state pollution discharge (SPDES) permits.

Best Management Practices (BMPs) issued by the NYSDEC, NYSDOT, USEPA and others should always be followed.

Many of the dams within the watershed are no longer in use. These dams should be systematically evaluated and removed where practical.

Fishkill Creek Main Stem Watershed

Failing and out– of– date sewage systems need to be upgraded to protect water quality and human health.

Sediment in the lower Fishkill Creek should be analyzed to determine the concentration and lateral extent of toxic heavy metal contamination. This should be done before the large dams in the area are breached or deteriorate naturally.

If feasible, remove the many, small (less than 3' high) dams along the Fishkill Creek documented during Streamwalk, 2004.

Sprout Creek Watershed

In their 1994 report, Stevens et al. recommended all new nutrient enhancements and/or reductions in dissolved oxygen need to be carefully evaluated.

Cumulative impacts should be assessed prior to the issuance of permits to discharge to the waters of the Sprout Creek, and in the design of septic systems within 200 feet of the stream.

Agricultural operations that do not follow best management practice guidelines should be identified and encouraged to follow them.

Clove Creek Watershed

In 1985, Schmidt and Kiviat recommended upgrading the NYSDEC classification of Clove Creek to class B due to the amount of primary contact recreation (swimming) that occurs in the stream. Recently, the stream was upgraded from class C to class C(TS) in recognition of the trout spawning that occurs in the stream. If the stream is being utilized for primary contact recreation (swimming), as observed by Kiviat and Schmidt (1985), it should be afforded the protections that accompany a B classification.

As described by Stevens et al. (1994), the Clove Creek watershed is under intense residential, commercial, and industrial development pressure. Therefore, proposals should be scrutinized with the intention of maintaining the high biotic quality present through the period of study (1985 through 2001).

Efforts should be made to protect the highly valuable drinking water available in the Clove Creek aquifer.

Jackson Creek Watershed

Jackson Creek has been subjected to intense development pressures over the last four years (2000– 2004). It is imperative to the health of the biotic communities that water quality and quantity issues be considered during the approval of development projects.

The geomorphic stability of the stream needs to be assessed to determine the impact of an increasing number of stream crossings and land contour changes due to development, particularly in the steep sloped areas upstream of the Route 55 crossing.

Further chemical water quality analysis is warranted to establish base line chemical parameters for Jackson Creek.

Whaley Lake Brook Watershed

Due to relatively high chloride concentrations in Whaley Lake Brook, further chemical studies are warranted to identify potential sources.

Effects of increased sewage inputs on stream flora and fauna need to be evaluated to determine the required level of sewage treatment necessary to minimize impacts from the rapidly developing area (Stevens et al., 1994).

Whortlelkill Watershed

Due to recent rapid watershed development, it would be prudent to conduct further research to determine if land use impacts have damaged biological communities.

Wiccopee Watershed

Proper erosion and sediment controls should be required during construction if the healthy fish populations documented in 1985 are to be restored or maintained.

Other potential impacting land uses, such as gravel mining and orchards, should be investigated to determine their possible effects on in– stream water quality (Schmidt and Kiviat, 1986).

The stream should be assessed chemically and physically to determine potential impacts—specifically, the identity and possible source of the unidentified black substance noted by Stevens et al., (1994).

V. Additional Watershed Protection Measures

Litter/ Solid Waste

The Fishkill Creek Streamwalk of 2004 identified litter as a significant problem along Fishkill Creek (and probably within the entire watershed). A systematic, regularly scheduled effort should be undertaken to address this issue. Annual stream cleanup events should be held in various locations, particularly in the lower Fishkill Creek where the worst of the litter was observed. Regularly scheduled roadside cleanup events should also be done in cooperation with municipalities and NYSDOT. In high litter areas, deterrents such as signage and/or increased police patrols should be employed.

Old or Inadequate Stormwater Runoff Infrastructure

The Fishkill Creek Streamwalk of 2004 documented many discharge pipes emptying directly into the Fishkill Creek. Most of these pipes discharged untreated runoff into the creek, and many of the outfalls created significant erosion features, such as gullies. These old systems should be upgraded to prevent gully formation, and at least partially treat the runoff through the use of the five NYS Stormwater design practices (ponds, wetlands, infiltration, filtering practices and open channels). Additional information can be found in the *Urban/Stormwater Runoff Management Practices* in the Best Management Practices section of this document.

Water Quality Monitoring

The streams, lakes and wetlands within the watershed should be regularly monitored for water quality, water quantity, biodiversity, as well as for physical and habitat changes. Monitoring these changes will help identify which practices or land use changes have significant adverse impacts on the watershed, so these can be avoided in the future.

Water quality monitoring should continue to be conducted to track changes in biological community structure and water chemistry. Macroinvertebrate studies should be repeated approximately every 5 years. Dissolved oxygen, temperature, conductivity, nitrate, phosphate, sulfate, and chloride are water quality constituents of particular interest for tracking human–induced as well as natural changes in water quality. In addition, streamwalk physical assessment surveys, analyses of water quantity and biodiversity studies should be conducted. Finally, mapping of riparian and in– channel habitats should be completed. The mapping should be updated on a 5 year basis in order to track changes.

Regulatory Analysis

A watershed– wide evaluation of regulations, including ordinances and zoning laws, should be undertaken. The evaluation should seek to identify regulatory gaps and determine if the current laws and ordinances adequately protect the watershed. The evaluation should also analyze current municipal zoning regulations for impervious surface/sprawl inducing aspects.

Municipal Studies (Land–Use, Master Plans, etc.)

Various studies commonly conducted by municipalities, such as master plans, land–use studies, and build–out analyses are very useful to watershed protection efforts. An effort should be made to identify which of these studies need to be updated and encourage municipalities to do so.

Evaluation of Projects and Procedures

All projects and procedures undertaken by the Fishkill Creek Watershed Committee should be evaluated to determine whether or not they are effective. Ineffective projects must be modified or abandoned. The Committee should encourage other entities working within the watershed to evaluate their project effectiveness as well.

White–Tailed Deer Management

In recent years deer populations have greatly increased throughout the watershed. Coupled with a decrease in hunters, lack of natural predators and an increase in development the issue of deer overpopulation has grown significantly. Excessive deer browse has damaged forest understories and stream buffer zones, virtually eliminating the next generation of trees. A humane method to control deer populations must be found to reduce the environmental damage caused by overpopulation.

Additional Issues

Important issues such as air and noise pollution are often overlooked when considering the health of a watershed. Air pollution produces acid rain precipitation as well as nitrogen and mercury deposition. Noise pollution adversely affects the quality of life of humans, and can have significant adverse impacts on non– human species. These issues need additional monitoring, and new and creative solutions need to be considered.

Incentive Programs for Watershed Conservation

Tax incentives, cost sharing programs, and award programs can be effective in protecting critical wetlands, watercourses and habitat areas. Tax reductions can be made at the local and county level for deed restrictions, covenants and conservation easements on properties identified for protection. There is also an opportunity for a reduction in income taxes through several donation and gift provisions in the Internal Revenue Code, which can provide attractive incentives for wetland and floodplain protection to landowners (DCEMC, 1999).

Open space assessment programs can be effective where the locality has adopted an open space plan. Within the guidelines of the open space plan or local master plan, assessments supporting local services such as water, sewer, and flood control can be reduced on property that will not be developed in the future.

The following are examples of cost sharing and award programs used both locally and on a national level:

Wetland Reserve Program (WRP)

www.nrcs.usda.gov/programs/wrp

WRP is a U.S. Department of Agriculture (USDA) program designed to help farmers and other landowners take agricultural lands out of production and restore them as wetlands. Technical Assistance is provided by USDA's Natural Resource Conservation Service (NRCS). In exchange for the landowner's agreement to restore and protect the wetland, payments are made for establishing wetland easements on eligible property. In 2004, for permanent easements, 100% of all eligible costs and the appraised agricultural value of the land are paid. For 30– year easements, 100% of all eligible costs and 75% of the appraised value is paid. Wetlands eligible for the program include prior converted cropland, farmed wetlands, farmed wetland pasture, stream corridors, or land substantially altered by flooding. The applicant must own the land for at least 12 months before the end of the sign– up period, and must have a clear title.

Wetland restoration agreements are also available, either in conjunction with an easement or as a stand– alone contract, where the landowner agrees to maintain certain conservation practices for 10 years. Under the restoration program the landowner or another source of funding pays 25% of the cost and USDA– NRCS pays 75%.

Conservation Reserve Program (CRP)

www.fsa.usda.gov/dafp/cepd/crp.htm

CRP encourages farmers to voluntarily plant permanent areas of grass and trees on land that needs protection from erosion, to act as windbreaks, or in places where vegetation can improve water quality or provide food and habitat for wildlife. In 2004, farmers must enter into 10 to 15 year contracts with the United States Department of Agriculture’s Commodity Credit Corporation (CCC). In return, they receive annual rental payments, incentive payments for certain activities and cost– share assistance to establish protective vegetation. Eligible land includes cropland that was planted to an agricultural commodity in 4 of the previous 6 most recent crop years, and marginal pastureland that is suitable for use as a riparian buffer to be planted to trees. Landowners who have owned the land for at least one year or operators who have leased the acreage for at least one year are eligible.

Green Power Partnership

http://www.epa.gov/greenpower/index.htm

The Green Power Partnership is a voluntary Partnership between the U.S. Environmental Protection Agency (EPA) and organizations that are interested in buying green power. Through this program, the EPA supports organizations that are buying or planning to buy green power. As a Green Power Partner, an organization pledges to replace a portion of its electricity consumption with green power within a year of joining the Partnership. In 2004, the EPA offered credible benchmarks for green power purchases, market information, and opportunities for recognition and promotion of leading purchasers.

Wildlife Habitat Incentives Program

http://www.nrcs.usda.gov/programs/whip/

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP, USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost–share assistance to establish and improve fish and wildlife habitat. WHIP agreements between the NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed.

WHIP has proven to be a highly effective and widely accepted program across the country. By targeting wildlife habitat projects on all lands and aquatic areas, WHIP provides assistance to conservation minded landowners who are unable to meet the specific eligibility requirements of other USDA conservation programs.

Education

The Fishkill Creek Watershed Committee has identified education as one of the most important components of a watershed planning strategy. In the past two years the Committee has started a website containing educational information (along with the Dutchess County EMC – FishkillCreekWatershed.org), obtained a Hudson River Estuary Program Grant to create K–12 lesson plans about the watershed (along with the DC Water and Wastewater Authority), helped organize and run the Fishkill Creek Streamwalk Program of 2004 (along with DCEMC and DC Soil and Water Conservation District), participated in the Hudson River Valley Ramble in 2004, organized a Canoe Trip on the Fishkill Creek open to the public (along with DCEMC), operated a booth at East Fishkill Community Day 2004 with displays and free information, and conducted monthly meetings that are open to the public and often have a featured speaker. These efforts should continue annually.

Additional Educational Initiatives (many originating from the Wappinger Creek Watershed Planning Committee) (DCEMC, 2000)

Community Networking

- Develop a centralized source, such as a non– profit group or regional agency, to distribute information and curriculum about the watershed.
- Establish a network among community groups by creating a Fishkill Watershed Resource Partner Book that describes each organization and how to contact them.

Public Education

- Develop routine methods to educate new landowners about water issues. For example, provide realtors with brochures already available from the EMC and SWCD titled, *What is a Wetland?*, *Reducing Nonpoint Source Pollution*, *Streamside Protection for Landowners* and *The Fishkill Creek Watershed*.
- Develop a hands—on display and accompanying presentation that could travel with staff or volunteers to public places such as malls, festivals, community days, teen centers, churches, senior centers or scout meeting places. Include the definition of a watershed, how people affect the watershed in their daily lives, and what they can do to help improve water quality.
- Create a video based on the hands—on display and presentation that could be purchased or loaned out to school and community groups.
- Provide workshops for local officials and landowners about the importance of open space and how it affects the tax base, the importance of agriculture and a healthy forest, and existing NYSDEC regulations.
- Present information on water quality and water quantity to chambers of commerce.
- Have a "Fishkill Creek Watershed Week" in late April or early May with various events planned and corporate sponsors.
- Advertise the benefits and values of the Creek by publishing maps, guides and telephone numbers for stream information in local newspapers and magazines.
- Establish contact with streamside homeowners. Inform them about the importance of vegetated buffers and involve them in community restoration efforts.
- Develop an outreach program to educate homeowners about how their actions can lead to loss of habitat and damage the ecology of our natural systems. Provide economic incentives for homeowners to not only protect habitat, but to restore it.

- Implement neighborhood workshops focusing on integrated pest management, best management practices for lawn care, maintenance of riparian buffers (vegetation along streams), and wetland protection to reduce pollutant loading from pesticides, toxins, sediment and nutrients.

School Programs

- Promote use of a recently developed *Watershed Education for Teachers* booklet developed through the Fishkill Creek Watershed Committee.
- Encourage the use of a watershed curriculum guide developed by Cornell University (Edelstein et al., n.d.).
- Encourage the use of water quality protocols developed by the Hudson Basin River Watch (Behar and Cheo, 2000).
- Develop a Fishkill Creek Watershed training guide for schools based on the data and information in the *Natural Resources Management Plan for the Fishkill Creek Watershed*.
- Provide seminars and workshops for teachers so they are more comfortable with the vast technical information available to them. Use the tools noted above for the workshops. Explore partnering with organizations such as BOCES, Hudson Basin River Watch, NYSDEC Hudson River Estuary Program and IES to cosponsor the programs.
- Send out a teacher survey asking what they currently teach related to watershed protection, and what they would like to have available. Based on the response, recommend the resources noted above or develop additional materials to meet their needs.
- Work at the state level to integrate environmental education into the base curriculum for public schools in a practical and creative way. Encourage or mandate the state board of public education and local school boards to add to programs and provide more time, funding and encouragement for environmental education.
- At the grade school level teach children to educate other children and their parents about environmental protection. Examples include children encouraging their parents to use the town transfer station for recycling and/or high school students mentoring elementary school children on water resource topics.

VI. Best Management Practices

The best management practices listed below were developed as recommendations and required implementation measures by the New York State Department of Environmental Conservation, New York State Department of Transportation, and others. The following practices should be followed to protect the Fishkill Creek watershed.

Agricultural Management Practices

The following is a list of agricultural best management practices. For a detailed description of each practice see the Agricultural Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State (NYSDEC, 1992). Additionally, there are other recommendations that can be obtained through the Natural Resources Conservation Service and Soil and Water Conservation District.

Access Road Improvement – Structural and vegetative improvements made to farm roadways.

Barnyard Runoff Management System – An installed system for the interception, collection, and safe disposal of runoff water from a barnyard or concentrated livestock area.

Conservation Tillage – Any tillage and planting system that leaves a minimum of 30% of the soil surface covered with plant residue after the tillage or planting operation. Strip– till, ridge– till and reduced– till are all included under minimum– till definition.

Constructed Wetlands – A constructed, shallow water area, usually a marsh, dominated by cattail, bulrush, rushes or reeds, designed to simulate the water quality improvement function of natural wetlands. Constructed wetlands are usually a component practice in a total system approach to agricultural wastewater and surface agricultural runoff treatment.

Contour Farming – The alignment and operation of all farm tillage, planting and harvesting practices as close to the true contour as possible.

Cover and Green Manure Crop – A crop of close growing grasses, legumes, or small grains grown primarily for temporary, seasonal soil protection and improvement. It is usually grown for 1 year or less. Green manure crops are cover crops, sod crops or intercrops that are plowed under and incorporated into the soil.

Critical Area Protection: Permanent Vegetative Cover – To establish and/or preserve permanent vegetation on highly erodible areas or land vulnerable to nonpoint source pollution.

Critical Area Protection: Structural Slope Protection – The stabilization of erosive slopes with riprap, walls or other non– vegetative materials.

Critical Area Protection: Streambank and Shoreline Protection – The use of vegetation, structures, biotechnology (willow wattles, live cribwalls, brush layering), or management techniques to stabilize and protect streambanks and shorelines.

Critical Area Protection: Mulching – The application of plant residues or other suitable materials to protect permanent vegetative cover or to stabilize soil independently.

Critical Area Protection: Temporary Vegetative Cover – Close– growing grasses or legumes established primarily for temporary, seasonal soil protection and improvement.

Crop Rotation – A planned sequence of annual and/or perennial crops.

Diversion – An earthen drainageway of parabolic or trapezoidal cross– section with a supporting ridge on the lower side.

Fencing – To enclose or divide an area of land with a suitable permanent structure that acts as a barrier to livestock.

Filter Strip – A strip of perennial grasses, legumes or shrubs and trees established or maintained across the slope and managed for pollutant removal by overland flow.

Grassed Waterway – A natural or constructed channel or parabolic or trapezoidal cross– section that is below ground level and is established in suitable vegetation for the stable conveyance of runoff.

Integrated Pest Management – An ecologically– based integrated pest control strategy designed to keep pest populations below economically injurious levels using a variety of control tactics, including: biological controls, cultural practices, resistant crop varieties, scouting, and trap crops.

Irrigation Water Management – A planned system that determines and controls the rate, amount, and timing of irrigation water. May also include "trickle" irrigation systems which deliver water directly to the root zone of plants by means of low volume, low pressure applicators.

Nutrient Management – An integrated system approach to maximizing the efficient use of plant nutrients. Techniques include composting, wise fertilizer management, timed application of manure, analysis of manure nutrients, proper manure storage, and soil testing.

Nutrient/Sediment Control System – A sequential system of structural and vegetative component practices installed down gradient from concentrated operations.

Pasture Management: Short– duration Grazing Systems – A pasture management system using 10 or more paddocks for a grazing season, alternating paddocks every week to allow for forage re–growth.

Pesticide Management – An integrated systems approach to managing the selection, handling, mixing, use, placement, storage and disposal of pesticides used in agricultural crop production. This may include computerized precision application, evaluation of site– specific leaching and surface loss potentials, a permanent structure for pesticide handling, proper equipment calibration, and proper timing and use of pesticides.

Riparian Forest Buffer – An area of trees, shrubs and grasses located adjacent to and up gradient from water bodies.

Strip cropping – Growing annual and perennial crops in a systematic arrangement of strips or bands. When the system is planted on the contour, it is called contour strip cropping. When the system is planted across the general slope, it is called field strip cropping.

Terraces – An earth embankment, a channel, or a combination ridge and channel constructed across the slope.

Construction and Resource Extraction Management Practices

(see also Urban/Stormwater Runoff Management Practices)

Soil erosion from construction and mining in areas where exposed soil is subject to erosion from rainfall events is one of the major causes of sedimentation in the Fishkill Creek Watershed. Even though earth disturbances may take place for a relatively short period of time, the movement of sediment and other pollutants is often severe (NYSDEC, 1992a). In addition, uncontrolled construction site sediment loads have been reported to be on the order of 35 to 45 tons per acre per year (USEPA Office of Water, 1997). Conversely, sediment loadings from undisturbed woodlands are typically less than 1 ton per acre per year (USEPA Office of Water, 1997).

Best Management Practices can be used to prevent erosion from construction and mining sites. The following is a list of best management practices developed by the Construction Management Practices Sub– Committee of the New York State Nonpoint Source Management Practices Task Force. Detailed descriptions of these practices can be found in the Construction Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State (NYSDEC, 1992a).

Administrative Control Mechanisms – Erosion and sediment control ordinances, subdivision rules & regulations, site review, zoning regulations and special easements and covenants can be adopted town– wide, countywide, or for special designated areas.

Check Dam – Small, temporary stone dams constructed across a swale or drainageway.

Construction Road Stabilization – The temporary stabilization of access routes, on– site vehicle transportation routes, and parking areas on construction sites.

Construction Waste Management – The proper use or disposal of solid waste materials from construction sites.

Critical Area Protection (See description under *Agricultural Practices*)

Diversions (See description under *Agricultural Practices*)

Dust Control – Application of water, construction of wind barriers, or roughening of soil surface to control the movement of airborne pollutants from land– disturbing activities.

Filter Strip (See description under Agricultural Practices)

Grade Stabilization Structure – A structure for controlling the grade and gully erosion in natural or artificial channels.

Grassed Waterway (See description under Agricultural Practices)

Hazardous Material Management – The proper handling, storage and application of materials defined as hazardous in the Department of Transportation Code of Federal Regulations, Title 49 or in NYS Rules and Regulations, Part 371.

Level Spreader – A non– erosive outlet constructed to disperse concentrated flows uniformly across a slope.

Lined Waterway or Outlet – A channel or outlet permanently protected with rock, concrete or other erosion– resistant material for its entire design depth.

Paved Flume – A small concrete– lined channel used to convey water on a relatively steep slope.

Pipe Slope Drain – A closed drain installed from the top to the bottom of a slope.

Planned Land Grading – Reshaping the land surface to planned erosion– resistant grades as determined by engineering survey and layout.

Riparian Forest Buffer – An area of trees, shrubs and grasses located adjacent to and up gradient from water bodies.

Silt Fence – A temporary barrier of geotextile fabric supported by posts and entrenched in the soil.

Stabilized Construction Entrance – A stable pad of coarse aggregate underlain with filter cloth located at points of construction ingress and egress.

Staged Land Clearing and Grading – Scheduled or phased land disturbances, each phase being limited to what is required for immediate construction activity.

Storm Drain Inlet Protection – A sediment barrier installed around a storm drain inlet.

Straw Bale Dike – A temporary barrier of straw or hay bales that are staked and entrenched in the soil for a depth of at least 4 inches.

Sub– surface Drain – A conduit installed beneath the ground to collect and/or convey drainage water.

Sump Pit – A small basin constructed to collect excess water and sediment from excavation.

Temporary Dike/Swale – A temporary berm and/or excavated channel constructed to direct water to a desired location and stabilized with appropriate materials.

Temporary Sediment Basin – An earthen basin constructed to intercept sediment– laden runoff and to trap and retain the sediment and water– borne debris.

Temporary Sediment Trap – A small ponding area constructed to intercept sediment– laden runoff and retain the sediment.

Temporary Storm Drain Diversion – A re–directed stormwater conveyance that discharges into a sediment– trapping device.

Temporary Watercourse Crossing – A stable structure installed across a watercourse to provide short– term access for construction traffic.

Topsoiling – Conserving and utilizing a specified quality and quantity of topsoil on disturbed areas.

Turbidity Curtain – A flexible barrier used to trap sediment in water bodies.

Waterbar – A ridge, or ridge and channel, constructed across sloping roads, rights– of– way, or other narrow disturbed areas.

Hydrologic and Habitat Modification Management Practices

Hydrologic modification includes stream channelization, dredging, and flow regulation or modification through the use of dams and other structures. Habitat modification occurs when riparian (riverside) vegetation is removed, streambanks are modified and destabilized, and surface water is impounded behind a dam or other structure altering the type of habitat available to plants and animals. Somewhere between 70 and 90 percent of natural riparian ecosystems in the United States have been lost due to human activity (USEPA Office of Water, 1997). These activities can have both short and long– term effects on water quality and quantity in the watershed.

The following practices can be used to lessen the impact of these activities on water resources. Detailed descriptions can be found in *Hydrologic and Habitat Modification Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State* (NYSDEC, 1992b).

- ***Modifying, Operating and Maintaining Flood Control Structures*** – Design modifications, retrofit modifications, and structural or non– structural practices that can be used in addition to or instead of traditional flood control structures, designs or procedures for their operation or upkeep to improve nonpoint pollution control.
- ***Modifying, Operating and Maintaining Reservoirs*** – Operational, vegetative and structural practices that can be used in the maintenance of reservoirs to reduce nonpoint source pollution.
- ***Proper Dam Breaching*** – The partial or total dismantling of a water impounding structure.

Streambank and Shoreline Protection

- ***General*** – The use of vegetation, structures, biotechnology, or management techniques to stabilize and protect streambanks and shorelines.
- ***Biotechnical Methods*** – The use of live dormant stem cuttings or plants in combination with geotextiles or structural devices for erosion control.
- ***Selective Clearing and Snagging*** – Selective removal of trees, log– jams, sediments, and other obstructions from the stream channel in order to re– establish the original hydraulic capacity and gradient of the channel.
- ***Stream Grade Stabilization Structures*** – Selective use of instream flow control structures to control scouring and sedimentation in the stream channel due to both natural and human causes.
- ***Structural Slope Protection*** – The stabilization of steep or erosive slopes with riprap, retaining walls, or other non– vegetative materials either, on the streambank or upslope of the stream channel.

Water Quality and Habitat Protection

Constructed Wetlands (see description in the *Agricultural Practices*)

Improving Instream and Riparian Habitat – Instream and on– bank structures built, or vegetation grown, to improve or create fish habitat in the stream and enhance biodiversity, generally, in the riparian buffer.

Restoring Freshwater Wetlands – Reestablishing the functions and character of a wetland that had been degraded or lost by actions such as filling, excavating, draining, altering hydrology, loss of adequate buffer, or introduction of contaminants. Returning a degraded or former freshwater wetland to a close approximation of pre– disturbance condition.

Restoring Tidal Wetlands – Reestablishing the functions and character of a tidal wetland that has been degraded or lost to a close approximation of pre– disturbance condition.

Riparian Forest Buffer – A corridor of trees, shrubs and grasses of varying width located adjacent to and up gradient from waterbodies.

Stream Corridor Protection Program (Greenbelting) – A program to protect and restore a stream corridor, carried out in cooperation with a unit of government (federal, state or local), the residents of the watershed and other interested conservation organizations.

On–site Wastewater Treatment Systems (septic systems) Management Practices

At least two bodies of water within the watershed (Hillside Lake and Whaley Lake) exhibit elevated levels of nutrients, with on– site septic systems believed to be the primary source (NYSDEC, 1996). In 2004 Whaley Lake suffered a significant, long– term algal bloom, possibly induced by high nutrient levels (*Rick Oestrike, Personal Communication, January 18, 2005*). Impairment of waterways occurs when septic systems fail, when systems are densely located in residential or commercial areas, or when soil types do not allow for filtration of nutrients before they reach groundwater or waterways.

The following techniques can be used by contractors and local governments to reduce the water quality impact of septic systems. For a detailed description of these practices see On–site Wastewater Treatment Management Practices Catalogue for Nonpoint Source Pollution

Prevention and Water Quality Protection in New York State (NYSDEC, 1994). Please note that all wastewater treatment systems must be approved by the Dutchess County Department of Health.

Site and Soils

- ***Soil and Site Analysis*** – Identifying crucial soil, water and other land characteristics that determine site suitability for on– site wastewater treatment systems.
- ***Percolation Tests*** – On–site percolation tests for use in design of appropriate on– site wastewater treatment systems.
- ***Deep Test Holes*** – On– site soil profile evaluation for use in design of appropriate on– site wastewater treatment systems.

Conventional Septic Systems

- ***Septic Tanks and Standard Absorption Fields (Trenches)*** – A large (e.g. 1,000 – 1,750 gallon) buried, watertight chamber for settling wastewater with inlet and outlet baffles to prevent discharge of solids, followed by a distribution box that diverts flow equally to two or more perforated pipes laid in gravel trenches within natural, undisturbed soil.
- ***Aerobic Systems and Standard Absorption Fields*** – A partitioned watertight compartment with a pump, air compressor or other device to inject air into the sewage in the first compartment. The next component is a settling chamber or filtering device. This is followed by solid piping to a distribution box that distributes effluent to perforated pipes in buried gravel trenches or a gravel bed for infiltration into the soil.
- ***Gravelless Absorption Systems*** – A distribution system installed without gravel– filled trenches, where aggregate is not economically available. It receives effluent from the distribution box in the overall wastewater treatment system. Two types of systems commonly used are: (1) Chamber design (2) Geotextile– wrapped corrugated plastic pipe or tubing.
- ***Deep Absorption Trenches*** – A conventional soil absorption system downstream of a septic or aerobic tank. Used in sites where a thick layer of impermeable soil overlies more suitable soil.
- ***Shallow Absorption Trenches*** – A conventional soil absorption system down gradient of a septic or aerobic tank and having additional soil with permeability equal to the original underlying soil used for fill.
- ***Cut and Fill Systems*** – A standard absorption trench system installed on sites where impermeable soil overlays a permeable or usable soil.
- ***Absorption Bed Systems*** – Similar to the absorption trench except that several pressure distribution laterals are installed in a single excavation rather than single laterals in several excavations.
- ***Seepage Pits*** – A covered pit with an open–jointed or perforated lining (either concrete or masonry) through which septic tank effluent infiltrates into the surrounding soil. These devices are sometimes called a leaching pit, leaching pool or dry well and are incorrectly called a cesspool. These are generally discouraged by many local regulatory agencies in favor of trench or bed systems.

Alternative Systems

- ***Raised Systems*** – A conventional absorption trench system constructed in stabilized (in place for at least six months and one freeze/thaw cycle) permeable fill placed above the original ground surface on a building lot. (Note: Granular soils with a percolation rate of 5– 30 min/inch do not require stabilization.)

- ***Elevated Sand Mounds*** – A pressure– dosed absorption system that is elevated above the original soil surface in a sand fill. The system consists of a septic tank (or aerobic tank), dosing chamber and the elevated sand mound.
- ***Intermittent Sand Filters*** – A biological and physical treatment process consisting of a bed of sand receiving periodic doses of wastewater from the septic tank. The liquid passing through the sand filter is then discharged to a mound absorption system. This practice is called a Buried Sand Filter in some literature.

Administration, Operation and Maintenance

- ***Operation and Maintenance for Septic Tanks and Standard Absorption Systems*** – Tasks that the user or a municipal agent must perform to prevent premature failure of a septic system and to assure the longest possible life span and optimum performance. These include annual inspection, providing new homeowners with a septic system location map, discouraging garbage grinders, avoiding disposal of bulky items in the septic system, discouraging use of septic tank additives, limiting discharges from hot tubs, pool backwash, and whirlpool baths to five gallons per minute, keeping swimming pools and heavy equipment away from leach field, keeping roof and cellar drains away from the system, and practicing water conservation.
- ***Inspection and Pumping*** – Periodic (e.g. yearly) septic system inspections and routine pumping (every 1 to 5 years, depending on tank size and number of people in household) of the septic tank.
- ***Administrative Control Measures*** – Regulations, permit processes and other controls available to local units of government for reducing nonpoint source pollution. Examples: Septic surveys, property/home sale contingencies, subdivision rules and regulations, site review and zoning regulations, watershed rules and regulations, wellhead protection measures, and NYS Health Department regulation addendums.

Conservation Measures

- ***High Efficiency Plumbing Fixtures*** – Enforcing the use of high efficiency plumbing devices for new systems, and promoting their use as a contingency for the approval of a replacement or upgraded system.
- ***Graywater Separation*** – Separating toilet water from the wastewater stream and retaining and treating the resulting graywater on–site.

Public Education

- ***Advocating Proper System Design and Construction*** – Preventing future on–site wastewater treatment system failure by promoting professional designer, installer and homeowner education on the design and construction of on– site wastewater treatment systems.
- ***Proper Use and Disposal of Household Hazardous Substances*** – Providing guidelines on the proper use and disposal of household hazardous substances and alternative products that are less hazardous.

Engineered Systems for Nitrate Removal

- ***Anaerobic Upflow Filters (AUF)*** – A component of an on– site wastewater treatment system consisting of a 500– 2,500 gallon tank (or sand filter underdrain system of equal capacity) containing gravel or rock. The unit is continually submerged in septic tank or sand filter effluent to maintain an anaerobic environment.
- ***RUCK System*** – A blackwater/graywater separation and treatment system using two septic tanks, a 3– stage sand filter and a standard or custom– designed soil absorption system.

- ***Recirculating Sand Filters*** – A modified intermittent sand filter in which sand filter effluent is mixed with septic tank effluent and recirculated through the sand filter. A portion of the filtered effluent is discharged to the soil absorption system.
- ***Non–Waterborne Systems*** – Elimination of toilet (blackwater) waste from the soil absorption system by use of a composting toilet, incinerator toilet, chemical toilet, oil recirculating toilet, pit privy, or pumping to a holding tank.
- ***Constructed Wetlands*** – An aquatic plant/microbial filter constructed in a gravel bed or gravel trenches. It may be constructed down gradient from the septic or aerobic tank and followed by an absorption field. It may also be constructed down gradient from an elevated sand mound for effluent polishing. It is a component of a complete wastewater treatment system.

Innovative or Other Systems

- ***Holding Tanks for All Wastewater*** – Temporary underground storage tanks used to retain all wastewater generated by the household, used only when weather conditions, impending sanitary sewers or other conditions make installation of on– site treatment system impossible or impractical.
- ***Rotating Biological Contactors*** – A type of aerobic wastewater treatment system where a module rotates through the stored solids that are used as a biological food source, even in no flow or low flow periods.
- ***Trickling Filter–type Systems*** – A package plant relying on both aerobic and anaerobic bacteria, providing secondary treatment. It receives influent from a septic or aerobic tank and its effluent discharges to a soil absorption system.
- ***Septic and Aerobic Tanks: Septage Disposal Management*** – Determining the most practical economic and publicly acceptable means of disposing of the pumped contents of septic tanks, cesspools (no longer allowed for new facilities in New York State) or other individual sewage treatment facilities that receive domestic sewage wastes.

Leaks, Spills and Accidents Management Practices

The storage and transport of petroleum products is regulated at the federal and state level by the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation. The following is a list of practices that are required by these agencies, with references for more information contained in the Leaks, Spills and Accidents Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State (NYSDEC, 1992c).

- Proper Design of Tanks, Piping Systems and Containment Structures
- Proper Materials Handling and Transfer Operations
- Containing Leaks and Spills
- Detecting Leaks and Spills
- Facility Inspection, Facility Maintenance and Personnel Training Programs
- Temporary and Permanent Closure of Storage Facilities
- Controlling Initial Spills (First Response)
- Upgrading Storage Systems
- Testing and Inspecting Underground Storage Tank Systems
- Inspecting and Maintaining Aboveground Storage Tank Systems
- Record keeping
- Spill Reporting Procedures
- Good Housekeeping Practices

- Materials Compatibility Analysis
- Security Measures
- Risk Identification and Assessment
- Roadway and Right–of–way Maintenance Management Practice

Roadway and Right-of-Way Maintenance Management Practices

State, county and local highway departments have the responsibility of maintaining our roadways in a safe condition. This entails the use of deicing materials (salt and sand), herbicides and asphalt preparations. However, the use and storage of these materials can also cause water quality impairment when activities are located near streams, lakes or storm drains which are often direct connections to local waterways.

The following are management practices that can be used to lessen the impacts of road maintenance activities on water quality. For a detailed description of these practices see the Roadway and Right– of– Way Maintenance Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State (NYSDEC, 1994a).

Abrasive and Deicing Material Application and Cleanup – Proper calibration of equipment, spreading and clean– up of abrasive and deicing material based on the storm conditions to avoid excessive accumulation of the material.

Catch Basin Cleaning – Cleaning out the catch basins regularly to maintain their sediment trapping ability.

Control of Bridge Paint Residuals – Methods to avoid the transport to waterbodies of paint chips and dust resulting from surface preparation, grinding, sanding, or washing bridges.

Deicing Material Mixing and Handling – Taking precautions during mixing and transportation of bulk quantities of deicing chemicals to prevent the transport of salt residue and brine from mixing areas, salt delivery trucks or maintenance vehicles directly to waterbodies.

Dust Control – Methods controlling the movement of airborne pollutants and particulate matter from unpaved roads.

Filter Strip – (See description in *Agricultural Practices*)

NYSDOT Highway Maintenance Guidelines, Snow and Ice Control, (NYSDOT, 1993)

- Salt should be applied to roads very early in a storm to be most effective.
- Application rates shall be from 225 lbs of salt per mile, per lane (during light to moderately accumulating snow) to 270 lbs of salt per mile, per lane (during rapidly accumulating dense snow, freezing rain, sleet or pre– existing pack). Follow– up application shall be 115 lbs of salt per mile, per lane.
- Applicators should be calibrated to within 7– ½ % of the target values.
- Spreading patterns and speed should be checked to ensure the spreading pattern of the salt is appropriate.
- Abrasives should generally be used where low traffic volume and/or low temperature will preclude salt from working properly.
- Mixtures of 50:50 salt and abrasive are wasteful and inefficient. For most of NY State, 5% salt mixed with abrasive is sufficient.

- All pure salt shall be stored, covered and housed on an impermeable pad in an acceptable structure.
- The salt storage area selected should not drain directly into a stream, reservoir, well, well aquifer, or adjacent residential property.
    - Herbicide and Vegetation Management
    - Proper Equipment Calibrations
    - Proper Timing of Herbicide Application
    - Read and Follow Herbicide Label Directions
    - Selective Aerial Application

Selective Herbicide Application in Sensitive Areas

- ***Maintenance of Vegetative Cover*** – Maintenance and inspection of vegetative cover in critical areas on a regular basis and re– establishment of vegetation in exposed soils.
- ***Proper Mechanical Control of Vegetation*** – Proper use of mechanical equipment to remove or reduce undesirable vegetation.
- ***Proper Road Ditch Maintenance*** – Techniques for providing stable conditions on roadside ditches during routine sediment removal, clean up, and ditch reshaping operations.
- ***Proper Species Selection for Vegetative Cover*** – Selection of appropriate vegetative species to stabilize the soil and minimize the need for maintenance.
- ***Restoration of Disturbed Areas Within the Right of Way*** – Restoration of the disturbed area to its original condition of slope, soil compaction, ground cover, and hydrologic pattern through appropriate practices.

Salt Storage

- ***Drainage*** – A system used to temporarily store and properly dispose of salt brine solutions collected at salt loading docks, ramps, or other areas associated with a salt storage system where exposure of salt to precipitation is unavoidable.
- ***Foundation/Floor*** – Raising the foundation to an elevation higher than surrounding terrain to prevent run– in; paving the storage area's floor; and providing impermeable padding for the mixing area of the salt storage system.
- ***Shelter/Cover*** – The use of a structure, shed, shelter, or impermeable cover to protect the salt from direct precipitation.
- ***Site Location Selection*** – Selection of salt storage site location considering the protection of water resources.
- ***Street Sweeping/Road Cleanup*** – Use of a mechanical broom sweeper, motorized vacuum sweeper, loaders, or hand tools to clean impervious surfaces.

Silviculture Management Practices

Silviculture management practices are simple, low– cost practices and techniques that can be incorporated into timber harvest to protect water quality, maintain the productivity of the forest, improve public confidence in timber harvesters, and maintain public support for forest management and timber harvesting. Erosion and sedimentation are the primary potential nonpoint source pollution problems associated with forest management activities, especially at stream crossings for forest roads and skid trails (New York State Forestry, 2000). Other associated problems include the removal of overstory vegetation shade that can increase water temperatures, and harvesting operations can greatly increase the amount of organic material (leaves, sticks, etc.) in the waterbody, which can deplete oxygen and alter stream habitats (USEPA Office of Water, 1997).

The following is a list of silvicultural management practices. Detailed descriptions of these practices are available in the *Silviculture Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State* (NYSDEC, 1993). Additional guidelines are available in the New York State Forestry – *Best Management Practices for Water Quality: BMP Field Guide* (New York State Forestry, 2000).

Hazardous Material Management – The proper storage, handling and application of materials defined as hazardous in the Department of Transportation Code of Federal Regulations, Title 49 or in NYS Rules and Regulations, part 371.

Planned Access Routes – The proper location and design of logging road/skid trail systems.

Planned Harvest Operations – Harvesting forest products according to a well– developed plan.

Planned Watercourse Crossings – A stable structure installed across a watercourse to provide temporary access for logging equipment.

Riparian Buffer Protection – Preservation of natural vegetation and soil cover adjacent to streams or other waterbodies.

Road Water Management – The control of water on log roads and skid trails.

Sediment Barriers – Temporary structures installed cross– slope to trap sediment before it reaches watercourses.

Vegetation Establishment – Seeding grasses and legumes on exposed forest soils.

Urban/Stormwater Runoff Management Practices

Stormwater causes a significant proportion of water quality impairments in urban areas. Stormwater is usually conveyed to streams through storm sewers, roadside ditches, grassed swales, and ponds. Typically, storms sewers transport runoff rapidly with no pretreatment or filtering before the runoff enters local streams (Westchester County Department of Planning. 1998). One third of the rivers and lakes on the Hudson River basin priority waterbodies list cite urban runoff as the primary source of impairment (NYSDEC, 2000). The primary threat to Hudson Valley drinking water reservoirs is residential/commercial development and the associated urban/suburban runoff of sediment and nutrient loads that promote eutrophication and silt/sediment attributed to stream bank erosion (NYSDEC, 2000).

Pollutants found in urban runoff include heavy metals, toxic organic chemicals, sediment, nutrients, bacteria and protozoa. Also, urban runoff may cause flash flooding because pavement and rooftops prevent rainwater and snowmelt from soaking into the ground.

The following is a list of structures and practices that can be used to filter pollutants or reduce the impact of stormwater on water bodies. For detailed descriptions of these practices see the Urban/Stormwater Runoff Management Practices Catalogue for Nonpoint Source Pollution Prevention and Water Quality Protection in New York State (NYSDEC, 1994b). Additional practices are outlined in the New York State Stormwater Management Design Manual (NYSDEC, 2001), and the New York Standards and Specifications for Erosion and Sediment Control (NYSDEC, 2005).

Catch Basins – Stormwater runoff inlets equipped with a small sedimentation sump or grit chamber.

Check Dams – Small temporary stone dams constructed across a drainage way.

Collection & Treatment of Stormwater – Physical and chemical operations that provide treatment of urban stormwater runoff but are less involved and costly than treatment plant technology and can be either used independently or interfaced with other best management practices.

Concrete Grid & Modular Pavement – Pavement consisting of strong structural materials having regularly interspersed void areas which are filled with pervious materials, such as sod, gravel, or sand.

Constructed Wetlands – (See description under Agricultural Practices)

Construction Road Stabilization – The stabilization of temporary construction access routes, on–site vehicle transportation routes and construction parking areas.

Critical Area Protection (See description under *Agricultural Practices*)

Debris Basins – Barriers or dams constructed across a waterway or other suitable locations to form a basin for catching and storing sediment and other waterborne debris.

Diversions (See description under *Agricultural Practices*)

Dry Detention Basins – A basin designed to collect and store stormwater runoff in a temporary pool of water for less than 24 hours.

Dust Control – The control of dust resulting from land– disturbing activities.

Earth Dikes – A temporary berm or ridge of compacted soil, located in such a manner as to channel water to a desired location.

Extended Detention Basin – A basin designed to collect and store stormwater runoff in a temporary pool of water for 24 hours or greater.

Filter Strip (See description under *Agricultural Practices*)

Fluidic Flow Regulators – Self– powered flow control devices operating according to a closed–loop signal system, which is responsive to changes in water level and flow characteristics.

Grade Stabilization Structures – Structures to stabilize the grade or to control head cutting in natural or artificial channels.

Grassed Swales – Small vegetated depressions constructed on permeable soils, and designed to convey stormwater runoff from areas less than 1 acre in size.

Grassed Waterways (See description under *Agricultural Practices*)

Implementation of Land Use Planning – Adoption and implementation of comprehensive environmental regulations to govern the development process for the purpose of providing long–term watershed protection.

Infiltration Basins & Pits – An excavated basin (or pit) constructed in permeable soils, for the temporary collection and storage of urban stormwater runoff prior to exfiltration.

Infiltration Trench – A blind sub– surface trench backfilled with gravel for the temporary collection and storage of stormwater runoff prior to exfiltration.

Integrated Pest Management (See description under *Agricultural Practices*)

Irrigation Water Management (See description under *Agricultural Practices*)

Level Spreaders – Non– erosive outlets for concentrated runoff constructed to disperse flow uniformly across the slopes.

Lined Waterways or Outlets – Waterways or outlets with a lining of concrete, stone, or other permanent material. The lined section extends up the side slopes to the designated depth. The earth above the permanent lining may be vegetated or otherwise protected.

Nutrient Management: (See description under *Agricultural Practices*)

Composting Yard and Home Wastes	Fertilizer Management	Soil Testing•

Paved Flumes – Small concrete– lined channels to convey water on a relatively steep slope.

Peat/Sand Filter System – Peat/sand filters are gravity driven, constructed filtration systems designed to reduce nonpoint source pollutant loading from urban watersheds to receiving waterbodies.

Perimeter Dikes/Swales – Temporary ridges of soil excavated from an adjoining swale located along the perimeter of the site or disturbed area.

Pesticide Management – An integrated systems approach to managing the selection, handling, mixing, use, placement, storage and disposal of pesticides used on turf grasses and ornamental plants in urban areas.

Pipe Slope Drains – Temporary structures placed from the top of a slope to the bottom of a slope.

Porous Pavement – Porous pavement is graded aggregate cemented together by asphalt into a coherent mass that has sufficient interconnected voids to provide a high rate of permeability to water.

Portable Sediment Tanks – Sediment tanks are compartmented tank containers through which sediment– laden water is pumped to trap and retain the sediment.

Proper Use and Disposal of Household Hazardous Substances (See description under On–site Wastewater Treatment System Practices)

Public Education – Nonpoint source instructional programs, workshops and information campaign conducted by educational institutions, agencies and organizations for the public.

Reduction of Traffic– generated Pollutants – Pollution prevention measures to lower the amount of pollutants originating from motor vehicle traffic in urban areas.

Retaining Walls – Structural walls constructed and located to prevent soil movement.

Retention Pond (Wet Pond) – An excavated pond designed to store and retain a permanent pool of water for evaporation or partial infiltration.

Riparian Forest Buffer – (see description under Hydrologic and Habitat Modification Management Practices).

Riprap Slope Protection – A layer of stone designed to protect and stabilize areas subject to erosion.

Rock Dams – Rock embankments located to capture sediment.

Rock Outlet Protection – A section of rock protection placed at the outlet end of the culverts, conduits or channels.

Roof Runoff System – A system to handle roof runoff by directing it to down spouts and into trenches prior to infiltration into permeable soil.

Sediment Basins – Temporary barriers or dams constructed across a drainage way or at other suitable locations to intercept sediment– laden runoff and to trap and retain the sediment.

Sediment Traps – Temporary sediment control devices formed by excavation and/or embankment to intercept sediment– laden runoff and to retain the sediment.

Silt Fences – Temporary barriers of geotextile fabric (filter cloth) used to intercept sediment– laden runoff from drainage areas of disturbed soil.

Stabilized Construction Entrances – Stabilized pads of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right– of– way, street, alley, sidewalk or parking area.

Stormwater Conveyance System Storage – Providing storage capability within stormwater conveyance systems for temporary detention and controlled release of urban stormwater during wet weather.

Straw Bale Dikes – Temporary barriers of straw or similar material used to intercept sediment– laden runoff from small drainage areas of disturbed soil.

Stream Corridor Protection Program – (See Hydrologic and Habitat Modification Management Practices section).

Street and Pavement Sweeping – Use of a mechanical broom sweeper or motorized vacuum sweeper to clean impervious surfaces.

Storm Drain Inlet Protection – Permeable barriers installed around inlets in the form of a fence, berm or excavation around an opening, thereby reducing sediment content of sediment laden water.

Structural Streambank Protection – Stabilization of eroding streambanks by the use of designed structural measures.

Subsurface Drains – Conduits, such as tile, pipe or tubing, installed beneath the ground surface that intercept, collect, and/or convey drainage water.

Surface Roughening – Roughening a bare soil surface with horizontal grooves running across the slope, stair– stepping, or tracking with construction equipment.

Sump Pits – Temporary pits which are constructed to trap and filter water for pumping to a suitable discharge area.

Temporary Access Waterway Crossings – A temporary access waterway crossing is a structure placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings shall not be utilized to maintain traffic for the general public.

Temporary Storm Drain Diversions – The redirection of storm drain lines or outfall channels so that they may temporarily discharge into a sediment– trapping device.

Temporary Swales – Temporary excavated drainage ways.

Turbidity Curtains – Flexible, impenetrable barriers used to trap sediment in water bodies. These curtains are weighted at the bottom to achieve closure while supported at the top through a flotation system.

Urban Forestry (Trees and Shrubs) – Protecting and planting trees and shrubs before, during and after urban site development.

Water Bars – Ridges or ridges and channels constructed diagonally across a sloping road or utility right– of– way that is subject to erosion.

Water Quality Inlet (Oil/Grit Separators) – Water quality inlets (also known as oil/grit separators) are subsurface, multi– chamber inlets installed in parking lots to trap heavy sediment and hydrocarbons from urban stormwater runoff.

Pathogen and Nutrient Management Control

- ***Nuisance Bird Waste Management and Control*** – Activities undertaken by individuals, corporations and units of government to deter nuisance birds that contribute fecal material to urban stormwater runoff and groundwater.
- ***Pet Waste Management and Control*** – Institutional control measures employed by local governments and management measures employed by individuals to prevent nonpoint source pollution by urban canines and felines.
- ***Waterfowl Waste Management and Control*** – Activities undertaken by individuals, corporations and units of government to deter nuisance waterfowl that contribute fecal material to waterbodies and groundwater.

Policy and Programs for Stormwater Control

by Barbara Kendall, Stormwater Outreach Specialist, Hudson River Estuary Program, NYSDEC Region 3

Numerous studies have documented water quality and water quantity impacts from stormwater runoff, as well as the role of impervious surface in a watershed in creating those impacts. But how can we control these impacts when land use decisions take place at the local level? The EPA has recognized that the control of stormwater impacts must be shared by multiple levels of government by promulgating the Phase II Stormwater Regulations under the National Pollutant Discharge Elimination System (NPDES) program. New York State has implemented this program under the State Pollutant Discharge Elimination System with two general permits: The SPDES General Permit for Stormwater Discharges from Construction Activity (GP– 02– 01) and the SPDES General Permit for Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s) (GP– 02– 02).

Construction Site Runoff

The construction activity general permit was developed by New York State in response to the research that showed that construction sites can be major contributors of sediment to streams, lakes and wetlands. The construction permit also reflects research showing that imperviousness can be quantified, managed and controlled during land development. In effect as of March 2003, GP– 02– 01 requires any owner or operator of construction activities of more than one acre to file with the NYSDEC a Notice of Intent to discharge stormwater and prepare a Stormwater Pollution Prevention Plan (SWPPP) for the site. All activities require a level one SWPPP consisting of an erosion and sediment control plan including such items as silt fences, sediment traps and phasing sequences. In some cases, a level two SWPPP is also required that includes post– construction stormwater controls such as stormwater ponds, stormwater wetlands, filtering and infiltration practices.

Recognizing the impervious area impacts on watershed function, New York State has incorporated impervious area calculations into the formulas that are required under GP– 02– 01 for sizing of stormwater management practices as detailed in the New York State Stormwater Management Design Manual (Design Manual). The Design Manual was written by the Center for Watershed Protection in Maryland, in consultation with the New York State Department of Environmental Conservation. Based on the most recent research, the Design Manual contains a wealth of information, including an entire chapter on the impacts of new development on our waterways. The approved stormwater management practices that are listed in the Design Manual have been proven through research to remove 80% of the total suspended solids and 40% of the total phosphorus from stormwater when installed correctly.

Municipal Stormwater Programs

The General Permit for Stormwater Discharges from MS4s (GP– 02– 02), while sounding like a wastewater permit program, is, in actuality, a community– wide watershed planning program. MS4s, defined as a population center of 50,000 with an associated surrounding area of 1,000 people per square mile or more, must develop a local Stormwater Management Program by 2008 that contains six minimum measures of control: Public Education and Outreach, Public Involvement and Participation, Illicit Discharge Detection and Elimination, Construction Site Runoff Control, Post– Construction Runoff Control, and, finally, Pollution Prevention and Good Housekeeping. The required activities include identification of impaired waterways, mapping of stormwater outfalls, public education on the impacts of stormwater, and adoption of a local law or other regulatory mechanism to control sedimentation from construction sites and stormwater impacts from newly created impervious areas. Optional items include water quality monitoring of streams and stormwater discharges. As one can see, these activities involve multiple levels of involvement by planning, conservation, educational and scientific groups at the local level.

The NYSDEC has developed various tools to assist communities with this program, including a Stormwater Management Guidance Manual for Local Officials that contains a Model Local Law for Stormwater Management, educational materials, and a grant program for MS4s from the Environmental Protection Fund. The Model Local Law is designed to be adopted as amendments to a municipality’s zoning, site plan, subdivision and erosion control laws. Through adoption of these amendments, the municipality will then require a Stormwater Pollution Prevention Plan (or equivalent) during subdivision and site plan review that contains stormwater management practices that reflect the most recent research on pollutant controls and stream channel protection. Since New York State is a home rule state, the most effective way to produce change at the local level is to include requirements for stormwater controls during the local review process.

Exciting Enhancements to the Required Program

There are exciting opportunities to build on the requirements of the Stormwater Phase II program and create even better land use projects that will be reflected in more livable communities and even better watershed quality. The concept of Low Impact Development (LID) incorporates infiltration and filtering of stormwater at the individual lot level, while emphasizing use of natural contours and protection of existing riparian buffers. LID also encourages subdivision layouts that reduce street widths, provide sidewalks on one side of the street, and eliminate cul– de– sacs. When combined with the techniques outlined in the Design Manual, LID can reduce impervious cover and reduce the required size of stormwater management practices.

A community should also look beyond the requirements of the Stormwater Phase II program and incorporate protection of wildlife habitat and biodiversity when approving stormwater management practices for a site. While stormwater ponds and wetlands do create wildlife habitat, they may attract certain amphibians that cannot survive in fluctuating water levels. By mapping sensitive habitat areas on a community– wide basis within a watershed planning process, local boards can then recognize areas where infiltration and filtering practices would be a better choice than stormwater ponds and wetlands. In addition, use of certain infrastructure practices such as "Cape Cod Curbs" can facilitate the movement of amphibians in urban and suburban areas. Cape Cod Curbs are designed with a maximum 1:4 slope.

Finally, by incorporating riparian buffer, wetland and watercourse, and steep slope regulations along with a stormwater management law at the local level, communities can provide a suite of natural resource protection laws that provide protection for their waterways and habitats. Other techniques such as conservation subdivisions, overlay districts, and purchase of development rights also provide site– specific tools for managing land use. The Pace Land Use Law Center has developed a series of guides that can assist communities in developing these land use controls (see the Starting Ground Series, 2003, available from the Land Use Law Center, Pace University School of Law and the NYSDEC Hudson River Estuary Program).

The NYSDEC Hudson River Estuary Program is currently providing education and outreach on the Stormwater Phase II program for communities in the Hudson Valley. Please contact Barbara Kendall at 845– 256– 3163 or blkendal@gw.dec.state.ny.us. If you would like to order the Stormwater Management Guidance Manual for Local Officials, other educational materials or would like to schedule a presentation. The Hudson River Estuary Program also provides technical assistance and grants to communities and non– profit organizations on watershed planning, biodiversity and Hudson River education programs.

Vernal Pool Management

Vernal pools, a type of seasonal or temporary wetland, are very important to the survival of many Hudson Valley plants and animals. The rapid wet– dry cycle of vernal pools prevents fish from becoming established, allowing critical breeding and rearing habitat for amphibians, crustaceans, and insects (Biebighauser, 2002). The multitude of organisms supported by these pools are key links within the Hudson Valley's web of life.

The management guidelines below are taken from *Forestry Habitat Management Guidelines for Vernal Pool Wildlife*, MCA Technical Paper Series: No. 6 (Calhoun and deMaynadier, 2004) and *The Best Development Practices, Conserving Pool– Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States*, MCA Technical Paper Series: No. 5 (Calhoun and Klemens, 2002). The management areas include the Vernal Pool Depression itself, the Vernal Pool Envelope (extending 100' outward from the pool edge) and the Critical Terrestrial Habitat (extending from 100' to 750' outward from the pool edge).

- Property owners should be aware of the importance of vernal pools and where on their land the pools are located.
- Develop a strategy for mapping and tracking potential vernal pools either from aerial photography or as discovered in the field.
- Identify highly productive vernal pools suitable for more rigorous protection strategies.
- Maintain the vernal pool basin, associated vegetation and pool water quality in an undisturbed state.
- Within 100' of the pool's edge, maintain an undeveloped forested habitat around the pool, including both canopy and understory. Avoid barriers to amphibian dispersal. Protect and maintain pool hydrology and water quality. Maintain a pesticide– free environment.
- From 100' to 750' of the pool's edge, maintain or restore a minimum of 75% of the zone in contiguous forest with undisturbed ground cover. Maintain or restore forested corridors connecting wetlands or vernal pools. Provide suitable terrestrial habitat for pool– breeding amphibian populations by maintaining or encouraging at least a partially closed– canopy stand that will provide shade, deep litter, and woody debris. Minimize disturbance to the forest floor. Where possible, maintain native understory vegetation.
- Roads and driveways should be excluded from the vernal pool depression and the vernal pool envelope (within 100' of the pool edge).
- Roads and driveways with projected traffic volumes in excess of 5– 10 cars per hour should not be sited within 750' of a vernal pool. The total length of roads within 750' of the pool should be limited to the greatest extent possible.
- Use Cape Cod– style curbing or no– curb alternatives on low capacity roads.
- Use oversize square box culverts (2' wide x 3' high) near wetlands and known amphibian migration routes to facilitate amphibian movement under roads. These should be spaced at 20' intervals and use curbing to deflect amphibians toward the box culverts.

- Use cantilevered roadways (i.e., elevated roads that maximize light and space underneath) to cross low areas, streams, and ravines that may be important amphibian migratory routes.
- Cluster development to reduce the amount of roadway needed and place housing as far from vernal pools as possible.
- During construction, minimize disturbed areas and protect down– gradient buffer areas to the extent practicable.
- Site clearing, grading and construction activities should be excluded from within 100' of a vernal pool.
- Site clearing, grading and construction activities should be limited to less than 25% of the entire area out to 750' from the pool edge.
- Limit the area of clearing, grading and construction by clustering development.
- Minimize erosion by maintaining vegetation cover on steep slopes.
- Avoid creating ruts and other artificial depressions that hold water. If ruts are created, refill to grade before leaving the site.
- Refill percolation test pits to grade.
- Use erosion and sediment control best management practices to reduce erosion.
- Limit forest clearing on individual house lots, within the developed sections less than 750' from the edge of a pool, to no more than 50% of lots that are two or more acres in size. Encourage landscaping with natural woodland, containing native understory and groundlayer vegetation, as opposed to lawn.
- Silt fencing should be used to exclude amphibians from active construction areas. Construction activities should, ideally, occur outside of peak amphibian movement periods (which include early spring breeding and late summer dispersal).
- Vernal pool depressions should never be used, either temporarily or permanently, for stormwater detention or biofiltration.
- Treat stormwater runoff using grassy swales with less than 1:4 sloping edges. If curbing is required, use Cape Cod curbing. Maximize open drainage treatment of stormwater.
- Use hydrodynamic separators only in conjunction with Cape Cod curbing or swales to avoid funneling amphibians into treatment chambers, where they are killed.
- Maintain inputs to the vernal pool watershed at pre– construction levels. Avoid causing increases or decreases in water levels.
- Accessory structures (e.g., outbuildings, swimming pools) should be excluded within 100' of the edge of a vernal pool.
- Belowground swimming pools located within 750' of a vernal pool should be surrounded by some sort of barrier. A fine mesh wire at the base of a picket fence or a one– foot high, 90– degree curb or barrier would deter amphibians from traveling into the pool.
- Alteration of existing conditions within vernal pools and other small wetlands should be avoided.
- Creation of ponds and similar wetlands should be avoided within 750' of a vernal pool.

- Redirect effort from creating low value, generalized wetland to enhancing terrestrial habitat around vernal pools. These enhancements could include reforestation of post– agricultural lands within 750' of a vernal pool, restoration of forest, importing additional cover objects (e.g., logs, stumps) and removal of invasive plants and animals.
- Discourage predators by keeping garbage and other supplemental food sources unavailable.
- Consider keeping cats indoors at all times. This would reduce predation on a wide variety of species, ranging from pool– breeding amphibians to ground– nesting birds. Attaching bells to cat collars does not significantly reduce the ability of cats to prey on small vertebrates.
- Mark the edge of a protected area (within 750' of a vernal pool) with permanent markers. Well– marked boundaries make enforcement of restricted areas clear to both homeowners and the local wetlands enforcement agency.
- Use covenants or deed restrictions to assure that the vernal pool and its envelope are conserved, and that pesticide use, lot clearing and other degrading activities are kept out of associated areas. Assign the homeowner or homeowner's association with responsibility for ensuring that conditions of the covenant or deed restriction are met. Provisions should also be included to allow a third party, such as the town or local land trust, with adequate notice, to enter the property and conduct appropriate management and remediation, charging the homeowner for these services.
- In the case of a homeowner's association or other type of multiple tenant arrangement, a stewardship manual could be prepared that would educate each purchaser, or lessee, as to the unique nature of the property they are purchasing or renting, what their collective obligations to protect the resource entail, and where to obtain additional assistance or information.
- A conservation easement, covering at a minimum to 100' from the vernal pool (and, preferably to 750') could be held by a municipality, land trust or other non– government organization.

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Appendices

Appendix 1.
Acronyms

avg. = average
cc. = cubic centimeter
cm. = centimeter
cfs = cubic feet per second
deg. = degree
gm. = gram
gpm = gallons per minute
gpd = gallons per day
gph = gallons per hour
hr. = hour
L = liter(s)
ml = milliliter(s)
mg/L = milligrams per liter
ppb = parts per billion
ppm = parts per million

AEM = Agricultural Environmental Management Program
AU = Animal Unit (1 AU = 1000 lbs. Animal)
BMP = Best Management Practice
CAFO = Concentrated Animal Feedlot Operation
CCE = Cornell Cooperative Extension
CEA = Critical Environmental Area
CRP = Conservation Reserve Program
CSLAP = Citizens Statewide Lake Assessment Program
CWA = Clean Water Act
CWQCC = County Water Quality Coordinating Committee
DCEMC = Environmental Management Council DEC = Department of Environmental Conservation
DOH = Department of Health
DOS = Department of State
EAF = Environmental Assessment Form
ECL = Environmental Conservation Law
EIS = Environmental Impact Statement
EPA = Environmental Protection Agency
EPF = Environmental Protection Fund
EPT = Ephemeroptera, Plecoptera and Trichoptera
EQIP = Environmental Quality Incentives Program
FCWC = Fishkill Creek Watershed Committee
FEMA = Federal Emergency Management Administration
FIP = Forestry Incentives Program
FIRM = Flood Insurance Rate Maps
FLPP = Farm Land Protection Program
FSA = Farm Service Agency
GIS = Geographic Information System
HVRC = Hudson Valley Regional Council
IBA = Important Bird Area
IES = Institute of Ecosystem Studies
LID = Low Impact Development
LUNR = Land Use and Natural Resources Inventory
MTBE = Methyl tertiarybutyl ether
NPS = Nonpoint Source
NRCS = National Resources Conservation Service
NYSDEC = New York State Department of Environmental Conservation
NYSDOT = New York State Department of Transportation
PAH = Polycyclic aromatic hydrocarbons
PCE = Perchlororthylene
PWL = Priority Waterbody List of the NYSDEC
RIBS = NYSDEC Rotating Intensive Basin Study
RBP = Rapid Bioassessment Protocols
SEQR = State Environmental Quality Review
SEQRA = State Environmental quality Review Act
SPDES = State Pollution Discharge Elimination System
SWCC = Soil and Water Conservation Committee
SWCD = Soil and Water Conservation District
TCA = Trichloroethylene
TCE = Trichloroethylene
USDA = United States Department of Agriculture
USGS = United States Geological Survey
WCWPC = Wappinger Creek Watershed Planning Committee
WFP = Whole Farming Program
WSP = Water Supply Protection
WHIP = Wildlife Habitat Incentives Program
WRP = Wetlands Reserve Program

Appendix 2.
Watershed Environmental Resource Directory

Names, Addresses, Phone Numbers, Email, Websites
(12/23/04)

Watershed Groups, and Other Interested Parties

Catskill Center for Conservation and Development
Tom Alworth, Executive Director
Aaron Bennett, Watershed Coordinator
P.O. Box 504, Route 28
Arkville, NY 12406
(845) 586-2611
(845) 586-3044 (fax)
Email: abennett@catskill.net
Website: www.catskillcenter.org

Fishkill Creek Watershed Committee
Website: FishkillCreekWatershed.org
Online Discussion:
groups.yahoo.com/group/Fishkillwatershed

Onesquethaw Coeyman's Watershed/ NYS Council, Trout Unlimited
Roy Lamberton
PO Box 90
East Berne, NY 12059
(518) 872-2217
Email: roymcl@aol.com

Onesquethaw-Coeymans Watershed Council
Fred Realbuto
46 Rarick Road
Selkirk, NY 12158
(518) 767-9051 x 15

PlanPutnam
Jeff Green
145 Miller Hill Road
Kent Cliffs, NY 10512
Email: jeff@planputnam.org
Website: www.planputnam.org

Protect the Plattekill Creek & Watershed
Sandra Thorpe, Coordinator
290 Fish Creek Rd.
Saugerties, NY 12477
(845) 246-7174
Email: rthorpe@hvc.rr.com

Quassaick Creek Coalition
Bob Ewald
261 Van Keuren Ave.
Pine Bush, NY 12566
(845) 361-5069
Email: rbewald@citlink.net
Website: www.qcreek.org

Quassaick Creek Coalition
Jean Wort
PO Box 988
Ft. Montgomery, NY 10922
(845) 446-5831
Email: jeanwort@aol.com

Saugerties Watershed Council
Joe Damrath
(845) 657-6069

Sawkill Watershed Alliance
Mary McNamera
PO Box 241
Woodstock, NY 12498
(845) 679-7664
Email: mmcnamara@parnassussquare.com

Saw Mill River Coalition (a program of Groundwork Yonkers)
Carol Capobianco
6 Wells Avenue
Yonkers, NY 10701
(914) 375-2151
Email: carol@groundworkyonkers.org

Sparkill Watershed Conservancy
Greg Mercurio
PO Box 771
Ft. Montgomery, NY 10922
(845) 446-5885
Email: pikaiafish@aol.com

Sparkill Watershed Conservancy
Larry Vail
389 King's Highway
Tappan, NY 10983
(845) 365-1159
Email: Ldvail@optonline.net

Wallkill River Task Force
Martha Cheo
115 Springtown Road
New Paltz, NY 12561
(845) 256-9316

Wallkill River Task Force/Orange County Land Trust
Ann Botshon
350 Burlingham Road
Pine Bush, NY 12566
(845) 361-1322
Fax. (845) 361-1322
Email: botshon@warwick.net

Wappinger Creek Watershed Planning Committee
Bruce Donagan, Chair
Dutchess County Environmental Management Council
2715 Route 44, Suite 2
Millbrook, NY 12545
(845) 677-5253

Local and Regional Environmental and Conservation Organizations

Dutchess Land Conservancy
Becky Thornton
Executive Director
2908 Route 44
Millbrook, NY 12545
(845) 677-3002
Website: www.dutchessland.org

Environmental Advocates of New York
Website: www.eany.org

Hudson Basin River Watch
Website: www.hudsonbasin.org

Hudson River Valley Greenway Conservancy
Carmella R. Mantello, Executive Director (acting)
Capitol Building, Capital Station, Room 254
Albany, NY 12224
(518) 473-3835
Email: hrvg@hudsongreenway.state.ny.us
Website: www.hudsongreenway.state.ny.us

Hudsonia Limited, Inc.
Executive Director
Bard College Field Station
Annandale, NY 12504
(845) 758-7273
Website: www.hudsonia.org

Hudson River Sloop Clearwater
Andy Mele, Executive Director
Manna Jo Greene, Environmental Director
112 Little Market Street
Poughkeepsie, NY 12601
(845) 454-7673
Website: www.clearwater.org

Hudson River Environmental Society
Stephen O. Wilson, Executive Director
6626 Stitt Road
Altamont, NY 12009
(518) 861-8020
Website: www.hres.org

Institute of Ecosystem Studies
Alan Berkowitz, Director of Education
Box R
Millbrook, NY 12545
(845) 677-5359
Website: www.ecostudies.org

Local Government Environmental Assistance Network (LGEAN)
www.lgean.org

NY City Dept. of Environmental Protection (DEP)
www.nyc.gov/dep

NY Public Interest Research Group
www.nypirg.org

Pictures along Dutchess Co. Rd. 29 (Fishkill Creek) in East Fishkill
dutchess29.org/protect_pages/Protect_East_Fishkill_Resources_Page_1.html

Rivers & Estuaries Center on the Hudson
199 Main Street
Beacon, NY 12508
(845) 838-1600
Email: Info@riversandestuaries.org
Website: www.riversandestuaries.org

Riverkeeper
PO Box 130
Garrison, NY 10524
800-217-4837
Email: info@riverkeeper.org
Website: www.riverkeeper.org

Scenic Hudson
Ned Sullivan, Executive Director
9 Vassar Street
Poughkeepsie, NY 12601
(845) 473-4440
Website: www.scenichudson.org

The Nature Conservancy, Lower Hudson Chapter
Kathleen Moser, Executive Director
19 North Moger
Mt. Kisco, NY 10549
(845) 244-3271
Website: (New York Chapter)
www.nature.org/wherewework/northamerica/states/newyork

County and State Government Offices

Cornell Cooperative Extension of Dutchess County (CCEDC)
Farm and Home Center
2715 Route 44, Suite 1
Millbrook, NY 12545
(845) 677-8223
Website: www.cce.cornell.edu/~dutchess/splash.htm

Dutchess County Department of Health (DOH)-(Main Office)
Dr. Michael Caldwell, Commissioner
387 Main Street
Poughkeepsie, NY 12601
(845) 486-3404
Email: healthinfo@co.dutchess.ny.us
Website:
www.co.dutchess.ny.us/CountyGov/Departments/Health/HDIndex.htm

Dutchess County Department of Planning and Development
Roger Akeley, Commissioner
27 High Street
Poughkeepsie, NY 12601
(845) 486-3610
Email: plandev@co.dutchess.ny.us
Website:
www.dutchessny.gov/CountyGov/Departments/Planning/PLIndex.htm

Dutchess County Resource Recovery Agency
96 Sand Dock Road
Poughkeepsie, NY 12601
(845) 462-6090
Email: agency@dcrra.org
Website: www.dcrra.org

Dutchess County Soil and Water Conservation District
Website: dutchess.ny.nacdnet.org

Dutchess County Water and Wastewater Authority
27 High Street
Poughkeepsie, NY 12601
(845) 486-3601
Email: dcwwa@co.dutchess.ny.us
Website:
www.dutchessny.gov/CountyGov/Departments/WaterandWaste/WRIndex.htm

Dutchess County Department of Public Works
Michael Murphy, Commissioner
22 Market St.
Poughkeepsie, NY 12601
(845) 486-2121
Email: dpwadmin@co.dutchess.ny.us
Website:
www.dutchessny.gov/CountyGov/Departments/PublicWorks/PWIndex.htm

Dutchess County Legislature
Bradford Kendall, Chairman
22 Market St.
Poughkeepsie, NY 12601
(845) 486-2100
Email: countylegislature@co.dutchess.ny.us
Website:
www.dutchessny.gov/CountyGov/Departments/Legislature/CLindex.htm

New York State Department of Environmental Conservation (DEC)

DEC Central Office, Division of Water
625 Broadway
Albany, NY 12233
(518) 402-8233
Website: www.dec.state.ny.us/website/dow

DEC Region 3
Marc Moran, Regional Director
21 South Putt Corners Rd
New Paltz, NY 12561
(845) 256-3000
Website: www.dec.state.ny.us/website/reg3

DEC Region 4
1150 North Westcott Rd.
Schnectady, NY 12306
(518) 357-2234
Website: www.dec.state.ny.us/website/reg4

DEC - Environmental Notice Bulletin
(weekly)
Website: www.dec.state.ny.us/website/enb

DEC - Stony Kill Farm Environmental
Education Center
79 Farmstead Lane
Wappingers Falls, NY 12590
(845) 831-8780
Website:
www.dec.state.ny.us/website/education/stonykil.html

DEC - The NYS Hudson River Homepage
Website:
www.dec.state.ny.us/website/hudson

DEC - Hudson River Estuary Program
Scott Cuppett, Watershed Program Manager
21 South Putt Corners Rd
New Paltz, NY 12561
(845) 256-3029
Email: swcuppet@gw.dec.state.ny.us
Website:
www.dec.state.ny.us/website/hudson/hrep.html

NY State Environmental Facilities
Corporation
Website: www.nysefc.org

Environmental Management Councils

New York State Association of
Environmental Management Councils
Website: www.nysaemc.org

Dutchess County EMC
Farm and Home Center
2715 Route 44, Suite 2
Millbrook, NY 12545
Website: dutchessemc.org

Putnam County EMC
Barbara Scuccimarra Chairperson
Putnam County EMC
37 Highridge Road
Garrison NY 10524
(845) 265-2601
bscucc@aol.com

Rockland County EMC
Diane Gruskin
50 Sanitorium Road, Building P
Pomona, NY 10970
(845) 364-2669
GruskinD@co.rockland.ny.us

Ulster County EMC
Marian Strouse, Staff Coordinator
PO Box 557
Stone Ridge, NY 12484
(845) 687-0267
Mstrouse@hvi.net

Westchester County EMC
Kay L. Eisenman, Staff Coordinator
148 Martine Avenue
432 Michaelian Office Building
White Plains, NY 10601
(914) 995-4424/4422
kle1@westchestergov.com

Soil and Water Conservation Districts - www.nacdnet.org

Hudson Valley Region

Albany County Soil and Water Conservation District
Box 497, Martin Rd.
Voorheesville, NY 12186
(518) 765-7923

Columbia County Soil and Water Conservation District
1024 Rt. 66
Ghent, NY 12075
(518) 828-4386

Delaware County Soil and Water Conservation District
44 West St
Suite 1
Walton, NY 13856
(607) 865-7161

Dutchess County Soil and Water Conservation District
Farm and Home Center
2715 Route 44, Suite 1
Millbrook, NY 12545
(845) 677-8011
Website: www.dutchess.ny.nacdnet.org
Email: dutchess@ny.nacdnet.org

Greene County Soil and Water Conservation District
11C # 3 Box 907
Cairo, NY 12413
(518) 622-3620
Website: www.gcswcd.com

Lower Hudson Coalition of Conservation Districts
4433 Route 81
Greenville, NY 12083
Website: www.lhccd.org

Orange County Soil and Water Conservation District
225 Dolson Ave., Suite 103
Middletown, NY 10940
(845) 343-1873

Putnam County Soil and Water Conservation District
841 Fair Street
Carmel, NY 10512
(845) 878-7918

Rensselaer County Soil and Water Conservation District
Ag and Life Science Building
61 State Street
Troy, NY 12180
(518) 271-1740

Rockland County Soil and Water Conservation District
50 Sanitorium Rd
Pomona, NY 10970
(845) 364-2667

Saratoga County Soil and Water Conservation District
50 West High Street, Building 5
Ballston Spa, NY 12020
(518) 885-6900

Sullivan County Soil and Water Conservation District
69 Ferndale-Loomis Rd
Liberty, NY 12754
(914) 292-6552

Ulster County Soil and Water Conservation District
Times Square Office Park
652 Route 299
Highland, NY 12528
(845) 883-7162

Westchester County Soil and Water Conservation District
432 Michaelain Building
148 Martine Avenue
White Plains, NY 10601
(914) 285-4422

Federal Agencies

United States Environmental Protection Agency (EPA), Region 2
290 Broadway
New York, NY 10007
(212) 637-3000
Website: www.epa.gov/region2

EPA Environmental Response Team
Website: www.ertresponse.com

EPA Superfund Program
Website: www.epa.gov/superfund

United States Geological Survey
425 Jordan Road
Troy, NY 12180
(518) 285-5600
Website, general: www.usgs.gov
Website, Waters in NY:
water.usgs.gov/wid/html/ny.html

National Wildlife Federation
Website: www.nwf.org

US Army Corps of Engineers (USACE)
New York District , Jacob K. Javits Federal Building
26 Federal Plaza
NY, NY 10278-0090
(212) 264-0100
George Nieves, Chief of Operations
(212) 264-9020
John Cavolaro, Deputy Chief of Operations
Ella Snell, Chief Supervisor
(212) 264-0238
Mark Roth - Western Permits
James Cronin - Dutchess County Project Manager
Mr. Bryon Orzel
Website (NY): www.nan.usace.army.mil
Website (US): www.usace.army.mil

Additional USACE Websites

USACE Headquarters, Regulatory Branch
www.usace.army.mil/inet/functions/cw/cecwo/reg

USACE New York District, Nationwide Permits and Regional Conditions
www.nan.usace.army.mil/business/buslinks/regulat/permits

USACE's Waterways Experiment Station (WES)
www.wes.army.mil

USACE's Wetlands Regulatory Assistance Program (WRAP)
www.wes.army.mil/el/wrap

USACE Wetland Management Handbook
el.erdc.usace.army.mil/wrap/pdf/srel00-16.pdf

Recent Corps Regulatory Announcements & Decisions
www.usace.army.mil/inet/functions/cw/cecwo/reg/citizen.htm

Guidance on Compensatory Mitigation Projects, Regulatory Guidance Letter 02-2
www.usace.army.mil/inet/functions/cw/hot_topics/RGL_02-2.pdf

Summary of 2002 Nationwide Permits (PDF format)
www.usace.army.mil/inet/functions/cw/cecwo/reg/Summary_table.pdf

Nationwide Permit Summaries
www.spk.usace.army.mil/pub/outgoing/co/reg/nwp

Current Decision Documents (Environmental Assessments), Nationwide Permits
www.usace.army.mil/inet/functions/cw/cecwo/reg/nw2002dd

USACE's Aquatic Resources News
www.usace.army.mil/inet/functions/cw/cecwo/reg/aqua_ltr.htm

Joint Application for Permit Form
http://www.nan.usace.army.mil/business/buslinks/regulat/formdocs/jtperm.pdf

USACE's Public Notice Distribution List Request Sheet
http://www.nan.usace.army.mil/business/buslinks/regulat/formdocs/pnmail2.pdf

USDA - Stream Corridor Restoration
Website: www.nrcs.usda.gov/technical/stream_restoration

Watershed Websites

American Rivers - provides directory to rivers and river groups, river issues including landuse and urban sprawl, water quality, floodplains and wetlands, fish and wildlife and wild and scenic rivers,
(www.americanrivers.org)

American Heritage Rivers - provides recent information on President Clinton's American Heritage Rivers (AHR) initiative to support community-led efforts,
(www.epa.gov/rivers)

Association of State Wetland Managers - provides information on wetland and watershed management consisting of a guidebook that makes recommendations for integrating wetlands into broad watershed management efforts. It also includes information on specific water programs including floodplain management, stormwater management, source water protection, point source pollution control, and nonpoint source pollution control programs,
(www.aswm.org)

Bonneville Power Administration, Fish and Wildlife - provides information on their Watershed Management Environmental Program and provides examples of watershed projects,
(www.efw.bpa.gov)

Center for Watershed Protection - provides tools and resources for watershed protection,
(www.cwp.org)

Stormwater Manager's Resource Center ,
(www.stormwatercenter.net)

Clean Water Network - provides water quality standards, and nutrient guidance document for rivers and streams,
(www.cwn.org)

Conservation Technology Information Center - contains Know Your Watershed guides, and information on Building Local Partnerships and Putting Together a Watershed Management Plan,
(www.ctic.purdue.edu/CTIC/CTIC.html)

League of Woman Voters of Westchester - provides information about stormwater pollution and the government's role, also contains information on WestchesterCounty watersheds including the Croton Watershed, Hudson River Watershed, Long Island Sound Watershed and Bronx River Watershed.,
(www.watpa.org/lwv)

International Year of Freshwater 2003 - The United Nations has designated 2003 as the International Year of Freshwater,
(www.wateryear2003.org)

National Institute for Water Resources - contains information about the NIWR program which conducts research to solve water problems in specific areas and contains links to water resource information,
(http://niwr.montana.edu/)

National Marine Fisheries Service - provides information on essential fish habitat and recreational fisheries,
(www.nmfs.noaa.gov)

Natural Resource Conservation Service - contains downloadable version of National Watershed Manual and "Aging Watershed Infrastructure" documents and provides information on Watershed Protection and Flood Control Operations, Watershed Surveys and Planning, Wetlands Conservation Compliance, Wetlands Reserve

Program and Wildlife Habitat Incentives Program,
(www.nrcs.usda.gov)

Natural Resources Defense Council - contains information on various subjects including clean air and energy, global warming, clean water & oceans, wildlife & fish, parks, forests & wetlands, toxic chemicals & health, cities & green living, and environmental legislation,
(www.nrdc.org)

New England Interstate Water Pollution Control Commission (NEIWPCC) - provides information on water quality issues including total maximum daily loads (TMDL's), nonpoint source pollution, surface water management, and stormwater along with downloadable technical documents and newsletters (Water Connection),
(www.neiwpcc.org)

New York Sea Grant - provides information on water quality, aquatic invaders, seafood safety , education, coastal resources, fisheries, new initiatives and coastal businesses,
(www.seagrant.sunysb.edu)

New York State Department of Environmental Conservation, Division of Water,
(www.dec.state.ny.us/website/dow)

New York State Water Resource Institute - provides information and technical assistance relating to the state's water resources,
(wri.eas.cornell.edu)

Nonpoint Education for Municipal Officials - provides information on non-point source pollution and watershed protection measures,
(www.nemo.uconn.edu)

Office of the Attorney General - provides publications and studies prepared by the environmental's bureau lawyers and scientists, provides a link to the report on phosphorous loads in NYC watershed reservoirs,
(www.oag.state.ny.us/environment/environment.html)

The River Network - contains a resource library with information on watershed protection and restoration, links to major environmental organizations, state government agencies, federal agencies and U.S. Congress River and Watershed organizations, and the annual River Rally conference that offers workshops on river protection and restoration,
(www.rivernetwork.org)

Tennessee Valley Authority - provides water quality information in the Tennessee River System,
(www.tva.gov/environment/water)

Terrene Institute - contains factsheets on delineating watersheds, integrated stream management and how to reduce impacts to aquatic habitats. Reasonably-priced books available,
(terrene.org)

Trout Unlimited - describes Embrace a Stream Program and stream protection,
(www.tu.org)

United States Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds,

Index of Watershed Indicators	www.epa.gov/watershed/waacademy	Protecting and Restoring America's Watersheds	www.epa.gov/owow/protecting
Lessons Learned	www.epa.gov/owow/lessons	Online Watershed Management Training	www.epa.gov/watertrain
Model Ordinances	www.epa.gov/owow/nps/ordinance	Watershed Restoration	www.epa.gov/owow/restore
Surf your watershed	www.epa.gov/owow/watershed		

United States Geological Survey, National Water Quality Assessment Program - details the NAWQA program, which is conducted in more than 50 major river basins; includes data about water chemistry, hydrology, land use, habitat and aquatic life,
(water.usgs.gov/nawqa)

United States Department of Interior, Bureau of Land Management, Riparian Recovery Initiative - provides general information on riparian areas and provides downloadable flyers on the protection and restoration of riparian areas,
(www.blm.gov/riparian)

Water Forum - offers a forum for the discussion of surface and groundwater issues, including drinking water, fisheries and wildlife use, wetlands, contamination and related topics,
(www.egroups.com/group/waterforum)

Watershed Information Network - provides information on federal water resource protection programs and facts about many watersheds,
(www.epa.gov/win)

The Watershed Report Card - provides a step by step process to help you learn about what keeps a watershed functioning,
(www.watershedreportcard.org)

America's Clean Water Foundation (ACWF),
(www.acwf.org)

Association of State & Interstate Water Pollution Control Administrators (ASIWPCA)
(www.asiwpca.org)

Cornell Center for the Environment,
(environment.cornell.edu)

The Foundation Center - Help for Grant Seekers,
(fdncenter.org)

Cornell Pesticide Management Education Program,
(pmep.cce.cornell.edu)

List of Local Representatives - Pok Journal,
(www.poughkeepsiejournal.com/news/extras/lawmakers.htm)

Local Media

Our Environment - Poughkeepsie Journal
www.poughkeepsiejournal.com/sections/environment

Valley Water Under Siege - Poughkeepsie Journal
www.poughkeepsiejournal.com/projects/water/index.shtml

River & Estuaries Center - Poughkeepsie Journal
www.poughkeepsiejournal.com/projects/institute

Environmental Protection Rights - Poughkeepsie Journal
www.poughkeepsiejournal.com/projects/environment

Links to Local Papers - from Dutchess Co. Government
dutchessny.gov/QuickLinks/Newspapers.htm

RNN - TV
RNN Kingston Studio
721 Broadway
Kingston, NY 12401
(845) 339-6200
fax: (845) 339-6210
Diane Lee - covers Shenandoah Superfund site
Email: dlee@rnn.com
Website : www.rnntv.com

Poughkeepsie Journal
85 Civic Center Plaza
PO Box 1231
Poughkeepsie, NY 12602
NEWSROOM: (845) 437-4800, (800) 765-1120
Fax: (845) 437-4921
Email: newsroom@poughkee.gannett.com
Website: www.poughkeepsiejournal.com
Dan Shapley, Environment Writer & Editor
Email: dshapley@poughkee.gannett.com
(845) 437-4814

Mid_Hudson Valley Fact Book (Annual) - Poughkeepsie Journal
www.poughkeepsiejournal.com/projects/factbook

Mid-Hudson News Network
midhudsonnews.com

Southern Dutchess News
84 East Main Street
Wappingers Falls, NY 12590
(845) 297-3723
(845) 297-6810 (fax)
Email: newsplace@aol.com

LEGAL NOTICES - Poughkeepsie Journal
http://vh80259.vh8.infi.net/osform/MVCCService?osform_template=/standard/query.oft&publication=pojo&displayCount=10&category=Legal

Local Municipalities

City of Beacon - www.cityofbeacon.org

Town of Beekman - www.townofbeekman.com

Town of Fishkill - www.fishkill-ny.gov

Village of Fishkill - www.vofishkill.com

Town of East Fishkill
370 Route 376
Hopewell Junction, NY 12533
(845) 221-9191
Planning Board (845) 221-2428
Peter Idema, Town Supervisor 221-4303
Town Clerk - Dottie McKeel 221-9191
Website: www.eastfishkillny.org

Town of East Fishkill Conservation Advisory Council (CAC)
Brent Feldweg, Chairman
(845) 226-4553
Fax:(845) 221-1924
227-1449 (H?)
Email: efcac@nysnet.net
Website: www.eastfishkillny.org/cac.html

Town of Kent - www.townofkent.org

Town of La Grange - www.lagrangeny.org

Town of Pleasant Valley - www.ci.pleasant-valley.ny.us

City of Poughkeepsie -
www.cityofpoughkeepsie.com

Town of Poughkeepsie -
www.townofpoughkeepsie.com

Town of Union Vale -
www.marist.edu/unionvale

Town of Unionvale Conservation Advisory Council (CAC) -
www.marist.edu/unionvale/HdCAC.htm

Town of Wappinger -
www.townofwappinger.us

Publications and Laws

A Citizen's Guide to Environmental Information in New York State (PDF file)
www.oag.state.ny.us/environment/citizens_guide_to_envir_info.pdf

EPA Watershed Outreach Documents
www.epa.gov/owow/watershed/outreach/documents/

NY State Constitution
assembly.state.ny.us/leg/?co=0

NY State Legislature Resources
www.nysl.nysed.gov/ils/legislature/legis.html

NY State Laws - NY State Assembly
assembly.state.ny.us/leg/?sl=0

NY State Environmental Law
www.nyenvlaw.com

Land Use Law Center - Pace University
www.law.pace.edu/landuse

State Environmental Quality Review Act (SEQR)
www.dec.state.ny.us/website/dcs/seqr

Legal Publications - including Land Use Technical Series - NY State Dept. of State, Div. of Local Govt.
www.dos.state.ny.us/lgss/list9.html

See the Watershed Environmental Resource Directory for updates:
http://FishkillCreekWatershed.org/pubs/Resource_Directory.html

Appendix 3.
Geographic Information System (GIS) Data Sources for Maps

Dutchess County EMC GIS Lab,
Stacy Hoppen, GIS Coordinator
shoppen@co.dutchess.ny.us

Dutchess County GeoAccess
www.dutchessny.gov/GeoAccess.htm

EPA's EnviroMapper
www.epa.gov/enviro/html/em

NY Public Interest Research Group (NYPIRG) Community Mapping Assistance Project (CMAP)
www.nonprofitmaps.org

NY State DEC's Environmental Navigator
www.dec.state.ny.us/website/imsmaps/navigator

NY State Political District Maps
latfor.state.ny.us/maps

NY State GIS Maps
www.nysgis.state.ny.us

Appendix 4.
NYSDEC and National Wetland Inventory Wetland Classifications

National Wetland Inventory Classifications:

QUICK CROSS REFERENCE OF MAP CODES TO COMMON WETLAND TYPES (Using System, Subsystem and Class)

MAP CODE	COMMON NAME or WETLAND TYPE
PFO	FORESTED OR WOODED SWAMP OR BOG
PSS	SHRUB SWAMP OR BOG
PEM	EMERGENT MARSH, FEN, OR WET MEADOW
PUB	POND
PUS	POND SHORELINE
PAB	POND WITH FLOATING OR SUBMERGED AQUATIC VEGETATION
R1UB	FRESHWATER TIDAL RIVER
R2UB	SLOW MOVING RIVER WITH FLOODPLAIN
R2AB	RIVER WITH AQUATIC VEGETATION (PICKERELWEED)
R3US	BANK OR SHORELINE OF FAST FLOWING RIVER
R4SB	INTERMITTENT STREAM CHANNEL
R5UB	RIVER SHOWING CHARACTERISTICS OF BOTH UPPER AND LOWER PERENNIAL RIVERS
M1UB	OPEN OCEAN WITH UNCONSOLIDATED BOTTOM
M2AB	INTERTIDAL SEAWEED BED IN OCEAN
M2RF	INTERTIDAL OYSTER AND MUSSEL REEFS IN OCEAN
E2EM	SALT OR BRACKISH TIDAL MARSH
E2SS	ESTUARINE SHRUB SWAMP
E2US	ESTUARINE FLATS, BEACH, OR SAND BARS
E1UB	OPEN WATER ESTUARY
L1UB	DEEPWATER ZONE OR LAKE
L2US	LAKE SHORE OR SHALLOW WATER ZONE OF LAKE
L2AB	AQUATIC VEGETATION IN LAKE
L2UB	SHALLOW WATER ZONE OF LAKE

DEC Wetland Classifications:

664.5 Classification System

Not all wetlands supply equally the benefits explained in section 664.3 (b). The degree to which wetlands supply benefits depends upon many factors, including: their vegetative cover, their ecological associations, their special features, their hydrological and pollution control features, and their distribution and location; and these may vary considerably from wetland to wetland.

Because of this variation, the act requires the commissioner to classify wetlands in a way that recognizes that not all wetlands are of equal value. This section establishes four ranked regulatory classes of wetlands, depending upon the degree of benefits supplied. The benefits cited in section 24-0105 (7) of the act are translated into discernable wetland characteristics, and these characteristics are used to classify wetlands. Section 664.6 describes each characteristic in some detail and discusses the benefits supplied by a wetland when it contains that characteristic.

(a) Class I wetlands.

A wetland shall be a Class I wetland if it has any of the following seven enumerated characteristics:

664.5 (a)

Ecological associations

(1) it is a classic kettlehole bog (664.6 (b) (2));*

Special features

(2) it is resident habitat of an endangered or threatened animal species (664.6 (c) (2) and (4));

(3) it contains an endangered or threatened plant species (664.6 (c) (4));

(4) it supports an animal species in abundance or diversity unusual for the state or for the major region of the state in which it is found (664.6 (c)(1) and (6));

Hydrological and pollution control features

(5) it is tributary to a body of water which could subject a substantially developed area to significant damage from flooding or from additional flooding should the wetland be modified, filled, or drained (664.6 (d) (1));

(6) it is adjacent or contiguous to a reservoir or other body of water that is used primarily for public water supply, or it is hydraulically connected to an aquifer which is used for public water supply (664.6 (d) (2), (3), and (4)); or

Other

(7) it contains four or more of the enumerated Class II characteristics. This department may, however, determine that some of the characteristics are duplicative of each other, therefore do not indicate enhanced benefits, and so do not warrant Class I classification. Each species to which paragraphs 664.5 (b) *(6) through (8) apply shall be considered a separate Class II characteristic for this purpose.*

664.5 (b)

Class II wetlands.

A wetland shall be a Class II wetland if it has any of the following seventeen enumerated characteristics:

Covertype

(1) it is an emergent marsh in which purple loosestrife and/or reed (phragmites) constitutes less than two-thirds of the covertype (664.6 (a) (2));*

Ecological association

(1) it contains two or more wetland structural groups (664.6 (b) (1));

(2) it is contiguous to a tidal wetland (664.6 (b) (3));

(3) it is associated with permanent open water outside the wetland (664.6 (b) (4));

(4) it is adjacent or contiguous to streams classified C(t) or higher under article 15 of the environmental conservation law (664.6 (b) (5));

Special features

(1) it is traditional migration habitat of an endangered or threatened animal species (664.6 (c) (3) and (4));

(2) it is resident habitat of an animal species vulnerable in the state (664.6 (c) (2) and (5));

(3) it contains a plant species vulnerable in the state (664.6 (c) (5));*

(4) it supports an animal species in abundance or diversity unusual for the county in which it is found (664.6 (c) (7));

(5) it has demonstrable archaeological or paleontological significance as a wetland (664.6 (c) (8));

(6) it contains, is part of, owes its existence to, or is ecologically associated with, an unusual geological feature which is an excellent representation of its type (664.6 (c) (9));

664.5 (b)

Hydrological and pollution control features

(1) it is tributary to a body of water which could subject a lightly developed area, an area used for growing crops for harvest, or an area planned for development by a local planning authority, to significant damage from flooding or from additional flooding should the wetland be modified, filled or drained (664.6 (d) (1));

(2) it is hydraulically connected to an aquifer which has been identified by a government agency as a potentially useful water supply (664.6 (d) (4));

(3) it acts in a tertiary treatment capacity for a sewage disposal system (664.6 (d) (3);

Distribution and location

(1) it is within an urbanized area (664.6 (e) (1));

(2) it is one of the three largest wetlands within a city, town, or New York City borough (664.6 (e) (3));*

(3) it is within a publicly owned recreation area (664.6 (e) (4)).

664.5 (c)

Class III wetlands.

A wetland shall be a Class III wetland if it has any of the following fifteen enumerated characteristics:

Covertypes

(1) it is an emergent marsh in which purple loosestrife and/or reed (phragmites) constitutes two-thirds or more of the covertype (664.6 (a) (2));

(2) it is a deciduous swamp (664.6 (a) (3));

(3) it is a shrub swamp (664.6 (a) (5));

(4) it consists of floating and/or submergent vegetation (664.6 (a) (6));

(5) it consists of wetland open water (664.6 (a) (5));

Ecological associations

(1) it contains an island with an area or height above the wetland adequate to provide one or more of the benefits described in section 664.6 (b) (6);

Special features

(1) it has a total alkalinity of at least 50 parts per million (664.6 (c)(10));

(2) it is adjacent to fertile upland (664.6 (c) (11));*

(3) it is resident habitat of an animal species vulnerable in the major region of the state or in the major region of the state in which it is found, or it is traditional migration habitat of an animal species vulnerable in the state or in the major region of the state in which it is found (664.6 (c) (1), (2), (3), and (5));

(4) it contains a plant species vulnerable in the major region of the state in which it is found (664.6 (c) (1) and (5));

664.5 (c)

Hydrological and pollution control features

(1) it is part of a surface water system with permanent open water and it receives significant pollution of a type amenable to amelioration by wetlands (664.6 (d) (3));

Distribution and location

(1) it is visible from an interstate highway, a parkway, a designated scenic highway, or a passenger railroad and serves a valuable aesthetic or open space function (664.6 (e) (2));

(2) it is one of the three largest wetlands of the same covertype within a town (664.6 (e) (3));

(3) it is in a town in which wetland acreage is less than one percent of the total acreage (664.6 (e) (3)); or

(4) it is on publicly owned land that is open to the public (664.6 (e) (5)).

664.6 (a)

Class IV Wetlands

A wetland shall be a Class IV wetland if it does not have any of the characteristics listed as criteria for Class I, II, or III wetlands. Class IV wetlands will include wet meadows (664.6 (a) (1))* and coniferous swamps (664.6 (a) (4)) which lack other characteristics justifying a higher classification.

The reference in parentheses after each characteristic is to the description of that characteristic and its associated benefits in section 664.6.

Appendix 5.
New York State Department of Environmental Conservation's stream classification
(From: 6 NYCRR Part 701)

FRESH SURFACE WATERS

§701.2 Class N fresh surface waters
(a) The best usages of Class N waters are the enjoyment of water in its natural condition and, where compatible, as a source of water for drinking or culinary purposes, bathing, fishing, fish propagation, and recreation.

(b) There shall be no discharge of sewage, industrial wastes, or other wastes, waste effluents or any sewage effluents not having had filtration resulting from at least 200 feet of lateral travel through unconsolidated earth. A greater distance may be required if inspection shows that, due to peculiar geologic conditions, this distance is inadequate to protect the water from pollution.

(c) These waters shall contain no deleterious substances, hydrocarbons or substances that would contribute to eutrophication, nor shall they receive surface runoff containing any such substance.

§701.3 Class AA-Special (AA-S) fresh surface waters
(a) The best usages of Class AA-S waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

(b) These waters shall contain no floating solids, settleable solids, oil, sludge deposits, toxic wastes, deleterious substances, colored or other wastes or heated liquids attributable to sewage, industrial wastes or other wastes.

(c) There shall be no discharge or disposal of sewage, industrial wastes or other wastes into these waters.

(d) These waters shall contain no phosphorus and nitrogen in amounts that will result in growths of algae, weeds and slimes that will impair the waters for their best usages.

§701.4 Class A-Special (A-S) fresh surface waters
(a) The best usages of Class A-S waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

(b) This classification may be given to those international boundary waters that, if subjected to approved treatment, equal to coagulation, sedimentation, filtration and disinfection with additional treatment, if necessary, to reduce naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

§701.5 Class AA fresh surface waters
(a) The best usages of Class AA waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

(b) This classification may be given to those waters that, if subjected to approved disinfection treatment, with additional treatment if necessary to remove naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

§701.6 Class A fresh surface waters

(a) The best usages of Class A waters are: a source of water supply for drinking, culinary or food processing purposes; primary and secondary contact recreation; and fishing. The waters shall be suitable for fish propagation and survival.

(b)This classification may be given to those waters that, if subjected to approved treatment equal to coagulation, sedimentation, filtration and disinfection, with additional treatment if necessary to reduce naturally present impurities, meet or will meet New York State Department of Health drinking water standards and are or will be considered safe and satisfactory for drinking water purposes.

§701.7 Class B fresh surface waters

The best usages of Class B waters are primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival.

§701.8 Class C fresh surface waters

The best usage of Class C waters is fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

§701.9 Class D fresh surface waters

The best usage of Class D waters is fishing. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery, or stream bed conditions, the waters will not support fish propagation. These waters shall be suitable for fish survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes.

Historical Note

Sec. filed July 3, 1985; repealed, new filed Aug. 2, 1991 eff. 30 days after filing.

Cover Description	Source Citation
State Pollution Discharge Elimination Systems (SPDES) Facilities	DCEMC GIS Lab automated, 1998
Road and Road Labels	New York State Department of Transportation, 1995
Streams	Originated by Dutchess County Environmental Management Council based on the New York State Department of Conservation Biological Survey Maps, published in 1991, edited in 1999
Surficial Water	Originated by Dutchess County Environmental Management Council based on the New York State Department of Conservation Biological Survey Maps, published in 1991, edited in 1999
State Wetland	Department of Environmental Conservation, Division of Fish and Wildlife, Habitat Inventory Unit created in 1994
Federal Wetland	US Fish and Wildlife Service, Digital Line Graph files, October 1995
Sub-watershed Boundary	SUNY ESF delineated boundaries using USGS 10-meter DEM and BASINS software, 2003

Appendix 6.
Fishkill Creek Streamwalk Program, 2004
by Rick Oestrike, Chair, Fishkill Creek Watershed Committee

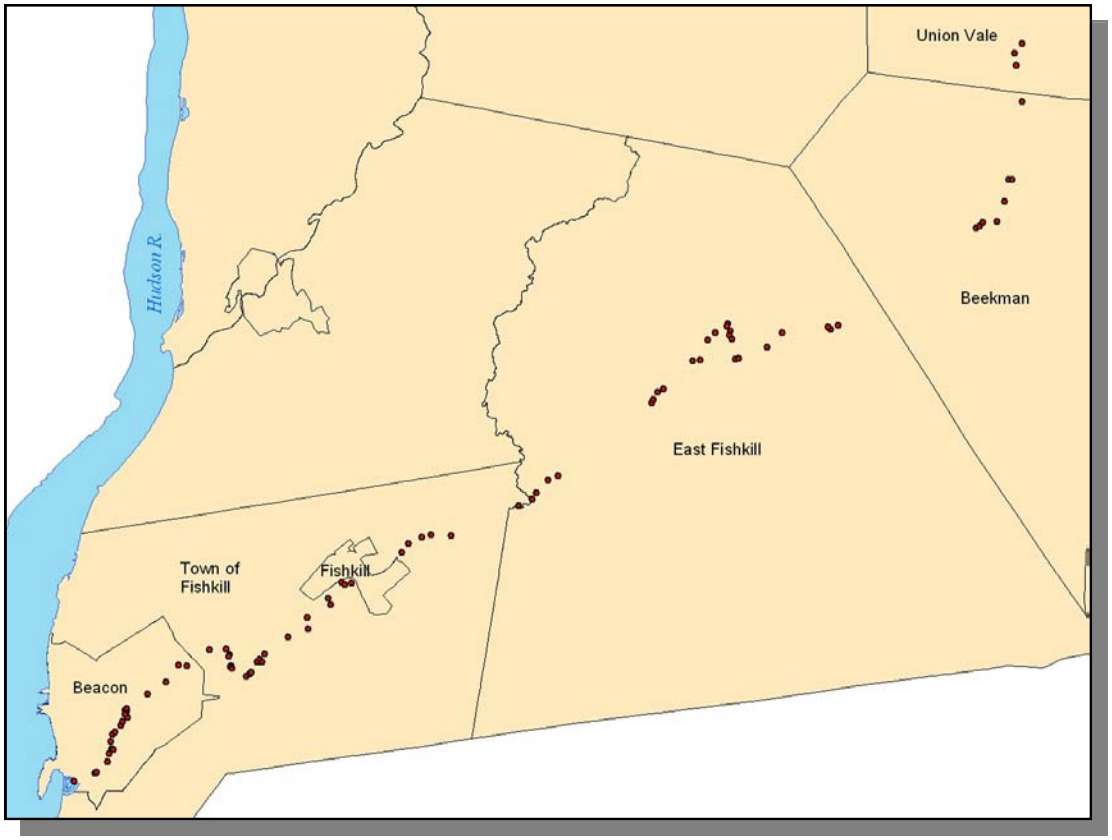
Streamwalk, a volunteer assessment program was conducted between May and August of 2004 along the main stem of the Fishkill Creek. This program was designed by the Natural Resources Conservation Service and implemented by the Lower Hudson Coalition of Soil and Water Conservation Districts and the Dutchess County Environmental Management Council. Sixteen stream segments, or approximately 16 miles, were studied along the main stem of the Fishkill Creek. Fifty-five impaired sites were surveyed, with a total of 104 impairments. Over 700 digital photographs were taken of the stream and surrounding areas, and over 90 global positioning system (GPS) coordinates were taken of features of interest including bridges, dams, outlet pipes, areas of erosion, etc. The participating volunteers donated 477 hours of their time to complete the project.

The main stem of the Fishkill Creek was subdivided into 26 segments, from FC-01 (near the confluence with the Hudson River), to FC-26 (near the headwaters). Ideally, each segment was one-mile long and had a recognizable landmark at each end. Since landmarks are not spaced equally, the actual segments varied from about half a mile to one and a half miles in length. In 2004, 16 of the 26 segments were studied. Of the segments studied, none received a score of excellent, seven received a score of good, four received a score of fair and five received a score of poor. When these scores were considered geographically, a clear trend became apparent. The downstream portion of the creek rated low and the upstream portions rated much higher. All of the segments that rated as poor were located in the lower portion of the creek in the Town of Fishkill and City of Beacon. In the upper portion of the creek in the Towns of Unionvale and Beekman, all of the segments rated as good.

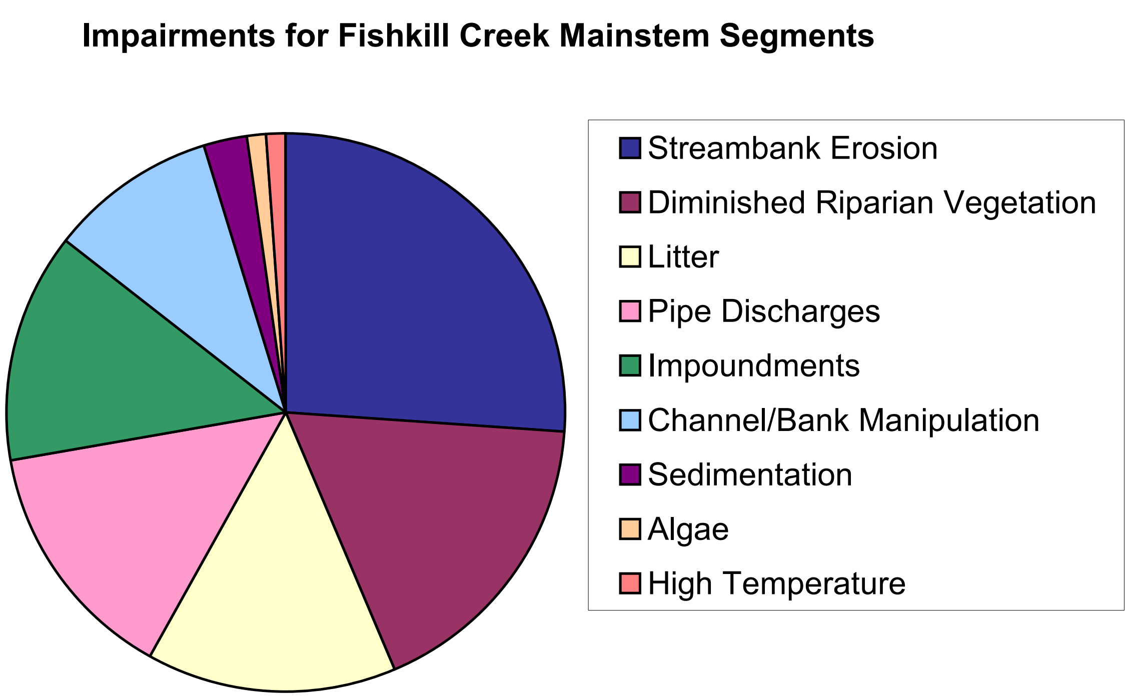
On average, there are 3.4 impaired sites per mile studied, and many of these sites had more than one impairment. The most common impairment observed was streambank erosion, which was present at 49% of all impaired sites. The second most common impairment was diminished riparian vegetation, which occurred at 44% of impaired sites. Both litter and pipe discharges occurred at 27% of impaired sites. The term litter implies significant piles of trash or large manmade objects, such as shopping carts, lawn tractors, washing machines, etc. Impoundments, including dams, occurred at 25% of impaired sites. Channel or bank manipulation occurred at 18% of impaired sites. Finally, both excess algae and high water temperatures occurred at 2% of the impaired sites.

Some types of impairments displayed geographic trends. For example, extensive litter was fairly common in the lower portion of the creek, but uncommon in the middle and upper reaches. Diminished riparian vegetation was uncommon in the lower Fishkill Creek, but commonplace in the middle and upper portions of the creek. Streambank erosion was most abundant in the middle portions of the creek in the Town of East Fishkill. Impoundments were uncommon in the middle portion, but common in the lower and upper sections of the creek.

Other information recorded during the Streamwalk program included water temperature, pH, stream depth and width, local land uses, water appearance, fish and macroinvertebrate habitats and substrate embeddedness. Impaired site reports included any unusual smells, type of streambank vegetation, stream bottom composition, presence/absence of waterfowl and observed human activates near the creek.



Impaired Sites in the Fishkill Creek Main stem identified by Streamwalk, 2004.



Streamwalk Segment Scores for the City of Beacon, Town of Fishkill, Town of East Fishkill, Town of Beekman and Town of Union Vale

Impairments	Percentage (%)
Streambank Erosion	49
Diminished Riparian Vegetation	33
Litter	27
Pipe Discharges	27
Impoundments	25
Channel/Bank Manipulation	18
Sedimentation	5
Algae	2
High Temperature	2

Percentages related to chart from previous page

City of Beacon/Town of Fishkill

Section No.	Area	Condition
FC-01	Fishkill Creek mouth to Wolcott Ave. Bridge- Rte 9D:	POOR
FC-02	Wolcott Ave. Bridge to East Main St. Bridge:	POOR
FC-03	East Main St. Bridge to Front St.:	GOOD
FC-04	Front St. to railroad bridge upstream of Maple St.:	POOR
FC-05	Maple St. to Greenwood Dr. near mid-section adjacent to creek:	FAIR
FC-06	Greenwood Drive to I-84	POOR
FC-07	I-84 to Rte. 9	FAIR
FC-08	Fishkill Glen Dr. adjacent to railroad tracks:	NO DATA
FC-09	Fishkill Glen Dr. to Rte. 52 Bridge	POOR
FC-10	Rte. 52 Bridge to East Fishkill Town Line	NO DATA

Town of East Fishkill

Section No.	Area	Condition
FC-11	East Fishkill Town Line to substation near intersection of Rt. 82 & Lake Walton Rd (Helin Rd.)	GOOD
FC-12	Helin Rd. to Rte. 376 (South of firehouse):	NO DATA
FC-13	Rte. 376 to Carol Drive	GOOD
FC-14	Carol Drive crossing to near Carpenter Rd. (North end of creek meander at intersection of Rt. 9 & Augusta Rd.)	FAIR
FC-15	Augusta Rd. to dam (former Greenburg property, now Behr	FAIR
FC-16	dam to Stormville Rd. bridge near Taconic State Parkway	GOOD
FC-17	Stormville Rd. to Phillips Rd	GOOD
FC-18	Phillips Rd. to East Fishkill/Beekman Town Line (end of Moonlight Drive	NO DATA

Town of Beekman		
Section No.	Area	Condition
FC-19	Town of East Fishkill Boundary to Williams Dr.	NO DATA
FC-20	Williams Dr. to Greenhaven Rd.	NO DATA
FC-21	Greenhaven Rd. to Beekman-Poughquag Rd	NO DATA
FC-22	Beekman-Poughquag Rd. to Limbach Rd	GOOD
FC-23	Limbach Rd. to Dorn Rd.	NO DATA
FC-24	Dorn Rd. to Bruzgul Rd. (portion in towns of Beekman and Union Vale)	GOOD

Town of Union Vale		
Section No.	Area	Condition
FC-25	Bruzgul Rd. to Bruzgul Rd. (goes through Tymor Lake and loops around to Bruzgul Rd.)	NO DATA
FC-26	Bruzgul Rd. to confluence near Clove Rd.	NO DATA