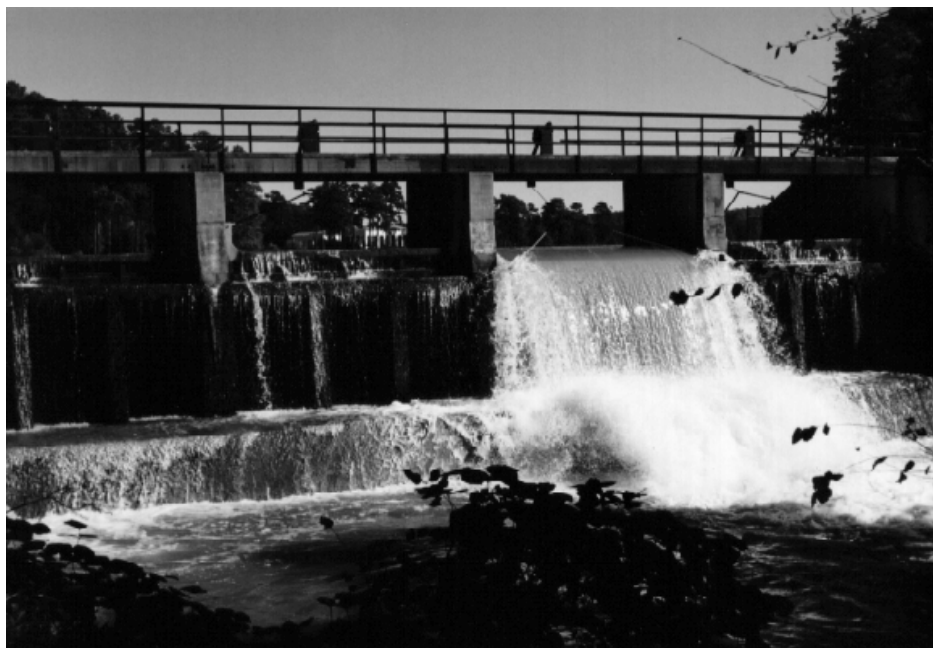


Bureau  
Of  
Water

# The Gills Creek Watershed Project

*An Urban Nonpoint Source Project:  
Richland County, S.C.  
February 1994-September 1996*

**Final Report**



South Carolina Department of Health  
and Environmental Control

Water Quality  
Division

*Promoting Health, Protecting the Environment*

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## **Final Report February 1997**

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# I. Introduction

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## ***Basic Purpose***

The Gills Creek Nonpoint Source Pollution Project was launched in February 1994 with the stated purpose of establishing a means to identify and recommend measures for the control of nonpoint source (NPS) water pollution in the Gills Creek Watershed. Simply stated, NPS pollution can be defined as all the pollution that **rainfall runoff** picks up as it flows over and through the surface of the watershed. As the rain water flows over exposed surfaces, natural and manmade pollutants become entrained in the runoff and eventually are deposited into local waterways. Unlike pollution from a point source, such as the treated effluent from a factory or sewage treatment plant, NPS originates from many diffuse sources throughout the watershed.

The Gills Creek Project has employed the "Watershed Protection Approach" in this water pollution control effort. The Watershed Protection Approach refers to an integrated, holistic strategy that recognizes the importance of taking into consideration the entire watershed, its water resources, the human interests and all possible pollution sources for the ultimate purpose of applying an integrated, multi-faceted and cost effective NPS control action plan (USEPA 1994).

Gills Creek and its associated tributary system result from the drainage of a natural basin that runs in a generally north-south direction through the central portion of Richland County. The various streams and lakes of the Gills Creek system occur within the jurisdictions of five different governmental entities, those being: the U.S. Army Installation at Fort Jackson, the Towns of Arcadia Lakes and Forest Acres, the City of Columbia, and Richland County itself (see map). It is a rapidly urbanizing region that includes a variety of land uses, each of which can have varying degrees of NPS impacts. The watershed includes regions of heavy commercial activity typical of most suburban areas (eg. regional malls) as well as large tracts of high and low density residential land use. Agricultural and light industrial activities occur as well, mostly in the southern portion of the watershed. As the region grows, road expansion, new commercial sites and the population of new residential areas will place greater stresses on water quality and the natural resources of the watershed.

The Gills Creek Project has the stated objective: "...to **maintain** and **enhance** existing water quality and uses in the Gills Creek Watershed by controlling diffuse sources of water pollution." Achieving this goal will require a determined, concerted, and sustainable effort by the various local governments, the endorsement of all affected stakeholders and the commitment of a majority of area homeowners to lessen their frequently small but additive personal impacts on water quality.

## ***Project Background***

The Gills Creek Project is one element of the State of South Carolina's NPS Management Program and is funded under the Federal Government's 319 program. 319 refers to the section of 1987 Clean Water Act (CWA) amendments which provides assistance to states specifically to combat nonpoint sources of pollution. The reason for

this special emphasis stems from the realization that while important water quality improvements have been achieved through the conventional, permit driven point source controls, there still is significant water quality impairment throughout the nation's rivers, lakes and estuaries. This impairment has been determined to result principally from NPS pollution. The most recent National Water Quality Assessment estimates that NPS pollution is the primary culprit in up to **two thirds** of waterbody use impairment (USEPA 1992b).

NPS discharges can be responsible for water quality degradation, loss of beneficial stream and lake uses, adverse wildlife impacts, flooding from increased runoff volumes, and stream channel erosion. Nonpoint sources of pollution may adversely affect both surface water and groundwater. The way in which NPS pollution results in impaired water quality depends, to a large degree, on how the land in the surrounding watershed is used. Land uses and some of the associated NPS pollutants are listed below:

- **Agriculture:** Pesticides, herbicides, nutrients( eg. nitrogen, and phosphorus containing fertilizers), sediment, salts, biochemical oxygen demanding material (BOD) and bacteria from livestock waste.
- **Forestry:** Nutrients, sediment and BOD material.
- **Mining:** Sediments, heavy metals, inorganic toxics, acid drainage.
- **Construction:** Sediments, paints, metals, wood preservatives, trash and litter.
- **Urban Land Use:**

*Industrial:* Toxic chemicals, petroleum hydrocarbons (when spilled or exposed to rain),

*Residential:* Fertilizers (nutrients) and herbicides, fecal bacteria from seepage and pet waste, BOD material, household chemicals and automotive chemicals.

*Commercial:* Trash and litter, thermal pollution due to runoff from hot paved surfaces, petroleum hydrocarbons from parking lots, golf course runoff.

*Streets and Highways:* Oil and grease, Polycyclic Aromatic Hydrocarbons (PAH's), lead, zinc, copper, sediment, trash and litter.

*Other urban:* sewer system overflows, increased volumes and velocities of storm water due to excess paved area, chemical spills, landfill runoff.

As part of South Carolina's initial 319 strategy, a state wide assessment of the State's waters was required to determine which waters were impacted by these NPS pollutants. In the assessment, 336 waterways and watersheds were identified as being significantly impacted by NPS pollution. Of these, 50 were targeted for water quality projects. One of these watersheds was the Gills Creek Watershed.



Available data indicated that significant NPS impacts to Gills Creek were occurring. In consideration of this and recognizing the potential for further degradation in this fast growing watershed, Gills Creek was chosen for a comprehensive watershed project (SC DHEC 1989).

The Two Notch Rd. Home Depot Site was begun in the summer of 1994. Other large construction projects begun during the Gills Creek Project included: The Forest Dr. Wal Mart complex, O'Neil Court Extension, Deer Field Run Apts, Sesqui Place subdivision, Forest Dr. First Citizens Bank, Widening of Forest Dr.

## **II. What is the Gills Creek Watershed?**

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The Gills Creek Watershed encompasses 76 square miles of central Richland County S.C.. Gills Creek itself runs for about 20 miles in a generally north/south direction. The Creek originates at Hughes Pond near the northeastern boundary of Richland County and then proceeds through the U.S. Army base of Fort Jackson. After passing through the base, it passes under Percival Road and into the residential neighborhoods of Rockbridge and Forest Lake. Parts of this section have been impounded to form the two Rockyford Lakes (upper and lower). West of the Gills Creek origin, two major tributary systems originate. The Jackson Creek system begins in the Wildewood residential area and runs through Sesquicentennial State Park where it has been dammed to form Centennial Lake. It then continues southward to form the Windsor Lakes chain. West of Jackson Creek, there exists another tributary system known as Little Jackson Creek. It begins in the Spring Valley subdivision and is impounded at a number of locations including Spring Valley Country Club, Green Gate Pond and Springwood Lake. Little Jackson Creek combines with Jackson Creek below Windsor Lakes to provide the water supply for Cary Lake (also known as Arcadia Lake). Just below the Arcadia Lakes section of the watershed, Jackson Creek is impounded again at Spring Lake. Jackson Creek then joins with Gills Creek to form Forest Lake. After Forest Lake, the Creek continues onward through the Lake Katherine neighborhood where it is joined by Eightmile and Pen Branches, two intermittent streams which drain developed areas to the west. The final major lake in the system is Lake Katherine. The



tributary Wildcat Creek joins with Gills Creek just below Lake Katherine. From there, Gills Creek continues southward for a number of miles, winding through various commercial, residential, agricultural, and flood plain areas until it empties into the Congaree river south of the Southeast Beltway bridge.

The State use classification for all of the stream sections is currently FW (fresh water) allowing for all major uses. Uses that are meant to be supported under the FW classification include fishing, swimming, and aquatic life uses. Aquatic life use requires conditions that will support the survival and propagation of a balanced, indigenous flora and fauna. It is important to note that even though Gills Creek waters are classified as FW, it does not mean that water quality currently meets the criteria necessary to support these uses throughout the water course.

The watershed has a maximum elevation of 430ft and slopes an average 1.99ft/1000ft to its low of 105 ft. at the confluence with the Congaree (U.S Corps of Engineers, 1986). The slope range varies from 0-15%. Gills Creek is located at the margin of the Coastal Plains Physiographic Province of South Carolina. A principle geologic feature in the northern section of the watershed is the area known as the "Sand Hills". This area of rolling hills, scrub oak and pine is composed mostly of moderately coarse sandy soil with a high potential for rainwater infiltration. As a result, numerous springs originate in the area. In fact, the origin of Gills Creek emanates from some of these springs at Hughes Pond(U.S. Soil and Conservation Service 1977).

The climate in the area is characterized by generally mild winters with an average temperature of 48 degrees Fahrenheit (°F). The lowest recorded temperature was -1°F in January of 1985. The average summer temperature is around 80°F with the highest monthly average maximum of 90°F occurring during August 1983. The highest temperature on record was 107°F also in 1983. Total annual precipitation in the area averages 49.83 inches, the majority of which falls in the warmer months of April through September. Highest average rainfall usually occurs during the month of August while the lowest tends to occur in October. The area can expect about 74 rain events annually with about 15 amounting to one inch or more. The highest one day rainfall on record of 7.7 inches occurred in August of 1949 (from data provided by S.C. Dept. of Natural Resources).

Land use/land cover in the watershed has been calculated by the South Carolina Department of Natural Resources as 48.7% urban, 7.56% agricultural, 1.33% scrub/shrub, 36.38% forested, 3.34% wetland, 2.53% water and .07% barren.

Urbanization in the area, especially in the northern half, is occurring rapidly. The Northeast Richland County Land Use Plan adopted by the Richland County Planning Commission in 1987 approved areas near Springwood and Windsor Lakes as suitable for high density residential development. Large areas further north have been reserved for low and medium density residential development. Considerable acreage has become available for development due to the Trenholm Road. and O'Neil Court Extensions. These areas have been zoned for commercial development. Office/Institutional uses have been encouraged in the area near the I-77/I-20 interchange. A number of other areas, mostly in the extreme northern part of the watershed (eg. Clemson Road Extension, Percival Road.), have been designated for new industrial development. Further residential, commercial, institutional and transportation development projects are

expected in support of the proposed northeastern growth (Central Midlands Regional Planning Council 1987).

A calculation of the population of the Gills Creek Watershed has been derived by using 1990 U.S. census data for tracts that were largely contained within the Gills Creek Watershed. The watershed has about 123,789 people residing within or near its limits (See Appendix B). This is about 45% of the population of Richland County. In general, residents in the watershed are more affluent than most having a median household income of \$42,525 compared to the state median of \$34,357. Continued population growth in the region is expected. The year 2000 population of Richland County is expected to have grown by 20% of 1980 levels. A large proportion of this growth will occur in the Richland Northeast area. Growth projections specifically for the Gills Creek area are estimated at about 22% by 2015, amounting to an increase of 23,765 individuals above 1990 levels (based on modified same census tract projections supplied by Central Midlands Regional Planning Council).

### **III. What's So Special About Gills Creek?**

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While many long time residents may take the Columbia area's rivers, lakes, and streams for granted, newcomers soon discover that water is one of the defining elements of Richland County. From the Broad River, Saluda River and Lake Murray access in the west all the way to the Wateree/Congaree confluence to the east, water is an ever present



A lakefront home in the Wildewood subdivision

aspect of life in the South Carolina Midlands. The relaxing invitation of the cool waters and compelling splendor of the associated forests and wetlands are always nearby to help take the edge off of our frequently disquieting urban existence.

The Gills Creek Watershed, including the streams, lakes and associated flood

plains within it, has been historically and continues to be a principal feature of the Midlands landscape. The initial settlement of the area closely coincided with proximity to these waterbodies. Location near water provided a number of benefits for living, including a ready drinking water supply, a source of food, a means of transportation and

fertile flood plain soils. A large Congaree Indian presence had long existed in the area when the first contacts with Europeans took place. Some of the earliest of these settlers to the region established themselves near the banks of Gills Creek and its tributaries. The first recorded plats were certified in 1732 at the mouth of Gills Creek just across the Congaree River from the Congaree Fort trading post. An early immigrant, James Gill, settled in the area some time before the revolutionary war and is most likely the one to whom Gills Creek owes its name. Two brothers, Richard and Philip Jackson had plats recorded in 1740 thus we have Jackson and Little Jackson Creeks. Later, other settlers were actually granted land along Jackson Creek as "bounty" for distinguished service in the Revolutionary War (Green 1932).

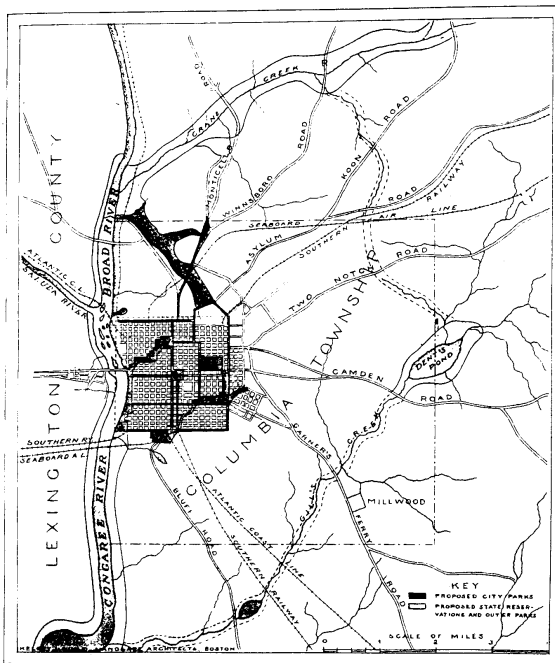
In the early days of the area's history, when water was a crucial element in commerce and industry, the flowing waters were used to power a number of mills on Gills Creek and other creeks in the area. A cotton spinning mill, owned by the Taylor family, operated for a number of years at a location in present day Forest Acres. Remnants of this old mill still stand. However, for most of its history, Richland County was primarily a farming community. It is likely that Gills Creek waters played an important part in the operation of these agricultural enterprises.

Local water resources have been used for comfort and recreation over the years as well. The area's original Boy Scout camp, Camp Barstow, was first located in the Gills Creek watershed on present day Fort Jackson and featured a small lake that was

doubtlessly used quite extensively. Dents Pond, now called Forest Lake, has long been a popular bathing and fishing spot for Columbia residents even before it was developed for residential property.

In 1905, a special planning study commissioned by the Civic League of Columbia actually proposed the establishment of an outer system of parks encircling Columbia which would incorporate area waterways such as Dents Pond. Beginning at the Gills Creek/Congaree junction, this proposed "parkway" would follow the length of Gills Creek to Dents Pond. It would then proceed eastward along a Gills Creek tributary and beyond to connect to the Crane Creek system of North Columbia.

It would proceed from there to the Broad river. This system was expected to be connected with a roadway and would



Plan Showing a Suggested System of Inner and Outer Parks and Reservations, and Connecting Roads and Driveways

From Kelsey and Guild, 1905

provide for a scenic ride through what was still at that time "the country." The authors commented that: "This [the parkway] may be a dream for the future but it is at least a worthy one, and dreams are sometimes realized"(Kelsey and Guild 1905). It's evident that people have recognized for quite a while now, the inherent value that creeks and their associated greenways can have for this region.

Many natural springs emerge in the Gills Creek watershed. Many of these served in earlier times as centerpieces of local “resorts” which were very popular attractions during the summer. During the 1800's one in particular, the Lightwood Knot Springs portion of the watershed near Parklane Road, was once a very popular picnic area where city residents would go to avail themselves of the cool air and verdant sanctuary that this small spring fed brook provided from the brunt of the Carolina summer. This same area was also extensively used as a Confederate Civil War encampment and training ground known as Camp Johnson (Green 1932). Historical markers are located on Forest Dr. and Parklane Rd. indicating the past significance of local water related sites.

Today the principal use of Gills Creek and its tributaries is for recreational enjoyment and for the aesthetic value afforded by the wetlands, lakes and ponds that occur where stream runs are impounded. There are over 100 impoundments within the watershed, large and small, that provide local residents with fishing and swimming opportunities, lawn irrigation water, pleasing vistas and interesting wildlife to observe. Among the larger impoundments in the watershed are Windsor Lake, Rockyford Lake, Spring Lake, Forest Lake, Lake Katherine, Cary Lake and Springwood Lake. Most of these impoundments are surrounded by residential homes whose owners enjoy significant property value advantages by virtue of the lakeside location. (Hall and Boyle 1994).

Many of the lakeside residents, as well as their friends and neighbors, do in fact use these lakes for fishing, swimming and boating throughout the summer. The Gills Creek Lakeside Residents Survey, conducted in the fall of 1994, revealed that lakeside families around 12 of the major lakes engaged in water sports related activities an average of 26 times per summer season. The highest average occurred at Windsor Lake where residents reported usage at 45 events per season (Appendix A). Even those who don't live along these lakes make use of the water resources. It is not unusual to see children from the surrounding



Summertime on Arcadia Woods Lake

neighborhoods swimming at dams and bridges. Many others can be seen fishing these same areas as well as other places along the creeks. Popular fishing spots in the watershed are located in front of the K-Mart on Jackson Blvd., and all along Beckham Swamp Rd. which parallels portions of lower Gills Creek below Bluff Rd. Although probably not as important as it has been in the past, some people in the watershed probably still use the Gills Creek fishery as a significant source of nutrition.

Of course the most heavily used waterbody in the Gills Creek Watershed is located in the middle of Sesquicentennial State Park. There, Jackson Creek is impounded to form Centennial Lake. The park offers the public a wide range of activities to enjoy

including supervised swimming during the summer months, rental paddle boats and ample areas for fishing. In addition, park staff occasionally offer to the public guided activities such as "Owl Prowls" and twilight canoe trips. The park is an extremely



The swimming area at Sesquicentennial State Park

valuable amenity for the entire region. In 1995 over 329,000 documented visits to the park were made. Of these, close to 7,000 paid to swim and over 2,800 involved fishing. Over 7,500 visitors were from out of state (SC DPRT 1996).

Centennial Lake itself is not the only water related amenity existing in the park. Jackson Creek and other small connecting creeks transect extensive wetland areas. These are

criss-crossed by well-worn nature trails and a jogging path. These zones of vegetated depression allow park users excellent opportunities to observe representative wildlife, and the lush, relatively cool riparian areas that intersect the jogging trail offer needed relief for the many joggers and bikers who use the area for more intense recreation.

Without a doubt, having a State Park the caliber of Sesquicentennial in the Columbia Metro area is a tremendous asset for the growing Midlands region. With aquatic resources being a central feature of the park, it is clear that preservation of water quality here should be a priority.

But recreation and amenity values are not the only aspects of the Gills Creek Watershed that are special. The greenspaces and shoreline vegetation supply much of the habitat for the fish, fowl and other fauna that inhabit our area. The rich diversity of wildlife in our region is, in no small part, dependent on the aquatic and riparian habitats that Gills Creek supports. The streams, lakes, wetlands and the associated forests and vegetation are integral parts of the local landscape. They provide familiar landmarks that all can identify, and they are an important part of what gives Columbia its character. The natural resources of the area are intertwined with the life experiences for all those who make their lives here. In essence, the Gills Creek Watershed is "home" to close to 125,000 individuals.

To a considerable degree, water resources in Gills Creek can be looked at as a quality of life issue for many in the watershed.



The present and future quality of life for Gills Creek Watershed residents is in no small part dependent on the health of the watershed both socially and environmentally. These two issues are to a certain degree intertwined. Achieving a healthy watershed will take a concerted effort by all residents and governmental bodies. It will require that we begin to take **The Watershed Approach**.

## **IV. NPS Pollution in the Gills Creek Watershed**

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### ***Runoff Pollution In the Urban Environment***

Urban runoff pollution has become a “hot” issue over the last decade and has been the focus of many environmental research projects. Probably the most widely referenced study, the National Urban Runoff Program (NURP) was coordinated by The U.S. EPA in the early 1980's. The program was a coordination of 28 different urban runoff studies conducted by a variety of organizations at various locations throughout the U.S.. Over 1900 storm events were sampled using standardized methods and analyzed collectively. Although there was a great deal of variability in the data, some generalizations could be made. Among these were:

1. Heavy metals were the most prevalent EPA priority pollutant found in urban runoff.
2. Organic pollutants such as pesticides and petroleum hydrocarbons were common but detected at generally lower effective concentrations than heavy metals.
3. Fecal coliform bacteria are present at high levels in urban runoff and are more highly concentrated in warm weather months.
4. Nutrients such as nitrogen and phosphorus are common but average concentrations were usually not of a magnitude that would indicate widespread water quality problems.
5. Oxygen demanding substances in urban storm water are of a magnitude similar to municipal wastewater discharges.

6. Sediments are significantly concentrated in urban stormwater and are likely to have other pollutants adsorbed.
7. There was a high degree of variability in pollutant levels from city to city and even between storms in the same city.

Of course each watershed has its unique characteristics and combinations of land uses, so urban pollution levels in any particular watershed will be unique as well (USEPA 1983b).

Because of nonpoint source pollution many urban waterways around the U.S. have already been forced to deal with the problem of urban runoff. In the early 1980's Birmingham, Alabama's Village Creek, beginning as a pristine spring fed stream, had at times become dark green, malodorous and practically devoid of animal life by the time it passed through the city. NPS pollution was cited as the primary culprit (Woodward Clyde 1989). The City of Milwaukee Wisconsin's Menomonee River has been impacted in urban sections to the extent that only pollution tolerant fish species are present. The aquatic insect population in these sections, an important indicator of water quality, are severely reduced in numbers and diversity. A public health related NPS threat occurred recently, also in Milwaukee, when upstream agricultural runoff was implicated in the 1993 drinking water contamination episode that exposed over 400,000 of the city's residents to the harmful *Cryptosporidium* microbe (Smith, 1994).

Adverse impacts from urban NPS pollution, both from the standpoint of ecological health as well as recreational impairment, have been documented all over the United States:

Anacostia River: Washington DC	Coyote Creek: San Jose, CA
Saddle River :Lodi, NJ	Kelsey Creek: WA
Town Lake: Austin, TX	Lake Worth:Fort Worth, TX
Westport River: MA	Malibu Creek:Los Angeles, CA
Chattahoochee River:Atlanta, GA	Dillon Reservoir: Denver, CO

It has been demonstrated that all aquatic ecosystems located in urban areas with significant impervious surface area will be impacted to some degree by urban runoff pollution. (Center For Watershed Protection 1994; US EPA 1992b; US EPA 1994).

The lakes and streams in the Gills Creek Watershed have been, and continue to be, impacted by urban runoff pollution. Similar to other growing metropolitan areas, the watershed routinely receives the full spectrum of NPS pollutants after each heavy rainfall. A variety of land uses occur throughout the watershed and each adds a characteristic load of pollutants. They all contribute to the NPS equation in the watershed.

The key to assessing the impact of nonpoint source pollution in a watershed is to simultaneously consider the value of the threatened water resource and the degree of actual or threatened impairment that NPS pollution poses in the watershed. It should be clear from the previous section that water quality is a valuable asset in the Richland County community both in tangible ways, such as recreation and property values, as well as intangible ways like aesthetic/wildlife values and community image.

## ***The Gills Creek NPS Assessment***

An assessment of NPS pollution in the Gills Creek watershed was accomplished using a combination of information sources:

**Fixed Monitoring Network:** DHEC acquires water quality data routinely from four stations in the watershed which are part of the statewide Fixed Monitoring Network (FMN). Primary stations are C-001 at Garners Ferry Rd., C-017 at Bluff Rd and C-068 at the Forest Lake Dam. A secondary station, C-48 is sampled at the Windsor Lake spillway. The primary stations are sampled once per month year round for a number of water quality parameters. Secondary stations are generally sampled May through October only. These data have been compiled over a number of years and have been used to determine long term water quality trends in the Gills Creek watershed. An analysis of trends in this data set is contained in DHEC's publication "Watershed Water Quality Management Strategy: Saluda-Edisto Basin"(SC DHEC 1995b).

**Special Gills Creek Monitoring Project:** A special water quality assessment was undertaken in the summer and fall of 1994 as an integral part of the overall Gills Creek



Electrofishing for tissue samples on Windsor Lake

Project. The objective of the program was to provide an assessment of the extent and sources of NPS pollution in the watershed and its current impact on general water quality, biological health and recreational uses. The project consisted of twice monthly water quality samples at 10 stations, one fish tissue sample from each of five area lakes, five sediment samples and an assessment of the stream

insect diversity in three areas of the watershed. The results of this intensive effort allowed for a more detailed appraisal of Gills Creek water resources (SCDHEC 1995d).

**Field Observations:** Direct observation has been an important source of information in the Gills Creek NPS assessment. Problem identification field surveys were performed both by program staff and citizen volunteers. Sometimes NPS problems only become apparent immediately after rainfall, so trips to the field were useful in indicating where sources of NPS were and where some of the more critically impacted areas in the watershed were.

Volunteers were instrumental in obtaining data on lake transparency. Throughout the 1994 and 1995 growing seasons, lake clarity data was taken at a number of lakes in the watershed with assistance from involved members of the community (see Appendix E).



**Scientific Knowledge:** There has been a considerable amount of research undertaken in the last two decades on the subject of nonpoint source pollution. As described earlier, the EPA project known as the Nationwide Urban Runoff Program (NURP) studied the combined results of 28 urban runoff sampling projects in cities around the country. Since Gills Creek is similar to many of the watersheds studied so intensively, it was reasonable to infer that, to some degree, these fundamentals apply to Gills Creek as well. Where there is limited hard data specific to Gills Creek, general scientific fundamentals have been used in the assessment of NPS pollution in Gills Creek.

**Uncertainty in the Assessment:** In the assessment that follows, it is acknowledged that no direct data for nonpoint source pollution exist for the Gills Creek Watershed. No actual samples of runoff were taken during this project, and the water quality samples that were taken were not necessarily associated with rain events. Also, due to funding constraints, there is very little data available on petroleum based hydrocarbons in Gills Creek waters. Of the data that does exist, no consideration of hydrological factors such as precipitation or runoff volume was taken in the analysis. However, since for most of the watershed there are no point sources, the link to nonpoint source pollution as the causal factor for water quality problems is implicit. It is also acknowledged that some NPS pollution derives from natural sources.

### ***NPS Pollutants In The Gills Creek Watershed***

Considering a number of factors related to water quality: public health threats, use impairment, public complaints/perceptions, ecological threats, and economic impacts, the following priority for pollutants in the watershed has been made based on the aggregate of actual or potential impacts on these factors:

#### **Priority:**

1. Fecal coliform bacteria (can indicate possible sewage contamination)
2. Litter/Solid Waste
3. Sediment
4. Heavy metals
5. Chemicals/Pesticides
6. Nutrients

#### **Fecal Coliform Bacteria:**

##### *Facts:*

- \* *State fecal coliform standards violated 59 times in Gills Creek Watershed between Jan. 1989 and Feb. 1995*
- \* *Standard violated 43% of the time at Bluff Rd and Garners Ferry sites, Summer 94.*
- \* *Sesquicentennial swimming area closed for a period in Summer of 1994*
- \* *Primary contact recreation not supported at and below Garners Ferry Rd. site.*

Fecal coliform bacteria are endemic to the digestive system of warm blooded animals, and measurements of them are used in water quality monitoring as indicators of possible human sewage contamination. Exposure to human sewage is a public health concern due to the associated pathogenic bacteria and viruses that it may contain. The data from DHEC's ongoing monitoring in the watershed have indicated that fecal coliform levels are frequently above the standards for FW (Fresh Water) classified waters at certain points on Gills Creek. Meeting the FW standard for fecal coliform implies that the water is safe for primary contact recreation, ie. swimming.

Excursions above the fecal coliform standard have been a chronic problem in the watershed, mostly in the lower portion at and below station C-001 where Garner's Ferry Rd. crosses over Gills Creek. Results from the more intensive sampling of 1994's water quality assessment of Gills Creek validated these observations. A high of 18,000 organisms per 100 milliliters was detected in a sample taken from C-017. The standard is 400 organisms per 100 milliliters. Although it is assumed that very little swimming occurs in the lower portions of Gills Creek, primary contact recreation is not supported at those locations due to these elevated fecal coliform concentrations. Upstream, the Sesquicentennial State Park swimming area was closed for a short period in 1994 due to elevated fecal coliform levels.

Possible sources of fecal coliform bacteria in the watershed include malfunctioning septic tanks, sewer line overflows, pet waste, and waste from natural wildlife. Lack of proper sewage management in the Arthurtown area of the watershed was cited in the Gills Creek special assessment as a probable cause for the traditionally high levels at the Bluff Rd. sampling stations. As of this report, the Arthurtown area has just come on line with the municipal sewer system. It is anticipated that this will have a positive impact on fecal coliform levels in the lower portion of Gills Creek. Ongoing monitoring at DHEC's permanent Bluff Rd. station will verify whether or not those infrastructure improvements result in improved water quality.

Sewer line leakage and overflows during heavy rains could also be contributing to fecal coliform problems. Involved members of the community did, in fact, report a number of instances where there were rain associated overflows of sewer line manholes.

Pet and wildlife waste could be contributing as well. In the residential areas of Gills Creek, pet ownership is prevalent and it is inevitable that some portion of their waste is entrained in stormwater. Owners should take steps to clean up after their pets when it is likely that the waste will be washed off directly into waterbodies and storm drains. Additionally, it has been demonstrated that fecal coliform bacteria are known to multiply naturally in sediments at the bottom of storm drains, especially in the summer months. Since bacteria are ubiquitous, some amount of fecal coliform bacteria in water is inevitable.

### **Litter/Solid Waste:**

#### *Facts: \_*

- \* *Litter was rated as the #1 threat to water quality by lakeside residents.*
- \* *Over 1600 articles of trash were removed from two lake areas as a part of 1994 Beach/River Sweep.*

- \* *12 intersections were found to have regularly heavy build ups of trash & litter.*

Trash and litter, as an NPS pollutant, is a pervasive problem throughout the watershed. As part of the NPS problem identification effort, project staff and citizen volunteers identified twenty-three commercial areas and sections of roadways that tended to have moderate to heavy trash buildups. Most of the big road intersections tended to have large buildups of trash and litter. A large portion of this material is eventually transported through storm drains to Gills Creek waterways.

Trash and litter is a very conspicuous problem throughout the watershed, but it's especially bad in area lakes. Few people realize that much of that trash they see along the road eventually gets washed into storm drains. The litter ends up concentrating in area lakes where most of the runoff is collected. In the Gills Creek Lakeside Survey, 76% of all lakeside residents reported that litter built up in their lakes after heavy rains. In four lakes over 90% observed this problem (Appendix A).

Local homeowners and school groups got involved in solving the problem during the Gills Creek Project. As a part of the national Beach/River Sweep, coordinated in S.C. by the Department of Natural Resources, trash and litter clean ups were conducted at Cary Lake, Little Lake Katherine, the Crowson Rd.

section of Gills Creek, and Greengate Lake. These efforts really only dealt with the symptoms of the litter problem, not the sources. The source of litter obvious to most everyone is that of trash thrown out of moving vehicles. However, an important source of litter has also been observed to stem from trash disposal problems at dumpsters located behind shopping centers, restaurants, and other businesses. The dumpsters are often located right on the banks of watershed streams. In the course of the project, Gills Creek staff and citizens frequently observed that many of the dumpsters were left open to wind and rain, occasionally brimming over with trash, and with trash laying on the ground around the dumpsters. More care needs to be taken in the location, handling, and maintenance of these dumpsters and the areas surrounding them.



Example of poor dumpster maintenance in the watershed

More care needs to be taken in the location, handling, and maintenance of these dumpsters and the areas surrounding them.

**Sediment/Turbidity:**

*Facts:*

- \* *Increased turbidity trends were observed at all four permanent stations in the watershed*
- \* *Construction site runoff near Springwood Lake caused temporary transparency decrease of 88%*
- \* *\$1,172, 944 was spent dredging out Southeastern Beltway construction sediments.*

\* *A TSS sample of 3000mg/l was taken from Gills Creek after a heavy rain on Ft. Jackson (Summer 1994).*

Nationwide, sediment runoff accounts for the largest contribution by volume of any NPS pollutant. Sediment pollution can be significant because of adverse impacts to aquatic life. Excess sediment can actually damage the gills of fish and cause reductions in populations by covering over spawning areas. Too much sediment can also affect the food chain by reducing the populations of bottom dwelling insects which are a critical part of the food chain in aquatic ecosystems. It can take years for a streambed community to recover after being silted in from construction runoff (Bowen and Manuel 1994).

The problem of sediment runoff has human implications as well. An habitually muddy, sediment-laden waterbody is less attractive to swimmers and detracts from the aesthetic beauty of the resource. While sedimentation of lakes is a natural process, accelerated filling results from man's activities. This can cause loss of recreational uses and reduces flood storage capacity.

Besides the aesthetic considerations, sediment runoff can have adverse economic impacts. This has certainly been the case in the Gills Creek watershed. Over one million dollars were spent to dredge sediment from Lake Katherine, The Rockyford Lakes and Forest Lake after the Southeastern Beltway was built.

Sediment and turbid water are a continuing problem in the watershed. Analysis of long term data trends in the multiple year set from DHEC's four monitoring stations in the watershed revealed increasing turbidity trends at both stations on Gills Creek as well as at Windsor and Forest Lakes.

Total Suspended Solids (TSS) were monitored as a part of the 1994 Gills Creek Assessment. By and large, these twice monthly samples were below the state mean TSS level of 13 mg/l. However, samples taken after large storm events were found to have much higher TSS levels. They were especially high at stations where there was construction or land clearing nearby. For example, one sample taken from Springwood Lake about 12 hours after a heavy rainfall had a TSS level of 800 mg/l, likely due to runoff from two nearby construction sites. This level reduced the transparency of the lake by 88%. A Gills Creek site on Fort Jackson had a TSS level of 3000 mg/l after a rain event. This site was just downstream from an area being cleared of forest cover. Although there is no regulatory standard for TSS, a level above 50 mg/l is considered high

Turbidity due to the erosion and scouring of stream banks has also been observed in many areas of the watershed after storms. This is a common problem in growing urban areas due to increases in impervious surface areas (rooftops, roads, parking lots etc.). This results in higher peak storm runoff flow rates through stream channels.



## **Heavy Metals:**

### *Facts:*

- \* *Zinc levels in the top 10% statewide have been found in Forest Lake and Gills Creek.*
- \* *Lead in water column and in sediment reported near Fort Jackson firing range.*
- \* *Elevated copper levels detected in fish samples taken from Gills Creek.*
- \* *Due to mercury bioaccumulation, fish consumption advisories issued for four watershed lakes.*

Metal pollutants such as copper, zinc and cadmium have been shown to be frequent components of urban runoff. Other metals such as lead, mercury, chromium and selenium can also be found. Metals in runoff come from a variety of sources such as worn automobile components, galvanized metal from construction materials like guard rails, and roof guttering, as well as other sources related to industrial and commercial land use.

The data available from Gills Creek waters appear to indicate some metal contamination. Zinc and copper, two of the more common urban runoff pollutants, are naturally elevated in South Carolina waters. However available data indicate that, at least for zinc, concentrations in Gills Creek waters are significantly high even for S.C.. Concentrations of zinc are elevated at all three stations in the watershed where zinc is routinely monitored. Zinc does not represent any significant health threat to people but has the potential for affecting some important forms of aquatic life (Horner and Skupien 1994).

Instances of elevated lead levels were found in some water and sediment samples. These occurred in the upper reaches of Gills Creek on the Fort Jackson Military Reservation, and it is probable that the observed lead is derived from the military firing ranges nearby. Preliminary sampling has determined that no detectable levels of lead are leaving the military reserve. The problem is under further investigation by the Department.

In the Gills Creek monitoring effort, significant amounts of mercury were found to be present in fish tissue samples. As a result, fish consumption advisories were issued for fish caught in Centennial, Springwood, Cary, and Windsor Lakes (Appendix C). Mercury was not found in detectable quantities in the water but accumulations in fish tissue have occurred over time as mercury has built up in the food chain. The source of the mercury has not been determined exactly, but it is not perceived to be a result of the type of conventional land use related runoff pollution that is being considered in the Gills Creek Project. It has been theorized that the mercury perhaps derives from atmospheric deposition and/or from natural erosive processes. The problem has been encountered in many other areas of S.C. and the U.S. The problem is not unique to the Gills Creek Watershed.

## **Organic chemicals and pesticides:**

### *Facts:*

- \* *Ground water contamination has been detected at three sites near Gills Creek waterways.*
- \* *Pesticide residues have been detected in Gills Creek sediments.*
- \* *Trace amounts of thirteen pesticides have been detected in Gills Creek waters.*
- \* *Automobile and industrial derived chemicals have been detected in Gills Creek sediments.*

Urban runoff can contain a diverse array of petroleum hydrocarbons. The origin of these compounds can, to a large degree, be traced to the extensive use in modern society of manufactured organic chemicals. Pervasive use of automobiles results in hydrocarbon deposition over the land surface due to the settling of incomplete combustion products and the leaking of lubricants and other fluids onto roadways and parking lots. Furthermore, runoff from a variety of other land uses such as gas stations, junkyards, truck depots, industrial sites and waste dumps have the potential to become "hot spots" of organic chemical runoff.

In the limited organic chemicals data available for Gills Creek there have been sporadic detections of important chemical pollutants, mostly in sediment samples. Water samples taken annually at the Forest Lake and Bluff Road stations have not indicated the presence of any toxic organics over the last three years. However, a DHEC study in 1991 revealed evidence of organic chemical pollution from an area just upstream of two South Beltline industrial facilities. The area still receives a considerable amount of industrial landuse drainage from other sources upstream sources.

Two pesticides, DDT and Chlordane, have been detected in sediment samples at the Bluff Road station . Both of these chemicals have been banned for use for a number of years. Due to their long half lives, these are probably indicators of past inputs rather than ongoing pollution.

A recent preliminary finding from an ongoing USGS study has shown that trace amounts of a variety of commonly used pesticides can be found throughout the Gills Creek Watershed. Their initial sampling of 16 stations within the watershed revealed that a variety of pesticide residues can be found in watershed waters. Thirteen of the sampling stations had seven or more pesticide/herbicide detections. Interestingly, the stations on the undeveloped area of Fort Jackson and the station below Sesquicentennial State Park had the fewest detections (from 0 to five) (Sickerman 1997). This observation seems to reinforce the intuitive correlation between the degree of urbanization and the degree of NPS pollution. These levels and types of pesticide detection have been observed in other urban runoff studies around the country. The concentrations of these pesticides are quite low (less than one part per billion) and their potential for aquatic toxicity at these concentrations is uncertain. Even so, their widespread incidence in the watershed may be significant.

Some inputs of organic chemicals have resulted in groundwater contamination. An inactive industrial site in the Richland Northeast area sits above groundwater contaminated with trichloroethylene, a common industrial solvent. It has been determined that some of the chemical has seeped into a small tributary to Jackson Creek. A remediation project is on line there to remove contaminants from the stream water. In the industrialized area just above Shop Rd., two manufacturing sites on the banks of Gills Creek have been identified as having contaminated ground water as well.

Surface water samples from Gills Creek in the 1994 monitoring program did not indicate any detectable amounts of organic contaminants in both upstream and downstream locations. However, relatively little organic chemicals data have been collected in the watershed. From what is known of urban runoff pollution though, low levels of numerous organic chemicals are commonly present in urban runoff. Generally they do not become concentrated enough in the receiving water to be acutely toxic to aquatic organisms nor do they tend to build up to concentrations harmful to human health (USEPA 1981). Accidental spills and long term, chronic effects to aquatic invertebrate and fish species populations are probably the greatest threats.

### **Nutrients:**

*Facts:*

*\*1994 phosphorus levels above EPA reference levels at five of twelve sites*

*\*Phosphorus levels in Gills Creek waters are generally below the state 50th percentile.*

Excessive nutrients, such as phosphorus and nitrogen compounds, can cause water quality problems when they reach levels high enough to promote excessive aquatic plant growth and/or nuisance algae blooms. These eutrophic conditions can result in nuisance weeds, noxious smells and, when decaying plant material causes oxygen depletion, fish kills.

Sources of excess nutrients in runoff can originate from agricultural activities, residential lawn fertilizers, golf course maintenance, sewer line leaks and land clearing activities.

Excess nutrients do not appear to be an urgent problem in the Gills Creek watershed. In fact, DHEC's long term data indicate that improving trends in total phosphorus and total nitrogen are occurring in the watershed.

The 1994 Gills Creek monitoring study did find, however, that total phosphorus levels were above levels suggested by EPA for two lake stations and three stream stations. Excessive lake weed growth was evident in two area lakes which may indicate abundant nutrient levels. Although acute nutrient impacts such as nuisance algal blooms or fish kills are not common in Gills Creek, experiences elsewhere suggest that the potential exists for future problems. Given the significant value of lakeside property in the area, phosphorus levels should be limited to the greatest extent practicable.

### ***Ramifications of NPS Pollution***

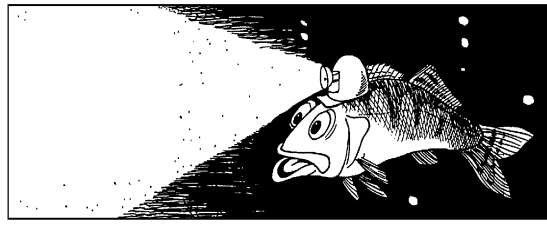
Adverse impacts from nonpoint source pollution are being absorbed in both the natural environment and the local human community.

Biological sampling conducted as a component of the Gills Creek Project indicated that the creek near Bluff Rd. and a fairly urbanized stretch of Fort Jackson are rated only fair based on aquatic insect populations. The station where Jackson Creek goes under Alpine Road below Sesquicentennial State Park was rated as good. Biological samples, taken in the 1989 DHEC special study of the industrialized section of Gills Creek (Shop Rd. to Bluff Rd. area), also showed significantly impaired aquatic insect communities there. Adverse impacts from land use related nonpoint source

pollution and associated habitat alterations are known to be causes of these kinds of macroinvertebrate population impairment. Macroinvertebrates are an important component of the aquatic food chain. Possible causes in the Gills Creek watershed are: loss of habitat variety due to sedimentation, channelization of the streambed, physical displacement due to high velocity stream flows, removal of stream side forest canopy, higher than normal zinc levels and chronic toxicity due to exposure to mildly contaminated sediments.

No scientifically evaluated fisheries data exists but responses by fishermen in the Lakeside Residents Survey indicated that 51% felt that fishing success had become worse in the past five years. A cursory examination of raw fisheries data collected by the Department of Natural Resources seems to indicate that a reasonable diversity of fish species exists throughout the watershed.

Adverse impacts on lake transparency have been observed in the watershed. Lake transparency is an important parameter in a natural lake system. Chronically opaque conditions can impact both plant and animal species diversity by suppressing the growth of submerged aquatic vegetation, hindering predator fish from seeing their prey, and increasing the capacity of the water to retain heat. Volunteer clarity data have indicated that some of the lower lakes, Lake Katherine and Forest Lake, seem to have lower average clarity than upper lakes like Windsor Lake and Centennial Lake. Observations in the Gills Creek watershed suggest that the primary reason for decreased lake transparency is probably due to silt and sediment runoff from the continuous and widespread construction activities in the area. Field observations during 1994 rain events indicated that construction site runoff was indeed impacting the transparency of a number of lakes in the watershed.



Besides physical and biological effects, NPS pollution has also had adverse impacts on the recreational and aesthetic value of Gills Creek waterbodies. Recreational uses have been impacted directly from observed NPS pollutants such as litter and indirectly due to perceptions of contamination from toxic chemicals and the fear of fecal contamination. Centennial Lake at Sesqui State Park was, in fact, closed to swimmers for part of 1994 due to elevated levels of fecal coliform indicator bacteria. The frequent episodes of turbid conditions in area lakes make swimming less desirable. Only 26% of surveyed lakeside residents reported that they or their immediate family had used their lake for swimming during the past summer. Indirect impacts occur due to perceptions related to NPS pollution. Many lakeside residents, aware of the nature of urban stormwater pollution, limit their recreational uses of the waterbody, especially after thunderstorms.

Throughout 1994 and 1995, recreational uses were interrupted alternately in Lake Katherine, Rockyford Lake and Forest Lake due to the dredging activities required for removal of sediments flushed into the lake during the Southeastern Beltway construction. Sedimentation has also resulted in increased shallow areas in some lakes limiting boating



activities. In Springwood lake, decreased lake depth has resulted in a significant portion of the lake being covered with emergent lake weeds.

The increasing percentage of impervious surfaces in the watershed has resulted in water quantity problems in the watershed. The increased acreage of roads, parking lots and rooftops allows larger volumes of runoff to reach waterways after rain events. The result has been higher and quicker peak flow rates with subsequent flash flooding events and stream bank erosion. Since the beginning of the project, there have been reports by citizen participants that flood events have increased in certain areas of the watershed. Some of the problems associated with this flooding have been property damage, stream bank erosion and sewer line overflows.

The impact that NPS pollution has on other assets valued by the local community can be considerable. In the Gills Creek Lakeside Resident's Survey, the attribute that was most highly valued among the residents was "View/Aesthetics." This attribute is affected adversely by litter accumulation, sedimentation and habitat alteration related to urban growth, all of which are occurring in this watershed. "Property values", the second most valued lake attribute, can also be impacted negatively by NPS pollution and is, of course, related to adverse impacts on aesthetic values. A real estate study conducted in Maine pointed out that significant property value depressions were experienced in property located on NPS impacted lakes compared to that surrounding similar but unimpacted lakes (Hall and Boyle 1994). While no such study has been done in the Gills Creek Watershed, it is probable that the potential is there for NPS pollution to have such an impact on the marketability of lakeshore property here as well.

"Wildlife" was the third highest rated attribute valued by lakeside residents. In a growing urban watershed, one of the primary threats to wildlife is the loss of habitat. The loss of streamside forest strips results in less habitat for many of the water birds and other animals valued by so many. These streamside forest areas also function as NPS filters, so preservation is advantageous from both perspectives.

*"Siltin in has caused such shallow water that a boat is not able to navigate in many places where it used to at the head of the lake".*

Lake Katherine Resident



## ***Conclusions***

The waterbodies within the Gills Creek watershed currently exhibit a significant degree of water quality impairment. Similar to other growing metropolitan areas, the lakes and streams of the region routinely receive the full spectrum of NPS pollutants after each heavy rainfall. Water quality is more severely impacted in the lower half of the watershed below Garners Ferry Rd., down to and below the Bluff Rd. site. This is mostly due to chronically high fecal coliform levels and general NPS pollution as evidenced by the impacted biological communities. The upper portion of the watershed, which includes Centennial Lake and the other residential lakes, still has generally good water quality. However, some impairment does occur due primarily to sedimentation and the



The paddle boats at Sesquicentennial State Park

aesthetically objectionable aspect of litter. This impairment is generally transitory in nature, being related to storm events. Evidence does exist, however, that urban runoff is capable of causing chronic excursions from water quality norms throughout the watershed as seen in the higher than normal levels of zinc, a common urban runoff contaminant.

Of concern also are nonpoint source impacts downstream of the Gills Creek Watershed. Congaree River sediment samples taken as a part of DHEC's monitoring program at sites above the Congaree National Monument have been found to contain a number of organic PAH's (Polycyclic Aromatic Hydrocarbons). These are most likely attributable to upstream nonpoint sources(SC DHEC 1995b). While the effects of these small amounts of PAH's are not entirely clear, and there are no State regulatory standards for this class of chemicals, potential impacts to this outstanding natural resource should be of concern to Midlands residents.

The available data, in combination with visual observations made throughout the project, indicate a moderately impacted though threatened watershed. As such, an ideal opportunity exists for local governments, businesses, and individual homeowners to take measures that support a **preventative approach** to the protection of the valuable water related assets that the Gills Creek Watershed has to offer.

In most sections, Gills Creek supports a reasonably healthy aquatic system. However, evidence exists of significant present NPS impacts and, given the experiences of other cities, the potential exists for more acute problems. With the accelerating urbanization of the watershed, water quality in any portion of Gills Creek can not be taken for granted.

## V. Existing NPS Control Efforts

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There are a number of ongoing programs and activities targeted towards nonpoint source pollution control in the watershed. A few of these are administered through state, federal or local government agencies. Others are undertaken independently.

### *Regulations*

One of the 1987 amendments to the Federal Clean Water Act required EPA to develop regulations specifically aimed at controlling stormwater discharges. In "Phase I", these regulations were to be applied to municipal storm sewer systems in larger cities (100,000 + population), to stormwater discharges associated with certain specified industrial activities and to larger construction sites (greater than five acres). Similar to the permits that are used to regulate pollution from **point source** dischargers, these "stormwater permits" are a part of the National Pollutant Discharge Elimination System (NPDES). These permits require that the originator propose and implement a **Stormwater Pollution Prevention Plan** (SWP3). These SWP3's can be fairly simple in the case of a small industrial facility or extremely elaborate for a unit of government such as a county.

In South Carolina, DHEC's Bureau of Water is charged with administering the Stormwater NPDES program. Since the beginning of the Gills Creek Project, over twenty-seven industrial facilities and fifty-seven eligible construction projects in the Gills Creek Watershed have been reviewed and permitted by DHEC staff.

Only two municipalities in South Carolina qualified for Municipal Stormwater NPDES permits, those being Greenville and Richland Counties. Both municipalities have submitted permit applications which are now under review by DHEC's Industrial, Agricultural and Stormwater Permitting Division. The approval and implementation of Richland County's Municipal Stormwater NPDES permit should greatly enhance the ability to control NPS pollution in the Gills Creek watershed.

DHEC has regulatory authority under the State's stormwater control legislation known as The South Carolina Stormwater Management and Sediment Reduction Act . These regulations require that a sediment and soil erosion control plan be submitted to DHEC for approval for any land disturbing activities of two or more acres. General requirements for these permits include a minimum standard for both quality and quantity of runoff. The regulations state that during construction, 80 percent of sediment must be retained on site. Post construction runoff quantities are limited to "predevelopment" levels. Various stormwater management measures are used to achieve this, most commonly stormwater detention/retention ponds. Since regulations were promulgated, over 285 permits have been granted for eligible construction sites in Richland County.

DHEC also undertakes NPS control action through the operation of its Central Midlands Environmental Quality Control (EQC) District Office located at State Park on Farrow Rd. In response to complaints from local citizens, District personnel are frequently called upon to investigate problems involving sewage overflows, illegal connections to storm drains, hazardous waste spills, sediment and erosion control

violations, illegal dumping and many other environmental problems. In 1996, a full time position was added to District staff to concentrate efforts specifically towards NPS related complaints. When pollution origins are determined, corrective actions are taken and, if necessary, enforcement procedures initiated. Since the Gills Creek Project started, the DHEC Bureau Water's Water Pollution Enforcement Section has pursued five significant NPS related violations in the county resulting in \$43,660 in fines. Another action, initiated prior to the Gills Creek Project, compelled one Gills Creek area manufacturer to install a \$250,000 stormwater pre-treatment system at their facility. These enforcement actions are authorized by a number of environmental laws that NPS pollution can violate. Among these are the above described Federal Clean Water Act, the State Sediment and Erosion Control Act, the S.C. Pollution Control Act, and laws dealing with solid and hazardous waste wastes.

Richland County also administers some programs that relate to NPS control. The county has long administered their own storm drainage and soil erosion control ordinances. The County has recently been delegated the S.C. Stormwater and Erosion Control permitting authority by DHEC.

NPS control activities have been aggressively pursued on Fort Jackson. In compliance with stormwater NPDES requirements, Fort Jackson received an NPDES stormwater permit from DHEC in December 1995. Subsequently, they have implemented a comprehensive Stormwater Pollution Prevention Plan containing a number of site specific BMP recommendations, personnel training procedures and a public education program. An erosion control program has been instituted on base for construction sites and firing range areas (Fort Jackson Training Center 1993). A 1992 inventory of the post by the United States Department of Agriculture (USDA), in conjunction with Fort personnel, identified 87 sites where significant erosion was occurring. Since that time, close to one third of those sites (those with the highest priority) have been stabilized. Anti-litter campaigns have also been a part of the Fort's NPS control activities. Fort Jackson's well executed conservation measures have recently been recognized. The Fort has been named as one of the three outstanding South Carolina Stewardship Developments for 1996 in a conservation recognition program sponsored by the S.C. Department of Natural Resources.

### ***Volunteer:***

Volunteers in the watershed are making a difference undertaking efforts to "Turn the Tide" on NPS pollution in their communities. As part of the Gills Creek Project, citizen volunteers became involved on a number of citizen's advisory committees. Among these were the Education Committee, the Monitoring Committee, and the Database Committee. Citizen participators undertook a number of activities supporting the project including identification of NPS problem sites, lake clarity monitoring and public education. A promotional Gills Creek Project poster, produced through the Education Committee with art work supplied by a Heathwood Hall student (Adair Stevenson), won a state advertising award.

The annual Beach/River Sweep, which occurs nationwide each September, has had considerable involvement from Gills Creek residents. Since the project began, litter clean ups have taken place at a shoreline section of Cary Lake, the Crowson Rd. section

of Gills Creek near Forest Dr., on Greengate Lake and twice on Little Lake Katherine. Homeowners associations, particularly those around some of the lakes, are becoming active in informing their memberships about NPS pollution and are "watch dogging" their watersheds for activities that adversely impact water quality. Many in the watershed have called in NPS related complaints to DHEC's EQC District Office for investigation.

A DHEC administered program known as S.C. Water Watch is now underway and is designed to facilitate volunteer stewardship of the State's waterways. One group of Gills Creek area participants, a class at Cardinal Newman Middle School has begun a project to stencil storm drains in the Forest Acres area with a "Do Not Dump, Drains To Creek!" message. This is an excellent way of educating the public about the connection between stormwater and water quality. It is hoped that other groups in the watershed who want to take action towards preserving and restoring Gills Creek will become involved in the Water Watch program.

### ***Education:***

Public education activities are currently underway in the watershed. Recognizing that everyone is a contributor to NPS pollution and can thus have an impact on its solution, DHEC has applied considerable resources toward education in the Gills Creek Watershed. Various educational materials are sent out periodically that contain facts about NPS pollution and guidance for homeowners on what they can do to help mitigate the problem. A collaborative effort between DHEC, Union Camp Inc., DuPont and WIS TV known as "Champions of the Environment" has produced a series of short NPS related educational television spots. These are aired regularly to a considerable audience in and around the Gills Creek watershed. Through the program, students who undertake notable, environmentally-related projects are recognized. Those projects that are deemed outstanding receive scholarship awards. A number of students and classes attending schools in the Gills Creek watershed have been named "Champions of the Environment." Watershed schools to win this award have been Spring Valley High School, Brennan Elementary, Hammond Academy and Richland Northeast High School.

The Clemson Extension Service is very much involved in NPS education and has been a key partner in the Gills Creek Project from the beginning. They have devoted a significant portion of the Sandhills Research Station as a site for the demonstration of a number of practical, environmentally-friendly methods for home and garden maintenance. The area, known as the Sandhills Urban Conservation Center, includes actual working examples of these methods including composting techniques, integrated pest management, recycling and xeriscaping. As a component of the Gills Creek Project, Extension personnel used the center for a number of seminars designed for target groups likely to have an influence on NPS pollution in the watershed. A total of six seminars were conducted during the project . Among the target audiences were construction contractors, real estate developers, natural resource agency personnel, and homeowners. In April 1996, the center served as a site for the Northeast Sparkleberry Festival at which over 1,500 were in attendance. A future project to take place at the center involves the design and construction of a “Conservation Station.” This will be a permanent environmental training venue located in a natural setting. It will be available for school, civic, and other organizations to use in learning activities.



Storm Drain Stenciling

## **VI. Tackling The NPS Problem in Gills Creek**

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### ***Best Management Practices***

In the parlance of water pollution control, the available measures used to control water pollution are known as **Best Management Practices**, BMP's for short. These BMP's can be of the structural/engineered type, vegetative or institutional in nature.



Stormwater detention basin serving the Forest Dr. Wal Mart complex

Structural BMP's frequently employed include wet and dry stormwater detention ponds, construction site silt fencing, stormwater infiltration trenches and prefabricated stormwater inlet structures which separate a portion of NPS pollutants from the stormwater flow. Vegetative measures include grassed swales, stream side forest buffers and stormwater wetlands. Institutional BMP's are typically those that involve the employment of a watershed-wide, jurisdictional strategy, usually enacted by some governing or regulatory authority (eg. municipal government, state water pollution control agency). Examples of institutional BMP's would include zoning ordinances, changes in development codes, the allocation of resources for a street sweeping program, targeted educational programs or perhaps some tax incentive offered to encourage structural BMP's. The body of regulations promulgated under The State Sediment and Erosion Control Act is an example of an institutional BMP. See Appendix D for further information on the types of BMP's available for NPS control.

### ***Recommendations for the Gills Creek Watershed***

In the recommendations that follow, most are applicable to the entire watershed. However, where resource constraints exist, specific measures can be targeted towards areas of the watershed that have a particularly acute NPS problem or where resource values are more highly prized. Following the recommendations section is a table that divides the watershed into four subwatersheds. Ideally, an action plan would include some measures implemented on a watershed basis and others targeted to relieve NPS problems at the subwatershed level.

Many of the NPS control measures recommended here also provide benefits in the way of flood control, community beautification and enhanced property values. These aspects should enhance the attractiveness of any plan that decision makers may choose to sanction and could make implementation of the recommendations and any resource allocations required more acceptable to the general public.

**1. Improve Litter Control : An aggressive litter remediation, prevention, and control program should be undertaken by all stakeholders in the Gills Creek Watershed.**

**The program should include at a minimum:**

- *Increased commitments to monitor and enforce existing litter and solid waste ordinances.*
- *Removal where possible of dumpsters from close proximity to the banks of Gills Creek and its tributaries*
- *Regularly scheduled use of work crews to clean up litter at critical roadside areas.*
- *More widespread participation in the National Beach/River Sweep.*
- *Increased Involvement of waste hauling companies in maintenance of dumpster areas and controlling blow off from trash trucks.*
- *Involvement of retail establishments and shopping center owners and/or management companies in upgraded management of their waste disposal/loading dock areas.*
- *Controlling litter by workers at construction sites*  
(The national Keep America Beautiful Program has initiated a “Build America Beautiful” educational campaign to support this purpose).
- *A locally oriented mass media anti-litter campaign.*

Other measures to be considered might include, possible purchase of street sweeping equipment for use at intersections and the installation and maintenance of litter exclusion screens at critical drain inlets.

**2. Minimize the amount of impervious surface in the watershed:** It has been well established that the ecological health of streams in urban areas is highly correlated with the percentage of impervious surfaces in the surrounding watershed (The Center For Watershed Protection 1994b). This proportionality also applies to quantity issues such as peak stream flow rate, time to peak flow rate, dry weather flow, etc. Prevention is the best way to control NPS impacts in the Gills Creek watershed!



**Therefore, measures should be taken in the watershed to prevent, to the greatest extent possible, increases in impervious surfaces in the watershed. Such measures may include:**

- *Downzoning of current land use zoning , to reduce the acreage of higher impervious surface land uses.* This may require a new zoning class for application at critical areas.
- *Modify current development codes and subdivision regulations to require preservation of a certain percentage of the original vegetation and pervious surface for new developments.* A critical area to implement such measures is the O'neil Court/Trenholm Road Extension area due to already extensive impervious surroundings.
- *Modify any provisions in current zoning/development codes that mandate practices which increase impervious surfaces and excessive runoff.* eg. minimum parking lot ratios, pavement requirements, curb and gutter requirements, prohibitions on mixed use development, two sided sidewalks.
- *Provide incentives to encourage preservation of pervious areas, and the use of preventative stormwater management measures in developing acreage.*  
eg. lower tax rates, technical advice, waiver of permit fees/requirements, contractor certification and recognition programs.
- *Acquisition programs to conserve natural areas in the urban environment.* eg. greenway development, expand city and county park system, conservation easements.
- *Reclamation of unused impervious areas of the watershed.* eg. retrofitting or ecologically restoring abandoned or decaying parking lots, industrial sites and commercial areas (make use of incentives above to encourage).

**3. Bring about the formation of a citizens watershed advocacy organization: Since NPS pollution is linked so closely to land use and individual practices there is a need for a locally focused watershed organization to provide for organized long term advocacy of water quality in the area.**

Currently there are no grassroots environmental organizations in the Columbia area with a strictly local emphasis. Any organization formed to promote water quality in the Gills Creek watershed should be inclusive of major stakeholders and not be dependent on local or state government for its functioning. The organization should be formal to the extent that it could qualify for public and private grants.

Watershed organization such as the proposed have been formed all over the United States and there are a number of nationwide networks of such organizations to which a newly forming group could turn to for advice and support (Issac Walton League 1994; Coalition To Restore Urban Waterways 1995).

Although indirectly, attempts have been made in the Gills Creek Project to foster the formation of a watershed advocacy group for Gills Creek. As of the printing of this

document none has formed. There are many interested individuals in the watershed though, and some have been very active in the watershed, accomplishing a great deal. It is anticipated that through other activities of the State's NPS program or perhaps as a result of this set of recommendations, a Gills Creek Watershed or Greater Midlands water quality advocacy group will become a reality.

**4. Develop a comprehensive watershed management action plan: Local and state governments should coordinate their stormwater control and water quality programs in the Gills Creek Watershed within the framework of a comprehensive watershed wide action plan.**

In the development history of much of the watershed, there has been little consideration as to how activities in one area of the watershed will impact areas downstream. And even now, except for sediment and soil erosion control, there seems to be little coordinated action for controlling NPS water pollution. A commitment to a coordinated strategy is needed to facilitate comprehensive NPS pollution control as well as to prevent a proliferation in the water quantity problems that this growing urban area is now facing.

A framework has been promulgated for such an action plan in the South Carolina Stormwater Management and Sediment Reduction Regulations Part 72-309. This regulation outlines criteria for making certain watersheds in the state with special stormwater related needs or problems, **Designated Watersheds**. These watersheds are designated through a process involving local government sponsorship, public participation, and detailed study of the needs and specific measures needed to alleviate specific stormwater problems. A designated watershed program makes possible a coordinated permitting and BMP implementation process that takes into account the entire hydrologic regime of the watershed. The goals for implementing the designated watershed program are: 1. reduction of existing flooding or water quality impacts, 2. prevention of future flooding or water quality impacts, and 3. minimization of economic and social losses. A significant portion of the work required for gaining designated status for the Gills Creek Watershed has been accomplished through activities of the Gills Creek Project. It is recommended that area local governments initiate the process for making the Gills Creek Watershed a designated watershed.

The formation of a whole watershed NPS control strategy is very complex and involves a multitude of factors ranging from land use patterns to local climate variations. If a watershed wide control strategy is formulated and employed, it will require a considerable degree of cooperation among the various governmental jurisdictions.

In order to facilitate this cooperation, an inter-jurisdictional coordination committee should be formed with members inclusive of **all** major jurisdictions in the area: Richland County, City of Columbia, Fort Jackson, State of South Carolina, Forest Acres and Arcadia Lakes. The mission of this committee should be to coordinate the design and, with stakeholder comment, implementation of the action plan over the long term. Meetings should be regularly scheduled. Members might include public works directors, planners, regulatory administrators, and parks and recreation personnel. Membership should be delegated from the manager level with sanctioning from governing bodies, eg. boards or councils. Resolutions should be passed by each

jurisdiction's governing body recognizing the value of NPS pollution control and committing to a cooperative effort.

**5. Make use of the recommendations contained in Richland County's Municipal Stormwater NPDES Permit application: As part of the Federal Municipal Stormwater NPDES application process, Richland County has already proposed a comprehensive NPS management program meant to satisfy permit requirements.**

In developing the permit application, the county acquired and organized a great deal of information and data pertaining to stormwater and NPS pollution in all of the watersheds within the county including that of Gills Creek.

The proposed management program detailed in the permit application includes plans for dealing with most of the important issues in urban stormwater management such as identification of critical areas, NPS identification, assessment and application of BMP's, evaluation of regulatory effectiveness, illicit connections to storm drains, accidental spills and public education on NPS pollution. A budget and potential financing mechanisms are proffered in the application.

Richland County's permit is currently under review, and a detailed permit is to be written by DHEC's Stormwater and Agricultural Permitting Section. Utilizing the experience gained from other cities around the country, many of which have been working under Municipal NPDES Stormwater Permits for years, an ideal opportunity exists for area government to develop an efficient, state of the art NPS water pollution control strategy for the Columbia Metro community.

Since NPS pollution does not restrict itself to political boundaries, all jurisdictions should participate in the implementation of this plan. Memorandums of agreement should be entered into among the involved jurisdictions to ensure long term cooperation. The above mentioned **inter-jurisdictional committee** could provide an excellent forum for this cooperative effort.

**6. Increase the effectiveness of erosion control ordinances: Measures should be taken by both local and state permitting authorities to ensure full implementation of current erosion control laws and ordinances.**

Considering the accelerating rate of development in the watershed and its associated land disturbing activities, it is imperative that adverse impacts from soil erosion be minimized. Both Richland County and the State have existing rules and regulations aimed at control of stormwater from new construction and both have enforcement authority for compliance. Most of the oversight of these permit programs occurs prior to site development through analysis of stormwater management plans submitted by the applicant.

However, field surveys by Gills Creek project staff and observations by citizens involved in the project have shown that erosion control measures at construction sites throughout the watershed frequently fail during rain events. It is not unusual to visit a site in the watershed and find silt fencing in disrepair and clear evidence of off site sediment runoff. Often, these problem areas are not permanently repaired. While

DHEC's Pollution Source Compliance Section and Central Midlands Environmental Quality Control District provide for inspection of permitted sites, there are so many sites developing simultaneously that it is not possible to inspect sites with enough frequency to ensure universal compliance.

The most cost effective remedy to this situation would be to strictly enforce the provision of the stormwater permit that requires permittee **self inspection**. The regulations state that “qualified personnel (provided by the discharger) shall inspect disturbed areas of the construction site and areas used for storage of materials that are exposed to precipitation that have not been finally stabilized, structural control measures and locations where vehicles enter or exit the site at least once every seven calendar days and within 24 hours of the end of a storm that is 0.5 inches or greater" (SCDHEC 1995a). Strict adherence to this self inspection requirement would ensure the ongoing functionality of the erosion control measures originally installed on the construction site and more fully justify the expenses taken in their installation.

Given the number of land disturbing activities taking place simultaneously in the watershed, combined impacts from soil erosion can be severe. In dealing with contraventions of stormwater and sediment and erosion control regulations, permit administrators should consider the penalty option to motivate compliance in the regulated community.

*Other measures:*

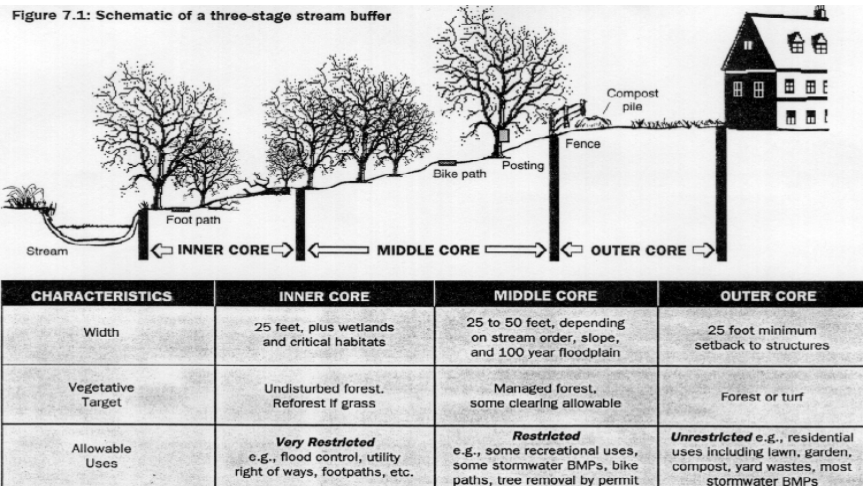
- *Establish ordinance/disincentive to limit the pre-clearing of lots without imminent plan for site development.*
- *Require phased clearing of out parcels to minimize disturbed area.*
- *Incorporate buffer requirements into zoning ordinances to protect critical areas.*

7. **Preserve riparian buffer zone:** The forested area along stream banks and lake shorelines are extremely important to the overall health of the waterbody they border. Besides providing organic leaf litter and temperature regulating shade, both important to fish and other aquatic life, these riparian areas perform the function of filtering significant amounts of NPS pollution from runoff (USEPA 1993).

**Efforts should be made to preserve forested areas along Gills Creek and its tributaries and, wherever achievable, restore degraded areas.**

*Measures might include:*

- *State or local watershed-based ordinance establishing a riparian buffer zone.* Guidelines are available to serve as a model (Schuler T. 1994).



Example of a stream side buffer zone (From Shueler T.R. 1994)

- *Restore deforested and/or eroding stream bank areas.* This is an activity taking place in many areas of the country, sometimes aided by the use of volunteers such as school children, Scouts, and prison crews using donated materials. A number of detailed guidelines and manuals exist for these types of projects. (Tennessee Division of Water Pollution Control 1994, Issac Walton League 1994).
- *Obtain conservation easements on undeveloped stream-side forest areas.* This could be accomplished as an expansion of the City of Columbia’s **Gills Creek Greenway** presently under development in the area between Garner’s Ferry Rd. and Bluff Rd.



Upstream view: Gills Creek at S. Kilbourne Rd.

- *Create overlay zoning category that restricts the land uses along stream side property to those uses less destructive to the riparian buffer.*

**8. Promote NPS protection habits by individuals throughout the watershed:** Since NPS depends so much on individual actions, public education is essential for water pollution prevention in the urban watershed.

**Extensive educational outreach efforts should be continued, targeted at both the general public, as well as at certain special groups who require more specific information and guidance.**

- *General public education on the issue of NPS should be continued in the watershed using various methods including mailouts, news releases as well as electronic media, eg. TV/Radio/Internet.*

DHEC, The Richland County Soil Conservation Service, Clemson Extension Service, Fort Jackson and groups like Keep America Beautiful and the local chapter of the Sierra Club have been active locally in getting the word out on NPS pollution. The State newspaper has demonstrated a strong commitment to covering the issue by publishing a number of feature articles on the subject. Continuation of such efforts is encouraged. Involvement by local governments, perhaps through messages on their billing mailouts or through activities of their environmental, health, and/or parks and recreation departments would greatly enhance the scope of these outreach efforts.

- *Special efforts should be made to educate and "sell" the following target groups on the need for reducing their contributions to NPS pollution:*
  - \* Auto Shop/Gas Station owners/workers (wash off of metals and automotive fluids)
  - \* Waste hauling managers and workers (trash and litter management)
  - \* Land clearing and construction contractors and their employees.
  - \* Carpet cleaning operators and their employees
  - \* Real estate developers
  - \* Retail operators and their employees (dumpster/loading dock housekeeping)
  - \* Painting Companies
  - \* Landscaping Companies
  - \* Homeowners
  - \* School classes
  - \* Public works personnel
- *Storm Drain stenciling.* A portion of the storm drain inlet covers in Gills Creek area neighborhoods should be painted with a message such as "Do not dump, drains to Lake/Creek". This is an excellent means of illustrating the direct connection between storm drains and water pollution to local residents and the driving public. (National Geographic 1996).

- *Increase access to Gills Creek water resources.* Other than Sesquicentennial State park there are no easy public access points in the watershed suitable for recreation, eg. fishing, hiking. An expanded Gills Creek Greenway could be equipped with boardwalks, hiking and bicycling trails, fishing access points and security support to facilitate public use. A public that uses the water resources regularly will value the benefits afforded and thus be more motivated to help protect the resource.
- *Increase coordination of activities and events among lake associations and neighborhood associations.* This could encourage the use and value of local water resources, perhaps facilitated by the formation of a lake district. Lake festivals could be held to showcase area lakes and make possible such activities as community fishing tournaments, boat races, sailing regattas and fund raising.



Young boaters on Lake Katherine

9. **Structural and engineered controls:** Structural and engineered NPS pollution control measures, including vegetative ones like stormwater wetlands, can be very effective in removing a significant portion of nonpoint source pollutants from stormwater. The use of these kinds of measures is highly specific to the characteristics of the site they are intended to serve. Usually these types of measures are employed to serve small scale projects but occasionally they can be applied to treat large subwatersheds, for example, a regional detention pond. Wherever employed, a detailed engineering analysis would be needed to determine suitability. It is also important to ensure that structural BMP's are adequately maintained. Resources should be committed up front to ensure that BMP's will continue to perform their function over time.

**The use of best available NPS pollution control technologies should be promoted and encouraged for use in both public and private projects.**

**The increased use of these technologies can be facilitated by:**

- *Combining NPS pollution control considerations in public flood control projects and drainage improvements*

- *Establishing an urban retro-fit ordinance requiring upgraded NPS BMP's for re-development of urban areas (NPS Newsnotes 1996).*
- *Identifying critical sites for BMP implementation as part of a comprehensive NPS management strategy by local governments (see Recommendations part 3).*
- *Providing incentives to encourage BMP use in planned urban development proposals.*
- *Consideration of new and innovative methods where applicable and cost effective.*

## ***Targeting***

The preceding section describes a set of general recommendations applicable to the entire watershed. In order to more efficiently focus and manage NPS control efforts, it would be beneficial to organize the Gills Creek watershed into subwatersheds based on differences in land use, NPS impacts, water quality goals, and institutional arrangements. **figure three** illustrates a suggested array of subwatersheds for the Gills Creek Watershed.

## ***VII. Steps to Success***

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**1. Implement the easy things first:** Certain of the recommendations and NPS measures are more easily implemented than others. Some can be implemented relatively simply without extensive deliberations and funding outlays. Among these are:

- \* The targeted educational campaigns.
- \* Increased enforcement of existing litter control and erosion control regulations.
- \* Volunteer storm drain stenciling.
- \* Improved commercial dumpster maintenance.
- \* Formation of a citizen's watershed advocacy organization.
- \* Incentives for and recognition of land use that incorporates impervious surface minimization and riparian buffer zone preservation.

The other measures, particularly those that involve changes in ordinances, new regulations or the acquisition of new funding, will require extensive negotiations among the various stakeholder groups.

**2. Involve all stakeholders:** It is vitally important to solicit the opinions of all the various stakeholders in the area regarding which specific measures will be taken to



control NPS in the watershed, especially institutional BMP's. Extensive efforts should be made to resolve any conflicts that arise. A consensus should be sought on all actions.

**3. Demonstrate political commitment:** In order for NPS control efforts to proceed further it must be clear that the various governmental jurisdictions are committed to improving and/or protecting Gills Creek water quality. It would be highly beneficial to have resolutions to that effect drawn up and endorsed by the governing councils and the executives of affected municipalities. This would facilitate the formulation and implementation of the action plan since the affected stakeholders would know that any consensus reached on difficult matters would have some degree of pre-approval.

**4. Identify and secure adequate funding:** Implementation of a comprehensive NPS control plan in the Gills Creek watershed will likely call for some new or redirected source(s) of funds. Some of the uses of these funds might be:

- \* Public drainage and storm water detention projects.
- \* Increased personnel for litter clean ups.
- \* Water quality monitoring to pinpoint NPS sources.
- \* Expenses for public education, eg. publications, TV/Radio time.
- \* Land acquisition and reforestation projects.
- \* Engineering expenses relating to data analysis and planning.
- \* Inspection and enforcement personnel
- \* Installation of other NPS best management practices

Local governments have a variety of means available to secure funding and NPS control resources. Among these are:

- \* Reapportionment of existing funds.
- \* Special tax assessments, surcharges, commodity taxes etc.
- \* Fees for building permits or other activities.
- \* Implementation of a stormwater utility where property owners pay a fee based on amount of impervious surface on their property.
- \* Issuance of bonds.
- \* Public/Private partnerships.
- \* Grants: federal, state, foundation.
- \* Solicitation of volunteer contributions of funds and labor.

**5. Cycle implementation by subwatersheds:** It would be expedient to consider planning and implementation of NPS control measures on the basis of subwatershed units as detailed in Table 1. This method will allow for a more focused approach and will lessen the likelihood that implementation will become overly complex. The Center for Watershed Protection in Washington D.C. outlines a method whereby data collection, planning, implementation, and monitoring activities are performed in a cycle, each activity being rotated continuously among the subwatersheds on an annual basis (Center

for Watershed Protection 1996). DHEC uses a similar system in its Watershed Water Quality Management Strategy where the state is broken down into five major river basins. Permitting, special monitoring and other water resource protection projects are done in each basin sequentially on a yearly rotation. Cost savings and improved coordination have resulted in a more efficient program.

## **VIII. For The Future**

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In a previous section of this document the importance of the Gills Creek Watershed was described. As a public and private recreational amenity, an economic asset, a habitat for fish and wildlife, and as an element of the highly prized Congaree River Watershed, the Gills Creek Watershed enriches the quality of life in the region. Given the rapid rate of development in the watershed and the expected increases in population projected to occur, it seems clear that the time is now to implement a comprehensive NPS control plan to ensure that these benefits are not diminished.

This situation is, of course, not unique to the Midlands area. Many urban centers around the country are facing up to the issue of urban water quality and the effects of urban runoff. Some cities have already instituted comprehensive NPS control plans. Since November of 1993, the City of Charlotte, N.C. and the surrounding Mecklenburg County have, partially due to municipal stormwater NPDES permit requirements, developed and implemented a comprehensive stormwater management program that deals with both quantity and quality issues. Like many municipalities, their program is administered by an independent stormwater utility which receives funding by a special user fee assessed on all landowners in the watershed. The fee is primarily based on the estimated area of impervious surface the property contains. Typical fees charged to single family home owners are about \$3.00 per month. The 1996 projected revenues for the utility were \$13,374,234. The Charlotte-Mecklenburg Stormwater Services utility provides a variety of functions including flood control engineering, urban water quality monitoring, enforcement of stormwater related ordinances, emergency spill response and public education. (Charlotte-Mecklenburg Stormwater Services 1995). The Charlotte area stormwater management program is a good example of a broad-ranging, well-funded and effective urban NPS management program. There are many other urban areas around the country, especially in the Great Lakes Region, Pacific Northwest, and Chesapeake Bay area, that have been tackling the NPS pollution issue for a number of years now. There is thus a considerable body of experience available for municipal areas just beginning the process, such as the Columbia Metro Region.

Given its prominent location in the capitol city of South Carolina, the condition of the Gills Creek Watershed can be perceived as emblematic of the degree to which urban water resources will be valued in this state. In looking to the future, various scenarios can be envisioned for the fate of Gills Creek waters. Will the creeks and lakes in the watershed continue to slowly become degraded and taken for granted, as they appear to be now? Or, will they become perceived as vital community assets, as they once were,

and managed as such? It is up to the present local population, the major stakeholders: the citizens, property owners, decision makers, government agency personnel, and members of the business community, to decide **today** how the Gills Creek Watershed will evolve over the next decade. The recommendations given in this document are meant to provide a basis upon which to guide actions that will preserve water quality and protect the Watershed's valuable benefits to the community.



As Project Manager, John Chigges works with Dent Middle School students on freshwater ecology issues at a site near Cary Lake.

## Bibliography

- 102 Congress of U.S.. 1991. Hearings Before the Subcommittee on Public Works and Transportation: Nonpoint Pollution in the U.S.. GPO:Washington, May 1, 1991.
- Bowen, T. W. And Kenneth L. Manuel 1994. "Howard Creek Macroinvertebrates: 1993 Summary" Report. Huntersville, N.C.:Duke Power Company.
- Burgis, Mary, J. and Pat Morris. 1987. The Natural History of Lakes. Cambridge Press: Cambridge.
- The Center for Watershed Protection. 1994(a). Watershed Protection Techniques V1, N1. Winter, 1994.
- The Center For Watershed Protection. 1994(b).Watershed Protection Techniques V1, N3 Fall, 1994.
- The Center For Watershed Protection. 1994(c) . 1994 Edition of National Directory Of Urban Watershed Restoration Efforts. Silversprings Md..
- The Center For Watershed Protection. 1996. "Crafting Better Urban Watershed Protection Plans." Watershed Protection Techniques, Vol. 2, N2, Spring 1996.
- Central Midlands Regional Planning Council. Richland County Comprehensive Land Use Plan Update:Northeast Area. Columbia, S.C., March 2 1987.
- Central Midlands Regional Planning Council. 1992.. Richland County Comprehensive Land Use Plan Update: Lower Richland Area. Columbia, S.C..
- Charlotte-Mecklenburg Stormwater Services. 1995. City of Charlotte Annual Report: NPDES Municipal Separate Storm Sewer System Stormwater Discharge Permit. Aug. 31,1995.
- Coalition to Restore Urban Waterways. 1995. Coalition to Restore Urban Waters: Long Range Plan. August, 1995.
- Cordova, Andrew J.. 1991. Thesis:The Effectiveness Of A Sediment and Erosion Control Ordinance:Richland County S.C. USC: Columbia S.C..
- Eisma, Doeke. 1992. Suspended Matter in the Aquatic Environment. Springer Verlag:Berlin.
- Federal Emergency Management Administration. 1989. Flood Control Study for Richland County S.C.

- Federal Emergency Management Administration. 1991. Flood Control Study For Forest Acres S.C.
- Fort Jackson Training Center. 1993 Secretary Of Defense: Natural Resources Conservation Award Report: 1991-1993.
- Green, Edwin. 1932. A History of Richland County. R.L. Bryan:Columbia S.C.
- Hall, J. and K. Boyle. 1994. "The Relationship Between Property Values and Water Quality of Maine Lakes." Lake Line, June 1994.
- Hadley, Richard F. and Takahisa Mizuyama. 1993. Sediment Problems: Strategies for Monitoring and Control. IAHS: Oxfordshire UK.
- Horner, Richard and Joseph Skupien, *et al.* 1994. Fundamentals of Urban Runoff Management: Technical and Institutional Issues. Washington D.C.:Terrene Inst., August, 1994.
- Issac Walton League 1994. A Citizen's Streambank Restoration Handbook Nov. 1994.
- Kelsey and Guild. 1905. The Improvement Of Columbia S.C. Report To The Civic League Of Columbia.
- Kyzer, Braxton. 1965. Thesis:Flood Prediction and Flood Plain Management for the Gill's Creek Watershed. U.S.C: Columbia.
- NALMS for EPA. 1990.The Lake and Reservoir Restoration Guidance Manual 2nd Ed.
- National Geographic Society. 1996. "Our Polluted Runoff." National Geographic, Feb. 1996.
- Novotny, Vladimir Ed. 1988. Proceedings of the Symposium on Nonpoint Pollution:1988 Policy, Economy, Management and Tech. Milwaukee WI.:AWRA.
- Overcash, Michael and James Davidson. 1980. Environmental Impact of Nonpoint Source Pollution. Ann Arbor Mich: Ann Arbor Science.
- Schueler T.R. 1994. The Stream Protection Approach: Guidance for Developing Effective Local Nonpoint Source Control Programs in the Great Lakes Region. Terrene Inst.:Washington D.C., Jan. 1994.
- Sickerman, T 1997 Provisional data from:"National Water-Quality Assessment Program The Santee Basin and Coastal Drainage, N.C. and S.C." U.S.G.S, Columbia, S.C.

- Smith, Velma. 1994. "Disaster in Milwaukee." EPA Journal, Summer 1994.
- South Carolina D.H.E.C. 1989. Assessment of Nonpoint Source Pollution for the State of South Carolina. Columbia, S.C. October, 1989.
- South Carolina D.H.E.C. 1989. Nonpoint Source Management Program For The State Of South Carolina: Update. January, 1989.
- South Carolina D.H.E.C.. 1995(a). South Carolina Stormwater Management and Sediment Control Handbook For Land Disturbing Activities. Sept. 1995.
- South Carolina D.H.E.C. 1995(b). Watershed Water Quality Management Strategy: Saluda-Edisto Basin. No. 003.-95.
- South Carolina D.H.E.C. 1995(c). A General Guide to Environmental Permitting In South Carolina, Nov. 1995.
- South Carolina D.H.E.C. 1995(d). A Water Quality Assessment of Gills Creek, Richland County, South Carolina. No. 006-95, 1995.
- South Carolina D.H.E.C. 1996. 1996 Statewide Water Quality Assessment, A Report to Congress Pursuant to Section 305(b) of Clean Water Act.
- South Carolina Land Resources Commission. 1986. Erosion, Sediment and Stormwater: Problems, Progress and Needs, March 1986.
- South Carolina Parks Recreation And Tourism. 1996. Personal Communication, Sept. 4 1996.
- Tennessee Div. of Water Pollution Control. 1994. Riparian Restoration And Streamside Erosion Control Handbook. Nov. 1994.
- Terrene Institute. 1996. "Rockville Mall Redevelopment Offers Opportunity for Stormwater Retro-fit." Nonpoint Source News-Notes, N. 44, April/May 1996.
- U.S. Corps of Engineers. 1988. Charleston District Interim Review of Report Santee River-South Carolina: Draft, Gills Creek Flood Control Feasibility Study. July 1988.
- U.S. Dept. of Agriculture, Soil Conserv. Service. Water Quality Indicators Guide: Surface Waters. Sept. 1989.
- U.S. EPA. 1979. Quantitative Techniques for the Assessment of Lake Quality. Jan. 1979.

- U.S. EPA. 1983(a). Results of the Nationwide Urban Runoff Program: Executive Summary. Washington D.C., Dec. 1983.
- U.S. EPA. 1983(b). Final Report of the Nationwide Urban Runoff Program: Volume 1. Washington D.C., Sept. 30 1983.
- U.S. EPA. 1984(a). Report to Congress: Nonpoint Source Pollution in the U.S.. Washington D.C., Jan 1984.
- U.S. EPA. 1984(b). Seminar publication: Nonpoint Source Watershed Workshop. Eastern Research Group: Arlington, Ma., Sept. 1984.
- U.S. EPA. 1992(a). Proceedings of: Third National Citizen's Volunteer Water Monitoring Conference. Annapolis Md., March 29 1992.
- U.S. EPA 1992(b). Impacts of Storm Water Discharges: A National Profile. Washington D.C., June 1992.
- U.S. EPA 1992(c). Lake Restoration, Protection and Management: Proceedings of 2nd Annual Conf. NALMS. Oct 26-29 1992.
- U.S. EPA. 1993(a). Guidance Specifying Management Measure For Sources Of Nonpoint Pollution In Coastal Waters. Jan. 1993.
- U.S. EPA. 1993 (b). Handbook: Urban Runoff Pollution Prevention Control and Planning. Cincinnati OH, Sept 1993.
- U.S. EPA. 1994. The Watershed Protection Approach 1993/1994: Activity Report Nov. 1994.
- U.S. Soil Conservation Service. 1977. Soil Survey of Richland County S.C.
- USCOE: Charleston District. 1988. Interim Review of Report: Santee River-S.C.: Gill's Creek Flood Control Feasibility Study. Sept. 1988.
- Woodward Clyde. 1989. Urban Targeting and BMP Selection: An Information and Guidance Manual For State NPS Program Staff, Engineers and Managers. Dec. 1989.