CHAPTER 3

CAUSES OF IMPAIRMENT AND SOURCES OF POLLUTION

3.1 INTRODUCTION

Water pollution is caused by a number of substances including sediment, nutrients, bacteria, oxygen-demanding wastes, metals, color and toxic substances. *Sources* of these pollution-causing substances are divided into broad categories called *point* sources and *nonpoint* sources. Point sources are typically piped discharges from wastewater treatment plants and large urban and industrial stormwater systems. Nonpoint sources can include stormwater runoff from urban areas, forestry, mining, agricultural lands and others. **Section 3.2** identifies and describes the major causes of pollution in the Hiwassee River basin. **Sections 3.3** and **3.4** describe point and nonpoint source pollution in the basin.

3.2 CAUSES OF IMPAIRMENT

Causes of impairment refers to the substances which enter surface waters from point and nonpoint sources and result in water quality degradation. The major causes of water quality impairment include biochemical oxygen demand (BOD), sediment, nutrients, toxicants (such as heavy metals, chlorine, pH and ammonia) and fecal coliform bacteria (Table 3.1). Each of these causes of impairment is discussed in the following sections.

Table 3.1 Causes of Impairment and Sources of Water Pollution

Cause of Impairment	Source of Pollution
Sediment	Construction and mining sites, disturbed land areas, streambank erosion and alterations, cultivated farmland
Nutrients	Fertilizer on agricultural, residential, commercial and recreational lawns, animal wastes, trout farm effluent, leaky sewers and septic tanks, atmospheric deposition, municipal wastewater
Toxic and Synthetic Chemicals	Pesticide applications, disinfectants (chlorine), automobile fluids, accidental spills, illegal dumping, urban stormwater runoff
Oxygen-Consuming Substances	Wastewater effluent, organic matter, leaking sewers and septic tanks, animal waste
Fecal Coliform Bacteria	Failing septic tanks, animal waste, runoff from livestock operations, wildlife, improperly disinfected wastewater effluent
Road Salt	Applications to snow and ice
Oil and Grease	Leaky automobiles, industrial areas, illegal dumping
Thermal Impacts	Heated landscape areas, runoff from impervious areas, tree removal along streams, wet detention ponds

3.2.1 Sedimentation

Sedimentation is the most widespread cause of nonpoint source pollution in the state and results from land-disturbing activities including agriculture, building and highway construction, uncontrolled urban runoff which erodes streambanks, mining and timber harvesting. Unpaved roads and driveways on steep slopes are also significant sources of sediment. While no waters in the Hiwassee River basin have been identified through DWQ sampling efforts as impaired due to sedimentation, several waters in the basin do have sedimentation problems during rainfall events and high flows. Most sediment-related impacts are associated with nonpoint source pollution. Recommendations aimed at addressing sedimentation are listed in Section 6.3 of Chapter 6 and programs are briefly described under nonpoint source pollution controls in Chapter 5.

Effects of Sedimentation

Sedimentation is often divided into two categories: *suspended load* and *bed load*. Suspended load is composed of small particles that remain in suspension in the water. Bed load is composed of larger particles that slide or roll along the stream bottom. Suspension of load types depends on water velocity and stream characteristics. Indirect effects of increased sediment loads may include increased stream temperatures and decreased intergravel dissolved oxygen. Biologists are often primarily concerned with the *concentration* of the suspended sediments and the *degree of sedimentation* on the streambed (Waters 1995).

The concentration of suspended sediments affects the availability of light for photosynthesis, as well as the ability of aquatic animals to see their prey. Several researchers have reported reduced feeding and growth rates by fish in waters with high suspended solids. In some cases it was noted that young fish left those stream segments with turbid conditions. Suspended sediments can clog the gills of fish and reduce their respiratory abilities. These forms of stress may reduce the tolerance level of fish to disease, toxicants and chronic turbid conditions. Suspended solids are reported as Total Suspended Solids or as Turbidity. They are measured in parts per million or milligrams per liter (Waters 1995).

The degree of sedimentation affects both the habitat of aquatic macroinvertebrates and the quality and amount of fish spawning and rearing habitat. Degree of sedimentation can be estimated by observing the amount of streambed covered, the depth of sedimentation, and the percent saturation of interstitial space or embeddedness. Eggs and fry in interstitial spaces may be suffocated by the sediments thereby reducing reproductive success (Waters 1995).

The findings of academic research have noted the potential impact of sedimentation on fisheries, in particular on wild trout populations. This topic is also discussed in Chapter 4 of this plan. Sedimentation is one of the main factors limiting trout production in western North Carolina. Inorganic sediments can affect trout productivity in three ways: direct effects - impairment of respiration, feeding habits, and migration patterns; reduced egg hatching and emergence due to decreased water velocity and dissolved oxygen; and, trophic effects - reduction in prey (macroinvertebrates). As fine suspended solids increase in the waters, the dissolved oxygen, permeability, and apparent velocity decrease (West, date unknown). Erosion and sedimentation resulted in lower hatching and emergence success of trout embryos, reduced trout biomass and growth rates when comparing two streams in western North Carolina (West et. al, 1982).

The impact of sedimentation on fish populations depends on both concentration and degree of sedimentation, but impact severity can also be affected by the duration (or dose) of sedimentation. Suspended sediments may occur at high concentrations for short periods of time, or at low concentrations for extended periods of time. The greatest impacts to fish populations will be seen at high concentrations for extended time periods. The use of a dose-response matrix in combination with field investigations can help predict the impact of suspended sediments on various life stages of fish populations (Newcombe 1996).

Sedimentation impacts streams in several other ways. The amount of sediment can affect channel shape, pattern, and the relative balance between pools and riffles. Eroded sediments may gradually fill lakes and navigable waters and may increase drinking water treatment costs. Sediment also serves as a carrier for other pollutants including nutrients (especially phosphorus), toxic metals, pesticides, and road salts.

Measuring Sediment Loads

Suspended sediment is a very useful indicator of active erosion in a particular basin. Suspended sediment concentrations are very sensitive to landscape disturbance, and its conceptual simplicity as a measurement tool gives it broad appeal. The primary problem with using suspended sediment as a monitoring tool is its inherent variability. Representative samples are difficult to obtain, and suspended sediment samples vary tremendously over time and space. Most sampling schemes take individual or composite samples at regular time intervals (e.g. daily). Since high flows are relatively rare, a sampling system based on equal time intervals will result in a large number of samples at relatively low flows, when suspended sediment concentrations are low, and very few samples at high flows, which is when most of the suspended sediment transport takes place. This is both inefficient and results in a high level of uncertainty with regard to the total sediment load. For a clear picture of sediment dynamics in a particular watershed, sediment sampling programs should be carefully designed using staged, point integrated, or depth integrated samplers to include measurements at relatively high flows.

Statistics compiled by the US Department of Agriculture, Natural Resource Conservation Service (formerly known as the Soil Conservation Service) indicate a statewide decline in erosion from 1982 to 1992 (USDA, NRCS, 1992) as shown in Table 3.2.

Table 3.2 Overall Erosion Trends in North Carolina

	1982	1987	1992
Area (1,000 acres)	33,708.2	33,708.2	33,708.2
Gross Erosion (1,000 tons/yr)	46,039.5	43,264.6	36,512.9
Erosion Rate (Tons/Yr/Ac)	1.1	1.4	1.3

The most widely used tool to evaluate erosion at the landscape level is the Universal Soil Loss Equation (USLE). The NRCS statistics also indicate a statewide reduction per acre on cropland erosion using the Universal Soil Loss Equation (Table 3.3). However, the USLE produces results which are difficult to interpret for the NC mountains. Although tons/acre/year is a standard unit of measurement for erosion, it does not reflect the high spatial and temporal variability of erosion. Sediment impacts do not in generally originate from a county wide "average" area; the majority of sediment comes from localized high impact areas. It is very easy to average out a sediment impact over a whole watershed or county or state area and thereby give the impression that the problem is less significant than it actually is in the immediate area. It makes much more sense from a management perspective to reduce sediment from 40 tons/acre to 2 tons/acres in a high impact area than to reduce erosion from cropland from 6.5 to 6.3 tons/acre. This points to the need for targeted management efforts coupled with a monitoring strategy which effectively measures sediment transport under both average and extreme conditions.

Table 3.3 USLE Erosion on Cultivated Cropland in North Carolina

	1982	1987	1992
Cropland Area (1,000 acres)	6,318.7	5956.8	5538.0
Gross Erosion (1,000 tons/yr)	40,921.4	37475.3	30,908.3
Erosion Rate (Tons/Yr/Ac)	6.5	6.3	5.6

In the Blue Ridge Mountains region, which encompasses the entire Little Tennessee River basin and several others, the overall erosion picture is not very clear. Table 3.4 shows a significant decline in cultivated cropland acreage and a corresponding decline in gross erosion over the past ten years, but the erosion rate per acre increased from 12.7 tons/acre/year in 1982 to 20.8 tons/acre/year in 1987 and then dropped to 18.3 tons/acre/year in 1992. Non-cultivated cropland erosion rates also increased over the ten year period from 1.4 tons/acre/year in 1982 to 1.7 tons/acre/year although pasture land rates dropped from 2.6 to 2.2 tons/acre/year over the same period.

According to the Raleigh NRCS office, several factors may explain the large erosion rate increase from 1982 to 1987. The mountains were the last region of the state to be accurately soil-mapped, and so more recent data may reflect an improved knowledge of soil loss. Secondly, there have been some revisions in soil loss coefficients for individual soil types. And third, Christmas tree farms have been included in the cropland acreage figures. Many farms are located on extremely steep lands and the large increase in the Christmas tree industry could play an important role in these numbers.

Table 3.4 North Carolina Erosion in Blue Ridge Mountain Region

	1982	1987	1992
Cropland Area (1,000 acres)	122.9	97.9	76.2
Gross Erosion (1,000 tons/yr)	1555.6	2035.2	1397.5
Erosion Rate (Tons/Yr/Ac)	12.7	20.8	18.3

Compared to other regions of the state, the overall erosion rate per acre for cultivated cropland in the mountains is very high although it is noted that the rate has dropped since 1987 (Table 3.5).

Much of this data relates to cropland and the need to continue to improve cropland erosion controls in the mountains. It also carries a broader message of the high erosion potential in the mountains, not only from agricultural activities, but for all land-disturbing activities on the steep slopes which are so prevalent in this region. Of particular concern are potential sediment losses from logging operations that do not follow forestry best management practices, streambank erosion, second home development and highway construction.

Table 3.5 North Carolina Erosion on Major Land Resource Areas (MLRA)

	1982	1987	1992
Blue Ridge Mountains	12.7	20.8	18.3
Southern Piedmont	12.3	12.0	10.5
Carolina and Georgia Sand Hills	6.0	5.6	5.1
Southern Coastal Plain	3.9	3.9	4.0
Atlantic Coast Flatwoods	3.2	3.1	3.2
Tidewater Area	1.4	1.5	1.6

Sediment and Streamflow

Peak flows have important effects on stream channel morphology and bed material particle size. Specifically, since higher flows move larger particles, peak flows determine the stable particle size in the bed material. Large stable particles provide important habitat niches for invertebrates and small fish. The size of peak flows is also important in determining the stability of large woody debris and the rate of bank erosion. Increased bank erosion and channel migration will affect the riparian vegetation and alter the amount of active sediment in the stream channel. Periods of high flow are periods of bank modification and deposition on active floodplains, especially in areas with dense riparian vegetation.

The vast majority of the sediment transport occurs during peak flows, as sediment transport capacity increases exponentially with discharge. The ability of a stream to transport the incoming sediment will help determine whether there is deposition or erosion within the active stream channel. The relationship between sediment load and sediment transport capacity will affect the distribution of habitat types, channel morphology, and bed material particle size. Increased size of peak flows due to urbanization have been shown to cause rapid channel incision and severe decline in fish habitat quality.

In developing areas, the erosive forces brought by increased flood flows must be addressed at the source—increased runoff—for instream fixes to be successful. Recent studies underscore the importance of overall watershed imperviousness in determining stream water and habitat quality. Increased impervious cover in a watershed has many direct impacts on streams in the watershed. Streams broaden or deepen to accommodate larger flushes of water, specialized habitats such as pool and riffle structures and overhanging vegetation are lost, instream water quality declines, stream temperatures rise and stream biodiversity, from aquatic insects to anadromous fish declines. Each of these impacts has been shown to increase with higher levels of watershed imperviousness.

A change in the size of peak flows can also have important consequences for human life and property. Structures such as bridges, dams, and levees are designed according to a presumed distribution of peak flows. If the size of the peak flows is increased, this could reduce the factor of safety and lead to more frequent and severe damage.

Sediment and Streambank Erosion

Streambank erosion, which can contribute sediment loads to a stream, has many potential causes, such as clearing of instream obstacles or streamside vegetation, livestock trampling of stream banks, or higher than normal floods resulting from increased impervious cover. In alluvial channels, the stream and river banks tend towards a dynamic equilibrium with the discharge and sediment load. The bank material, vegetation type, and vegetation density also affect the stability and form of the streambanks. Change in any one of these factors is likely to be reflected in the size and shape of the stream channel, including the banks.

Streambank stability is a term which refers to the propensity of the stream bank to change in form or location over time. Streambank stability can be an important indicator of watershed condition and can directly affect several designated uses of streams. A higher incidence of bank instability can be initiated by natural events that disrupt the quasi-equilibrium of the stream, or by human disturbance. Unstable banks contribute sediment to the stream channel by slumps and surface erosion. Because all the material from an eroding streambank is delivered directly to the stream channel, the adverse impact of bank instability can be much greater than the adverse effects of a comparable area of eroding hillslope.

Even in undisturbed streams some streambank instability usually occurs. In valleys with a defined floodplain there is often lateral migration through bank erosion and point bar accretion. In Vshaped valleys there is less opportunity for lateral migration and bank instability may steam from the input and eventual removal of obstructions emanating from fallen trees, landslides, or debris flows.

Although in some cases the erosion of one bank will be matched by deposition on the opposite bank, streambank erosion caused by human activities generally will increase stream width. The corresponding increase in stream surface area allows more direct solar radiation to reach the stream surface, and this will raise maximum summer water temperatures. In most cases an eroding streambank will provide little or no cover for fish.

Actively eroding streambanks also support little or no riparian vegetation, and the loss of this vegetation adversely affects a wide range of wildlife species, reduces available forage for domestic livestock, and reduces the long-term input of organic matter into the aquatic ecosystem. Both the increase in summer water temperatures and the loss of fish cover along an eroding stream bank will be exacerbated by the reduction in riparian cover.

Historic practices of disturbing the stream channel and removing large woody debris have been shown to increase the amount of fine sediment in the steam channel. Removal of, or a reduction in, the riparian vegetation is another mechanism by which management activities can increase the amount of fine sediments. Grazing often exacerbates the effect of reducing the vegetative cover by simultaneously trampling the vegetation, compacting the soil, and trampling the streambanks. The use of structural techniques such as: bank sloping, use of tree roots for stabilization, buffer strips, and fencing cattle out of streams can greatly reduce streambank erosion. Average annual soil loss has been shown to be decreased by 40% after cattle were fenced away from streams. This decrease resulted in nearly a 60% reduction in average sediment concentration during stormflow events (Owens, et al 1996). Stormwater management measures for urban development areas can also lessen the potential for streambank erosion.

Stream Modification

Natural streams around the world have certain physical characteristics in common, regardless of location and geologic conditions. One of the most important of these characteristics is known as bankfull stage. The bankfull stage corresponds to the flow at which channel maintenance is most effective, that is, the discharge that results in the average size and shape of channels.

Almost all natural streams have a bankfull discharge with a recurrence interval of 1-1.5 years. In other words, natural stream channels do not form with the capacity to carry a 50 year, 25 year, or even 2 year storm without overflow. Natural channels on average can carry the flow from an annual storm without overflow. In streams that have not been channelized or manipulated by human activities, streamflows larger than a typical annual event are generally carried in both the channel and a floodplain.

Humans have modified many natural streams by increasing the capacity of the stream channel to carry high flows, sometimes to carry even the flow from a 50 or 100 year storm. Such modifications are conceived in the name of flood control and are often used to justify development of floodplains for human occupance and other activities which constrict or encroach upon the floodplain.

Most engineering channel designs give a great deal of attention to conveyance of floodwaters. Very few channel designs include close attention to sediment conveyance. Given that the equilibrium channel size tends toward a bankfull discharge with a 1-1.5 year recurrence interval, larger stream channels will naturally initiate disequilibrium erosional processes. For example, a channel that has been straightened and enlarged to carry a 50 year storm, will begin building a smaller channel, point bars, floodplains, meanders, etc. as a result of the natural physical behavior of sediment and the frequency distribution of streamflows. As a result, we have created streams which are unstable; they lose their equilibrium shape and slope and erode, degrade, and aggrade rapidly. Such unstable channel conditions can ultimately lead to degraded water quality as result of excessive sediment loads.

Sedimentation and Erosion in the Hiwassee River Basin
Sedimentation is a problem parameter on Shooting Creek and Little Fires Creek, although both of these creeks are currently fully supporting their uses. Shooting Creek was first sampled in 1994 and it was noted during sampling that the stream bottom showed signs of sedimentation from nonpoint sources. Sampling in Little Fires Creek, Junaluska Creek and South Shoal Creek have also noted sedimentation and bank erosion.

3.2.2 Fecal Coliform Bacteria

Fecal coliform bacteria are bacteria typically associated with the intestinal tract of warm-blooded animals. These bacteria are widely used as an indicator of the potential presence of pathogenic, or disease-causing, bacteria and viruses. Common sources of fecal coliform bacteria include leaking or failing septic systems, leaking sewer lines or pump station overflows, runoff from livestock operations and wildlife, and improperly disinfected wastewater effluent.

Fecal coliform bacteria are widely used as indicators of the potential presence of waterborne pathogenic organisms (which cause such diseases as typhoid fever, dysentery, and cholera). Fecal coliform bacteria in treatment plant effluent are controlled through disinfection methods including chlorination (sometimes followed by dechlorination), ozonation or ultraviolet light radiation.

Fecal Coliform Bacteria in the Hiwassee River Basin
Elevated levels of fecal coliform bacteria have caused use-impairment in Brasstown Creek (Partially Supporting) due to effluent from the Young Harris Water Pollution Control Plant in Georgia. Fecal coliform bacteria has not caused use-support impairment in the Hiwassee River basin at either ambient monitoring station, however elevated levels of fecal coliform in the Hiwassee River above Murphy and the Valley River at Tomotla have been noted.

Due to the low number of farm animal operations and limited development in the basin, the chances of bacterial contamination in streams is low. However, failing septic systems, straight piping and animal operations without appropriate best management practices in place can cause elevated bacterial levels in any of the many unmonitored streams.

3.2.3 Toxic Substances

Regulation 15A NCAC 2B. 0202(36) defines a toxicant as "any substance or combination of substances ... which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, has the potential to cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions or suppression in reproduction or growth) or physical deformities in such organisms or their offspring or other adverse health effects". Toxic substances frequently encountered in water quality management include chlorine, ammonia, organics (hydrocarbons and pesticides) heavy metals and pH. These materials are toxic to different organisms in varying amounts, and the effects may be evident immediately or may only be manifested after long-term exposure or accumulation in living tissue.

North Carolina has adopted standards and *action levels* for several toxic substances. These are contained in 15A NCAC 2B .0200. Usually, limits are not assigned for parameters which have action levels unless 1) monitoring indicates that the parameter may be causing toxicity or, 2) federal guidelines exist for a given discharger for an action level substance. This process of determining action levels exists because these toxic substances are generally not bioaccumulative and have variable toxicity to aquatic life because of chemical form, solubility, stream characteristics and/or associated waste characteristics. Water quality based limits may also be assigned to a given NPDES permit if data indicate that a substance is present for which there is a federal criterion but no water quality standard.

Whole effluent toxicity (WET) testing is required on a quarterly basis for major NPDES dischargers (≥ 1 MGD) and any discharger containing complex (industrial) wastewater. This test shows whether the effluent from a treatment plant is toxic, but it does not identify the specific cause of toxicity. If the effluent is found to be toxic, further testing is done to determine the specific cause. This follow-up testing is called a toxicity reduction evaluation (TRE). WET testing is discussed in Sections 4.2.4 and 5.2.5 of Chapters 4 and 5 respectively. Other testing, or monitoring, done to detect aquatic toxicity problems include fish tissue analyses, chemical water quality sampling and assessment of fish community and bottom-dwelling organisms such as aquatic insect larvae. These monitoring programs are discussed in Chapter 4.

Each of the substances below can be toxic in sufficient quantity or concentration.

pH

Changes in pH to surface waters is primarily through point source discharges. However, changes can also occur with the introduction of substances in the form of spills to a waterbody and through acid deposition. Refer to Section 4.2.8 in Chapter 4 for more information on acid deposition and how it may affect the waters of the Hiwassee River basin. As the pH of a water decreases, metals are more bioavailable within the water column and are therefore more toxic to the aquatic organisms. As the pH increases, metals are precipitated out of the water column and less toxic to aquatic organisms. If a surface water has had chronic introductions of metals and the pH gradually or dramatically decreases, the metals in the substrate will become more soluble and be readily available in the water column. While lower pH values may not be toxic to the aquatic organisms, the lower values can have chronic effects on the community structure of macroinvertebrates, fish, and phytoplankton. Macroinvertebrates will show a shift from tolerant species to intolerant species and have less community diversity.

The NC standard for pH in surface waters is 6.0 to 9.0. Trout will not survive in waters with pH values below 5.5.

Metals

Municipal and industrial dischargers and urban runoff are the main sources of metals contamination in surface water. North Carolina has stream standards for many heavy metals, but the most common ones in municipal permits are cadmium, chromium, copper, nickel, lead, mercury, silver and zinc. Standards are listed in Appendix I. Each of these, with the exception of silver, is also monitored through the ambient network along with aluminum and arsenic. Point source discharges of metals are controlled through the NPDES permit process. Mass balance models are employed to determine allowable concentrations for a permit limit. Municipalities with significant industrial users discharging wastes to their treatment facilities limit the heavy metals from these industries through a *pretreatment program*. Source reduction and wastewater recycling at WWTPs also reduces the amount of metals being discharged to a stream. Nonpoint sources of pollution are controlled through best management practices.

Chlorine

Chlorine is a commonly used disinfectant at NPDES discharge facilities which have a domestic (i.e., human) waste component. These discharges are a major source of chlorine in the State's surface waters. Chlorine dissipates fairly rapidly once it enters the water, but its toxic effects can have a significant impact on sensitive aquatic life such as trout and mussels. At this time, no standard exists for chlorine in waters supplementally classified as trout waters and an action level has been established for all other waters. A standard for all waters may be adopted in the future. In the meantime, all new and expanding dischargers are required to dechlorinate their effluent if chlorine is used for disinfection. If a chlorine standard is developed for North Carolina, chlorine limits may be assigned to all dischargers in the State that use chlorine for disinfection.

Ammonia (NH_3)

Point source dischargers are one of the major sources of ammonia. In addition, decaying organisms which may come from nonpoint source runoff and bacterial decomposition of animal waste also contribute to the level of ammonia in a waterbody. At this time, there is no numeric standard for ammonia in North Carolina. However, DWQ has developed an interim set of instream criteria of 1.0 mg/l in the summer (April - October) and 1.8 mg/l in the winter (November - March). These interim criteria are under review, and the State may adopt a standard in the near future.

Toxic substances in the Hiwassee River Basin

The Valley River monitoring site between Stewart Road and a site about 3 miles below Andrews was given a Partially Supporting rating due to toxicity and is therefore use-impaired. It was determined that the sampling site above the Andrews WWTP showed the most severe water quality problems, although there are no permitted dischargers in this area. Further investigations may determine the source of toxicity.

3.2.4 Oxygen-Consuming Wastes

Oxygen-consuming wastes include decomposing organic matter or chemicals which reduce dissolved oxygen in the water column through chemical reactions or biological activity. Raw domestic wastewater contains high concentrations of oxygen-consuming wastes that need to be removed from the wastewater before it can be discharged into a waterway. Maintaining a sufficient level of dissolved oxygen in the water is critical to most forms of aquatic life.

The concentration of dissolved oxygen (DO) in a water body is one indicator of the general health of an aquatic ecosystem. Dissolved oxygen concentrations are affected by a number of factors. Higher dissolved oxygen is produced by turbulent actions, such as waves, rapids and water falls, which mix air and water. Lower water temperatures also generally allows for retention of higher dissolved oxygen concentrations. Therefore, the cool swift-flowing streams of the mountains are generally high in dissolved oxygen. Low dissolved oxygen levels tend to occur more often in warm, slow-moving waters that receive a high input of effluent from wastewater treatment plants during low flow conditions. In general, the lowest dissolved oxygen concentrations occur during the warmest summer months and particularly during low flow periods. Water depth is also a factor. In deep slow-moving waters, such as reservoirs or estuaries, dissolved oxygen concentrations may be very high near the surface due to wind action and plant (algae) photosynthesis but may be entirely depleted (anoxic) at the bottom.

Sources of dissolved oxygen depletion include wastewater treatment plant effluent, the decomposition of organic matter (such as leaves, dead plants and animals) and organic waste matter that is washed or discharged into the water. Sewage from human and household wastes is high in organic waste matter, as is waste from trout farms. Bacterial decomposition can rapidly deplete dissolved oxygen levels unless these wastes are adequately treated at a wastewater treatment plant. In addition, some chemicals may react with and bind up dissolved oxygen. Industrial discharges with oxygen consuming wasteflow may be resilient instream and continue to use oxygen for a long distance downstream.

Oxygen-Consuming Waste in the Hiwassee River Basin

There are no waters known to be impaired by oxygen-consuming wastes in the Hiwassee River basin.

3.2.5 Nutrients

The term *nutrients* in this document refers to two major plant nutrients, phosphorus and nitrogen. These are common components of fertilizers, animal and human wastes, vegetation, trout farms and some industrial processes. Nutrients in surface waters come from both point and nonpoint sources. Nutrients are beneficial to aquatic life in small amounts. However, in overabundance and under favorable conditions, they can stimulate the occurrence of algal blooms and excessive plant growth in quiet waters such as ponds, lakes, reservoirs and estuaries.

Nutrients in the Hiwassee River Basin

Nutrients have not been identified as a significant source of water quality impairment in the Hiwassee River Basin.

3.3 POINT SOURCES OF POLLUTION

3.3.1 Defining Point Sources

Point sources refers to discharges that enter surface waters through a pipe, ditch or other well-defined point of discharge. The term applies to wastewater and stormwater discharges from a variety of sources. Wastewater point source discharges include municipal (city and county) and industrial wastewater treatment plants and small domestic wastewater treatment systems that may serve schools, commercial offices, residential subdivisions and individual homes. Stormwater point source discharges include stormwater collection systems for medium and large municipalities which serve populations greater than 100,000 and stormwater discharges associated with industrial activity as defined in the Code of Federal Regulations [40 CFR 122.26(a)(14)]. The primary pollutants associated with point source discharges are oxygen-demanding wastes, nutrients, sediment, color and toxic substances including chlorine, ammonia and metals. Definitions and examples of the various categories can be found in Table 3.6.

Point source dischargers in North Carolina must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state. Discharge permits are issued under the NPDES program which is delegated to North Carolina by the EPA. See Chapter 5 for a description of the NPDES program and permitting strategies.

3.3.2 Wastewater Point Source Discharges in the Hiwassee River Basin

There are 16 permitted NPDES wastewater dischargers in the Hiwassee River basin. There are twelve dischargers covered under individual permits and four dischargers covered under general permits. Table 3.7 lists the wastewater dischargers in the Hiwassee River basin along with a summary of general information. The locations of these permitted facilities are shown in Figure 3.1 and 3.2. Permit renewals are conducted at five year intervals. Permits for the Hiwassee River basin are scheduled to be renewed in December 1997.

Total permitted flow for all facilities is 2.94 million gallons per day (MGD). The average actual flow from all facilities is 1.70 MGD. Table 3.8 provides the total and average discharge for each category of permitted facility.

There is one permitted NPDES wastewater discharge from a trout farm in the Hiwassee River basin. Craig's Trout Farm is located on Owl Creek in Cherokee County and is covered under a

Table 3.6 Definitions of Categories of NPDES Permits

CATEGORY	DEFINITION	EXAMPLES
Major vs. Minor discharges (NCOO Facilities)	For publicly owned treatment works, any facility discharging over 1 MGD is defined as a Major discharge. For industrial facilities, the EPA provides evaluation criteria including daily discharge, toxic pollutant potential, public health impact and water quality factors. Any facilities which do not meet the criteria for Major status are defined as Minor discharges.	There are no major dischargers in the Hiwassee River basin.
General Permits (NCG Permit Facilities)	Permits for dishcargers in categories which all have similar discharges, operations and monitoring, and limits. Generally minor effluent on receiving stream individually.	Trout farms and most stormwater permits.
100% Domestic	A system which treats wastewater containing household-type wastes (bathrooms, sinks, washers, etc.).	Housing subdivision WWTPs, schools, Mobile Home Parks,
Municipal	A system which serves a municipality of any size.	NC0020800 - Town of Andrews WWTP
Process Industrial	Water used in an industrial process which must be treated prior to discharge.	There are no Process Industrial facilities in the Hiwassee River basin.
Nonprocess Industrial	Wastewater which requires no treatment prior to discharging[1].	NCG500006 - Coats American (Non-contact cooling water and cooling tower blowdown)
Stormwater Facilities	Discharges of runoff from rainfall or snow melt. NPDES permits are required for "stormwater discharges associated with industrial activity" and from municipal stormwater systems for towns over 100,000 in population.	"Stormwater discharges associated with industrial activity" include most types of manufacturing plants. Landfills, mines, junkyards, steam electric plants, transportation terminals and any construction activity which disturbs 5 acres or more during construction.

1: Non-contact cooling water may contain biocides; however, the biocides must be approved by our Aquatic Survey and Toxicology Unit. The approval process verifies that the chemicals involved have no detrimental effect on the stream when discharged with the non-contact cooling water.

general permit. At present there are no sampling sites on Owl Creek to determine the effect of the trout farm on water quality. No water quality problems resulting from the farm have been reported. Trout farms can be a source of nutrients to surface waters if the farms are not managed properly. The impacts from trout farms are typically found within a short stream length from the farm. In this way, impacts from trout production are localized and can result in lower macroinvertebrate ratings. Changes caused by trout farms can be in the form of algal production and higher than normal nutrients. The effects from trout farms are more often seen during low flows and high water temperatures. Trout farms can also cause water quality problems if there is more than one farm on a stream reach. See Appendix IV for the requirements of a general permit.

The Town of Andrews operates a 1.5 million gallon per day (MGD) wastewater treatment plant. This plant consistently meets its permit limits, but regularly experiences equipment problems.

Table 3.7 Summary of NPDES Wastewater Permits in the Hiwassee River Basin

Map #	Permit #	Facility	Receiving Stream	County
Subbasin 04-05-01				
1	NC0026697	Hayesville WWTP	Town Creek	Clay
3	NC0021148	USDAFS/Jack Rabbit Mtn Recreation Area	Chatuge Lake	Clay
4	NC0027332	TVA/Chatuge Hydro Plant	Hiwassee River	Clay
5	NCG550427	J. Davenport Residence	Tusquitee Creek	Clay
-	NCG500128	Nantahala P&L/Mission Hydro Plant	Hiwassee River	Clay
Subbasin 04-05-02				
1	NC0079031	Industrial Opportunities, Inc.	Hyatt Creek	Cherokee
2	NC0020800	Town of Andrews WWTP	Valley River	Cherokee
3	NC0023001	CWS/Bear Paw WWTP	Hiwassee River	Cherokee
3	NC0027359	TVA/Hiwassee Hydro Plant	Hiwassee River	Cherokee
4	NC0080683	Litton Systems/Clifton Precision	Slow Creek	Cherokee
5	NC0020940	Murphy WWTP	Hiwassee River	Cherokee
7	NC0063088	Riverside Bar-B-Que	Nottely River	Cherokee
10	NC0035386	Hiwassee Dam School	Thompson Branch	Cherokee
12	NCG530068	Craig's Trout Farm	Owl Creek	Cherokee
-	NC0069892	Town of Andrews WTP	Dan Holland Creek	Cherokee
-	NCG50006	Coats American	Hyatt Creek	Cherokee

These problems have been linked to significant inflow and infiltration resulting from an antiquated collection system. The collection system is primarily constructed from clay pipe which is subject to failure resulting in excessive inflow and infiltration. A sewer line study is currently under way to identify problem lines and target priority areas for renovation.

The Clay County Water and Sewer District (CCWSD) presently owns and operates a 0.097 MGD wastewater treatment plant (WWTP) for Hayesville. The WWTP discharges to Town Creek which is classified as WS-IV waters. This facility has been in continuous violation of permit limits for BOD and TSS in the past year due to increases in wastewater flows and inadequately designed treatment units.

The CCWSD is proposing to construct a new 300,000 gallons per day (GPD) WWTP on property owned by Clay County located off of Jarrett Road just outside of the Hayesville Town Limits. The proposed discharge for the new WWTP is directly into the Hiwassee River approximately 1000 linear feet upstream of the Tusquitee Road Bridge. Construction of a new facility will remedy the permit violation problems while allowing additional growth in the area. Relocation of the treatment plant discharge to the Hiwassee River will allow for greater assimilation of wastewater, relieving much of the stress that has been placed on the much smaller Town Creek.

The existing Hayesville WWTP serves 379 customers, located both inside and outside of the town limits. Based on the historical demographics and wastewater flow data, the 300,000 GPD WWTP is projected to handle maximum daily flow beyond the year 2015.

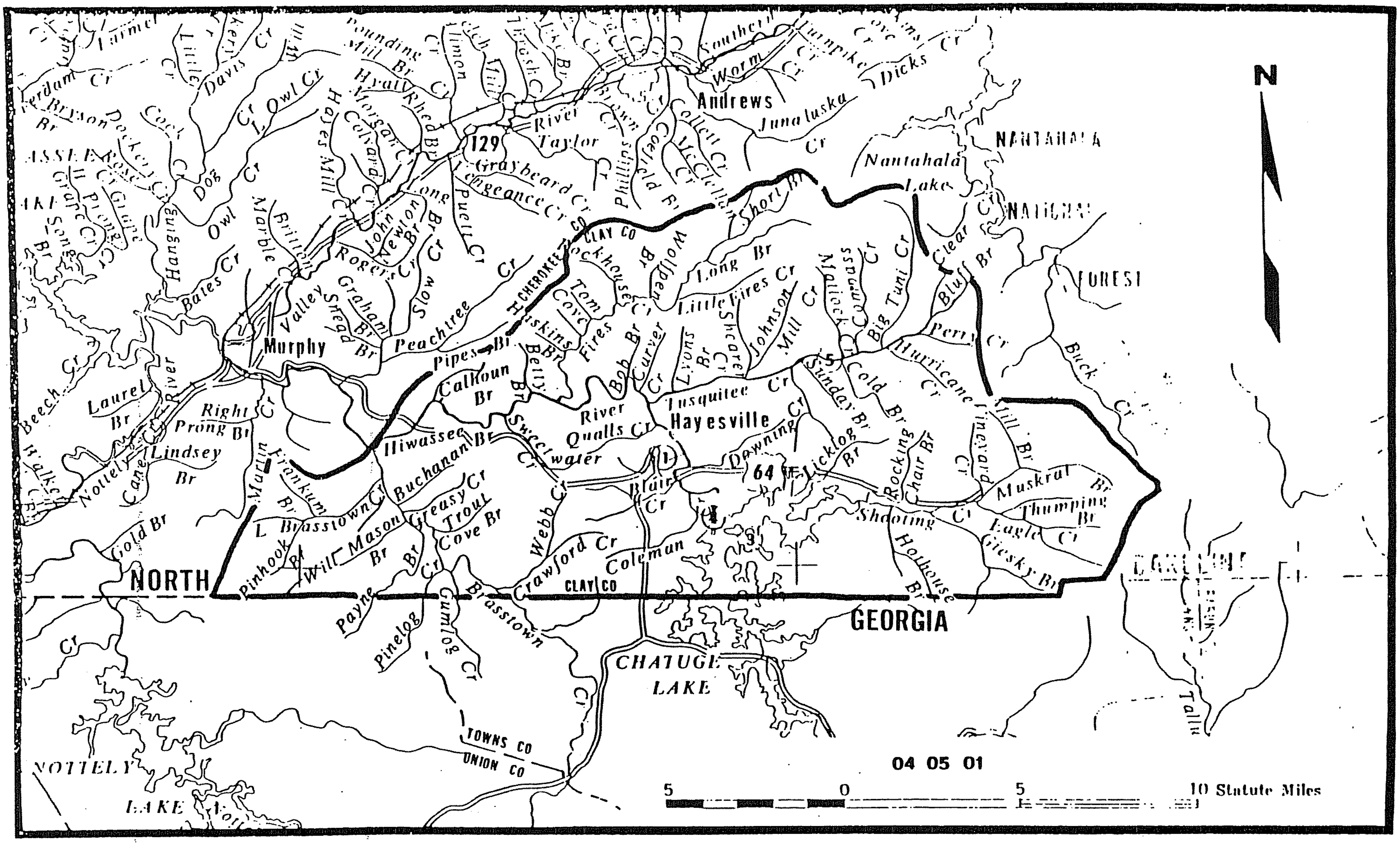


Figure 3.1 Map of NPDES Dischargers in the Chatuge Lake and Hiwassee River (Subbasin 04-05-01)

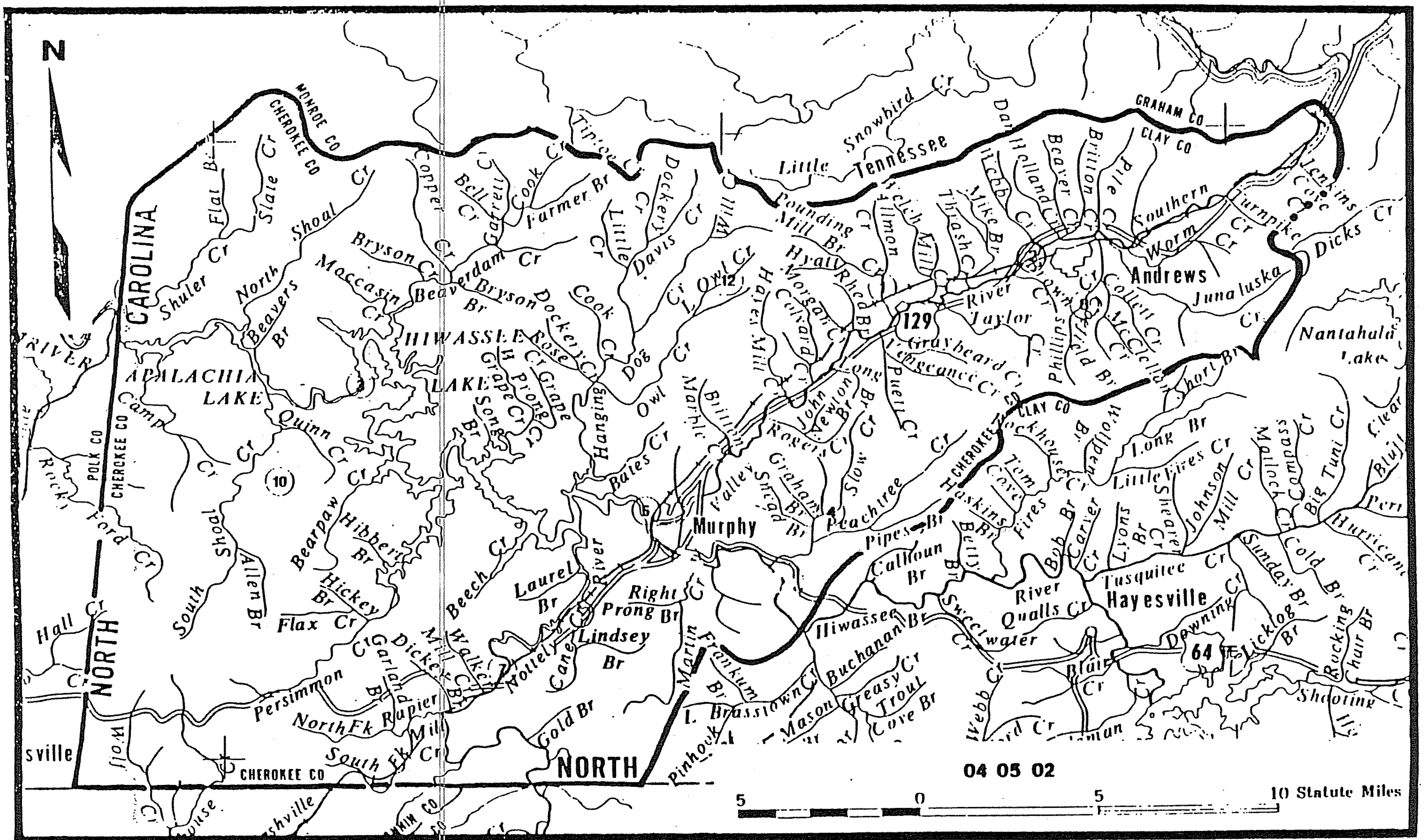


Figure 3.2 Map of NPDES Dischargers in the Hiwassee River, Hiwassee Lake and Apalachia Lake (Subbasin 04-05-02)

Table 3.8 Summary of Major/Minor NPDES Dischargers and Permitted and Actual Flows by Subbasin for the Hiwassee River Basin

FACILITY CATEGORIES	SUBBASIN 01	SUBBASIN 02	TOTALS
NC00 Individual Facilities	3	9	12
Stormwater Facilities	3	13	16
NCG General Permit Facilities	2	2	4
Total Facilities	8	24	32
Total Permitted Flow (MGD)	0.11	2.83	2.94
# of Facilities Reporting	2	7	9
Total Avg. Flow (MGD)	0.09	1.61	1.70
***Major Discharges**	0	1	1
Total Permitted Flow (MGD)	0	1.5	1.5
# of Facilities Reporting	0	1	1
Total Avg. Flow (MGD)	0.00	0.72	0.72
***Minor Discharges**	3	8	11
Total Permitted Flow (MGD)	0.11	1.33	1.44
# of Facilities Reporting	2	7	9
Total Avg. Flow (MGD)	0.09	0.89	0.98
100% Domestic Wastewater	1	4	5
Total Permitted Flow (MGD)	0.01	0.11	0.12
# of Facilities Reporting	1	4	5
Total Avg. Flow (MGD)	0.00	0.01	0.01
Municipal Facilities	1	1	2
Total Permitted Flow (MGD)	0.48	1.50	1.98
# of Facilities Reporting	1	1	2
Total Avg. Flow (MGD)	0.24	0.72	0.96
Major Process Industrial	0	0	0
Total Permitted Flow (MGD)	0	0	0
# of Facilities Reporting	0	0	0
Total Avg. Flow (MGD)	0.00	0.00	0.00
Minor Process Industrial	0	0	0
Total Permitted Flow (MGD)	0.00	0.00	0.00
# of Facilities Reporting	0	0	0
Total Avg. Flow (MGD)	0.00	0.00	0.00
Nonprocess Industrial	0	2	2
Total Permitted Flow (MGD)	0.00	0.30	0.30
# of Facilities Reporting	0	2	2
Total Avg. Flow (MGD)	0.00	0.01	0.01

* NC00 Individual permit facilities

The Murphy WWTP is currently operating near its permitted capacity of 0.925 MGD. This facility is under moratorium for the addition of new sewer lines and an evaluation of the existing infrastructure is underway. The results of this evaluation will determine if the facility will have to expand or can reduce flow through the facility by renovating the existing infrastructure to address inflow and infiltration .

3.3.3 Stormwater Point Source Discharges in the Hiwassee River Basin

In the Hiwassee River basin, stormwater permitted industrial activities include the manufacture of ready mixed concrete, asphalt, metal products and equipment, textiles, timber products, furniture, stone, clay, and glass products, and mining activities. A complete list of permitted stormwater dischargers in the Hiwassee River basin is provided in Table 3.9. Figure 3.3 shows the locations of all permitted stormwater discharges.

The primary source of concern from these facilities is the contamination of stormwater from contact with exposed materials. In addition, poor housekeeping can lead to significant contributions of sediment and other pollutants to receiving streams. Water quality problems caused by excessive sediment loading have been reported in association with a ready mixed concrete facility on Whitaker Lane near Andrews. However, under new management this facility has installed best management practices to reduce the discharge of sediment from the site. The sediment basin installed has proven to be effective at resolving the water quality concerns identified. No other water quality concerns have been raised with regard to NPDES stormwater permitted dischargers.

3.4 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) pollution refers to runoff that enters surface waters through stormwater, snowmelt or atmospheric deposition (e.g., acid rain). There are many types of land use activities that can serve as sources of nonpoint source pollution including land development, construction, mining operations, crop production, animal feeding lots, failing septic systems, landfills, roads and parking lots. As noted earlier, stormwater from large urban areas (>100,000 people) and from certain industrial sites is technically considered a point source since NPDES permits are required for piped discharges of stormwater from these areas. However, a discussion of urban runoff will be included in this section.

Sediment and nutrients are major pollution-causing substances associated with nonpoint source pollution. Others include fecal coliform bacteria, heavy metals, oil and grease, and any other substance that may be washed off the ground or removed from the atmosphere and carried into surface waters. Unlike point source pollution, nonpoint pollution sources are diffuse in nature and occur at random time intervals depending on rainfall events. Below is a brief description of major areas of nonpoint sources of pollution in the Hiwassee River Basin.

3.4.1 Agriculture

There are a number of activities associated with agriculture that can serve as sources of water pollution. Land clearing and plowing make soils susceptible to erosion, which can then cause stream sedimentation. Pesticides and fertilizers (including chemical fertilizers and animal wastes) disposal sites. Construction of drainage ditches on poorly drained soils enhances the movement of stormwater into surface waters. Concentrated animal feed lot operations or dairy farms without adequate waste management systems or fencing to keep cows away from streams can be a significant source of BOD, fecal coliform bacteria, sediment and nutrients. Untreated discharge from a large operation can be compared to the nutrient load in the discharge from a secondary waste treatment plant serving a small town.

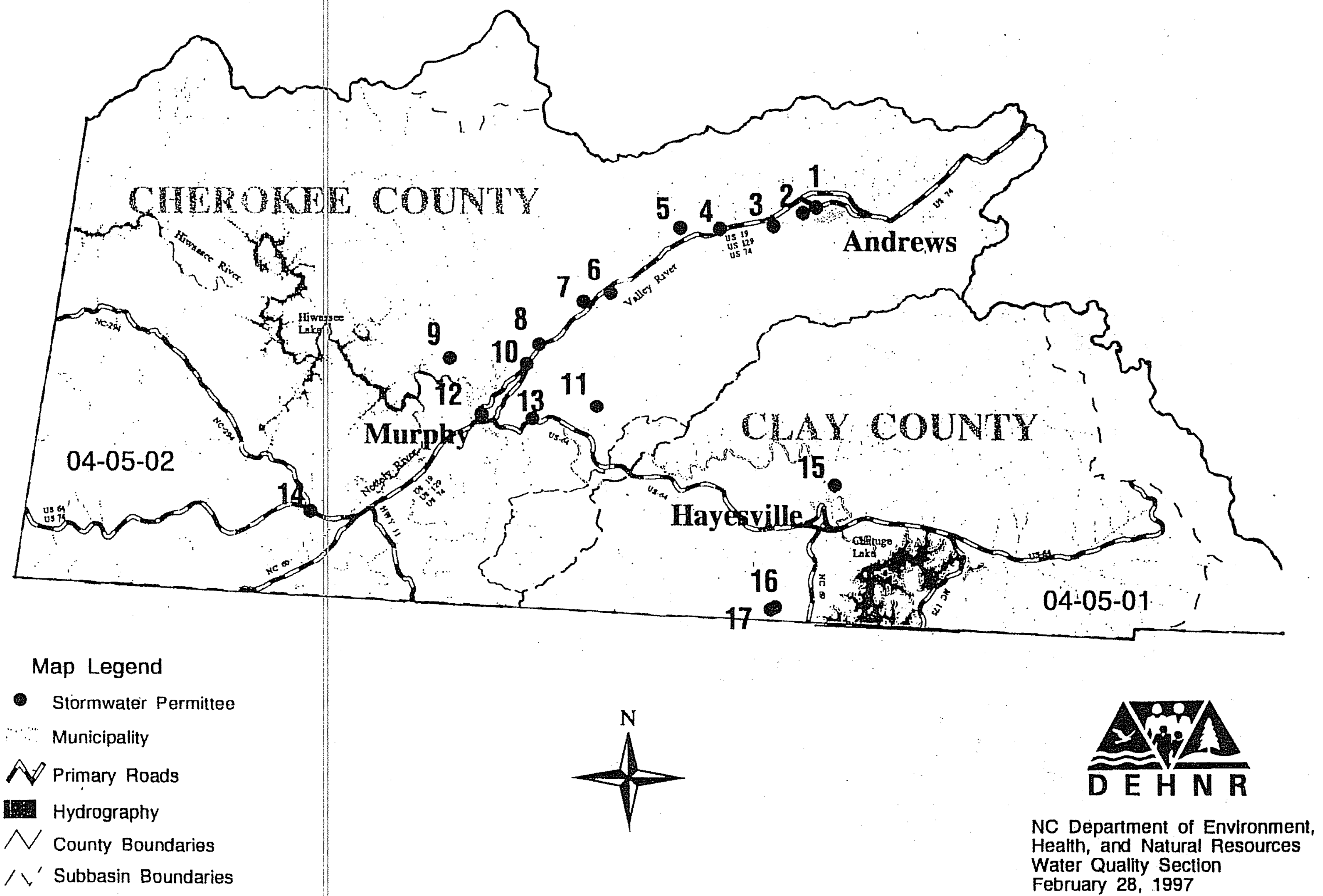
Table 3.9 Summary of NPDES Stormwater Permits in the Hiwassee River Basin

Permit #	Facility	Receiving Stream	County
NCG020244	Harrison Construction Co. Hayesville Quarry	Beech Branch	Clay
NCG030317	Intercomp Wire & Cable	UT Hiwassee River	Clay
NCG160032	APAC Tennessee Inc.	Crooked Creek	Clay
NCG020246	Harrison Construction Co. Hanging Dog Quarry	Hiwassee River	Cherokee
NCG030026	Outboard Marine Corp.	Valley River	Cherokee
NCG030084	Clifton Precision, Div. Of Litton Systems, Inc.	Slow Creek & Hiwassee River	Cherokee
NCG030171	Emerson Electric Co.	Hiwassee River	Cherokee
NCG040125	Cooper Manufacturing Of Murphy, NC, Inc.	Valley River	Cherokee
NCG040129	Valwood Corporation	Welch Mill Creek & Coalville Branch	Cherokee
NCG040294	Bernhardt Furniture Co. Mundy's Lumber	Valley River	Cherokee
NCG070039	Whittaker, Clark & Daniels, Inc., Cherokee Minerals	Marble Creek	Cherokee
NCG140005	Southern Concrete Materials, Inc.	Valley River	Cherokee
NCG140148	Southern Concrete Materials Inc.-Regal St.	Valley River	Cherokee
NCG140154	Southern Concrete Materials Inc.-Whitaker Ln.	Valley River	Cherokee
NCG170268	Coats American-Cherokee	Hyatt Creek	Cherokee
NCG180140	Baker, Knapp & Tubbs	Whittaker Creek	Cherokee

Sediment production and transport is greatest from row crops and cultivated fields (Waters 1995; Lenat et al. 1979). Contour plowing, terracing and grassed waterways are several common methods used by most farmers to minimize soil loss. Maintaining a vegetated buffer between fields and streams is another excellent way to minimize soil loss to streams. Fencing cattle and dairy cows from streams protects streambanks from trampling, protects streamside vegetation and decreases the introduction of nutrients and fecal coliform bacteria from animal waste.

The primary cause of stream impairment associated with agriculture in the mountains is sedimentation. Chapter 5 discusses agricultural nonpoint source control programs. A list of BMPs for addressing agricultural runoff is presented in Appendix V.

Figure 3.3 Map of the Location of NPDES Stormwater Permittees in the Hiwassee River Basin



3.4.2 Urban/Residential

It is commonly known that urban streams are often polluted streams. There are questions concerning what aspects of urbanization cause the degradation, to what extent urbanization alone can be called the source of degradation, and what can be done about the pollutants and human habits that cause the degradation. Some potential impacts of stormwater runoff include:

- Polluted water: Numerous pollutants may be present in urban stormwater, including sediment, nutrients, bacteria, oxygen demanding substances, oil and grease, trace metals, road salt, and toxic/synthetic chemicals. These pollutants can impair aquatic life, reduce recreational value and threaten public health if drinking water sources and fish tissue become contaminated.
- Flooding: Flooding damages public and private property, including infrastructure. It can also threaten public safety.
- Eroded streambanks: Sediment clogs waterways and fills lakes and reservoirs. It can also smother the plants and animals in waterbodies and destroy the habitat necessary for reproduction of fish and aquatic animals. The erosion of streambanks causes loss of valuable property as stream width grows.
- Economic impacts: The economy can be impacted from a loss of recreation-related business and an increase in drinking water treatment costs.

Runoff from urbanized areas, as a rule, is more localized but can often be more severe than agricultural runoff. Any type of land-disturbing activity such as land clearing or excavation can result in soil loss and cause sedimentation into the waters in the watershed. The rate and volume of runoff in urban areas is much greater due both to the high concentration of impervious surface areas and to storm drainage systems that rapidly transport stormwater to nearby surface waters. This increase in volume and rate of runoff can result in streambank erosion and sedimentation in surface waters.

These drainage systems, including curb and guttered roadways, also allow urban pollutants to reach surface waters quickly and with little or no filtering. Pollutants include lawn care products such as pesticides and fertilizers; automobile-related pollutants such as fuel, lubricants, abraded tire and brake linings; lawn and household wastes (often dumped in storm sewers); road salts, and fecal coliform bacteria (from animals and failing septic systems). The diversity of these pollutants makes it very challenging to attribute water quality degradation to any one pollutant.

Replacement of natural vegetation with pavement, removal of streamside buffers and managed lawns reduce the ability of the watershed to filter pollutants before they enter the stream. The chronic introduction of these pollutants and increased flow and velocity into a stream results in degraded waters. Many urban streams are rated as biologically poor.

The population density map presented in Chapter 2 is an indicator of where urban development and potential urban stream impacts are likely to occur. Management strategies for addressing urban runoff are presented in Chapter 6. A list of BMPs for addressing urban runoff is presented in Appendix V.

3.4.3 Construction

Construction activities that entail excavation, grading or filling (such as road construction or land clearing for development) can produce significant sedimentation if not properly controlled. Sedimentation from developing urban areas can be a major source of pollution due to the cumulative number of acres disturbed in a basin. Construction of single family homes in rural areas can also be a source of sedimentation when homes are placed in or near stream corridors. This latter form of development can be seen throughout the Hiwassee River basin.

As a pollution source, construction activities are typically temporary, but the impacts can be severe and long lasting (see discussion in sediment section above). Construction activities tend to be concentrated in the more rapidly developing areas of the basin. However, road construction is widespread and often involves stream crossings in remote or undeveloped areas of the basin. In addition, resort development in relatively undeveloped areas can be devastating to previously unimpacted streams.

Construction-related sedimentation is addressed through the Sedimentation Pollution Control Act (see Section 5.5.3 in Chapter 5). A list of BMPs for controlling erosion and sedimentation is presented in Appendix V.

3.4.4 Timber Harvesting

Forested areas are an ideal land cover for water quality protection. They stabilize the soil, filter rainfall runoff and produce minimal loadings of organic matter to waterways. In addition, forested stream buffers can filter impurities from runoff from adjoining nonforested areas.

Improper forest management practices can adversely impact water quality in a number of ways. This is especially true in mountainous regions where steep slopes and fragile soils are widespread. Without proper BMPs, large clearcutting operations can change the hydrology of an area and significantly increase the rate and flow of stormwater runoff. This results in both downstream flooding and stream bank erosion. Clearcutting, when compared to selective cutting, can cause a much higher rate of erosion (Waters 1995). The hydrology of a watershed can also change due to selective cutting sites if best management practices are not used (Henson, pers. comm.).

Careless harvesting and road and stream crossing construction can transport sedimentation to downstream waters. Streams with sedimentation may require many years to restore. Removing riparian vegetation along stream banks can cause water temperature to rise, destabilize the shoreline and minimize or eliminate the runoff protection benefits of the buffer. Sedimentation due to forestry practices is most often associated with the development and use of logging roads, particularly when roads are built near streams (Waters 1995). Density and length of logging roads can be major factors in the amount of sedimentation produced.

Most forest roads in the basin are under the National Forest Service and are reported to be constructed and maintained very well. Federal forest lands follow the USDA Forest Service Transportation System Management Guidelines (Appendix VII). The NC Division of Forest Resources reports that the US Forest Service complies very well to the NC Forestry Best Management Practices.

Other adverse effects resulting from forestry operations include: 1) an increase in woody debris clogging stream channels which can alter the stream channel and prevent fish movement; 2) loss of riparian vegetation which can reduce shade cover and raise stream temperatures; 3) loss of canopy which can alter the interface of the aquatic and terrestrial ecosystems. This is especially true where populations of amphibians are concerned (Waters 1995).

Timber harvesting is an important industry in the Hiwassee River basin. It is critical that all efforts be made to minimize sediment loss and runoff so as to protect other natural resources in this basin. These resources include trout waters, drinking water supplies and aesthetics. This is especially important in light of a trend toward increased logging in North Carolina and in the southeast United States, in general.

The NC Division of Forest Resources (DFR) presently tracks timber harvesting trends by county rather than by river basin. The DFR is working toward tracking information by river basin in the future. Table 3.7 presents timber harvest trends for private lands in Cherokee and Clay counties.

Actual harvest trends within the basin boundaries are unknown, since only a portion of each county lies within the Hiwassee River basin. Table 3.10 shows that 1987 to 1990 were higher timber harvest years for the region. While total timber harvesting was slightly lower in 1992, both counties show increased harvest rates from 1992 to 1994.

Table 3.10 Timber Harvest Removal Trends (in Thousand Cubic Feet) by County for 1979 to 1994 (Division of Forest Resources).

County	1979	1983	1987	1990	1992	1994
Clay	784	857	1971	1575	695	986
Cherokee	3476	4071	8004	4939	2635	4290
Totals	4260	4928	9975	6514	3330	5276

The DFR is implementing various measures for protecting water quality statewide. These measures include the development of the Forest Practice Guidelines (FPGs) Related to Water Quality of 1976 and Best Management Practices (BMPs) of 1987. The FPGs have mandatory performance standards that must be met in order for landowners to remain exempt from all of the requirements associated with the Sedimentation Pollution Control Act enforced by the Division of Land Resources.

BMP compliance inspections are done by DFR continuously. A recent limited statewide sampling survey (based on 450 site inspections statewide) showed overall compliance rate with forestry BMPs and Forest Practice Guidelines (FPGs) was 92% (Henson 1995; 1996). A summary of activities and past accomplishments in the Hiwassee River basin is reported in Chapter 5.

Section 5.3.6 describes several programs that are aimed at either encouraging or requiring utilization of forest best management practices at the state and federal level. A list of forest BMPs is presented in Appendix V.

3.4.5 Mining

Mining operations can produce high sedimentation in localized streams if not properly conducted. The North Carolina Mining Act of 1971 covers all persons or firms that are involved in any activity or process that disturbs or removes the surface soil in order to remove minerals or other solid matter, or prepares, washes, cleans or in any way treats minerals or other solid materials to make them suitable for commercial, industrial, or construction use. These operations can range from large quarries to small borrow pits. The Mining Act applies only to those operations that affect one acre or more.

The Mining Act requires a permit application form with mine maps and design calculations for erosion and sediment control measures to be submitted to the Division of Land Resources (DLR) for review and approval. The Land Quality Section of DLR is required by law to make routine inspections of all permitted mines and determine if the operator is in compliance with provisions of the mining permit. The Mining Act allows for civil penalties and fines if the Act is violated.

The Mining Act also requires operators to submit a reclamation plan that outlines the method to be used in restoring the land to a condition suitable for its intended future use.

In the Hiwassee River basin there are some gem mining operations. Operators of these mines are not required to file a permit application form if these operations affect less than one acre of soil surface. Most of the gem mines in the Hiwassee River basin are too small to fall within the requirements of the Mining Act.

Information on the North Carolina Mining Act and the state's mining program are listed in Appendix VI. Mining BMPs are listed in Appendix V.

3.4.6 Onsite Wastewater Disposal

Septic systems contain all of the wastewater from a household or business. The septic tank removes some wastes, but the soil drainfield provides further absorption and treatment. Septic tanks can be a safe and effective method for treating wastewater if they are sized, sited, and maintained properly. However, if the tank or drainfield malfunction or are improperly placed, constructed or maintained, nearby wells and surface waters may become contaminated.

Some of the potential problems from malfunctioning septic system include:

- <u>Polluted groundwater</u>: Pollutants in sewage include bacteria, nutrients, toxic substances, and oxygen-consuming wastes. Nearby wells can become contaminated by septic tanks.
- <u>Polluted surface water</u>: Often, groundwater carries the pollutants mentioned above into surface waters, where they can cause serious harm to aquatic ecosystems. Septic tanks can also leak into surface waters both through or over the soil.
- <u>Risks to human health</u>: Septic system malfunctions can endanger human health when they contaminate nearby wells, drinking water supplies, and fishing and swimming areas.

Pollutants associated with onsite wastewater disposal may also be discharged directly to surface waters through *straight pipes* (i.e., direct pipe connections between the septic system and surface waters). These types of discharges, if unable to be eliminated, must be permitted under the NPDES program and be capable of meeting effluent limitations specified to protect the receiving stream water quality, including disinfection. The prevalence of straight piping in some western counties of the state has recently drawn the attention of the Year of the Mountains Commission. Legislation has recently been passed to establish a program to eliminate domestic sewage or wastewater discharges from straight pipes or failing septic systems.

Onsite wastewater disposal is most prevalent in rural portions of the basin and at the fringes of urban areas. Fecal coliform contamination from failing septic systems is of particular concern in waters used for swimming, tubing, water supply and other related activities (Chapter 4). Regulatory programs and BMPs pertaining to onsite wastewater disposal are presented in Appendix V.

3.4.7 Solid Waste Disposal

Solid wastes may include household wastes, commercial or industrial wastes, refuse or demolition waste, infectious wastes or hazardous wastes. Improper disposal of these types of wastes can serve as a source of a wide array of pollutants. The major water quality concern associated with modern solid waste facilities is controlling the leachate and stabilizing the soils used for covering many disposal facilities. Properly designed, constructed and operated facilities should not significantly effect water quality.

Groundwater and surface water monitoring is required at all permitted Municipal Solid Waste Sites (MSW) and all Construction and Demolition landfills. Monitoring efforts have been required since July 1989. All MSW landfills must have a liner system in place by January 1, 1998. All existing unlined landfills must close at this same time.

Section 5.3.5 briefly summarizes state, local and federal solid waste recycling programs.

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