CHAPTER 3

CAUSES AND SOURCES OF WATER POLLUTION IN THE CATAWBA RIVER BASIN

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 small urban areas (population less than 100,000), forestry, mining, agricultural lands and others. **Section 3.2** identifies and describes the major causes of pollution in the Catawba basin. **Sections 3.3** and **3.4** describe point and nonpoint source pollution in the basin.

3.2 DEFINING CAUSES OF POLLUTION

The term *causes* of pollution refers to the substances which enter surface waters from point and nonpoint sources and result in water quality degradation. The major causes of pollution discussed throughout the basin plan include *biochemical oxygen demand (BOD)*, *nutrients*, *sediment*, *toxicants* (such as heavy metals, chlorine and ammonia), *color* and *fecal coliform bacteria*. Each of the following descriptions indicates whether the cause is point or nonpoint source-related (or both).

3.2.1 Oxygen-Consuming Wastes

Oxygen-consuming wastes are substances such as decomposing organic matter or chemicals which remove dissolved oxygen from the water column. 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. Understanding oxygen-consuming wastes and their impact on water quality is enhanced by some basic knowledge of the factors which affect dissolved oxygen concentrations in the water.

The concentration of dissolved oxygen (DO) in a water body is one indicator of the general health of an aquatic ecosystem. A lack of sufficient DO in the water will threaten aquatic life. The United States Environmental Protection Agency (EPA) states that 3.0 milligrams per liter (mg/l) is the threshold DO concentration needed for many species' survival (EPA, 1986). Higher concentrations are needed to promote propagation and growth of a diversity of aquatic life in North Carolina's surface waters. North Carolina has adopted a water quality standard of 5.0 mg/l to protect the majority of its surface waters. Exceptions to this standard exist for waters supplementally classified as *trout waters* and those supplementally classified as *swamp* (not found in the Catawba Basin). Trout waters have a DO standard of 6.0 mg/l due to the higher sensitivity of trout to low DO levels. Swamp waters often have naturally low levels of DO, and aquatic life typically found in these waters is adapted to the lower DO levels. Sluggish swamp waters in the coastal plain portion of the state may have natural DO levels of 3.0 to 4.0 mg/l or less at times. Therefore, the DO standard for swamp waters may be less than 5.0 mg/l if that lower level is judged to be the result of natural conditions. Many of the freshwater streams in the Coastal Plain portion of the basin are swamp waters.

DO concentrations are affected by a number of factors. Higher DO is produced by turbulent actions which mix air and water such as waves, rapids and water falls. This process is referred to as reaeration. In addition, lower water temperature generally allows for retention of higher DO concentrations.

Aquatic plant life, including algae, can also produce DO, although this effect is generally temporary and usually occurs nears the surface. Oxygen is produced by algae and other plants in the presence of sunlight through a process called *photosynthesis*. At night, however, photosynthesis and DO production stop and DO is consumed by plants through a process called *respiration*. During the summer months, this daily cycle of daytime oxygen production and nighttime depletion often results in supersaturation of the surface water by oxygen during the afternoon hours on bright, sunny days, and low DO concentrations during the late night and early morning hours.

Another cause of DO depletion is the decomposition of organic matter such as leaves, dead plants and animals, and organic waste matter that may be washed or discharged into the water. Human and household wastes are high in organic waste matter, and bacterial decomposition can rapidly deplete DO levels unless these wastes are adequately treated at a wastewater treatment plant to remove much of the organic component. In addition, some chemicals may react with and bind up DO, and high water temperatures reduce the ability of water to retain DO. Therefore, in general, lowest DO concentrations usually occur during the warmest summer months and particularly during low flow periods. Low DO levels often occur in warm, slow-moving waters that receive a high input of effluent from wastewater treatment plants during low flow conditions. Water depth is also a factor. In deep slow moving waters such as reservoirs or estuaries, DO 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.

Biochemical oxygen demand, or BOD, is a technical term that describes the overall demand on DO from the various oxygen-depleting processes presented above. BOD can be further subdivided into two broad categories: *carbonaceous* biochemical oxygen demand (CBOD) and *nitrogenous* biochemical oxygen demand or NBOD (largely comprised of ammonia (NH_3)). CBOD accounts for the DO consumed by organic substances breaking down. NBOD refers to the bacterial conversion of ammonia to nitrite and nitrate which also uses dissolved oxygen. NPDES permits administered by DEM typically have limits for BOD_5 in each point source permit.

A large portion of the organic material discharged into the water from a wastewater treatment plant is readily decomposed as the oxygen-consuming decay process may begin to occur within a matter of hours. As this decay process occurs in a moving water column, the area of greatest impact may be several miles below the point of discharge. This area can be often be identified by a marked reduction in instream dissolved oxygen concentrations and is commonly referred to as the *sag zone*. Frequently, DO concentrations will gradually rise downstream of the sag zone as the amount of readily decomposed organic matter is reduced. However, a significant portion of the organic matter in wastewater treatment plant effluent may take days to decompose. A commonly used measure of BOD is called BOD_5 where the "5" stands for five days. BOD_5 is a standard waste limit in most discharge permits. A limit of 30 mg/l of BOD_5 is the highest concentration allowed by federal and state regulations for municipal and domestic wastewater treatment plants. However limits less than 30 mg/l and sometimes as low as 5 mg/l are becoming more common in order to maintain DO standards in the receiving waters.

Oxygen Consuming Wastes in the Catawba Basin

The total daily loading of biochemical oxygen demanding wastes (BOD) from NPDES (National Pollutant Discharge Elimination System) municipal dischargers in the Catawba River Basin in 1993 is estimated to be significantly lower than it was 20 years ago despite a large increase in the total volume of treated wastewater. As noted in Figure 3.1a, the total loading of BOD has decreased from approximately 6.3 tons per day in the mid-1970s to approximately 4.2 tons per day in 1993 while the total daily volume of effluent discharged increased by 58% from 72 MGD in the mid 1970s to 114 MGD in 1993 (Figure 3.1b). This reduction in BOD loading is attributed to more stringent point source pollution control requirements mandated by the federal Clean Water Act and implemented through the state's NPDES program.

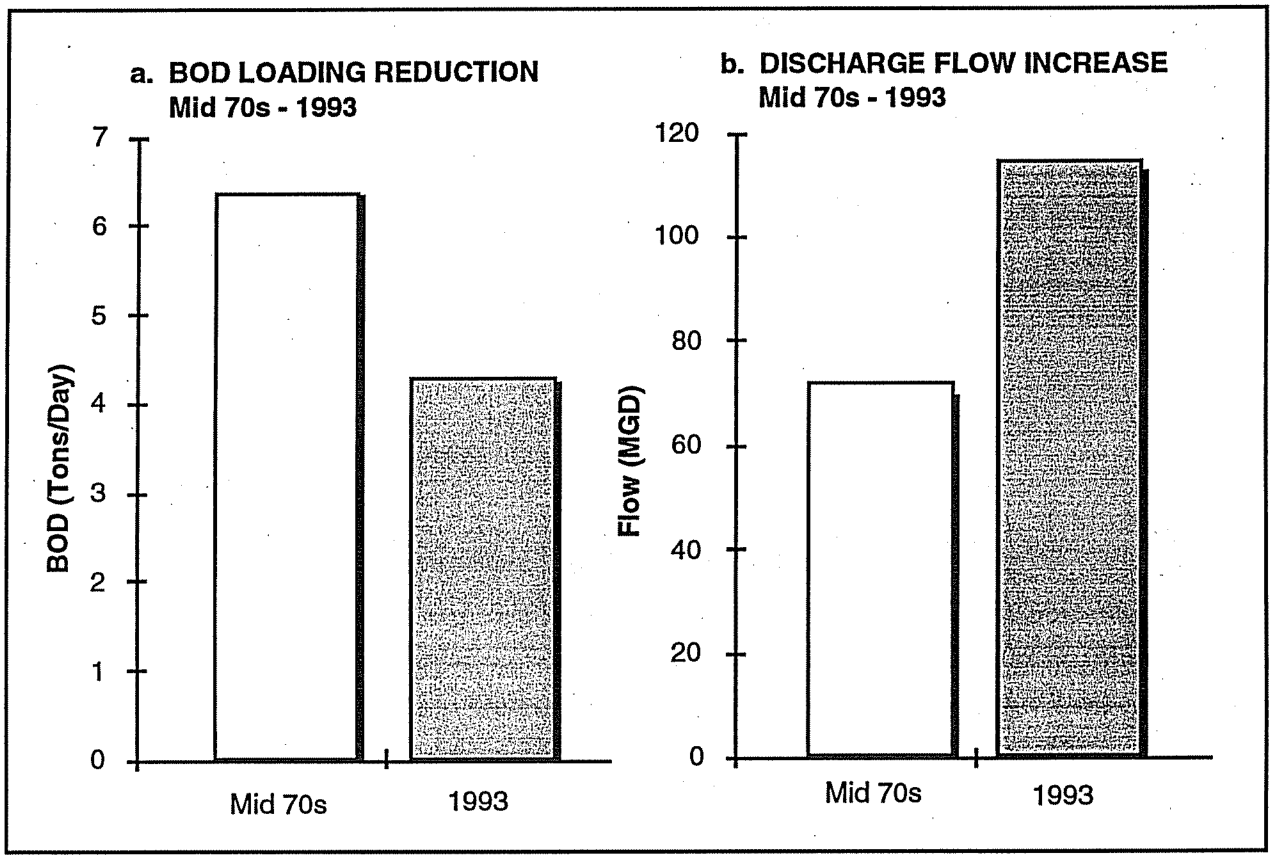

Figure 3.1 Comparison of (a) Total BOD Loading and (b) Effluent Flows from Municipal NPDES dischargers in the Catawba River Basin Between Mid-1970s and 1993

Comparisons of BOD loadings and flows from municipal wastewater treatment facilities in the basin are presented in Figures 3.2 and 3.3. For municipalities or municipal sewer authorities that operate more than one facility, such as Gastonia and the Charlotte-Mecklenburg Utility Department, the flows and loadings are combined. These numbers are based on actual loadings and flows through 1993.

In general, while water quality standards for dissolved oxygen are being met throughout most of the basin, modeling studies have indicated that the BOD assimilative capacity is either limited or has been exhausted in some waters in the basin. Also, treatment of BOD will need to continue to improve in order to maintain water quality standards in the face of future plant expansions. In addition, the tributary arms of many lakes in the basin are susceptible to impacts from loadings of BOD. Recommended strategies for addressing BOD are presented in Section 6.3 of Chapter 6.

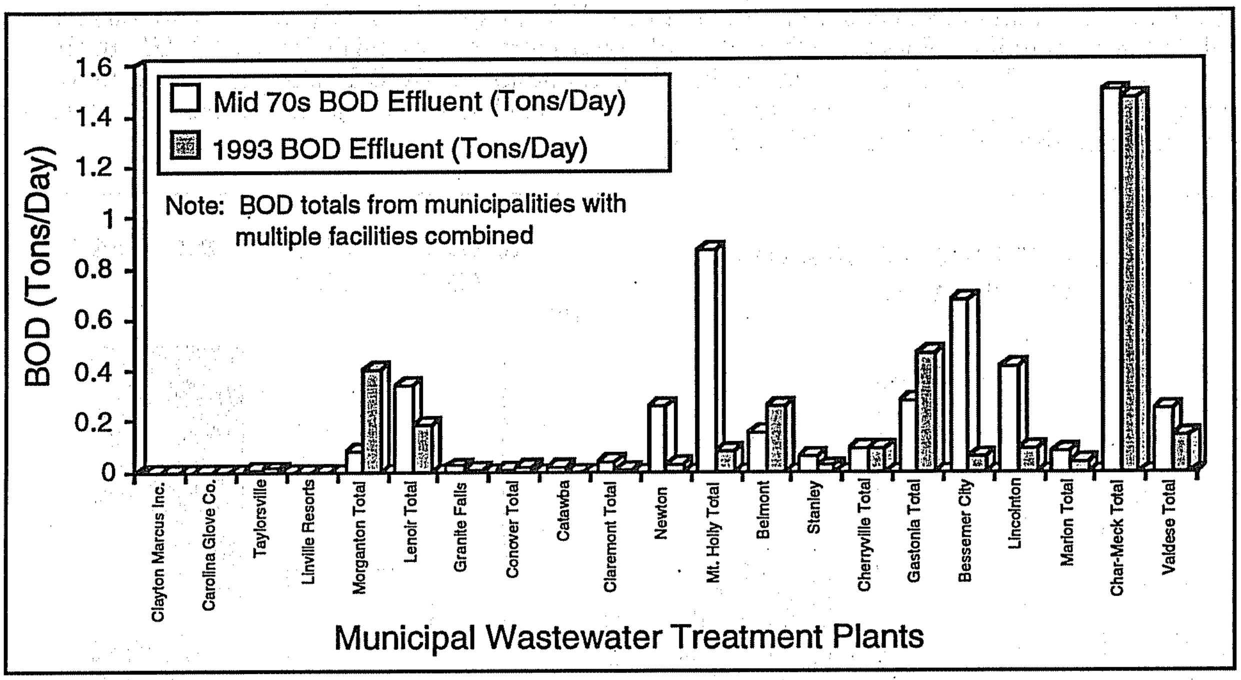

Figure 3.2 Comparison Between Mid-1970s and 1993 Loading of Biochemical Oxygen Demand (BOD) from Municipal Wastewater Treatment Plants in the Catawba Basin

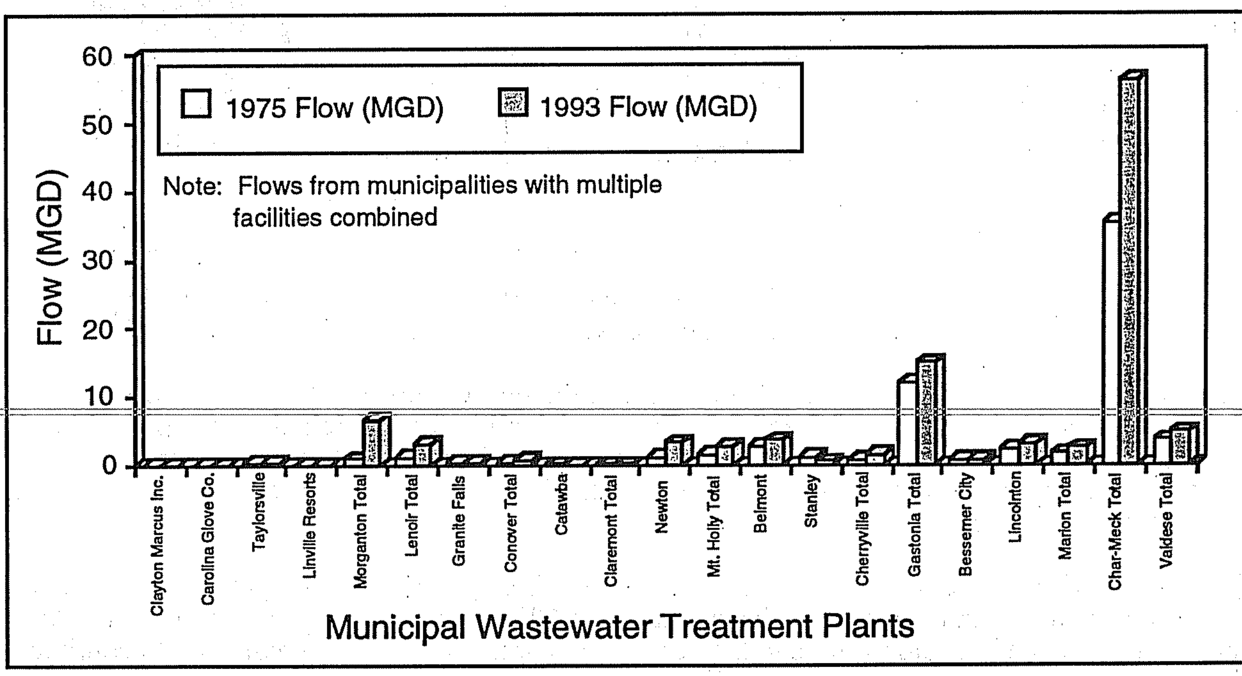

Figure 3.3 Comparison Between Mid-1970s and 1993 Daily Effluent Flow from Municipal Wastewater Treatment Plants in the Catawba Basin

3.2.2 Nutrients

The term *nutrients* in this document refers to the substances phosphorus and nitrogen, two common components of fertilizers, animal and human wastes, vegetation and some industrial processes. Nutrients in surface waters come from both point and nonpoint sources. While nutrients can be beneficial to aquatic life in small amounts, 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.

Algae blooms, through respiration and decomposition, deplete the water column of dissolved oxygen and can contribute to serious water quality problems. Nutrient overenrichment and the resultant problems of low DO are called *eutrophication*. In addition to problems with low DO, the blooms are aesthetically undesirable, impair recreational use, impede commercial fishing and pose difficulties in water treatment at water supply reservoirs. Excessive growth of larger plants, or macrophytes, such as milfoil, alligator weed and Hydrilla, can also be a problem. These plants, in overabundance, can reduce or eliminate swimming, boating and fishing in infested waters.

Agricultural runoff and wastewater treatment plants along with forestry and atmospheric deposition are the main sources of nutrients. Nutrients in nonpoint source runoff come mostly from fertilizer and animal wastes. Nutrients in point source discharges are from human wastes, food residues, some cleaning agents and industrial processes. A statewide phosphorus detergent ban implemented in 1988 significantly reduced the amount of phosphorus reaching and being discharged into surface waters from wastewater treatment plants. A report was prepared by the North Carolina Department of Environment, Health, and Natural Resources in 1991 to evaluate the effects of the ban. (NCDEHNR, 1991).

At this time, North Carolina has no numeric instream standards for total phosphorus (TP) and total nitrogen (TN), but analysis is underway, and standards or instream criteria may be developed for these parameters in the future. In addition, the State has a standard of 40 ug/l (micrograms per liter or parts per billion) for chlorophyll *a* Chlorophyll *a* is a constituent of most algae (it gives algae its green color). A chlorophyll *a* reading above the 40 ug/l standard is indicative of excessive algal growth and portends bloom conditions.

Nutrients in the Catawba Basin

Nutrients, especially phosphorus, are a potential water quality problem throughout much of the river basin because of their potential impacts on the many lakes found in the basin. Of particular concern are the impacts in the headwater tributaries of these lakes. Table 4.7 in Chapter 4 identifies three lakes as being threatened by nutrients based on observed high chlorophyll *a* levels: Lake Hickory, Lake Wylie and Maiden Lake. Discussions of nutrient-related concerns for these lakes are presented in Sections 4.4.3, 4.4.5 and 4.4.6. Ambient water quality data for nitrogen and phosphorus are presented in Section 4.3 of Chapter 4 (Figures 4.4, 4.9, 4.10, 4.11, and 4.13 through 4.17).

A special water quality study was conducted jointly by DEM and the South Carolina Department of Health and Environmental Control regarding nutrient loadings to Lake Wylie. The resulting 1992 report (North Carolina Department of Environment, Health, and Natural Resources, 1992) found that the lake's assimilative capacity for nutrients was exhausted in the tributary arms from Catawba Creek and Crowders Creek and nearly exhausted in the mainstem below the confluence of the Catawba River and South Fork Catawba arms. Figure 3.4 is a schematic representation of the lake which indicates the phosphorus and nitrogen loads entering the lake from the four main tributary arms: Catawba River, South Fork Catawba River, Catawba Creek and Crowders Creek. Also shown are the contributions of nutrients from seven major wastewater treatment plants. See Section 4.4.5 of Chapter 4 for a more detailed review of Lake Wylie Report findings.

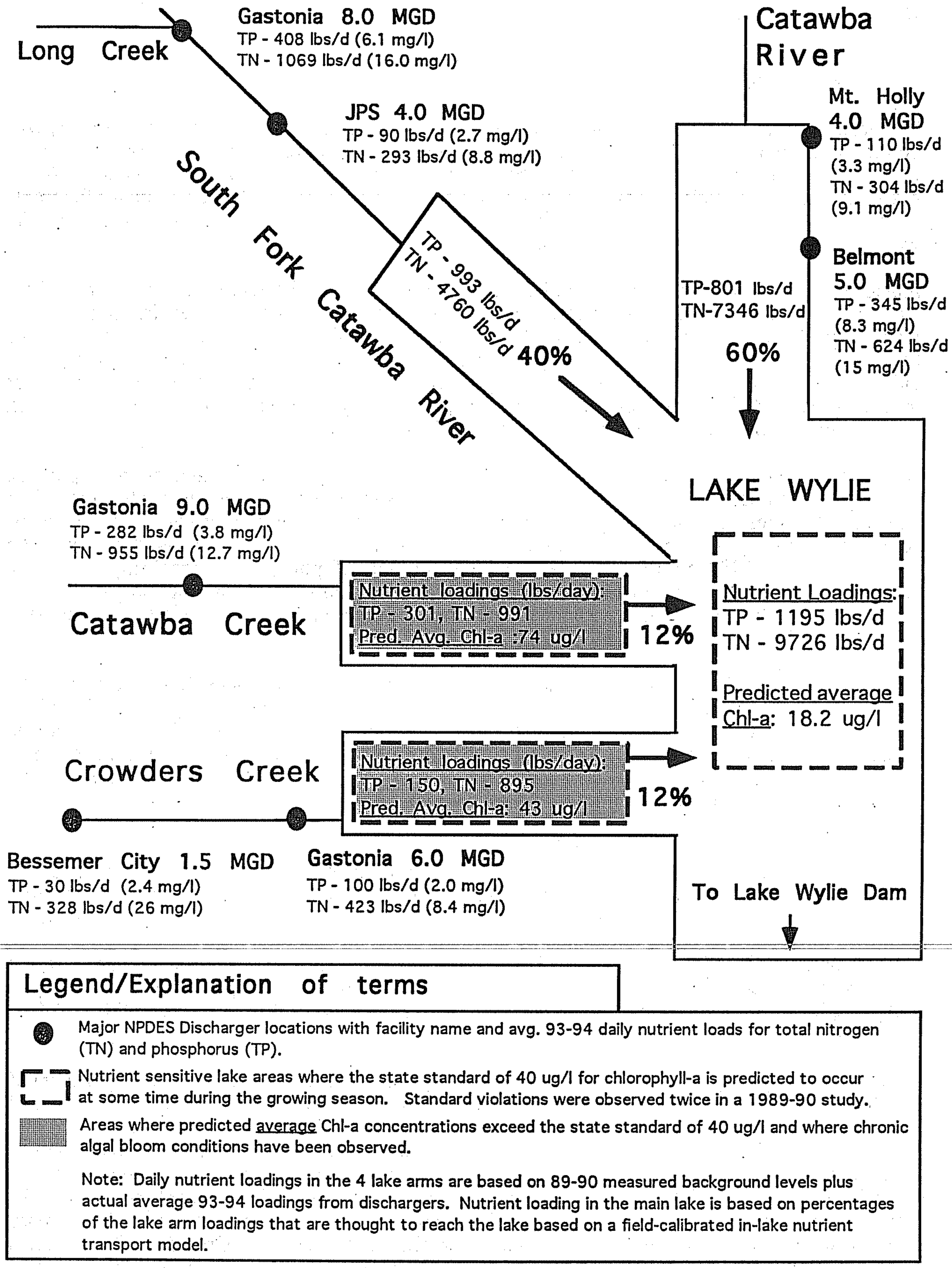

Figure 3.4 Schematic Diagram of Lake Wylie Showing Nutrient Loadings and Predicted Chlorophyll-a Concentrations in the 4 Major Arms and the Mainstem of the Lake

In each of the tributary arms to the lake, pounds per day of total phosphorus (TP) and total nitrogen (TN) are shown. For example, the TP for the South Fork Catawba River is 993 lbs/day. This number is derived by adding together background nutrient loadings from the 1989-90 study (with 89-90 nutrient loadings from the nearby major discharges subtracted out) with the 93-94 average daily loadings from the depicted wastewater treatment plants. The percentages shown in bold type and accompanied by an arrow indicate the percentage of the nutrients in each tributary arm that are estimated to reach the mainstem of the lake taking into consideration uptake of the nutrients by algae and other factors that would limit in-lake transport. As an example, 60% of the nutrients in the Catawba River arm of the lake are estimated to reach the nutrient sensitive mainstem segment of the lake. These percentages are based on a field-calibrated in-lake nutrient transport model run by DEM. The TP and TN values in the Lake Wylie portion of the diagram represent the combined nutrient loads transported from all four lake arms to the mainstem.

The areas of the lake enclosed by the dashed-line boxes are nutrient sensitive areas of concern. In each box is the predicted average chlorophyll *a* concentration over that segment of the lake during the growing season (April through October). As this is an average over the entire segment, chlorophyll *a* concentrations both above and below this value are expected. Hotspots with concentrations above the 40 ug/l state standard for chlorophyll *a* can be anticipated in the mainstem segment of the lake even though the predicted average concentration is 18.2 ug/l. In the Crowders and Catawba Creeks arms, the predicted average chlorophyll *a* concentrations are 43 and 74 ug/l, respectively. Both of these averages are above the state standard and have been shaded for emphasis.

Relative point source contributions of nutrients are summarized below:

	Major municipal	Industrial	Minor domestic
Total Phosphorus	86%	11%	3%
Total Nitrogen	73%	26%	1%

Recommended nutrient reduction strategies for point and nonpoint sources to Lake Wylie are presented in Section 6.4.1 of Chapter 6.

Ongoing and planned studies will further detail the assimilative capacity for nutrients in Rhodhiss Lake, Lake Hickory, Lookout Shoals Lake and Mountain Island Lake.

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, pesticides, herbicides), and *heavy metals*. 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 monitoring indicates that the parameter may be causing toxicity or 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 dischargers 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 followup testing is called a *toxicity reduction evaluation* (TRE). WET testing is discussed in Sections 4.2.5 and 5.2.5 of Chapters 4 and 5 respectively.

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

Metals

Municipal and industrial dischargers along with 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. 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 (Appendix III) are employed to determine appropriate limits. Municipalities with significant industrial users discharging wastes to their treatment facilities limit the heavy metals coming to them from their industries through their *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. The new urban stormwater NPDES program described in Chapter 5 should help address nonpoint source metals loading in the Charlotte area.

Chlorine

Chlorine is commonly used as a 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, but one may be adopted in the near future and an action level has been established. 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 products also contribute to the level of ammonia in a waterbody. At this time, there is no numeric standard for ammonia in North Carolina. However, DEM has agreed to address ammonia toxicity through 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.

Ammonia (NH_3) in the Catawba River Basin

Ammonia has been identified as a cause of stream use impairment in two streams in the basin in subbasin 34: Little Sugar Creek at Pineville and McAlpine Creek (Table 4.3 in Chapter 4). Instream ammonia-nitrogen data at ambient monitoring stations are presented in Section 4.3 (Figures 4.11, 4.15 and 4.17). Because ammonia is an oxygen-demanding waste, in addition to being a potential toxicant, management strategies for controlling ammonia are presented in Section 6.3 of Chapter 6.

3.2.4 Sediment

Sediment is the most widespread cause of nonpoint source pollution in the state. It impacts streams in several ways. Eroded sediment may gradually fill lakes and navigable waters and may increase drinking water treatment cost. Sediment may clog the gills of fish, eliminate the available habitat of organisms which serve as food for fish, or even completely cover shellfish beds. Sediment also serves as a carrier for other pollutants including nutrients (especially phosphorus), toxic metals and pesticides. Most sediment-related impacts are associated with nonpoint source pollution.

North Carolina does not have a numeric water quality standard for suspended solids, however all discharges must meet federal effluent guideline values at a minimum (e.g. 30 mg/l for domestic discharges). Also, most point source BOD limitations usually require treatment to a degree that removes sediments to a level below federal guidelines requirements. Discharges to high quality waters (HQW) must meet a total suspended solids (TSS) limit of 10 mg/l for trout waters and primary nursery areas and 20 mg/l for all other HQWs. In addition, the state has adopted a numerical instream turbidity standard for point and nonpoint source pollution. Nonpoint sources are considered to be in compliance with the standard if approved best management practices (BMPs) have been implemented.

Sedimentation in the Catawba River Basin

Sediment is the most widespread cause of freshwater stream impairment in the Catawba River Basin. Use support information presented in Section 4.5 of Chapter 4 indicates that 376 miles of streams are impaired as a result of sedimentation. Freshwater stream impairment from sedimentation is distributed as follows:

Subbasin No.:	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
Stream Miles Impaired by Sediment:	15	50	77	23	110	51		11	42

Section 6.6 of Chapter 6 discusses strategies for controlling sediment.

3.2.5 Fecal Coliform Bacteria

Fecal coliforms are bacteria typically associated with the intestinal tract of warm-blooded animals and are widely used as an indicator of the potential presence of pathogenic, or disease-causing, bacteria and viruses. They enter surface waters from improperly treated discharges of domestic wastewater and from nonpoint source runoff. Common nonpoint sources of fecal coliforms include leaking or failing septic systems, leaking sewer lines or pump station overflows, runoff from livestock operations and wildlife.

Fecal coliforms are used as indicators of waterborne pathogenic organisms (which cause such diseases as typhoid fever, dysentery, and cholera) because they are easier and less costly to detect than the actual pathogens. Fecal coliform water quality standards have been established in order to ensure safe use of waters for water supplies, recreation and shellfish harvesting. The current State standard for fecal coliforms is 200 MF/100 ml for all waters except SA waters. MF is an abbreviation for the Membrane Filter procedure for determining fecal coliform concentrations. This procedure entails pouring a 100 ml water sample through a membrane filter. The filter is then placed on a cultured medium and incubated for a specified period of time. The number of colonies of bacteria that grow on the medium is then compared to the standard of 200 colonies per 100 ml.

Fecal coliforms 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 Catawba River Basin

Of the 39 ambient water quality monitoring stations in the Catawba basin, fecal coliform measurements exceeded the state standard at least 10% of the time at 27 stations, and more than 25% of the time at 18 stations. According to Table 4.6 in Chapter 4, there are 50 miles of streams in subbasins 31, 34 and 35 considered to be use-impaired due to levels of fecal coliform bacteria above state standards. Use-impairment by fecal coliforms is based on ambient water quality data collected by DEM. Streams that are use-impaired, based on monitored data, are identified in Table 4.3 (see Fecal under Problem Parameter Column).

3.2.6 Color

Color in wastewater is generally associated with industrial wastewater or with municipal plants that receive certain industrial wastes, especially from textile manufacturers, that use dyes to color their fabrics, and from pulp and paper mills. For colored wastes, 15A NCAC 2B .0211(b)3(F) states that the point sources shall discharge only such amounts as will not render the waters injurious to public health, secondary recreation, or aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses. NPDES permit requirements regarding color are included on a case-by-case basis since no numeric standard exists for color, and because a discharger may have high color values but no visual impact instream due to dilution or the particular color of the effluent. Color monitoring is included in the NPDES permit where it has been perceived to be a problem instream.

Color in the Catawba River Basin

While no streams in the basin have been identified as use-impaired due to color, color has been identified as a concern in the South Fork Catawba River and several of its tributaries. Section 6.7 in Chapter 6 discusses ongoing efforts to study color and to address the issue in the Catawba Basin. It also lists facilities in subbasins 35 and 37 that are required to monitor for color.

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 points of discharge. The term most commonly refers to discharges associated with wastewater treatment plant facilities. These include *municipal* (city and county) and *industrial* wastewater treatment plants as well as small *domestic* discharging treatment systems that may serve schools, commercial offices, residential subdivisions and individual homes. In addition, discharges from *stormwater systems* at industrial sites are now considered point source discharges and are being regulated under new urban stormwater runoff regulations being required by the U.S. Environmental Protection Agency (EPA). The urban stormwater runoff program is discussed in more detail in Chapter 5 and Section 6.8 in Chapter 6. The primary substances and compounds associated with point source pollution are oxygen-demanding wastes, nutrients, color and toxic substances including chlorine, ammonia and metals.

Point source discharges are not allowed in North Carolina without a permit from the state. Discharge permits are issued under the National Pollutant Discharge Elimination System (NPDES) program delegated to North Carolina from EPA. The amount or loading of specific pollutants that may be allowed to be discharged into surface waters are defined in the NPDES permit and are called *effluent limits*. Under the NPDES permitting program, each NPDES discharger is assigned either *major* or *minor* status. Major facilities are large with greater flows. For municipalities, all dischargers with a flow of greater than 1 million gallons per day (MGD) are classified as major.

Most point source discharges, other than urban and industrial stormwater discharges, are continuous and do not occur only during storm events as do nonpoint sources. They generally have the most impact on a stream during low flow conditions when the percentage of stream flow composed of treated effluent is greatest. Permit limits are generally set to protect the stream during low flow conditions. The standard low flow used for determining point source impacts is called the *7Q10*. This is the lowest flow which occurs over seven consecutive days and which has an average recurrence of once in ten years.

Information is collected on NPDES permitted discharges in several ways. The major method of collection is facility self-monitoring data which are submitted monthly to the DEM by each individual permittee. NPDES facilities are required to monitor for all pollutants for which they have limits as well as other pollutants which may be present in their wastewater. All domestic wastewater dischargers are required to monitor flow, dissolved oxygen, temperature, fecal coliform, BOD, ammonia, and chlorine (if they use it as a disinfectant). In addition, facilities with industrial sources may have to monitor for chemical specific toxicants and/or whole effluent toxicity (see Section 3.2.3); and all dischargers with design flows greater than 50,000 gallons per day (GPD) monitor for total phosphorus and total nitrogen. Minimum NPDES monitoring requirements are provided in 15A NCAC 2B .0500.

Other methods of collecting point source information include effluent sampling by DEM during inspections and special studies. The regional offices may collect data at a given facility if they believe there may be an operational problem or as a routine compliance check. In addition, the DEM may collect effluent data during intensive surveys of segments of streams, and extensive discharger data have been collected during onsite toxicity tests.

3.3.2 Point Source Discharges in the Catawba

In the Catawba River Basin, there are 545 permitted NPDES dischargers, 32 of which have pretreatment programs. Table 3.1 summarizes the number of dischargers and their total permitted and actual 1993 flows for each subbasin. Table 3.2 summarizes this information for the entire basin by broad categories of dischargers including majors, minors, domestic, municipal, industrial (process and nonprocess) and stormwater.

A distribution map of the discharge facilities is shown in Figure 3.5a and b (upper and lower basin). Table 3.3 lists the major dischargers in the basin along with the NPDES number, permitted flow, receiving stream and category (e.g., municipal, industrial). Location numbers are provided in the table for each major discharger that correlate with numbered locations shown in Figure 3.5 (a and b).

Of the total 545 dischargers, 39 are major facilities, 165 are domestic, 45 are municipalities and 64 are industries. The total permitted flow for all facilities is 203 million gallons per day (MGD). The reason that the average actual flow was so much higher than the permitted flow is because some industrial discharges, such as those for cooling water, stormwater or nonprocess wastewater, do not have a total flow limit specified in their permit although they have reported total flow anyway. A more meaningful comparison is the difference between the permitted and actual flows for municipal dischargers. In this case, the actual flows are 70% of the permitted flows.

Thirty-two of the municipal facilities in the basin have pretreatment programs that serve 258 industrial users (Table 3.4). Under these pretreatment programs, regulated industries that discharge their wastes to the municipal plants are required to pretreat their wastes. This is done in order to minimize potential toxicity problems both at the plant in the receiving waters into which the municipality discharges. See Section 5.2.6 in Chapter 5 for more information on pretreatment.

Table 3.1 Summary of Major/Minor Dischargers and Permitted and Actual Flows by Subbasin

	SUBBASINS									
CATEGORIES	30	31	32	33	34	35	36	37	38	TOTALS
Total Facilities	53	53	107	31	152	57	39	42	11	545
Total w/o Stmwtr & Gen Permits	35	20	58	11	48	28	22	23	9	254
Total Permitted Flow (MGD)	10.59	19.89	14.10	7.78	79.81	22.30	26.66	18.35	3.46	202.96
# of Facilities Reporting	29	19	49	8	41	23	19	16	6	210
Total Avg. Flow 1993 (MGD)	6.98	17.84	161.96	51.08	65.07	13.40	244.45	12.00	0.24	573.01
Major Dischargers	3	4	7	3	6	6	5	5	0	39
Total Permitted Flow (MGD)	6.20	19.58	8.24	7.00	78.57	21.00	23.30	17.62	0.00	181.50
# of Facilities Reporting	3	4	7	3	5	6	5	5	0	38
Total Avg. Flow 1993 (MGD)	4.07	17.05	156.70	51.04	59.21	12.39	242.21	11.15	0.00	553.83
Minor Dischargers	50	49	100	28	146	51	34	37	11	506
Total Permitted Flow (MGD)	4.39	0.26	5.87	0.78	1.24	1.30	3.36	0.73	3.46	21.41
# of Facilities Reporting	26	15	42	5	36	17	14	11	6	172
Total Avg. Flow 1993 (MGD)	2.90	0.78	5.26	0.04	5.86	1.01	2.24	0.85	0.24	19.18
100% Domestic Wastewater	24	18	41	11	27	13	5	16	10	165
Total Permitted Flow (MGD)	0.81	0.19	1.44	0.59	1.09	0.36	0.11	0.33	3.46	8.39
# of Facilities Reporting	17	12	27	3	16	8	2	8	6	99
Total Avg. Flow 1993 (MGD)	0.23	0.06	0.16	0.01	0.17	0.04	0.04	0.05	0.24	1.02
Municipal Facilities	3	4	11	2	4	11	7	3	0	45
Total Permitted Flow (MGD)	4.10	19.64	11.22	7.00	74.67	20.83	9.80	16.50	0.00	163.76
# of Facilities Reporting	4	4	11	2	4	10	7	3	0	45
Total Avg. Flow 1993 (MGD)	2.91	13.48	6.20	4.74	57.79	12.24	6.07	10.46	0.00	113.88
Major Process Industrial	2	1	5	0	1	1	3	2	0	15
Total Permitted Flow (MGD)	3.20	0.00	1.04	0.00	3.90	1.00	15.30	1.12	0.00	25.55
# of Facilities Reporting	2	1	5	0	1	1	4	2	0	16
Total Avg. Flow 1993 (MGD)	1.70	3.62	152.45	0.00	1.42	0.74	237.00	0.69	0.00	397.62
Minor Process Industrial	5	3	4	3	24	3	4	3	0	49
Total Permitted Flow (MGD)	3.26	0.01	0.40	0.19	0.15	0.01	0.04	0.33	0.00	4.38
# of Facilities Reporting	3	1	4	2	19	2	4	3	0	38
Total Avg. Flow 1993 (MGD)	0.11	0.01	2.39	0.03	5.45	0.08	0.87	0.79	0.00	9.72
Nonprocess Industrial	8	11	10	6	19	11	11	9	0	85
Total Permitted Flow (MGD)	2.43	0.00	0.00	0.00	0.00	0.11	1.41	0.07	0.00	4.02
# of Facilities Reporting	3	1	2	1	1	2	2	0	0	12
Total Avg. Flow 1993 (MGD)	2.03	0.68	0.50	46.30	0.24	0.31	0.47	0.00	0.00	50.51
Stormwater Facilities	8	16	34	9	77	18	9	9	1	181
Total Avg. Flow 1993 (MGD)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 3.2 Summary of NPDES Discharge Permits in the Catawba Basin

Permit Category	No. of Facilities	% of Facilities	Permitted Flow (MGD)	Average 1993 Flow (MGD)	% of Permitted Flow
Total NPDES	545	100.0	202.96	573.01	282.3
Majors	39	7.2	181.50	553.83	305.1
Minors	506	92.8	21.41	19.18	89.6
Nonprocess	85	15.6	4.02	50.51	1,255.2
Domestic	165	30.3	8.39	1.02	12.1
Municipal	45	8.3	163.76	113.88	69.5
Major Process Industrial	15	2.8	25.55	397.62	1,556.1
Minor Process Industrial	49	9.0	4.38	9.72	221.9
Stormwater	181	33.2	0	0	0.0

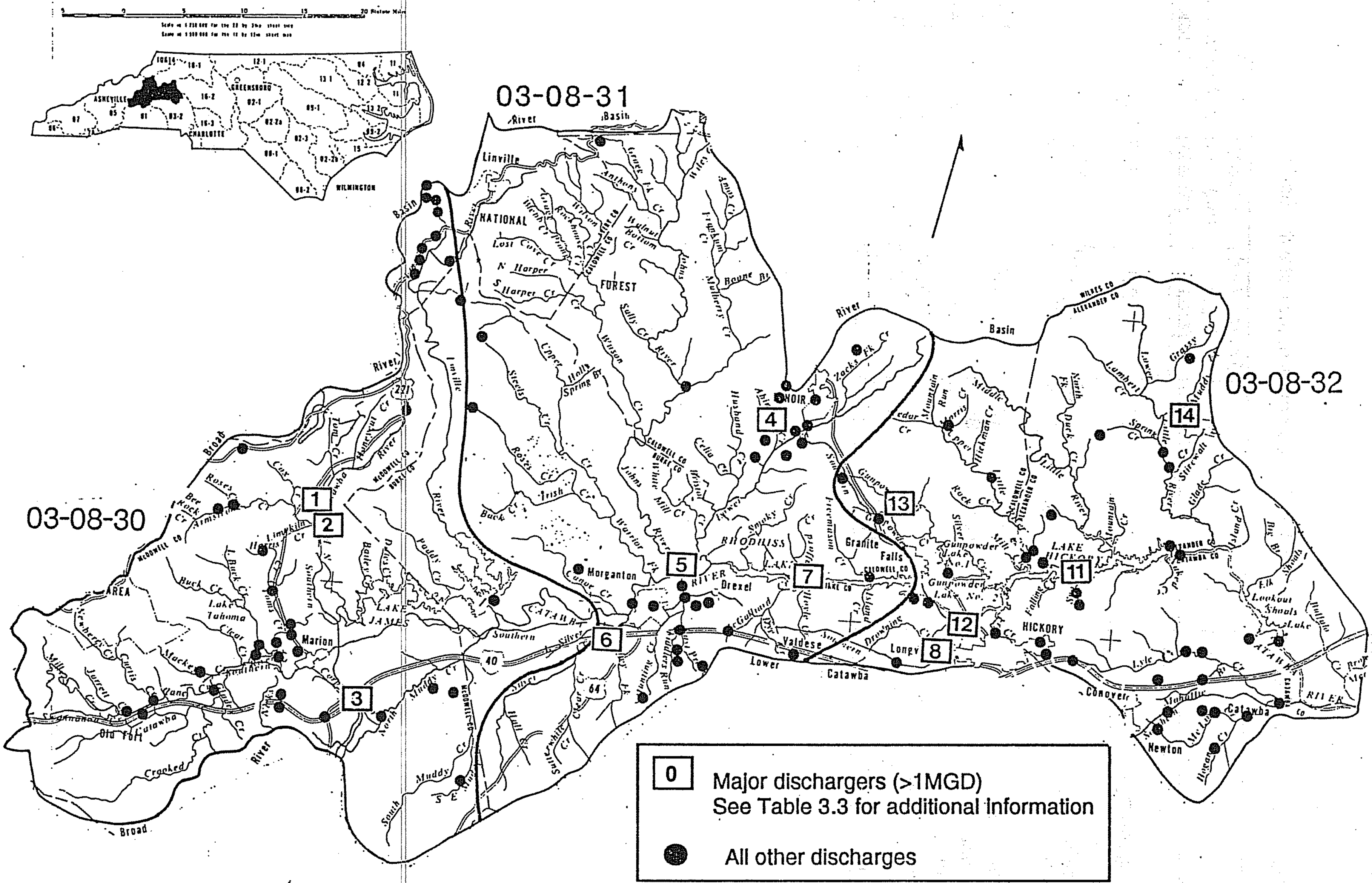

Figure 3.5a Distribution Map of Dischargers in the Upper Catawba River Basin

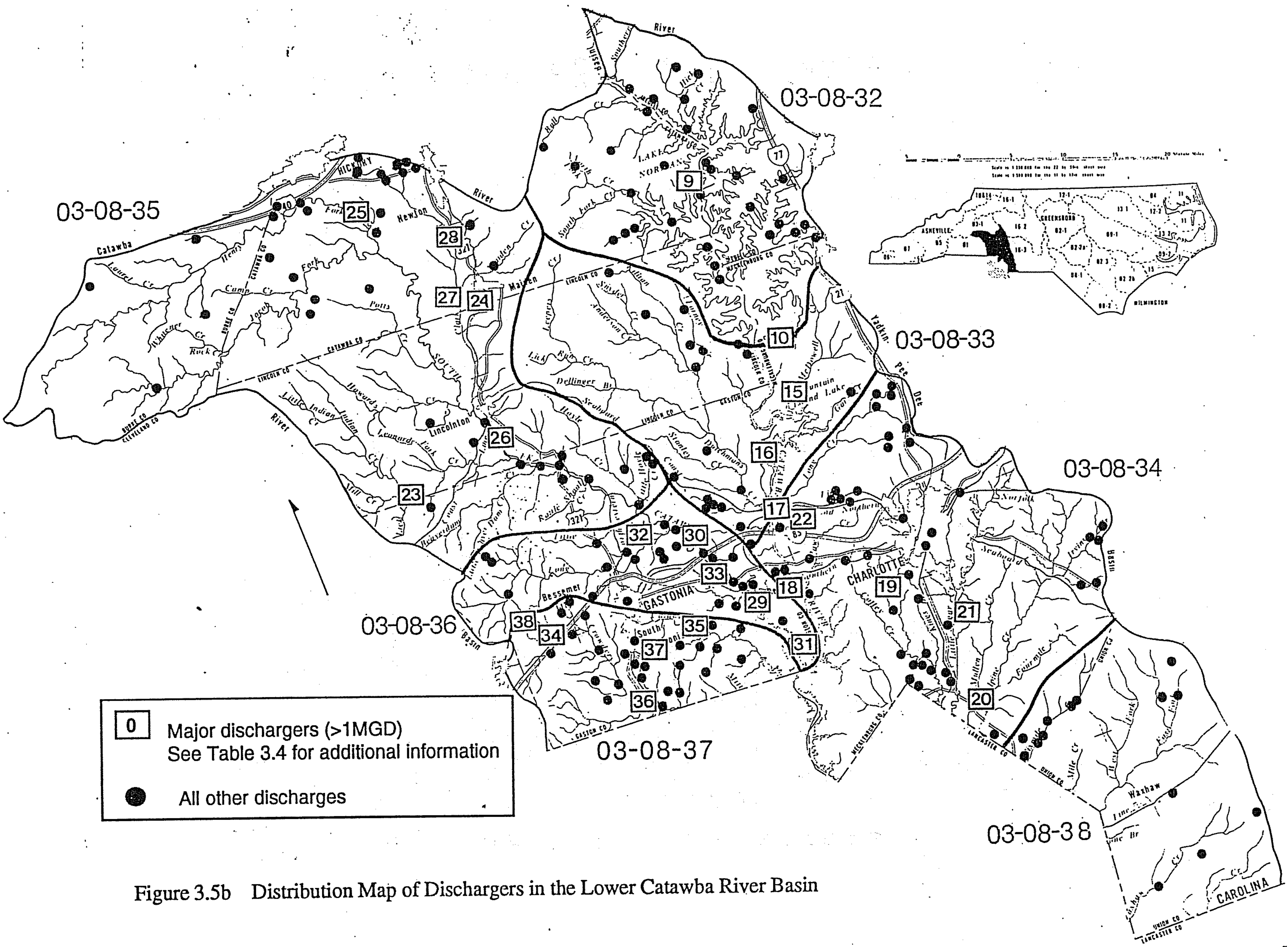

Figure 3.5b Distribution Map of Dischargers in the Lower Catawba River Basin

Table 3.3 Major NPDES Discharges in the Catawba River Basin

Map#	Name	NPDES No.	Subbasin	Type	Permitted Flow (MGD)
1	BAXTER HEALTHCARE CORP.	NC0006564	30	NON-MUNIC.	1.20
2	COATS AMERICAN INC.	NC0004243	30	NON-MUNIC.	2.00
3	MARION CORPENING CREEK WWTP	NC0031879	30	MUNICIPAL	3.00
4	LENOIR (LOWER CREEK WWTP)	NC0023981	31	MUNICIPAL	4.08
5	MORGANTON WWTP, CITY OF	NC0026573	31	MUNICIPAL	8.00
6	SIGRI GREAT LAKES CARBON CORP.	NC0005258	31	NON-MUNIC.	0.00
7	VALDESE, TOWN-LK RHODHISS WWTP	NC0041696	31	MUNICIPAL	7.50
8	ARLENE HOSIERY MILL, INC.	NC0007927	32	NON-MUNIC.	0.01
9	DUKE POWER CO., MARSHALL S.E.	NC0004987	32	NON-MUNIC.	0.00
10	DUKE POWER CO., MCGUIRE S.E.	NC0024392	32	NON-MUNIC.	0.00
11	HICKORY NORTHEAST WWTP	NC0020401	32	MUNICIPAL	6.00
12	HUFFMAN FINISHING COMPANY	NC0025135	32	NON-MUNIC.	0.25
13	LENOIR-GUNPOWDER CRK WWTP	NC0023736	32	MUNICIPAL	1.20
14	SCHNEIDER MILLS INC.	NC0034860	32	NON-MUNIC.	0.78
15	CMUD-MCDOWELL CREEK WWTP	NC0036277	33	MUNICIPAL	3.00
16	DUKE POWER CO., RIVERBEND S.E.	NC0004961	33	NON-MUNIC.	0.00
17	MOUNT HOLLY WWTP, CITY OF	NC0021156	33	MUNICIPAL	4.00
18	BELMONT, CITY OF WWTP	NC0021181	34	MUNICIPAL	5.00
19	CMUD-IRWIN CREEK	NC0024945	34	MUNICIPAL	15.00
20	CMUD-MCALPINE	NC0024970	34	MUNICIPAL	40.00
21	CMUD-SUGAR CREEK WWTP	NC0024937	34	MUNICIPAL	14.67
22	SANDOZ CHEMICALS CORPORATION	NC0004375	34	NON-MUNIC.	3.90
23	CHERRYVILLE WWTP, TOWN OF	NC0044440	35	MUNICIPAL	2.00
24	DELTA MILLS, INC.	NC0006190	35	NON-MUNIC.	1.00
25	HICKORY WWTP, CITY OF	NC0040797	35	MUNICIPAL	6.00
26	LINCOLNTON WWTP, TOWN OF	NC0025496	35	MUNICIPAL	6.00
27	MAIDEN WWTP, TOWN OF	NC0039594	35	MUNICIPAL	1.00
28	NEWTON (TOWN OF)-CLARK CREEK	NC0036196	35	MUNICIPAL	5.00
29	CRAMERTON AUTOMOTIVE PRODUCTS	NC0006033	36	NON-MUNIC.	4.00
30	CROMPTON & KNOWLES CORP-LOWELL	NC0005274	36	NON-MUNIC.	0.30
31	DUKE POWER CO., ALLEN S.E.	NC0004979	36	NON-MUNIC.	10.00
32	GASTONIA LONG CREEK WWTP	NC0020184	36	MUNICIPAL	8.00
33	PHARR YARNS INDUSTRIAL WWTP	NC0004812	36	NON-MUNIC.	1.00
34	BESSEMER CITY WWTP, TOWN OF	NC0020826	37	MUNICIPAL	1.50
35	GASTONIA CATAWBA CREEK WWTP	NC0020192	37	MUNICIPAL	9.00
36	GASTONIA-CROWDERS CREEK WWTP	NC0074268	37	MUNICIPAL	6.00
37	HOMELITE - TEXTRON	NC0005231	37	NON-MUNIC.	0.50
38	LITHIUM CORPORATION - CHEMICAL	NC0005177	37	NON-MUNIC.	0.62

Table 3.4 NPDES Facilities with a Pretreatment Program and their Significant Industrial Users

basin	Facility Name	NPDES OR ND Num	WWTP SIUs	REGION
30830	MARION (CORPENING CK)	NC0031879	4	ARO
	OLD FORT	NC0021229	5	ARO
			9	
30831	LENOIR (LOWER CK)	NC0023981	9	ARO
	MORGANTON	NC0026573	7	ARO
	VALDESE	NC0041696	11	ARO
			27	
30832	CLAREMONT (NORTH)	NC0032662	0	MRO
	CLAREMONT (SOUTH)	NC0026549	0	MRO
	CONOVER (NORTHEAST)	NC0024252	1	MRO
	CONOVER - SE	NC0024279	1	MRO
	HICKORY NE	NC0020401	7	MRO
	LENOIR (GUNPOWDER CK)	NC0023736	0	ARO
	TROUTMAN	NC0026832	0	MRO
			9	
30833	CMUD (MCDOWELL CK)	NC0036277	4	MRO
	MOUNT HOLLY	NC0021156	7	MRO
			11	
30834	BELMONT	NC0021181	5	MRO
	CMUD (IRWIN CK)	NC0024945	44	MRO
	CMUD (MCALPINE)	NC0024970	40	MRO
	CMUD (SUGAR CK)	NC0024937	34	MRO
			123	
30835	CHERRYVILLE	NC0044440	2	MRO
	CONOVER (SOUTHWEST)	NC0024261	0	MRO
	HICKORY - HENRY FK.	NC0040797	17	MRO
	LINCOLN COUNTY (HOYLE CK)	NC0041815	1	MRO
	LINCOLNTON	NC0025496	11	MRO
	MAIDEN	NC0039594	1	MRO
	NEWTON (CLARK CK)	NC0036196	13	MRO
	STANLEY	NC0020036	1	MRO
			46	
30836	GASTONIA (CROWDERS)	NC0074268	5	MRO
	GASTONIA (LONG)	NC0020184	12	MRO
	RANLO	NC0021318	1	MRO
			18	
30837	BESSEMER CITY	NC0020826	4	MRO
	GASTONIA (CATAWBA)	NC0020192	7	MRO
	KING'S MOUNTAIN (MCGILL CK)	NC0020745	4	MRO
			15	

ARO: Asheville Regional Office, MRO: Mooresville Regional Office

3.4 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) refers to runoff that enters surface waters through stormwater or snowmelt. There are many types of land use activities that can serve as sources of nonpoint source pollution including land development, construction, crop production, animal feeding lots, failing septic systems, landfills, roads and parking lots. As noted above, 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 intervals depending on rainfall events. Below is a brief description of major areas of nonpoint sources of concern in the Catawba Basin.

3.4.1 Agriculture

There are a number of activities associated with agriculture that may serve as sources of water pollution. Land clearing and plowing render soils susceptible to erosion which in turn can cause stream sedimentation. Pesticides and fertilizers (including chemical fertilizers and animal wastes) can be washed from fields or improperly designed storage or disposal sites. Concentrated animal feed lot operations can be a significant source of both BOD and nutrients. The untreated discharge from a large operation would be comparable to the nutrient load in the discharge from a secondary waste treatment plant serving a small town. Animal wastes can also be a source of bacterial contamination of surface waters. Construction of drainage ditches on poorly drained soils enhances the movement of stormwater into surface waters.

In the Catawba Basin, 245 (or 50%) of the miles of freshwater streams estimated to be impaired from nonpoint sources of pollution are attributed to agriculture. The highest number of impaired stream miles in any subbasin attributed to agriculture is 74 miles in subbasin 35 (upper South Fork Catawba). In other subbasins, the number of stream miles estimated to be impaired by agriculture ranges from 10 miles in subbasin 37 (Crowders Creek watershed in Gaston County) to 63 miles in subbasin 32 (mid Catawba basin). This information is derived from the table in Section 4.5 of Chapter 4 entitled Probable Sources of Use Support Impairment. The prime cause of freshwater stream impairment associated with agriculture is sedimentation.

Another important water quality concern associated with agriculture in the Catawba basin is nutrient runoff. Nutrient-related problems are not always evident in the receiving stream adjoining a farm but may manifest themselves in a downstream impoundment, sluggish creek or estuary many miles away. Chapter 5 discusses agricultural nonpoint source control programs. Recommended management strategies for reducing nutrients and sediment runoff are found in Sections 6.4 and 6.6 respectively, in Chapter 6.

3.4.2 Urban

Runoff from urbanized areas, as a rule, is more localized but generally more severe than agricultural runoff. 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. These drainage systems, including curb and guttered roadways, also allow urban pollutants to reach surface waters quickly and with little or no filtering. These 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); and fecal coliform bacteria (from animals and failing septic systems). Many urban streams are rated as biologically poor. The population density map in Chapter 2 is a good indicator of where urban development and potential urban stream impacts are likely to occur. Based on Table 4.5 in Chapter 4, there are 111 miles of streams that are impaired due to urban runoff.

3.4.3 Construction

Construction activities that entail excavation, grading or filling, such as road construction or land clearing for development, can produce large amounts of sediment if not properly controlled. As a pollution source, construction activities are temporary in nature but the impacts, discussed under the section on sediment, above, can be long lasting.

Construction activity tends to be concentrated in the more rapidly developing areas of the basin such as subbasins 32 through 35 and 38. 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. Based on Table 4.5 in Chapter 4, there are 137 miles of streams impaired due to construction activity.

3.4.4 Forestry

Forestry, a major industry in North Carolina, can impact water quality in a number of ways. Ditching and draining of naturally forested low-lying lands in order to create pine or hardwood plantations can change the hydrology of an area and significantly increase the rate and flow of stormwater runoff. Clearing of trees through timber harvesting and construction of logging roads can produce sedimentation. Removing riparian vegetation along stream banks can cause water temperature to rise substantially, and improperly applied pesticides can result in toxicity problems. Timber harvesting occurs throughout much of the upper basin and is often done at the onset of clearing for site development. Based on Table 4.5 in Chapter 4, there are 34 miles of streams impaired due to forestry activities.

3.4.5 Mining

Mining is a common activity in the Piedmont and Mountain regions and can produce high localized levels of stream sedimentation. Sediment may be washed from mining sites or it may enter streams from the wash water used to rinse some mined products. In addition, abandoned gold mined lands are suspected of being the sources of mercury in stream waters because of its historic use for the amalgamation of gold. The most prevalent type of mining activity in the Catawba River basin is for sand and gravel. Fourteen miles of streams have been impaired by mining activities in subbasin 38 (Waxhaw Creek subbasin) according to Table 4.5 in Chapter 4.

3.4.6 Onsite Wastewater Disposal

Septic tank soil absorption systems are the most widely used method of on-site domestic wastewater disposal in North Carolina. These systems can provide safe and adequate treatment of wastewater; however, improperly placed, constructed or maintained septic systems can serve as a significant source of pathogenic bacteria and nutrients. These pollutants may enter surface waters both through or over the soil. They 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 which includes a requirement for disinfection.

Onsite wastewater disposal is most prevalent in rural portions of the basin and at the fringes of urban areas. Nutrients from failing septic systems also contribute to eutrophication problems in some impoundments and coastal waters.

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.

REFERENCES CITED - CHAPTER 3

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