CHAPTER 3

CAUSES AND SOURCES OF WATER POLLUTION

3.1 INTRODUCTION

Water pollution is caused by a number of substances including oxygen-consuming wastes, nutrients, sediment, bacteria, , 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 French Broad River basin. **Sections 3.3** and **3.4** describe point and nonpoint source pollution in the basin.

3.2 CAUSES OF POLLUTION

3.2.1 Oxygen-Consuming Wastes

Oxygen-consuming wastes are substances such as 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. 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 (daily average with instantaneous readings not to fall below 4.0 mg/l) to protect the majority of its surface waters. An exception to this standard in the French Broad River Basin exists for waters supplementally classified as *trout waters*. Trout waters have a dissolved oxygen standard of 6.0 mg/l due to the higher sensitivity of trout to low dissolved oxygen levels.

Dissolved oxygen concentrations are affected by a number of factors. Higher dissolved oxygen is produced by turbulent actions which mix air and water such as waves, rapids and water falls. In addition, lower water temperature 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 usually 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.

Causes of dissolved oxygen depletion include 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 dissolved oxygen 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 dissolved oxygen.

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 often be identified by a marked reduction in instream dissolved oxygen concentrations and is commonly referred to as the *sag zone*. Frequently, dissolved oxygen 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.

Biochemical oxygen demand, or BOD, is a technical term that describes the overall demand on dissolved oxygen from the various oxygen-depleting processes presented above. A commonly used measure of BOD is called BOD5 where the "5" stands for five days. BOD5 is a standard waste limit in most discharge permits. A limit of 30 mg/l of BOD5 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 dissolved oxygen standards in the receiving waters.

Oxygen-Consuming Wastes in the French Broad River Basin

The total daily loading of biochemical oxygen demanding wastes (BOD) from NPDES (National Pollutant Discharge Elimination System) municipal and industrial dischargers in the French Broad Basin in 1993 is estimated to be approximately 65% less than it was 20 years ago despite just a 7% decrease in the total volume of treated wastewater. As shown in Figure 3.1a, the total

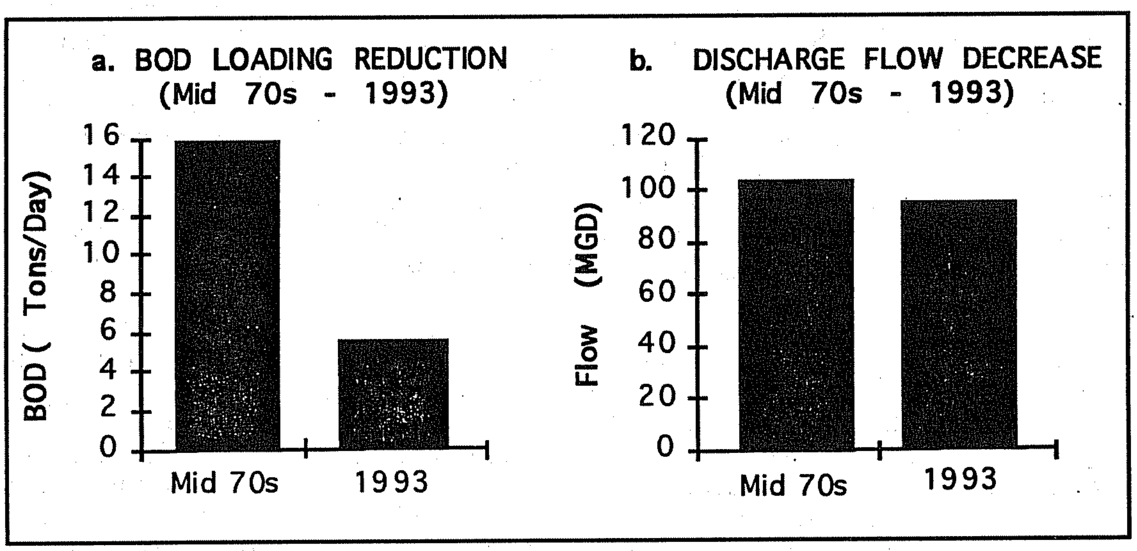


Figure 3.1 Comparison of (a) Total BOD Loading and (b) Effluent Flows from NPDES dischargers in the French Broad River Basin Between Mid-1970s and 1993

loading of BOD has decreased from approximately 16 tons per day in the mid-1970s to approximately 5.8 tons per day in 1993 while the total daily volume of effluent discharged decreased from 102 MGD in the mid 1970s to 95 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 as implemented through the state's NPDES program. Comparisons of BOD loadings and flows from selected wastewater treatment facilities in the basin are presented in Figures 3.2 and 3.3. These numbers are based on actual loadings and flows through 1993. In general, water quality standards for dissolved oxygen are being met throughout most of the basin. However, modeling studies have indicated that the BOD assimilative capacity is either becoming limited in some waters, such is in the upper French Broad and Pigeon Rivers, or has been severely stressed as in Mud and Gash Creek. Recommended management strategies for addressing BOD are presented in Section 6.3 of Chapter 6.

3.2.2 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 and some industrial processes. While nutrients are beneficial to aquatic life in small amounts, an overabundance under favorable conditions, can stimulate the occurrence of algal blooms and excessive plant growth in quiet waters such as ponds, lakes, reservoirs and estuaries.

Algae blooms deplete the water column of dissolved oxygen and can contribute to serious water quality problems. Nutrient overenrichment and the resultant problems of low dissolved oxygen are called *eutrophication*. In addition to problems with low dissolved oxygen, 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.

The main sources of nutrients are agricultural runoff, wastewater treatment plants, urban runoff and atmospheric deposition. 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. The State does have 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 and possible eutrophication. It is one of several measures used to assess the health of lakes and estuaries.

Nutrients in the French Broad Basin

Table 4.7 in Chapter 4 identifies Waterville (Walters) Lake in the Pigeon River watershed as being impaired by nutrients. Lake Junaluska is also being adversly affected by nutrients although it is currently rated as supporting its classified uses. Nutrient management strategies are discussed in Section 6.5 in Chapter 6.

Figure 3.2 Comparison Between Mid-1970s and 1993 Loading of Biochemical Oxygen Demand (BOD) from NPDES Dischargers in the French Broad River Basin

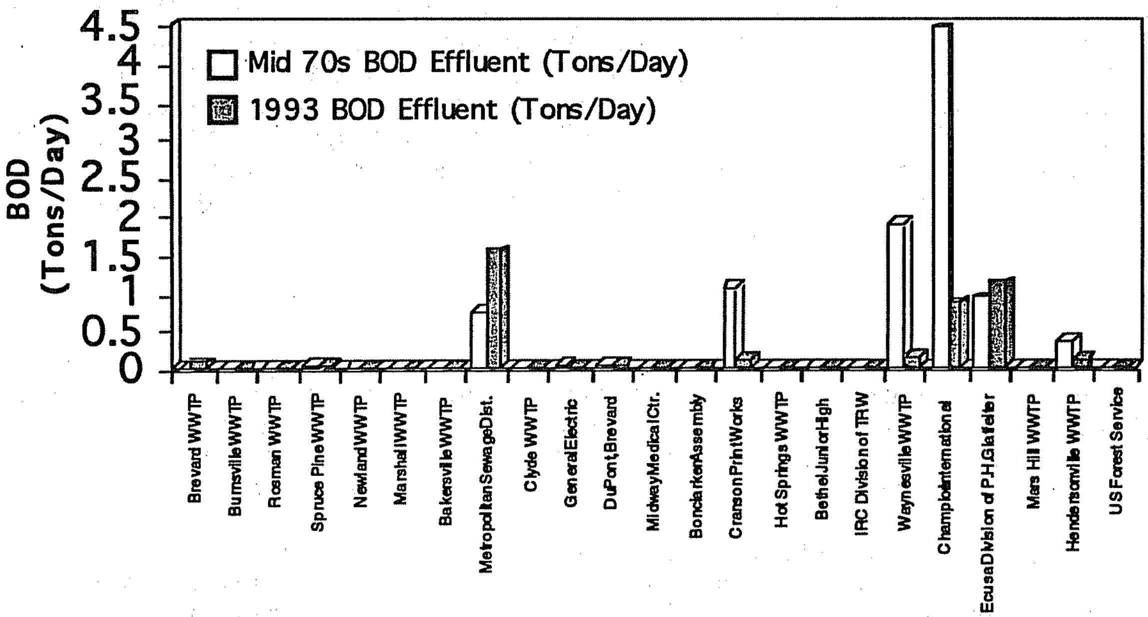
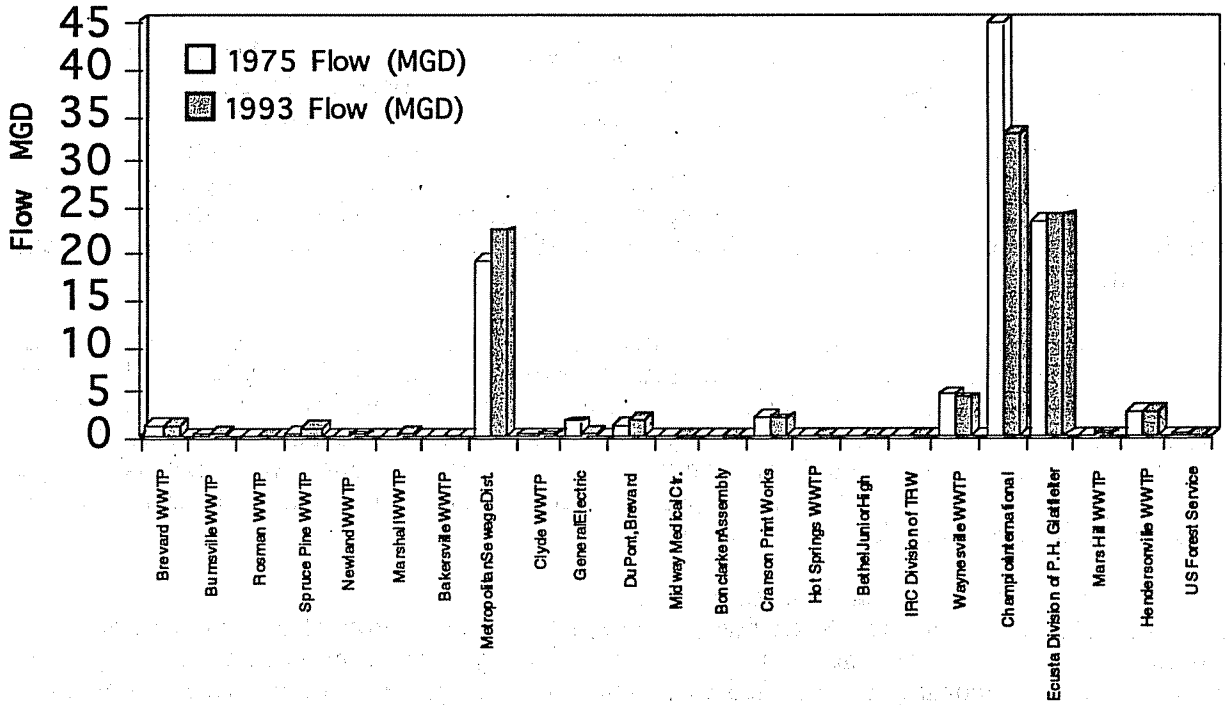


Figure 3.3 Comparison Between Mid-1970s and 1993 Daily Effluent Flow from NPDES Dischargers in the French Broad Basin



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 NPDES 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 4.2.4 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.

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. 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 (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.

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 except for discharges to trout water, but one may be adopted in the 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 (NH3)

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.

Toxic substances in the French Broad River Basin

There are streams in all three of the major watersheds in the basin that are being impacted by toxic substances. For most of those being impacted by point source discharges, actions have been taken, or are underway to address the problems. Where nonpoint source toxicity impacts are noted, finding and correcting the problems are more difficult and further studies may be recommended. Streams for which management toxicity problems have been identified are discussed in Section 6.3 include Little River (above Cascade Lake), Bat Fork Creek, Mud Creek, Clear Creek, Hominy Creek, Pigeon River and Richland Creek.

3.2.4 Sediment

Sedimentation is the most widespread cause of nonpoint source pollution in the state and results from land-disturbing activities including agriculture, construction, urban runoff, mining and forestry. 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.

Statistics compiled by the US Department of Agriculture, Soil Conservation Service indicate a statewide decline in erosion from 1982 to 1992 (USDA, SCS, 1992) as shown in Table 3.1.

Table 3.1 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)	1.4	1.3	1.1

The SCS statistics also indicate a statewide reduction per acre on cropland erosion using the Universal Soil Loss Equation (Table 3.2).

Table 3.2 USLE Erosion on Cultivated Cropland in North Carolina

	1982	1987	1992
CroplandArea (1,000 acres)	6,318.7	5,956.8	5,538
Gross Erosion (1,000 tons/yr)	40,921.4	37,475.3	30,908.3
Erosion Rate (Tons/Yr/Ac)	6.5	6.3	5.6

However, in the Blue Ridge Mountains region, which encompasses the entire French Broad Basin and several others, the overall erosion picture is less clear. Table 3.3 shows a significant decline in cultivated cropland acreage and a decline in gross erosion, but the erosion rate per acre is up from 12.7 tons/acre/year in 1982 to 18.3 tons/acre/year in 1992. Non-cultivated cropland erosion rates also increased 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.

Table 3.3 North Carolina Erosion in Blue Ridge Mountain Region

	1982	1987	1992
CroplandArea (1,000 acres)	122.9	97.9	76.2
Gross Erosion (1,000 tons/yr)	1,555.6	2,035.2	1,397.5
Erosion Rate (Tons/Yr/Ac)	12.7	20.8	18.3

Compared with other regions of the state, the overall erosion rates per acre for cultivated cropland in the mountains were very high. Also, the 10-year uptrend in the erosion rate was high compared to the other regions (Table 3.4) which were generally stable or slightly lower over the period.

Table 3.4 North Carolina Erosion on Major Land Resource Areas (MLRA) in Tons/acre/yr

	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

While 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. Given the high conversion of agriculture land to urban uses, strengthening erosion and sediment control programs related to construction practices is essential to the reduction of sediment-related problems in the basin.

Sedimentation in the French Broad River Basin

Sediment is the most widespread cause of freshwater stream impairment in the French Broad River Basin. Use support information presented in Section 4.5 of Chapter 4 indicates that 266 miles of streams are impaired as a result of sedimentation. Freshwater stream impairment from sedimentation is distributed by subbasin as follows:

Subbasin No.:	01	02	03	04	05	06	07
Stream Miles Impaired by Sediment:	4	155	4	77	20	1	4

Most sediment-related impacts are associated with nonpoint source pollution. Programs aimed at addressing sedimentation are listed in Section 6.4 (Table 6.3) in Chapter 6 and are briefly described under nonpoint source pollution controls in Chapter 5. Nonpoint sources are considered to be in compliance with the turbidity standard if approved best management practices (BMPs) have been implemented.

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, microorganisms. They enter surface waters from both nonpoint source runoff and point source discharges. Common nonpoint sources of fecal coliforms include runoff from livestock and wildlife, urban stormwater runoff, leaking sewer lines or pump station overflows, and leaking or failing septic systems. Point sources of fecal coliforms are generally limited to improperly treated wastewater effluent (usually from smaller facilities such as package treatment plants) and unpermitted discharges. The most common unpermitted discharge of concern regarding fecal coliform bacteria is direct discharges (or straight pipes) from onsite septic systems.

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 (coastal shellfish) waters. MF is an abbreviation for the Membrane Filter procedure for determining fecal coliform concentrations. 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 French Broad River Basin

According to Table 4.6 in Chapter 4, there are 74 miles of streams in subbasins 01, 02 and 05 considered to be use-impaired due to elevated levels of fecal coliform bacteria. However, the actual number of stream miles impaired by fecal coliform bacteria could be consideraly higher since bacteria measurements are only done at monthly intervals at 29 ambient monitoring stations on large streams within the basin (See Figures 4.1 through 4.7 for sampling locations). Streams that are use-impaired, based on monitored data, are identified in Table 4.3 (see "Fecal" under Problem Parameter column). Management strategies for addressing fecal coliforms are presented in Section 6.8 of Chapter 6.

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 French Broad River Basin

While no streams in the basin have been rated as use-impaired due to color, color has been identified in the past as a major concern in the Pigeon River below the Champion Paper Mill. In July of 1988, Champion was given a variance for instream color which required them to meet 50 true color units at the North Carolina/Tennessee state line on a monthly average basis. They are also required to study and evaluate color removal technologies and report their findings on an annual basis to DEM. Since 1988, Champion has modernized their facility at Canton and has achieved greater than 75% reduction in their effluent color. Champion is continuing to investigate color removal technology and will be conducting a full-scale trial on a new patented in-process methodology which they call Bleach Filtrate Recycling (BFR™). The final design should be completed in 1994. Construction will occur in 1995 and operation is to begin in late 1995 and continue into 1996. BFR™ takes advantage of oxygen delignification, 100% chlorine dioxide substitution, oxidative extraction, and other technologies to significantly reduce the discharge of kraft pulp bleaching residues. This process has the potential to remove approximately 50% of the <u>remaining</u> effluent color. Another potential benefit associated with this new process is a decrease in the total chlorinated organic matter and BOD discharged from the bleach plant. These reductions are estimated to be 85% for total chlorinated organic matter and 70% for BOD.

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 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 6.7 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 French Broad Basin

In the French Broad River Basin, there are 353 permitted NPDES dischargers, 176 of which are general permits or stormwater permits. Table 3.5 summarizes the number of dischargers and their total permitted and actual 1993 flows for each subbasin. A distribution map of the discharge facilities is shown in Figure 3.4. It includes a list of the major dischargers in the basin. Location numbers are provided in the list for each major discharger that correlate with numbered locations shown in Figure 3.4 .

Of the total 353 dischargers, 14 are major facilities, 202 are domestic, 15 are municipalities and 84 are industries. The total permitted flow for all facilities is 120 million gallons per day (MGD). The average actual flow is higher than the permitted flow 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 56% of the permitted flows.

A total of 119 stream miles have been identified as being impaired by point source discharges.

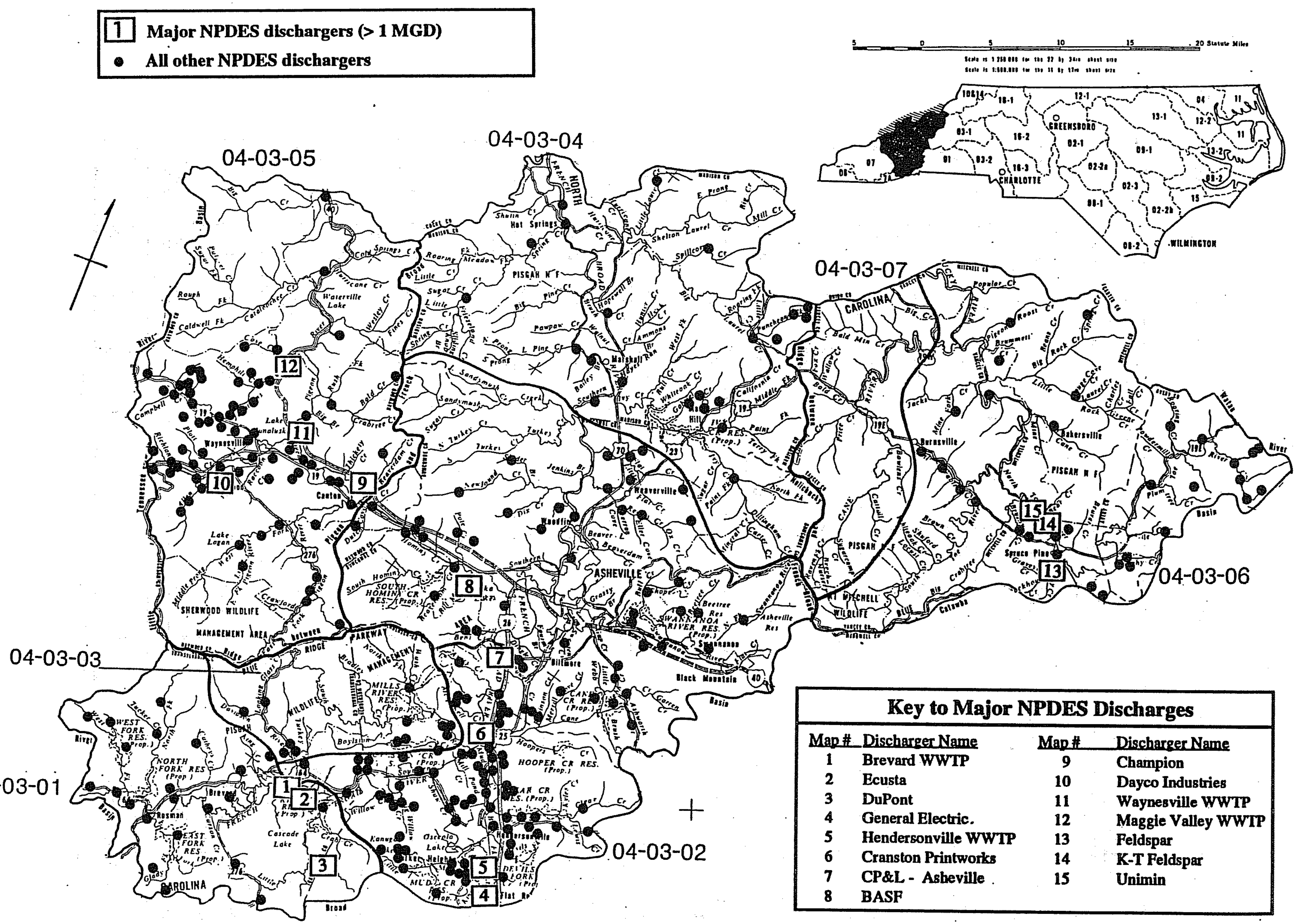
3.4 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) 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, 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, given the dispersed nature of stormwater runoff discussion of urban runoff will be included in this section.

Table 3.5 Summary of Major/Minor NPDES Dischargers and Permitted and Actual Flows by Subbasin

FACILITY CATEGORIES	SUBBASIN 01	02	03	04	05	06	07	TOTALS
Total Facilities	25	181	12	25	62	43	5	**353**
Facilities w/o Stormwtr & Gen. Permits	11	95	9	13	25	21	3	**177**
Total Permitted Flow (MGD)	32.48	59.50	0.31	1.01	11.40	14.63	0.83	**120.17**
# of Facilities Reporting	10	75	9	10	22	15	3	**144**
Total Avg. Flow (MGD)	27.51	259.47	0.17	0.39	7.98	5.07	0.46	**301.06**
***Major Discharges**	3	6	0	0	2	3	0	**14**
Total Permitted Flow (MGD)	32	56.5	0	0	6.75	8.83	0	**104.08**
# of Facilities Reporting	3	6	0	0	2	3	0	**14**
Total Avg. Flow (MGD)	27.29	257.38	0.00	0.00	6.44	3.99	0.00	**295.09**
***Minor Discharges**	8	89	9	13	23	18	3	**163**
Total Permitted Flow (MGD)	0.48	3.00	0.31	1.01	4.65	5.81	0.83	**16.09**
# of Facilities Reporting	7	69	9	10	20	12	3	**130**
Total Avg. Flow (MGD)	0.22	2.09	0.17	0.39	1.54	1.08	0.46	**5.96**
100% Domestic Wastewater	6	109	10	13	40	20	4	**202**
Total Permitted Flow (MGD)	0.34	1.60	0.13	0.11	0.24	0.10	0.03	**2.55**
# of Facilities Reporting	3	60	8	6	16	7	2	**102**
Total Avg. Flow (MGD)	0.15	0.56	0.05	0.01	0.09	0.03	0.01	**0.90**
Municipal Facilities	2	3	0	3	3	3	1	**15**
Total Permitted Flow (MGD)	2.59	43.20	0.00	0.91	6.96	0.84	0.80	**55.29**
# of Facilities Reporting	2	2	0	3	3	3	1	**14**
Total Avg. Flow (MGD)	1.14	23.84	0.00	0.38	4.54	0.66	0.45	**31.01**
Major Process Industrial	2	4	0	0	0	3	0	**9**
Total Permitted Flow (MGD)	29.5	13.3	0	0	0	8.83	0	**51.63**
# of Facilities Reporting	2	4	0	0	0	3	0	**9**
Total Avg. Flow (MGD)	26.18	233.54	0.00	0.00	0.00	3.99	0.00	**263.71**
Minor Process Industrial	3	12	0	3	5	7	1	**31**
Total Permitted Flow (MGD)	0.04	1.10	0.00	0.00	4.20	4.87	0.00	**10.21**
# of Facilities Reporting	2	6	0	1	1	2	0	**12**
Total Avg. Flow (MGD)	0.02	0.32	0.00	0.01	1.08	0.39	0.00	**1.82**
Nonprocess Industrial	8	14	2	5	9	6	0	**44**
Total Permitted Flow (MGD)	0.02	0.30	0.18	0.00	0.00	0.00	0.00	**0.50**
# of Facilities Reporting	1	3	1	0	2	0	0	**7**
Total Avg. Flow (MGD)	0.01	1.22	0.12	0.00	0.23	0.00	0.00	**1.58**
Stormwater Facilities	4	39	0	1	5	4	0	**53**
Total Avg. Flow (MGD)	0	0	0	0	0	0	0	**0**

*** Number of facilities without stormwater and general permits**



Key to Major NPDES Discharges

Map #	Discharger Name	Map #	Discharger Name
1	Brevard WWTP	9	Champion
2	Ecusta	10	Dayco Industries
3	DuPont	11	Waynesville WWTP
4	General Electric.	12	Maggie Valley WWTP
5	Hendersonville WWTP	13	Feldspar
6	Cranston Printworks	14	K-T Feldspar
7	CP&L - Asheville	15	Unimin
8	BASF		

Figure 3.4 Distribution Map of NPDES Dischargers in the French Broad River Basin

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 French Broad River Basin. There are a total of 356 miles of streams in the basin identified as being impaired due to nonpoint pollution sources.

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 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, orchards, Christmas tree farms 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 French Broad River Basin, 256 (over 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 53 miles in subbasin 04 (lower French Broad watershed). 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. 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. Best management practices for addressing agricultural nonpoint source pollution are presented in Appendix VI.

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. 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 an indicator of where urban development and potential urban stream impacts are likely to occur. Based on Table 4.5 in Chapter 4, there are 75 miles of streams that are impaired due to urban runoff. Management strategies for addressing urban runoff are presented in Chapter 6. Best management practices for addressing urban nonpoint source pollution are presented in Appendix VI.

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 severe and long lasting.

Construction activity tends to be concentrated in the more rapidly developing areas of the basin such as subbasins 02 and 05. 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 61 miles of streams impaired due to construction activity. Construction-related sedimentation is addressed through the Sedimentation Pollution Control Act (see Section 5.5.3 in Chapter 5).

3.4.4 Forestry

Forestry is a major industry in North Carolina that has the potential to impact water quality in a number of ways if not properly managed. In mountainous areas, sedimentation is a prime concern. Clear-cutting and improper construction of logging roads and stream crossings can produce damaging sedimentation. In addition, removing riparian vegetation along stream banks can cause water temperature to rise substantially, and improperly applied pesticides can result in toxicity problems.

In the French Broad River Basin, over 50% of the land area is forested and portions of 1.2 million-acre Pisgah National Forest occur in all of the counties in the basin. Trees in the forest are maturing from the last major round of cutting earlier this century, so timbering activity is expected to increase. The National Forest Service has been working on revising and updating its 1987 forest management plan aimed, in part, to ensure that harvesting is done in an environmentally sound manner. Clear-cutting, for example, will be all but eliminated, and harvesting on many of the steeper slopes will be minimized. Also, the North Carolina Division of Forest Resources has established voluntary best-management practices for forestry activities on private lands (Section 5.3.6 in Chapter 5). Based on Table 4.5 in Chapter 4, there are 11 miles of streams impaired due to forestry activities. Best management practices for addressing froestry nonpoint source pollution are presented in Appendix VI.

3.4.5 Mining

Mining is another important industry in the French Broad River Basin, especially in the Nolichucky watershed area including portions of Yancey, Mitchell and Avery Counties. While stone quarries are common throughout the basin, the Nolichucky watershed is valued as a source of feldspar, mica, olivine and gem stones. Mining operations can produce high localized levels of stream sedimentation if not properly treated. Chemicals used in the production of mined materials can also pose a problem such as the use of hydrofluoric acid in the production of feldspar and quartz. These operations have resulted in high fluoride levels in receiving streams that are being addressed through revised NPDES permit limits (see section 6.5.2 in Chapter 6). Nonpoint source impacts associated with mining are addressed, in part, through the Mining Act (see section 5.3.7 in Chapter 5). Best management practices for addressing mining nonpoint source pollution are presented in Appendix VI.

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 can also contribute to eutrophication problems in impoundments. Best management practices for addressing onsite wastewater disposal nonpoint source pollution are presented in Appendix VI.

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 solid wastes can serve as a source of a wide array of pollutants. As an example, CERCLIS and State Inactive Hazardous Waste Sites can represent unregulated nonpoint sources discharges to surface waters in the French Broad basin that have local water quality impacts. These sites are investigated and addressed through programs administered by the NC Division of Solid Waste Management and the US Environmental Protection Agency. Permitted solid waste facilities, where properly designed, constructed and operated, should not significantly affect water quality.

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