
In This Section

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- Summary of Stressors Affecting Water Quality

Section 4

Water Quality: Environmental Stressors

Sections 4, 5, 6, and 7 are closely linked, providing the foundation for the water quality concerns in the basin, identifying the priority issues based on these concerns, and finally, recommending management strategies to address these concerns. Therefore, the reader will probably want to flip back and forth between sections to track specific issues.

This section describes the important environmental stressors that impair or threaten water quality in the Satilla River basin. Section 4.1 first discusses the major sources of environmental stressors. Section 4.2 then provides a summary of individual stressor types as they relate to all sources. These include both traditional chemical stressors, such as metals or oxygen demanding waste, and less traditional stressors, such as modification of the flow regime (hydromodification) and alteration of physical habitat.

4.1 Sources and Types of Environmental Stressors

Environmental stressors are first catalogued by type of source in this section. This is the traditional programmatic approach, and it provides a match to regulatory lines of authority for permitting and management. Assessment requires an integration of stressor loads across all sources, as described in Section 4.2.

4.1.1 Point Sources and Non-discharging Waste Disposal Facilities

Point sources are defined as discharges of treated wastewater to the river and its tributaries, regulated under the National Pollutant Discharge Elimination System (NPDES). These are divided into two main types—permitted wastewater discharges, which tend to be discharged at relatively stable rates, and permitted storm water

discharges, which tend to be discharged at highly irregular, intermittent rates, depending on precipitation. Nondischarging waste disposal facilities, including land application systems and landfills, which are not intended to discharge treated effluent to surface waters, are also discussed in this section.

NPDES Permitted Wastewater Discharges

The EPD NPDES permit program regulates municipal and industrial waste discharges, monitors compliance with limitations, and takes appropriate enforcement action for violations. For point source discharges, the permit establishes specific effluent limitations and specifies compliance schedules that must be met by the discharger. Effluent limitations are designed to achieve water quality standards in the receiving water and are reevaluated periodically (at least every 5 years).

Municipal Wastewater Discharges

Municipal wastewater treatment plants are among the most significant point sources regulated under the NPDES program in the Satilla River basin, accounting for the majority of the total point source effluent flow (exclusive of cooling water). These plants collect, treat, and release large volumes of treated wastewater. Pollutants associated with treated wastewater include pathogens, nutrients, oxygen-demanding waste, metals, and chlorine residuals. Over the past several decades, Georgia has invested more than \$12.5 million in construction and upgrade of municipal water pollution control plants in the Satilla River basin; a summary of these investments is provided in Appendix C. These upgrades have resulted in significant reductions in pollutant loading and consequent improvements in water quality below wastewater treatment plant outfalls. As of the 2000 water quality assessment, several estuarine waterbodies were identified in which municipal or industrial discharges contributed to not fully supporting designated uses, which are being addressed through the NPDES permitting and hazardous waste cleanup processes.

Table 4-1 displays the major municipal wastewater treatment plants with permitted discharges of 1 million gallons per day (MGD) or greater in the Satilla River basin. The geographic distribution of dischargers is shown in Figure 4-1. In addition, there are discharges from a variety of smaller wastewater treatment plants, including both public facilities (small public water pollution control plants, schools, marinas, etc.) and private facilities (package plants associated with non-sewered developments and mobile home parks) with less than a 1-MGD flow. These minor discharges might have the potential to cause localized stream impacts, but they are relatively insignificant from a basin perspective. A complete list of permitted dischargers in the Satilla River Basin is presented in Appendix D.

Table 4-1. Major Municipal Wastewater Treatment Plant Discharges with Permitted Monthly Flow Greater than 1 MGD in the Satilla River Basin

NPDES Permit No.	Facility Name	County	Receiving Stream	Permitted Monthly Avg. Flow
HUC 03070201				
GA0024431	Douglass Southeast	Coffee	Seventeen Mile Creek	6.0
GA0020966	Waycross WPCP	Ware	Satilla River	6.7
HUC03070203				
GA0025313	Brunswick Academy	Glynn	Academy Creek	13.5
GA0020508	Jekyll WPCP	Glynn	Jekyll River	1.0
GA0021521	Saint Simons Island	Glynn	Dunbar Creek	3.0

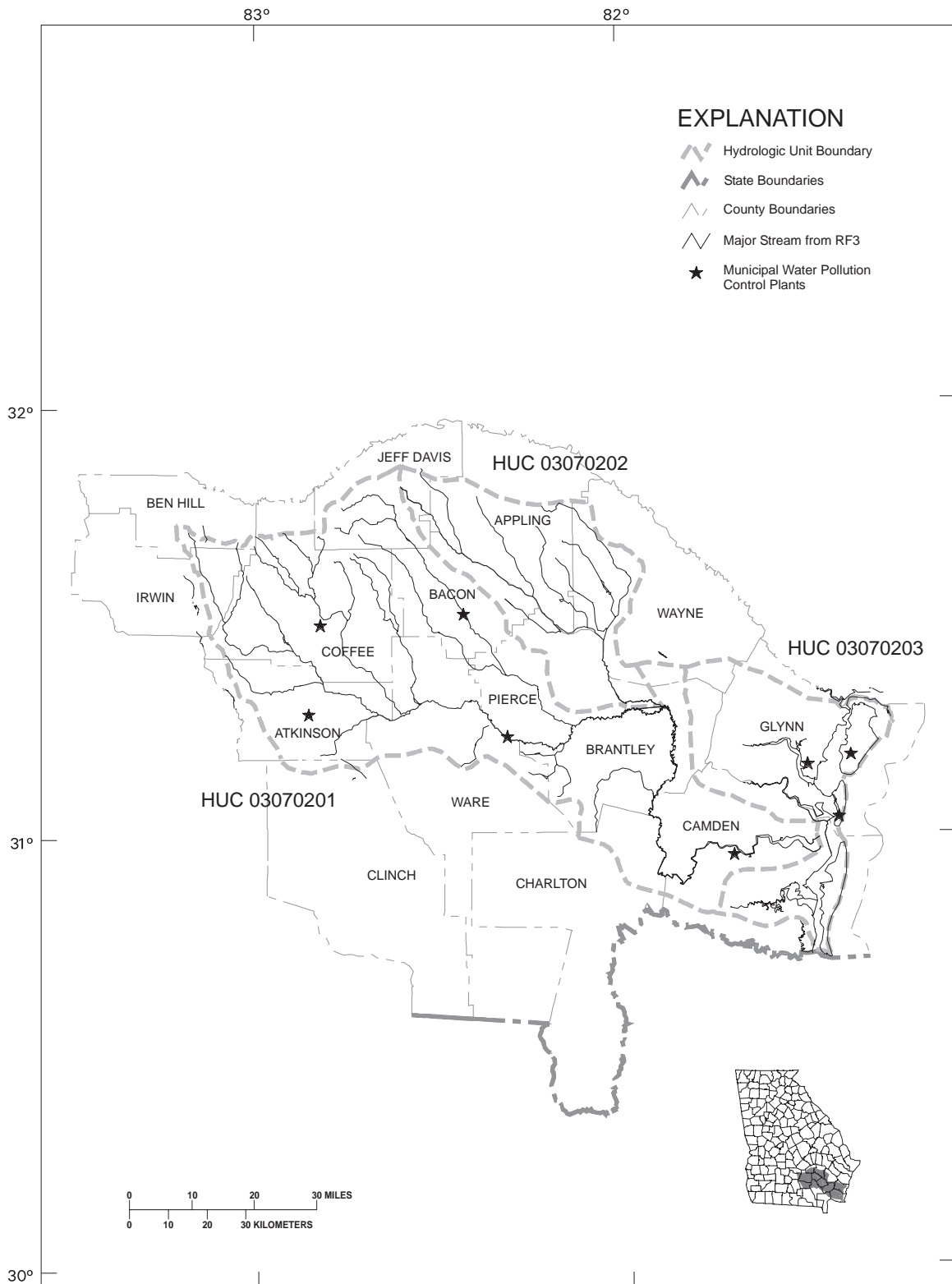


Figure 4-I. Location of Municipal Wastewater Treatment Plants in the Satilla River Basin

Most urban wastewater treatment plants also receive industrial process and nonprocess wastewater, which can contain a variety of conventional and toxic pollutants. The control of industrial pollutants in municipal wastewater is addressed through pretreatment programs. The major publicly owned wastewater treatment plants in this basin have developed and implemented approved local industrial pretreatment programs. Through these programs, the wastewater treatment plants are required to establish effluent limitations for their significant industrial dischargers (those which discharge in excess of 25,000 gallons per day of process wastewater or are regulated by a Federal Categorical Standard) and to monitor the industrial user's compliance with those limits. The treatment plants are able to control the discharge of organics and metals into their sewerage system through the controls placed on their industrial users.

Industrial Wastewater Discharges

Industrial and federal wastewater discharges are also significant point sources regulated under the NPDES program. There are a total of 34 permitted municipal, state, federal, private, and industrial wastewater and process water discharges in the Satilla River basin, as summarized in Table 4-2. The complete permit list is summarized in Appendix D.

Table 4-2. Summary of NPDES Permits in the Satilla River Basin

HUC	Major Municipal Facilities	Major Industrial and Federal Facilities	Minor Public Facilities	Minor Private and Industrial Facilities	Total
03070201	2	0	3	8	13
03070202	0	0	2	2	4
03070203	3	2	0	12	17
Total	5	2	5	22	34

The nature of industrial discharges varies widely compared to discharges from municipal plants. Effluent flow is not usually a good measure of the significance of an industrial discharge. Industrial discharges can consist of organic, heavy oxygen-demanding waste loads from facilities such as pulp and paper mills; large quantities of noncontact cooling water from facilities such as power plants; pit pumpout and surface runoff from mining and quarrying operations, where the principal source of pollutants is the land-disturbing activity rather than the addition of any chemicals or organic material; or complex mixtures of organic and inorganic pollutants from chemical manufacturing, textile processing, metal finishing, etc. Pathogens and chlorine residuals are rarely of concern with industrial discharges, but other conventional and toxic pollutants must be addressed on a case-by-case basis through the NPDES permitting process. Table 4-3 lists the major industrial and federal wastewater treatment plants with discharges into the Satilla River basin in Georgia.

Table 4-3. Major Industrial and Federal Wastewater Treatment Facilities in the Satilla River Basin

NPDES Permit No.	Facility Name	County	Description	Flow(Mgd)	Receiving Stream
HUC 03070203					
GA0003654	Georgia Pacific Brunswick	Glynn	Pulp and Paper	32.2	Turtle River
GA0003735	Hercules Brunswick	Glynn	Pulp and Paper	8.7	Dupree Creek

There are also minor industrial discharges which may have the potential to cause localized stream impacts, but are relatively insignificant from a basin perspective. The locations of permitted point source discharges of treated wastewater in the Satilla River basin are shown in Figures 4-2 through 4-4.

Combined Sewer Overflows

Combined sewers are sewers that carry both storm water runoff and sanitary sewage in the same pipe. Most of these combined sewers were built at the turn of the century and were present in most large cities. At that time both sewage and storm water runoff were piped from the buildings and streets to the small streams that originated in the heart of the city. When these streams were enclosed in pipes, they became today's combined sewer systems. As the cities grew, their combined sewer systems expanded. Often new combined sewers were laid to move the untreated wastewater discharge to the outskirts of the town or to the nearest waterbody.

In later years wastewater treatment facilities were built and smaller sanitary sewers were constructed to carry the sewage (dry weather flows) from the termination of the combined sewers to these facilities for treatment. However, during wet weather, when significant storm water is carried in the combined system, the sanitary sewer capacity is exceeded and a combined sewer overflow (CSO) occurs. The surface discharge is a mixture of storm water and sanitary waste. Uncontrolled CSOs thus discharge raw diluted sewage and can introduce elevated concentrations of bacteria, BOD, and solids into a receiving water body. In some cases, CSOs discharge into relatively small creeks.

CSOs are considered a point source of pollution and are subject to the requirements of the Clean Water Act. Although CSOs are not required to meet secondary treatment effluent limits, sufficient controls are required to protect water quality standards for the designated use of the receiving stream. In its 1990 session, the Georgia Legislature passed a CSO law requiring all Georgia cities to eliminate or treat CSOs.

There are no known combined sewer overflows in the Satilla River basin.

NPDES Permitted Storm Water Discharges

Urban storm water runoff in the Satilla basin has been identified as a source of stressors from pollutants such as oxygen-demanding waste (BOD) and fecal coliform bacteria. Storm water may flow directly to streams as a diffuse, nonpoint process, or may be collected and discharged through a storm sewer system. Storm sewers are now subject to NPDES permitting and are discussed in this section. Contributions from nonpoint storm water is discussed in later sections.

Pollutants typically found in urban storm water runoff include pathogens (such as bacteria and viruses from human and animal waste), heavy metals, debris, oil and grease, petroleum hydrocarbons and a variety of compounds toxic to aquatic life. In addition, the runoff often contains sediment, excess organic material, fertilizers (particularly nitrogen and phosphorus compounds), herbicides, and pesticides which can upset the natural balance of aquatic life in lakes and streams. Storm water runoff may also increase the temperature of a receiving stream during warm weather, which potentially threatens valuable fisheries in the Satilla River basin. All of these pollutants, and many others, influence the quality of storm water runoff. There are also many potential problems related to the quantity of urban runoff, which can contribute to flooding and erosion in the immediate drainage area and downstream.

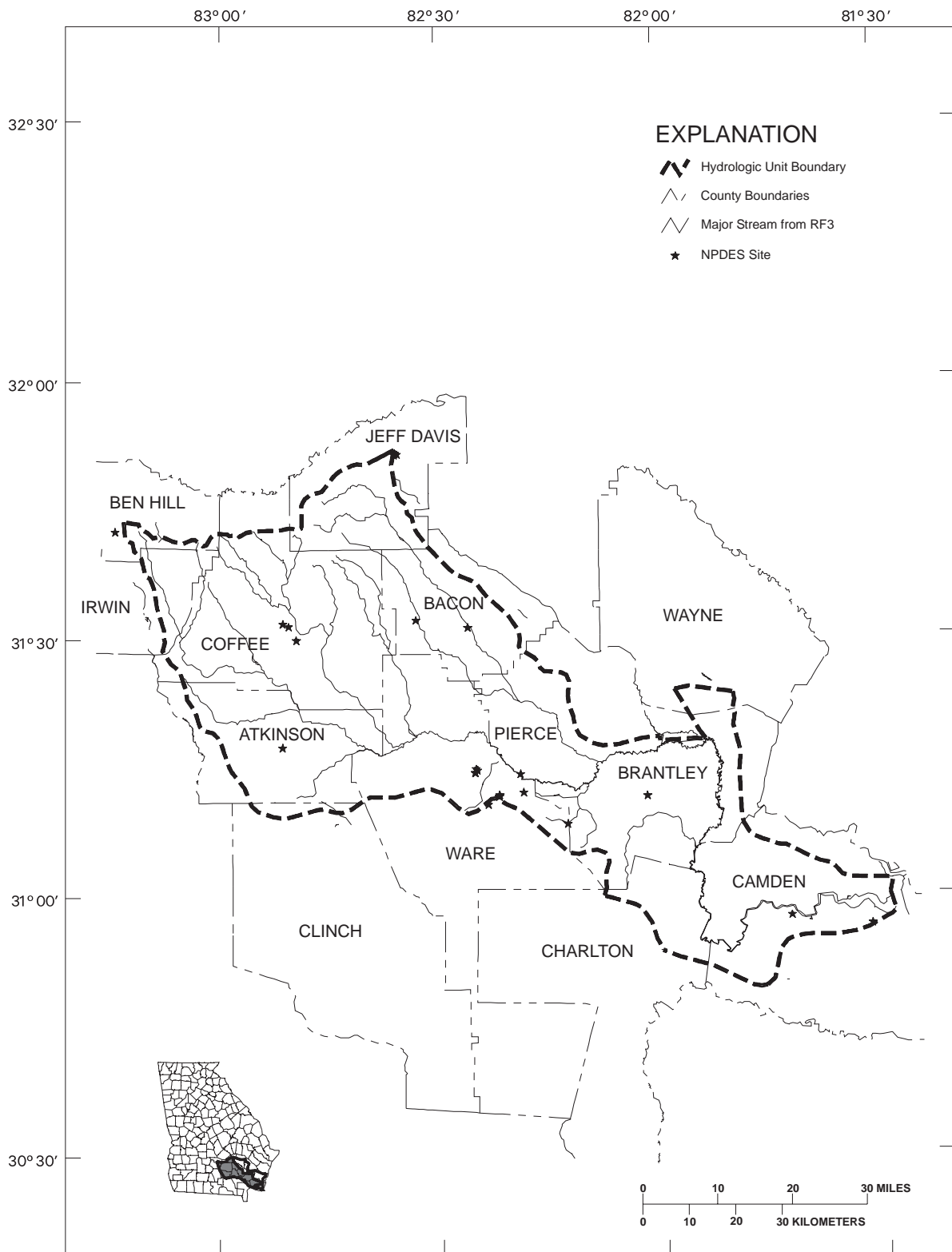


Figure 4-2. NPDES Sites Permitted by GAEPD, Satilla River Basin, HUC 03070201

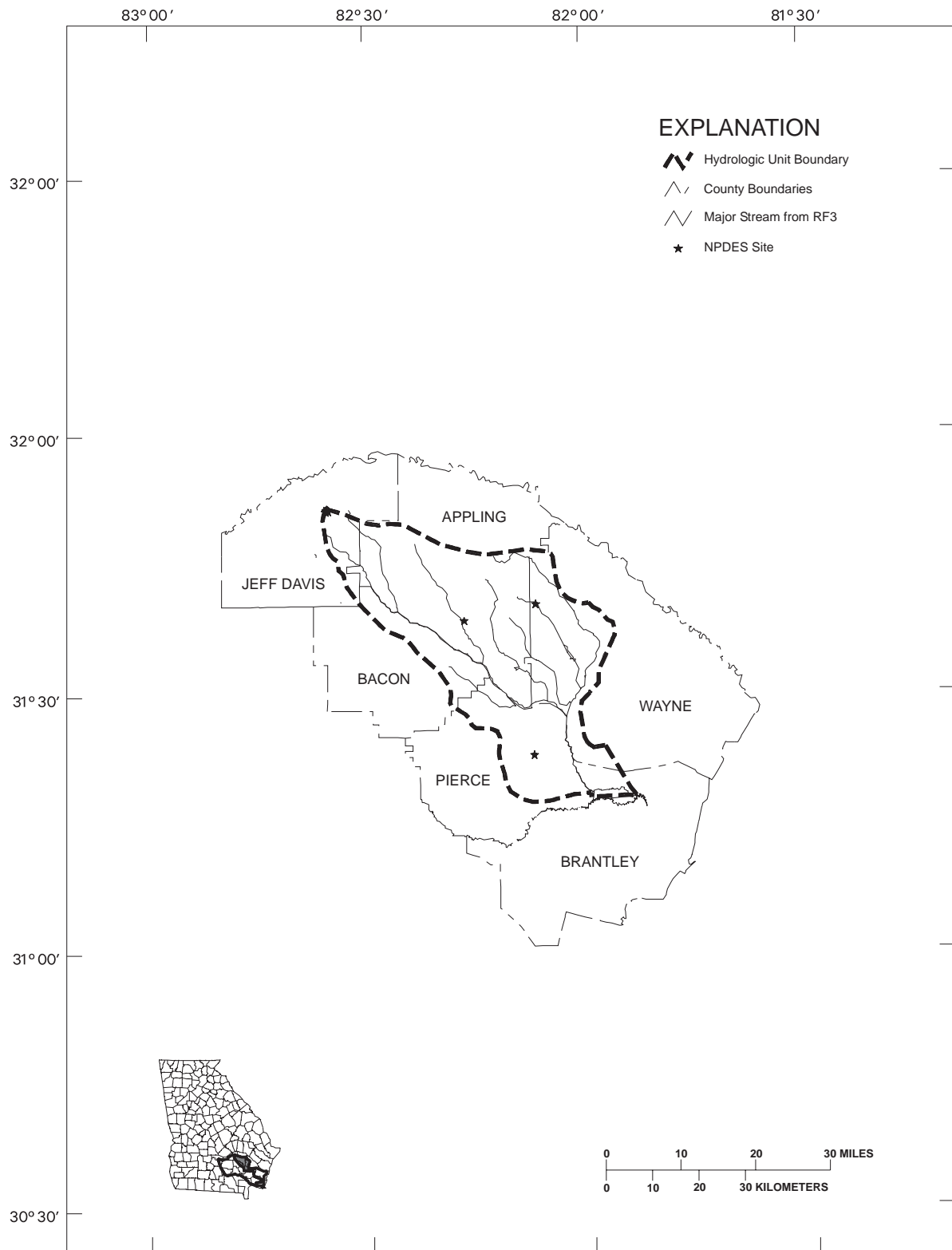


Figure 4-3. NPDES Sites Permitted by GAEPD, Satilla River Basin, HUC 03070202

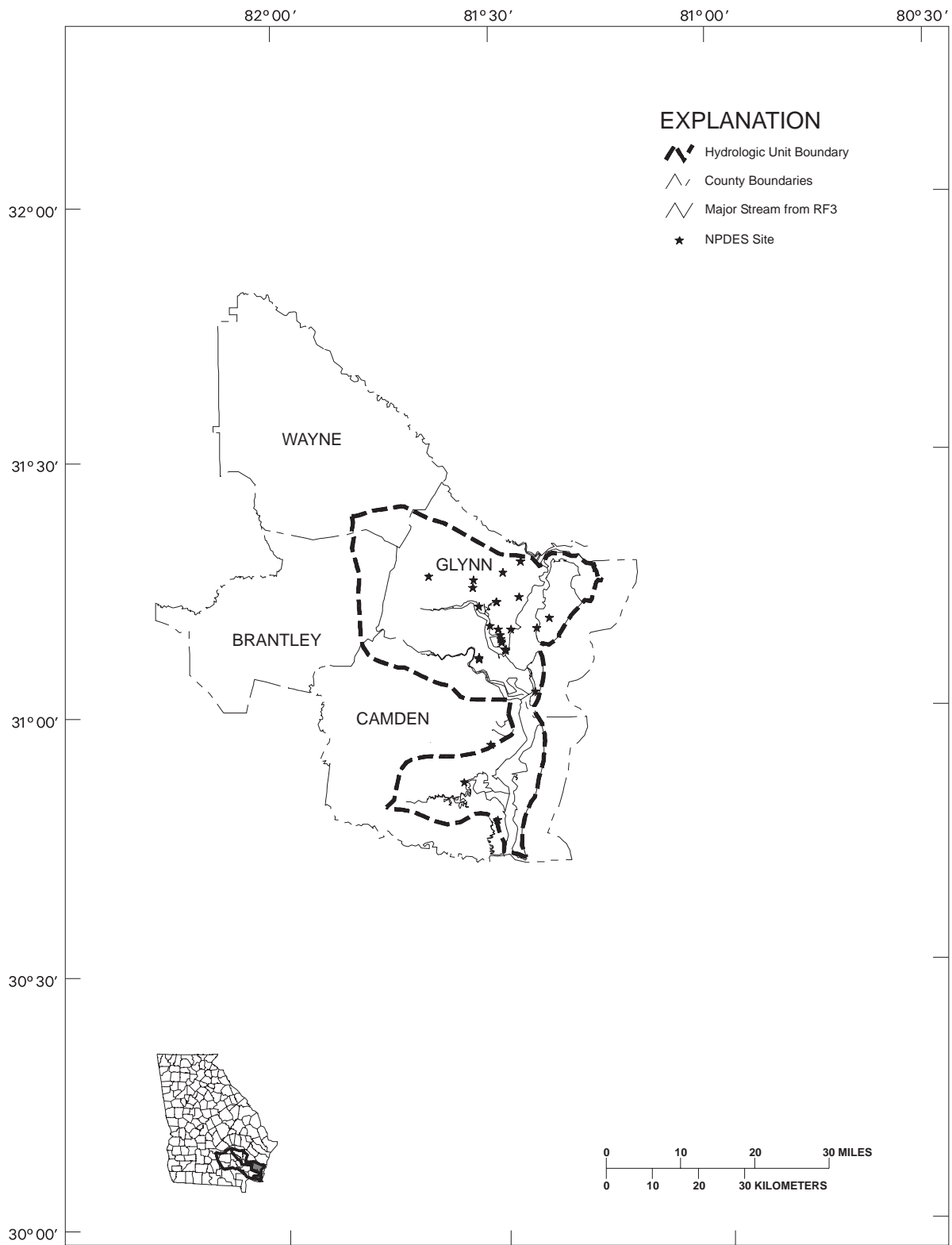


Figure 4-4. NPDES Sites Permitted by GAEPD, Satilla River Basin, HUC 03070203

Municipal Storm Water Discharges

In accordance with Federal “Phase I” storm water regulations, the state of Georgia has issued individual areawide NPDES municipal separate storm sewer system (MS4) permits to 58 cities and counties in municipal areas with populations greater than 100,000 persons. There were no permits issued in the Satilla River basin.

Industrial Storm Water Discharges

Industrial sites often have their own storm water conveyance systems. The volume and quality of storm water discharges associated with industrial activity is dependent on a number of factors, such as the industrial activities occurring at the facility, the nature of the precipitation, and the degree of surface imperviousness (hard surfaces). These discharges are of intermittent duration with short-term pollutant loadings that can be high enough to have shock loading effects on the receiving waters. The types of pollutants from industrial facilities are generally similar to those found in storm water discharges from commercial and residential sites; however, industrial facilities have a significant potential for discharging at higher pollutant concentrations, and may include specific types of pollutants associated with a given industrial activity.

EPD has issued one general permit regulating storm water discharges for 10 of 11 federally regulated industrial subcategories. The general permit for industrial activities requires the submission of a Notice of Intent (NOI) for coverage under the general permit; the preparation and implementation of storm water pollution prevention plan; and, in some cases, analytical testing of storm water discharges from the facility. As with the municipal storm water permits, implementation of site-specific best management practices is the preferred method for controlling storm water runoff.

The 11th federally regulated industrial subcategory (construction activities) is covered under NPDES General Permit No. GAR100000. This general permit regulates storm water discharges associated with construction activity at sites and common developments disturbing more than five acres. The general permit requires the submission of a Notice of Intent (NOI) to obtain coverage under the permit, the preparation and implementation of an Erosion, Sedimentation, and Pollution Control Plan, and the preparation and implementation of a Comprehensive Monitoring Program which provides for monitoring of turbidity levels in the receiving stream(s) and/or storm water outfalls(s) during certain rain events. The general permit became effective on August 1, 2000 and will expire on July 31, 2003.

Nondischarging Waste Disposal Facilities

Land Application Systems (LASs)

In addition to permits for point source discharges, EPD has developed and implemented a permit system for land application systems (LASs). LASs for final disposal of treated wastewaters have been encouraged in Georgia and are designed to eliminate surface discharges of effluent to waterbodies. LASs are used as an alternative to advanced levels of treatment or as the only alternative in some environmentally sensitive areas.

When properly operated, an LAS should not be a source of stressors to surface waters. The locations of LASs are, however, worth noting because of the (small) possibility that a LAS could malfunction and become a source of stressor loading.

A total of 147 municipal and 53 industrial permits for land application systems were in effect in Georgia in 2000. Municipal and other wastewater land application systems within the Satilla Basin are listed in Table 4-4. The locations of all LASs within the basin are shown in Figures 4-5 through 4-7.

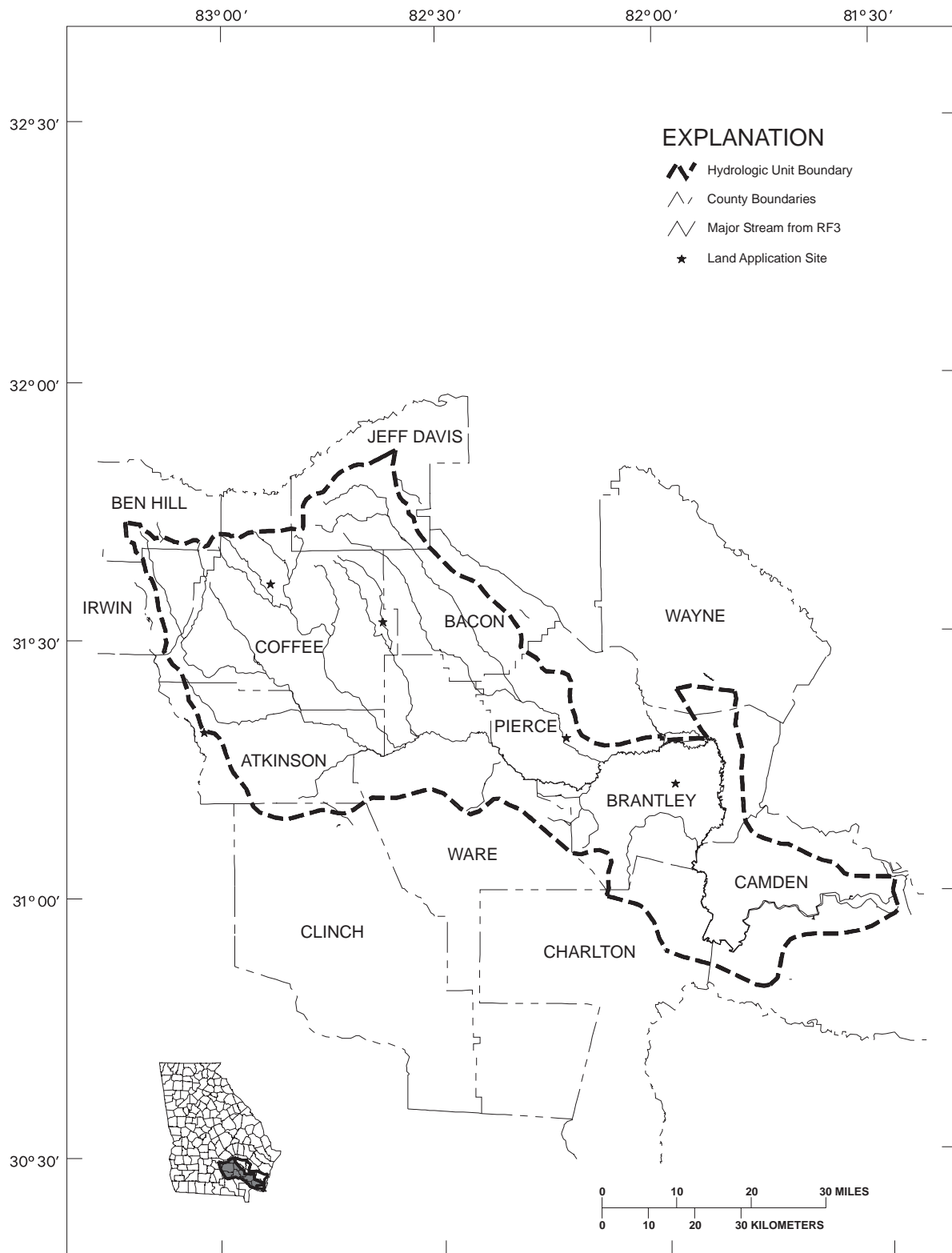


Figure 4-5. Land Application Systems, Satilla River Basin, HUC 03070201

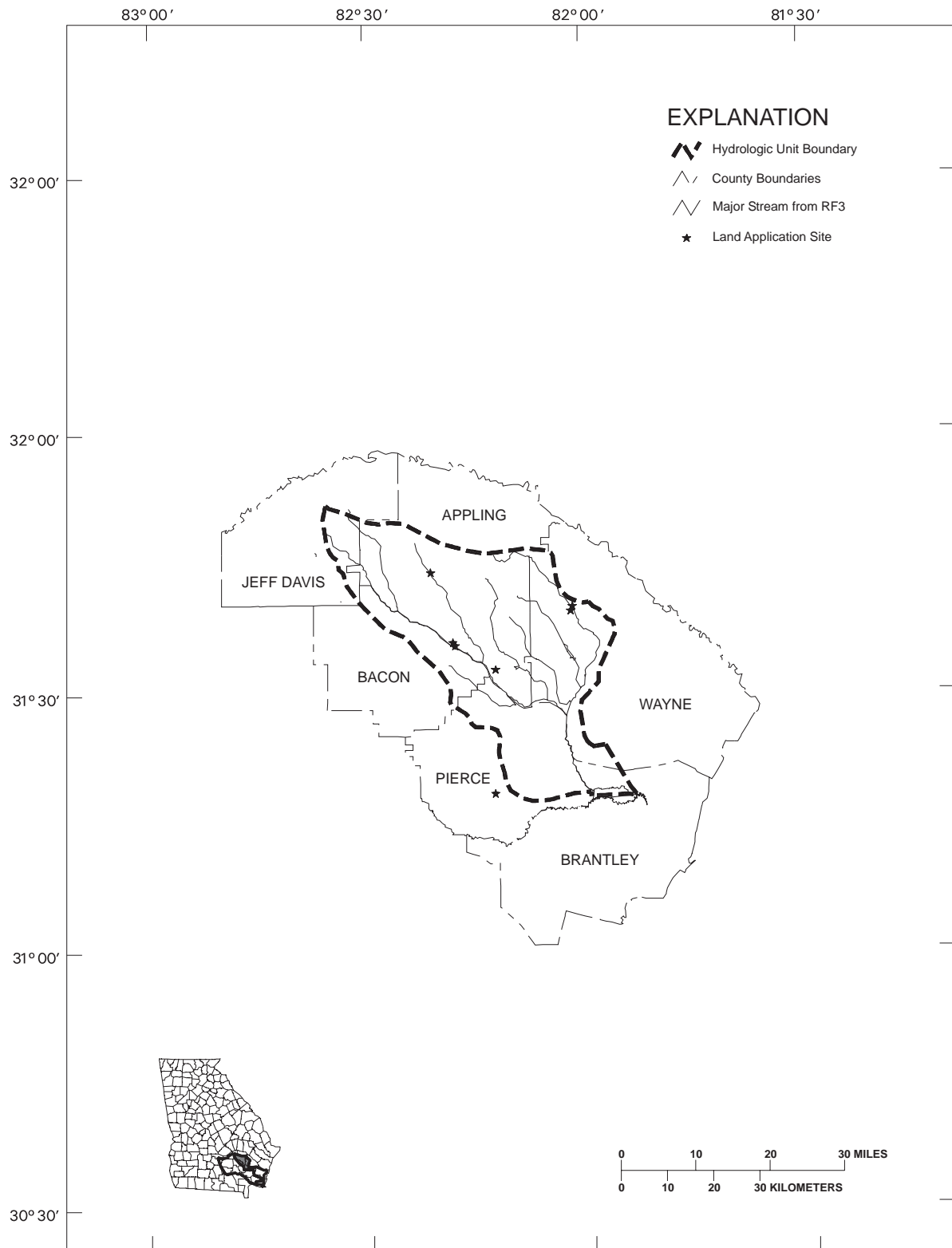


Figure 4-6. Land Application Systems, Satilla River Basin, HUC 03070202

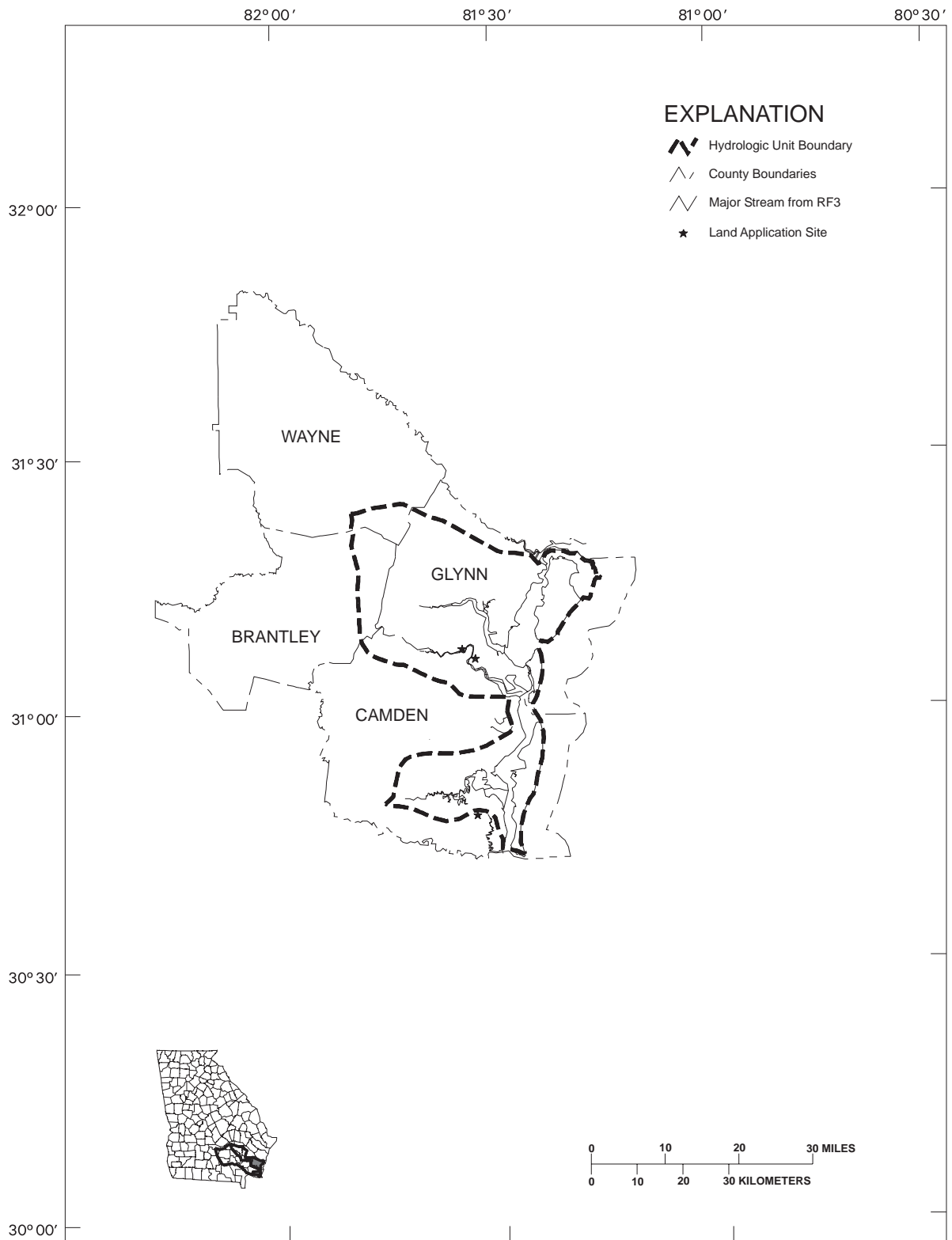


Figure 4-7. Land Application Systems, Satilla River Basin, HUC 03070203

Table 4-4. Wastewater Land Application Systems in the Satilla River Basin

Facility Name	County	Permit No.	Permitted Flow (Mgd)
Baxley	Appling	GA02-182	1.4
Blackshear	Pierce	GA02-001	0.35
Broxton	Coffee	GA02-124	0.162
Dixon Dairy Farms	Appling	GA01-374	
Glynn Co.I-95/US 17	Glynn	GA02-059	0.3
Lee Meats	Bacon	GA01-321	0.1
Mickey's Meats Inc.	Wayne	GA01-449	0.005
Millenium Specialty Chem	Glynn	GA01-519	0.04
Nahunta LAS	Brantley	GA02-062	0.12
Nichills LAS	Coffee	GA02-267	0.242
Odum LAS	Wayne	GA02-027	0.075
Pierce Co. Bd of Ed.	Pierce	GA02-035	0.028
Willachoochee	Atkinson	GA02-164	0.355
Wright's Appling Co Dairy	Appling	GA01-594	0.109
Wright's Appling Co Farms Inc	Appling	GA01-365	0.109

Landfills

Permitted landfills are required to contain and treat any leachate or contaminated runoff prior to discharge to any surface water. The permitting process encourages either direct connection to a publicly owned treatment works (although vehicular transportation is allowed in certain cases) or treatment and recirculation on site to achieve a no-discharge system. Direct discharge in compliance with NPDES requirements is allowed but is not currently practiced any landfills in Georgia. Groundwater contaminated by landfill leachate from older, unlined landfills represents a potential threat to waters of the state. Ground water and surface water monitoring and corrective action requirements are in place for all landfills operated after 1988 to identify and rededicate potential threats. The provisions of the Hazardous Sites Response Act address threats posed by older landfills as releases of hazardous constituents are identified. All new municipal solid waste landfills are required to be lined and to have a leachate collection system installed.

EPD's Land Protection Branch is responsible for permitting and compliance of municipal and industrial Subtitle D landfills. The location of permitted landfills within the basin is shown in Figures 4-8 through 4-10.

4.1.2 Nonpoint Sources

The pollution impact on Georgia's streams has radically shifted over the last two decades. Streams are no longer dominated by untreated or partially treated sewage discharges, which had resulted in little or no oxygen and little or no aquatic life. The sewage is now treated, oxygen levels have recovered, and healthy fisheries have followed. Industrial discharges have also been placed under strict regulation. However, other sources of pollution are still affecting Georgia's streams. These sources are referred to as *nonpoint sources*. Nonpoint sources are diffuse in nature. Nonpoint source pollution can generally be defined as the pollution caused by rainfall or snowmelt moving over and through the ground. As water moves over and through the soil, it picks up and carries away natural pollutants and pollutants resulting from human activities, finally depositing them in lakes, rivers, wetlands, coastal waters, or ground water. Habitat alteration (e.g., removal of riparian vegetation) and hydrological modification (e.g., channelization,

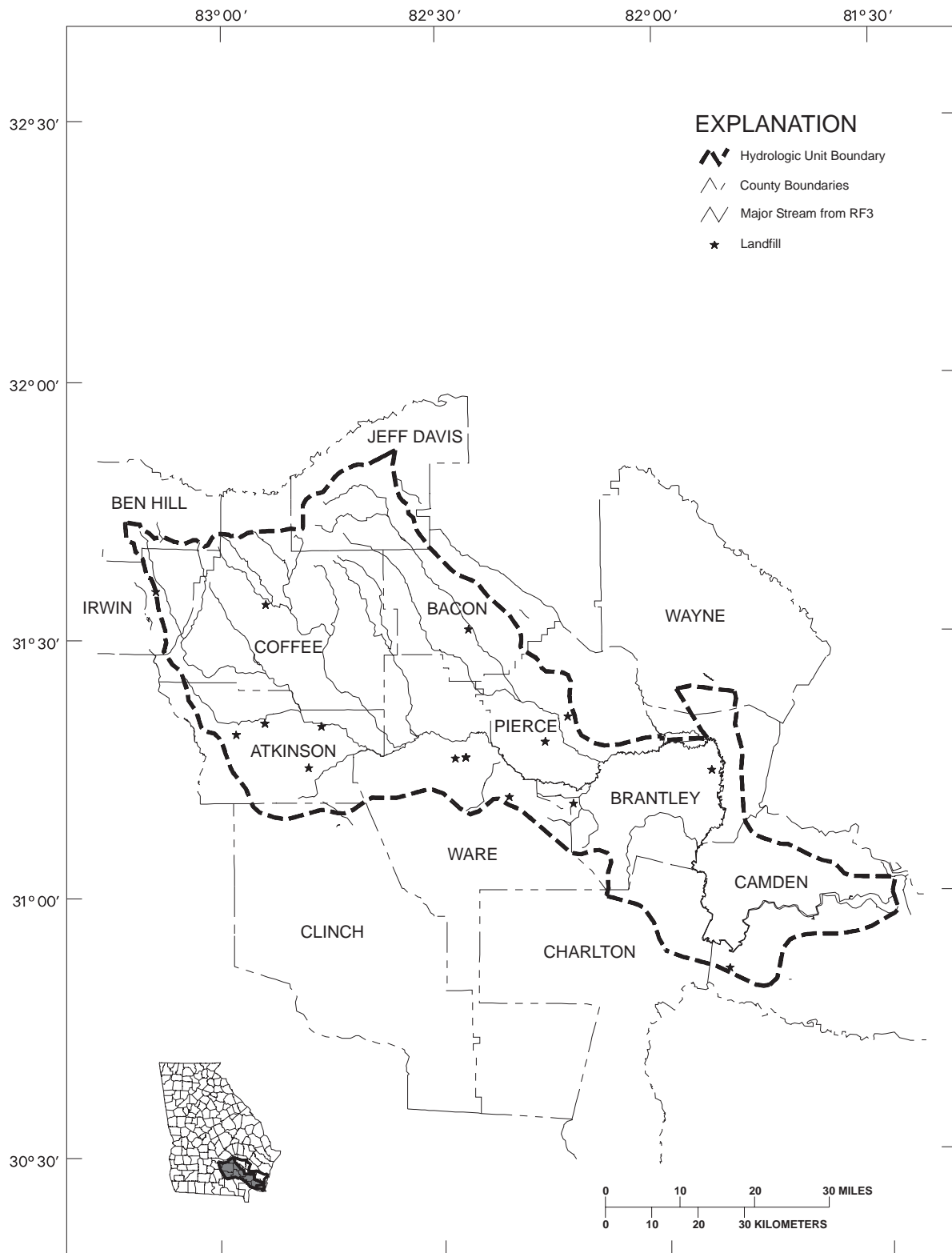


Figure 4-8. Landfills, Satilla River Basin, HUC 03070201

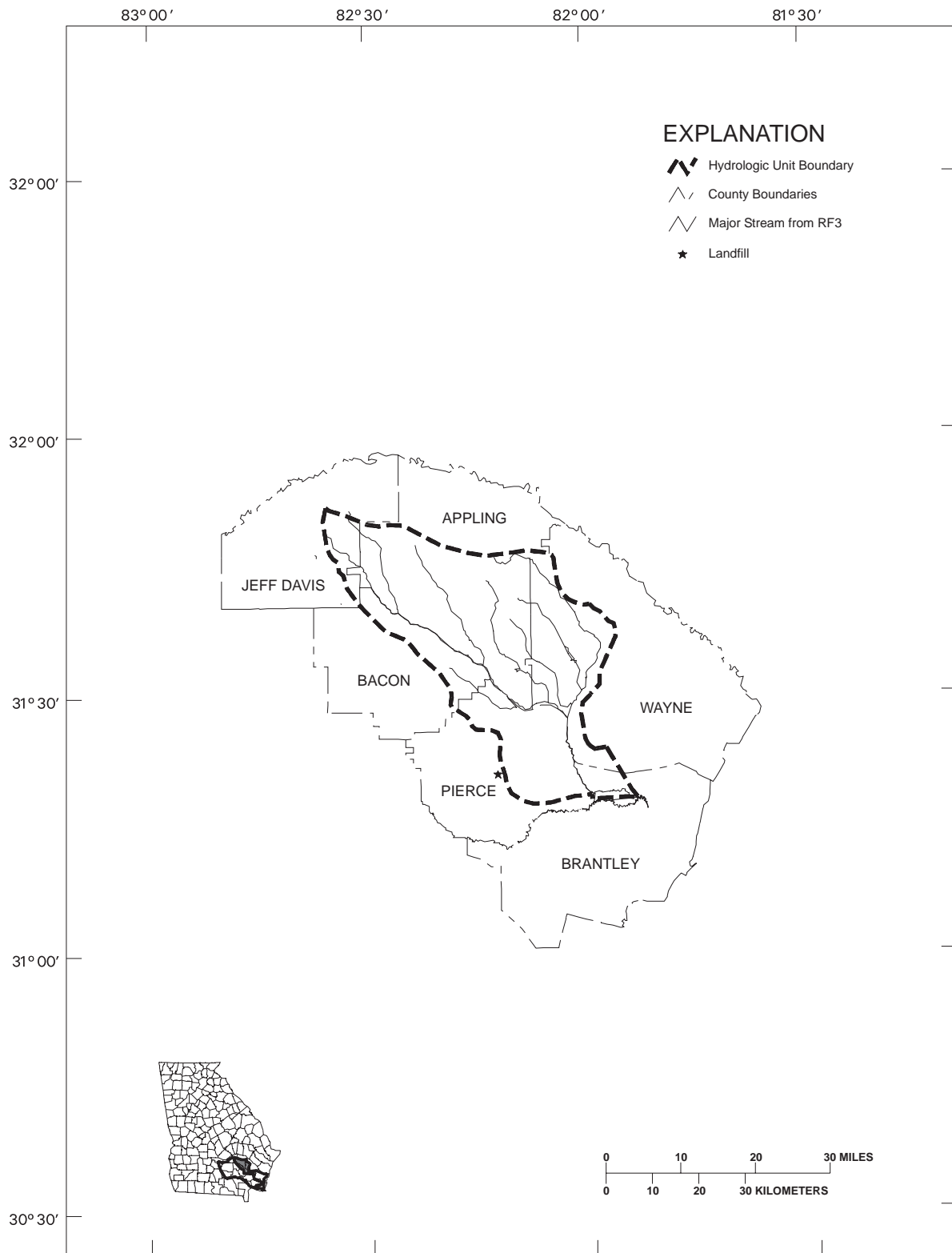


Figure 4-9. Landfills, Satilla River Basin, HUC 03070202

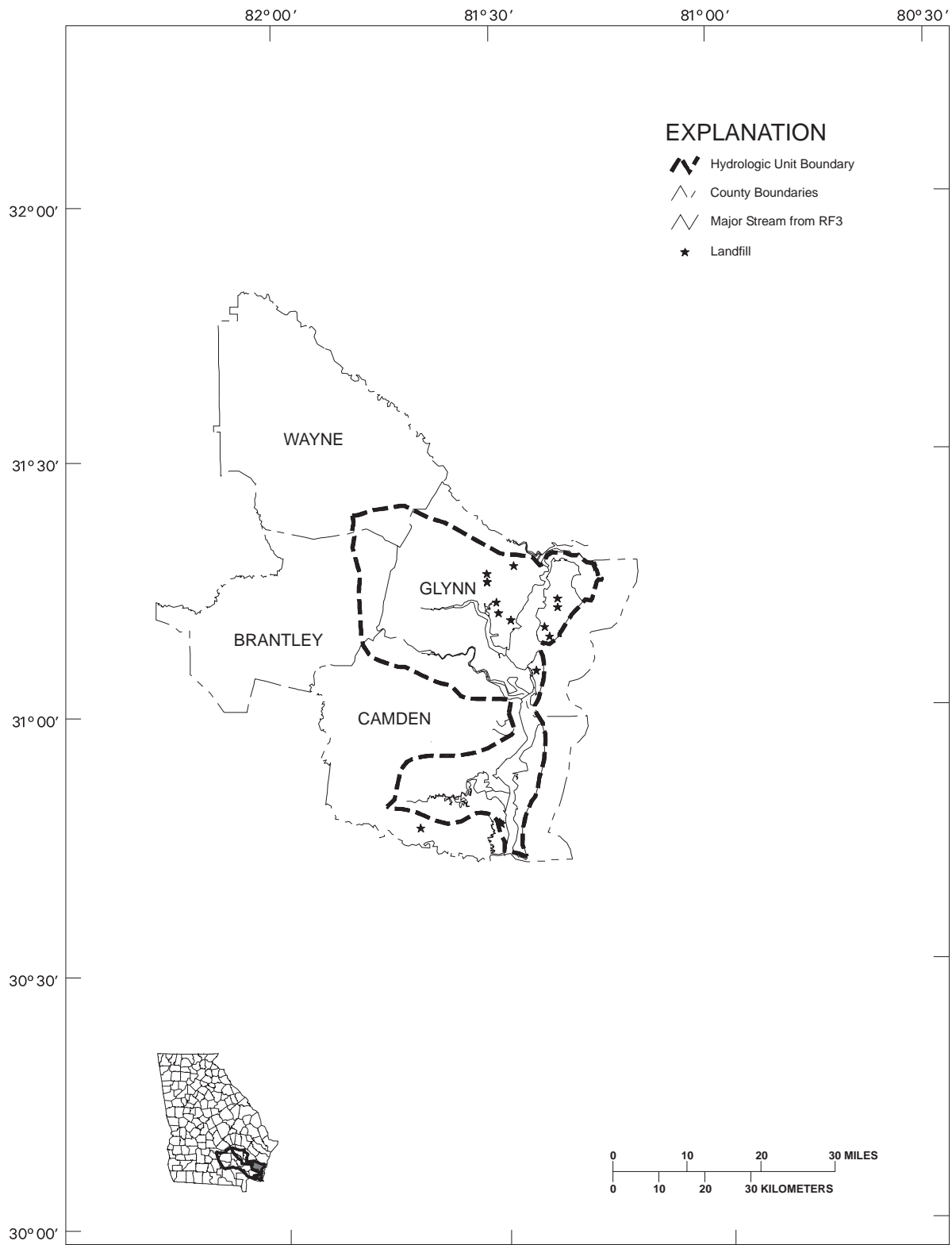


Figure 4-10. Landfills, Satilla River Basin, HUC 03070203

bridge construction) can also cause adverse effects on the biological integrity of surface waters and are also treated as nonpoint sources of pollution.

Nonpoint pollutant loading comprises a wide variety of sources not subject to point source control through NPDES permits. The most significant nonpoint sources are those associated with precipitation, washoff, and erosion, which can move pollutants from the land surface to water bodies. Both rural and urban land uses can contribute significant amounts of nonpoint pollution. A review of the 1998-1999 water quality assessment results for the Satilla basin indicates that urban runoff and rural nonpoint sources contribute significantly to lack of full support for designated uses. The major categories of stressors for nonpoint sources are discussed below.

Nonpoint Sources from Agriculture

Agricultural operations can contribute stressors to water bodies in a variety of ways. Tillage and other soil-disturbing activities can promote erosion and loading of sediment to water bodies unless controlled by management practices. Nutrients contained in fertilizers, animal wastes, or natural soils may be transported from agricultural land to streams in either sediment-attached or dissolved forms. Loading of pesticides and pathogens is also of concern for various agricultural operations.

Sediment and Nutrients

Sediment is the most common pollutant resulting from agricultural operations. It consists mainly of mineral fragments resulting from the erosion of soils, but it can also include crop debris and animal wastes. Excess sediment loads can damage aquatic habitat by smothering and shading food organisms, alter natural substrate, and destroying spawning areas. Runoff with elevated sediment concentrations can also scour aquatic habitat, causing significant impacts on the biological community. Excess sediment can also increase water treatment costs, interfere with recreational uses of water bodies, create navigation problems, and increase flooding damage. In addition, a high percentage of nutrients lost from agricultural lands, particularly phosphorus, are transported attached to sediment. Many organic chemicals used as pesticides or herbicides are also transported predominantly attached to sediment.

Agriculture can be a significant source of nutrients, which can lead to excess or nuisance growth of aquatic plants and depletion of dissolved oxygen. The nutrients of most concern from agricultural land uses are nitrogen (N) and phosphorus (P), which may come from commercial fertilizer or land application of animal wastes. Both nutrients assume a variety of chemical forms, including soluble ionic forms (nitrate and phosphate) and less-soluble organic forms. Less soluble forms tend to travel with sediment, whereas more soluble forms move with water. Nitrate-nitrogen is very weakly adsorbed by soil and sediment and is therefore transported entirely in water. Because of the mobility of nitrate-nitrogen, the major route of nitrate loss is to streams by interflow or ground water in deep seepage.

Phosphorus transport is a complex process that involves different components of phosphorus. Soil and sediment contain a pool of adsorbed phosphorus, which tends to be in equilibrium with the phosphorus in solution (phosphate) as water flows over the soil surface. The concentrations established in solution are determined by soil properties and fertility status. Adsorbed phosphorus attached to soil particles suspended in runoff also equilibrates with phosphorus in solution.

Animal Waste

In addition to contributing to nutrient loads, animal waste may contribute high loads of oxygen-demanding chemicals and bacterial and microbial pathogens. The waste may reach surface waters through direct runoff as solids or in their soluble form. Soluble forms may reach ground water through runoff, seepage, or percolation and reach surface

waters as return flow. As the organic materials decompose, they place an oxygen demand on the receiving waters, which may adversely affect fisheries, and cause other problems with taste, odor, and color. When waters are contaminated by waste from mammals the possible presence of pathogens that affect human health, include fecal bacteria, is of particular concern. In addition to being a source of bacteria, cattle waste might be an important source of the infectious oocysts of the protozoan parasite *Cryptosporidium parvum*.

Pesticides

Pesticides applied in agricultural production can be insoluble or soluble and include herbicides, insecticides, miticides, and fungicides. They are primarily transported directly through surface runoff, either in dissolved forms or attached to sediment particles. Some pesticides can cause acute and chronic toxicity problems in the water or throughout the entire food chain. Others are suspected human carcinogens, although the use of such pesticides has generally been discouraged in recent years.

The major agricultural pesticide/herbicides use within the basin include 2,4-d, Prowl, Blazer/Basagran/Trifluralin/Treflan/Trilin, Aatrex/Atizine, Gramoxone, Classic, Lexone/Sencor, and Lasso (alachlor) (compiled from the Georgia Herbicide Use Survey summary (Monks and Brown 1991)). Since 1990, the use of alachlor in Georgia has decreased dramatically since peanut wholesalers no longer buy peanuts with alachlor.

Nonherbicide pesticide use is difficult to estimate. According to Stell et al. (1995), pesticides other than herbicides are currently used only when necessary to control some type of infestation (nematodes, fungi, and insects). Other common nonherbicide pesticides include chlorothalonil, aldicarb, chlorpyrifos, methomyl, thiodicarb, carbaryl, acephate, fonofos, methyl parathion, terbufos, disulfoton, phorate, triphenyltin hydroxide (TPTH), and synthetic pyrethroids/pyrethrins. Application periods of principal agricultural pesticides span the calendar year in the basin. However, agricultural pesticides are applied most intensively and on a broader range of crops from March 1 to September 30 in any given year.

It should be noted that past uses of persistent agricultural pesticides that are now banned might continue to affect water quality within the basin, particularly through residual concentrations present in bottom sediments. A survey of pesticide concentration data by Stell et al. (1995) found that two groups of compounds had concentrations at or above minimum reporting levels in 56 percent of the water and sediment analyses. The first group included DDT and metabolites, and the second group included chlordane and related compounds (heptachlor, heptachlor epoxide)—while dieldrin was also frequently detected. The USEPA now bans all of these pesticides for use in the United States, but they might persist in the environment for long periods of time.

Nonpoint Sources from Urban, Industrial, and Residential Lands

Water quality in urban waterbodies is affected by both point source discharges and diverse land use activities in the drainage basin (i.e., nonpoint sources). One of the most important sources of environmental stressors in the Satilla River basin, particularly in the developed and rapidly growing areas is diffuse runoff from urban, industrial, and residential land uses (jointly referred to as “urban runoff”). Nonpoint source contamination can impair streams that drain extensive commercial and industrial areas due to inputs of storm water runoff, unauthorized discharges, and accidental spills. Wet weather urban runoff can carry high concentrations of many of the same pollutants found in point source discharges, such as oxygen-demanding waste, suspended solids, synthetic organic chemicals, oil and grease, nutrients, lead and other metals, and bacteria. The major difference is that urban runoff occurs only intermittently, in response to precipitation events.

The characteristics of nonpoint urban sources of pollution are generally similar to those of NPDES permitted storm water discharges (these are discussed in the previous section). Nonpoint urban sources of pollution include drainage from areas with impervious surfaces, but also includes less highly developed areas with greater amounts of pervious surfaces such as lawns, gardens, and septic tanks, all of which may be sources of nutrient loading.

There is little site-specific data available to quantify loading in nonpoint urban runoff in the Satilla River basin, although estimates of loading rates by land use types have been widely applied in other areas.

Pesticides and Herbicides from Urban and Residential Lands

Urban and suburban land uses are also a potential source of pesticides and herbicides through application to lawns and turf, roadsides, and gardens and beds. As an example Stell et al. (1995) provide a summary of usage in the Atlanta Metropolitan Statistic Area (MSA). The herbicides most commonly used by the lawn-care industry are combinations of dicamba, 2,4-D, mecoprop (MCP), 2,4-DP, and MCPA, or other phenoxy-acid herbicides, while most commercially available weed control products contain one or more of the following compounds: glyphosphate, methyl sulfometuron, benefin (benfluralin), bensulide, acifluorfen, 2,4-D, 2,4-DP, or dicamba. Atrazine was also available for purchase until it was restricted by the State of Georgia on January 1, 1993. The main herbicides used by local and state governments are glyphosphate, methyl sulfometuron, MSMA, 2,4-D, 2,4-DP, dicamba, and chlorsulfuron. Herbicides are used for preemergent control of crabgrass in February and October, and in the summer for postemergent control. Data from the 1991 Georgia Pest Control Handbook (Delaplane, 1991) and a survey of CES and SCS personnel conducted by Stell et al. indicate that several insecticides could be considered ubiquitous in urban/suburban use, including chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Chlorothalonil, a fungicide, is also widely used in urban and suburban areas.

Other Urban/Residential Sources

Urban and residential storm water also potentially includes pollutant loads from a number of other terrestrial sources:

Septic Systems. Poorly sited and improperly operating septic systems can contribute to the discharge of pathogens and oxygen-demanding pollutants to receiving streams. This problem is addressed through septic system inspections by the appropriate County Health Department, extension of sanitary sewer service and local regulations governing minimum lot sizes and required pump-out schedules for septic systems.

Leaking Underground Storage Tanks. The identification and remediation of leaking underground storage tanks (LUSTs) is the responsibility of the EPD Land Protection Branch. Petroleum hydrocarbons and lead are typically the pollutants associated with LUSTs.

Nonpoint Sources from Forestry

Silvicultural operations may serve as sources of stressors, particularly excess sediment loads to streams, when Best Management Practices (BMPs) are not followed. From a water quality standpoint, woods roads pose the greatest potential threat of any of the typical forest practices. It has been documented that 90 percent of the sediment that entered streams from a forestry operation was directly related to either poorly located or poorly constructed roads. The potential impact to water quality from erosion and sedimentation is increased if BMPs are not adhered to.

Silviculture is also a potential source of pesticides/herbicides. According to Stell et al. (1995), pesticides are mainly applied during site preparation after clear-cutting and during the first few years of new forest growth. Site preparation occurs on a 25-year cycle on most pine plantation land, so the area of commercial forest with pesticide application in a given year is relatively small. The herbicides glyphosate (Accord), sulfometuron methyl (Oust), hexazinone (Velpar), imazapyr (Arsenal), and metsulfuron methyl (Escort) account for 95 percent of the herbicides used for site preparation to control grasses, weeds, and broadleaves in pine stands. Dicamba, 2,4-D, 2,4-DP (Banvel), triclopyr (Garlon), and picloram (Tordon) are minor use chemicals used to control hard to kill hardwoods and kudzu. The use of triclopyr and picloram has decreased since the early 1970's.

Most herbicides are not mobile in the soil and are targeted to plants, not animals. Applications made following the label and in conjunction with BMPs should pose little threat to water quality.

Chemical control of insects and diseases is not widely practiced except in forest tree nurseries which is a very minor land use. Insects in pine stands are controlled by chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Diseases are controlled using chlorothalonil, dichloropropene, and mancozeb. There are five commercial forest tree nurseries within the basin.

According to the Water Quality in Georgia 1998 Report, no streams were identified in the basin as impacted due to commercial forestry activities.

Statewide BMP Implementation Survey

The Georgia Forestry Commission (GFC) conducted statewide BMP implementation surveys in 1991 and 1992 and most recently completed its third survey in 1998. The purposes of these surveys are to determine to what extent forestry BMPs are being implemented and are they effective in minimizing erosion. The surveys were set up to evaluate streamside management zones (SMZs), roads, stream crossings, timber harvesting, mechanical site preparation, chemical treatments, burning, and regeneration operations typically associated with forestry.

During the 1992 survey, the GFC evaluated 2,523 acres of land on 28 sites within the Satilla Basin. Sixteen (16) sites involving 1,188 acres were on private lands and 12 sites involving 1,335 acres were on forest industry land. Overall compliance with BMPs was 89 percent. By ownership, compliance was approximately 96 percent on private lands and 98 percent on forest industry lands.

Approximately 99 percent of the 15.1 miles of main haul roads evaluated on 21 sites were in compliance with BMPs. By ownership, road compliance for private lands and forest industry was 100 percent and 99 percent, respectively.

Specific road construction BMPs identified where improvements are needed include reshaping and stabilizing road surfaces in critical areas such as stream crossings and locating roads outside streamside management zones.

Approximately 96 percent of the 2,123 harvested acres evaluated on the 27 sites were in compliance with BMPs. By ownership, harvesting compliance for private lands was 94 percent and forest industry was 98 percent. Specific harvesting BMPs identified where improvements are needed include stabilizing log decks, minimizing rutting within SMZs, removing logging debris left in the streams, and minimizing the number of temporary stream crossings.

One site was evaluated for site preparation (control burning) and that occurred on private land. Of the 400 acres evaluated all were in compliance with BMPs.

No sites were evaluated for reforestation.

During the 1998 survey, the GFC evaluated 4,381.2 acres on 30 sites within the Satilla River Basin. Twenty sites involving 1,807.1 acres were on private land and ten sites involving 2,574.1 acres were on forest industry land. Overall, the percentage of applicable BMPs implemented was 92 percent. By ownership, implementation was 87 percent on private land and 99 percent on forest industry land. The percentage of acres in compliance with BMPs was 99.8 percent on both forest industry and private lands.

Streamside Management Zones: Approximately 130.4 acres of SMZs were evaluated on 12 sites. Five sites were on forest industry land and 7 were on private land. Overall the percentage of applicable BMPs implemented was 92 percent. By ownership, the percentage of applicable BMPs implemented was 85 percent on private land and 100 percent on forest industry. Overall, the percentage of acres in compliance with the BMPs was 98 percent. By ownership, the percentage of acres in BMP compliance was 77 percent on private land and 100 percent on forest industry. Most noted problems on private land involved inadequate stabilization of roads and skid trails within the SMZ, logging debris left in streams and log decks within the SMZ.

Main Haul Roads: Approximately 17.6 miles of main haul roads were evaluated on 16 sites. Eight sites on both ownerships were evaluated. The percentage of applicable BMPs implemented was 91 percent. By ownership, BMP implementation was 81 percent on private land and 100 percent on forest industry land. Overall, the percentage of actual miles in compliance with the BMPs was 97 percent. By ownership, the percentage of miles in BMP compliance was 84 percent on private land and 100 percent on forest industry. Most noted problems on private land involved inadequate water diversion measures and stabilization of roads.

Stream Crossings: Fourteen stream crossings were evaluated on 6 sites. Three sites involving 9 crossings were evaluated on private land and 3 sites involving 5 crossings were evaluated on forest industry land. The percentage of applicable BMPs implemented was 78 percent. By ownership, BMP implementation was 50 percent on private land and 96 percent on forest industry land. Overall, the percentage of actual crossings in compliance with BMPs was 29 percent. By ownership compliance was 11 percent on private lands and 60 percent on forest industry land. Most noted problems on private land involved skidders randomly using fords in streams for crossings and not stabilizing the approaches. On forest industry land, the problem was road ditches tied directly into streams.

Timber Harvesting Outside the SMZ: Approximately 1,786.6 acres were evaluated on 17 sites. Six sites involving 1,314 acres were on forest industry land and 11 sites involving 472.6 acres were on private land. The percentage of applicable BMPs implemented was 96 percent and averaged 100 percent on forest industry land and 94 percent on private land. Overall, the percentage of acres in BMP compliance was over 99 percent and averaged 100 percent on forest industry and 94 percent on private land.

Mechanical Site Preparation Outside the SMZ: Approximately 963.1 acres were evaluated on 14 sites. Four sites involving 382 acres were on forest industry and 10 sites involving 581.1 acres were on private land. The percentage of applicable BMPs implemented was 98 percent and averaged 100 percent on forest industry land and 97 percent on private land. The percentage of acres in BMP compliance was 100 percent for both ownerships. Trash was not removed from one private site.

Chemical Treatments Outside the SMZ: Approximately 463 acres were evaluated on 4 sites. Three sites involving 263 acres were on forest industry land and 1 site involving 200 acres was on private land. The percentage of applicable BMPs implemented was 100

percent on both ownerships. The percentage of acres in BMP compliance was 100 percent on both ownerships.

Control Burning Outside the SMZ: Approximately 219 acres were evaluated on 1 private and 1 forest industry land site. The percentage of applicable BMPs implemented was 100 percent on both and the percentage of acres in BMP compliance was 100 percent on both.

Artificial Regeneration Outside the SMZ: Approximately 819.1 acres were evaluated on 12 sites. Four sites involving 303 acres were on forest industry land and 8 sites involving 516.1 acres were on private land. The percentage of applicable BMPs implemented was over 99 percent and averaged 89 percent on industry land and 100 percent of private land. The percentage of acres in BMP compliance was over 99 percent and averaged over 98 percent on forest industry and 100 percent on private land.

Stream Miles: Approximately 6.87 miles of stream were evaluated on 12 sites. Five site involving 4.5 miles were on forest industry and 7 sites involving 2.37 miles were on private land. The percentage of miles in compliance with BMPs was 95 percent and averaged 100 percent on forest industry and 86 percent on private land. A stream habitat assessment was conducted above and below 5 sites. The above site stream assessment was the reference section and used to compare against the downstream section below the forestry operation that would typically show up any potential impairment. The downstream segments were comparable to the upstream reference.

Another statewide BMP survey is scheduled for calendar year 2001.

Atmospheric Deposition

Atmospheric deposition can be a significant source of nitrogen and acidity in watersheds. Nutrients from atmospheric deposition, primarily nitrogen, are distributed throughout the entire basin in precipitation. The primary source of nitrogen in atmospheric deposition is nitrogen oxide emissions from combustion of fossil fuels. The rate of atmospheric deposition is a function of topography, nutrient sources, and spatial and temporal variations in climatic conditions.

Atmospheric deposition can also be a source of certain mobile toxic pollutants, including mercury, PCBs, and other organic chemicals.

4.1.3 Flow and Temperature Modification

Many species of aquatic life are adapted to specific flow and temperature regimes. In addition, both flow and temperature affect the dissolved oxygen balance in water, and changes in flow regime can have important impacts on physical habitat.

Thus, flow and temperature modifications can be important environmental stressors. They also interact with one another to affect the oxygen balance: flow energy helps control reaeration rate, while water temperature controls the solubility of dissolved oxygen, and higher water temperatures reduce oxygen solubility and thus tend to reduce dissolved oxygen concentrations. Further, increased water temperature increases the rate of metabolic activity in natural waters, which in turn may increase oxygen consumption by aquatic species.

4.1.4 Physical Habitat Alteration

Many forms of aquatic life are sensitive to physical habitat disturbances. Probably the major disturbing factor is erosion and loading of excess sediment, which changes the nature of the stream substrate. Thus, any land use practices that cause excess sediment input can have significant impacts.

Physical habitat disturbance is also evident in many urban streams. Increased impervious cover in urban areas can result in high flow peaks, which increase bank erosion. In addition, construction and other land-disturbing activities in these areas often provide an excess sediment load, resulting in a smothering of the natural substrate and physical form of streams with banks of sand and silt.

4.2 Summary of Stressors Affecting Water Quality

Section 4.1 described the major sources of loads of pollutants (and other types of stressors) to the Satilla basin. What happens in a river is often the result of the combined impact of many different types of loading, including point and nonpoint sources. For instance, excess concentrations of nutrients may result from the combined loads of wastewater treatment plant discharges, runoff from agriculture, runoff from residential lots, and other sources. Accordingly, Section 4.2 brings together the information contained in Section 4.1 to focus on individual stressor types, as derived from all sources.

4.2.1 Nutrients

All plants require certain nutrients for growth, including the algae and rooted plants found in lakes, rivers, and streams. Nutrients required in the greatest amounts include nitrogen and phosphorus. Some loading of these nutrients is needed to support normal growth of aquatic plants, an important part of the food chain. Too much loading of nutrients can, however, result in an overabundance of algal growth with a variety of undesirable impacts. The condition of excessive nutrient-induced plant production is known as eutrophication, and waters affected by this condition are said to be eutrophic. Eutrophic waters often experience dense blooms of algae, which can lead to unaesthetic scums and odors and interfere with recreation. In addition, overnight respiration of living algae, and decay of dead algae and other plant material, can deplete oxygen from the water, stressing or killing fish. Eutrophication of lakes typically results in a shift in fish populations to less desirable, pollution-tolerant species. Finally, eutrophication may result in blooms of certain species of blue-green algae which have the capability of producing toxins.

For freshwater aquatic systems, the nutrient in the shortest supply relative to plant demands is usually phosphorus. Phosphorus is then said to be the “limiting nutrient” because the concentration of phosphorus limits potential plant growth. Control of nutrient loading to reduce eutrophication thus focuses on phosphorus control.

Point and nonpoint sources to the Satilla also discharge large quantities of nitrogen, but nitrogen is usually present in excess of amounts required to match the available phosphorus. Nitrogen (unlike phosphorus) is also readily available in the atmosphere and ground water, so it is not usually the target of management to control eutrophication in freshwater. The bulk of the nitrogen in fresh-water systems is found in three ionic forms—ammonium (NH_4^+), nitrite (NO_2^-), or nitrate (NO_3^-). Nitrite and nitrate are more readily taken up by most algae, but ammonia is of particular concern because it can be toxic to fish and other aquatic life. Accordingly, wastewater treatment plant upgrades have focused on reducing the toxic ammonia component of nitrogen discharges, with corresponding increase in the nitrate fraction.

Sources of Nutrient Loading

The major sources of nutrient loading in the Satilla basin are wastewater treatment facilities, urban runoff and storm water, and agricultural runoff. Concentrations found in the streams and rivers of the Satilla basin represent a combination of a variety of point and nonpoint source contributions.

Point source loads can be quantified from permit and effluent monitoring data, but nonpoint loads are difficult to quantify. Rough estimates of average nutrient loading rates from agriculture are available; however, nonpoint loads from urban/residential sources in the basin have not yet been quantified. The long-term trends in phosphorus within the Satilla River basin can be obtained by examining results from EPD long-term trend monitoring stations. The trend in instream total phosphorus concentrations at one site in the Satilla River basin is shown in Figure 4-11. In general, phosphorus concentrations have declined over time as a result of improvements in wastewater treatment technology.

4.2.2 Oxygen Depletion

Oxygen is required to support aquatic life, and Georgia water quality standards specify minimum and daily average dissolved oxygen concentration standards for all waters. Violations of water quality standards for dissolved oxygen was the most commonly listed cause of nonsupport of designated uses in 1998-1999. Problems with oxygen depletion in rivers and streams of the Satilla basin are associated with oxygen-demanding wastes from point and nonpoint sources. Historically, the greatest threat to maintaining adequate oxygen levels to support aquatic life has come from the discharge of oxygen-demanding wastes from wastewater treatment plants. Treatment upgrades and more stringent permit limits have reduced this threat substantially. Today, dissolved oxygen issues in the Satilla River basin are mainly associated with nonpoint source discharges. It should be noted that dissolved oxygen concentrations are naturally lower in parts of the Satilla River basin.

The trend in instream dissolved oxygen concentrations at one site in the Satilla River basin is shown in Figure 4-12. All waters in the Satilla basin have a state water quality standard of 4.0 mg/L. As shown in Figure 4-12, dissolved oxygen concentrations are usually above this standard.

4.2.3 Metals

A violation of water quality standards for metals attributed to nonpoint sources was detected in one estuarine segment of the Satilla River during the 1998 sampling.

4.2.4 Fecal Coliform Bacteria

Violations of the standard for fecal coliform bacteria were the second most commonly listed cause of nonsupport of designated uses in the 1998-1999 water quality assessment. Fecal coliform bacteria are monitored as an indicator of fecal contamination and the possible presence of human bacterial and protozoan pathogens in water. Fecal coliform bacteria may arise from many of the different point and nonpoint sources discussed in Section 4.1.

Human waste is of greatest concern as a potential source of bacteria and other pathogens. One primary function of wastewater treatment plants is to reduce this risk through disinfection. Observed violations of the fecal coliform standard below several wastewater treatment plants on the Satilla River have generally been rapidly corrected in recent years.

The trend in instream fecal coliform concentrations at one site in the Satilla River basin is shown in Figure 4-13.

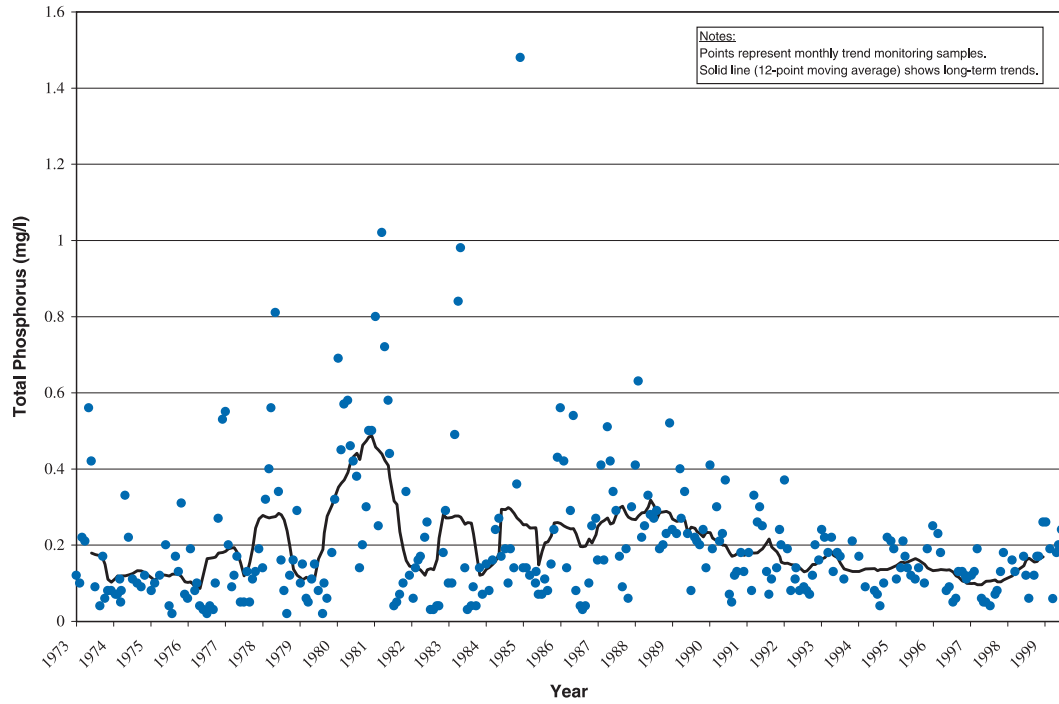


Figure 4-II. Total Phosphorus Concentrations, Satilla River at Georgia Highways I5 and I2I

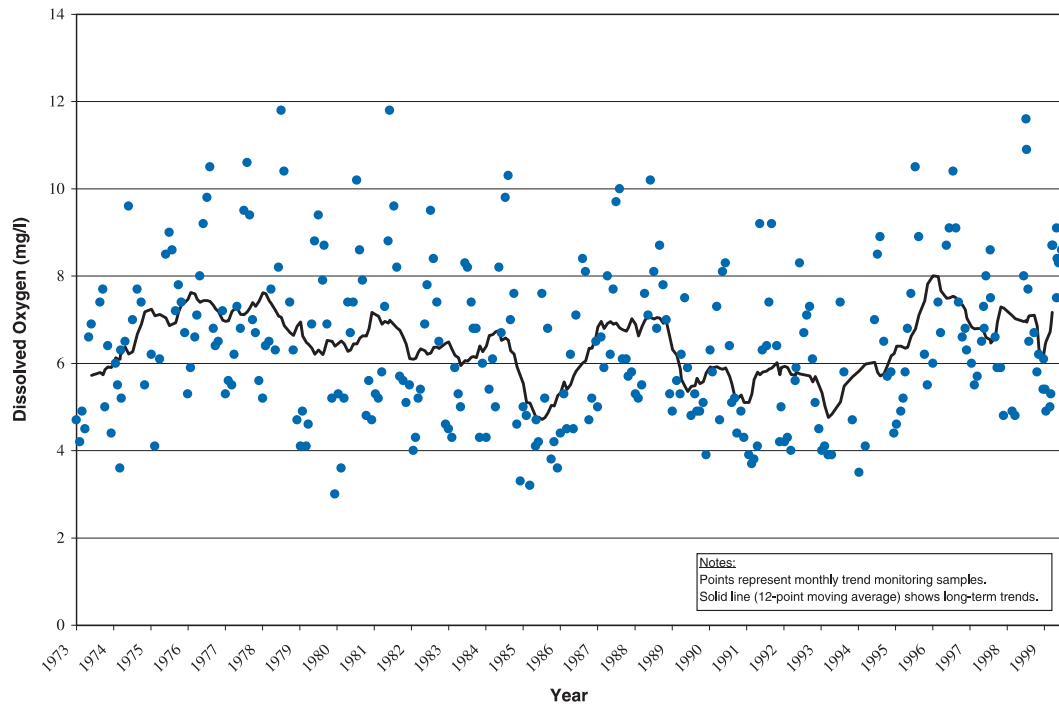


Figure 4-I2. Dissolved Oxygen Concentrations, Satilla River at Georgia Highways I5 and I2I

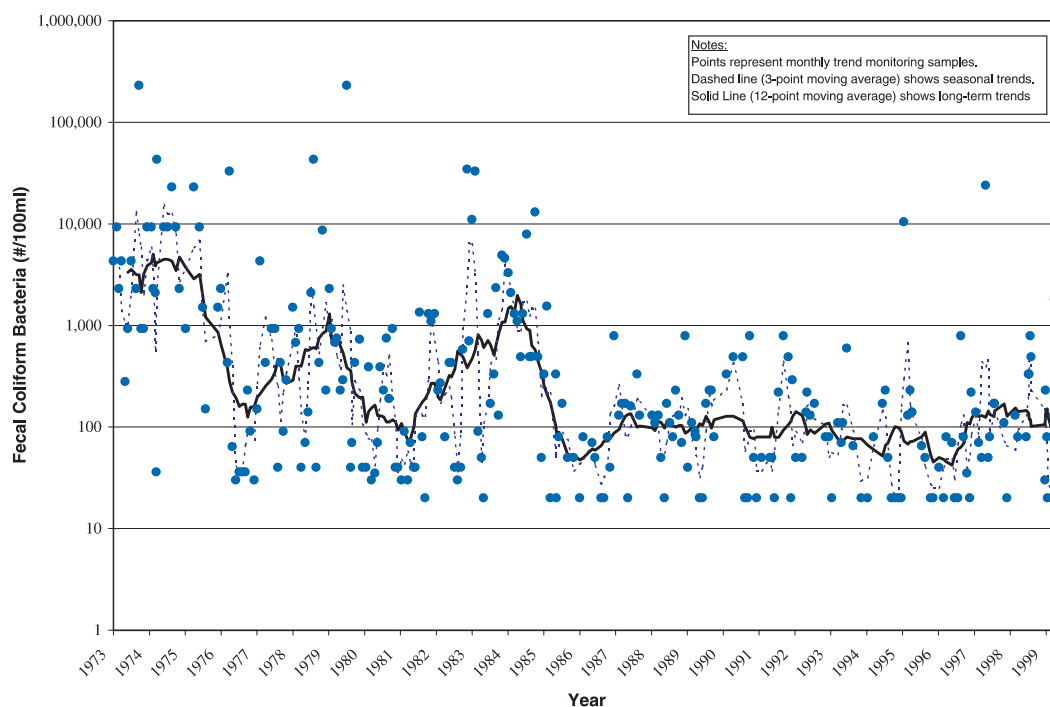


Figure 4-13. Fecal Coliform Bacteria Concentrations, Satilla River at Georgia Highways 15 and 121

As point sources have been brought under control, nonpoint sources have become increasingly important as potential sources of fecal coliform bacteria. Nonpoint sources may include

- Agricultural nonpoint sources, including concentrated animal operations and spreading and/or disposal of animal wastes.
- Runoff from urban areas transporting surface dirt and litter, which may include both human and animal fecal matter, as well as a fecal component derived from sanitary sewer overflows.
- Urban and rural input from failed or ponding septic systems.

4.2.5 Synthetic Organic Chemicals

Synthetic organic chemicals (SOCs) include pesticides, herbicides, and other man-made toxic chemicals. SOCs may be discharged to waterbodies in a variety of ways, including

- Industrial point source discharges.
- Wastewater treatment plant point source discharges, which often include industrial effluent as well as SOCs from household disposal of products such as cleaning agents and insecticides.
- Nonpoint runoff from agricultural and silvicultural land with pesticide and herbicide applications.
- Nonpoint runoff from urban areas, which may load a variety of SOCs such as horticultural chemicals and termiticides.
- Illegal disposal and dumping of wastes.

SOCs were not detected in the surface waters of the Satilla River basin in problem concentrations. It should be noted, however, that most monitoring has been targeted to

waters located below point sources where potential problems were suspected. Agricultural sources were potentially important in the past, particularly from cotton production in the Coastal Plain, but the risk has apparently greatly declined with a switch to less persistent pesticides. Recent research by USGS Hippe et al., 1994; Stell et al., 1995) suggests pesticide/herbicide loading in urban runoff and storm water may be of greater concern than agricultural loading, particularly in streams of the metropolitan Atlanta area.

4.2.6 Stressors from Flow Modification

Stress from flow modification is primarily associated with stormflow in smaller streams associated with development and increased impervious area.

4.2.7 Sediment

Erosion and discharge of sediment can have a number of adverse impacts on water quality. First, sediment can carry attached nutrients, pesticides, and metals into streams. Second, sediment is itself a stressor. Excess sediment loads can alter habitat, destroy spawning substrate, and choke aquatic life, while high turbidity also impairs recreational and drinking water uses. Sediment loading is of concern throughout the basin, but is of greatest concern in the developing urban areas and major transportation corridors. The rural areas are of lesser concern with the exception of rural unpaved road systems and areas where cultivated cropland exceeds 20 percent of the total land cover.

Long term observation of river bathymetry associated with fisheries studies indicate evidence of fish habitat alteration through sedimentation. Suspended sediments for the most part appear to be originating from the upper part of the watershed where agriculture (i.e. cotton) is expanding again.

4.2.8 Habitat Degradation and Loss

In many parts of the Satilla basin, support for native aquatic life is potentially threatened by degradation of aquatic habitat. Habitat degradation is closely tied to sediment loading, and excess sediment is the main threat to habitat in rural areas with extensive land-disturbing activities, as well as in urban areas where increased flow peaks and construction can choke and alter stream bottom substrates. A second important type of habitat degradation in the Satilla basin is loss of riparian tree cover, which can lead to increased water temperatures.

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