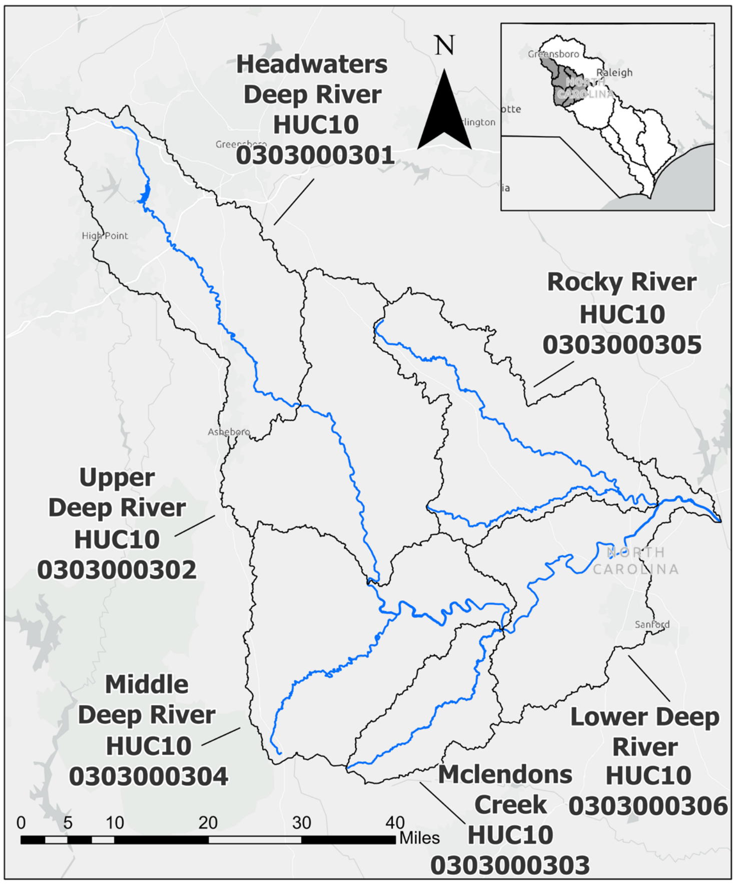

DRAFT
Chapter 7
Deep River Subbasin
HUC 03030003

BASINWIDE WATER RESOURCES MANAGEMENT PLAN

CYCLE 4 – CAPE FEAR RIVER BASIN 2026

North Carolina
Department of Environmental Quality
Division of Water Resources
Basin Planning Branch

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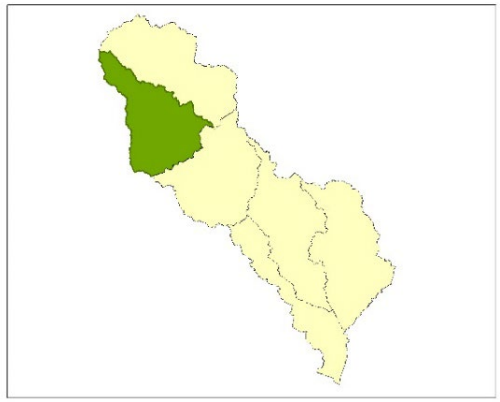
7 Deep River Subbasin (HUC8 03030003)

7.1 General Description



The Deep River subbasin 8-digit hydrologic unit code (HUC) boundary (HUC8: 03030003) is in the northwesternmost portion of the Cape Fear River Basin. The subbasin lies within portions of Guilford, Randolph, Chatham, Lee and Moore counties. Major municipalities in the subbasin include Greensboro, High Point, Asheboro and Sanford. Rural residential properties and communities are also scattered throughout the subbasin. The Deep River subbasin covers approximately 1,449 square miles (mi^2), or 927,360 acres, including the Deep River watershed from the headwaters in Forsyth and Guilford counties to the confluence with the Haw River, which forms the Cape Fear River. There are six 10-digit HUCs (HUC10). Major tributaries of mainstem Deep River include the Rocky River, Richland Creek, Haskett Creek, Fork Creek and Bear Creek. A large percentage of the Deep River watershed is classified as water supply watershed, and there are 47.2 miles of streams classified as High Quality Waters (HQW). A general map showing major municipalities alongside permitted facilities and water quality monitoring stations is shown in *Figure 7-1*.

Based on the Level IV Ecoregions classification, the Deep River subbasin lies in the Southern Outer Piedmont, Carolina Slate Belt, Triassic Basin, Northern Outer Piedmont and Sandhills, with the Carolina Slate Belt making up most of the subbasin (Griffith et al., 2002). Significant natural heritage areas include the NC Zoological Park, White Pines Nature Preserve and Deep River State Trail. A small portion of the Uwharrie National Forest borders the southwestern part of the subbasin.

Across the Deep River subbasin, approximately 1,122 miles of freshwater (FW) streams and rivers are monitored alongside 4,105.9 acres of freshwater lakes and reservoirs (*Table 7-1*). Of the total freshwater areas in the subbasin, approximately 164.1 miles of streams and rivers and 65.9 acres of freshwater are listed as exceeding criteria based on the 2022 Integrated Report (IR). Most water quality impairments were found in the upper third of the subbasin. Basinwide, the impaired waters in the Deep River subbasin accounted for a quarter (25.5%) of the total impaired freshwater miles in the Cape Fear River Basin and 0.5% of the FW acres.

Water quality impairments vary throughout this subbasin and include aquatic life and recreational impairments as listed in *Table 7-2*. Excess nutrients, high fecal coliform bacteria and elevated pulses of turbidity are the primary concerns that need to be addressed throughout the subbasin. Several waterbodies, including the Deep River, Rocky River, the Cape Fear River below the confluence with the Haw River (behind Buckhorn Dam), and many drinking water reservoirs are impacted by elevated nutrients, resulting in impairments in the form of violations of the chlorophyll *a* water quality standard seen throughout this subbasin (*Table 7-2*). The Deep River flows into Randleman Lake, a drinking water reservoir created in 2004 to serve the greater Greensboro area.

Figure 7-1: General Map of Monitoring Stations and Permitted Facilities in the Deep River Subbasin.

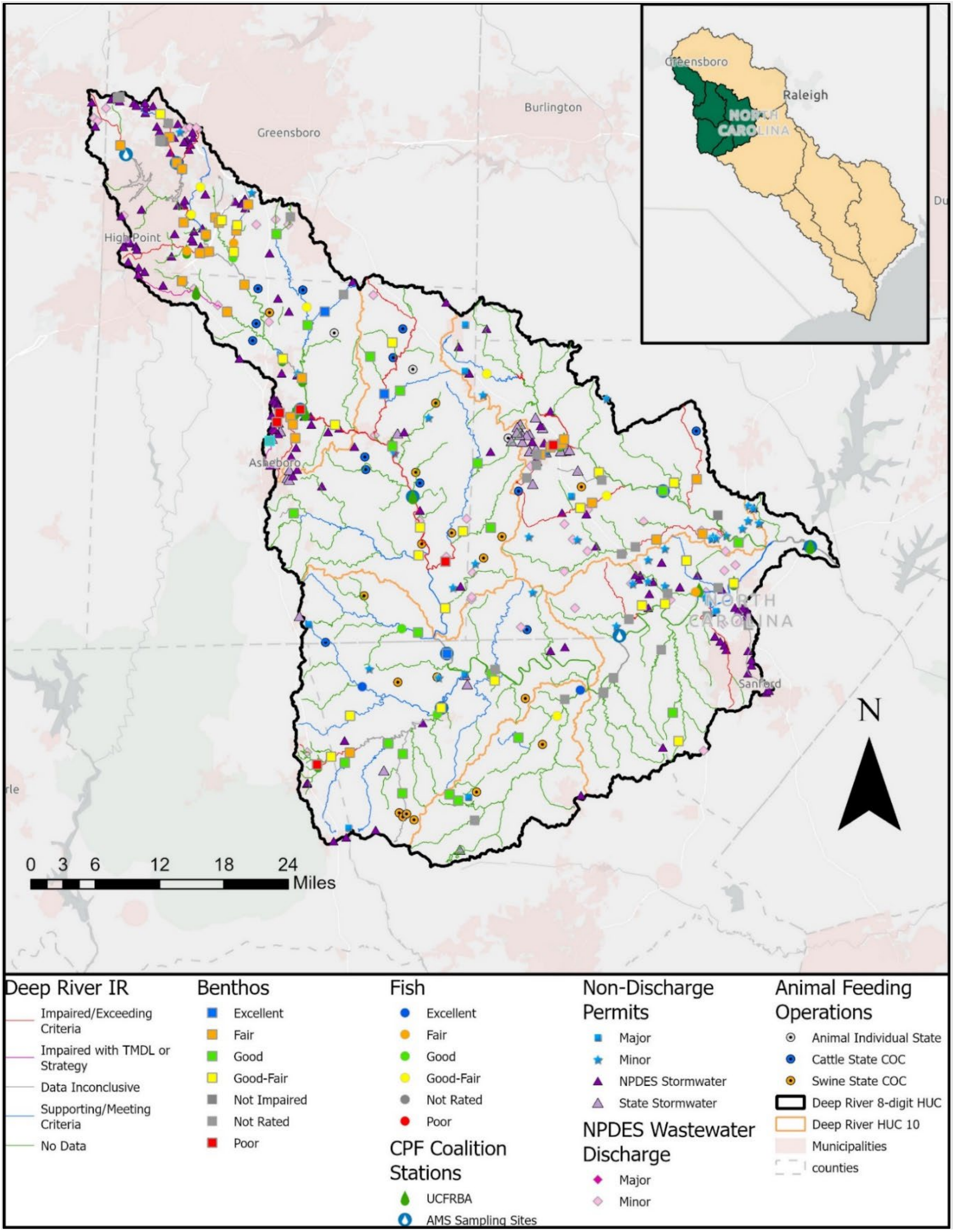


Table 7-1: Deep River Subbasin 2022 Integrated Report Summary.

Assessment Unit[1]	Map Color	FW Miles[2]	FW Acres[2]
Total	All Colors Combined	1,122.0	4,105.9
Total Monitored	Combined Blue, Gray, Red, Purple, Pink	497.8	4,105.9
Not Monitored	Green	624.2	0
Meeting Criteria (Category 1)	Blue	240.5	0
Data Inconclusive (Category 3)	Gray	93.2	4,040.0
Exceeding Criteria 303(D) (Category 5)	Red	149	65.9
Exceeding Criteria with Watershed Action Plan (Category 5r)	Purple	7.4	0
Exceeding Criteria with TMDL (Category 4)	Pink	7.7	0
Exceeding Criteria (Combined Category 4, 5, and 5r)	Combined Red, Purple, Pink	164.1	65.9
% Exceeding of Monitored Exceeding (Combined Category 4, 5, and 5r)	Combined Red, Purple, Pink / Total	33.0%	1.6%

[1]All waterbodies in North Carolina are impaired for Fish Tissue Mercury and are not included on this table.
[2]FW – Freshwater

Table 7-2: Deep River Subbasin 2022 Impairments by Parameter (Category 4, 5, and 5r).

PARAMETER (Category 4, 5, and 5r Combined)[1,2]	FW Miles[3]	FW Acres[3]
Benthos (Nar, AL, FW)	81	0
Chlorophyll a (40 µg/l, AL, NC)	22.7	65.9
Copper (7 µg/l, AL, FW)	24.5	0
Dissolved Oxygen (4 mg/l, AL, FW)	5.2	0
Fecal Coliform (GM 200/400, REC, FW)	20.6	0
Fish Community (Nar, AL, FW)	41.2	0

[1]Waterbody Uses: AL – Aquatic Life, REC – Recreation.
[2]Waterbody Type: FW – Freshwater, NC - All North Carolina waters.
[3]Other: GM – Geometric Mean, Nar – Narrative.

The only nutrient management strategy in place in this subbasin is for Randleman Lake. The Randleman Lake Water Supply Watershed Rules (15A NCAC 02B .0720 - .0724) were put into place during reservoir development. The Randleman Lake rules address wastewater discharge, urban stormwater management and the protection and maintenance of the riparian buffer zones in this watershed (see Section 7.7.1.13 for more information regarding Randleman Lake).

The central portion of the Cape Fear River Basin from Randleman and Jordan Lake dams down to Lock and Dam #1 on the mainstem Cape Fear River has been recognized as nutrient over-enriched. As such, the Division of Water Resources (DWR) has a permitting strategy that requires a no-net increase in watershed loading for nitrogen and phosphorus while additional processes are underway that will assist DWR in understanding how best to protect the water quality for all uses. These actions include the development of watershed models for the central portion of the Cape Fear River Basin and working with the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) to develop potential instream nutrient criteria or a response variable that protects the most sensitive uses of the resource. These actions could lead to the need for future reductions in nutrient loading to this system from all point and nonpoint watershed sources. More information is available in the permitting strategy section 3.2.4 of chapter 3 and the NCDP (2.14) and chlorophyll *a* (2.5.8 and 2.7) sections of chapter 2.

Turbidity and fecal coliform bacteria contamination is also a growing issue throughout the subbasin. There are several Total Daily Maximum Loads (TMDLs) approved in this subbasin to address several of these impairments. More information on TMDLs in this subbasin can be found under the Ambient Water Quality section of this chapter.

The North Carolina Department of Environmental Quality's (NCDEQ) Division of Mitigation Services (DMS) has undertaken several planning efforts in the Cape Fear River Basin since 2004. Specifically, in the Deep River subbasin, the Upper and Middle Rocky River Local Watershed Plan was published in 2005. The upper Rocky River watersheds (consisting of three 14-digit HUCs) were selected as high-priority areas for watershed planning due to two primary factors:

1) Documented water quality and aquatic habitat problems in selected stream segments, including segments listed on the 2004 Clean Water Act Section 303(d) list of impaired waters submitted to the U.S. Environmental Protection Agency (EPA).

2) Ongoing threats to local watershed health, which may be attributed to impacts from urban/suburban development, clearing of riparian buffers, agricultural activities and/or other nonpoint sources (DMS, 2005).

In 2022, DMS published the Cape Fear 02/03 Regional Watershed Plan (RWP), which includes an analysis of the Deep River subbasin. DMS initiated the RWP for a portion of the Cape Fear River Basin to aid in planning and prioritizing mitigation. The ultimate objective of the RWP is to create a modeling strategy based on available data to evaluate the conditions of a watershed, link issues back to their underlying causes, recommend strategies to preserve areas in good condition and to mitigate sources of inadequacies in (or barriers to) the three main functions of a watershed—hydrology, water quality, and habitat—as well as the resources themselves. An interactive map of DMS projects can be found at https://deq.nc.gov/about/divisions/mitigation-services/dms-planning/dms-web-map. Key objectives of the Cape Fear 02/03 RWP were:

- Satisfy compensatory mitigation requirements on a programmatic level through watershed planning.

- Enhance the natural resources of North Carolina by addressing watershed needs through a process that utilizes the best available data and incorporates stakeholder input to maximize the potential watershed functional improvement.

- Prioritize watersheds where compensatory mitigation actions maximize functional improvement and promote synergy due to concentrated implementation of hydrology, water quality and habitat projects.
- Develop a planning approach that is forward looking, identify watersheds which are likely to develop and identify linchpin watersheds that can cause cascading effects in a region with high development potential.

- Provide feedback to improve the DMS statewide Watershed Prioritization Model through cross-validation (DMS, 2022).

Of the 1,122 freshwater (FW) miles in the Deep River subbasin, approximately 34% have a supplemental designation as water supply (WS) *(Table 7-3)*. Ninety-nine percent of the FW acres in the Deep River subbasin have a WS classification. The large percentage of WS classifications in the Deep River subbasin is indicative of the reliance on these waterbodies for human consumption, industrial processing, and power generation. Typically, WS-I waters are associated with watersheds with little to no development, and the amount of development generally increases up to WS-V. WS-I and WS–II are synonymous with the High Quality Water (HQW) designation. There are no WS-I or WS–II classifications in the Deep River subbasin, however, WS-III may also have a supplemental HQW classification, which is the case for in the Deep River subbasin. Approximately 2% of the FW miles, approximately 19.2 miles, are classified for primary contact, Class B, including sections of Richland Creek and Suck Creek, as well as several of their tributaries.

Table 7-3: Deep River Subbasin Surface Water Classifications.

Classification*	Freshwater Miles	Freshwater Acres
C	1,122.0	4,106.0
B	19.2	0
WS-III	226	74
WS-IV	149.2	3,998.0
WS-V	10.3	0
WS TOTAL	385.5	4,072.0
CA	29.8	4,052.7
HQW	47.2	0

*Waterbody Classification C - Aquatic life propagation and secondary recreation, B - Primary contact recreation, WS - Water Supply, CA - Water Supply Watershed Critical Area

There have been several concerning water resource-related issues in the Deep River subbasin during the timeframe of this plan, 2002 to 2020:

- Several impairments exist in the subbasin consisting of benthos, chlorophyll *a*, copper, dissolved oxygen, fecal coliform bacteria and fish community (Section 7.1).
- Rapid population growth and development of areas around High Point and Greensboro in the Headwaters Deep River watershed of the Deep River subbasin (Section 7.2).

- General loss of agricultural and forested lands and increase in developed land and grass/shrubland (Section 7.2).

- Randolph County has the third most poultry in the Cape Fear River Basin (Section 7.2).
- Impaired or declines in bioclassification ratings for benthos and/or fish communities in the East Fork Deep River (Section 7.7.1.1); Long Branch (Section 7.7.1.2); West Fork Deep River (Section 7.7.1.3); Hickory Creek (Section 7.7.1.7); Polecat Creek (Section 7.7.1.9); Haskett Creek (Section 7.7.1.11); Penwood Branch (Section 7.7.1.12); Deep River [AU#: 17-(3.7)] (Section 7.7.1.13.3); Richland Creek (Section 7.7.2.2); Brush Creek (Section 7.7.2.3); Cabin Creek [AU 17-26-5-(1)b] (Section 7.7.4.5); Rocky River (Section 7.7.5); Loves Creek (Section 7.7.5.2); Meadow Creek (Section 7.7.5.3); Tick Creek (Section 7.7.5.4); Harlands Creek (Section 0); Bear Creek (Section 0); Indian Creek (Section 7.7.6.1); Big Buffalo Creek (Section 7.7.6.2).

- The Rocky and Deep Rivers and their tributaries have had the highest numbers of the endangered species Cape Fear shiner (*Notropis mekistocholas*) among all waterways surveyed (Section 7.4.4).

- Elevated levels of 1,4-dioxane were identified downstream of the Asheboro Wastewater Treatment Plant (Section *7.7.1.11* and Chapter 2 and 13).

- Several Total Maximum Daily Loads (TMDLs), 9-element plans, and watershed actions plans are established for the Deep River, East Fork Deep River, Richards Creek, Muddy Creek, Cotton Creek, Upper and Middle Rocky River, and Haskett Creek for impaired water quality in the Deep River subbasin (Section 7.6). A watershed action plan is nearly complete for Loves Creek (Section 7.7.5.2)

- Elevated turbidity and fecal coliform bacteria pulses alongside stressed benthos in East Fork Deep River (Section 7.7.1.1) and West Fork Deep River (Section 7.7.1.3).

- Elevated nitrogen, turbidity and fecal coliform bacteria concentrations in Richland Creek (Section 7.7.1.5), Muddy Creek (Section 7.7.1.8), Haskett Creek (Section 7.7.1.11), Cotton Creek (Section 7.7.4.3).
- Sections of the Deep River are impaired for stressed benthos [AU#: 17-(3.7)], chlorophyll *a* [AU # 17-(10.5)d1], and copper [AU#: 17-(10.5)d2], alongside elevated fecal coliform bacteria and turbidity pulses, as well as elevated nutrients (total nitrogen and phosphorus) (Sections 7.7.1.13, 7.7.2.4, 0, 7.8).

- High Point Lake (Section 7.7.1.13), Randleman Reservoir (Section 7.7.1.13), Sandy Creek Reservoir (Section 7.7.2.1), and Carthage Lake (Section 7.7.3.1) were determined to exhibit elevated biological productivity or eutrophic conditions in 2018. Upper Rocky River and Charles Turner Reservoirs in the Rocky River watershed are classified as hypereutrophic (Section 7.7.5.1.2 and 7.7.5.1.3).

- Sandy Creek/ Sandy Creek Reservoir [AU #: 17-16-(1)b and 17-16-(3.5)] (Section 7.7.2.1), Upper Rocky River Reservoir [AU #17-43-1(b) and 17-43-(5.5)a] (Section 7.7.5.1.2), and the Charles Turner Reservoir [AU # 17-43-(5.5)b] (Section 7.7.5.1.3) are impaired from chlorophyll *a* standard violations.

- Elevated nutrients from point and nonpoint sources in the Rocky River create excessive biological productivity throughout the system and is limiting recreational uses and impairing water supply reservoirs (Section 7.7.5).

- DEQ's Modeling and Assessment Branch will be evaluating and modeling the Deep River watershed below Randleman Lake to address the nutrient-related impairments in the Deep, Rocky and the Cape Fear rivers (Section 7.1 and Chapter 2, section 2.14).

7.2 Population and Land Use

Based on the 2020 census data, the population in the Deep River subbasin is estimated to be 311,579 (*Table 7-4*). The largest municipalities in the subbasin are High Point, Asheboro and Sanford. The southwestern portion of Greensboro also lies in the subbasin. Each of these municipalities experienced a net increase in population from 2010 to 2020.

Table 7-4: Estimated Population of the Watershed Boundary Scale (HUC10).

HUC 10 Watershed Name	HUC 10	Land Area (mi^2)	Population 2010	Population 2020	Population Density 2020 (pop/mi^2)	Population change 2010-2020
Headwaters Deep River	303000301	283	180,587	193,052	682	+12,465
Upper Deep River	303000302	294	35,245	34,833	118	-412
McClendons Creek	303000303	101	6,367	6,157	61	-210
Middle Deep River	303000304	302	18,908	17,431	58	-1,477
Rocky River	303000305	243	22,975	23,295	96	+320
Lower Deep River	303000306	226	35,277	36,811	163	+1,534
Deep River Subbasin Total		**1,449**	**299,359**	**311,579**	**215**	**+12,220**

Table data is from NC One Map US Census Block Data for 2010 and Esri Living Atlas for 2020 USA Census Redistricting Blocks processed for Cape Fear River Basin HUC10s.

The Deep River subbasin drains approximately 1,450 square miles (mi^2) of agricultural, forested and developed land. Land cover provides a perspective for which to view the water quality in the Deep River subbasin. Developed lands, agricultural lands, forest lands and grass/shrub-covered lands all engage with the environment to influence the water quality. Approximately 15% of the Deep River subbasin is developed, with most of that concentrated in the upper part of the basin near the fringes of Greensboro and High Point. Other developed areas in the Deep River subbasin include the cities of Asheboro and Sanford. Agricultural land has been decreasing throughout the subbasin since 2001 with 6.8% (20.6 mi^2) converted from agricultural to other land covers. Basinwide, the Headwaters Deep River watershed (HUC10: 0303000301) has lost the most agriculture, 8 mi^2. Forested lands are most prevalent in the lower parts of the Deep River subbasin (55% of total land cover), which is the highest percentage of forested land of any subbasin in the Cape Fear River Basin, although the Deep River subbasin overall has lost 2.7% (22 mi^2) of its forested lands since 2001.

The National Land Cover Dataset (NLCD) was analyzed for the Deep River subbasin for 2001, 2011 and 2019, and is summarized in *Table 7-5* and at the HUC10 watershed scale in *Table 7-6*. As of 2019, the land cover across this subbasin is dominated by forest (55.37%), agriculture (19.61%) and developed (14.80%) land *Table 7-5*. *Figure 7-2* shows the spatial distribution of land cover in the Deep River subbasin. Agriculture and forest land both showed considerable declines, with more than 20 mi^2 land cover lost for each land cover classification across the subbasin between 2001 and 2019 (*Table 7-5*). Coinciding with this loss, similar increases in developed and grassland/shrub land were observed between 2001 and 2019. *Table 7-6* shows that the Headwaters Deep River watershed is the most developed (37.8%), the Upper Deep River and Rocky River watersheds has the most agriculture (27.9% and 25.3% respectively) and the McClendons Creek watershed has the highest percentage of forested (66.1%) and grass land (14.2%).

Forestry (silviculture) activities pose a potential nonpoint source of pollution if poorly implemented or if managed forestry practices impact water quality and stream habitat. Properly planned and executed forest management practices, however, facilitate the sustainable harvest of forest products while also protecting water quality. The North Carolina Forest Service (NCFS) is delegated the authority to monitor forestry operations in North Carolina for compliance with the "Forest Practice Guidelines (FPGs) Related to Water Quality." The FPGs are a set of results-based guidelines meant to protect water quality and are mandatory statewide requirements defined by North Carolina Administrative Code (02 NCAC 60C .0100-.0209). Best management practices (BMPs), such as temporary bridges (e.g., bridgemats), can be used to ensure that the forest operators and landowners remain in compliance with the Forest Practice Guidelines. The NCFS conducts site surveys across the state to assess the implementation of forest practice guidelines on timber harvests. The Forest Development Program (FDP), an afforestation or reforestation stand improvement cost-sharing program offered to private landowners, is also administered by NCFS. In addition, NCFS provides several types of management plans, such as a stewardship or pre-harvest plan, to private landowners (NCFS, 2022). Basinwide, the upper three subbasins in the Cape Fear River Basin, including the Deep River, have the highest percentage of forest cover and the largest loss of forest cover since 2001 as compared to the lower three subbasins (See Chapter 1, Section 1.2.2). More information about FPGs, timber harvest inspections, FDPs and management plans in the Cape Fear River Basin is available in Chapters 1 and 4.

The total numbers, total acreages and subbasin percentages for timber harvest inspections, forest management plans and afforestation/reforestation from May 1, 2005, to October 31, 2021, in the Deep River basin are shown in *Table 7-7* and *Figure 7-3*. The distribution of forest management plans across the subbasin is also displayed in *Figure 7-4*. In the Deep River subbasin, during this 15-year time-period, 10.32% of the subbasin was inspected for timber harvests, forest management plans were produced for 18.81% of the subbasin and afforestation/reforestation management approaches were implemented in 4.9% of the subbasin (NCFS, 2022). See Chapter 1 for the basinwide distribution of timber harvest inspections and Chapter 4 for the basinwide density of forest management plans and afforestation/reforestation management.

Table 7-5: Land Cover of the Deep River Subbasin.

Land Cover[1]	2001	2011	2019	% Change 2001-2019	Mi^2 Change 2001-2019	Total Mi^2 2019
Agriculture	21.04%	19.86%	19.61%	**-6.76%**	**-20.63**	**284.42**
Barren Land[2]	0.09%	0.09%	0.13%	**46.72%**	**0.62**	**1.94**
Developed	13.71%	14.57%	14.80%	**7.93%**	**15.77**	**214.64**
Forest	56.90%	55.39%	55.37%	**-2.69%**	**-22.23**	**802.86**
Grassland/Shrub	6.54%	8.05%	8.02%	**22.67%**	**21.49**	**116.3**
Open Water	0.77%	1.09%	1.10%	**43.10%**	**4.79**	**15.91**
Wetlands	0.96%	0.95%	0.97%	**1.37%**	**0.19**	**14.04**
Total Mi^2						**1,450.11**

[1]Data were downloaded from the Multi-Resolution Land Characteristics NLCD website and processed for each Cape Fear River Basin HUC8 in 2022.

[2]Barren Land is a catch-all category for tilled land, new development, and cutover and bare rock areas.

Table 7-6: 2019 Land Cover in the HUC10 Watersheds of the Deep River Subbasin.

Watershed	Land Area (mi^2)	Agriculture	Barren Land	Developed	Forest	Grassland/ Shrub	Open Water	Wetlands
Headwaters Deep River	283	18.4%	0.2%	37.8%	37.1%	3.5%	2.6%	0.4%
Upper Deep River	294	27.9%	0.0%	10.0%	52.7%	8.5%	0.6%	0.4%
Mclendons Creek	101	6.8%	0.1%	7.0%	66.1%	14.2%	0.9%	4.8%
Middle Deep River	302	18.1%	0.1%	7.5%	63.1%	9.9%	0.6%	0.6%
Rocky River	243	25.3%	0.1%	9.2%	57.6%	6.7%	0.7%	0.5%
Lower Deep River	226	12.0%	0.3%	11.5%	64.2%	9.2%	1.1%	1.6%

[1]Data was downloaded from the Multi-Resolution Land Characteristics NLCD website and processed for each Cape Fear River Basin HUC8 in 2022.

[2]Barren Land is a catch-all category for tilled land, new development, cutover, bare rock areas.

Figure 7-2: Land Cover in the Deep River Subbasin.

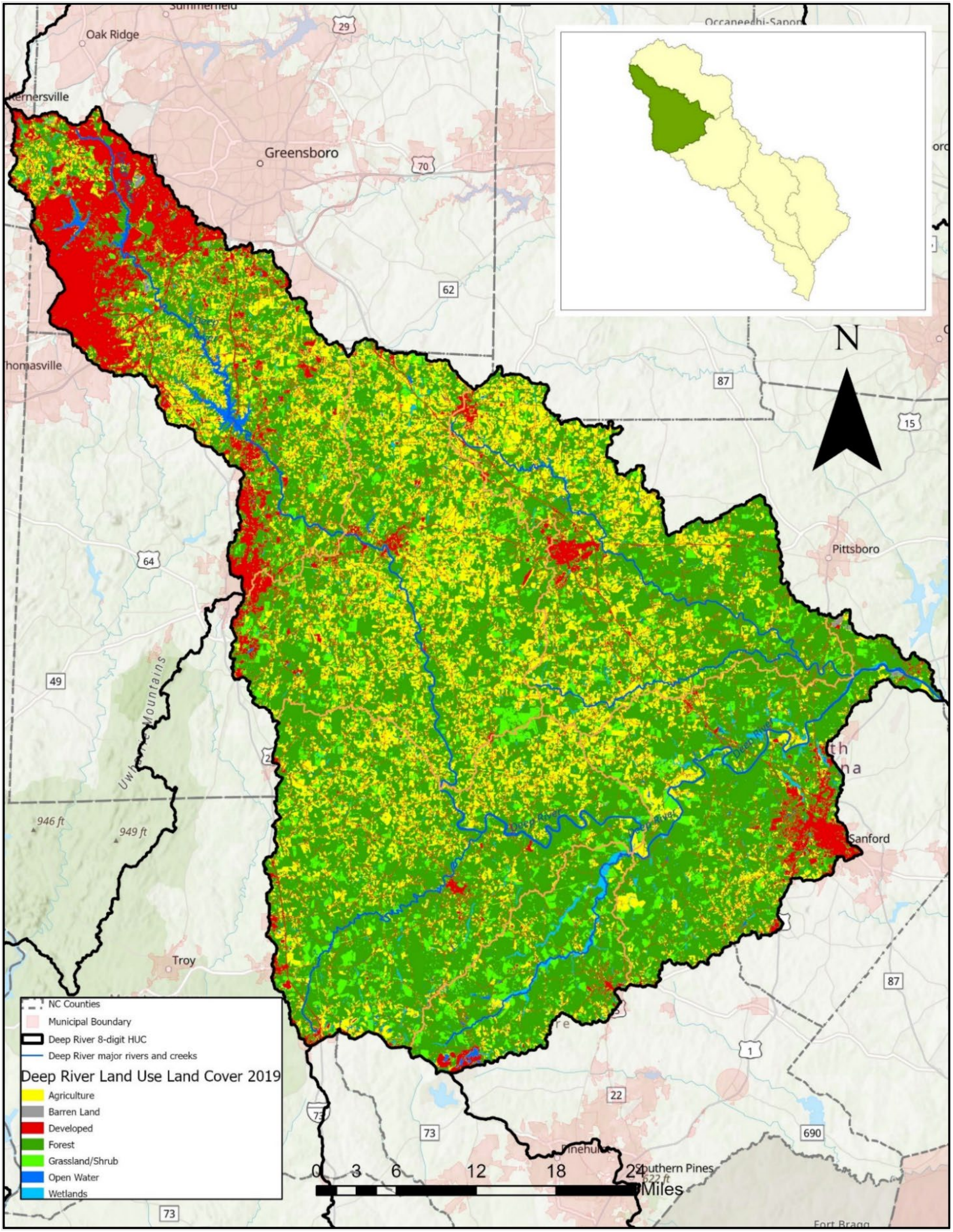


Table 7-7: Deep River Basin NCFS Management Approaches May 2005 to October 2021 (NCFS 2022).

NCFS Management Approach	Number	Total Acres[1]	% of Subbasin
Harvest Inspections	1,750	95,809	10.32%
Forest Management Plans[2]	3,700	174,586	18.81%
Afforestation/ Reforestation	1,055	45,528	4.91%

[1]There are 928,079 total acres in the Deep River basin

[2]Forest Management Plan types include Forest Management, Pre-Harvest, Practice, Regeneration, Rehabilitation, Replant, Stewardship and Urban plans.

Figure 7-3: Deep River Subbasin Percentage of Area (Acres) Assisted by NCFS Services (NCFS 2022).

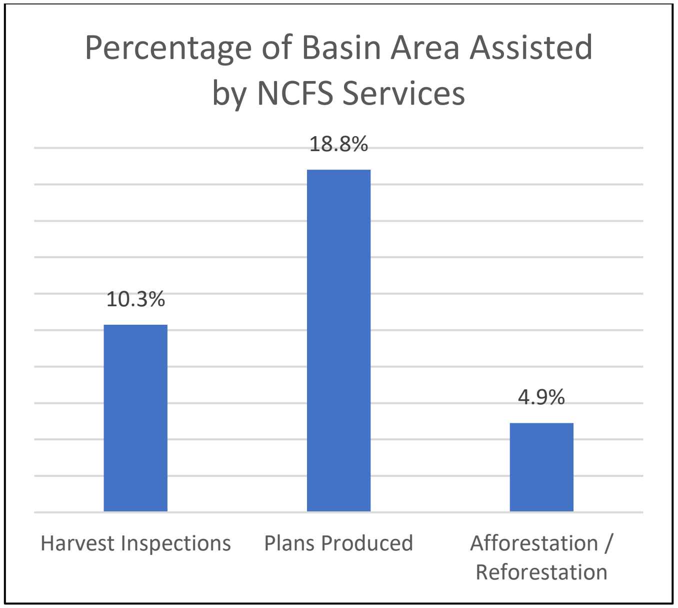
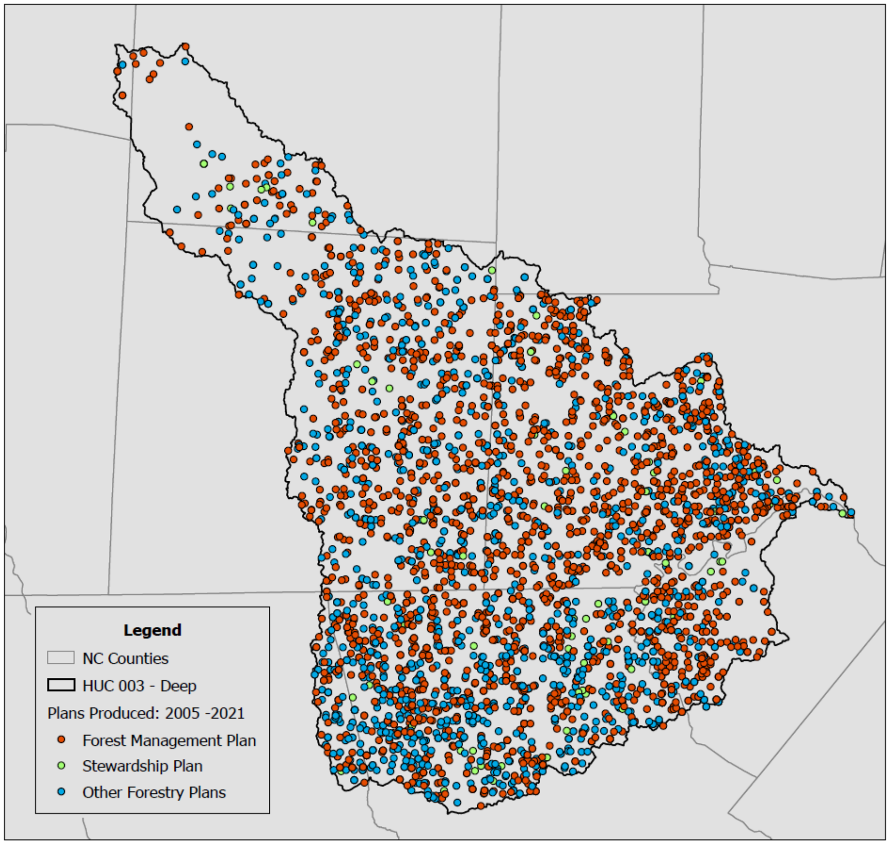


Figure 7-4: Deep River Distribution of plans provided by the NCFS from May 2005 to October 2021 (NCFS 2022).



7.3 Permits

As of May 2022, there were 79 National Pollutant Discharge Elimination System (NPDES) wastewater permits, 44 non-discharge and land application permits, 146 NPDES stormwater permits, 30 state stormwater permits and 35 animal feeding operation (AFO) permits issued in the Deep River subbasin (*Table 7-8*). *Figure 7-5* shows the location of the permitted facilities in the Deep River subbasin.

The Deep River subbasin accounts for 13% (56.504 Million Gallons per Day (MGD)) of the total permitted as-built discharge (425.47 MGD) in the Cape Fear River Basin. There are six major NPDES permitted municipal wastewater treatment plants (WWTPs) and 33 minor NPDES wastewater (excluding single family) permits in the subbasin, with a total, permitted as-built discharge flow of 56.5 MGD. Facilities designated as major are permitted to discharge more than 1 million gallons per day (1 MGD). Four of the major facilities discharge directly to the Deep River, including the City of High Point's Eastside WWTP (Permit Number: NC0024210), which has the greatest as-built discharge flow in the subbasin and is permitted to discharge up to 26 MGD. Other waterbodies receiving discharge from major WWTPs include Haskett and Loves creeks. Thirteen of the minor permits are for small WWTP "package plants" (discharging 100% domestic waste, <1 MGD). Many of the smaller (minor) facilities do not have the same monitoring or reporting requirements as larger facilities. All facilities, however, are inspected on a routine basis by DWR regional office personnel.

The Deep River subbasin also accounts for close to 20% (4,443 acres) of the total permitted field acreage (21,771 acres) for non-discharge and residual land application permits. Permitted fields are primarily used for land application of residual solids. There are several single-family wastewater systems located in the Deep River subbasin that are permitted under the NPDES wastewater discharge or non-discharge programs in the lower part of the Deep River subbasin, primarily in Chatham County, where the Triassic Basin Level IV and Carolina Slate Belt ecoregions are located. In this region of the Deep River subbasin, there are 40 NPDES single-family domestic wastewater discharge permits and 18 non-discharge single-family residence wastewater irrigation permits (*Table 7-8*). An overall basin map is also available for these single-family permitted locations in Chapter 3, Section 3.2.

Five of the 30 NPDES MS4 (Municipal Separate Stormwater Sewer Systems) stormwater permits in the Cape Fear River Basin are in the Deep River subbasin. NPDES MS4 permits are required for owners/operators of facilities in areas that the US Census Bureau has designated as urbanized. MS4 stormwater permits are held by Archdale, Greensboro, High Point, Jamestown and Kernersville. More information about Urbanized Areas can be found in Chapter 3. A complete list of all permits can be found in the Chapter 3 Appendix.

Fewer AFOs are located in the Deep River subbasin compared to watersheds located in the lower part of the basin. Permitted AFO facilities include 13 state cattle COCs (Certificates of Coverage), 18 swine state COCs and four individual state permits. Overall basin maps and summary tables are available in Chapter 1, Section 1.5.1, Chapter 1 Appendix and permit maps and tables are in Chapter 3, Section 3.6.

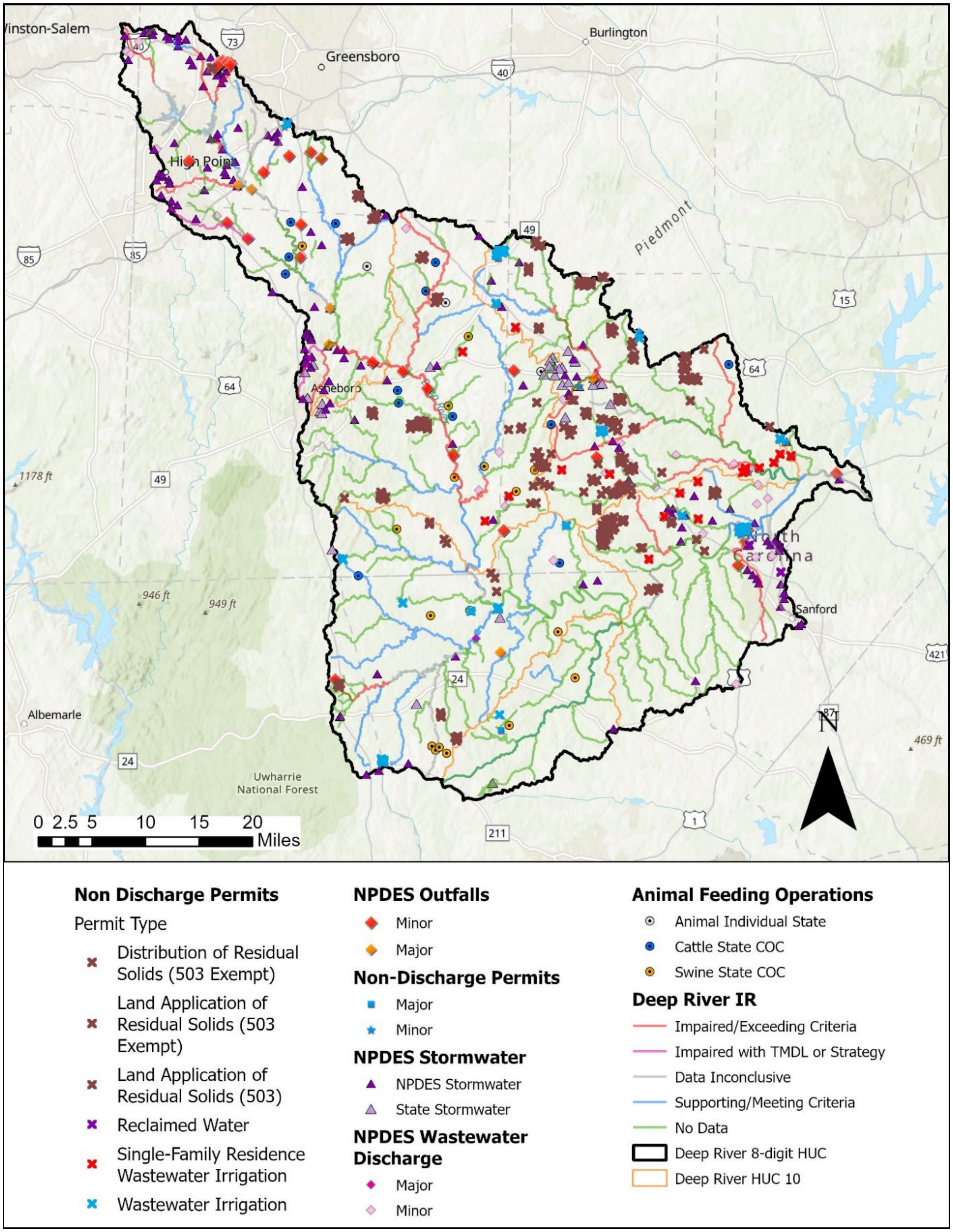
In addition to permitted animal operations, the US Department of Agriculture (USDA) 2022 Census of Agriculture data indicates there are numerous poultry, swine and cattle operations in the counties located entirely or partially within the Deep River subbasin. Many of these operations are considered deemed permitted under North Carolina Administrative Code (NCAC) [15A NCAC 02T .103]. Deemed permitted is defined as "a facility that is considered to have a needed permit and to be in compliance with the permitting requirements of [General Statute 143-215.1(a)] even though it has not received an individual permit for its construction or operation." The Census of Agriculture can be used to help evaluate which counties have the highest agricultural activity. It can also be used to evaluate historic agricultural trends to formulate policies, develop programs and identify and allocate local and national funds for agricultural programs.

Table 7-8: Total Number of Permits Found in the Deep River Subbasin.

Number of Permits[1]		Permit Information[1]	
NPDES Wastewater Discharge[2]			
Major	**Minor**	**Permitted As-Built (MGD)**	
6	33	56.504	
Single-Family Domestic Wastewater Discharge			
Number of Permits		**Permitted As-Built (MGD)**	
40		0.016	
Non-Discharge and Land Application[3]			
Major	**Minor**	**Field Number**	**Field Acres**
12	14	316	4,442.7
Single-Family Residence Wastewater Irrigation			
Number of Permits		**Field Number**	**Field Acres**
18		18	6.3
Stormwater			
State	**NPDES**	**NPDES Outfalls**	
30	146	250	
Animal Feeding Operations			
Number of Permits		**Allowable Headcount**	**Allowable Weight (lb)**
35		84,650	30,403,176

[1] Active and expired permitted facilities and associated permit data were queried from the DWR Basinwide Information Management System (BIMS) in May 2022. All permits are associated with active facilities.
[2] Permitted NPDES Discharge facility numbers are based on the number of facilities and as-built totals that discharge to the Cape Fear River Basin
[3] Some permitted fields are associated with facilities located outside of the Cape Fear River Basin.

Figure 7-5: NPDES Wastewater, NPDES Non-Discharge, NPDES Stormwater, and Animal Feeding Operations Permits in the Deep River Subbasin.



To understand animal agriculture in the subbasin, Chatham, Moore and Randolph counties were queried for poultry and cattle. Between 2007 and 2017, there was a decline in total poultry production numbers within these three counties (*Table 7-9*). For poultry inventory, total numbers dropped between 2007 and 2017 but increased in 2022 to 23.6 million birds, a 7.7% increase in inventory since 2007. When reviewing the Census of Agriculture for all counties in the basin, Randolph County had the third highest poultry inventory and production numbers behind Duplin and Sampson counties (Figure 7-6, Figure 7-7). Basinwide in 2022, Randolph and Chatham counties had the highest inventories for cattle (43,848 and 30,497, respectively) (*Figure 7-8*). Randolph had more cattle than what was reported in Sampson and Duplin counties combined (40,950) and nearly 13,000 more than Chatham (30,497). More information about counties queried for the Census of Agriculture can be found in Chapter 1 and the Chapter 1 Appendix and permitted animal operation basin maps and summary tables in Chapter 3, section 3.6.

Table 7-9: USDA Census Data for Poultry and Cattle in Deep River Subbasin Counties.

USDA Data	Chatham	Moore	Randolph	Total
Poultry 2007				
Inventory[1]	5,939,978	6,829,982	9,152,283	21,922,243
Contract[2]	26,730,076	33,434,200	39,403,141	99,567,417
Poultry 2012				
Inventory[1]	4,120,641	5,190,516	8,748,721	18,059,878
Contract[2]	19,878,914	26,084,385	37,110,849	83,074,148
Poultry 2017				
Inventory[1]	4,671,172	5,206,683	8,316,289	18,194,144
Contract[2]	19,263,124	26,859,000	36,843,634	82,965,758
Poultry 2022				
Inventory[1]	6,694,386	5,976,909	10,938,392	23,609,687
Contract[2]	27,901,390	27,312,400	43,139,464	98,353,254
Cattle 2007				
Inventory	31,691	7,859	40,563	80,113
Cattle 2012				
Inventory	38,420	11,489	45,481	95,390
Cattle 2017				
Inventory	32,403	10,902	41,671	84,976
Cattle 2022				
Inventory	30,497	12,032	43,848	86,377

[1] USDA Inventory numbers represent a point in time (End of December) when the census data was collected. Poultry includes broilers, layers, pullets, and roosters.

[2] USDA Production Contract numbers are "totals for the portion of agriculture production raised and delivered under production contract" (USDA, 2017). Production accounts for data items associated with broilers, layers, and pullet in 2012 to 2022 and only broilers and pullets for 2007. Production Contract and Inventory represent different data items and cannot be combined or added.

[3] The counties included in this table had >45% land area within the Cape Fear River Basin.

Figure 7-6: USDA Census of Agriculture Chicken/Poultry Inventory (USDA, 2022)

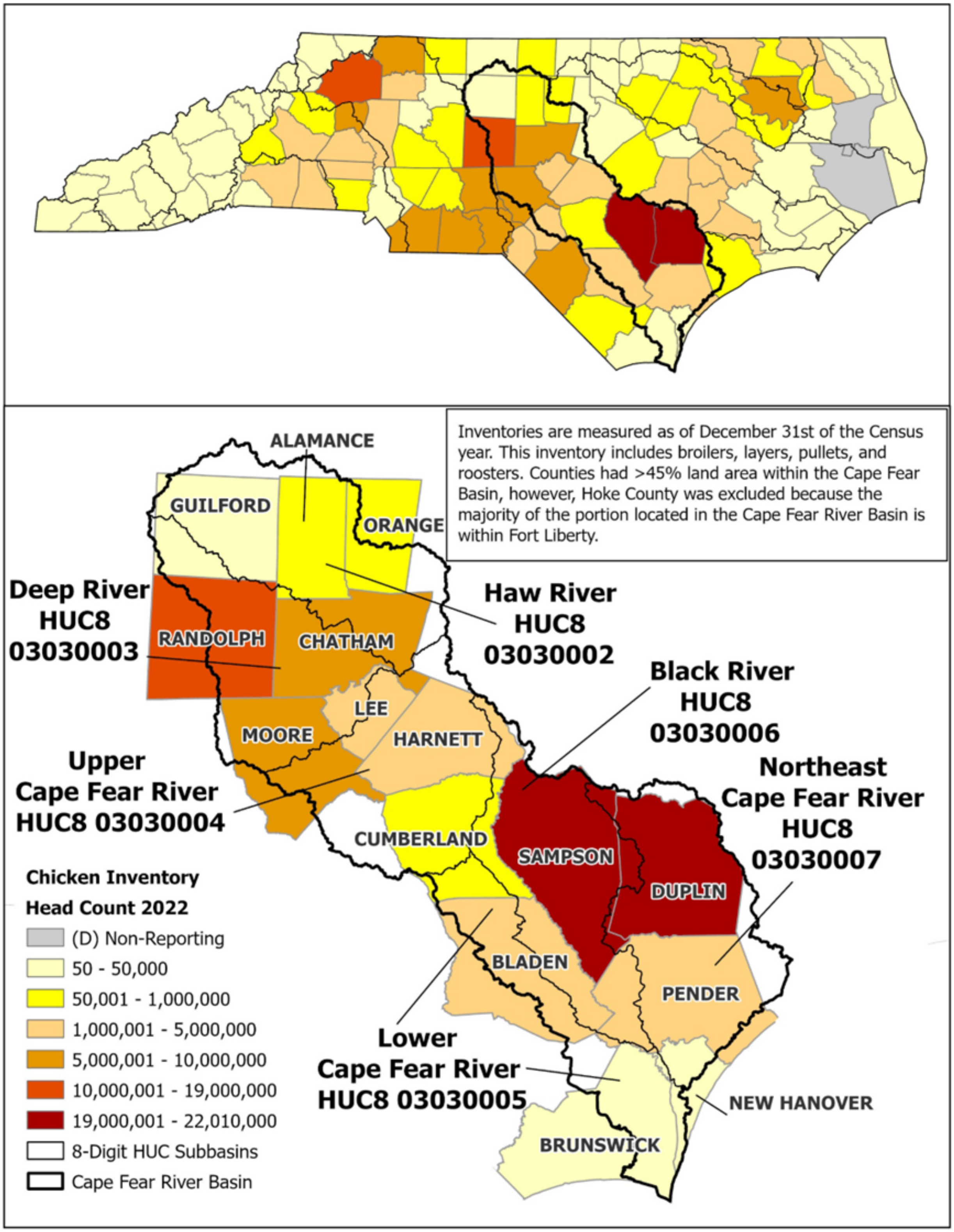


Figure 7-7: USDA Census of Agriculture Chicken/Poultry <u>Production</u> (USDA, 2022)

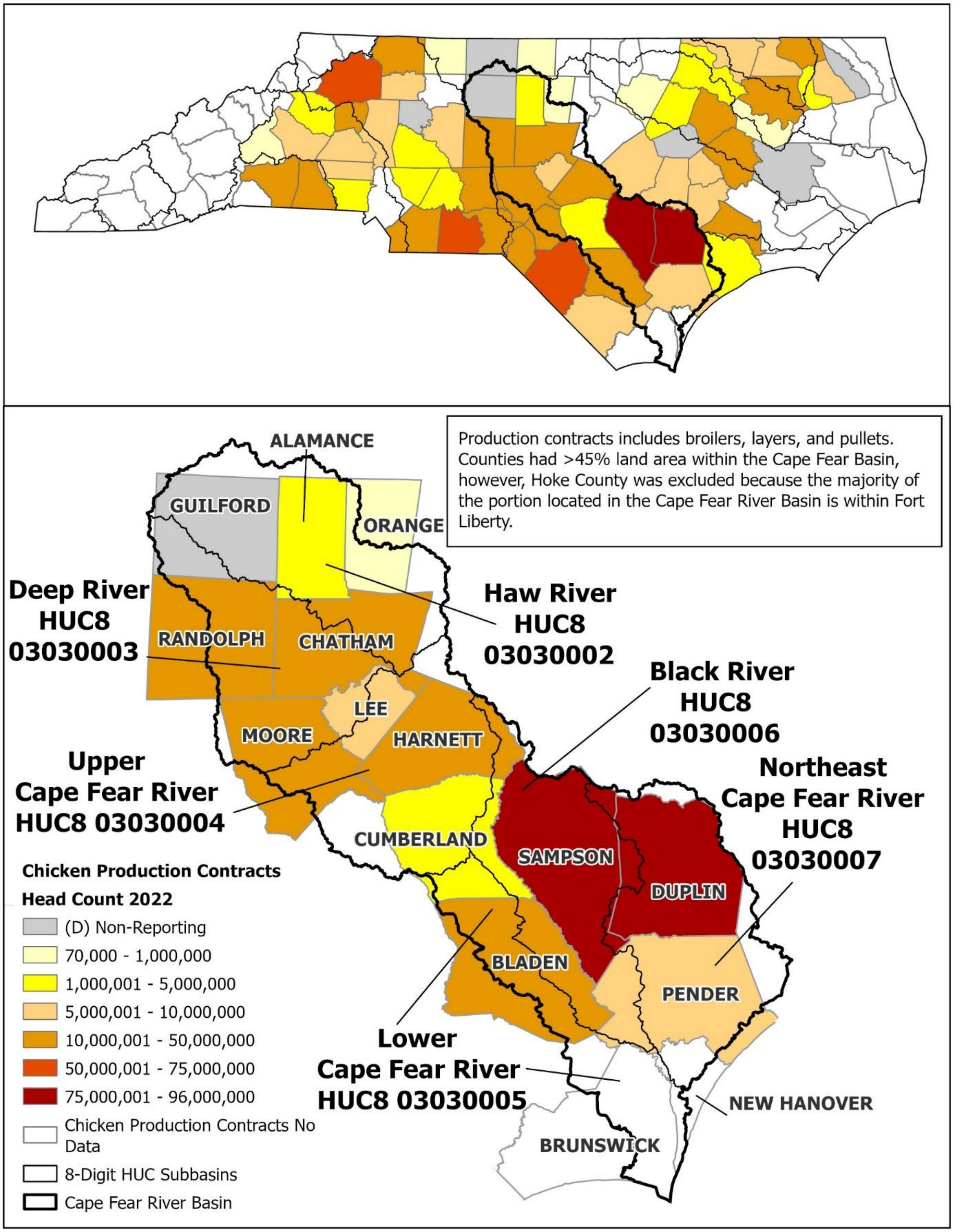
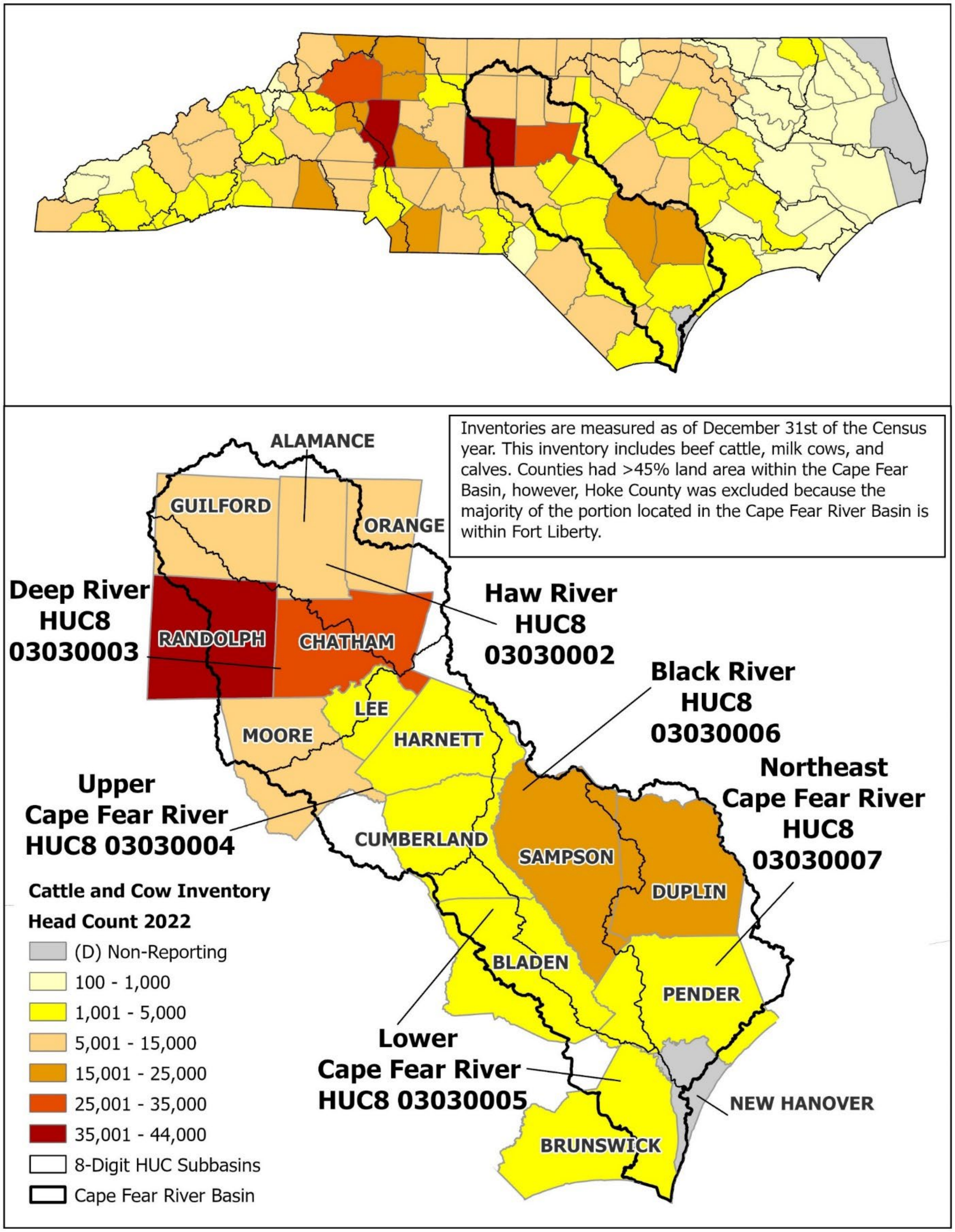


Figure 7-8: USDA Census of Agriculture Cattle Inventory (USDA, 2022)



7.4 Biological Health

Biological communities are highly sensitive to changes in water quality and quantity, and can reflect both long- and short-term environmental conditions. Benthos and fish community survey information are collected on species richness (i.e., diversity), abundance, and composition, as well as site-specific conditions, such as stream habitat, physical water quality parameters, stream width, and flow regime. Survey results, and the presence of pollution-tolerant and/or -intolerant benthos species, are used to calculate an IBI, or an Index of Biotic Integrity score. Fish community IBIs evaluate the effects of all classes of factors that influence the fish community (i.e., water quality, energy source, habitat quality, flow regime and biotic interactions). Therefore, not all changes in the fish community are related to water quality. Fish community scores are a measure of the ecological health of the waterbody and may not directly correlate to water quality as benthic scores do. IBI scores are assigned a descriptive rating, or bioclassification: Excellent, Good, Good-Fair, Fair, Poor, Not Rated or Not Impaired. An "EPT" Biotic Index (BI) can also be used to assign ratings by using pollution sensitive species of mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and caddisflies (*Trichoptera*). Benthic biocriteria, bioclassification assignment and sampling methodology can vary with region and stream conditions. An "EPT" Biotic Index (BI) can also be used to assign ratings by using pollution-sensitive species of mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and caddisflies (*Trichoptera*). In the Deep River subbasin, four assessment methodologies were used: Full Scale, EPT, Qual4 and Qual5. See the Benthic Standard Operating Procedures (SOP) or the Fish Community SOP available through DWR Water Sciences Section (WSS) for more information on biological monitoring and bioclassification ratings. More information on basinwide biology sampling is also available in Chapter 2.

The Biological Assessment Branch monitors each basin on a rotating 5-year cycle. Basin monitoring locations are often re-visited during each cycle. Additional locations, called special study sites, may be monitored once or multiple times and are assessed during the monitoring cycle year and/or between cycle years. The basin monitoring cycle years covered in this plan were completed in 2008, 2013 and 2018. Biological monitoring is occurring in 2023 as well, but will not be included in this plan's update. The results of the previous monitoring cycle, completed in 2003, were evaluated as a point of comparison.

The periods 2003 to 2008/2009, 2008/2009-2013, and 2013 to 2018 showed most of the Deep River watershed fish and benthos community sites experiencing no changes in their bioclassification ratings. This analysis could only be performed on basin sites that were monitored consistently during the assessment periods. Several basin sites were not monitored during all assessment cycles, or were skipped in some assessment cycles, making drawing conclusions about changes in their bioclassifications difficult.

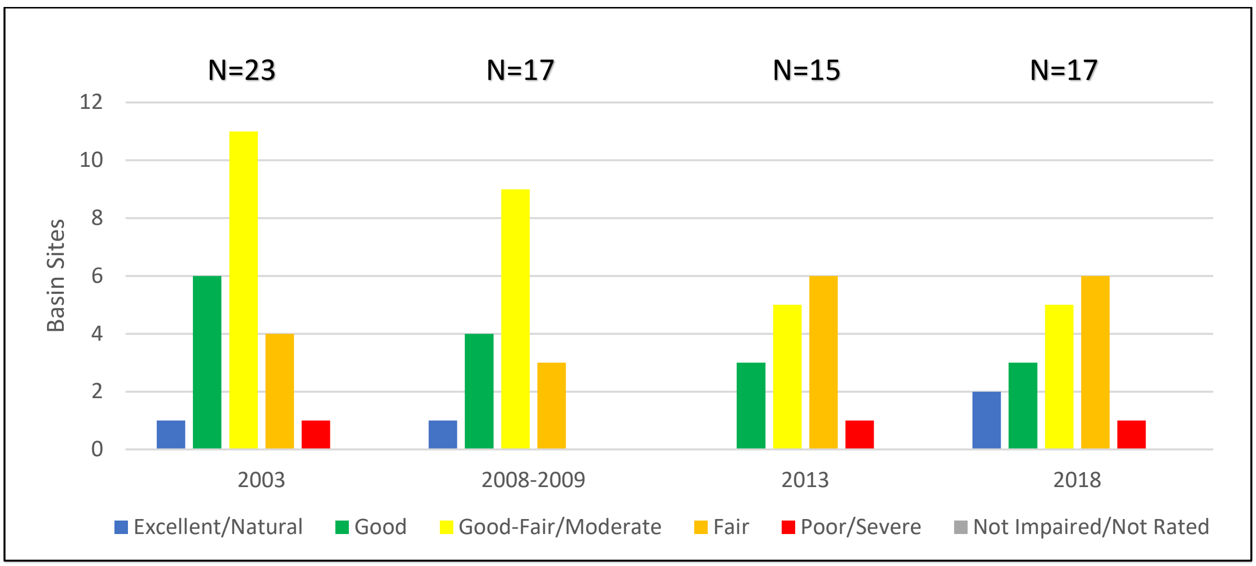
From 2003 to 2008/2009, two sites declined in rating, three improved, and eight did not change. From 2008/2009 to 2013, three sites declined in rating, two improved, and three did not change. There are 21 Assessment Units (AUs) in the watershed impaired for benthos or fish. The most common reasons cited by field staff for bioclassification rating decline in this watershed included sedimentation and land disturbance. Fish and benthos basin sites that experienced bioclassification rating changes are discussed below and throughout this chapter. Special studies conducted during the plan years are also included in the discussion.

7.4.1 Benthic Macroinvertebrates

Each benthic station monitored during the current cycle, including data collected during special studies, along with its latest biological rating, is shown in *Figure 7-10*. As of the 2018 sampling cycle, 53% of the basin stations are classified as supporting (ratings of Excellent, Good, and Good-Fair), 27% as impaired (ratings of Fair and Poor) for aquatic life, and 20% of sites are not rated. Most of the impaired benthos stations in this subbasin are in HUC 0303000301 (Headwaters Deep River) and HUC 0303000305 (Rocky River). Many of the sites are discussed in more detail in the watershed sections below. Between the last two basinwide cycles, 9% of the stations declined, while 36% of the stations experienced an improvement over the previous rating in 2013 based on 11 comparable stations. The 2018 sampling cycle saw the largest percentage of improvement at benthos sites as compared to the 2003 and 2013 sampling cycles.

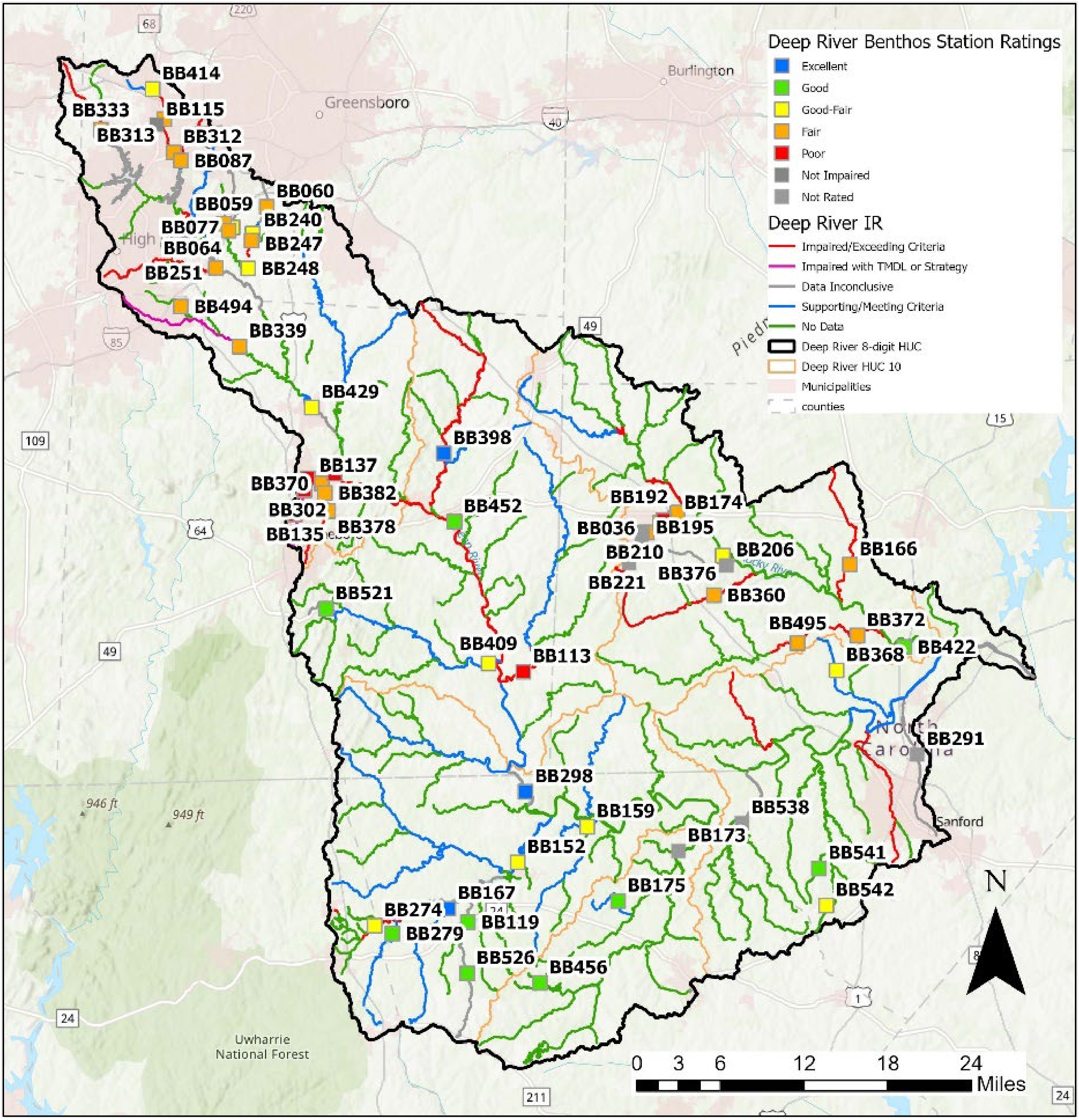
The Deep River subbasin benthos monitoring results for the four cycle-years are displayed in *Figure 7-9*. Basin site monitoring results for 2009 were also combined with 2008, as some stations were sampled (or resampled) in 2009 due to drought in 2008. *Figure 7-10* shows that benthos stations in the northern and southeastern portions of the subbasin tend to rate lower than sites in southwest portion of the subbasin. This may be attributable in part to differing land uses in these areas, particularly urban development, and concentration of NPDES permitted activities, both of which can affect stream quality. The southwest portion of the basin is predominantly forest and agriculture while urban development is more prominent in the upper and southeastern portions of the subbasin. All of the results from benthos station collected between 2002 to 2021 are available in Chapter 2 Appendix.

Figure 7-9: Deep River Benthos Monitoring Stations Sampled Per Cycle and Ratings, 2002-2018.



There is some variability in the basin monitoring sites chosen for monitoring cycle years 2003, 2008-2009, 2013, 2018.
Graph data contains one station result per cycle year for 2003, 2013, 2018 and one station result for combined years 2008-2009. Where applicable, the most recent result for stations sampled >1 time per year(s) OR the most common result for stations sampled >2 times per year(s) was used.

Figure 7-10: Benthos Station Locations and Ratings in the Deep River Subbasin.

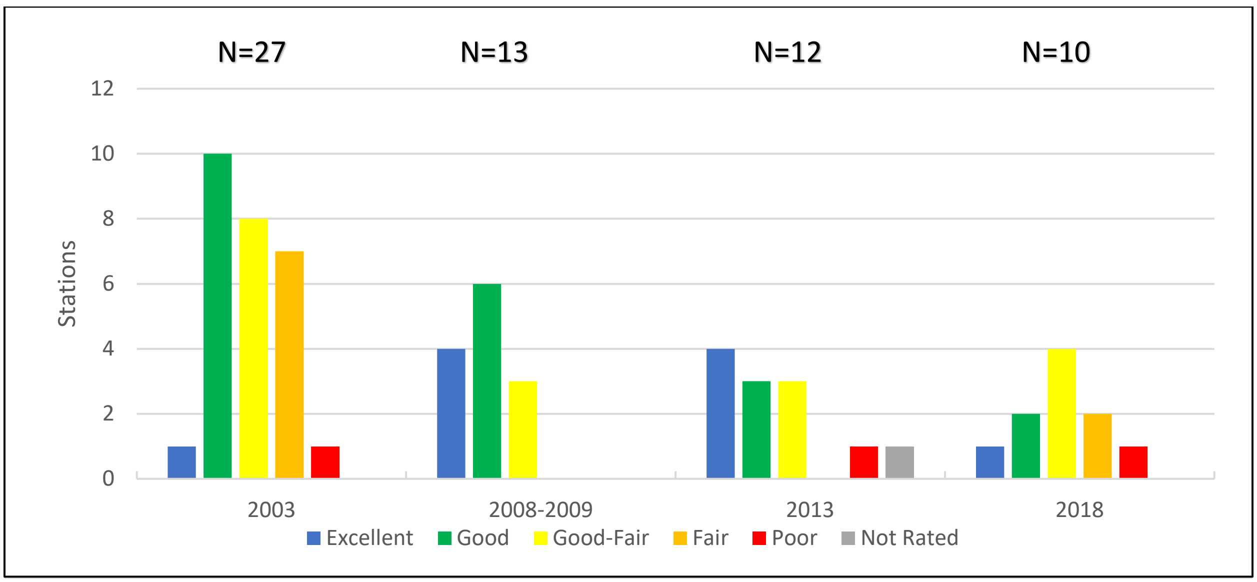


7.4.2 Fish Communities

Fish community scores rate the ecological health of the waterbody and may not directly correlate to water quality like benthic scores. IBI scores are assigned a descriptive rating, or bioclassification, of Excellent, Good, Good-Fair, Fair, Poor, Not Rated, or Not Impaired. The Deep River fish community monitoring results for the four cycle years are displayed in *Figure 7-11*. Monitoring results for 2003-2004 and 2008-2009 were combined for data used in the graphics as monitoring was not completed during regular cycle years due to drought conditions. Each fish community station monitored during the current cycle (including data collected during special studies) along with its latest biological rating is shown in *Figure 7-12*; all fish community station results from 2002 to 2018 are available in Appendix 2.

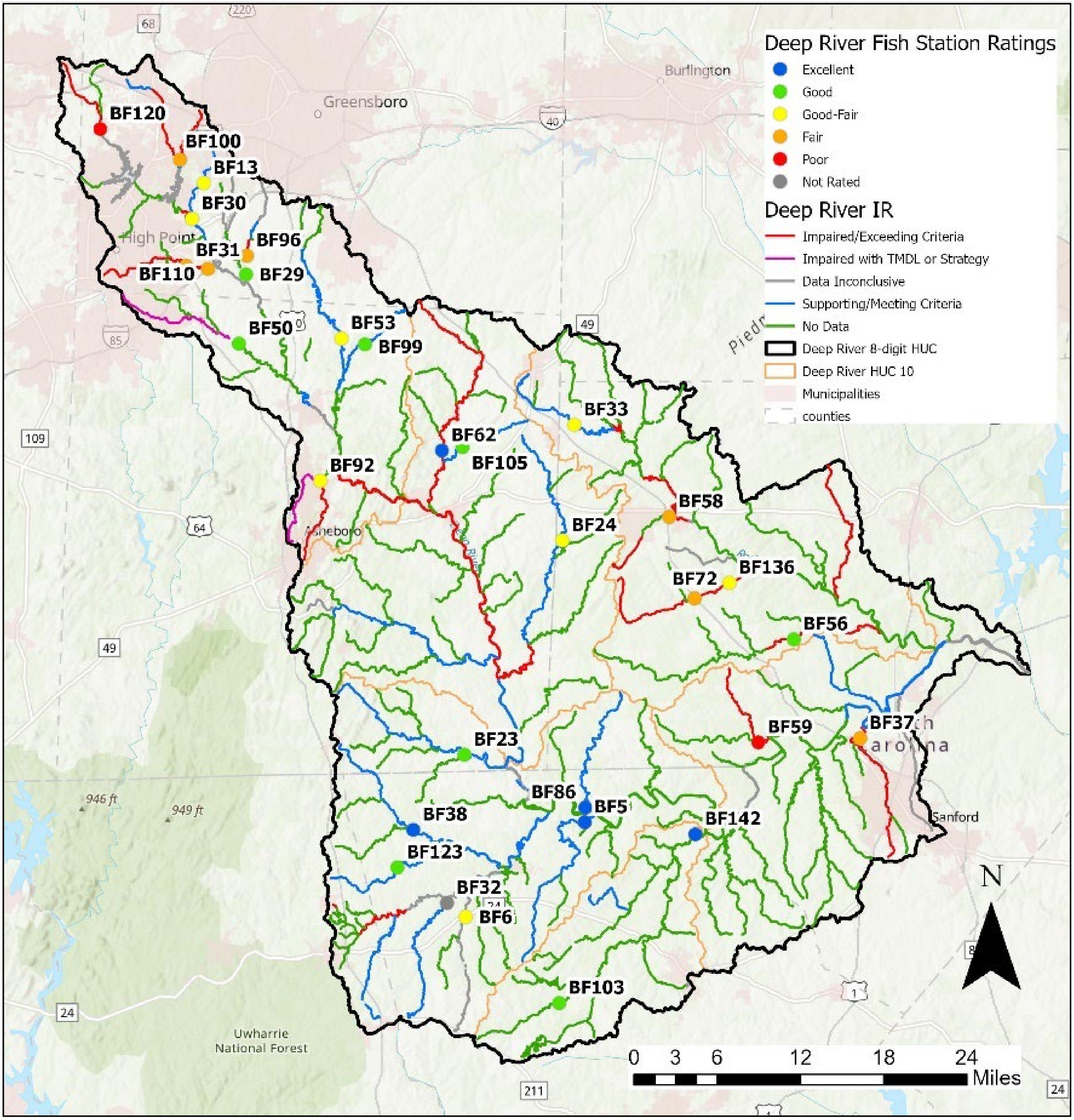
As of 2018, 70% of the fish sites were rated as supporting and 30% as impaired for fish community biological integrity. Trends indicate fewer Excellent and Good fish bioclassifications in the Deep River subbasin between 2003 and 2018. As with the benthos stations, fish community sites in the northern and southeastern portions of the subbasin tend to rate lower than sites in southwest portion of the subbasin. This may be attributable in part to differing land uses in these areas, particularly urban development, and concentration of NPDES permitted activities, all of which can affect stream quality. The southwest portion of the basin is predominantly forest and agriculture while urban development is more prominent in the upper and southeastern portions of the subbasin.

Figure 7-11: Deep River Fish Community Bioclassification Ratings 2003-2004, 2008-2009, 2013, and 2018.



There is some variability in the basin monitoring sites chosen for monitoring cycle years 2003, 2008-2009, 2013, 2018. Graph data contains one station result per cycle year for 2013 and 2018 and one station result for combined years 2003-2004 and 2008-2009. Where applicable, the most recent result for stations sampled >1 time per year(s) OR the most common result for stations sampled >2 times per year(s) was used.

Figure 7-12: Fish Community Station Locations and Ratings in the Deep River Subbasin.



7.4.3 Fish Kills/Spill Events

The largest fish kill in the Deep River in this planning cycle, affecting more than 1,000 fish, occurred in May 2008 in Lake Sequoia in Moore County. While the cause is listed as unknown, it was likely due to high levels of copper sulfate, a chemical commonly used as an aquatic herbicide to control aquatic weeds and algal growth. After the fish kill was reported, a copper level of 11 µg/L was detected at the lake spillway. Two other fish kills in the subbasin had unknown causes; another at Hayes Pond in 2008 was due to suspected low DO (*Table 7-10*).

Table 7-10: Reported Fish Kills in HUC8 03030003 (2005-2011).

Kill Report#	Report Date	Waterbody	Location	County	Duration	Kill Area	Mortality #	Cause
RA08002	3/26/08	Rocky River	South of Pittsboro	Chatham	2 days	NA	75	Unknown
FA08002	5/15/08	Lake Sequoia	Seven Lakes	Moore	7 days	250 acres	1,000	Unknown
FA08004	10/5/08	Hayes Pond	Near Dover	Moore	NA	2 acres	185	DO
RA11009	9/28/11	Deep River	US 15-501	Lee	1 day	NA	100	Unknown

7.4.4 Endangered Species in the Deep River Subbasin

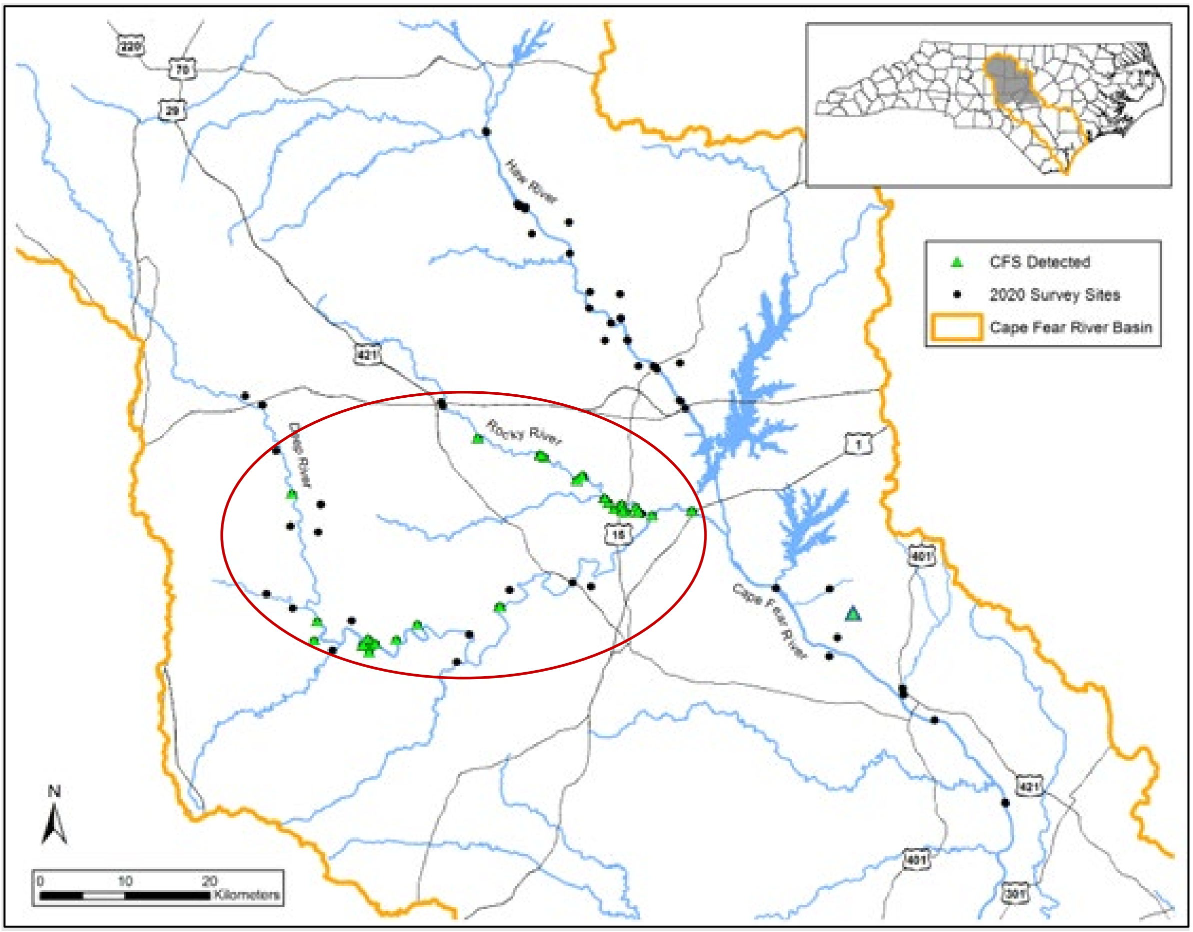
The Cape Fear shiner (*Notropis mekistocholas*) is a freshwater minnow endemic to the upper Cape Fear River Basin in central North Carolina. It was listed as endangered on September 25, 1987, throughout its range. A recovery plan was published in 1988, and the most recent 5-year review was completed by the US Fish and Wildlife Service (FWS) in 2022.

At the time the Cape Fear shiner was listed as an endangered species, it was only known from three small stream reaches in the Rocky-Deep River subbasin. Over the past three decades, significant conservation actions, particularly successful captive propagation, and dam removal have benefited the species, along with improved and connected habitat within the Deep River basin. The Cape Fear shiner's current ability to sustain populations in the wild, while improved since the time of listing, is not currently sufficient for the species to overcome catastrophic events into the future. Improved viability in the future will be reliant on human intervention by reconnection of habitats via dam removals or passage; species restoration efforts via captive propagation and augmentation; the maintenance of adequate water quality and constant vigilance against the spread of invasive species in the upper Cape Fear River Basin.

The Rocky and Deep rivers and their tributaries have had the highest numbers of individuals among all Cape Fear shiner surveys. During the 2020 survey, the Rocky River survey effort consisted of 33 total site visits over eight sites on the mainstem and two additional site visits for two sites within the Bear Creek tributary. Data from these site visits indicated that 320 individuals were observed in the mainstem of the Rocky River with abundance ranging from zero to 50 individuals per site, including juvenile size classes at several of the sites surveyed. The presence of juveniles indicated successful recruitment. An additional 41 individuals were collected in Bear Creek and its confluence with the Rocky River downstream of the former Hoosier Dam location. The Deep River mainstem sampling included 28 total site visits within 10 sites, with additional visits to 14 tributary sites. A total of 67 individual Cape Fear shiners were observed in the Deep River mainstem with an abundance ranging from zero to 18 individuals per site. Among the 14 tributary sites, 57 Cape Fear shiners were observed in four locations: Buffalo Creek, Falls Creek, Tysons Creek and Grassy Creek (*Figure 7-13*). Fork Creek, a previously occupied tributary from a 1985 survey, was surveyed, with no individuals observed during the 2020 survey (US FWS, 2022).

See a UNC-TV YouTube video [*Protecting a Tiny, Shiny Fish*] to see Brena Jones from the North Carolina Wildlife Resources Commission (WRC) and the efforts being taken to restore Cape Fear shiner population in the Deep River watershed (August 2023).

Figure 7-13: Survey Locations and Sites Where Cape Fear Shiners Were Detected in the Deep River Subbasin During 2020 NC WRC Surveys (USFWS, 2022).



7.5 Ambient Water Quality

Monthly chemical and physical samples are taken by DWR through the Ambient Monitoring System (AMS) stations and coalitions of NPDES permit holders that are active in the Cape Fear River Basin. In the Deep River subbasin, all the coalition stations are monitored by the Upper Cape Fear River Basin Association (UCFRBA). Many of the ambient stations are associated with waterbody locations where potential pollution could occur from known land use activities in the subbasin. There are also portions of the subbasin where no water quality data are collected; therefore, water quality in those areas cannot be evaluated. Parameters collected depend on the waterbody classification, but typically include conductivity, dissolved oxygen, pH, temperature, turbidity, nutrients and fecal coliform bacteria. Each classification has an associated set of standards detailing parameters that must be met to be considered supporting the waterbody's designated uses. Stressors are either chemical parameters or physical conditions that, at certain levels, prevent waterbodies from meeting the standards for their designated use.

The method used to identify an impaired waterbody for the Integrated Report (IR) is typically based on 10% exceedance rate of a standard and 90% percent confidence for a set of data generally collected over five years. The IR methodology also addresses less common situations such as small datasets (with less than 10 samples) as can happen with lake and reservoir sampling. See Chapter 2 for information on the IR methodology and the ambient monitoring programs, including the Random Ambient Monitoring System (RAMS). It is important to note that fecal coliform results not collected using a 5-in-30 methodology are used for screening purposes only.

There is currently, nine AMS and 17 UCFRBA stations being monitored in the Deep River subbasin with two stations co-located for AMS and UCFRBA (B5100000 and B6040300) (*Table 7-11*; *Figure 7-14*). Ambient monitoring station sampling results are discussed in detail in this chapter and a basinwide discussion in Chapter 2. A complete list of all ambient monitoring stations from 2000 to 2020 is available in Chapter 2 Appendix.

An overall comparison of the Deep River's HUC10 watershed scale ambient water quality results for samples collected in the basin from 2016 to 2020 is shown in *Table 7-12*. Mean results for pH, dissolved oxygen (DO), conductivity, nutrients, turbidity, total suspended solids (TSS) and fecal coliform bacteria were determined for stations that had a minimum of five years and 40 average day records. *Table 7-12* also shows the HUC8 mean levels for these parameters from 2016 to 2020 in the Deep River subbasin, and for comparison purposes, the highest HUC8 and HUC10 mean levels basin-wide for conductivity, nutrients, turbidity, TSS and fecal coliform. An overall HUC8 scale comparison of the Cape Fear River basin's six subbasins is available in Chapter 2. All of the watershed (HUC10) scale parameter means, and the number of stations used in the analysis, are available in the Appendix for Chapter 2. At the subbasin (HUC8) scale the Deep River subbasin (HUC8: 03030003) had nearly the highest mean five-year results for turbidity, total suspended solids (TSS), total nitrogen (TN) and nitrate+nitrite (NOx); second only to the Haw River subbasin (HUC8: 03030002), which had the highest mean results for those parameters. The Northeast Cape Fear River subbasin (HUC8: 03030007) had the highest mean five-year results for conductivity, fecal coliform bacteria, total phosphorus (TP), ammonia (NH_3) and total Kjeldahl nitrogen (TKN). Ammonia, TKN, conductivity, TP and fecal coliform bacteria mean levels were lower in the Deep River subbasin relative to the Northeast Cape Fear River subbasin. The highest basinwide HUC10 values included in the *Table 7-12* are described in-depth in their respective watershed chapters spanning chapters 6 through 11 of this report.

Table 7-11: Ambient Monitoring System and Coalition Stations in the Deep River Subbasin.

Station ID	Station Location	Ecoregion LIII	Stream AU #	Stream Classification
B4210000	West Fork Deep River at SR 1818 near High Point	Piedmont	17-3-(0.7)a	WS-IV;CA
B4240000	East Fork Deep River at SR 1541 near High Point	Piedmont	17-2-(0.3)b	WS-IV
B4350000	Deep River at SR 1113 Kivett Dr. near Hayworth Spring	Piedmont	17-(4)a	WS-IV;CA
B4380000	Richland Creek at SR 1154 Kersey Valley Rd. near High Point	Piedmont	17-7-(4)	WS-IV;CA
B4621000	Muddy Creek at SR 1917 near Glenola	Piedmont	17-9-(1)	WS-IV
B4770500	Deep River at US 220 BUS Main St. at Randleman	Piedmont	17-(10.5)a	C
B4800000	Deep River at SR 2122 at Worthville	Piedmont	17-(10.5)b	C
B4870000	Haskett Creek at Asheboro WWTP Bridge near Asheboro	Piedmont	17-12b1	C
B4890000	Haskett Creek at SR2128 near Central Falls	Piedmont	17-12b2	C
B4920000	Deep River at SR 2261 Old Liberty Rd. near Central Falls	Piedmont	17-(10.5)d1	C
B5070000	Deep River at SR 2615 Brooklyn Avenue at Ramseur	Piedmont	17-(10.5)d2	C
B5100000	Deep River at SR 2628 Hinshaw Town Rd near Parks Crossroads	Piedmont	17-(10.5)d2	C
B5190000	Deep River at SR 1456 near High Falls	Piedmont	17-(10.5)e2	C
B5390800	Cotton Creek at SR 1372 Auman Rd. near Star	Piedmont	17-26-5-3b3	WS-III
B5480000	Bear Creek at NC 705 at Robbins	Piedmont	17-26-(6)	C
B5575000	Deep River at NC 42 at Carbonton	Piedmont	17-(32.5)	WS-IV
B5685000	Deep River at Deep River Park Bridge near Cumnock	Piedmont	17-(38.7)	C
B5820000	Deep River at US 15 and 501 near Sanford	Piedmont	17-(38.7)	C
B5890000	Loves Creek at Waste Treatment Plant Rd at Siler City	Piedmont	17-43-10b2	C
B5920000	Loves Creek at Progress Blvd at Siler City	Piedmont	17-43-10c	C
B5950000	Rocky River at US 64 near Siler City	Piedmont	17-43-(8)a	C
B5980000	Rocky River at SR 2170 Rives Chapel Rd. near Siler City	Piedmont	17-43-(8)b1	C
B6000000	Rocky River at NC 902 near Pittsboro	Piedmont	17-43-(8)b1	C
B6040300	Deep River at SR 1011 Old US 1 near Moncure	Piedmont	17-(43.5)	WS-IV

Figure 7-14: Ambient Monitoring System and Coalition Stations in the Deep River Basin.

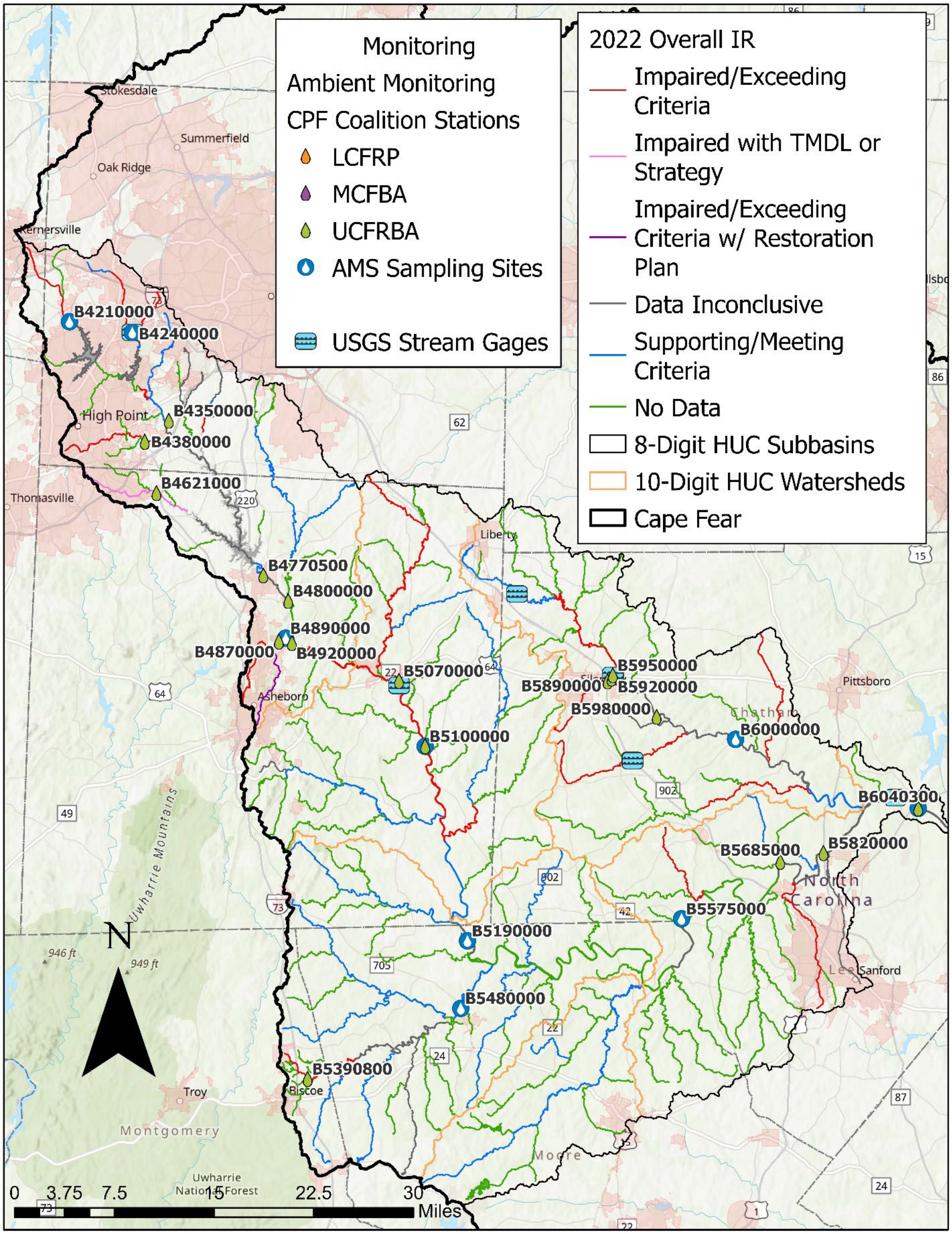


Table 7-12: Deep River Subbasin HUC10 Watershed Ambient Water Quality Means for 2016-2020.

Watershed HUC 10	Watershed Name	# of Stations^	pH	DO (mg/L)	Conductivity (µS/cm)	NH3 (mg/L)	TKN (mg/L)	NOx (mg/L)	TN (mg/L)	TP (mg/L)	Turbidity (NTU)	TSS (mg/L)	Fecal Coliform (CFU/100 mL)
Highest HUC 8 in Cape Fear River Basin		x̄			711	0.09	0.92	1.34	2.10	0.21	20.19	22.90	1,093
Highest HUC 10 in Cape Fear River Basin		x̄			1,413	0.27	1.44	2.62	3.48	0.38	26.63	26.64	2,478
03030003*	**HUC8 Deep River Watershed**	24	7.16	8.34	189	0.06	0.76	1.32	2.08	0.11	16.32	16.83	732
0303000301	Headwaters Deep	10	7.21	8.72	186	0.06	0.71	1.00	1.70	0.08	15.98		848
0303000302	Upper Deep	2	7.19	8.24	168	0.05	0.80	0.69	1.48	0.07	13.93		671
0303000304	Middle Deep	3	6.97	8.28	140	0.07	0.86	1.82	2.69	0.37	18.06	20.35	882
0303000305	Rocky	5	7.25	8.11	275	0.09	0.85	2.62	3.48	0.07	13.33	6.97	670
0303000306	Lower Deep	4	7.06	7.93	135	0.05	0.72	0.57	1.29	0.14	19.87	19.79	501
Healthy Piedmont Stream#					12-90	0.05		0.30	0.80	0.05			
EPA Nutrient Criteria - Piedmont+									0.70	0.038			

^Ambient stations with a minimum of data collected for 5 years from 2016 to 2020 and 40 average day records were included in the analysis.
#DWQ ESS- ISU Special Study. March 24, 2004, Rocky River Survey (Chatham County) Subbasin 03-06-12.
+ USGS Circular #1350 – The Quality of Our Nation's Water – Nutrients in the Nation's Streams and Groundwater, 1992-2004. Dubrovsky et al., 2010.
Orange highlighted values represent the highest mean instream concentration or lowest DO concentration in comparison to the other HUC 10 watersheds.
Green highlighted row represents the overall HUC 8 watershed mean for each constituent for comparison purposes.

At the HUC10 scale, the Rocky River watershed (HUC10: 0303000305) had the highest five-year mean levels for conductivity, ammonia, NOx, and TN (*Table 7-12*). Basinwide, the Rocky River watershed had the highest five-year mean NOx and TN concentrations compared to other HUC10 watersheds in the Cape Fear River Basin. The Middle Deep watershed (HUC10: 0303000306) had the highest HUC10 mean levels for TKN, TP, TSS, and fecal coliform bacteria, and the Lower Deep watershed (HUC10: 0303000306) had the highest HUC10 mean levels for turbidity compared to other HUC10 watersheds in the Deep River subbasin (*Table 7-12*). Notably, the mean TN and NOx concentrations in the Rocky River watershed were exceptionally high when compared to other watersheds in the Cape Fear River Basin.

Emerging compounds (EC) are lesser known compounds that are increasingly being detected in soil, groundwater and surface water. They come from a wide range of sources, including industrial chemicals and their by-products, firefighting foams, pesticides, lawn and agricultural products, disinfection products, wood preservatives, home goods, as well as pharmaceutical and personal care products (PCPs) (EPA, 2024). In addition to industrial sources, these contaminants are often sent to landfills and wastewater treatment plants (WWTP) and subsequently discharged to surface waters. Many of these compounds do not readily biodegrade in the aquatic environment. Consequently, they often persist in water and are readily transported downstream because of a unique combination of physical and chemical properties that make them highly mobile and resistant to natural degradation.

In the last several years, emerging compounds have become the primary concern for the residents living in and receiving drinking water from the Cape Fear River Basin. Per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane are currently the primary contaminants of emerging concern in the Cape Fear River Basin due to their impact on human health in drinking water. The presence of these contaminants has been documented through sampling by university researchers, DEQ, the NC Collaboratory, public water and wastewater utility providers and other local and state entities.

After observing elevated concentrations of 1,4-dioxane reported as part of the EPA's Third Unregulated Contaminant Monitoring Rule (UCMR3, 2013-2015), DWR initiated a study of 1,4-dioxane in surface waters of the Cape Fear River Basin (October 2014) with the objective of identifying potential sources, understanding changes in concentrations, and documenting data that will help the state develop a regulatory strategy. During the study, elevated levels of 1,4-dioxane were identified mainly downstream of the Greensboro, Reidsville and Asheboro WWTPs. DWR continues to work with these facilities to decrease the concentration of 1,4-dioxane in their discharges and requires effluent monitoring to ensure compliance with the CWA. DWR has also added ambient instream monitoring for 1,4-dioxane concentrations in areas where potential contamination might occur. Available instream 1,4-dioxane data is reported throughout the subbasin chapters. A 1,4-dioxane specific chapter (Chapter 13) with detailed Cape Fear River Basin studies and DEQ actions addressing the contaminant is included as part of the basin plan.

Researchers from North Carolina State University (NCSU) detected elevated levels of PFAS (including GenX) in the Cape Fear River in 2013-15. The next year, DEQ, along with DHHS, began investigating PFAS in the basin to identify the potential source of contamination. The source of GenX was traced to Chemours in Bladen County along the west bank of the Cape Fear River in the Lower Cape Fear River subbasin. Other PFAS compounds, some of which are no longer manufactured, are being found in surface and ground water throughout the basin. The sources of these compounds into the Cape Fear River system are from contaminated wastewater, groundwater and atmospheric deposition.

Due to the changing nature of the science and due to the extent and magnitude of PFAS contaminants found in the Cape Fear River Basin as well as what corrective actions to take, PFAS was not discussed in detail within the subbasin chapters of this plan. A PFAS specific chapter was completed after finalizing the water quality and quantity watershed portions of the plan. The most up to date information on the extent of PFAS contamination within the Cape Fear River Basin, completed studies, and what actions have been taken by DEQ and EPA are summarized in the PFAS chapter (Chapter 12). DEQ is actively working to identify sources of PFAS and working to reduce the loading to the Cape Fear River system.

In response to the rising interest in the public health effects associated with per- and polyfluoroalkyl substances (PFAS), the Intensive Survey Branch (ISB) conducted a special study in 2023 alongside their Ambient Lakes Monitoring Program (AMLP) to characterize the presence and concentrations of PFAS compounds in public drinking water supply reservoirs of the Cape Fear River Basin. For five months between May and September 2023, ISB tested surface water samples for 47 different PFAS at Ambient Lakes Monitoring stations nearest to the surface water intake of 15 public water supply (PWS) reservoirs in the Cape Fear River Basin, five of which are in the Deep River subbasin.

A total of 21 different PFAS compounds were found above the detectable laboratory practical quantitation limit (PQL) during the 2023 lakes monitoring study. At least one PFAS analyte was detected above the PQL in each reservoir during each sampling event. It is important to note that all analytical data reflect levels of target analytes detected in untreated surface waters, as opposed to finished drinking water. The results of this study are reported in detail in the PFAS Chapter of this plan (Chapter 12, Section 12.4.1.6).

The results demonstrated the widespread distribution of detectable PFAS in drinking water reservoirs in the Cape Fear River Basin. Additional long-term monitoring would be needed to evaluate the persistence of these compounds. The majority of the PWS facilities are taking part in the EPA Fifth Unregulated Contaminant Monitoring Rule (UCMR5) study, which requires PWS facilities to participate in monitoring for 29 different PFAS compounds in their finished drinking water. The results are reported to the State and EPA. The UCMR5 is discussed in detail section 12.4.2.4 of Chapter 12.

As science advances, laboratories are beginning to detect these compounds and researchers are discovering new details about their impacts. The science and research about emerging contaminants are quickly expanding, so DEQ has created a list of resources to help residents learn more. The latest information and updates can be found on the NC DEQ Emerging Compounds webpage.

7.6 Deep River Watershed Restoration Plans

The first step to watershed restoration is to develop a watershed plan. A watershed plan is a strategy and a work plan for achieving water resource goals that provides assessment and management information in a watershed. There are several approaches that DWR uses to restore and protect water resources in North Carolina that are generally referred to as Watershed Action Plans (WAPs). WAPs rely on existing approaches such as TMDLs or existing management strategies, but include voluntary restoration and protection approaches as well. More information on WAPs is available in Chapter 4 and on DWR's Modeling and Assessment Branch website. Chapter 4 contains maps with the geographic boundaries of each individual parameter addressed by single or combined WAPs (TMDLs and voluntary restoration). In addition, an interactive map is available for all of North Carolina's completed WAPs.

The TMDL Program is a federal program authorized under the Clean Water Act to address waters that are not meeting water quality standards. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. The TMDL is then used to establish limits on sources of the pollutant that are classified as either point sources (waste load allocation) or nonpoint sources (load allocation). The TMDL must account for seasonal variation in water quality and include a margin of safety to ensure that the TMDL allocations will be adequate to protect the body of water. TMDLs have been completed in the Deep River subbasin for waterbodies listed in *Table 7-13*. In addition to TMDLs, the Deep River subbasin has three EPA defined 9-element watershed plans that have been developed to address impaired waterbodies (*Table 7-14*). More information about watershed planning and 9-element plans can be found in Chapter 4.

Table 7-13: Deep River Subbasin TMDLs

HUC 10 Watershed 0303000 +	Stream Name	Assessment Unit #	Parameter of Concern	Percent Reduction	Date Approved	Stream Length (miles/acres)	Classification + NSW	Old Subbasin #
301	Deep River	17-(4)b	Fecal Coliform	75	1/11/2005	6.8	WS-IV	03-06-08
301	East Fork Deep River	17-2-(0.3)	Fecal Coliform	75	3/4/2004	6.5	WS-IV	03-06-08
301	East Fork Deep River	17-2-(0.3), 17-2(0.7)	Turbidity	62	3/4/2004	7.1	WS-IV & WS-IV, CA	03-06-08
301	Richard Creek	17-7-(0.5), 17-7-(4)	Fecal Coliform	82	5/17/2004	9.0	WS-IV & WS-IV, CA	03-06-08
301	Muddy Creek	17-9-(1), 17-9-(2)	Fecal Coliform	80	5/17/2004	6.1	WS-IV & WS-IV, CA	03-06-08
304	Cotton Creek	17-26-5-3a, 17-26-5-3b1, 17-26-5-3b2, 17-26-5-3b3, 17-26-5-3c	Cyanide, Nickel, Chromium, Lead, Total Residual Chlorine (TRC)	*	9/16/1997	6.5	WS-III	03-06-10

*TMDL reductions for the parameters of concern have been implemented through the addition of water quality-based effluent limitations in the affected NPDES permits in the watersheds listed. All of the associated dischargers have complied with the added NPDES permit limits. The NPDES permitting branch will continue to ensure compliance through their standard permitting practices and will add or modify limits and monitoring requirements where Reasonable Potential Analyses (RPAs) show they are necessary to maintain compliance with instream water quality standards for the protection of human health and aquatic life.

TMDL Webpage and Map

Voluntary restoration or protection WAPs are developed in a similar manner as TMDLs and management strategies, however, due to the voluntary nature of these plans, EPA does not approve them for removal from the 303(d) list if the waterbody/parameter is exceeding criteria. The Cape Fear River Basin has three approved WAPs located in the Deep River subbasin, the Haskett Creek WAP in the Haskett Creek-Deep River subwatershed (HUC12: 030300030110) developed for benthos, 2021 Richland Creek WAP in the Richland Creek subwatershed (HUC12: 030300030103) developed for fecal coliform bacteria, and the most recent is the 2024 Loves Creek Watershed Restoration and Protection Plan developed to restore water quality and aquatic habitat for benthic and fish communities and while providing sustainable recreational and economic opportunities (*Table 7-14*).

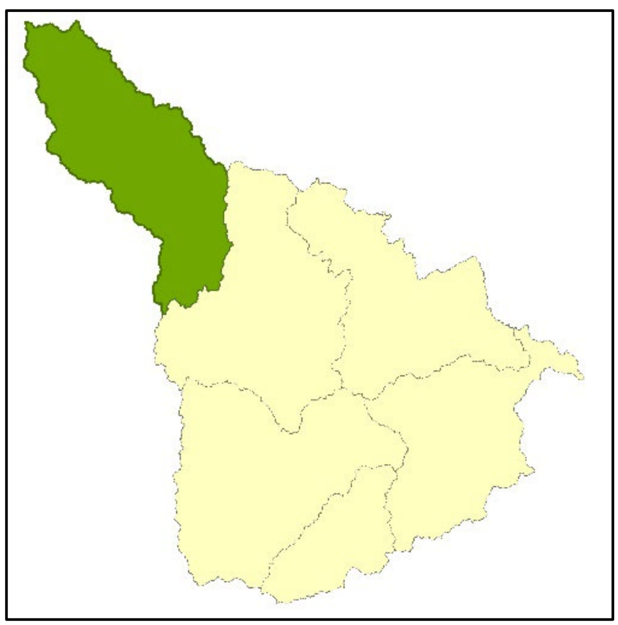
Table 7-14: Deep River Subbasin Watershed Plans

HUC8	HUC12	Watershed Plan	Plan Year	Plan Developer(s)
03030003	0010, 0020, 0050	Upper and Middle Rocky River Watershed 9-Element Checklist	2015	Triangle J Council of Governments
03030003	0110	Haskett Creek Watershed Plan	2020	Piedmont Triad Regional Council
03030003	0503	Loves Creek Watershed Restoration and Protection Plan (Website)	2024	See Plan for details
03030003	0501, 0502, 0503	Upper Rocky River Watershed Restoration and Protection Plan – under development		
Nine-Element/Watershed Restoration Plans Website and Interactive Map.				

7.7 Water Quality on the Watershed Scale (HUC 10)

To determine the source of pollutants in a watershed, it is useful to evaluate them on a smaller scale. Smaller-scale evaluations can also help identify where monitoring and restoration is needed or being conducted. North Carolina assigns numbers to surface waterbodies. For water quality assessment purposes, these numbers are referred to as assessment unit numbers (AU#). A letter attached to the end of the AU# indicates that the assessment unit has been segmented, or broken into smaller pieces, to target the water quality assessment and the data associated with it. AU#s that have water quality data associated with them are discussed here on a watershed (HUC 10) scale. Not all stream segments are monitored by DWR. DWR does, however, value qualitative information from stakeholders throughout the basin to understand what is impacting water quality in a particular area. Information provided by stakeholders is incorporated into each watershed along with recommendations to protect and improve water resources in the watershed.

7.7.1 Headwaters Deep River (0303000301)



The Headwaters Deep River watershed contains the mainstem Deep River formed by the confluence of several smaller waterways including West Fork Deep River, East Fork Deep River, Richland Creek, Muddy Creek, Haskett Creek, and Penwood Branch.

The Town of Jamestown is the only municipality fully within the watershed. Randleman, Asheboro, Archdale, Kernersville, Greensboro, High Point and Pleasant Garden are all partially in the watershed. The most common land use is forest (37%; *Table 7-6*). There are seven miles of designated HQW in this watershed.

As of 2022, there were three major and 24 minor NPDES wastewater facilities with a combined as-built discharge of approximately 36.99 million gallons per day (MGD). The major NPDES dischargers are the City of High Point's Eastside WWTP (NC0024210; 26 MGD), the City of Randleman's WWTP (NC0025445; 1.745 MGD), which discharges to the Deep River, and the City of Asheboro's WWTP, which discharges to Haskett Creek (NC0026123; 9 MGD). AFO facilities include four state cattle, one state swine, and one animal individual state permit.

There are also 85 NPDES and three state stormwater facilities and 165 acres of non-discharge wastewater irrigation and residual solids land application fields in this watershed. Most of the field acreage is for the application of residual solids, which are associated with the Randleman WWTP (WQ0004825; 103.8 acres) and the Asheboro WWTP (WQ0001684; 57.6 acres). The remaining four acres are associated with small wastewater irrigation permits for the Colonial Pipeline wastewater treatment facility (WWTF) (WQ0006317; 3.69 acres) and the Colfax Furniture WWTF (WQ0019095; 0.39 acres).

7.7.1.1 East Fork Deep River

The East Fork Deep River [AU#: 17-2-(0.3)a, 17-2-(0.3)b, and 17-2-(0.7)] is a headwater tributary classified as WS-IV* and WS-IV*, CA. This waterway flows from the source to the inlet of High Point Lake (also known as City Lake), a drinking water supply for High Point. The 14.8 square mile drainage area is located entirely within Guilford County, draining parts of Greensboro and High Point. The (*) symbol identifies waters that are within a designated Critical Supply Watershed and are subject to a special management strategy specified in 15A NCAC 2B .0248.

The East Fork Deep River was placed on the 2002 list of impaired waters for turbidity and fecal coliform bacteria. This was followed by an approved TMDL in March 2004 for both turbidity and fecal coliform bacteria. Notably, the turbidity standard was not used to develop the TMDL because turbidity is not a concentration and cannot be directly converted into a load reduction as required for a TMDL. Total suspended solids (TSS) were used as a surrogate measure for the development of the TMDL target and limits (*East Fork Deep River TMDL*). The turbidity TMDL covers the entire length of the East Fork Deep River from the source to the inlet for High Point Lake.

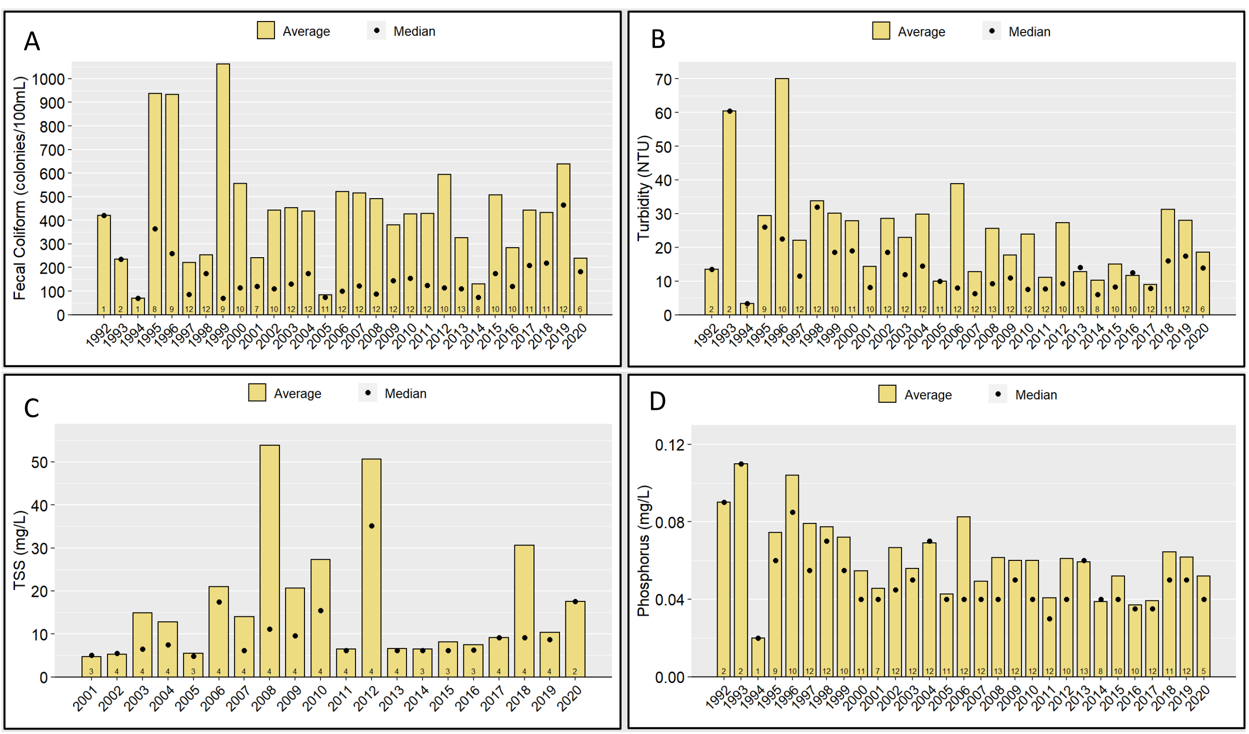
The land cover in this watershed has changed significantly since the early 1990s when most of this watershed was predominantly forest and agriculture. In recent years, much of this area has been converted to urban residential and commercial land uses. An assessment of the watershed land cover using United State Geological Surveys North Carolina StreamStats program, indicated that the "percent of area covered by all densities of developed land" changed from 16.3% in 1992 to 70% in 2019 (using the National Land Cover Dataset). This type of change in land cover often results in increased stormwater runoff, as well as increased stream peak flow and velocity, resulting in not only the transport of sediment and other pollutants from the land but also an increase in stream bank erosion.

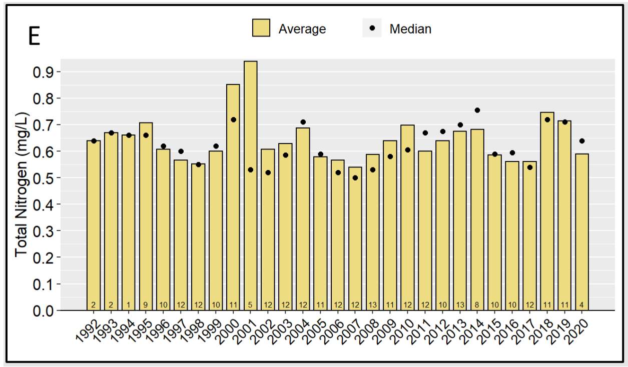
Overall, fecal coliform bacteria values fluctuated over time with multiple years that have a mean value above 400 colonies/100 mL based on data collected at ambient surface water quality station B4240000 on the East Fork Deep River (*Figure 7-15A*). Since approval of the TMDL, approximately 26% (29 out of 112) of samples exceeded the 400 colonies/100 mL water quality standard and several years (2006, 2007, 2008, 2012, 2015, 2018, 2019) recorded at least three samples that exceeded the fecal coliform bacteria water quality standard. The year 2019 was exceptional with 58% (7 out of 12) of samples exceeding the water quality standard.

Similarly, turbidity and TSS levels have fluctuated over time. Approximately 14% (16 out of the 113) of turbidity samples recorded instantaneous values that exceeded that 50 NTU water quality standard since approval of the TMDL. Since 2004, several years (2004, 2006, 2012, 2018 and 2019) had at least two samples which recorded turbidity values that exceeded the water quality standard. These elevated values are observable in the elevated annual mean values which approach or exceed 30 NTU (*Figure 7-15B*). The estimated median TSS for the turbidity standard is 23 mg/L TSS. The TSS results suggest only 2018 had a median value that exceeded 23 mg/L, based on quarterly sampling (*Figure 7-15C*).

Annual mean nutrients (phosphorus and total nitrogen) concentrations have generally declined since the early 1990s, while during the 2016 to 2020 time frame, values typically hovered around concentrations considered normal for healthy Piedmont streams (TP $\leq$ 0.05 mg/L; TN $\leq$ 0.8 mg/L) (*Figure 7-15D* and *Figure 7-15E*). DWR conducted a screening level Mann-Kendall trend test and found a seasonal increasing trend in fecal coliform bacteria and an insignificant non-seasonal trend in turbidity at station B4240000 on East Fork Deep River calculated at 95% confidence for data collected from 2000-2019. *The DWR should consider increasing sampling of TSS from a quarterly frequency to a monthly frequency at station B4240000 to assess the concentration of TSS in the East Fork Deep River.*

Figure 7-15: AMS Station B4240000 Mean and Median Fecal Coliform Bacteria, Total Nitrogen, Total Phosphorus, Turbidity, and Total Suspended Solids between 1992-2020.



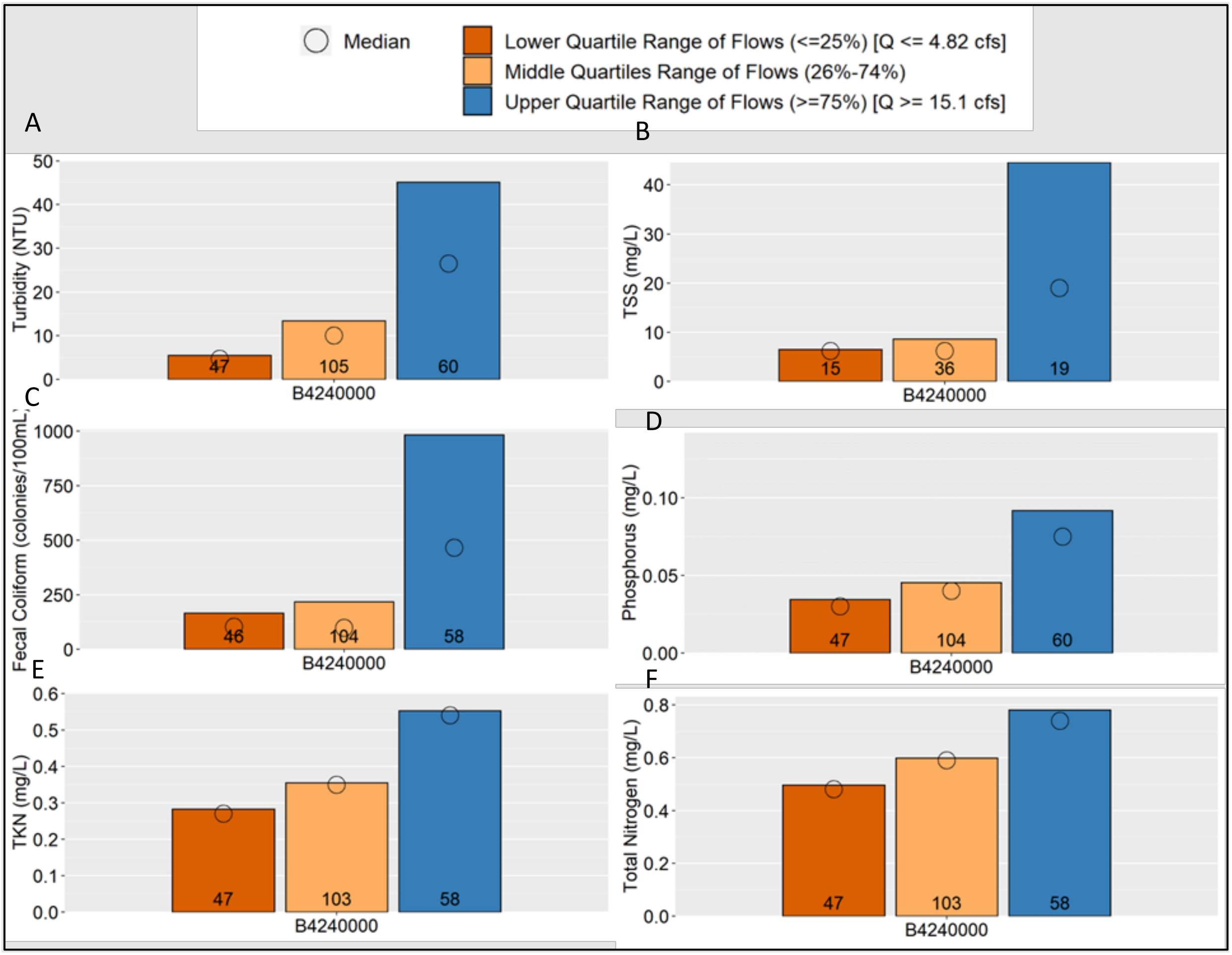


The increased transport of sediment during increased flow periods is suggested based on the water quality data at station B4240000 and the co-located US Geological Survey gage (02099000) on the East Fork Deep River. Based on data collected between 2002 and 2020, higher turbidity, TSS, fecal coliform bacteria, and total phosphorus values are typically recorded during higher flows (≥15.1 cfs) while lower values were observed during lower flows (≤4.82 cfs) (*Figure 7-16*). This suggests stormflow is mobilizing sediment and fecal coliform bacteria from the landscape and ultimately flows into the East Fork Deep River. The increased phosphorus concentrations could be the result of legacy phosphorus bound to sediment being transported by stormflows. Similarly, total Kjeldahl nitrogen concentrations are typically higher during higher flows and lower during lower flows, causing higher total nitrogen levels in the East Fork Deep River as total Kjeldahl nitrogen is the primary species of nitrogen in the total nitrogen signature for the East Fork Deep River (*Figure 7-16*). *Implementing stormwater best management practices, where appropriate, could help improve water quality impacts, especially during periods of elevated streamflow.*

In addition to fecal coliform bacteria and turbidity, a section of the East Fork Deep River [AU# 17-2-(0.3)b] is listed as Impaired for stressed benthos since the 2016 Integrated Report. There are four benthos community sites (BB414, BB313, BB312, and BB087) along this waterway that have been sampled at least once since 2003, however only one station (BB312) has been consistently sampled over multiple years. In addition to sampling on the East Fork Deep River, an unnamed tributary was sampled (BB115) and received a Not Impaired bioclassification. The most upstream station (BB414) on the East Fork Deep River rated as Good-Fair while the remaining stations along the East Fork Deep River have been rated as Fair.

Benthos sampling site BB312 on the East Fork Deep River drains urbanized western portions of the Greensboro into High Point Lake. Land cover in the drainage area is mostly developed with a high percentage of impervious surface resulting from mostly residential and industrial development. This sampling location has consistently received a Fair benthic bioclassification since sampling began at this site, except for the Good-Fair benthic bioclassification in 2008. EPT richness and the NC Biotic Index (NCBI) have all remained consistent since 1993. *High amounts of sedimentation and severe erosion along with limited riparian zones were noted in 2018. High flows and scour prior to the 2018 sample along with increased nonpoint source pollution runoff could have negatively affected the benthic fauna similar to conditions observed and reported in 2003. Field staff recommend that sampling should continue to be conducted in this stream to monitor conditions.*

Figure 7-16: Average and Median Values for Water Quality Data Collected at Station B4240000 between 2002 and 2020 Separated into Flow Bins based on Discharge Percentiles using Data Collected between 1991 and 2020 at USGS Gage 02099000.



7.7.1.2 Long Branch

BB087	
Year	**Bioclassification**
2003	Fair
BF100	
2004	Fair

Long Branch [AU#: 17-2-1-(1) and 17-2-1-(2)] is an urbanized watershed draining parts of western Greensboro and is classified as WS-IV* and Critical Area (CA). The headwaters flow underneath Fordham Boulevard and Interstate-73, and through the Martin Marietta Pomona Quarry and residential areas before emptying into High Point Lake. Further downstream, Long Branch flows through moderately dense residential development, although stream buffers appear to be more intact in this reach. There are eight minor wastewater discharge permits in the watershed, all associated with a petroleum storage facility, and seven NPDES stormwater discharge permits, associated with the petroleum storage facility and the quarry and related companies. The entire length of the stream is considered Impaired for stressed benthos and fish. A 2003 special study site (BB087) was established to analyze benthos in Long Branch. This study resulted in a Fair bioclassification, with an EPT BI of 5.53 and an overall biotic index score of 6.55. A 2004 fish community analysis at site BF100 resulted in a bioclassification of Fair because of poor habitat conditions. *Urbanization, habitat disturbances, heavy* *industrial land use, as well as point and non-point sources of pollution are likely contributing to biological impacts. A localized investigation of the potential point and nonpoint sources of pollution is recommended along Long Branch. Additionally, when resources allow sampling should continue to be conducted in this stream to monitor conditions.*

7.7.1.3 West Fork Deep River and Oak Hollow Reservoir

The headwaters of the West Fork Deep River [AU#: 17-3-(0.3)] serve as a source stream for Oak Hollow Lake reservoir [AU#: 17-3-(0.7)a and 17-3-(0.7)b] that drains west central Guilford County. This waterway is classified as WS-IV* and picks up the additional classification of CA as it approaches the inlet to Oak Hollow Lake reservoir. Development from growth in Kernersville is increasing in the headwaters, but the lower parts of the catchment area remain relatively forested or suburban, which may help mitigate nonpoint source runoff. There are three minor wastewater discharge permits in the drainage, all of which are single family wastewater systems. Five active NPDES stormwater permits affiliated with Amazon, FedEx distribution facilities and a ready-mix concrete company are in the drainage. The AU is impaired for stressed benthos and fish.

The West Fork Deep River benthos site (BB333) and fish site (BF120) are co-located at Sandy Ridge Road (SR 1850), on the northern end of Squire Davis Park in High Point. The West Fork is a source stream for the Oak Hollow Lake reservoir and is a moderately urbanized landscape. Field staff noted during 2008 and 2018 benthos sampling events that the sampling location is characterized by homogenous sandy substrates and a lack of riffle and pool habitats.

BB333	
Year	**Bioclassification**
2003	Good-Fair
2003	Good-Fair
2008	Good-Fair
2013	Fair
2018	Fair

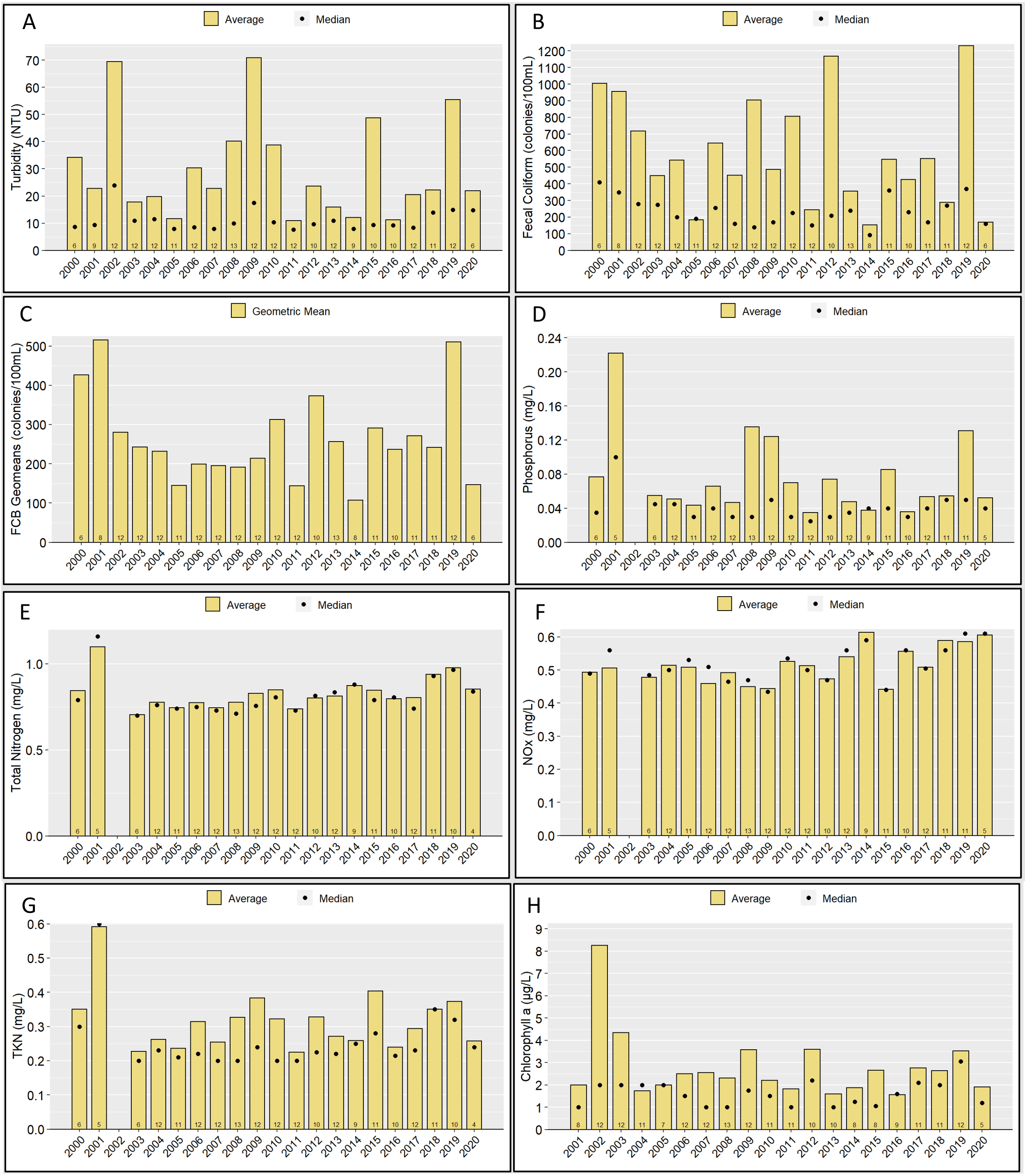
In 2008, the benthos basinwide sample was taken less than one mile downstream due to the presence of a beaver dam, but a low benthos habitat score, 50 of 100, was also recorded at this alternate location, due primarily to poor habitat. In 2013 and 2018, the station was sampled for benthos at its original location. It received a Fair bioclassification score both years. Biologists noted in 2018 that EPT richness remained consistent with previous samples taken in the early summer season. There were relatively few caddisflies (*Trichoptera*) collected in 2018, with representatives from only two families (*Hydropsychidae* and *Philopotamidae*). The habitat score at this location in 2018 was 55 of 100 due to a lack of instream habitat, including poor riffle and pool habitats in addition to a homogenous sandy substrate.

Oak Hollow Lake, also known as High Point Reservoir, was constructed by High Point as a second water supply reservoir. This lake has been monitored 23 times prior to the 2007, 2013, and 2018 sampling events. Nutrient concentrations for Oak Hollow Lake have been similar for this reservoir over the past three rounds of sampling (2007, 2013, and 2018) and are discussed in-depth in the Lake and Reservoir Assessments Cape Fear River Basin (Reports, Publications and Data | NC DEQ). Based on the calculated North Carolina Trophic Status Index (NCTSI) scores for the most recent three sampling events (2007, 2013, and 2018), Oak Hollow Lake exhibits elevated biological productivity (eutrophic conditions). Nuisance algal blooms are common, and in 2007, a forced air destratification system was in place to help improve the dissolved oxygen levels in the lake. Analysis of algae samples collected by staff at Oak Hollow Lake indicated that an algae bloom in September 2007 was dominated by the blue-green algae, *Cylindrospermopsis sp*. This alga is commonly associated with nutrient-rich waters and is responsible for taste and odor problems in drinking water.

During the past three monitoring rounds (2007, 2013, and 2018) water clarity based on Secchi depths ranged from less than one meter to 1.3 meters. This lake was listed on the 2006 303(d) list of impaired surface waters for turbidity values greater than the state's water quality standard of 25 NTU. Since then, this lake has been removed and is currently not listed as impaired for turbidity. Notably, annual mean and median turbidity values recorded at the AMS station B4210000 suggests that values approach and exceed 20 NTUs, however, the separation between the annual mean and median values suggests elevated pulses of turbidity are occurring in this waterway (*Figure 7-17A*). Land use in the watershed of AMS Station B4210000 shows that there has been a decline in both forested and agricultural land uses since 2001 while developed land use has steadily increased.

Fecal coliform bacteria annual mean and median values typically approach and exceed 400 colonies/100 mL and geometric mean values typically exceed 200 colonies/100 mL. This suggests water quality monitoring results frequently exceed the water quality standard during routine ambient sampling (*Figure 7-17B* and *Figure 7-17C*), although a 5-in-30 study has not been conducted, so the segment is not impaired. Notably, nutrient concentrations (total phosphorus and nitrogen) at the inlet to Oak Hollow Lake from West Fork Deep River typically hover around the concentrations considered normal for healthy piedmont streams (TN $\leq$ 0.8 mg/L and TP $\leq$ 0.05 mg/L) with a few annual mean values that exceeded these concentrations (*Figure 7-17D* and *Figure 7-17E*). While the total nitrogen concentrations are typically normal for healthy Piedmont streams, nitrate + nitrite concentration are typically higher than concentrations considered normal for healthy Piedmont streams (NOx $\leq$ 0.3 mg/L) (*Figure 7-17F*). Total Kjeldahl nitrogen and chlorophyll a concentrations at the inlet to Oak Hollow Lake are typically low (*Figure 7-17G* and *Figure 7-17H*). DWR conducted a screening level Mann-Kendall trend test and found a seasonal increasing trend in nitrate+nitrite. In addition, the test found a non-seasonal increasing trend in specific conductance and total Kjeldahl nitrogen at station B4210000 on the West Fork Deep River, calculated at 95% confidence for data collected from 2000-2019. <u>*Installing stormwater BPMs can help reduce runoff high in nutrients and sediment. Identifying and repairing failed septic systems, single family wastewater discharges, and straight pipes and excluding livestock from streams can reduce inputs of fecal coliform bacteria. Updating local ordinances can also help protect the watershed from additional nutrient, fecal coliform bacteria and sediment contributions.*</u>

Figure 7-17: AMS Station B4210000 Mean and Median for Turbidity, Fecal Coliform Bacteria, Total Phosphorus, Total Nitrogen, Nitrate+Nitrite, Total Kjeldahl Nitrogen, and Chlorophyll a *from 2000 – 2020.*



7.7.1.4 Bull Run

BF13	
Year	Bioclassification
2004	Good-Fair
2009	Good-Fair
BF30	
2003	Good-Fair

Bull Run [AU#: 17-5-(1) and 17-5-(2)] is a tributary of Deep River that flows through the southwestern part of Greensboro and has headwaters dominated by a large shopping center. As Bull Run flows downstream, it passes through several suburban developments, although it has a continuous, sometimes narrow, wooded buffer. It has been impounded to create a small lake in the Adams Farm housing development. After the stream exits the neighborhood, it passes through a relatively large and intact wooded buffer until its confluence with Deep River just upstream of Harvey Road in Oakdale. There is one NPDES stormwater permit in the watershed that is associated with a polyurethane manufacturer. Bull Run carries the classification of WS-IV* and CA and is therefore a critical area water supply watershed for the Randleman watershed and subject to the Randleman rules. Fish community analyses at both sampled sites, BF13 and BF30, on Bull Run rated Good-Fair at every sampling event since 2003. *When resources allow sampling should continue to be conducted in this stream to monitor conditions.*

7.7.1.5 Richland Creek

Richland Creek [AU#: 17-7-(0.5) and 17-7-(4)] flows 9.0 miles from its headwaters in southern High Point to Randleman Reservoir, draining approximately 16 mi^2. This waterway is classified as a WS-IV* and picks up an additional CA classification as it approaches Randleman Reservoir. The entire length of Richland Creek is Impaired due to Fair fish bioclassification and fecal coliform bacteria standard violations. According to the 2004 EPA approved Richland Creek fecal coliform bacteria TMDL, the watershed can be divided roughly into two halves: the urban, upstream portions, and the rural, downstream portion, and this remains accurate. The 12.4 mi^2 drainage area flowing to station B4380000 is about 79% developed, up from 76% in 2001, while forested and agricultural lands have both declined slightly. The urban sources of fecal coliform loading include domestic animal feces and wildlife such as geese that populate the golf courses. The rural downstream sources may include domestic animals, agricultural practices or wildlife.

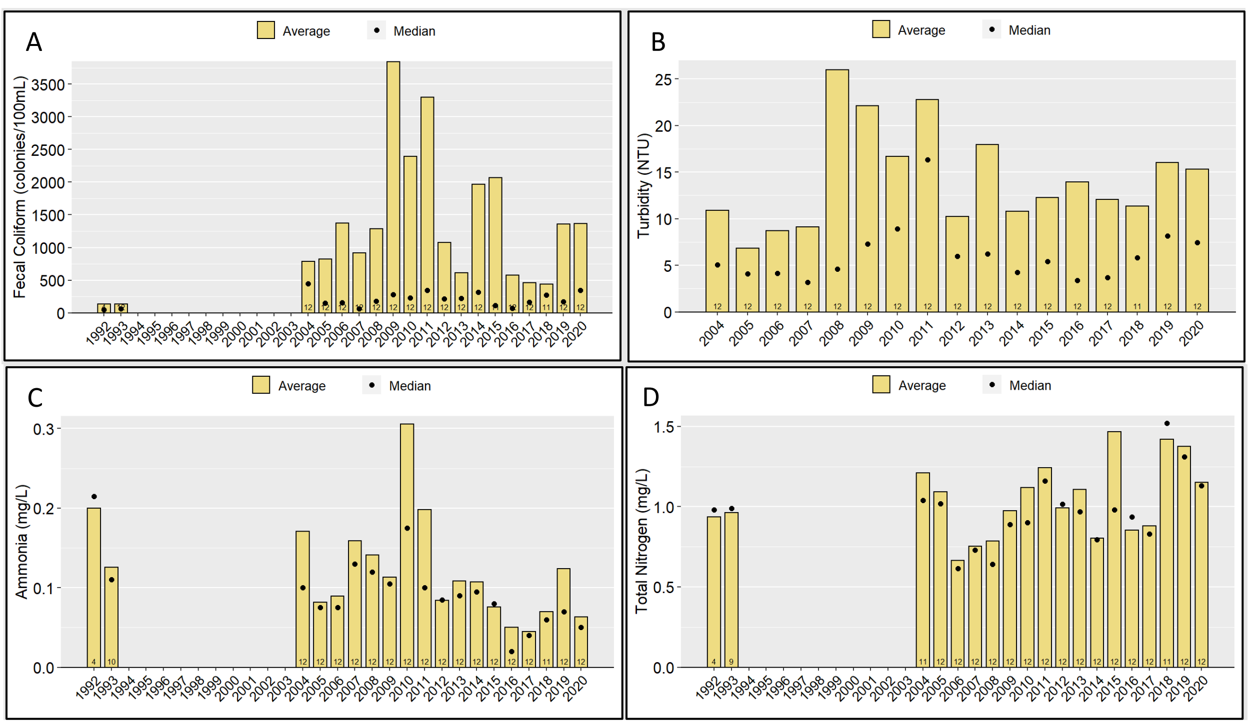
The data collected at ambient surface water quality monitoring station B4380000 is maintained by UCFRBA. This monitoring station is positioned upstream of the High Point Eastside WWTP outfalls which discharge their return flows. While UCFRBA does have monitoring stations upstream of the facility, on both Richland Creek (Station B4380000) and Deep River (Station B4350000), the nearest downstream monitoring station (Station B4770500) is 14 miles downstream with multiple dischargers in between. *When time and resources allow, DWR should work with the Upper Cape Fear River Basin Association (UCFRBA) to find an ambient surface water quality monitoring station downstream of the effluent discharge to understand any potential downstream impacts from the High Point Eastside WWTP.*

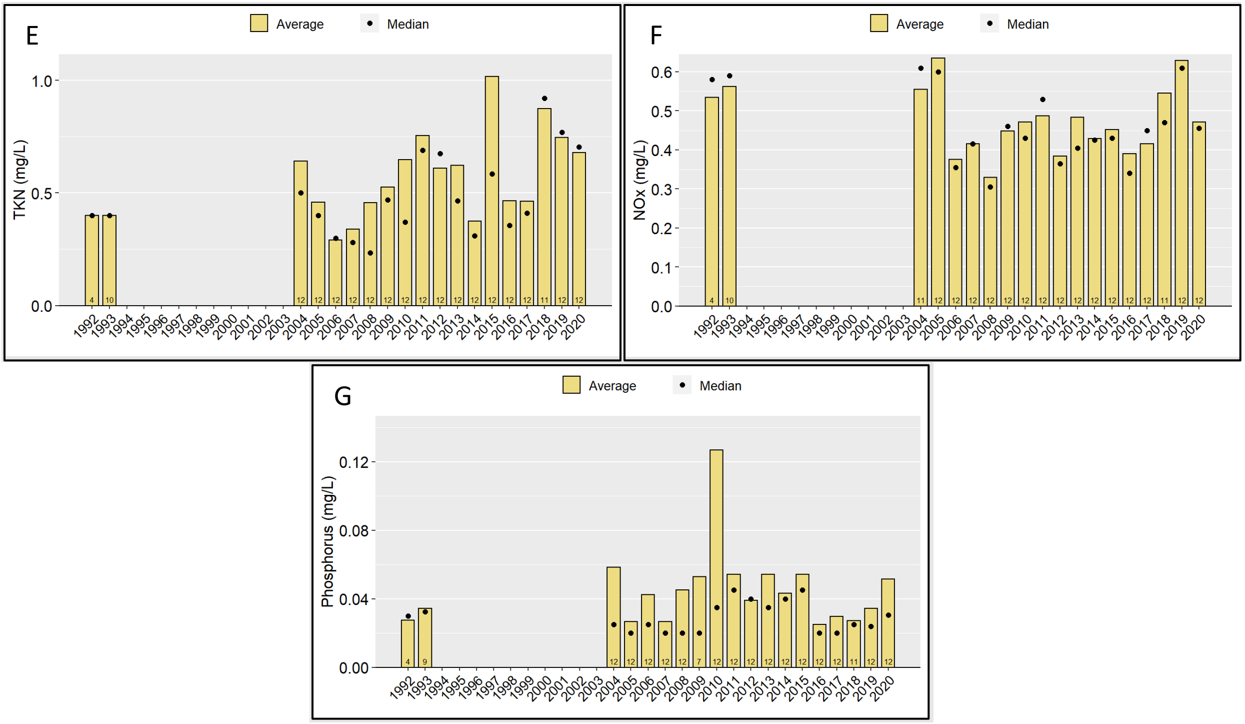
This station often records elevated fecal coliform bacteria concentrations with annual mean and median values that approach and exceed the 400 colonies/100 mL (*Figure 7-18A*). Historically, high fecal concentrations at the now-inactive Baker Road ambient station (B4378000) indicated that urban sources in the headwaters were contributing to the impairment of Richland Creek. The TMDL indicated that sewer pipe leakages in the High Point sanitary sewer collection system were likely the cause of low flow fecal coliform bacteria exceedances as they contributed high loads during periods where there was minimal amount of stream flow to dilute their contributions. Notably, annual mean and median turbidity values recorded at the AMS station B4380000 suggest that values approach and exceed 20 NTUs; however, the separation between the annual mean and median values suggests elevated pulses of turbidity are occurring in this waterway (*Figure 7-18B*).

Ammonia concentrations are notably higher than concentrations considered normal for healthy Piedmont stream (<u><</u>0.05 mg/L) (*Figure 7-18C*). Exfiltration or leaky sewer systems can occur in areas with inflow and infiltration (I&I) problems and likely contribute to elevated levels of fecal coliform and ammonia. Notably, the annual mean and median total nitrogen concentrations are elevated above concentrations considered normal for healthy Piedmont streams (TN ≤ 0.8 mg/L) during certain years (*Figure 7-18D*). This is the combined result of total Kjeldahl nitrogen and nitrate+nitrite concentrations (*Figure 7-18E* and *Figure 7-18F*). During most years, annual mean and median total phosphorus concentrations are around or below the concentrations considered normal for healthy Piedmont streams (TP ≤ 0.05 mg/L) (*Figure 7-18G*).

The downstream, rural portion of the watershed likely contributed less to the fecal coliform impairment. The downstream portion has a fairly contiguous forested buffer that should remain in place due to buffer rule requirements as part of the Randleman Lake Watershed Nutrient Reduction Strategy. A load-duration curve for the existing and target conditions was evaluated, and it was determined that an 83% reduction was needed to meet the TMDL endpoint. The target is an instantaneous limit of <360 cfu/100 mL. For additional information see the fecal coliform TMDL for Richland Creek.

Figure 7-18: AMS Station B4380000 Average and Median Fecal Coliform Bacteria, Turbidity, Ammonia, Total Nitrogen, Total Kjeldahl Nitrogen, Nitrate+Nitrite, Total Phosphorus from 1992-2020.





There is also one major NPDES permitted facility (High Point Eastside WWTP, Permit#: NC0024210) that historically discharged into Richland Creek. High Point Eastside WWTP has stopped its discharge to Richland Creek, and the outfall is currently only used as an emergency outfall when the primary outfall returning flows to the Deep River cannot be used. High Point Eastside WWTP (NC0024210) received an authorization to construct (ATC) permit in October 2003 to upgrade and increase their effluent discharge from 16 to 26 MGD. Construction was completed in April 2004. As required by the Randleman Lake strategy, improved effluent limits were based on a nutrient response model that allowed for a year-round TP limit of 0.5 mg/L--as a monthly average concentration--and a TN of 6 mg/L during the summer, April to October. The upgrade included Biological Nutrient Removal (BNR) to reduce nutrients in their effluent.

In April 1999, the *Randleman Lake Waters Supply Watershed: Nutrient Management Strategy* (15A NCAC 02B .0720-.0724) was put in place to protect this water supply reservoir from becoming impaired due to excess nutrient loading. Construction of the Randleman Dam began in 2001, and the reservoir was filled in 2007. Located in Randolph and Guildford counties, this reservoir provides drinking water for North Carolina's Piedmont Triad Region and is managed by the Piedmont Triad Regional Water Authority (PTRWA). Per rule, "there shall be no new or expanding permitted wastewater discharges in the watershed with the exception that the City of High Point Eastside Wastewater Treatment Plant may be allowed to expand provided that any new permit contain concentrations and mass limits predicted through water quality modeling or other analysis that shows to the Director [of DEQ] that discharges will provide a level of water quality in the Randleman Lake that meets all designated uses of those waters" [15A NCAC 02B .0722 (c)].

In 2022, High Point Eastside WWTP requested an expansion to 32 MGD and has submitted a Water Quality Analysis Simulation Program (WASP) model and report to NPDES. DWR's Modeling & Assessment Branch

(MAB) is working with NPDES to review the model and the expansion request. MAB and NPDES are continuing to work with High Point to review and reevaluate the model. Because Randleman Lake continues to be impacted by excess nutrients, no additional loading from the High Point Eastside WWTP will be permitted without clear modeling results that show no degradation to Randleman Lake and to downstream designated uses. See section 7.7.1.13 later in this chapter for more information on Randleman Lake. _Recommendations from the TMDL to achieve the required fecal coliform bacteria levels include increased emphasis on identification and repair of aging sewer and septic systems, minimization of SSO events, and review of current agricultural manure control practices._

7.7.1.6 Reddicks Creek and Jenny Branch

Reddicks Creek [AU#: 17-8-(0.5)a, 17-8-(0.5)b, and 17-8-(3)] is a WS-IV* classified waterway that picks up the additional CA classification as it approaches the inlet to Randleman Lake. Jenny Branch [AU#: 17-8-2] is a tributary of Reddicks Creek with the WS-IV* classification. These two waterways are both feeder streams of the Hickory Branch arm of Randleman Reservoir. The headwaters of Reddicks Creek flow through high-density residential development, a country club and a golf course and along the southwestern edge of Greensboro. There are inline ponds on both branches of the tributaries that come together. Reddicks Creek does have some backwater influence from Randleman Reservoir before its confluence with Hickory Creek.

BB059	
Year	**Bioclassification**
2003	Fair
BB077	
2003	Good-Fair
BB064	
2003	Fair

Special studies conducted in 2003 resulted in bioclassifications of Fair (Site BB059) and Good-Fair (Site BB077). This AU is designated Category 3a for benthos due to these results. Site BB059 was sampled in 2003 upstream of where Reddicks Creek flows under Interstate 85, and Site BB077 was sampled downstream of I-85. Impacts to benthos in this section of Reddicks Creek are likely due to nonpoint source runoff from the country club's golf course, residential development and the major highway. There are no point source dischargers in the watershed. Large segments of the right fork of the Reddicks Creek headwaters flow through a golf course fairway and appear to have little to no buffer. Downstream of I-85, Reddicks Creek meanders through low-density residential development and appears to have well-forested buffers all the way to its confluence with Hickory Creek. _When resources allow, sampling should continue to be conducted in this stream to monitor conditions._

Jenny Branch is a small tributary of Reddicks Creek. While the headwaters follow I-85, it appears to have an intact buffer. As it flows downstream to its confluence with Reddicks Creek, it flows through low-density residential development and small agricultural operations. Part of the Grandover Resort Golf Club also drains to Jenny Branch. There are no animal feeding operations or other permits in this watershed. A special study at site BB064 was conducted in 2003 and resulted in a Fair bioclassification and a Category 3a designation. _When resources allow, sampling should continue to be conducted in this stream to monitor conditions._

7.7.1.7 Hickory Creek

Hickory Creek [AU#: 17-8.5-(1)a 17-8.5-(1)b, and 17-8.5-(3)] is a feeder tributary to the Hickory Branch arm of Randleman Reservoir, is classified as a WS-IV, and picks up a CA classification as it approaches the inlet to Randleman Reservoir. The watershed includes south-central Guilford County, a part of southern

Greensboro, south of I-85 and east of US 220. The lower portion of the watershed is rural. Hickory Creek's headwaters originate in the I-85/I-73 interchange and are therefore very urbanized with little buffer. As it moves downstream, Hickory Creek flows through an area of light industrial development, including a yard waste facility and a trucking distribution facility. There is also a transfer facility, a demolition and construction landfill, and a ready-mix concrete supplier in the headwaters. After moving out of the industrial area, Hickory Creek flows through a landscape of low-density residential development. Buffers appear to be large and relatively intact all the way to the reservoir. One minor NPDES wastewater discharge permit and related outfall from a mobile home park is located on the mainstem, and a minor NPDES wastewater discharge permit and outfall that serves a small mobile home park is on a small unnamed tributary. There is also one minor non-discharge permit and an associated wastewater irrigation field located within the watershed. A special study was conducted in 2003 that resulted in a Good-Fair bioclassification and a Category 3a designation for benthos.

Hickory Creek [AU #: 17-8.5-(1)a] headwater is Category 3a for benthos based on the results of a special study conducted in 2003 in which a bioclassification of Good-Fair was received at site BB240 and a bioclassification of Fair was received at Site BB060.

BB240	
Year	**Bioclassification**
2003	Good-Fair
BB060	
2003	Fair

Hickory Creek [AU#: 17-8.5-(3)] is impaired for benthos due to basinwide site BB247 receiving a bioclassification of Fair the last time the basin site was sampled in 2013, down from Good-Fair that resulted from the 2003 and 2009 sampling events. A Total Maximum Dail Load (TMDL) stressor study, conducted in April 2003, identified sedimentation, habitat degradation, and urban runoff as the main impacts to this watershed. *When resources allow, sampling should continue to be conducted in this stream to monitor conditions.*

BB247	
Year	**Bioclassification**
2003	Good-Fair
2009	Good-Fair
2013	Fair

7.7.1.8 Muddy Creek

Muddy Creek [AU#: 17-9-(1) and 17-9-(2)] is a WS-IV* classified waterway that picks up the CA classification as it approaches the inlet to Randleman Reservoir. This waterway flows 6.1 miles from its headwaters in northwestern Archdale to its entrance into Randleman Reservoir. The entire length of Muddy Creek is impaired due to turbidity and fecal coliform bacteria standard violations.

According to the 2004 EPA-approved Muddy Creek fecal coliform TMDL, the watershed can be divided roughly into two halves: the urban, upstream portions, and the rural, downstream portion. The data collected by DWR and UCFRBA show an increase in fecal coliform bacteria concentrations during storm events as well as during typical and low-flow periods. Urban sources of fecal coliform loading include leaky sewer systems, septic systems, domestic animal feces and wildlife. The rural downstream sources in the Muddy Creek watershed are likely to include manure applications to cropland, cattle access to the streams or low-density residential areas with pets and septic systems. The watershed is dominated by urban/developed land use (70%), especially in the upper portion, with approximately 24% of that consisting of impervious surface. A load-duration curve for the existing and target conditions was evaluated, and it was determined that an 80% reduction was needed to meet the TMDL endpoint. The target is a geometric mean <180 cfu/100 mL. For additional information see the Fecal Coliform TMDL for

Richland and Muddy Creek, NC. *Recommendations from the TMDL to achieve the required fecal coliform bacteria levels include increased emphasis on identification and repair of aging sewer and septic systems, minimization of SSO events, review of current agricultural manure control practices and eliminating animal access to the creek.*

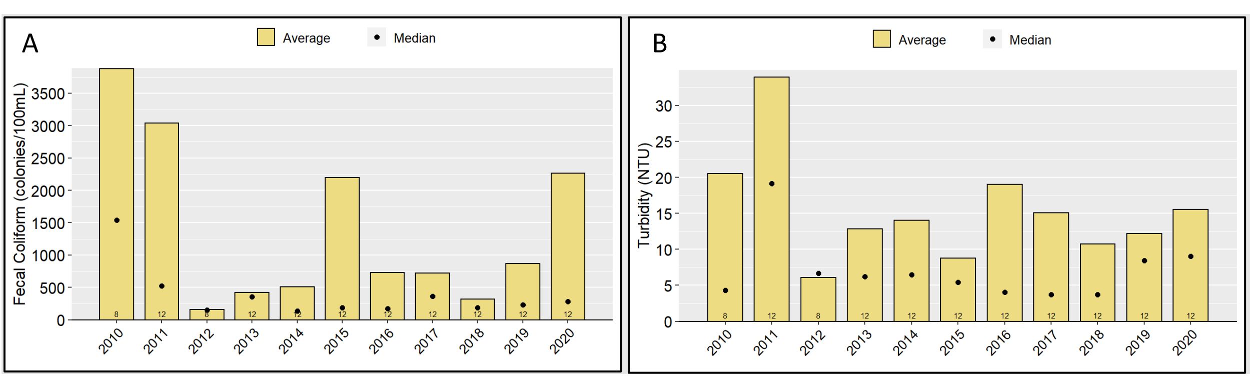
The UCFRBA discontinued station B4625000 in April 2010 due to backwater influences from the reservoir and replaced it with station B4621000 approximately two miles upstream. Since relocation of the surface water monitoring from station B4625000 to B4621000 in 2010, fecal coliform bacteria concentrations typically record annual mean values that exceeded the 400 colonies/100 mL water quality standard during most years (*Figure 7-19A*). There have also been only two years (2012 and 2014) during which less than three monthly samples have recorded values less than 400 colonies/100 mL. Between 2010 and 2020, approximately 35% of samples collected in this waterway have recorded values less than the 400 colonies/100 mL water quality standard.

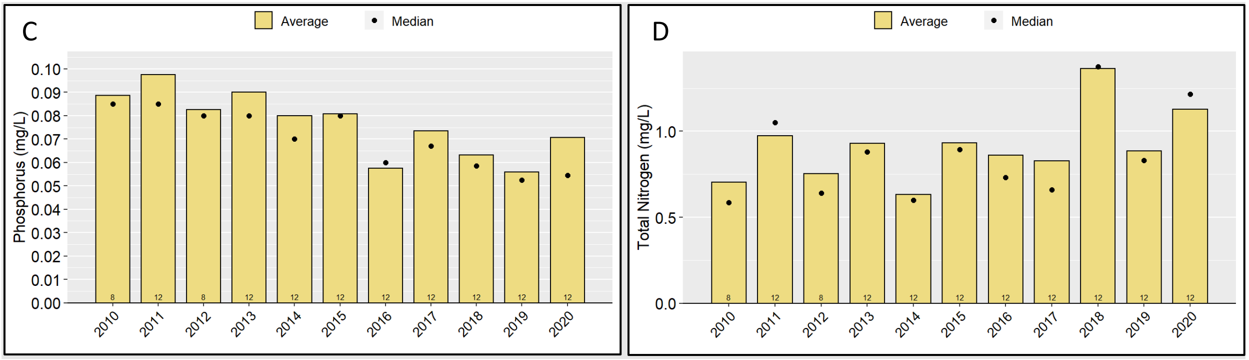
Elevated turbidity values are less frequent in this waterway, with only approximately 6% of the samples exceeding the 50 NTU water quality standard between 2010 and 2020. During this same timeframe, only 2011 had multiple samples (n=2) exceeding the water quality standard. Annual mean and median values are typically lower than 20 NTU; except in 2010 and 2011 (*Figure 7-19B*). Another notable water quality parameter is slightly elevated total phosphorus concentrations that initially had annual mean and median values that were twice the concentration of values considered normal for healthy Piedmont streams (0.05 mg/L); however, in recent years, annual mean values have declined slightly and are now hovering around 0.06 and 0.07 mg/L (*Figure 7-19C*). The annual mean and median total nitrogen concentrations often hover around and slightly above the concentrations considered normal for healthy Piedmont streams (*Figure 7-19D*).

The last time Muddy Creek was sampled for benthos and fish was 2003. At that time, benthos site BB339 received a bioclassification of Fair and fish site BF50 received a bioclassification rating of Good. These sites are co-located and are now inundated by backwater influence from Randleman Reservoir.

BB339	
Year	**Bioclassification**
2003	Fair
BF50	
2003	Good

Figure 7-19: AMS Station B4621000 Mean and Median Fecal Coliform Bacteria, Turbidity, Total Phosphorus, and Total Nitrogen for Data Collected between 1992-2020.





7.7.1.9 Polecat Creek

Polecat Creek [AU#: 17-11-(1)a, 17-11-(1)b, 17-11-(3.5), and 17-11-(5)] has its headwaters south of Greensboro and is classified as WS-III. While the watershed remains relatively rural/suburban, it is clear from aerial imagery that development pressures from Greensboro are already starting to encroach on the upper part of this watershed. As it flows downstream, light suburban development and agricultural land dominate the landscape. The stream appears mostly well buffered, though pastureland does encroach on some riparian areas. There is one animal feeding operation permit, associated with a dairy operation, in the watershed. Polecat Creek is impounded by Lake Nawaka and in its lower reach, receives backwater influence from Randleman Reservoir.

BF53	
Year	**Bioclassification**
2003	Good
2009	Excellent
2013	Good
2018	Good-Fair

Fish community site BF53 is located approximately five miles upstream of Camp Nawaka Lake. Field crew reports indicate that the riparian corridor was thin at the road crossing where the samples were taken, with row crops bordering both upstream margins. Instream habitats were primarily pools and sandy runs, with traces of gravel found in the deepest holes. Vertically cut stream banks, undercut root habitats and small stick riffles could be found within the 600-foot reach. In 2018, there was a large decline in total abundance (78%) as compared with the 2013 sample, including a loss of four species. A higher-than-normal percentage of diseased fish was also observed in 2018 (8.5%), causing a four-point loss in NCIBI score. Overall, a six-point drop in NCIBI score resulted in a rating of Good-Fair in 2018. However, many species had young-of-year present in 2018, including redbreast sunfish, bluegill, flat bullhead, bluehead chub, speckled killifish, whitemouth shiner and highfin shiner. While species richness and the overall abundance of the fish community in Polecat Creek dropped in 2018, the NCIBI trophic metrics (percent omnivores + herbivores, and percent insectivores) have maintained their maximum score of five since the first assessment in 2003. Water quality parameters have also remained stable over basin assessment years. Flow extremes in this entrenched watershed may help explain the decline in 2018, but that remains unclear. *Continued sampling is recommended to determine if the moderately diverse fish community will rebound to its former species richness during the next basin cycle.*

7.7.1.10 Little Polecat Creek

BF99	
Year	Bioclassification
2004	Good

Little Polecat Creek [AU#: 17-11-3] is a waterway classified as a WS-III and High Quality Water (HQW) located near Climax in Guilford County. It is impounded by two farm ponds in its headwaters and flows through a mostly agricultural and forested area with light suburban development. There is one NPDES stormwater permit in the watershed associated with the wood products industry. While there are areas of thin or no riparian buffer, the stream mostly has very good, wooded riparian buffers. Little Polecat Creek empties into Polecat Creek approximately 2.5 miles upstream of Lake Nawaka. The fish community site BF99 is located just downstream of the Providence Road crossing and was sampled in 2004. It received a bioclassification of Good but has not been sampled since.

7.7.1.11 Haskett Creek

Haskett Creek [AU#: 17-12a, 17-12b1, and 17-12-b2] is a Class C waterway located in Randolph County and originates in the city center of Asheboro. It lies within the Carolina Slate Belt ecoregion. Asheboro operates the only major wastewater discharge in this subwatershed and has the capacity to treat up to 9 MGD, although in 2018, it treated an average of 4.17 MGD (City of Asheboro, 2023). There are also 14 active NPDES stormwater permits in the basin for various industrial enterprises, including a ready-mix concrete plant, plastics recycler, metal fabrication companies and others. Haskett Creek is highly impacted by stormwater runoff, resulting in biological integrity impairment throughout the entire watershed. Portions of Haskett Creek [AU#: 17-12a, 17-12b1, and 17-12-b2] are impaired for stressed benthos since 1998 and exceedances of the copper water quality standard [AU#: 17-12-b2] since 2008. Another water quality concern is high nutrients (total nitrogen and phosphorus), mostly influenced by the return flows from Asheboro WWTP, which is affecting the water quality downstream as seen by the chlorophyll *a* impairment in the Deep River [AU # 17-(10.5)d1] below the confluence with Haskett Creek. This segment of the Deep River is impaired for chlorophyll *a* standard violation as result of high concentrations of instream nutrients. The Deep River and associated chlorophyll *a* impairment is discussed in more detail in section 7.7.1.13 below.

The average total nitrogen (TN) concentration for Asheboro's WWTP, based on the five-year period between 2016 and 2020, was approximately 14.82 mg/L. These concentrations have not declined considerably since 2000 (*Figure 7-20*). The primary species of nitrogen in their return flows contributing to these elevated total nitrogen concentrations is nitrate+nitrite, compared to total Kjeldahl nitrogen (*Figure 7-21*). Notably, total phosphorus (TP) concentrations in this facility's return flows have declined considerably since 2000, with the 2016 to 2020 average concentrations of approximately 0.40 mg/L (*Figure 7-22*). This facility does not currently have TN or TP limits in its NPDES permit, and permitted flow is well below the 9 MGD permitted flow (*Figure 7-23*). As the city grows, an overall increase in nitrogen loading is possible. This will likely change in the future as modeling of the watershed determines the appropriate instream waste load that this segment of the Deep River can appropriately assimilate and protect and maintain water quality standards in the Deep and Cape Fear rivers.

Figure 7-20: Monthly Average Concentrations for Total Nitrogen at Asheboro WWTP from 2000 – 2022.

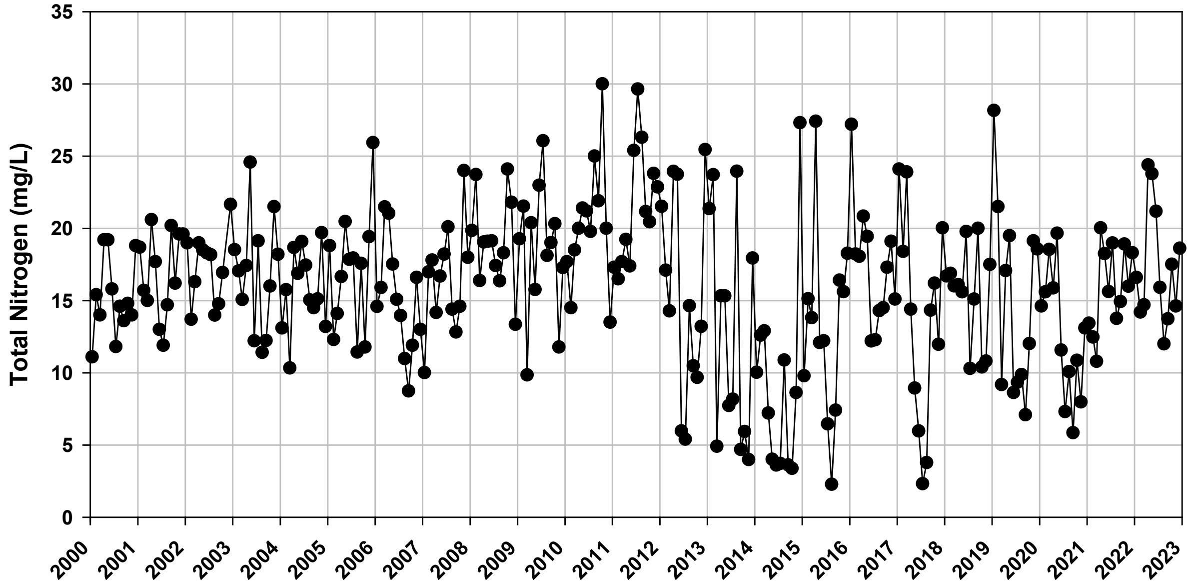


Figure 7-21: Monthly Average Concentrations for Total Nitrogen, Ammonia, Nitrate+Nitrite, and Total Kjeldahl Nitrogen at Asheboro WWTP from 2000 – 2022.

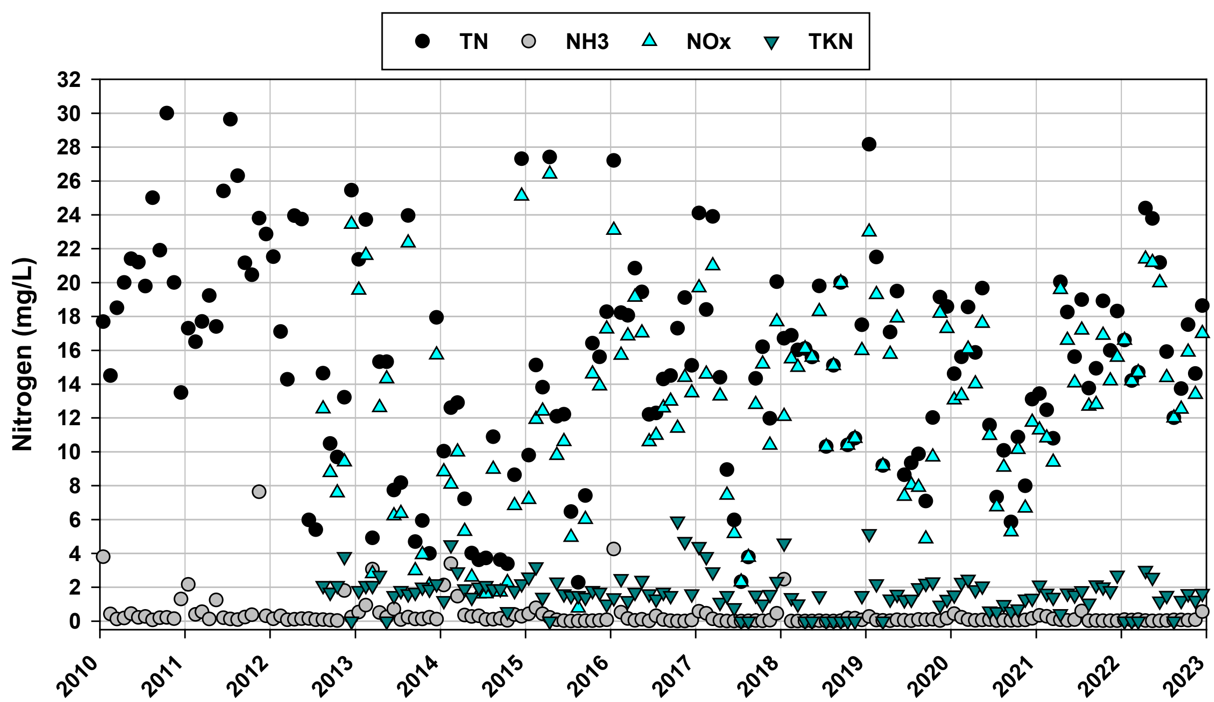


Figure 7-22: Monthly Average Concentrations for Total Phosphorus at Asheboro WWTP from 2000 – 2022.

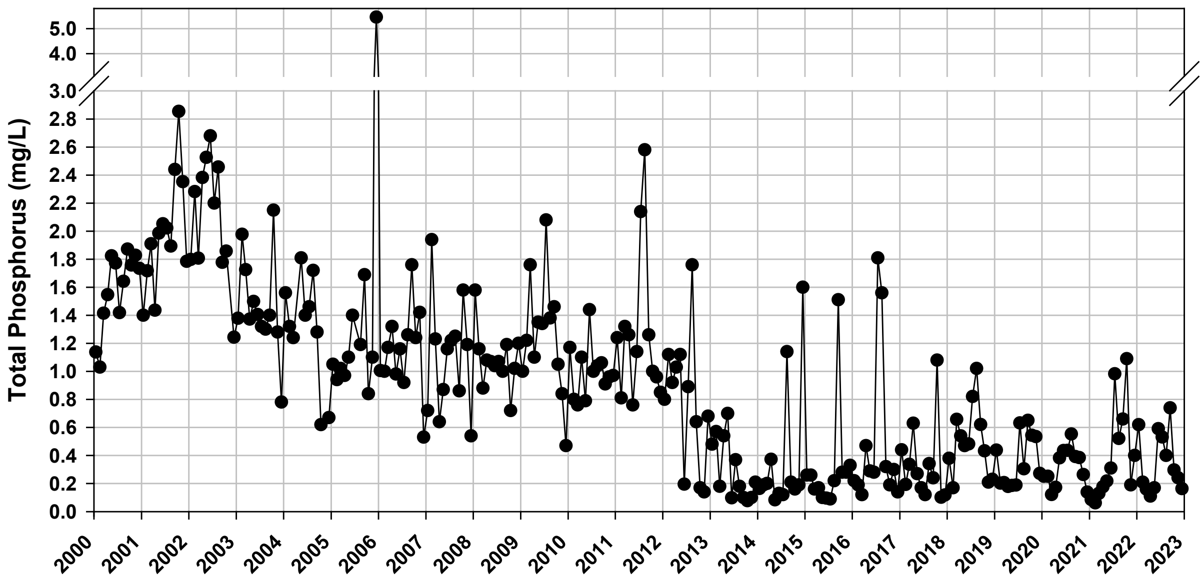
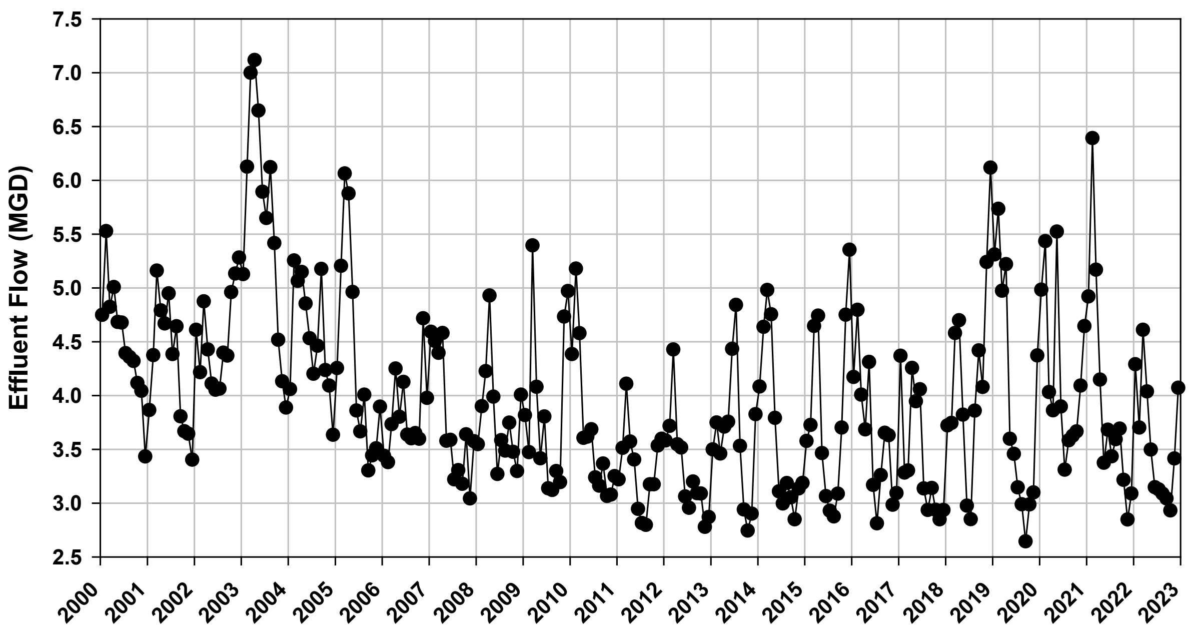


Figure 7-23: Monthly Average Return Flows from Asheboro WWTP from 2000 – 2022.



The headwaters of Haskett Creek [AU # 17-12a] are impaired for biological integrity based on a special study conducted at benthic sites BB135 and BB137 in 2003, resulting in a bioclassification of Poor at both sites. A special study conducted at benthic site BB302 in 2003 and 2006 produced a bioclassification of Poor in both sampling events. The results indicated that conditions had declined somewhat from the previous biological assessments conducted in 1987, 1988, 1990 and 1998. The biologist found the benthic community to be very sparse, which did not allow for a clear determination of the key stressors. They did suggest that low flows and instream water quality were likely the factors that influenced the results. Habitat scores were relatively high although there was evidence of habitat degradation likely due to stormwater runoff, stream bank erosion, altered hydrology, inadequate riparian areas and channelization. The biologist did indicate that the WWTP likely contributed to an additional decline in the invertebrate community below the discharge location.

BB135	
Year	**Bioclassification**
2003	Poor
BB137	
2003	Poor
BB302	
2003	Poor
2006	Poor

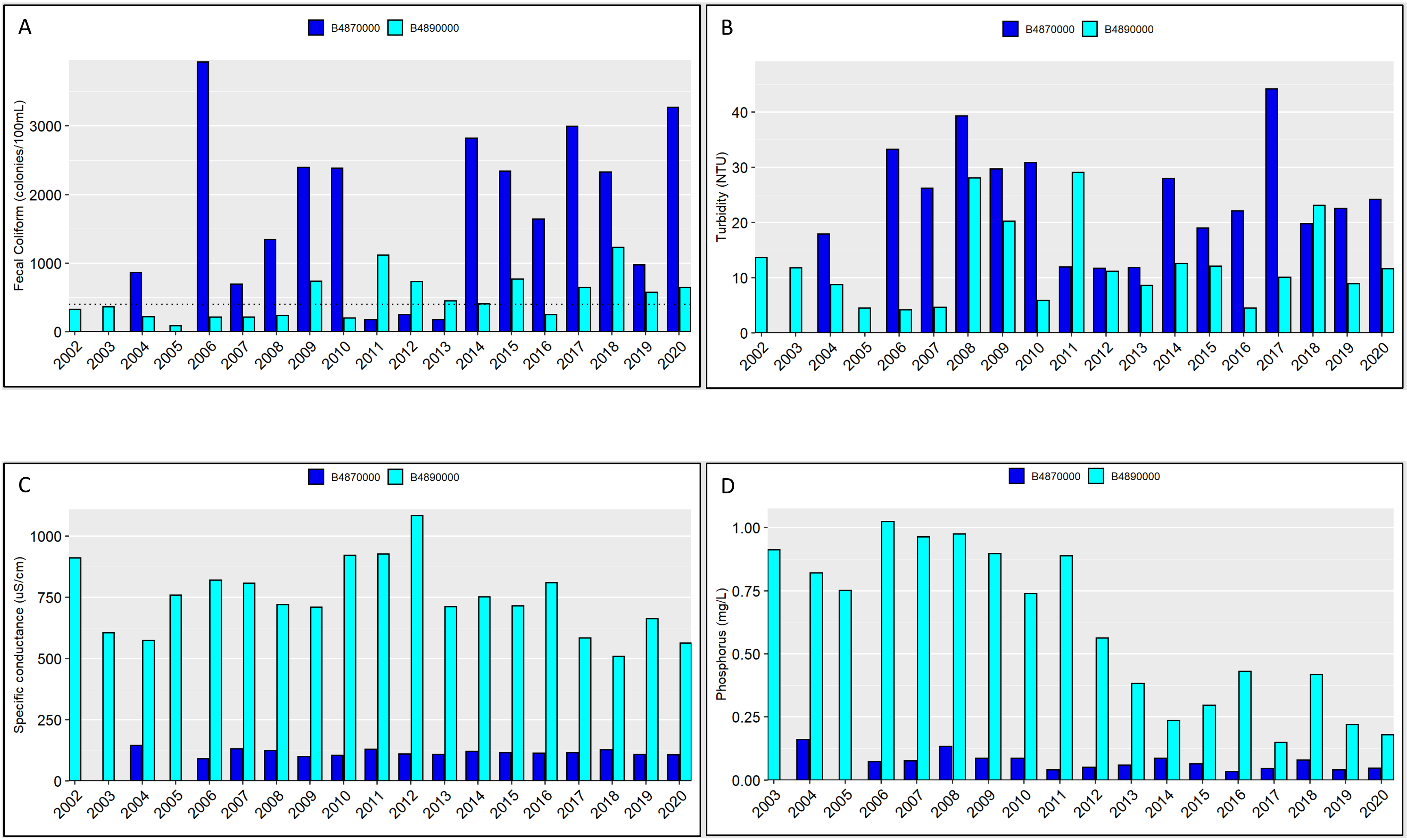
The downstream section of Haskett Creek [AU # 17-12b1 and 17-12b2] is also impaired for biological integrity based on a bioclassification of Fair during a special study sampling of benthic site BB370 in 2003. The fish community monitoring site BF92 is co-located with site BB370 and was sampled in 2004, which resulted in a classification of Good-Fair.

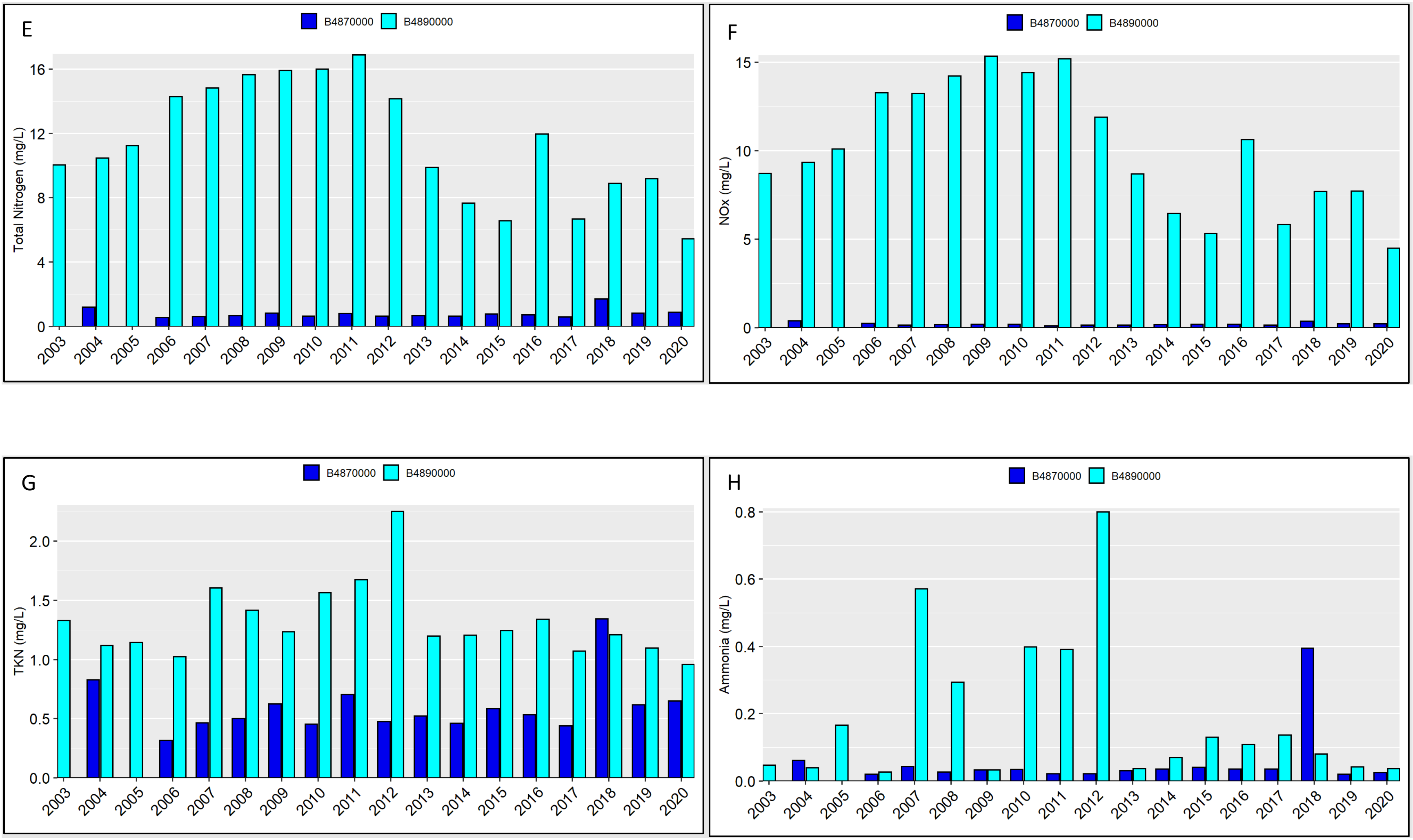
BB370	
Year	**Bioclassification**
2003	Fair
BF92	
2004	Good-Fair

Higher turbidity and fecal coliform bacteria levels are typically recorded in the upstream reach compared to the downstream reach in Haskett Creek (*Figure 7-24A*). The annual mean fecal coliform bacteria concentrations recorded at both the upstream and downstream stations often exceed the 400 colonies/100 mL water quality standard, especially during recent years. Annual turbidity values often approach or exceed 20 NTUs, with annual means exceeding 40 NTUs in 2017 at the upstream station in Haskett Creek (*Figure 7-24B*). The elevated fecal coliform and turbidity are likely caused by stormwater runoff and increased peak flows after storm events.

Downstream from the Asheboro WWTP, there is a considerable increase in specific conductance (*Figure 7-24C*), total phosphorus (*Figure 7-24D*), and total nitrogen (*Figure 7-24E*). A large fraction of the total nitrogen signature in this waterway is from the nitrate+nitrite (NOx) concentrations (*Figure 7-24F*). The NOx concentrations combine with the total Kjeldahl nitrogen concentrations (*Figure 7-24G*), which are comprised of ammonia (*Figure 7-24H*) and organic nitrogen, to produce the total nitrogen signature in Haskett Creek. The annual mean NOx, ammonia and total nitrogen concentrations all have years during which the concentrations considered normal for healthy Piedmont streams is exceeded (NOx $\leq$ 0.3 mg/L, Ammonia $\leq$ 0.05 mg/L, TN $\leq$ 0.8 mg/L). These nutrients are of concern as Haskett Creek has a zero summer and winter 7Q10 flow, indicating that during parts of the year, a large portion of the flow below the WWTP is discharge effluent. The ambient station data below the discharge point indicates that the Asheboro WWTP discharge is contributing a large nutrient load to the lower portion of Haskett Creek as well as to the Deep River below the confluence with Haskett Creek, as this section of the Deep River [AU # 17-(10.5)d1] is impaired for chlorophyll *a.*

Figure 7-24: Haskett Creek AMS Station B4870000 and B4890000 Annual Average for Water Quality Parameter from 2004-2020.




E
B4870000
B4890000
Total Nitrogen (mg/L)
0
4
8
12
16
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
F
NOx (mg/L)
0
5
10
15
G
TKN (mg/L)
0.0
0.5
1.0
1.5
2.0
H
Ammonia (mg/L)
0.0
0.2
0.4
0.6
0.8

Due to downstream impairments resulting from excess nutrients in Deep River and the Cape Fear River behind Buckhorn dam, an upgrade to the Asheboro WWTP is likely needed in the future. DWR's Modeling and TMDL unit will be evaluating and modeling the Deep River watershed below Randleman Lake to address the nutrient-related impairments in the Deep and the Cape Fear rivers. The results of the modeling will help resource managers to develop a plan to address these impairments. DWR conducted a screening level Mann-Kendall trend test and found a seasonal increasing trend in fecal coliform bacteria and a decreasing trend in NOx, total phosphorus, and specific conductance at station B4890000 on Haskett Creek calculated at 95% confidence for data collected from 2000-2019. *The need to reduce nutrients from both point and nonpoint sources is likely in order to achieve water quality standards. It would be beneficial to optimize the current treatment plant operations to reduce nitrogen and phosphorus as much as possible until such upgrades are possible. Implementation of stormwater BMPs to reduce pollutant runoff and reduce peak flows would be beneficial in this watershed and help improve the benthic macroinvertebrate community health. Ordinances controlling stormwater runoff and encouraging low impact development within the town's jurisdiction would be beneficial to protecting and improving water quality throughout the Haskett Creek watershed.*

As an alternative to a TMDL, the Haskett Creek Watershed Plan was developed in consultation with local stakeholders to guide water quality improvements and coordinate restoration efforts. The plan investigates potential sources of pollution in the watershed and identifies collaborative, cost-effective strategies to enhance and protect surface waters. The goal of the plan is to restore aquatic habitat in Haskett Creek and the adjoining tributary named Penwood Branch (discussed in the next section) to support diverse benthic communities and meet water quality standards. The plan is meant to be a living document and will be updated and revised as new information, challenges, or opportunities arise.

A study in the Cape Fear River Basin identified elevated levels of 1,4-dioxane downstream of the Greensboro, Reidsville, and Asheboro wastewater treatment plants (WWTPs). DWR has worked with these facilities to decrease the concentration of 1,4-dioxane in their discharge. To help facilitate the effort, DWR required all three WWTPs to submit steps to reduce 1,4-dioxane in their discharge.

Haskett Creek in the Deep River subbasin consistently had the highest instream 1,4-dioxane concentrations in the Cape Fear River Basin and across the state (see Chapter 13 for details). Haskett Creek flows through the City of Asheboro and drains to the Deep River between Cedar Falls and Randleman, NC. Asheboro's WWTP (NC0026123) discharges to Haskett Creek about 0.7 miles upstream of the confluence with the Deep River. DWR has collected 1,4-dioxane surface water samples at two stations in Haskett Creek, one upstream (B2 at Hub Morris Rd) and one downstream (B4890000 at Wow Rd) of the wastewater treatment plant.

For the data collected between November 2017 and December 2024, the upstream 1,4-dioxane concentrations ranged between <1 and 2.2 µg/L with only seven of the 59 samples (12%) above the PQL of 1 µg/L. The mean and median of the seven samples above the PQL was 1.5 and 1.2 µg/L, respectively. Of the 71 samples collected downstream of the Asheboro's WWTP at station B489000, only a single sample collected on May 7, 2023, was below the PQL. The range of the remaining 70 samples was between 1.9-1,000 µg/L. The mean and median concentrations were 115 and 55 µg/L respectively with 50.7% of the records over 50 µg/L and 83% over 10 µg/L (Chapter 13, Table 13-3). These high instream 1,4-dioxane concentrations are concerning as the downstream water supplies are consistently at risk of exceeding the EPA's drinking water health-based 1-in-a-million (1 x10^{-6}) lifetime cancer risk level of 0.35 µg/L (EPA IRIS, 2013).

The elevated concentrations of 1,4-dioxane in Haskett Creek has been traced primarily to discharges from Significant Industrial Users (SUIs) into the City of Asheboro's WWTP. In this specific case, two SIUs were identified as the source of 1,4-dioxane to the WWTP. The City of Asheboro's WWTP 1,4-dioxane effluent monitoring results range between less than 1 to 3,520 µg/L, with a mean and median of 96.9 and 36.5 µg/L respectively from 295 grab samples collected between January 2018 and October 2025.

DWR issued a NPDES permit to Asheboro with a 1,4 dioxane effluent limit of 21.58 µg/L monthly average and a daily maximum of 49.4 µg/L. On September 19, 2023, the City of Asheboro filed a petition for contested case hearing to the NC Office of Administrative Hearings (OAH). Asheboro's petition challenged various 1,4-dioxane effluent limitations and conditions contained in its NPDES renewal permit (NC0026123)(NC OAH 24 EHR 00862 Final Decision Sept. 12, 2024). On September 12, 2024, the administrative law judge (ALJ) determined that the 1,4-dioxane effluent limit included in the permit was void and unenforceable. As a result of the OAH ruling, in October 2024, DWR revised the NPDES permit to not include 1,4-dioxane discharge limits. In accordance with EPA requirements, DWR provided the October 2024 version of the permit to EPA for review.

"On October 31, 2024, EPA sent a General Objection to NC DEQ stating that, based on its preliminary review of the permit, the removal of the effluent limits for 1,4-dioxane may not be consistent with the Clean Water Act (CWA) Section 301(b)(1)(C) and 40 CFR § 122.44(d), which require NPDES permits to include effluent limits as stringent as necessary to meet state water quality standards" (EPA public notice September 4, 2025 and EPA website). According to a January 2025 EPA letter describing their objection, EPA describes in detail their concerns with the OAH ruling and approved of how and why DEQ included the 1,4-dioxane limits in the initial October 2023 NPDES permit for the City of Asheboro.

EPA is required to hold a public hearing on its specific objections if requested. An EPA public hearing was held in Asheboro, NC on October 22, 2025 and took public comments through October 31, 2025 (public hearing link). The Clean Water Act says that after considering the information provided during the public comment period, EPA must make a final decision that either reaffirms their objection, modifies the objection, or withdraws the objection to the permit. As of December 2025, EPA has not completed their final determination.

EPA's letter indicated that "if this objection is not resolved by the state, any permit that ultimately has to be issued by the EPA for Asheboro would include the WQBEL for 1,4-dioxane as established by the NC DEQ as necessary to meet the Narrative Standard" (EPA letter, Jan. 2024).

The original October 2023 City of Asheboro NPDES permit is still (Dec. 2025) in litigation. DEQ appealed the OAH decision to the NC Superior Court. The Wake County Superior Court held that DWR has the authority to include these limits but that decision is being appealed to the Court of Appeals.

Given the nature of 1,4-dioxane, the discharge to Haskett Creek is expected to persist downstream to the nearest water supply (WS-IV) boundary on the Deep River, located 43.5 miles downstream of the outfall. The final phased in effluent limit in the October 2023 permit was 21.58 µg/L which would protect the downstream water supply by preventing it from exceeding the EPA health-based drinking water concentration representing a 1-in-a-million (1 x10^{-6}) cancer risk level for 1,4-dioxane of 0.35 µg/L (EPA IRIS, 2013).

More information on 1,4-dioxane and other emerging contaminants, see Chapter 2 (section 2.13.2) and Chapter 13 for summary tables and figures for 1,4-dioxane in the Cape Fear River Basin between 2016 and 2024.

7.7.1.12 Penwood Branch

Penwood Branch [AU#: 17-12-1] is a Class C waterway located in Randolph County and originates in the Town of Asheboro. It lies within the Carolina Slate Belt ecoregion and drains to Haskett Creek above the wastewater treatment facility. According to the USGS StreamStats, about 56% of the watershed is covered by all densities of development and 39% is forested (2006 NLCD; USGS North Carolina StreamStats).

BB378	
Year	**Bioclassification**
2003	Fair
2006	Fair
BB382	
2003	Fair

Penwood Branch is highly impacted by stormwater runoff, causing biological integrity impairment throughout the entire watershed. Special benthic macroinvertebrate studies were done in 2003 at station BB382 and in 2003 and 2006 at station BB378 to identify stressors throughout the Haskett Creek watershed impacting the benthic communities. Penwood Branch was determined to be impaired due to a Fair benthic rating at both stations. The biologist found the benthic community to be very sparse, which did not allow for a clear determination of the key stressors. There was evidence of habitat degradation likely due to stormwater runoff, stream bank erosion, altered hydrology, inadequate riparian areas and channelization. *Implementation of stormwater Best Management Practices to reduce pollutant runoff and reduce peak flows would be beneficial in this watershed and help improve the benthic macroinvertebrate community health. Ordinances controlling stormwater runoff and encouraging low impact development within the town's jurisdiction would be beneficial to protecting and improving water quality throughout the Penwood Branch watershed.*

7.7.1.13 Deep River (including High Point Lake and Randleman Reservoir) in the Headwaters Deep River Watershed

7.7.1.13.1 High Point Lake

High Point Lake (also known as City Lake) [AU#: 17-(1)] was built in 1928 by High Point and is used for water supply and recreation. As such, this waterbody is classified as a WS-IV* and CA. The maximum depth of the lake is 33 feet (10 meters). Urban and residential areas as well as pasture and row crop farms dominate the watershed. The Jamestown Golf Course and the Piedmont Environmental Center are directly adjacent to the reservoir on the right descending bank. The two arms of the lake are fed by the East Fork Deep River and Long Branch on one arm and the West Fork Deep River on the other. These waterways were discussed previously in this chapter.

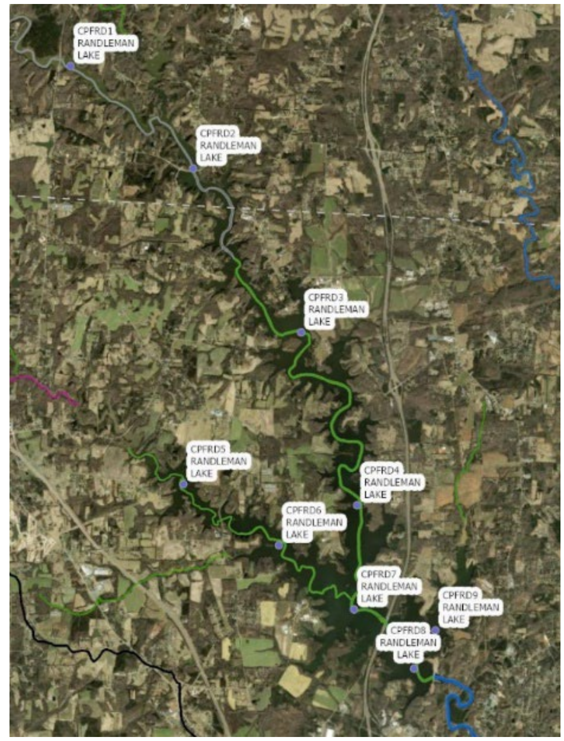
High Point Lake was sampled by DWR staff five times during the summer months in both 2007 and 2013 and four times in 2018. Prior to 2003, this lake was sampled 26 times by DWR. In 2007, dissolved oxygen was greater at the sampling site near the dam (CPF089E4) as compared with the sampling site located in the upper portion of the lake near the SR 1545 bridge (CPF089E2). The lowest surface dissolved oxygen values were observed on June 20 (5.8 mg/L) and on August 15 (5.4 mg/L). Neither dissolved oxygen value was less than the state water quality standard of 4.0 mg/L for an instantaneous reading. Total phosphorus was elevated at both lake sampling sites in June and September and total Kjeldahl nitrogen and total organic nitrogen were elevated from May through September 2007. The availability of nutrients in High Point Lake may have contributed to the elevated chlorophyll *a* values observed in June 2007 in the upper portion of the lake (45 µg/L) and at both lake sampling sites in September 2007 (62 and 72 µg/L) (NCDEQ, 2009).

During the 2013 sampling season, surface dissolved oxygen in this reservoir ranged from 5.2 to 8.9 mg/L, and surface water temperature ranged from 16.5 °C in May near the dam (CPF089E4) to 28.7 °C downstream of the SR 1545 bridge over the Deep River arm (CPF089E2) in August. The lowest surface pH values were observed in May and the greatest values were measured in August. Surface conductivities were greatest in May (110 to 120 µmhos/cm) and may have been associated with recent heavy rainfall in and around the lake the evening prior to lake sampling. Field notes by staff indicated that the lake water appeared brown and turbid. The majority of Secchi depth measurements during the field sampling of this lake in 2013 were less than a meter in depth. Nutrient concentrations in High Point Lake were similar to those previously observed in this lake. Surface total phosphorus in 2013 ranged from 0.04 to 0.08 mg/L, and total Kjeldahl nitrogen ranged from 0.50 to 0.83 mg/L. Chlorophyll *a* values ranged from 11 to 64 µg/L. The chlorophyll *a* values in the Deep River arm (CPF089E2) in June and July--57 and 64 µg/L, respectively--were greater than the state water quality standard of 40 µg/L (NCDEQ, 2014).

During the 2018 sampling season, surface dissolved oxygen in this reservoir ranged from 4.7 to 9.3 mg/L, and surface water temperature ranged from 22.6 °C in May downstream of the SR 1545 bridge over the Deep River arm (CPF089E2) to 29.6 °C near the dam (CPF089E4) in August. Surface pH values were fairly consistent, ranging from 7.3 to 7.6 s.u. Secchi depth measurements during the field sampling of this lake in 2018 ranged from 0.8 to 1.3 meters. Nutrient concentrations in High Point Lake were similar to those previously observed in this lake. Total phosphorus in 2018 ranged from 0.03 to 0.05 mg/L and total Kjeldahl nitrogen ranged from 0.55 to 0.74 mg/L. Chlorophyll a values ranged from 12 to 40 µg/L. These values did not exceed the state water quality standard of 40 µg/L (NCDEQ, 2018).

Based on the calculated NCTSI scores, High Point Lake was determined to exhibit elevated biological productivity or eutrophic conditions on each of the sampling dates in 2013 and 2018. There have been frequent public complaints in the past about taste and odor problems from processed drinking water taken from this lake related to algal blooms. To reduce this problem, the water treatment plant currently treats the raw water to reduce algae-related taste and odor problems. Low dissolved oxygen levels have been recorded at the water intake and a destratification system (forced air) was placed in the mainstem of the lake to help improve the dissolved oxygen levels. High Point Lake was listed on the 2006 303(d) List of Impaired Surface Waters for chlorophyll *a* values greater than the state water quality standard of 40 µg/L but was delisted for chlorophyll *a* in 2018 (NCDEQ, 2018).

7.7.1.13.2 Randleman Reservoir



The Randleman Lake [AU#: 17-(4)] portion of the Deep River runs from about I-85 to the Randleman Reservoir Dam and is classified as WS-IV; CA:*. Construction of the Randleman Dam began in 2001, and the reservoir was filled in 2007. Located in Randolph and Guildford counties, this reservoir provides drinking water for North Carolina's Piedmont Triad Region and is managed by the Piedmont Triad Regional Water Authority (PTRWA). The entire watershed was reclassified as a Water Supply IV use and a critical area watershed, identified using the asterisk (*) symbol in the classifications table (WS-IV:*).

In order to protect Randleman Lake from becoming impaired due to excess nutrient loading, the Randleman Lake Water Supply Watershed Nutrient Management Strategy (15A NCAC 02B .0720 - .0724) was put in place on April 1, 1999, and readopted in June 2020. The Randleman Lake rules focus on managing wastewater phosphorus concentrations, minimizing stormwater runoff from new development as well as protecting and preserving riparian buffers on all intermittent streams, perennial streams, lakes and ponds in the watershed. These rules were delegated to the local governments for implementation (*Table 7-15*). All of the delegated authorities were audited to ensure compliance with the management rules. A second round of compliance audits should take place in the next few years. At this time, the main issue with compliance appears to be the general lack of knowledge by individual landowners in regard to the buffer requirements throughout this watershed. General education about the requirements and the ecological benefits of riparian buffers in this watershed is needed. See *Table 7-16* for a summary of the management rules. Per rule, "there shall be no new or expanding permitted wastewater discharges in the watershed with the exception that the City of High Point Eastside Wastewater Treatment Plant may be allowed to expand provided that any new permit contain concentrations and mass limits predicted through water quality modeling or other analysis that shows to the Director [of DWR] that discharges will provide a level of water quality in the Randleman Lake that meets all designated uses of those waters" [15A NCAC 02B .0722 (c)]. These rules do not specifically address offsite target export reductions of nutrients from stormwater management or other nonpoint source contributions in the watershed such as agriculture. It has been noted that there are many cattle operations in this watershed and that cattle access to the streams are likely resulting in a decline in water quality that needs to be addressed.

Randleman Lake was sampled five times during the summer of 2008 (May to September) to assess the initial state of the lake. The Secchi depths ranged from 0.8 to 1.1 meters with the upper portion of the lake having the lowest clarity measurements. None of the nine stations assessed violated the turbidity standard of 25 NTU. The chlorophyll *a* concentrations ranged between 14 and 50 µg/L with the highest mean concentrations at the two uppermost Deep River arm stations (CPFRD1 = 36.5 µg/L and CPFRD2 = 39.5 µg/L). Approximately 50% of the chlorophyll *a* readings were more than 25µg/L, indicating a productive system. Total calculated hardness was also assessed at three stations and ranged between 42 and 61 mg/L.

Most recently, six sites on Randleman Reservoir were sampled by DWR field staff monthly from May through August 2018. Secchi depths ranged from 0.7 to 1.6 meters. Surface dissolved oxygen ranged from 7.2 to 10.7 mg/L, and surface water temperatures ranged from 25.7 °C to 31.4 °C. In July, the highest observed surface pH value (8.9 s.u.) occurred at the same sampling site that had the highest surface dissolved oxygen value (CPFRD1), which is located in the upper Deep River arm. Total phosphorus concentrations ranged from <0.02 to 0.08 mg/L, and total Kjeldahl nitrogen ranged from 0.44 to 0.81 mg/L. Total organic nitrogen ranged from 0.43 to 0.80 mg/L. Chlorophyll *a* values for Randleman Reservoir did not exceed the state water quality standard of 40 µg/L, ranging from 7.3 to 36.0 µg/L. Based on the calculated North Carolina Trophic Index (NCTSI) scores, Randleman Reservoir was determined to exhibit elevated biological productivity (eutrophic conditions) in 2018. See the Randleman Lake section of the Lake & Reservoir Assessment Cape Fear River Basin for more information on the ambient lake monitoring results.

Table 7-15: List of Delegated Authorities for the Randleman Lake Rules.

Delegated Authority
City of Archdale, City of Greensboro, City of High Point, City of Randleman, City of Trinity, Forsyth County/City of Winston-Salem, Guilford County, Piedmont Triad Regional Water Authority, Randolph County, Town of Jamestown, and Town of Kernersville

Table 7-16: Summary of the Randleman Lake Water Supply Watershed Nutrient Management Strategy (15A NCAC 02B .0720 - .0724).

Name	Rule # 15a NCAC	Applies To	Purpose
Nutrient Management Strategy	02B .0248 (.0720)	Entire Randleman Lake Watershed	Reclassification to Water Supply use and designated as a Critical Water Supply Watershed (WS-IV:*).
Wastewater Discharge Requirements	02B .0249 (Moved to .0722)	Discharge of domestic wastewater or wastewater containing phosphorus	To establish minimum phosphorus control requirements for point source wastewater discharges in order to maintain water quality and protect designated uses. - City of High Point Eastside facility shall meet total phosphorus concentrations needed to protect all designated uses. - No New or expanding wastewater discharges in the watershed with the exception of the City of High Point Eastside facility, provided that a new permit contains concentration and mass limits predicted to protect all designated uses.
Protection and Maintenance of Riparian Areas	02B .0250 (.0724)	All intermittent streams, perennial streams, lakes and ponds	To protect and preserve existing riparian buffers in order to maintain their nutrient removal and stream protection functions. 50 Foot Riparian Buffer - Zone 1 – 30-foot undisturbed area of vegetation Zone 2 – 20-foot vegetated ground cover
Stormwater Requirements	02B .0251 (.0721)	2 Stormwater Zones: - Upper watershed Watershed draining to Oakdale-Cotton Mill Dam. - Lower Watershed Watershed draining from Oakdale-Cotton Mill Dam to Randleman Dam.	To protect the Randleman Lake watershed from the potential impact of new development as well as preventing erosive flow through the buffers. Upper Watershed: Meet requirements for WS-IV classification as specified in 15A NCAC 02B .0104, .0202, and .0216, along with the specified stormwater management plan and program. Lower Watershed: Meet requirements for the specified stormwater management plan and program than meets the more stringent Randleman Lake stormwater management requirements as set forth in Sub-Item (3) of this rule.
These rules do not address nitrogen or other nonpoint source contributions in the watershed.			

7.7.1.13.3 Deep River in the Headwaters Deep River Watershed

The outlet of the High Point Lake Dam is the Deep River [AU#: 17-(1); 17-(3.3); 17-(3.7); 17-(4)a; 17-(4)b; 17-(4)c1; 17-(4)c2; 17-(10.5)a; 17-(10.5)b; 17-(10.5)c; 17-(10.5)d1; & 17-(10.5)d2]. The Deep River begins with a WS-IV* classification and picks up the CA classification as it approaches Randleman Reservoir after which it becomes a Class C waterway throughout the remainder of the Headwaters Deep River watershed (HUC10: 0303000301). This section of the Deep River is in Randolph County and lies within the Carolina Slate Belt ecoregion. This waterway receives drainage from previously mentioned High Point Lake and Randleman Reservoir, as well as the Town of Randleman, Polecat Creek and Haskett Creek drainage areas. Asheboro's 9 MGD WWTP and Randleman's 1.745 MGD WWTP are two major dischargers that drain to this segment of the Deep River below Randleman Lake.

Several surface water quality monitoring stations are established along Deep River, including four in the Headwaters Deep River watershed (HCU10: 0303000301). These include a station positioned below the outlet of High Point Lake and above the inlet to Randleman Reservoir (B4350000), one directly downstream of the Randleman Reservoir (B4770500), another downstream from the confluence with Polecat Creek (B4800000), and the fourth downstream of the confluence with Haskett Creek (B4920000). Alongside these surface water quality monitoring stations, there is a single benthos community monitoring station in the Deep River that has been consistently sampled over time through to at least 2018 (BB429).

Several sections of Deep River are impaired for exceeding water quality standards. The Deep River [AU#: 17-(3.7)] is impaired for stressed benthos, although the benthos community monitoring station is no longer monitored. Deep River [AU # 17-(10.5)d1; from Haskett Creek to Gabriels Creek] is impaired due to standard violations for chlorophyll *a* at station B4920000 (UCFRBA station), while AU # 17-(10.5)d2 is impaired due to standard violations for copper. The chlorophyll *a* impairment is based on data collected for the 2008 IR. The UCFRBA discontinued monitoring for chlorophyll *a* at this station in October 2004. The impairment is based on 18 samples collected between May 2002 and September 2004 (*Figure 7-25*). The chlorophyll *a* data ranged from 1-100 µg/L over this period. Cox Lake Dam is about 1.5 miles downstream from this station (B492000) at SR 2261 Old Liberty Road. The river flow likely slows down through this segment because of the dam, and the nutrient contributions from the drainage area cause an increase in biological productivity, algal bloom formation, in this section of the Deep River.

It appears that elevated nutrient loading from the Asheboro WWTP (NC0024210) is affecting the water quality downstream in the Deep River, as seen by the chlorophyll *a* impairment below the confluence with Haskett Creek. While the nutrients from both Asheboro and Randleman WWTPs are likely playing a role, the amount of nitrogen from the Asheboro treatment plant is potentially the driving factor. The nutrient loading from these treatment plants is also likely impacting the impairment behind Buckhorn Dam in the upper portion of the Cape Fear River below the confluence with the Haw River. See *Figure 7-20*, *Figure 7-21*, and *Figure 7-22* for the monthly mean nutrient effluent concentrations from the Asheboro WWTP.

The influence of elevated nitrogen from Haskett Creek is noticeable in the annual mean total nitrogen and nitrate+nitrite (NOx) concentrations viewed from upstream (B4350000) to downstream (B4920000) in the Deep River. The most downstream station (B4920000) is positioned below the confluence of Haskett Creek with the Deep River. Annual mean total nitrogen concentrations at the most downstream station are often above 1 mg/L with annual mean NOx concentrations often above 0.5 mg/L, both of which are considerably higher than the nearby upstream station (B4800000) (*Figure 7-26* and *Figure 7-27*). The annual mean total Kjeldahl nitrogen concentrations along the Deep River have fluctuated generally between 0.5 and 1 mg/L along the entire length of the Deep River, except in 2002 and 2018 (*Figure 7-28*). Another species of nitrogen is ammonia, which has been recorded as having annual mean concentrations that approach and exceed 0.25 mg/L downstream from Randleman Reservoir at station B4770500 between 2002 and 2011 (*Figure 7-29*). After 2011, the annual mean values were often below 0.13 mg/L, however, they approach this value in 2018 (*Figure 7-29*).

Another nutrient of concern is TP, which has annual mean values that are elevated above concentrations considered normal for healthy Piedmont streams (TP $\leq$0.05 mg/L) along the Deep River below Randleman Reservoir (*Figure 7-30*). While annual mean TP concentration have declined at all stations below Randleman Reservoir since 2002, the annual mean values in Deep River at stations B4800000 and B4920000 remain above concentrations considered normal for healthy piedmont streams (*Figure 7-30*). In addition to elevated nutrient concentrations, specific conductance appears to be elevated in the lowermost stations of the Deep River section in the Headwaters Deep River watershed (HUC10: 0303000301). Notably, the lowermost station (B4920000) is downstream from the confluence with Haskett Creek and often records the highest annual mean specific conductance (*Figure 7-31*).

Fecal coliform bacteria concentrations are also a parameter of concern, as annual mean concentrations at the lowermost two stations (B4800000 and B4920000) have often exceeded 400 colonies/100 mL during 2014 to 2020 (*Figure 7-32*). Interestingly, there is a considerable difference in fecal coliform bacteria between station B4770500 and B4800000 downstream from the outlet of Randleman Reservoir during certain years. A review of available concurrent effluent data from the nearby point source discharger, Randleman WWTP, between June 2018 to December 2022 suggests this facility does not appear to display a correlation between elevated fecal coliform in the discharge and elevated levels downstream. The only major tributary between these two stations is Polecat Creek, suggesting the elevated fecal coliform bacteria concentrations could be influenced by streamflow from this waterway and/or nonpoint sources along Deep River. Based on data collected between 2016 and 2020, station B4770500 had an exceedance rate of 10.0% while the two downstream stations B48000000 and B4920000 had exceedance rates of 23.3% and 30% respectively.

As noted previously in the Randleman Reservoir section, dissolved oxygen (DO), is a parameter of concern. Notably, the annual mean DO concentrations at the most upstream station (B4350000) is often the lowest between the four monitoring stations on the Deep River in the Headwaters Deep River watershed (HUC10: 0303000301) (*Figure 7-33*). Based on the data collected between 2016 and 2020, all four stations along this section of the Deep River did not record any dissolve oxygen levels exceeding the water quality standard. Between the 2006 and 2020, 4.7% of the DO samples collected at station B4350000 were exceeded the water quality standard compared to less than 1% at the remaining three stations.

DWR's Modeling and Assessment Branch has developed a modeling plan for the central Cape Fear River Basin to outline the modeling goals, spatial extent, parameters of concern and monitoring needs. The results of the modeling will help resource managers develop a plan to address these impairments. The need to reduce nutrients from point and nonpoint sources is likely in order to achieve water quality standards in this section of Deep River and the Cape Fear River (NCDEQ, 2017).

It is recommended that municipalities throughout the watershed improve local ordinances to reduce stormwater runoff and nutrient loading from existing and future development. Implementing low impact development can help reduce additional water quality impacts. Optimizing current wastewater treatment facilities to remove as much nutrients as technically feasible until an upgrade is required could help to improve water quality conditions. Until such a time that there is improved treatment at the Asheboro WWTP and/or other actions in the Haskett Creek watershed result in lower instream nutrient concentrations, this segment of *the Deep River [AU#: 17-(10.5)d1] should be monitored for chlorophyll a to determine if the Deep River can once again meet surface water quality standards.*

Figure 7-25: AMS Station B4920000 Median and Average Chlorophyll a Concentrations (µg/L) 2000-2004.

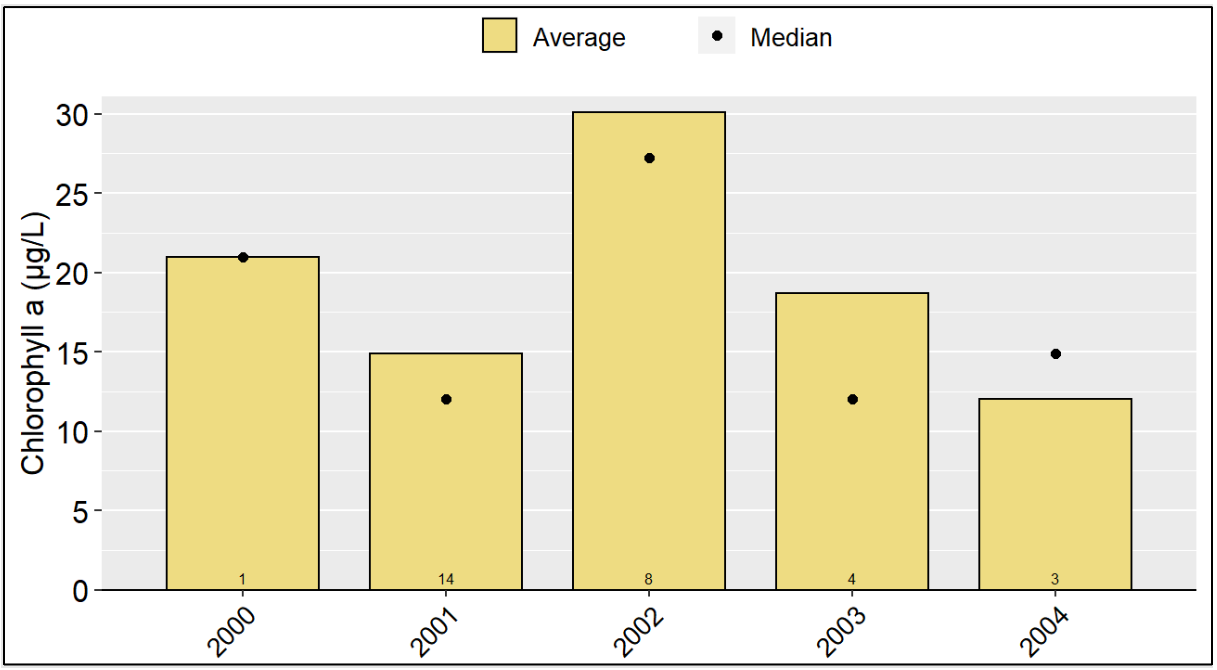


Figure 7-26: Annual Mean Total Nitrogen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).

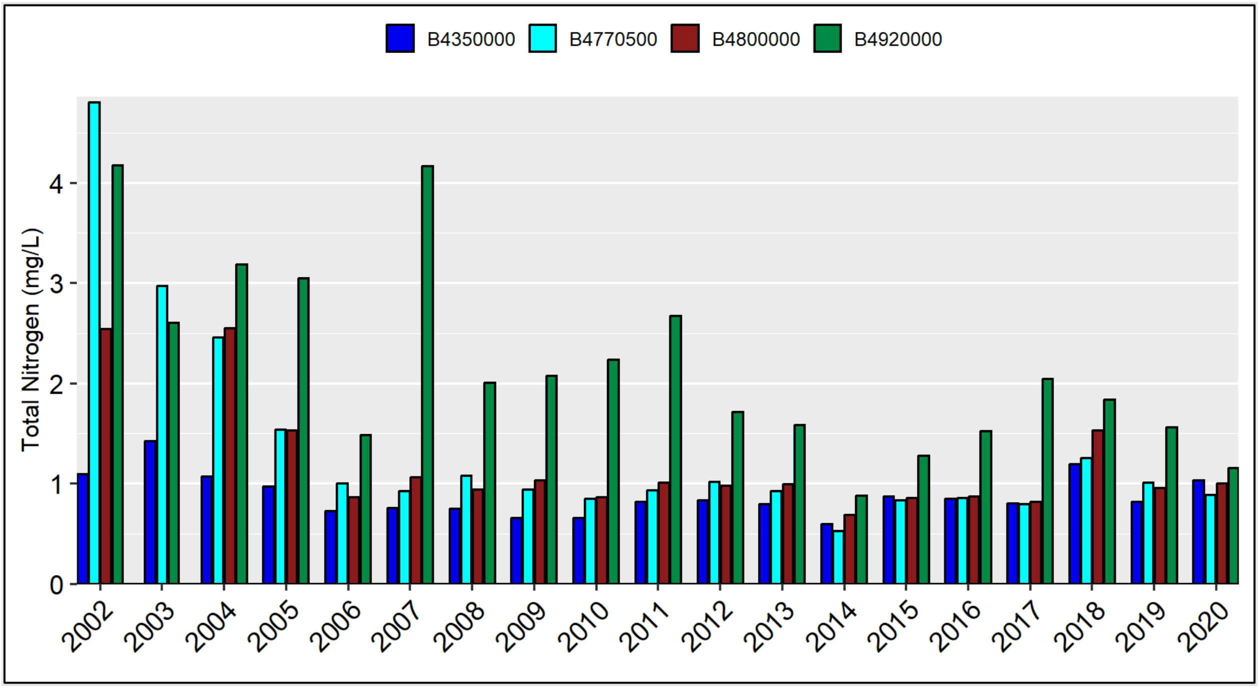


Figure 7-27: Annual Mean Nirate+Nitrite (NOx) Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).

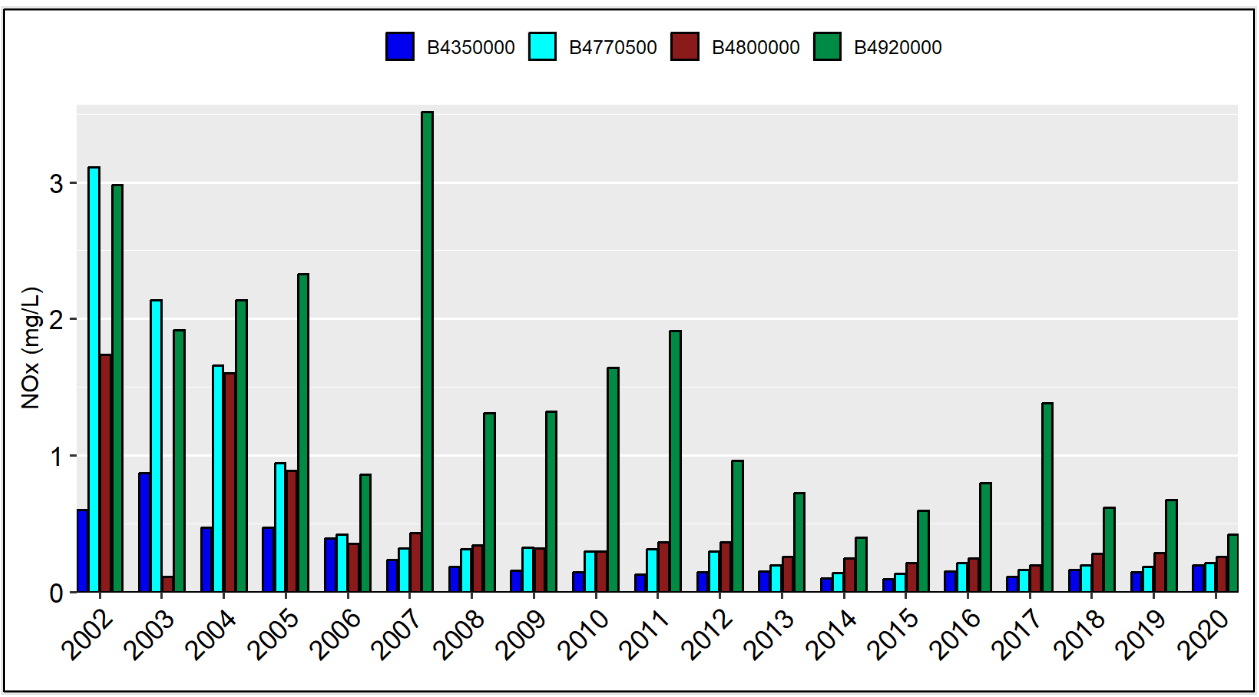


Figure 7-28: Annual Mean Total Kjeldahl Nitrogen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).

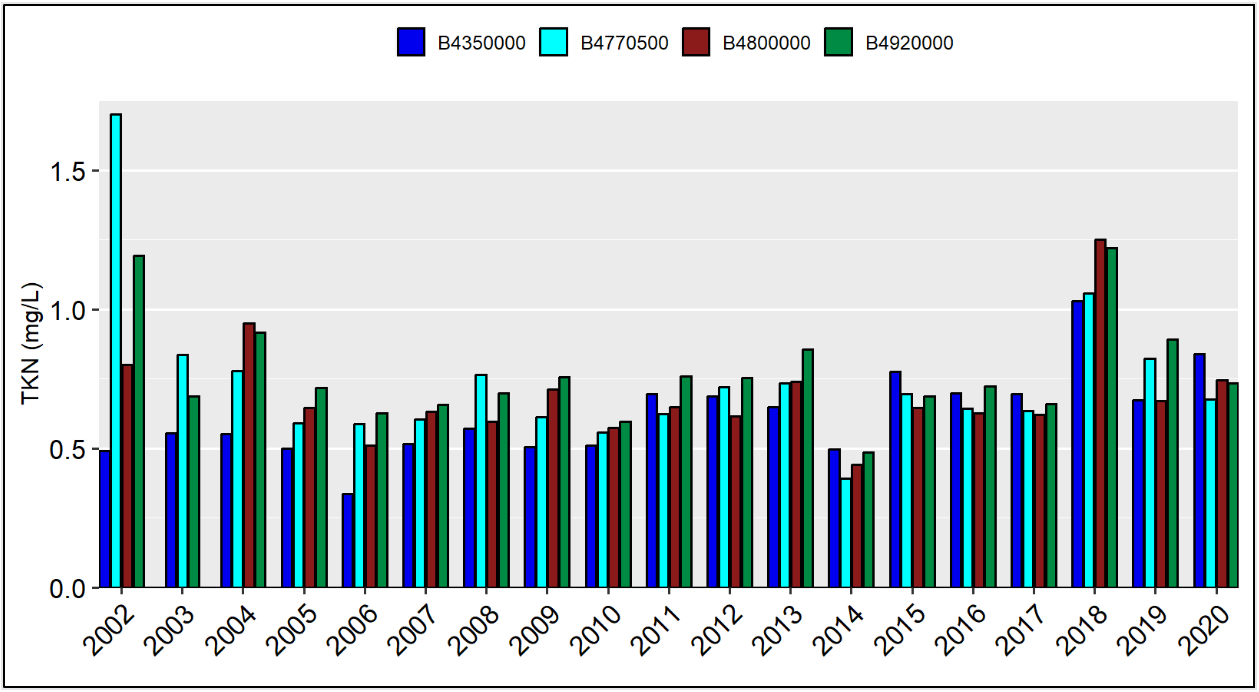


Figure 7-29: Annual Mean Ammonia Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).

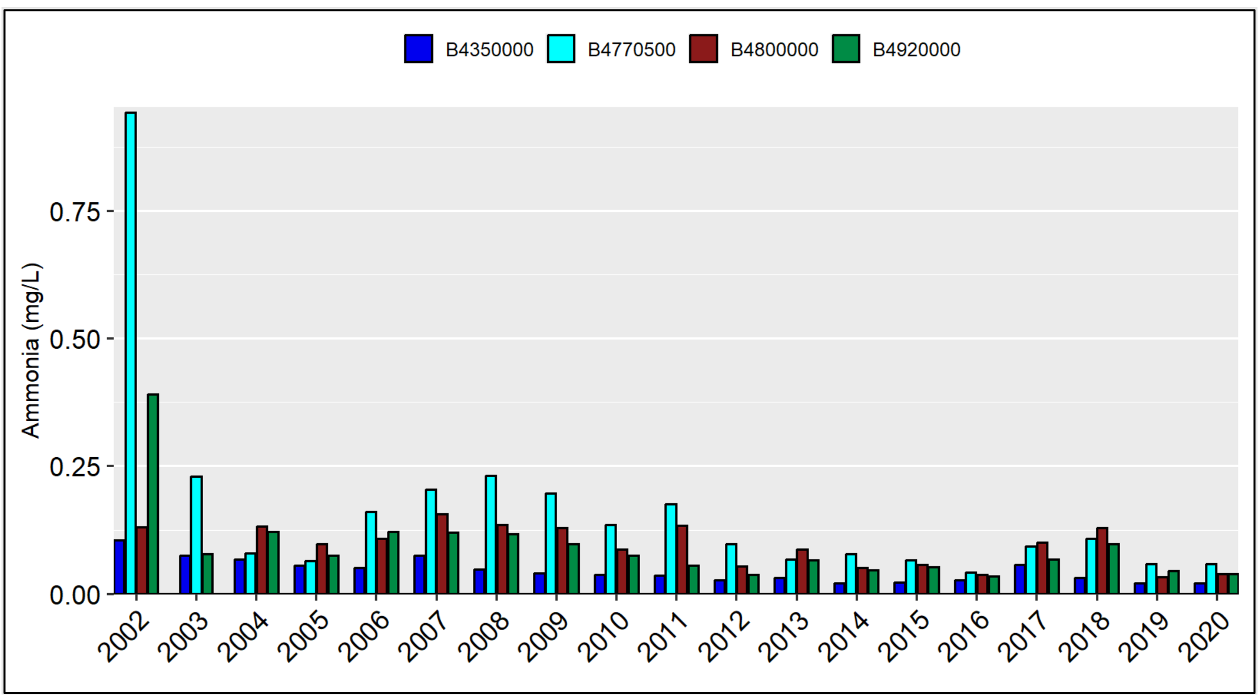


Figure 7-30: Annual Mean Total Phosphorus Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).

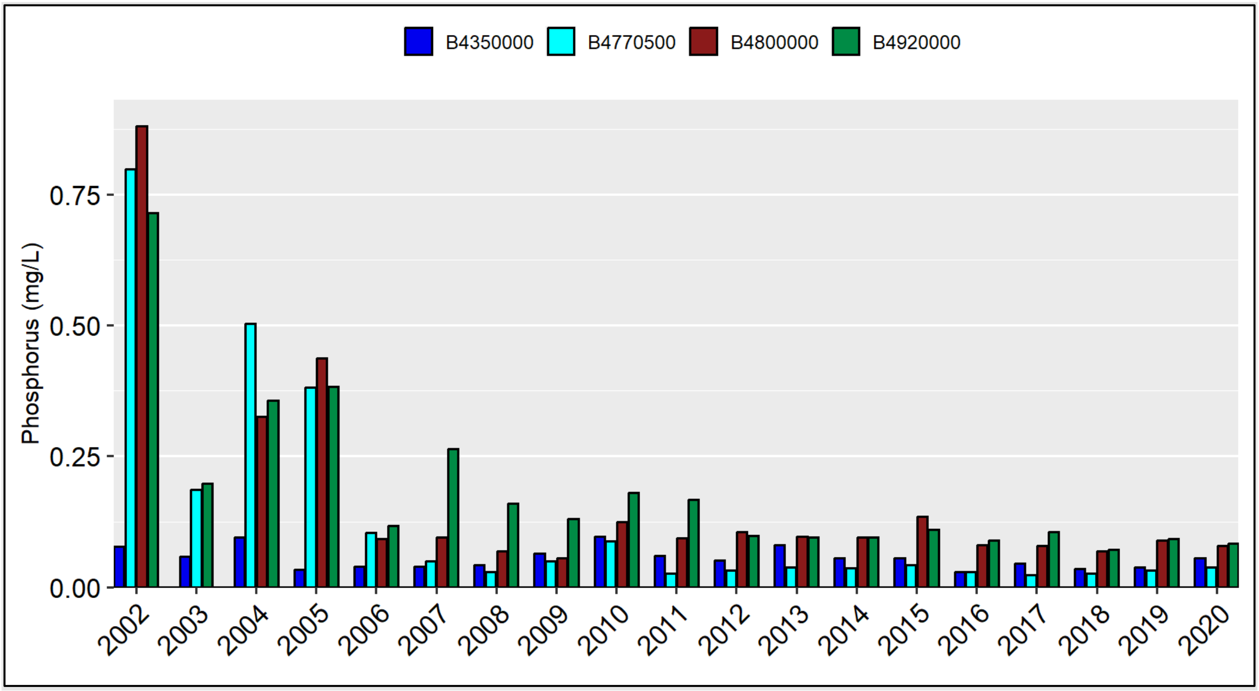


Figure 7-31: Annual Mean Specific Conductance for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).

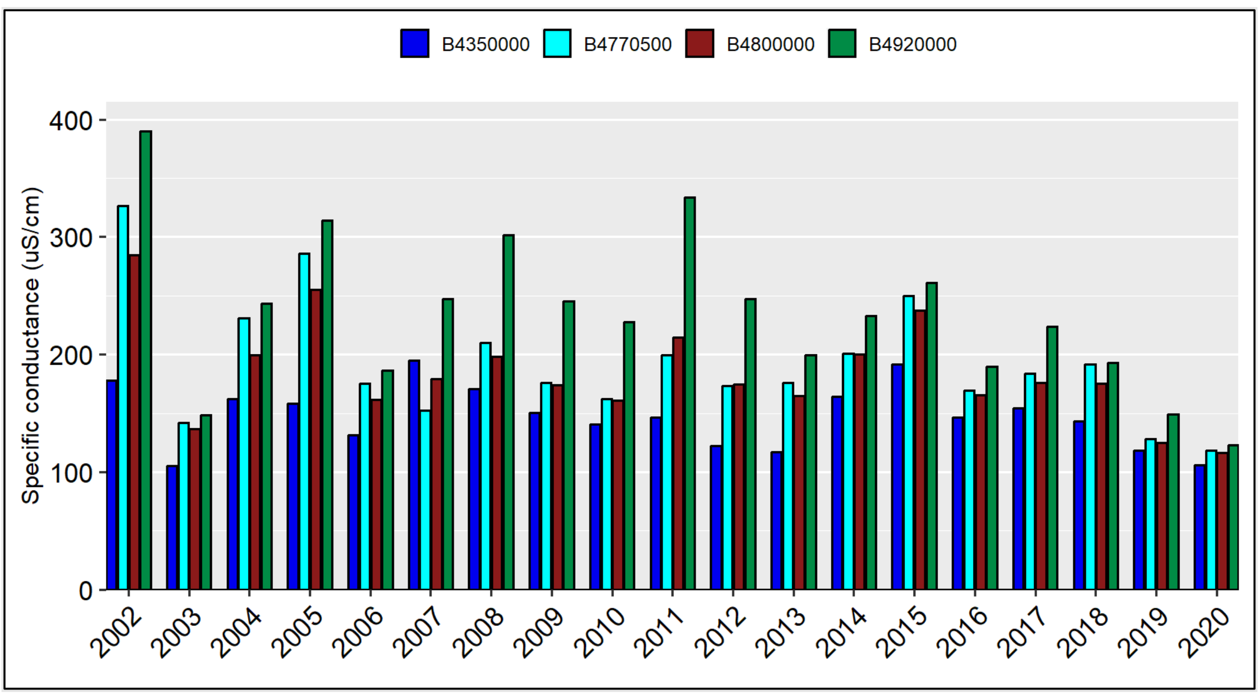


Figure 7-32: Annual Mean Fecal Coliform Bacteria Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).

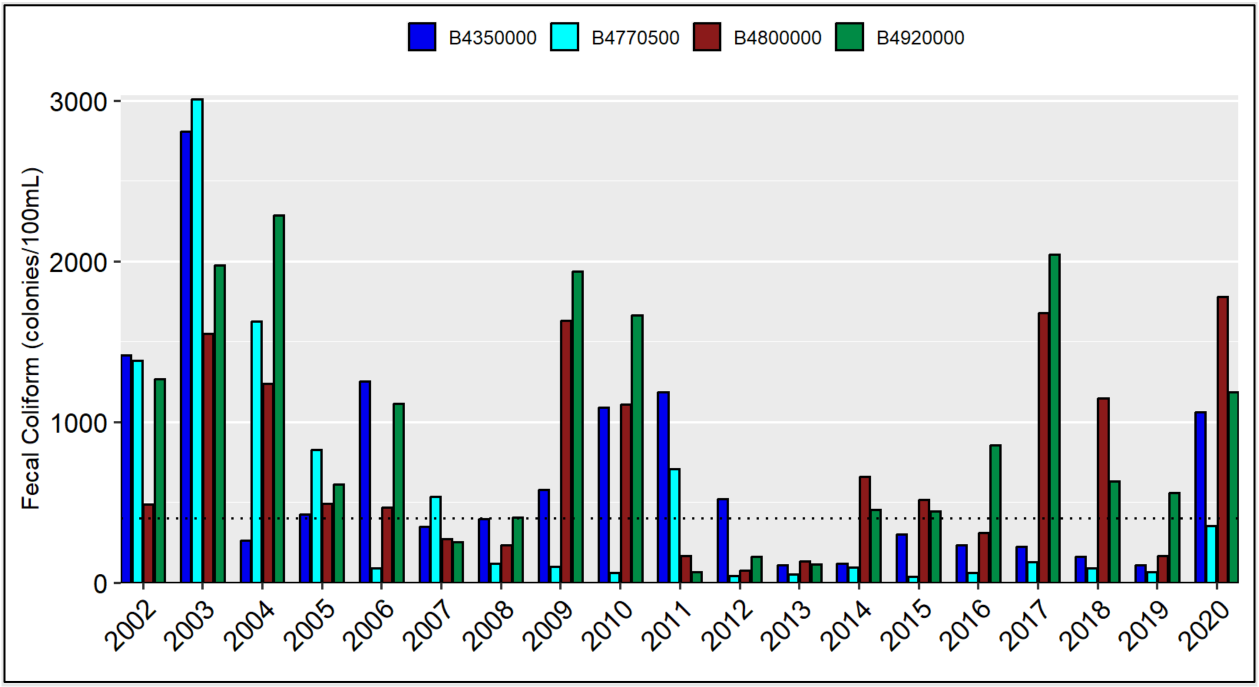
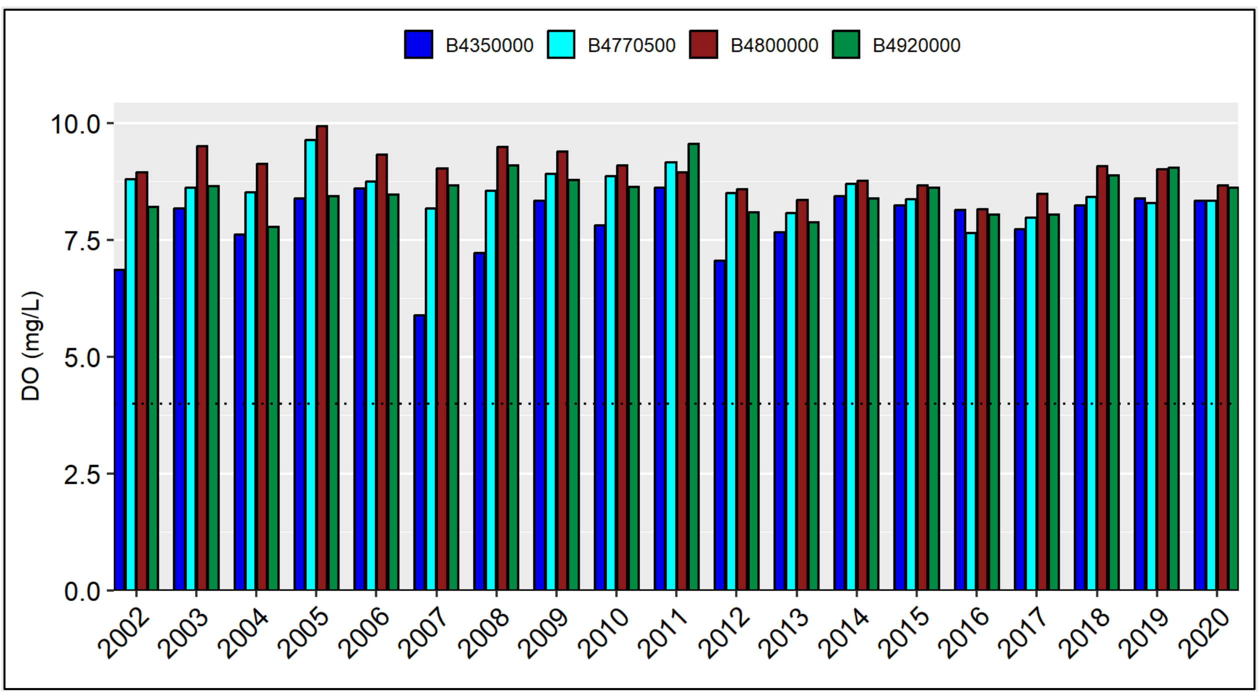


Figure 7-33: Annual Mean Dissolved Oxygen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4350000, B4770500, B4800000, and B4920000).



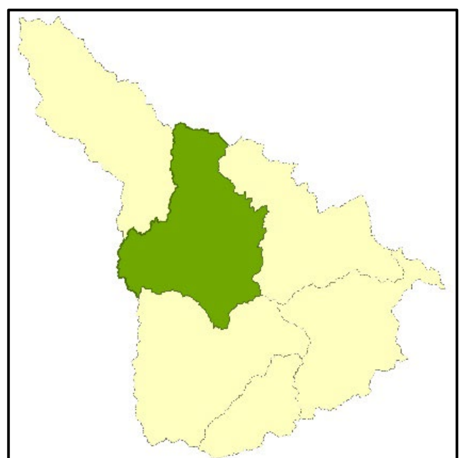
7.7.2 Upper Deep River Watershed (0303000302)

The Upper Deep River watershed includes: the Deep River [AU #: 17-(10.5)d1, d2 & e1]**;** Richland Creek (AU #: 11-22)**;** Sandy Creek [AU #: 17-16-(1)a]**;** and Brush Creek (AU #: 17-23a). The towns of Franklinville and Ramseur are the only municipalities fully within the watershed. Asheboro, Liberty and Staley fall only partially in the watershed. The predominant land uses in this HUC-10 are forested land, followed by agriculture and development.

As of 2022, there were no major and 13 minor NPDES wastewater facilities with a combined as-built discharge of 0.6 MGD. These minor NPDES wastewater facilities include Ramseur WWTP and WTP, Franklinville WWTP, S.S. Mobile Home Park, Coleridge Elementary School, Bennett Elementary School WWTP, as well as several single-family domestic wastewater discharge permits. Several of these facilities discharge return flows to the Deep River, while others discharge into Flat, Brush and Sandy creeks. The animal feeding operation (AFO) facilities include four state cattle (one of which is expired), one state swine and one animal individual state permit.

There are also nine NPDES and 10 state stormwater facilities in this watershed. In addition, there are 1,111 acres of non-discharge wastewater irrigation and residual solids land application fields. Most of the field acreage is for the application of residual solids from the City of Sanford (WQ0000543, 95.4 acres); the City of Asheboro (WQ0001684, 492.7 acres); the Town of Siler City (WQ0003226, 99.7 acres); City of Randleman (WQ0004825, 61.7 acres); Harnett County (WQ0007066, 49.7 acres); and Terra Renewal Services – Pilgrim's Pride (WQ0039391, 310.2 acres). The remaining 1.25 acres are associated with single-family residence wastewater irrigation permits.

7.7.2.1 Sandy Creek



Sandy Creek [AU#: 17-16-(1)a; 17-16-(1)b; 17-16-(3.5); 17-16-(4)] is a tributary to Deep River; its watershed drains a rural area between Randleman and Liberty in northeastern Randolph County. This waterway is classified as WS-III and picks up a CA classification as it approaches Sandy Creek Reservoir. After passing through Sandy Creek Reservoir, Sandy Creek becomes a Class C waterway. There are no NPDES permitted dischargers on Sandy Creek; however, large areas of the watershed are utilized for animal operations and cultivation. This causes excess nutrient inputs from agricultural practices that appear to be the driving force of enrichment, as is the case for much of the Carolina Slate Belt.

[illegible]	[illegible]
2018	Excellent
BF62	
Year	**Bioclassification**
2013	Excellent
*Special Study	

The upper portion of Sandy Creek [AU # 17-16-(1)a; from the source to SR 2495] is supporting aquatic life due to a healthy fish (BF62) and benthic macroinvertebrate (BB398) population, but is impaired for chlorophyll *a*. The fish population was last assessed in 2013 and received an excellent bioclassification. Field staff reported a high-quality Carolina Slate Belt-type instream habitat with boulder and snag pools and frequent rifles. They also noted the abundance of Fissidens and Podostemum plants in the riffles and slick, periphyton-covered rocks and breaks in the riparian zone at a bridge that was contributing sediment to runoff to the creek. Benthic macroinvertebrates received an Excellent rating in 2018 although high amounts of periphyton and blue-green algae were present on much of the hard substrate.

Sandy Creek/Sandy Creek Reservoir [AU #: 17-16-(1)b and 17-16-(3.5)] is impaired due to a chlorophyll *a* standard violation. Impounded in 1978, it is fed by Big Sandy Creek and Little Sandy Creek and is the water supply reservoir serving the Ramseur. Land use in the watershed is mostly characterized by forested and agricultural areas as well as urban development. Sandy Creek Reservoir was most recently monitored four times from May through August 2018. Secchi depths ranged from 0.6 to 1.1 meters. Surface DO (range = 6.4 to 12.3 mg/L) was generally elevated at the mid-lake sampling site (CPFSC2) and upper lake site (CPFSC3). Surface water temperatures in 2018 ranged from 21.3°C in June to 30.1°C in July and surface pH values ranged from 7.0 to 8.5 s.u. Nutrient concentrations in Sandy Creek Reservoir, while being similar to those levels previously measured in this reservoir, were elevated in 2018. Total phosphorus ranged from 0.03 to 0.16 mg/L and total Kjeldahl nitrogen ranged from 0.58 to 1.30 mg/L. Ammonia ranged from less than 0.02 to 0.08 mg/L and NOx ranged from less than 0.02 to 0.65 mg/L. Due to the ready availability of these nutrients, chlorophyll *a* values ranged from 1.4 to 210.0 ug/L. Eight of the 12 chlorophyll *a* measurements for 2018 (67%) were greater than the state water quality standard of 40 ug/L. A turbidity value for the upper lake site in August (34 NTU) also exceeded the state water quality standard of 25 NTU for lakes not designated as Trout Waters. Sandy Creek Reservoir was determined to exhibit elevated biological productivity (eutrophic conditions) in May and July 2018 and excessive productivity (hypereutrophic conditions) in June and August based on the calculated NCTSI scores. The mean NCTSI score for 2018 indicated that the overall trophic state of this lake was eutrophic. The elevated nutrients lead to severe algal blooms throughout the summer. Many of the algal species found are often associated with taste and odor problems. In 2005, Sandy Creek Reservoir was treated with copper sulfate to control an algal bloom problem.

It is important to reduce nutrients and stormwater runoff entering Sandy Creek. Efforts should also be made to determine if there are opportunities to install agricultural and forestry best management practices to reduce nutrient loading, fecal coliform bacteria, turbidity and stormwater runoff volume.

7.7.2.2 Richland Creek

Richland Creek [AU#: 17-22] is a Class C tributary of Deep River, spanning 14.6 miles and located in southeast Randolph County. The watershed is dominated by forested and agricultural land uses. There are no major or minor NPDES or animal feeding operation permits located in the watershed. The NC Zoological Park is located within the drainage. An unnamed tributary of Richland Creek runs along the southwestern portion of the property.

Results from 2018 benthic macroinvertebrate sampling suggest a Good-Fair water quality bioclassification at station BB409. A reduction of EPT taxa was observed from the historical high EPT richness seen in 1998. The loss of intolerant taxa, particularly mayflies and long-lived stoneflies, is evidenced by the increase in the EPT biotic index to the highest value yet recorded at this reach of Richland Creek. The aquatic habitat was good, and typical water quality measurements were within normal parameters for a Carolina Slate Belt stream. However, a sewage smell was noted at the time of sampling and high amounts of foam were visible on the surface of the water. As there are no permitted NPDES dischargers on Richland Creek, it is likely that a high nutrient load originates from non-point sources upstream, such as animal operations. Sampling should continue to be conducted in this stream to monitor changing conditions.

BB409	
Year	**Bioclassification**
2003	Good
2009	Good
2018	Good-Fair

7.7.2.3 Brush Creek

Brush Creek [AU #: 17-23a and 17-23b] is a Class C waterway receiving drainage from southeastern Randolph County and the western portion of Siler City in Chatham County. Brush Creek (AU 17-23a) is a 19-mile stretch that flows from the headwaters to the confluence with Little Brush Creek. Fish were last sampled at site BF24 in 2018, when it received a bioclassification of Good-Fair. The mature forested riparian corridor provides good shading to the creek but is bordered by row crops. Instream habitats are high quality Carolina Slate Belt types, primarily rocky runs with riffles, chutes, and pools. Abundant angular boulder and cobble substrates covered with periphyton make sampling here extremely difficult. In 2018, the fewest species were collected at this location to date, with a 12-point drop in overall NCIBI score since 2013.

The most notable changes occurred among the three trophic metrics that lost a total of eight metric points due to a dominance shift back to the bluehead chub (intermediate omnivore, 534% increase since 2013), replacing highfin shiner (intermediate insectivore, 91% decrease since 2013). However, the intolerant Piedmont darter was collected in 2018 (n=1), and the pollution tolerance metrics (number of intolerant species and percent tolerant fish) maintained their maximum scores of five over the last cycle. Also, several species exhibited young-of-year cohorts in 2018, indicating good recruitment: redbreast sunfish (n=14); green sunfish (n=2); creek chubsucker (n=11); bluehead chub (n=4); bluegill (n=2); redlip shiner (n=1); white shiner (n=2); and highfin shiner (n=22).

The fish assemblage of Brush Creek in 2018 was closer in species composition to the 2009 sample collection than the 2013 collection. The 2018 NCIBI score was just two points shy of a Good rating (as seen in the first two assessments in 2003 and 2009), which could have occurred with the addition of just one more fish taxa, such as warmouth or either pickerel species, thereby boosting the percent piscivore metric score. Overall, the water quality parameter measurements and the fish community shifts seen in 2018 do not appear to reflect a major change in water quality in this catchment.

BF24	
Year	**Bioclassification**
2018	Good-Fair

BB113	
Year	**Bioclassification**
2003	Good-Fair
2009	Good-Fair
2018	Poor

The lowermost section of Brush Creek [AU#: 17-23b] is a five mile stretch downstream of the confluence of Brush Creek and Little Brush Creek. There is one stormwater NPDES permit, one swine animal feeding operation permit, and three minor wastewater permits in the watershed. Land use from the headwaters to the mouth is dominated by forested land and agriculture. This AU is impaired for benthos. Brush Creek has been sampled at station BB113 since 1993, and in 2018, was the first rating below Good-Fair for this stream (Poor rating). A historically low number of EPT taxa were collected in 2018. In fact, only a total of 22 organisms were collected by a four-person biologist team over the course of one and a half hours. Instream macroinvertebrate habitat was adequate to support a potentially diverse community although few macroinvertebrates were found. Watershed land use is primarily forest (52%), but the high amount of animal operations and cultivation that is also present (32%) appears to have contributed to the excessive nutrient and sediment loads noted at the time of sampling, as well as the bad sewage-like water odor. Some disturbance in the watershed appears to have had a catastrophic effect on the aquatic biota of this stream, as evidenced by the increase in the specific conductance, a proxy measurement of pollution. *Field staff noted that the land-use effects on the water quality of this stream should be investigated further.*

7.7.2.4 Deep River in the Upper Deep River Watershed

The Deep River [AU#: 17-(10.5)d2] is a Class C waterway that spans an 18.2-mile segment and flows from Gabriels Creek near Franklinville to the Brush Creek confluence near the Town of Bennett. The following municipalities are contained in whole or in part within the catchment above this section of the Deep River: Kernersville; Greensboro; High Point; Jamestown; Pleasant Garden; Archdale; Randleman; Asheboro; Franklinville and Ramseur. The watershed is impacted from agriculture-based land use in the immediate area around the Deep River as well as the cumulative impact of upstream point and nonpoint sources.

The Deep River is impaired for copper standard violations in AU#: 17-(10.5)d2. The Ramseur WWTP discharges to this section of Deep River and the facility had several violations of total suspended solids during the summer of 2018 (June, July, August). During this time, the operator in responsible charge (ORC) stated that algae had grown in the finishing pond, which he believes caused the violations. He treated the algae in the pond with copper sulfate. Copper sulfate is used on occasions to treat small waterbodies to reduce the occurrences of nuisance algal blooms and aquatic weeds and is a possible source to consider for this impairment. It is unknown if copper sulfate treatment at the Ramseur WWTP is a common occurrence, but the frequency of treatment should be further investigated to see if treatment can be correlated to increased concentrations of copper in Deep River. Monitoring for instream metals ceased in 2007 due to a proposed change in the metal's standards. The instream copper standard went through the triennial review process in 2015. For the most up-to-date information on this process, refer to DWR's Surface Water Standards website. *This segment of the Deep River should be assessed using the new dissolved copper standard.*

Fecal coliform sampling data at ambient monitoring stations B5070000 and B5100000 in AU#: 17-(10.5)d2 and station B5190000 in AU#: 17-(10.5)e2 show consistent elevated fecal coliform bacteria concentrations exceeding the 400 colonies/100 mL water quality standard during most years with some years recording annual exceedances rates of more than 40% along the Deep River (*Figure 7-34* and *Figure 7-35*). These elevated fecal coliform bacteria concentrations can approach and exceed 10,000 colonies/100 mL, as recorded at stations B5070000 and B5100000 since 2002. Notably, between station B5070000 and B5100000 the annual fecal coliform bacteria concentrations often increase, suggesting the drainage area between these two stations is potentially contributing additional fecal coliform bacteria to the Deep River (*Figure 7-35*). The elevated values at station B5100000 are followed by a considerable decline in fecal coliform bacteria levels at station B5190000 during 14 of 19 years on record (*Figure 7-35*). Alongside elevated fecal coliform bacteria concentrations, elevated turbidity pulses have been recorded with values exceeding the 50 NTU water quality standard during several years with some years recording annual exceedance rates of more than 15% (*Figure 7-36*). While annual mean turbidity values are often below 50 NTU, turbidity pulses at stations B5100000 and B5190000 have recorded values that exceed 300 NTU. *Potential sources of fecal coliform bacteria and turbidity should be investigated to prescribe appropriate mitigation measures.*

Dissolved oxygen along Deep River is often not a concerning parameter; however, it is worth noting that higher dissolved oxygen levels are recorded at station B5190000. Annual mean dissolved oxygen levels are typically more than 10 mg/L (*Figure 7-37*). The annual median pH profile from upstream to downstream for these four stations along the Deep River is also notable because station B5190000 changed from having an annual median value lower than the upstream stations to a median value that approaches or exceeds the values recorded upstream (*Figure 7-38*). This notable change in water chemistry could indicate the presence of potential algal blooms, it could be the result of sampling changes, or it could exist for another reason. While these changes in parameters occurred, the co-located benthos monitoring station (BB298) consistently recorded either a Good or Excellent bioclassification since 1983 through 2018, suggesting this change has not impacted the benthos community in the area. Benthos monitoring station (BB298) is discussed in more detail later in this section.

Total nitrogen concentrations generally decline between these four stations along the Deep River; however, the annual mean values still hover around and often exceed 1 mg/L (*Figure 7-39*). The NOx concentrations recorded in this section of the Deep River generally decline from upstream to downstream except for a few years (2014, 2018, 2019 and 2020), which have similar NOx concentrations from upstream to downstream. This could be attributed to the declines in NOx concentrations from Haskett Creek (as discussed previously). While these NOx concentrations have declined overtime, the annual mean values are still above concentrations considered normal for healthy piedmont streams ($\leq$0.3 mg/L) (*Figure 7-40*). The total Kjeldahl nitrogen concentrations contribute to the elevated total nitrogen concentrations observed in the Deep River with a more variable chemical profile from upstream to downstream. Generally, the annual mean concentrations decline from upstream to downstream, however there are multiple years during which downstream stations will record higher annual mean total Kjeldahl nitrogen concentrations compared to the nearby upstream station (*Figure 7-41*). Similar to total Kjeldahl nitrogen, ammonia concentrations display a similar chemical profile and variability (*Figure 7-42*). Total phosphorus concentrations have declined considerably in the Deep River since 2002, although annual mean concentrations often hover around and exceed the concentrations considered normal for healthy Piedmont stream (0.05 mg/L) (*Figure 7-43*).

Figure 7-34: Annual Mean Fecal Coliform Bacteria Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

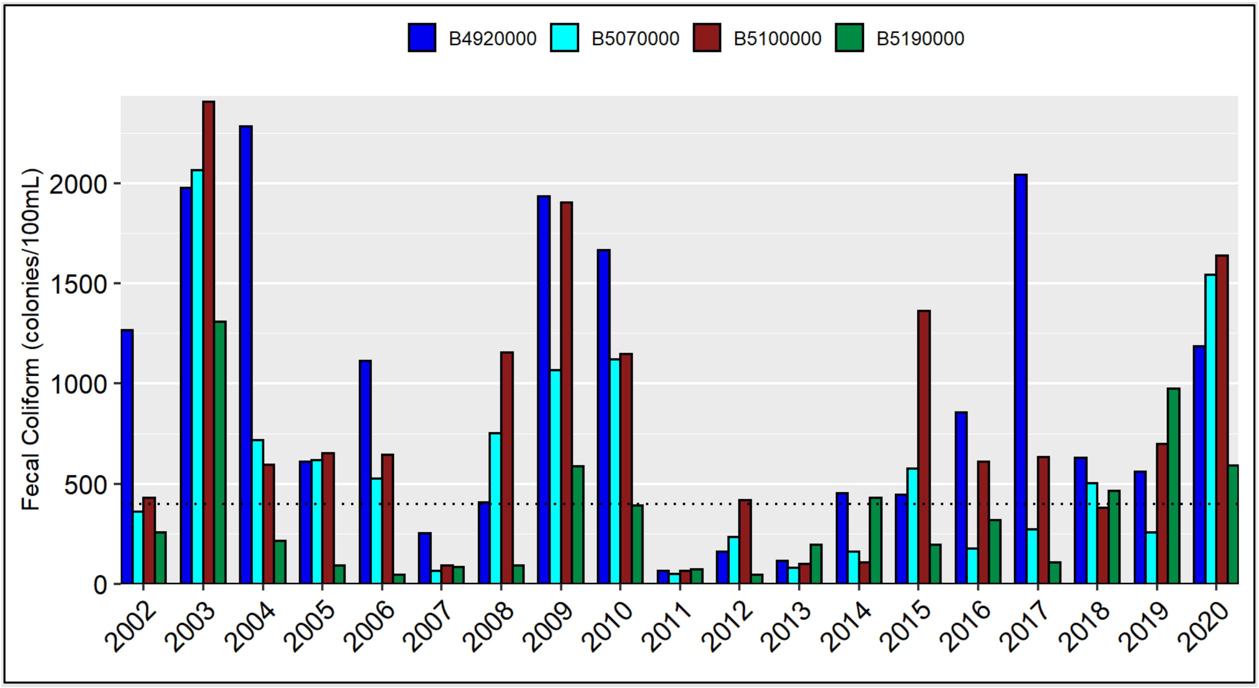


Figure 7-35: Annual Exceedance Rates for Fecal Coliform Bacteria for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

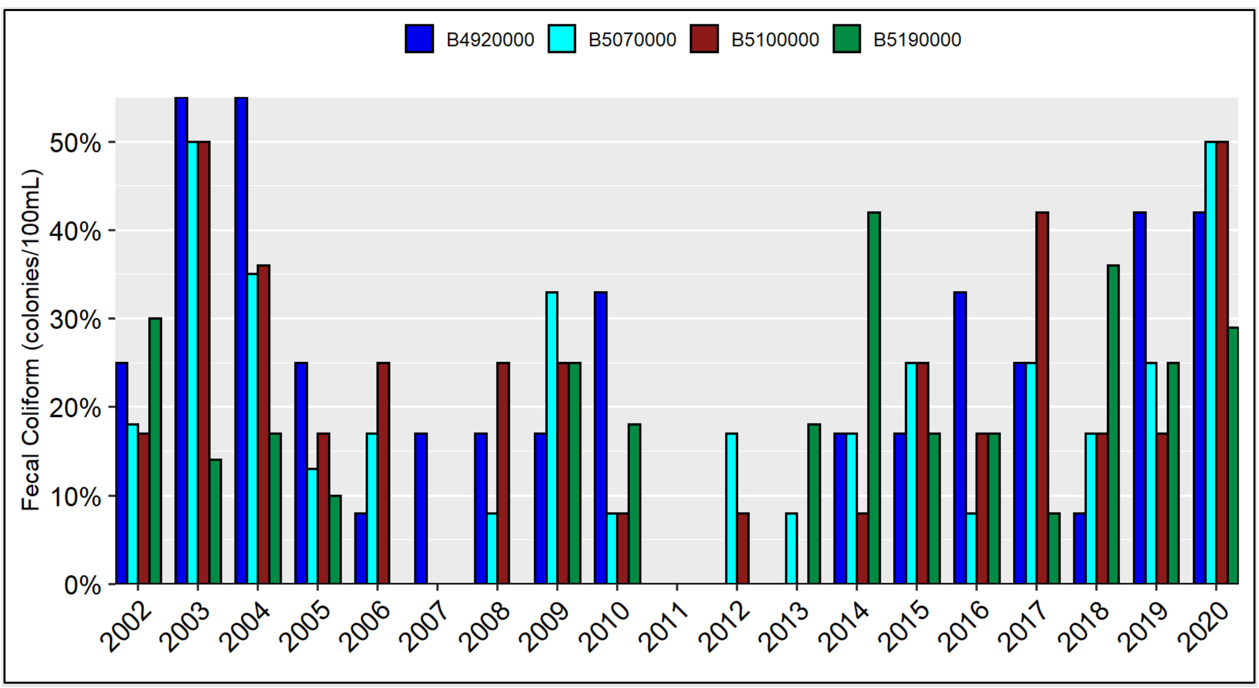


Figure 7-36: Annual Exceedance Rates for Turbidity for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

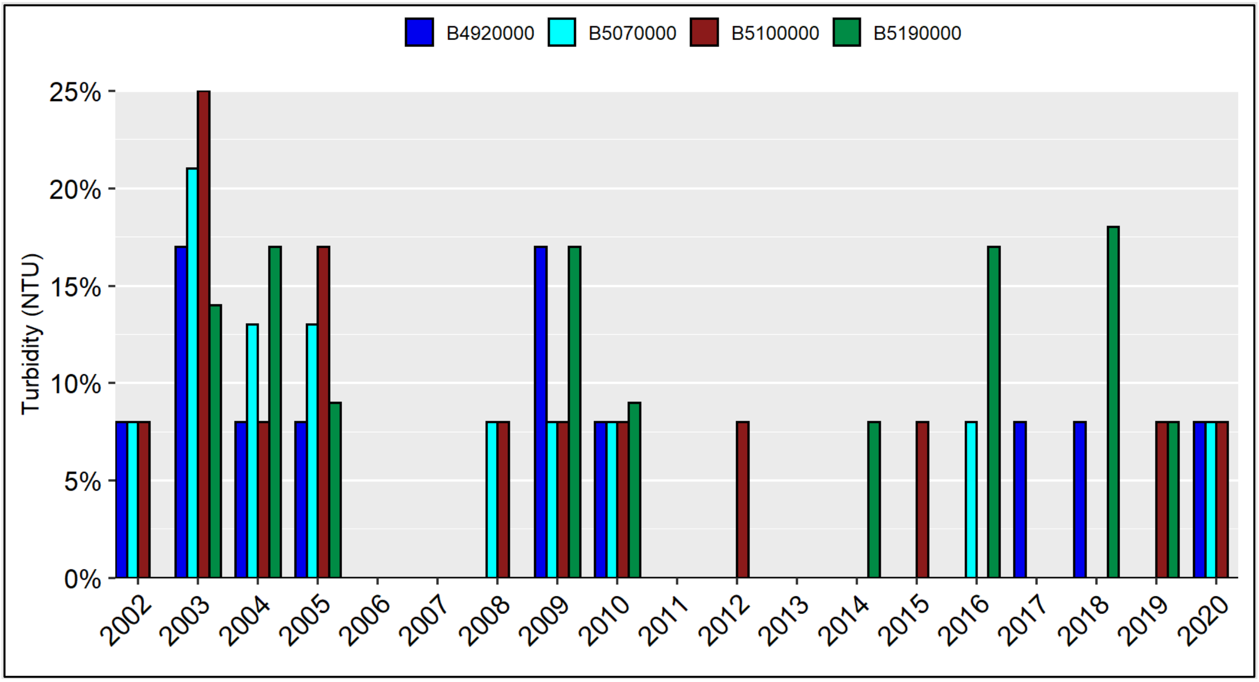


Figure 7-37: Annual Mean Dissolved Oxygen Concentrations for Ambient Surface Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

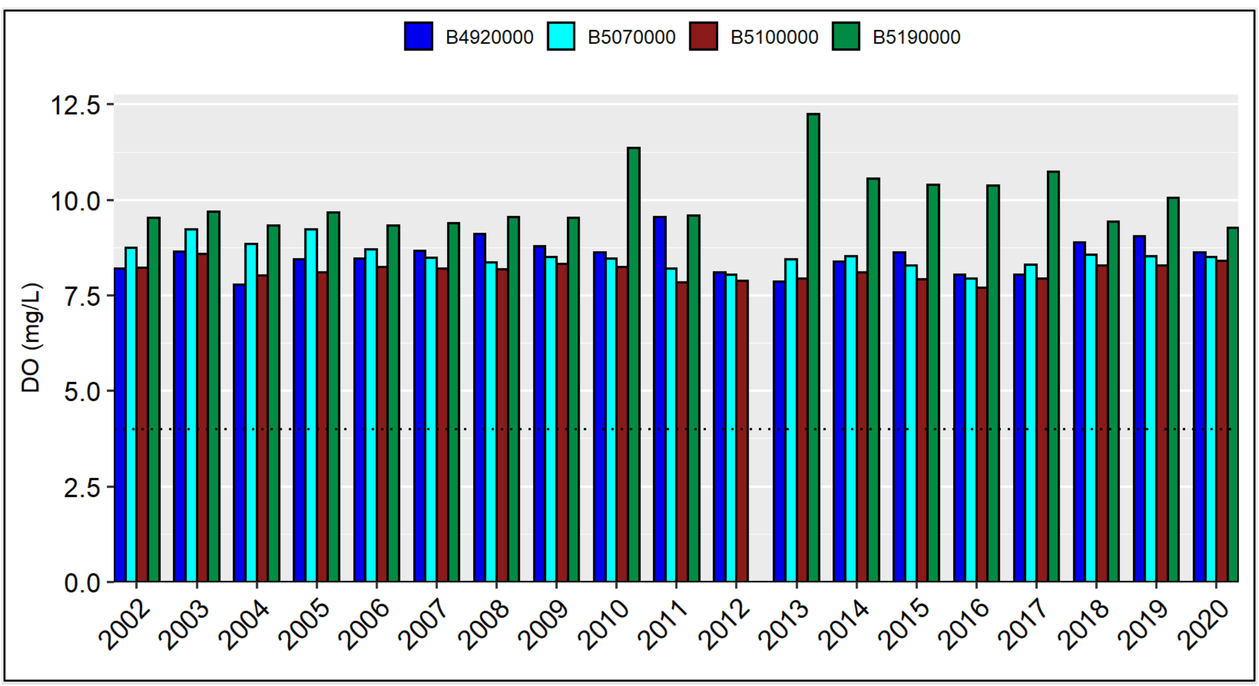


Figure 7-38: Annual Median pH Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

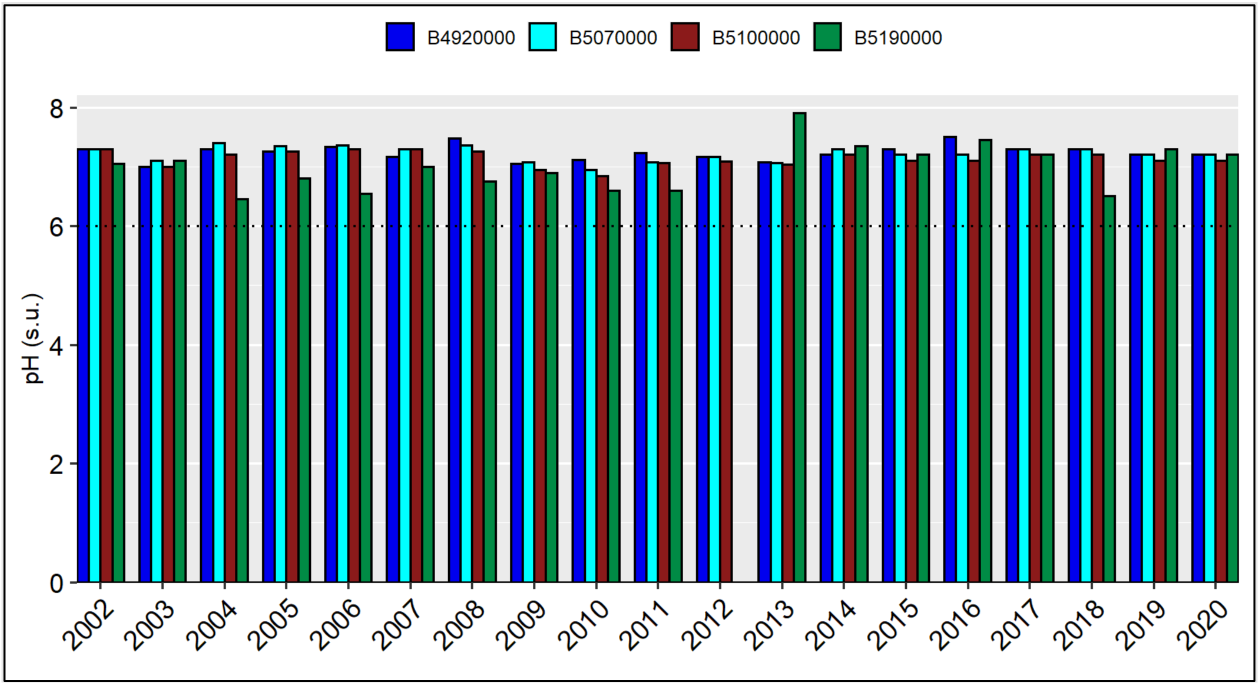


Figure 7-39: Annual Mean Total Nitrogen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

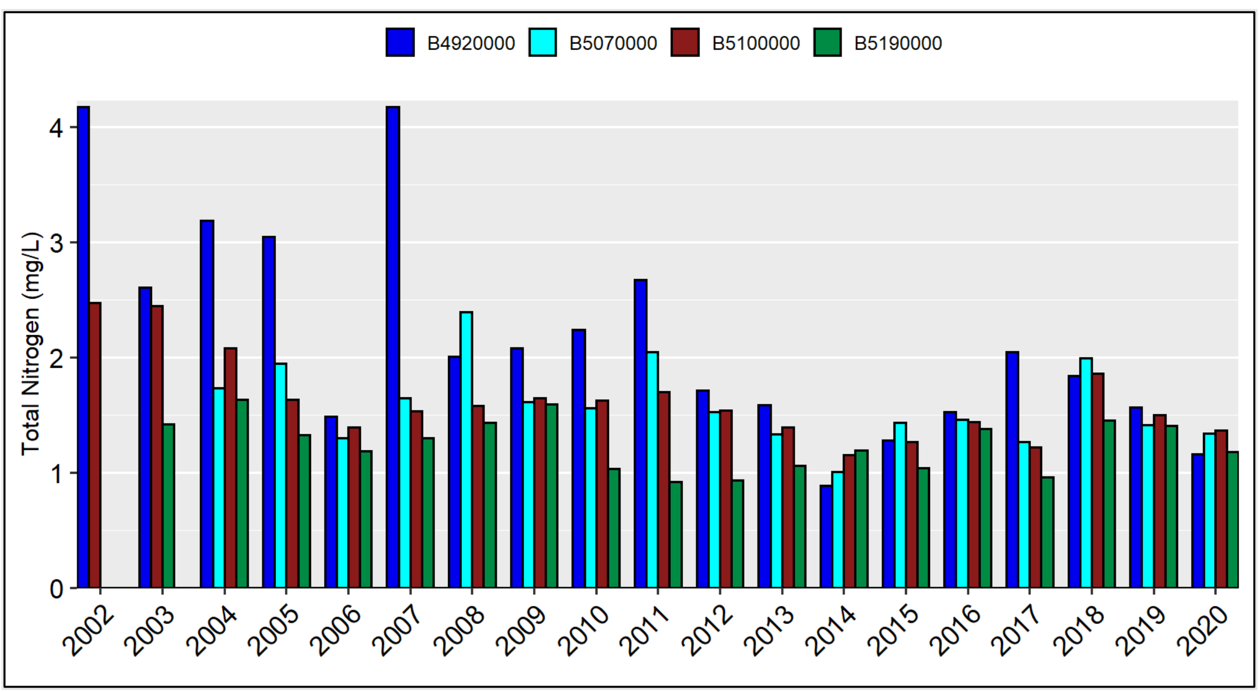


Figure 7-40: Annual Mean Nitrate+Nitrite Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

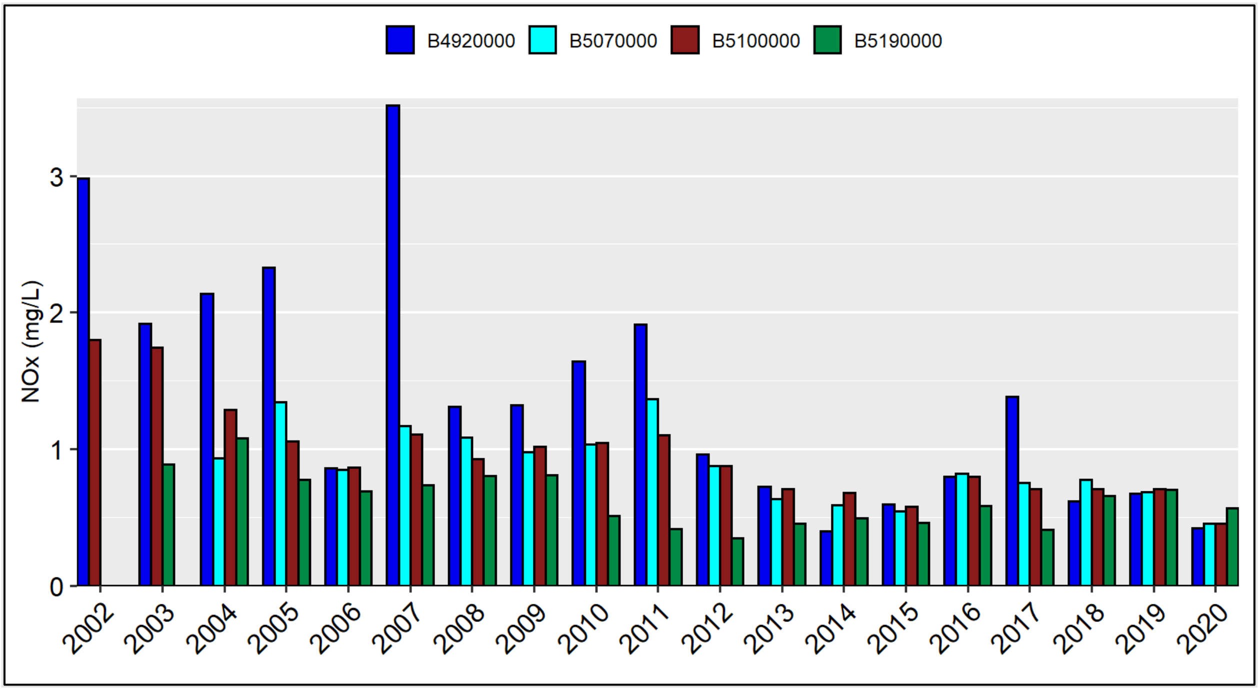


Figure 7-41: Annual Mean Total Kjeldahl Nitrogen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

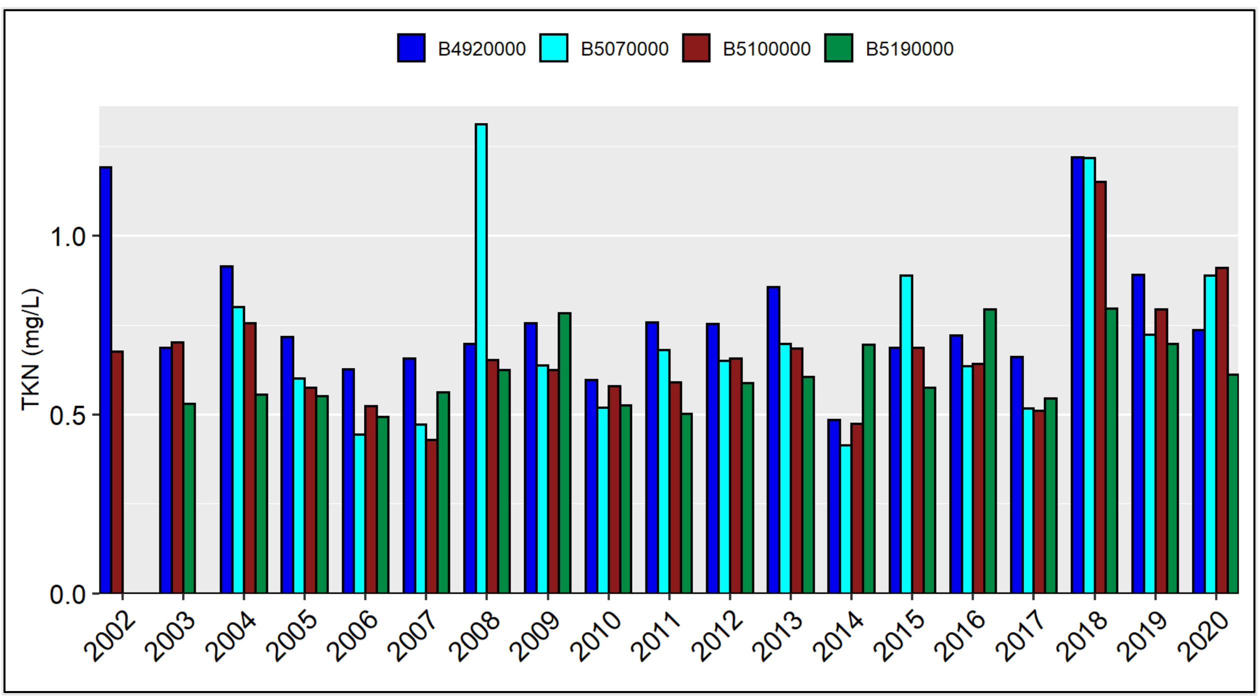


Figure 7-42: Annual Mean Ammonia Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).

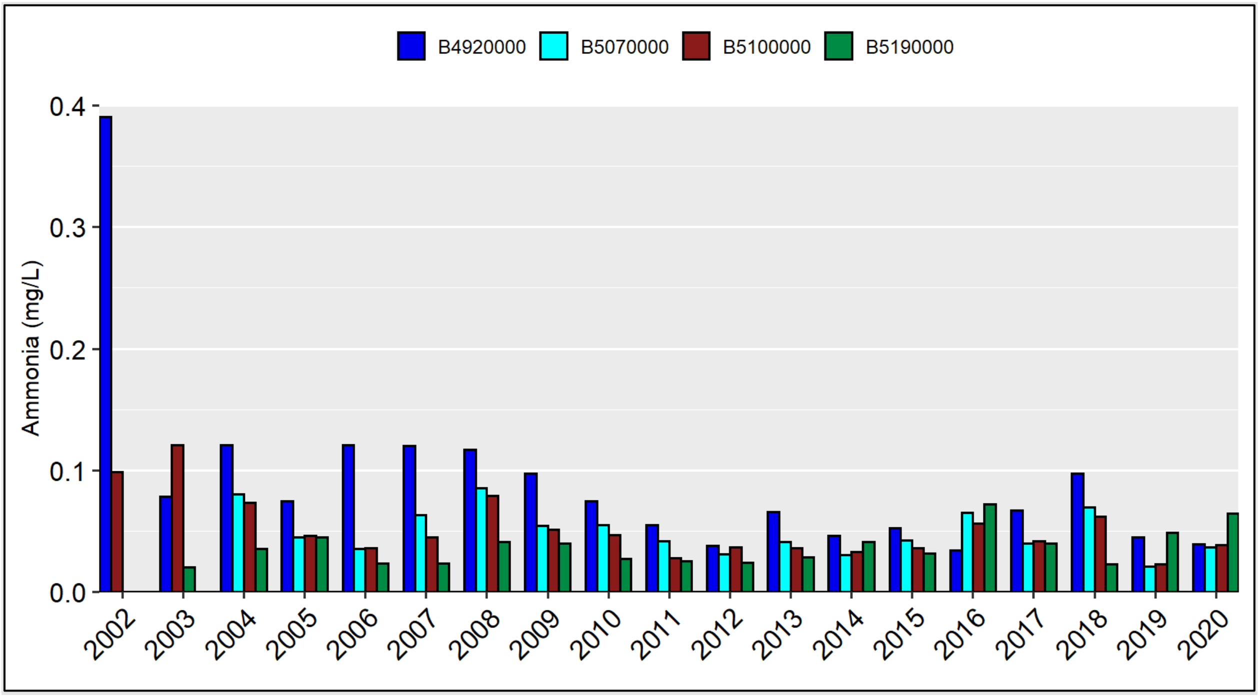
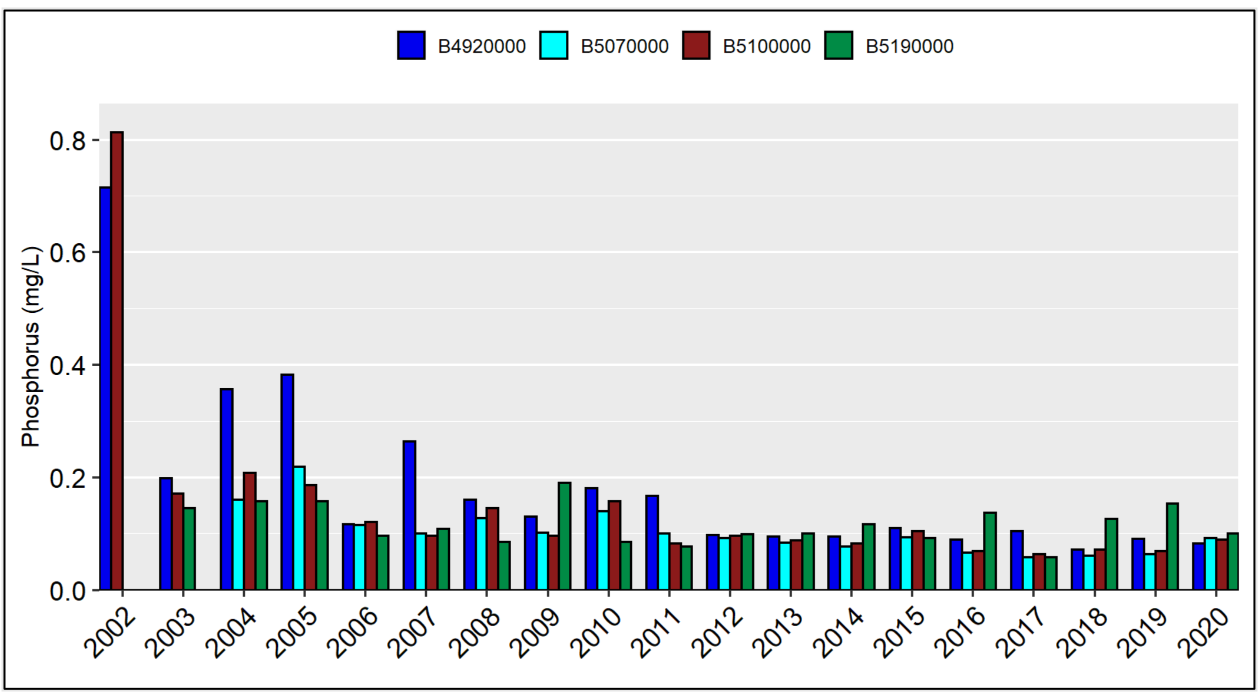
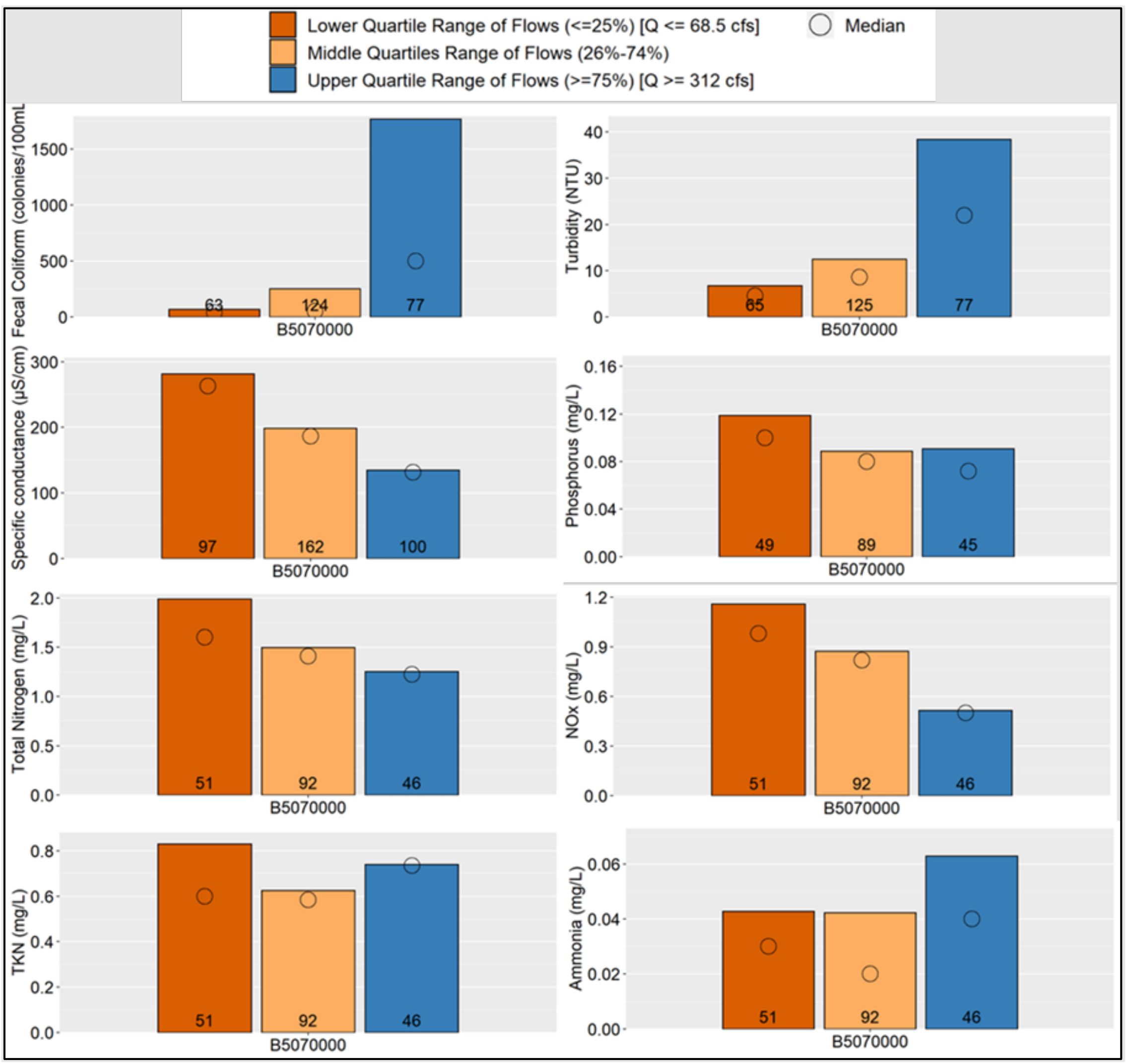


Figure 7-43: Annual Mean Total Phosphorus Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B4920000, B5070000, B5100000, and B5190000).



At station B5070000, there is a co-located USGS gage (02100500) that supports an analysis of how water quality parameters vary with respect to flow dynamics in the Deep River. Overall, fecal coliform bacteria concentrations, turbidity, and ammonia levels are typically higher during higher flows (≥312 cfs) and lower during low flows (≤68.5 cfs), which suggest storm driven flows are contributing to the elevated levels detected in the Deep River (*Figure 7-44*). Specific conductance, total nitrogen, and NOx concentrations display an inverse relationship with flow as lower flows (≤68.5 cfs) typically have higher values while higher flows (≥312 cfs) typically have lower values (*Figure 7-44*). This could be driven by contributions from upstream point source dischargers. Total Kjeldahl nitrogen and total phosphorus concentrations are reflective of the contributions from nonpoint and point source dischargers. The higher total Kjeldahl nitrogen and total phosphorus values during low flows (≤68.5 cfs) suggest point source influence, although the next highest concentrations typically occur during high flows (≥312 cfs), which could be contributions from nonpoint sources (*Figure 7-44*).

Figure 7-44: Average and Median Values for Water Quality Data Collected at Station B5070000 between 2002 and 2020 Separated into Flow Bins Based on Discharge Percentiles using Data Collected between 1991 and 2020 at USGS Gage 02099000.



BB452	
Year	Bioclassification
2003	Good
2008	Good
2013	Good
2018	Good

Deep River benthos station BB452 is located at the southern edge of Ramseur in eastern Randolph County. The land use in the watershed is comprised of rural and agricultural land below Randleman Lake, which mixes water from both High Point and Greensboro. Two major NPDES permitted dischargers in the vicinity of Randleman and water from eastern Asheboro contribute to the high specific conductance measured at this Deep River site. Nutrient enrichment also appears to be a problem as high biomass of algae and aquatic macrophytes were noted in the river channel. Due to a lack of time, this site was collected using the EPT method in 2013 rather than using the full scale method as has been done for each prior sampling event. This makes comparison of results difficult. However, the bioclassification of Good in 2013 was the same as for the prior two sampling events in 2003 and 2008 and is indicative of stable conditions at the site regarding the benthic community. In 2018, this site rated Good, as it has been for four consecutive cycles across a period of 20 years. Additionally, in 2018, EPT abundance and NCBI received their best values since monitoring began at this station in 1983. Overall, the trend at Deep River (SR 2615) is one of steady improvement.

BB298	
Year	Bioclassification
2002	Good
2003	Excellent
2008	Good
2013	Good
2018	Excellent

The Deep River segment [AU#: 17-(10.5)e2] is supporting the current designated uses. AMS Station B5190000, discussed previously, is co-located with benthos community site BB298. Benthos sampling site BB298 is in north central Moore County, about four miles north of Robbins. The site has consistently scored well for biotic indices and bioclassification since monitoring began 35 years ago. In each case, the bioclassification has been either Good or Excellent. The bioclassification decreased from Excellent in 2003 to Good in 2008; however, this does not necessarily reflect a change in water quality. The 2013 collection had the highest number of EPT taxa since the 1998 collection. The BI value, however, was near the top of the range for all samples collected at the site. In 2018, this site received a bioclassification of Excellent. The overall trend for this station is somewhat mixed, with the total of number of taxa (ST) and EPT decreasing over time. However, EPT BI and BI, which are based on the pollution tolerance of each taxon and their respective abundances, have either been stable or improving. Overall, there is little indication of water quality problems at the site. The DWR Biological Assessment Branch should continue to monitor station BB298 as long as resources allow.

It is important to understand how the upstream activities in this watershed are affecting the downstream biological communities. DEQ's Modeling and Assessment Branch will be evaluating and modeling the Deep River watershed below Randleman Lake to address the nutrient-related impairments in the Deep and the Cape Fear rivers. The results of the modeling will help resource managers to develop a plan to address these impairments. The need to reduce nutrients from point and nonpoint sources is in order to achieve water quality standards in this section of the Deep River and the Cape Fear River.

7.7.3 McLendons Creek Watershed (0303000303)

The McLendons Creek watershed drains central Moore County. Its headwaters are located in the Sandhills ecoregion, and its confluence with the Deep River is roughly 15 river miles downstream. Low gradient stream characteristics are present throughout this Triassic Basin stream; the Town of Carthage is the only municipality within the watershed. There is one NPDES stormwater permit associated with an asphalt plant, two permitted animal operations in the watershed (swine) and one wastewater irrigation permit associated with a Boy Scout camp. There are no designated High Quality Waters or Outstanding Resource Waters in this watershed, but there are no listed impairments. A USGS gage station, 0210108450, is located on Suck Creek in the basin. As of 2022, there were no major or minor NPDES wastewater facilities. AFO facilities consist of two state swine permits. There is also one NPDES and one state stormwater facility and 13 acres of non-discharge wastewater irrigation application fields in this watershed. The field acreage is entirely associated with the Occoneechee Council – Boy Scouts of America Camp Durant WWTF (WQ0029168, 13.01 acres). The most common land use is forest (67%), although a large portion of this forested land has been in timber management for several decades. Moore County is located in one of the primary timber management regions of North Carolina and the middle Cape Fear basin has seen nearly 100 years of forestry management over multiple growth cycles (Polizzi pers. comm., 2022). According to aerial photographs on ArcGIS and Google Earth, clear cutting has been recently done on several tracts in the watershed, and it appears that forestry best management practices may not have been followed in some instances. According to the Forest Practice Guidelines Related to Water Quality (02 NCAC 60C), "[a] streamside management zone (SMZ) shall be established and maintained along the margins of intermittent streams, perennial streams and perennial waterbodies" and the "SMZ shall confine visible sediment resulting from accelerated erosion." The guidelines also state: "Stream obstruction and the impediment of stream flow or degradation of water quality shall be prevented by keeping soil and debris from forestry-related, land-disturbing activities out of intermittent streams, perennial streams and perennial waterbodies" (NC Forest Service, 2018). Aerial photos like the one shown below of an unidentified logging tract in the McLendons Creek watershed indicate that a buffer is absent or appears to be too sparse and non-contiguous on some intermittent and perennial stream channels (*Figure 7-45*). Also, upon close inspection, an abundance of woody debris and felled trees can be seen crisscrossing an intermittent stream channel throughout the tract. There also does not appear to be adequate ground cover on the site to restrain erosion.

In order to protect water quality throughout the McLendons Creek watershed and the Cape Fear River Basin as a whole during timber harvests, *best management practices should be implemented as outlined in the North Carolina Forest Service's North Carolina Forestry Best Management Practices Manual to Protect Water Quality*. As funds are available, more inspectors should be hired to monitor timber harvesting in the basin and timber harvesting inspections should be increased. The establishment of a conservation program for forest buffers similar to existing federal and state cost share programs for agricultural lands should also be considered. The voluntary program could provide an economic incentive to landowners to conserve and manage forest buffers. Conserving and managing the forest buffers, in turn, could protect critical drainage areas, protect water quality, and provide aquatic and terrestrial habitat throughout the basin.

Water quality and biological monitoring activities should also be increased throughout the McLendons Creek subwatershed as resources allow. Fish and benthos special studies should be undertaken on tributaries that have the most potential land disturbance to determine whether these activities are impacting biological communities.

Figure 7-45: Aerial Photos of an Unidentified Logging Tract in the McLendons Creek Watershed.

Three benthos samples have been taken in the basin since 2003 at McLendons Creek (station BB173), Parkwood Branch (station BB175) and at Haystack Creek (station BB456). All are special study sites. McLendons Creek site BB173 (stream index # 17-30, stream class C) is within a tract that has been recently timbered, and it is recommended that another special study sample be done at this site. The land use in the Parkwood Branch (stream index # 17-30-5-4, stream class C) watershed is predominantly agriculture and forest, although the majority of the forested land in this drainage appears to be managed for timber. Buffers are mostly intact, but there are some buffer disturbances due to ongoing timber harvesting and forested land is in varying stages of regrowth. Haystack Creek (stream index 17-30-1-2, stream class B) is a tributary to Suck Creek. This mostly forested watershed lies almost entirely within the boundary of the Boy Scouts of America Camp Durant property. All three sites should be added to the regular Cape Fear benthos sampling cycle as resources to do so become available so that a clearer picture of biological health within the McLendons Creek watershed can be ascertained.

BB173	
Year	**Bioclassification**
2016	Fair
BB175	
2005	Good
BB456	
2021	Not Impaired

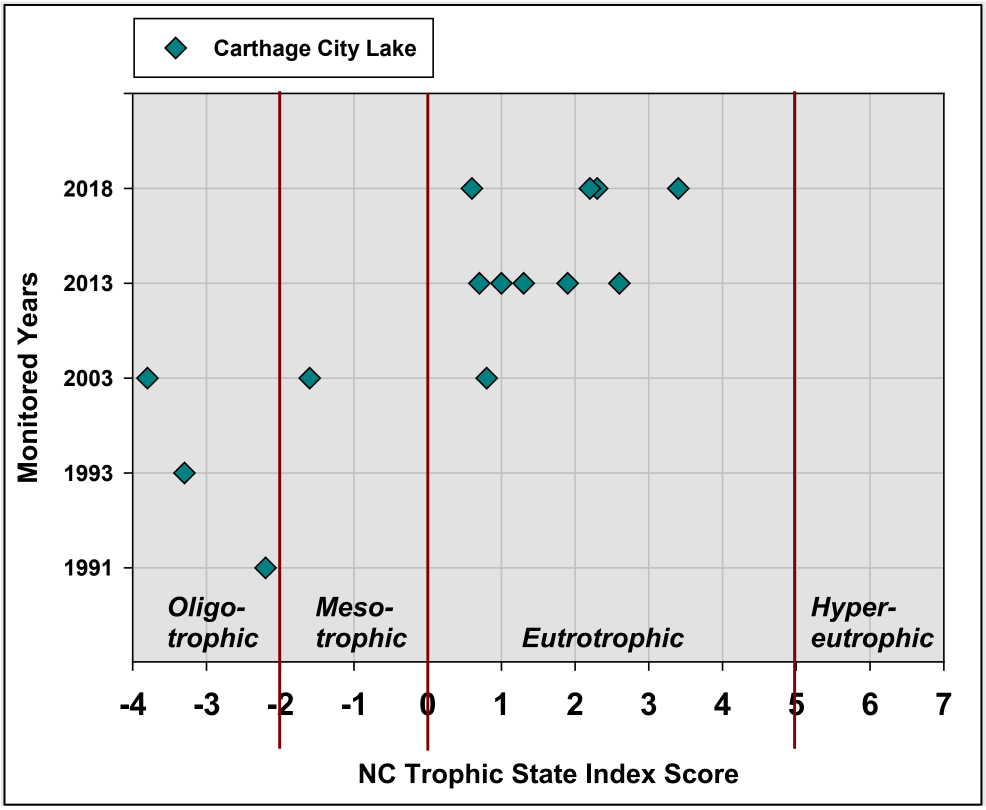
There is one fish community station in the watershed, BF103, McLendons Creek, and it is a regional reference site. There are wide forested riparian buffers and good canopy shading at this station. A previously logged tract just upstream on the left appeared to be in regrowth at the time of sampling in 2018. Instream habitats are primarily sandy runs with some undercuts and patches of woody debris, and a few short gravel riffles. There were no obvious habitat changes since the last time the site was sampled in 2013. A lower diversity fish community was collected in 2018, with six fewer species compared to the 2013 sample. However, the intolerant Piedmont darter (n=4) was regained in 2018, and new records of eastern mosquitofish were noted as well. Overall, there were shifts in half of the 12 NCIBI metrics (number of species, fish, darters, sunfish, intolerant species and percentage of species with multiple ages), but the total score and bioclassification remained unchanged since the last basin cycle. Species noted with young-of-year cohorts in 2018: bluehead chub (n=17); redfin pickerel (n=1); redbreast sunfish (n=1); white shiner (n=9); and highfin shiner (n=1). Water quality parameters, including specific conductivity, have remained consistent over three basin cycles. There are now 25 fish species known from this location. Overall, the fish community's trophic stability has remained unchanged over 20 years, as indicated by consistent overall metric scores, and four consecutive NCIBI ratings of Good.

BF103	
Year	**Bioclassification**
2018	Good
2013	Good
2009	Good
1998	Good

7.7.3.1 Carthage City Lake

Carthage City Lake, located in the headwaters of Killets Creek [stream index 17-30-3-(1), stream class WS-III;CA], is a small water supply lake for the Town of Carthage in Moore County. The deepest part of the lake, approximately eight to 10 feet, is located at the intake structure. The lake was impounded around 1950 and is spring fed. In dry weather conditions, water is pumped six miles from Nicks Creek (located in HUC 0303000403) to maintain an adequate water level. The watershed is moderately developed. Water quality monitoring of this small reservoir was most recently conducted monthly from May through August 2018. Surface DO ranged from 7.6 to 8.5 mg/L and surface pH ranged from 6.2 to 6.9 s.u. Due to the location of this lake in the Sandhills region of the state, the combination of mineral soils and pine trees contribute to pH values that can be lower than that of lakes in the Piedmont region. Secchi depths for Carthage City Lake ranged from 0.7 to 1.2 meters in 2018. Total phosphorus values were lowest in May (0.03 mg/L) and greatest in August (0.06 mg/L). Total Kjeldahl nitrogen followed a similar concentration pattern (range = 0.45 to 0.79 mg/L). Ammonia values were below the DWR laboratory detection level of 0.02 mg/L and nitrite plus nitrate ranged from <0.02 to 0.04 mg/L. Chlorophyll *a* ranged from 8.8 µg/L in June to 48.0 µg/L in August. The chlorophyll *a* value in August was greater than the state water quality standard of 40.0 µg/L. Carthage City Lake has shown a trend transitioning from oligotrophic in the late 1990s and early 2000s to eutrophic, i.e., exhibiting elevated biological productivity, in the 2010s (*Figure 7-46*). Changes in land use and other activities in the Carthage City Lake and Nicks Creek watersheds should be investigated to determine the cause of the shift in the lake's trophic status.

Figure 7-46: Carthage City Lake Trophic Status Change, 1991-2018.



7.7.4 Middle Deep River Watershed (0303000304)

The Middle Deep River watershed is located in portions of northwestern Moore, northeastern Montgomery and southeastern Randolph counties. The Town of Robbins is the only municipality fully within the watershed. Seagrove, Star, Candor and Biscoe fall partially in the watershed, which includes the major tributaries of Cotton Creek [AU #: 17-26-5-3a, b1, b2, b3, & c]**,** Lick Creek [AU #: 17-26-5-3-1] and Cabin Creek [AU #: 17-26-5-(1)b]. The most common land use is forest (63%). There are 40 miles of designated HQW and no Outstanding Resource Waters in this watershed (*Table 7-17*). In July 1989, the Environmental Management Commission adopted HQW rules that allow for additional protections for this subset of waters with water quality higher than the standards (15 NCAC 02B .0224). The HQW reclassification of the Deep River [AU # 17-(25.7), 17-(28.5) and 17-(32.5)] from Grassy Creek to highway NC 42 (in HUC 0303000306) occurred on August 1, 1990.

As of 2022, there was one major and one minor NPDES wastewater facility and two single family NPDES permits with a combined as-built discharge of 1.9 MGD. The major NPDES discharger is the Town of Robbins WWTP (NC0062855; 1.3 MGD), which discharges to the Deep River. The minor NPDES discharger is the Town of Star (NC0058548; 0.6 MGD). Animal feeding operation (AFO) facilities consist of eight state swine and two state cattle permits.

There are also six NPDES, four state stormwater facilities and 198 acres of non-discharge wastewater irrigation and residual solids land application fields in this watershed. Most of the fields are residual solids land application fields associated with the City of Asheboro (WQ0001684; 70.6 acres) and Harnett County (WQ0007066; 37.2 acres). There are also six wastewater irrigation fields; the largest of those are associated with the Seagrove-Ulah Metropolitan Water District WWTP (WQ0002648; 40 acres) and the Town of Candor WWTF (WQ0000633; 42 acres). The rest are three acres or less and are associated with restaurants, a church camp and a packing facility.

Table 7-17: High Quality Waters (HQW) in the Middle Deep River Subbasin (HUC10 0303000304).

Stream Name	AU #	Classification	Length (miles)	Data Type (station #)	2022 IR	
					Use Support	Category
Deep River	17-(25.7)*	C; HQW	12.4	None	No Data	3c
	17-(28.5)a*	WS-V; HQW	8.3	None	No Data	3c
	17(28.5)b*	WS-V; HQW	2.0	None	No Data	3c
	17-(32.5)*	WS-V: HQW	4.0	Ambient B5575000	Supporting	2
Cedar Creek	17-26.5	C; HQW	6.3	None	No Data	3c
Scotchman Creek	17-28.3	C; HQW	3.3	None	No Data	3c
Lick Creek	17-28.3-1	C; HQW	3.9	None	No Data	3c

*HQW reclassification occurred in 1990 as part of a large statewide reclassification process for HQW. Reclassification was based on Excellent Water Quality. (1989 Report of Proceedings for the Proposed Reclassification of Certain Surface Waters in the Following River Basins as HQW: Cape Fear River + 13 others and Amendments to Surface Water Quality Standards for HQW.)

7.7.4.1 Fork Creek

Fork Creek [AU#: 17-25] drains southern Randolph and northern Moore Counties with the Town of Seagrove in its headwaters. It is a Class C waterway with a supplemental classification of HQW. Fish community site BF23 is approximately 3.9 miles upstream of the creek's confluence with the Deep River. The watershed is dominated by forest and agriculture, although the stream appears to be mostly well-buffered. Instream habitats are high quality Carolina Slate Belt types, including mostly rocky runs and pools with small chutes and riffles.

BF23	
Year	Bioclassification
2003	Good
2009	Good
2013	Excellent
2018	Good

This regional reference site achieves consistently high habitat scores. Sampling was last done in 2018 and showed an abundant and highly diverse fish community (including the intolerant Piedmont darter), with a net increase of six species since the 2013 sample. Four of these additional fish species represent new DWR records for this location: [bluegill (n=1); redear sunfish (n=1); creek chub (n=3); and eastern mosquitofish (n=2)]. Overall, a change of 14 species occurred between the 2013 and 2018 sample collections. The gain in bluehead chub, an intermediately tolerant omnivore found throughout the Piedmont, is the main reason for the trophic shift towards a higher percentage of omnivores present in 2018. Species represented by young-of-year in 2018 include redbreast sunfish (n=6); green sunfish (n=1); bluegill (n=1); creek chubsucker (n=2); white shiner (n=1); and swallowtail shiner (n=4). This is a highly diverse site, with a total of 35 known fish species collected over three basin cycles. Water quality parameters and fish collections at this site have consistently shown stable water quality, with one Excellent, and three Good NCIBI ratings.

7.7.4.2 Wolf Creek

BF123	
Year	**Bioclassification**
2004	Good

Wolf Creek [AU#: 17-26-4] is 11.6 miles long and a tributary to Bear Creek. It is a water supply (WS-III) watershed. The watershed is primarily forested, with some agriculture and timber management; a large parcel near the confluence is regrowing from recent logging activity. There is one fish community station on Wolf Creek, which received a bioclassification of Good when it was last sampled in 2004.

7.7.4.3 Cotton Creek

Cotton Creek [AU#: 17-26-5-3a; 17-26-5-3b1; 17-26-5-3b2; 17-26-5-3b3; 17-26-5-3c] is a WS-III classified tributary of Cabin Creek and is a WS-III watershed. The towns of Star and Biscoe are in the headwaters. Land use in the watershed is primarily forest and agriculture with some urban development in the headwaters. Interstate 73 crosses the stream in the upper portion of the watershed. There is one minor wastewater discharger, the Star WWTP (NC0058548), and three NPDES stormwater permits associated with a wood chip company, a foundry and a metal fabrication company.

The Star WWTP is a 100% domestic waste treatment facility and serves a town population of 876. The facility discharges to Cotton Creek in the Cape Fear River Basin. Cotton Creek [AU # 17-26-5-3b] is a zero-flow 7Q10 stream for summer and winter with an average stream flow of 0.9 cfs. The facility has a design flow rate of 0.6 MGD and is currently operating at 0.5 MGD. During the last permit cycle (2016-2021), this facility had four Notices of Deficiency (NODs), all for monitoring frequency issues, and 16 Notices of Violation (NOVs). The notices were mainly for violations of limits for biological oxygen demand (BOD), fecal, TSS, and a few for NH3-N, DO and pH. There were also NOVs for frequency violations for several parameters and four NOVs for aquatic toxicity violations. There were also 13 enforcement actions over the permit cycle. Only three of these enforcement actions were for violations in the last two years (2019 and 2020). Cotton Creek appears as an impaired water on the 303(d) list for benthos and has a legacy impairment for total copper. Impacts to the stream have in the past been attributed, in part, to the discharge from the Star WWTP. In addition to the 303(d)-listed parameters, there is an established total maximum daily load for cyanide, nickel, chromium, lead, total residual chlorine (TRC) (*Table 7-13*).

In March 2003, the state encouraged the towns of Biscoe and Star to pursue a regional treatment facility with one discharge instead of two. An additional benefit would be the removal of both discharges from zero flow streams. Another possible alternative is land application or non-discharge. DEQ also recommended that both towns seek financial assistance to perform a regional feasibility study of the aforementioned wastewater treatment alternatives (2013 NPDES permit fact sheet for permit development).

Over many years, the DEQ Fayetteville Regional Office (FRO) has worked with Star WWTP and has helped them to improve their wastewater discharge. Star's whole effluent toxicity (WET) testing has greatly improved. In addition, during 2007-2008, the FRO took a more active role in the Cotton Creek watershed, working with different stakeholders to improve water quality. Some specific actions include:

- Conducting physical/chemical monitoring at 12 stations throughout the Cotton Creek watershed and stream walking much of the watershed to assist in identifying sources of water quality problems.
- Partnering with agencies such as the Montgomery County Soil and Water Conservation District and the US Department of Agriculture, Natural Resources Conservation Service to help facilitate communication with landowners and encourage them to implement agricultural best management practices and assist in identifying potential urban management measure locations.
- Working with the Montgomery County Health Department in having straight pipes that were identified during stream walks removed and septic systems repaired.

Based on the 2000 to 2020 effluent concentrations recorded at the Star WWTP, nitrogen and occasional fecal coliform bacteria are of concern and are most likely continuing to contribute to the impacts to water quality in Cotton Creek. Star WWTP discharges high concentrations of nitrogen into a small stream and has been shown to be impacting aquatic life in Cotton Creek as well as adding nutrients to the downstream reach, which is currently impaired for chlorophyll-a violations. Between 2009 and 2020, the total nitrogen ranged from 1.1 mg/L to 28.6 mg/L in their return flows (*Figure 7-47*). In 2019, the Star WWTP began sampling for NOx and total Kjeldahl nitrogen species in the effluent, indicating the system was operating properly as total Kjeldahl nitrogen were relatively low and most of the total nitrogen concentrations were comprised of NOx in the return flows (*Figure 7-47*). The NOx ranged from 6.4 to 25.0 mg/L based on data collected between 2019 and 2020. Between 2009 and 2020, the total phosphorus concentrations in the effluent ranged from 0.84 to 5 mg/L (*Figure 7-48*). Due to downstream impairments in the Cape Fear River behind Buckhorn dam, resulting from excess nutrients, *it is recommended that the WWTP optimize their facilities to remove as much nitrogen and phosphorus as technically feasible until an upgrade is required. This could help to improve water quality conditions until a watershed strategy is in place.*

Alongside elevated total nitrogen, elevated fecal coliform bacteria levels are recorded in the return flows. Between 2000 to 2020, fecal coliform bacteria levels ranged from less than 1 to 9,100 colonies/100 mL (*Figure 7-49*). While this point source discharger does have occasions when return flows have elevated fecal coliform bacteria, as noted by the permit limit violation previously, they are not the only source of fecal coliform bacteria in this watershed. Based on their 2020 effluent sampling, the fecal coliform bacteria levels ranged from less than 1 to 48 colonies/100 mL which is considerably lower than the 400 colonies/100 mL weekly average and 200 colonies/100 mL monthly average permitted limit. While this discharger maintained compliance with their permitted limits in 2020, the annual and median instream fecal coliform bacteria concentrations recorded downstream at station B5390800 were both calculated to be above 1,000 colonies/100 mL (*Figure 7-50A*). This suggests that nonpoint sources of pollution are impacting this waterway.

The annual mean and median turbidity levels in Cotton Creek are typically below the 50 NTU water quality standard (*Figure 7-50B*). During 2016 to2020, only one instantaneous value (73.7 NTU) was recorded to be above this water quality standard in May of 2020. As noted previously, there are recorded violations of the total suspended solids limit from the Star WWTP. Since 2010, the limit violations for total suspended solids in the Star WWTP effluent typically occurred in the months of December and January. Continuing to monitor turbidity and implement best management practices for both point and nonpoint source should be considered to protect Cotton Creek from elevated turbidity levels.

Nutrient (total nitrogen and phosphorus) concentrations in Cotton Creek are concerning as the annual mean and median concentrations are typically higher than concentrations considered normal for minimally impacted Piedmont streams (TN <0.8 mg/L; TP $\leq$ 0.05 mg/L) (*Figure 7-50C* and *Figure 7-50D*). The elevated total nitrogen concentrations in Cotton Creek are primarily composed of NOx (*Figure 7-50E*). Alongside these NOx concentrations, total Kjeldahl nitrogen concentrations comprise the remainder of the total nitrogen concentration, which a fraction of is attributed to ammonia concentrations (*Figure 7-50F*; *Figure 7-50G*). The elevated total phosphorus concentrations and total nitrogen concentration can be partially attributed to the return flows from Star WWTP; however, is it likely that nonpoint sources are also contributing to these elevated nutrient concentrations in this waterway.

Figure 7-47: Total Nitrogen, Total Kjeldahl Nitrogen, and Nitrate+Nitrite Concentrations in the Star WWTP Effluent from 2009 – 2020.

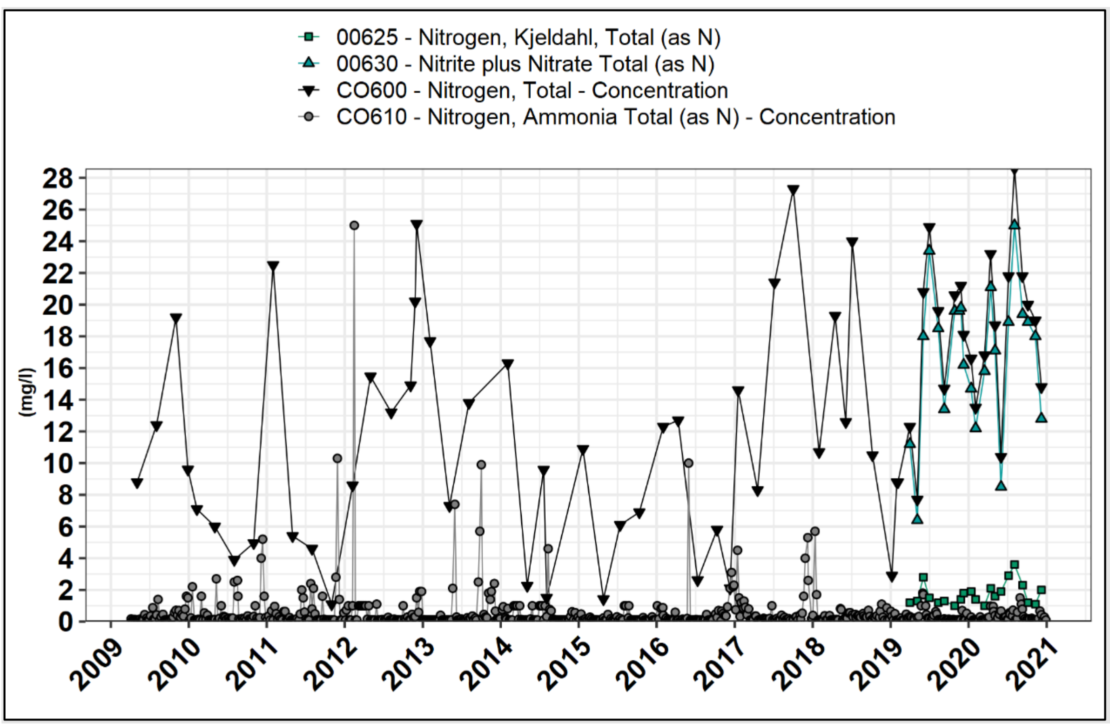


Figure 7-48: Total Phosphorus Concentrations in the Star WWTP Effluent from 2009 – 2020.

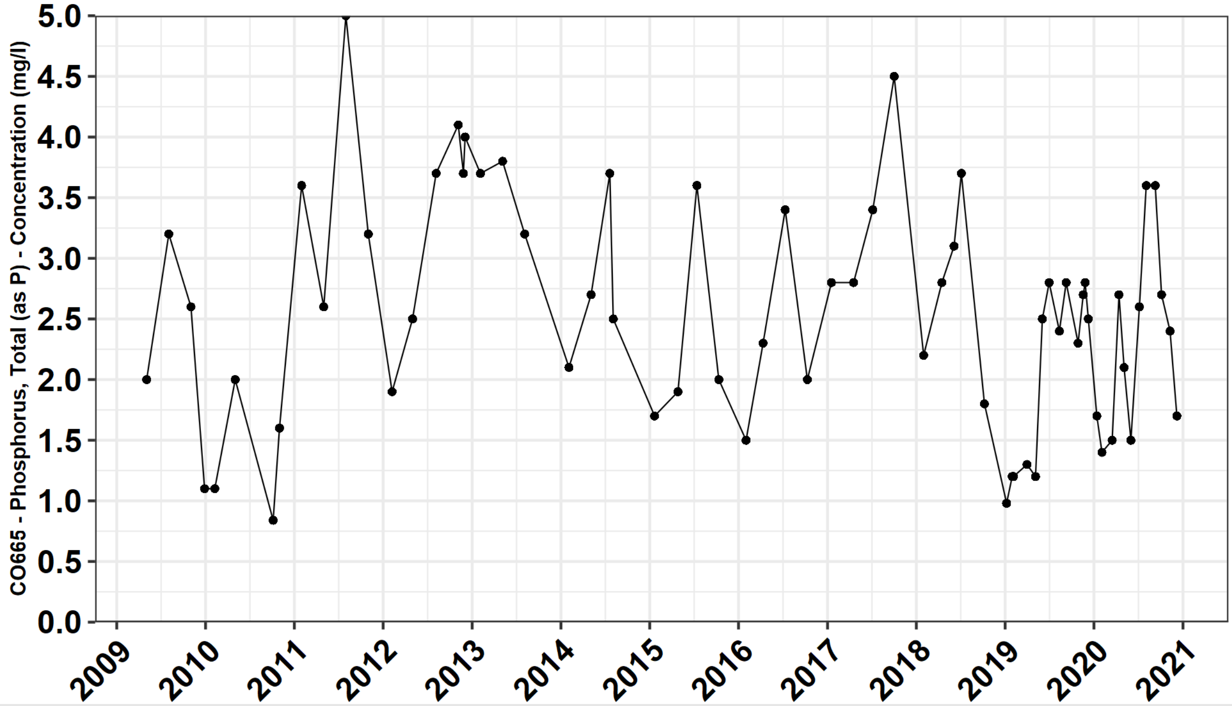


Figure 7-49: Fecal Coliform Bacteria Levels in the Star WWTP Effluent from 2000 – 2020.

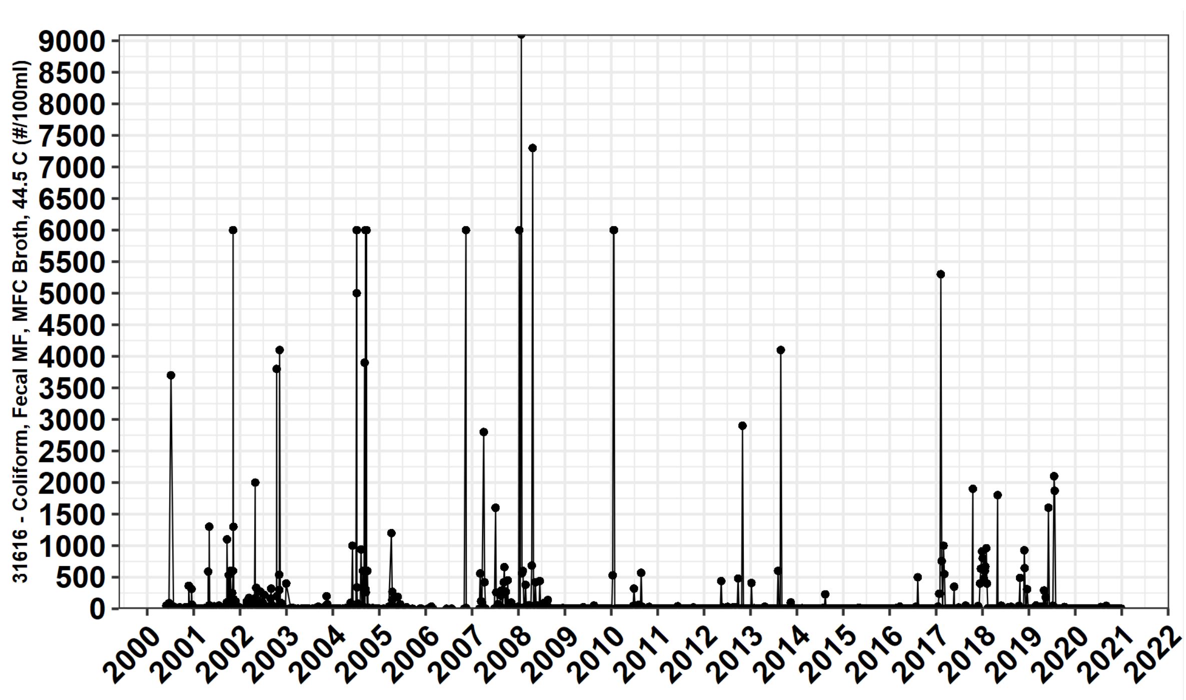
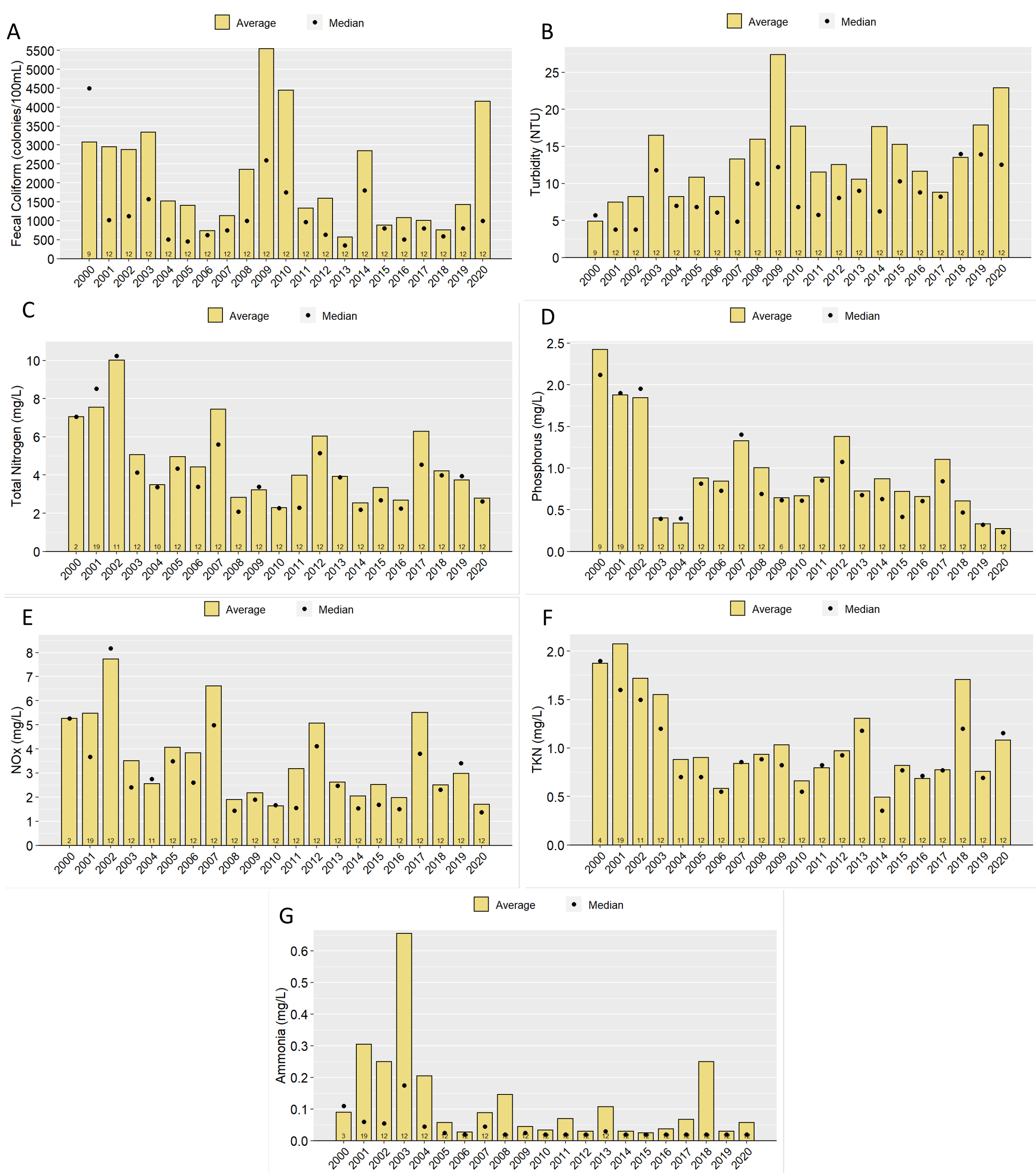


Figure 7-50: Annual Mean and Median Concentrations for Water Quality Parameters at Station B5390800.



DWR conducted a screening level Mann-Kendall trend test and found a seasonal increasing trend in total turbidity and a decreasing trend in specific conductance and total phosphorus at station B5390800 on Cotton Creek calculated at 95% confidence for data collected from 2000-2019.

7.7.4.4 Lick Creek

Lick Creek [AU#: 17-26-5-3-1] is a WS-III classified tributary of Cotton Creek. Inspections at a metal fabrication company in the Lick Creek watershed in 2011 and 2019 indicated that the company had three monitored stormwater outfalls that consistently exceeded permit limits for TSS, copper, and zinc since at least 2011. Inspectors noted in 2011 that only two of three outfalls were being monitored per permit requirements and that employee training and BMP installation were needed to bring the site into compliance. In January 2019, the facility was entered into Tier 2 monthly monitoring due to consistent violations of its permit limits for TSS and copper. The property was inspected again, and DEMLR staff found that concrete barriers had been installed around slag and sand stockpiles, and retention ponds had been cleaned out. Subsequent monitoring showed lower values for monitored parameters at one outfall, and all parameters were below benchmark at the other outfall. At the time of the inspection in 2019, one outfall had returned to semi-annual monitoring while the other remained in Tier 2 monthly monitoring status. During a 2009 inspection, another metal fabrication company in the Lick Creek watershed was also found to be violating its NPDES stormwater permit because it was not meeting the permit requirements for monitoring. Staff at the DEQ Fayetteville Regional Office were contacted in October 2022 and February 2023 and verified that one of the facilities was no longer in operation. The other facility, K-M Machine Company, NCG030672, now owned by Jordan Innovative Fabrication, had not conducted analytical monitoring since the takeover in 2021. There were no recent monitoring records available for review from when K-M Machine Company previously owned the facility. Jordan Innovative Fabrication was supposed to do analytical monitoring as part of the permit requirement, but was sent a Notice of Violation for not doing so (Joyner, pers. comm.).

BB274	
Year	**Bioclassification**
2001	Fair
2007	Good-Fair

Lick Creek, which is the receiving stream for these stormwater outfalls, is not monitored for water quality. However, the segment of Cotton Creek (AU #17-26-5-3c) downstream of its confluence with Lick Creek is impaired for copper, exceeding criteria (category 4s) for benthos, and has an approved TMDL for lead and chromium. As resources become available, water quality monitoring for dissolved copper and chromium should be conducted at Lick Creek and Cotton Creek and benthos monitoring should resume at site BB274. Regular inspections of the stormwater treatment system at the Jordan Innovation Fabrication facility should continue and effluent data checked to ensure continued permit compliance.

7.7.4.5 Cabin Creek

BB279	
Year	**Bioclassification**
2002	Poor
2003	Good
2003	Good
BF160	
1992	Fair
BB162	
1992	Good
2018	Good
BF32	
2014	Not Rated

Cabin Creek [AU#: 17-26-5-(1)a; 17-26-5-(1)b; 17-26-5-(1)c; 17-26-5-(7)] is a 21.2-mile WS-III tributary to Bear Creek. Its entire watershed is predominated by timber management that is in varying stages of growth with some agriculture. There is one NPDES-permitted facility associated with a talc mine that is close to the mouth of Cabin Creek. Stream buffers are mostly intact, although recent timbering activity has impacted buffer width on some portions of the stream. There are three benthos community sites on Cabin Creek. The first is site BB279 that was last sampled in 2003 recording a Good rating and a considerable improvement over the previous Poor rating in 2002. Downstream from the Cotton

Creek confluence with Cabin Creek is site BB160, sampled once in 1992 with a Fair rating. This section of Cabin Creek [AU 17-26-5-(1)b] that is monitored by site BB160 has been impaired for benthos since 2000, based on the 1992 sample at site BB160. The furthest downstream benthos site on Cabin Creek is site BB162, which was sampled in 1992. The site received a Good rating in 1992 and again in 2018. There is also one fish community site, BF32, which was sampled once in 2014 and classified Not Rated. This fish community site is co-located with site BB162.

7.7.4.6 Mill Creek

Mill Creek [AU#: 17-26-5-4] is 11.7 miles long, a tributary of Cabin Creek and has a WS-III classification. The town of Candor is in the headwaters. Land use is primarily forested with some agriculture, although some of the forested land is in timber management. There is one NPDES stormwater discharge permit associated with a sand and clay mine and one NPDES non-discharge permit for the Candor Wastewater Treatment Facility; both are near the headwaters of the stream. Other land uses near the headwaters include a sod company and two solar farms. The stream is supporting its uses.

BB167	
Year	**Bioclassification**
2003	Good
2008	Good-Fair
2009	Excellent

Mill Creek benthos community site BB167 rated Excellent in 2009, the same rating it received in winter of 1993. A sample collected in 2008, during a drought, reflects the susceptibility of the aquatic community here to hydrologic reductions. This is a possible reference site for Slate Belt streams, as it rates Good or Excellent in recent years (with good flow) yet reduced flows have a suppressing effect on EPT taxa as evident by the winter 2008 sample. This site had a very low EPT biotic index in 2009 similar to prior years, reflecting the pollution-intolerant aquatic community that resides here. *It is recommended that benthos monitoring resume at this site as resources allow.*

7.7.4.7 Wet Creek

BB119	
Year	**Bioclassification**
2003	Good
BB526	
2013	Good-Fair
2018	Good

Wet Creek [AU#: 17-26-5-5] is 10.6 miles long, and a tributary of Cabin Creek. It is a WS-III watershed, and the waterway is classified as a WS-III. Land use is primarily forest, although some of the forested land is in timber management. There is also agriculture, including four swine farms near the headwaters that each have associated NPDES permits for lagoons; waste is land-applied. There are two benthos community stations and one fish community station located on Wet Creek. Benthos station BB119 was last sampled in 2003 and it received a bioclassification of Good, as it did the two previous times it was sampled in 1993 and 1998. Station BB526 was last sampled in 2018 and received a bioclassification of Good, up from Good-Fair when it was sampled in 2013. Site BB526 replaces site BB119, which had to be abandoned due to beaver activity. The drainage area for BB526 is roughly half of that for BB119. The Good-Fair at BB526 in 2013 is due to fewer EPT taxa collected, which in turn may be due to the same rain events that produced spates in adjacent catchments. Sampling in 2018 resulted in 27 EPT taxa collected. A seasonal correction yielded 23, i.e., spring-only taxa were eliminated from the analysis to better compare to summer samples. Even after seasonal corrections were applied, five more EPT taxa were collected than in 2013. The majority of these taxa not collected in 2013 (*Ceraclea transversa, Rhyacophila fenestra/ledra, Dannella* spp) are pollution intolerant and thus reduce the overall measured tolerance value of the community in this stream. Macroinvertebrate habitat was good with no glaring problems noted at the time of sampling. Land use in this catchment is primarily forest with the remainder largely devoted to animal operations and open grass/shrub areas. *Benthos monitoring should continue at site BB526 and fish monitoring should begin at a new site co-located with the benthos site BB526 or at another site on the stream, as resources are available.*

Fish community station BF6 is co-located with benthos station BB119. It was sampled once in 2003 when it received a bioclassification of Good-Fair. It is likely that the beaver activity that caused the abandonment of BB119 also impacted the ability to resample this fish community site in subsequent years.

BF6	
Year	**Bioclassification**
2003	Good-Fair

7.7.4.8 Bear Creek

Bear Creek [AU#: 17-26-(1)] is classified WS-III and a tributary to Deep River, draining the northwestern tip of Moore County and small adjacent portions of southern Randolph and eastern Montgomery counties. Land use in this WS-III watershed is predominantly forest and agriculture. A low head dam exists about 3.5 river miles downstream from fish community site BF38 at the SR 1425 crossing (Browns Mill Rd) but does not seem to impede fish recruitment to and from the sampling area of fish community site BF38. The mature forested riparian corridor at this regional reference site provides good canopy shading to the stream channel, although there is a break in the buffer caused by an electric transmission line corridor and bridge crossing at the site. Instream habitats are typical of the Carolina Slate Belt, with extremely rocky runs and pools, and abundant short riffles, and bedrock chutes. No apparent habitat changes have occurred since sampling began at this site. A diverse and trophically balanced fish community was collected in 2018, including the intolerant Piedmont darter. Nine of the 12 NCIBI metrics showed maximum scores of five in 2018. Species collected with young-of-year cohorts included redbreast sunfish (n=11); bluehead chub (n=6); green sunfish (n=2); and redlip shiner (n=1). There are a total of 25 fish species known from this watershed, including two suckers, five sunfish, including largemouth bass, eight minnow species, three catfish and two darter species. Similar to many others in the basin, this slate belt stream is subject to low flows in dry years, thereby potentially influencing fish community abundances. However, this reference site has sustained Good and Excellent fish community ratings over a 20-year period, with 2018 marking its third Excellent fish bioclassification. *Monitoring should continue at this site.*

BF38	
Year	**Bioclassification**
2018	Excellent

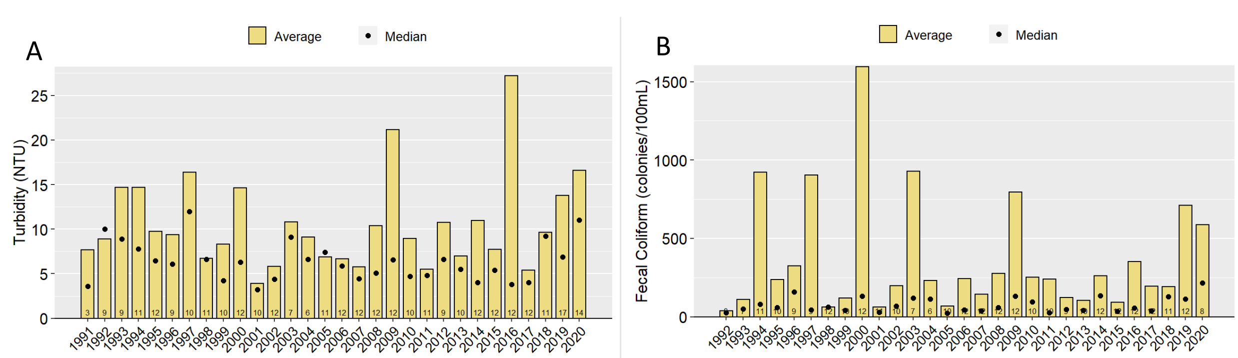
The downstream catchment of Bear Creek [AU#: 17-26-(6)] drains areas of the Town of Robbins with forest, commercial and residential development in the immediate watershed. Portions of Seagrove, Star, Biscoe, Candor and Robbins are also within the catchment. This segment of Bear Creek is heavily forested, but there is a small amount of animal agriculture, which could be contributing fecal runoff to the stream. Benthos community site BB152 was not rated in 2008 due to low streamflow as the result of drought. After the sample was collected, the lack of flow dependent taxa strongly suggested that flow had ceased or slowed to the point that the benthos was responding mainly to the drought. The site was last monitored in 2013 when EPT richness was higher and BI lower, indicating better conditions than 2008. However, the relatively low EPT richness in 2013 may be due, at least in part, to rainfall events that produced spates in adjacent catchments. *Monitoring should resume at this site during the next Cape Fear sampling cycle.*

BB152	
Year	**Bioclassification**
1993	Good-Fair
1998	Good
2003	Good
2008	Not Rated
2013	Good-Fair

AMS Station B5480000 is co-located with benthos community site BB152. Since 2000, turbidity levels in Bear Creek have remained typically below the 50 NTU water quality standard during most years. Only five samples have exceeded the standard with the highest value recorded in this waterway at 280 NTU in 2016. These elevated levels are reflected in the annual average values, as these elevated values occurred in 2000, 2009, 2016, 2019, and 2020, coinciding with some of the highest annual mean values (*Figure 7-51A*). Fecal coliform bacteria concentrations often exceed 400 colonies/100 mL at least once each year since 2000, except for three years (2001, 2005 and 2015). Although elevated fecal coliform bacteria levels are recorded, the annual means are often below 400 colonies/100 mL. Similar to turbidity, years with elevated fecal coliform bacteria recorded are reflected in the annual mean values that exceed 500 colonies/100 mL (*Figure 7-51B*).

In 2001, nutrient sampling was discontinued at station B5480000; however, in 2019 and 2020, nutrients were added at this station to assist with the central Cape Fear River modeling project. (See section 2.14 in Chapter 2 for more details.) Since there is a large gap in nutrient data at this station, it is difficult to make long-term interpretation; however, it is worth noting the range of values recorded during the 1992 to 2001 sampling compared to the 2019 and 2020 sampling events. Total phosphorus concentrations ranged from 0.03 to 0.76 mg/L between 1992 and 2001 and ranged from 0.06 to 0.58 mg/L between 2019 to 2020. The NOx concentrations ranged from 0.01 to 1.1 mg/L between 1992 and 2001 and ranged from 0.02 to 0.84 mg/L between 2019 to 2020. The total Kjeldahl nitrogen ranged from 0.1 to 1.0 mg/L between 1992 to 2001 and ranged from 0.41 to 1.7 mg/L between 2019 and 2020. The ammonia concentrations ranged from 0.01 to 0.57 mg/L between 1992 and 2001 and 0.02 to 0.21 mg/L between 2019 and 2020. The chlorophyll *a* concentrations were only monitored in 2019 and 2020, ranging from 1 to 35 µg/L. Interestingly, during the 2019 to 2020 sampling, only two samples recorded chlorophyll *a* concentrations greater than 8 µg/L which were 20 µg/L on July of 2019 and 35 µg/L on September of 2019.

Figure 7-51 Annual Mean and Median Turbidity and Fecal Coliform Bacteria Concentrations Between 1991 – 2020 at Station B5480000.



7.7.4.9 Falls Creek

BF86	
Year	**Bioclassification**
2010	Excellent

Falls Creek [AU#: 17-27] is a class C tributary of the Deep River. Its headwaters are near the community of Harpers Crossroads in the southwest corner of Chatham County, and it flows south into northern Moore County. Land use in the watershed is primarily forest and agriculture, and it appears that the land use is about evenly split between the two uses. There is one poultry farm in the headwaters along with a dairy farm that has an affiliated animal operations permit for a waste pond. There is also one NPDES single family domestic wastewater discharge permit in the watershed. Fish community site BF86 is located approximately 0.4 miles upstream of the mouth of Falls Creek. It was sampled once in 2010 and received a bioclassification of Excellent at that time. *When resources are available, site BF86 should be sampled again to determine if any changes to the fish community have occurred.*

7.7.4.10 Buffalo Creek

BB159	
Year	**Bioclassification**
2003	Good-Fair
2009	Good-Fair
2013	Good-Fair
2018	Good-Fair
BF5	
2009	Excellent
BF6	
2009	Excellent

Buffalo Creek [AU#: 17-28] is a tributary of the Deep River in Moore County that drains an area between the towns of Robbins and Carthage. Land use is predominantly forest followed by agriculture. In some areas, pasture and row crop have severely reduced buffer widths along the stream. Benthos community site BB159 and fish community site BF5 are co-located about 1.1 stream-miles from the confluence with Deep River at a crossing on NC 22. A small agriculture operation on the left descending bank along the sample reach has significantly reduced the buffer width. It has been consistently sampled as a benthos community site since 1993 and has rated Good-Fair each time except for the two cycles prior to the incorporation of spring seasonal corrections to the metrics.

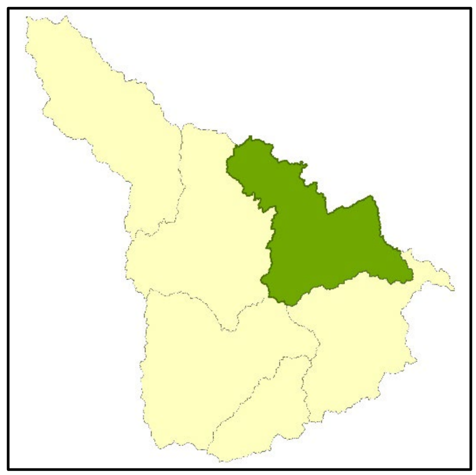
Fish community site BF5 was sampled once in 2009 and had a bioclassification of Excellent. The benthos community in this Carolina slate belt stream is sensitive to low and high flow events and biotic indices over the sampling cycles reflect this. The EPT community in 2018 was typical of a highly enriched, silt loaded slate belt stream, with few highly pollution-sensitive taxa. Hard substrates in the stream were densely colonized by diatoms and blue-green algae, making surfaces both slippery for walking and less available for macroinvertebrates. However, aside from the ubiquitous sediment and nutrient inputs into the stream, there are no permitted NPDES discharges into Buffalo Creek. It appears that Buffalo Creek has reached a somewhat steady state over the past 15 years in terms of water quality. When resources allow, nutrient and sediment sources in Buffalo Creek should be investigated.

7.7.4.11 Deep River in the Middle Deep River Watershed

There are multiple segments of the Deep River [AU#: 17-(10.5)e2; 17-(25.7); 17-(28.5)a] in the Middle Deep River watershed (HUC10: 0303000304), however, there is limited surface water quality, benthic macroinvertebrate, and fish community monitoring along the 23.5 miles of the river. Surface water quality monitoring and benthos monitoring does occur in AU# 17-(10.5)e2 and those results are discussed previously in Section 7.7.2.4 alongside upstream water quality monitoring results. There was a water quality monitoring station (B5520000) on AU# 17-(25.7), however, sampling events were discontinued indefinitely in May 2010.

The Town of Robbins operates a 1.3 MGD WWTP (NC0062855) that discharges to AU # 17-(25.7), an HQW segment of the Deep River. The wastewater permit was modified in April 2005 to include phased limits of 0.5 MGD and 1.3 MGD. A large industrial user ceased operations and this resulted in a reduced flow to the town's system. According to the 2021 NPDES permit development fact sheet, the facility is currently operating at 0.5 MGD flow, but is designed to operate at 1.3 MGD. The WWTP currently has a total phosphorus limit (2.0 mg/L quarterly average), but it does not have total nitrogen limits. The Robbins WWTP has received numerous notices of violations in the past several years, including violations of its permit limits for pH, nutrients, DO, and fecal coliform bacteria, which has resulted in fines. The surface water quality monitoring station (B5520000) 3.8 miles downstream of the Robbins WWTP was discontinued in May 2010, and the next monitoring station is approximately 22 miles further downstream (B5575000). The Robbins WWTP, as part of its permit conditions, is required to monitor instream for hardness upstream of the outfall and DO and temperature downstream of the outfall. *It is recommended that at the next permit renewal for the Town of Robbins include instream monitoring below the outfall for pH, fecal coliform, conductivity, and nutrients. Also, as resources allow, DWR should resume monitoring at AMS station B5520000.*

7.7.5 Rocky River Watershed (0303000305)



The 243 mi^2 Rocky River watershed is located in the Level IV 45c Ecoregion known as the Carolina Slate Belt (USEPA Ecoregions of North Carolina and South Carolina, 2002). This area is characterized by trellised drainage patterns, silty and silty clay soils, streams that tend to dry up, and low yielding groundwater wells. The towns of Liberty, Staley, and Siler City fall partially in the watershed. The most common land use is forest (57.6%) followed by agriculture (25.3%), and developed land (9.2%). The remainder of the land cover is grassland/shrub (6.7%), open water (0.7%), wetland (0.5%), and barren land (0.1%). Large sections of the Rocky River are designated as exceptional State Natural Heritage Area.

The mainstem Rocky River, North Prong Rocky River, and Greenbriar Creek come together at the upper Rocky River Reservoir. As mainstem Rocky River continues to flow beyond the Rocky River Reservoir, it is joined by several tributaries, including Loves Creek, Meadow Creek, Tick Creek, Harlands Creek and Bear Creek. Two impoundments located along the Rocky River serve as the drinking water supply for Siler City and some surrounding unincorporated rural communities. The upstream impoundment, known as the Rocky River Reservoir, is located approximately four miles north of Siler City and is the principal storage reservoir for the water supply. Water is released from the upper reservoir and flows down the river to a drinking water intake located in Charles Turner Reservoir, approximately 1.7 miles north of town. The expanded Charles Turner Reservoir (CTR) dam was approved by the Division of Land Resources (now DEMLR), Dam Safety Program on October 22, 2009, and the reservoir was full on November 13, 2009. The entire watershed above the Charles L. Turner Reservoir is classified as Water Supply III (WS-III). There are no designated High Quality Waters (HQW) or Outstanding Resource Waters (ORW) in this watershed, however, there is critical habitat for several threatened and endangered species.

Efforts are underway to reconnect critical habitat for these species in the Rocky River and Deep River watersheds. In 2018, the Hoosier (Woodys) Dam was removed on the lower Rocky River, expanding the range for the Cape Fear shiner at least up to Rives Chapel Road (based on a 2020 USFWS survey). The removal of the Hoosier Dam also eliminated a water quality impairment, delisted in 2020, on the Rocky River. The impoundment behind the dam allowed for the excessive growth of algae that was assessed as part of a special study in 2009. A North Carolina State University study provided data for use support purposes. With the removal of the dam, the water no longer pools, which would allow for the excessive growth of planktonic algae in this section of the Rocky River. There are, however, still concerns throughout much of the Rocky River watershed for the excessive growth of macrophytic algae or periphyton in response to excess nutrients. Many of the watershed stakeholders have and continue to express concerns about the excessive growth over the years impacting aquatic life and habitat as well as reducing the recreational uses of the river.

The Rocky River mainstem has been identified as nutrient enriched due to the excessive periphytic growth and due to the hypereutrophic status of the two reservoirs in the upper portion of the watershed. Both reservoirs are currently listed as impaired on the 2022 IR due to high chlorophyll *a* concentrations (*Table 7-18*). The sources of nutrients vary throughout the watershed. The upper portion is mainly impacted from agricultural related sources, which drain to the drinking water reservoirs. There are agricultural impacts downstream of CTR as well; however, the main source of nutrients to the lower Rocky River mainstem is wastewater discharge from the Siler City WWTP.

Many of the impaired waters in the Rocky River watershed are related to aquatic life impacts evaluated by assessing fish and/or benthic macroinvertebrates (*Table 7-18*). Water quality and insufficient habitat result in declining species richness and abundance, and assemblages are often dominated by pollution-tolerant species. The extreme fluctuation in stream flow conditions, from very low flow due to structural dams and low baseflow to very high flashy flows during storm events, may also play a role in the health of fish and benthos communities. The extreme flow conditions are partially due to the slate belt geology in this system, but dams will also restrict movement and recolonization of impacted species. *Table 7-18* includes all the assessed waters in the Rocky River watershed and their associate water quality use support status/IR category. The water quality standards not being met in this watershed include dissolved oxygen (<4mg/L), chlorophyll *a* (>40 µg/L in the reservoirs), as well as fish and benthos bioclassifications.

Table 7-18: Rocky River Watershed (0303000305) 2022 Integrated Report Status for Assessed Streams.

AU #	Miles (m)/ Acres (A)	Parameter Exceeding Standard	Listing date	IR Cat	Stream Description	Stream Class
LOVES CREEK						
17-43-10a	3.3 m	Fair Benthos Bioclassification	1998	5	From source to Chatham Ave.	C

AU #	Miles (m)/ Acres (A)	Parameter Exceeding Standard	Listing date	IR Cat	Stream Description	Stream Class
17-43-10b1	2.3 m	Low Dissolved Oxygen	2012	5	From Chatham Ave. to US 421	C
17-43-10b1	2.3 m	Fair Benthos Bioclassification	1998	4s	From Chatham Ave. to US 421	C
17-43-10b2	0.2 m	Fair Benthos Bioclassification	1998	5	From US 421 to Siler City WWTP	C
17-43-10b2	0.2 m	Fair Fish Bioclassification	2020	5	From US 421 to Siler City WWTP	C
17-43-10c	0.4 m	Fair Benthos Bioclassification	1998	5	From Siler City WWTP to Rocky River	C
ROCKY RIVER						
17-43-(1)a	10.6 m	None		1	From source to Upper Rocky River Reservoir	WS-III
17-43-(1)b	4 m	Chlorophyll a	2010	5	Siler City Upper Reservoir to 0.3 miles upstream of dam (Upper Reservoir dam)	WS-III
17-43-(5.5)a	15 A	Chlorophyll a	2010	5	Siler City upper Reservoir from 0.3 miles upstream of dam to the Upper Res. dam (Turner Reservoir Critical Area)	WS-III; CA
17-43-5.5)b	27 A	Chlorophyll a	2018	5	From Siler City Upper Reservoir dam to Charles L. Turner Reservoir Dam	WS-III; CA
17-43-(8)a	6.7 m	Fair Benthos Bioclassification	2018	5	From Charles Turner Reservoir dam to Varnals Creek	C
17-43-(8)b1	15.2 m	None (Fecal Coliform - not rated)		1	From Varnals Creek to backwater of Woody's Dam (Hoosier Dam)	C
17-43-(8)b2	35 A/ 0.9 m	None	Delisted 2018	1r	Former ponded area behind Woody's Dam (Hoosier Dam)	C
17-43-(8)b3	5.5 m	None		1	From Woody's Dam to Deep River	C
TICK CREEK						
17-43-13a	8.2 miles	Fair Fish Bioclassification	2006	5	From Source to US 421	C
17-43-13b	4.9 miles	Fair Benthos Bioclassification	2020	5	From US 421 to Rocky River	C
HARLANDS CREEK						
17-43-15	10.2 miles	Fair Benthos Bioclassification	2020	5	From Source to Rocky River	C
BEAR CREEK						
17-43-16b	2.0 miles	Fair Benthos Bioclassification	2010	5	From SR 2189 to SR 2187	C
17-43-16c	7.3 miles	Fair Benthos Bioclassification	2020	5	From SR 2189 to SR 2187	C

As of 2022, there were one major and three minor NPDES wastewater facilities and 17 single family NPDES permits with a combined as-built discharge of 4.02382 MGD. The major NPDES discharger is Siler City's WWTP (NC0026441; 4MGD), which discharges to Loves Creek. Permitted animal feeding operations include three state cattle and one state swine permit. Like most wastewater treatment facilities in North Carolina, Siler City's wastewater treatment plant currently (2024) does not have the ability to remove most of its nitrogen as part of the treatment process. They have ammonia and phosphorus effluent limits along with other requirements with which they must comply, but their treatment plant was not designed to completely eliminate nitrogen. This has resulted in very high levels of mostly nitrate+nitrite (NOx) being discharged into Loves Creek, the receiving stream, and into the Rocky River below US-64. The nutrients from the treatment plant have been a concern for some time. Additionally, over the last several years (2019-2022), the treatment plant has been unable to consistently comply with the effluent limits set forth in its NPDES Permit NC0026441, including effluent limits for biochemical oxygen demand (BOD), ammonia nitrogen, total suspended solids (TSS) and fecal coliform bacteria. The EPA has designated Siler City's WWTP as being in "significant non-compliance". DWR has issued several civil penalties for noncompliance with their NPDES permit (NC0026441), Collection System Permit (WQCS00056) and the associated water quality laws.

Due to Siler City's ongoing compliance issues, including treatment capacity issues, DWR placed the town's WWTP under a moratorium in May 2022, which prohibits the introduction of additional wastewater flow to the WWTP. The town is causing or contributing to pollution of the waters of the state within an area for which standards have been established, therefore, the Environmental Management Commission has the authority to enter into a Special Order of Consent (SOC). The SOC was approved by the EMC (EMC SOC WQ S22-003) and finalized on April 14, 2023. The SOC draws up a clear set of expectations for treatment upgrades, including sewer rehabilitation, WWTP expansion and improved treatment capabilities, and WTP pretreatment and solids handling. It also provides a clear schedule for each required action and provides relief from some of the penalties previously imposed; however, it also lays out clear penalties for failing to meet the obligations set out in the SOC. For more information, see the finalized April 2023 SOC (EMC SOC WQ S22-003). For more information on water quality impacts, see the Rocky River and Loves Creek sections.

Siler City amended SOC and WWTP update:

As of May 19, 2025, DWR and the Environmental Management Commission approved an amended SOC (EMC SOC WQ S22-003 Ad I). In the amended SOC, the Town proposed to bring the WWTP into compliance more quickly with the requirements of the NPDES Permit NC0026441 by upgrading the current 4 MDG plant by installing a four-stage BNR process until construction of the 6.0 MGD WWTP expansion is complete (Paragraph 1(h)(vi).

On August 30, 2024, the Town of Siler City submitted an application for an amendment to a SOC. At the time of the request. The Town had completed 20 of the 28 scheduled activities required in the 2023 SOC (WQ S22-003). Out of the eight remaining required activities, six cannot be completed in the original time frame allotted in the 2023 SOC which could result in large stipulated penalties.

According to the October 30, 2024, SOC quarterly report to DWR (Town of Siler City Public Works and Utilities EMC SOC WQ S22-033 4th Quarter 2024 report) the 6.0 MGD WWTP expansion funding was secured from DEQs Division of Water Infrastructure (DWI). The contract to build the 6 MGD WWTP was awarded in June 2024. The groundbreaking for the Siler City WWTP expansion took place on October 24, 2024. The $62 million WWTP upgrade and expansion increases the capacity from 4 to 6 MGD to support planned development which includes the new Wolfspeed computer chip manufacturing facility. The WWTP project will improve the plant's headworks, pump station, biological treatment process, filtration and disinfection, sludge dewatering, electrical distribution systems, controls and telemetry. The project will use advanced technologies to reduce nitrogen outputs to meet their NPDES permit limits, this includes reducing the amount of ammonia and total nitrogen in their effluent. According to the approved amended SOC (EMC SOC WQ S22-003 Ad I), the completed upgrade and expansion to 6 MDG is anticipated to be July 31, 2027. The foot note on this item includes "This activity is only eligible for one 90-day deadline extension pursuant to paragraph 2(c) and such extension shall only be granted if the Town complies with the Total Nitrogen limit of 54,800 lbs/year set forth in Permit NC0026441 for calendar year 2026".

The July 31, 2027 timeline incorporated interim improvements to the 4 MDG WWTP system in order to improve water quality to Loves Creek and the Rocky River sooner than 2027. A modified Authorization To Construct (ATC) permit (No. 026441A01) was issued on December 12, 2024, for an interim 4-stage Bardenpho process for the 4 MGD WWTP. This treatment process is a biological wastewater treatment process that removes nitrogen and phosphorus allowing Siler City to meet their permitted wastewater discharge effluent limit requirements.

The town also has a sewer rehabilitation project underway and anticipates completion of construction in 2026. Documents related to the towns wastewater permit (NC0026441) and SOC can be found on DWRs Laserfiche document storage system here.

In 2023, the NC General Assembly appropriated $75,250,000 [S.L. 2023-134 12.2.(e)(167) and 12.2.(g)(2)] to the Town of Siler City for wastewater improvements and required the Town to enter into an operational agreement with the City of Sanford which was finalized in December 2023 (Town of Siler City Board of Commissioners meeting minutes, Nov. 20, 2023 and Sanford City Council Agenda May21, 2024). The City of Sanford is in the process of developing a regional water and wastewater utility known as TriRiver Water (https://www.triRiverwater.com/).

While efforts were underway and interlocal agreements were signed over several years, in March 2024, the City of Sanford announced it was intending to provide regional water and wastewater utilities to surrounding towns and counties under the name TriRiver Water. On July 1, 2024, The Town of Pittsboro's utilities officially merged with the City of Sanford in the first step of the regionalization efforts. Siler City town commissioners voted to approve the utility merger on October 7, 2024 and Chatham County follows suit on November 4, 2024. Their utility merger and transfers occurred on July 1, 2025.

There are also 14 NPDES and 12 state stormwater facilities and 2,320 acres of non-discharge wastewater irrigation and residual solids land application fields in this watershed. Most of the fields are residual solids land application fields associated with the City of Burlington (WQ0000520; 403 acres); the City of Sanford (WQ0000543; 485 acres); the Town of Siler City (WQ0003226; 366 acres); the City of Durham

(WQ0003504; 112 acres); Harnett County (WQ0007066; 438 acres); and Terra Renewal Services - Pilgrim's Pride RLAP (WQ0039391; 240 acres). There is one large wastewater irrigation field associated with the Town of Liberty (WQ0003090; 154 acres) and nine small wastewater irrigation fields, mostly less than a third of an acre, associated with single family dwellings.

There are five primary ambient water quality stations used to assess a large portion of this watershed (*Table 7-19*). Two are located in Loves Creek and three on the mainstem Rocky River. Four of the five stations have been collected by the Upper Cape Fear River Basin Association and are focused on understanding the impacts from Siler City's wastewater discharge into Loves Creek, about 0.35 miles upstream of the confluence with Rocky River. DWR monitors an AMS station (B6000000) at NC Hwy 902 about 10 miles downstream of the confluence of Loves Creek and about 7.5 miles upstream of the former Hoosier (Woodys) Dam. In 2019 and 2020, three new AMS stations were monitored to support the central Cape Fear River watershed model. These include a station in the headwaters of the Rocky River, Landrum Creek, and Bear Creek. For more information, see Chapter 2 section 2.14.

Table 7-19: Rocky River- Deep River (0303000305) Ambient Monitoring Stations Collected by DWR and the Upper Cape Fear River Basin Association Monitoring Coalition.

River	Station ID	Station Location	Monitoring Program*	Distance From Loves Creek	Stream AU #
Loves Creek	B58850000	Off Moonrise Meadow Dr.	DWR/RAMS 2009-2010	NA	17-43-10a
Loves Creek	B5890000	Upstream of WWTP @ Waste Management Plant Rd.	UCFRBA	NA	17-43-10b
Loves Creek	B5920000	Downstream of WWTP on Progress Blvd.	UCFRBA	NA	17-43-10c
Rocky River	B5950000	Upstream of Loves Creek at US 64	UCFRBA	~0.2 miles upstream	17-43-(8)a
Rocky River	B5980000	Downstream of Loves Creek at Rives Chapel Rd.	UCFRBA	~4 miles downstream	17-43-(8)b1
Rocky River	B6000000	Downstream of Loves Creek at NC Hwy 902	DWR/AMS	~10 miles downstream	17-43-(8)b1
Central Cape Fear River Watershed Model Special Study Monitoring Stations (2019-2020)					
Rocky River	B5840000/ B5850000	~0.5 miles upstream of Upper RR Reservoir at Piney Grove Church Rd./SR 1362	DWR/AMS	NA	17-43-(1)a
Landrum Creek	B6002000	At NC Hwy 902	DWR/AMS	NA	17-43-14
Bear Creek	B6008000	Woody Dam Rd /SR 2156	DWR/AMS	NA	17-43-16
Monitoring Program*: DWR/AMS = Division of Water Resources Ambient Monitoring System; DWR/RAMS = Division of Water Resources Random Ambient Monitoring System; UCFRBA = Upper Cape Fear River Basin Association					

As part of the state 401 Certification for the CTR expansion project, a Rocky River Management Team (RRMT) was developed that consisted of several resource agencies, Siler City staff, and local stakeholders to guide DWR in its efforts to ensure the optimum operation of the reservoir for the protection and improvement of the quality of the Rocky River (*Table 7-20*). The RRMT reviews the need and provides recommendations for additional monitoring or studies of the river that will enable a better understanding of the causes of the excessive growth of aquatic plants that have been observed downstream of the reservoir. Due to the long-standing concerns about the amount of aquatic macrophytic algal/periphyton growth downstream of the CTR, the 401 Certification requires a 20 cfs pulse released from the dam every 30 days, unless a natural event of similar magnitude occurs. This requirement was intended to mimic a natural storm event and dislodge filamentous algal mats that occur along the river.

Table 7-20: Rocky River Management Team Constituents.

Resource Agencies	Siler City Staff	Stakeholders
Division of Water Quality (DWQ; Merged with DWR in 2013)	Town Manager	Friends of Rocky River
Division of Water Resources (DWR)	Public Utilities Director	Rocky River Heritage Foundation
Soil and Water Conservation District – Chatham County (SWCD)	WWTP Operator	Rocky River Watch
Wildlife Resources Commission (WRC)	WTP Operator	Local landowners
US Fish and Wildlife Service (USFWS)		Unique Places

A Rocky River Interagency Workgroup was also formed in 2021, made up of the same resource agencies listed above, specifically to address water quality and habitat concerns for the threatened and endangered species in this watershed. These include the federally listed Cape Fear shiner, a small minnow, and several mussels, including the Savannah lilliput. Pollution and water quality degradation have been identified as contributing factors to declining populations (Dr. Tom Augspurger, USFWS).

Since 2015, Siler City has partnered with several stakeholders from federal, state, and local agencies as well as local businesses, local citizens, and conservation groups to create the Loves Creek Watershed Stewards (LCWS). Through combined efforts, they have obtained over $1.1 million in grant funds ($1.7 million in grant funds and matching funds) to implement restoration activities targeting stormwater reductions and improving Loves Creek tributary water quality and ecological habitat in Siler City (Loves Creek website). Loves Creek Watershed Stewards' efforts are ongoing, and the group meets quarterly with stakeholders to discuss issues in the watershed and propose ways to address them. More information is available in the Loves Creek watershed local initiative write-up below and in the Local Initiative section of Chapter 4.

In addition to the previously mentioned efforts, there have also been many special studies over the last 15 years to help guide understanding of this critically important system. Some of this information will be included in the watershed write-ups below. Additional information will be included in the Cape Fear River

Story Map version once the plan is approved. Please contact the Cape Fear River Basin Planner for more details on these studies.

7.7.5.1 Rocky River

7.7.5.1.1 Headwaters of the Rocky River

The Rocky River [AU #17-43-(1)a; WS-III], from its source to approximately 0.3 mile upstream of the Town of Siler City upper reservoir dam, drains northeastern Randolph and northwestern Chatham counties and flows through a primarily forested landscape with moderate agriculture, including timber management, and a small amount of urban development in the Town of Liberty in the headwaters of the Rocky River. There are two small impoundments in the headwaters. There is one NPDES stormwater permit for a timber products stormwater discharge located on an unnamed tributary to Rocky River and two non-discharge permits: one for a wastewater irrigation from a poultry hatchery and feed mill and another for a single-family residence.

A 2010 water quality study conducted by DWR showed that the North Prong of the Rocky River appeared to have high/elevated total phosphorus, ammonia and total Kjeldahl nitrogen. The most upstream part of catchment is predominantly agriculture with cattle and some poultry operations active in the landscape. The DWR Raleigh Regional Office recommended *that when resources allow, investigate the extent of cattle access to streams, dry litter poultry operations and waste residuals (sludge) land applications in the upper reaches/headwaters of the Rocky River watershed* (NCDEQ, 2010). *It is recommended that the county Soil and Water Conservation District work with local landowners to implement BMP in this watershed, specifically to reduce nutrient contributions to surfaces waters and the local drinking water reservoirs.*

BF33	
Year	**Bioclassification**
2018	Good-Fair
2013	Good-Fair
2009	Good
2003	Good-Fair

There is a single fish community site BF33 on this section of the Rocky River, which was last sampled in 2018. The fish community site is about 4.3 miles upstream of the Siler City water supply reservoir, City Lake, in AU # 17-43-(1)a. The fish community site has matured forested riparian buffers above and below the bridge crossing that bisects the reach, except for the left upper two-thirds of the 600-foot sample reach, which is bordered by open pasture and has no canopy. During the last sampling in 2018, some temporary fencing was being used along the left bank, but livestock still had access to the stream just above the bridge (a hanging exclusion fence still crossed the stream near the bridge). A large tree had also been recently removed from the stream along the lower left of the reach leaving about 50 feet of bare soil to the stream edge. Although located in the Carolina Slate Belt, finer sand and gravel substrates were prevalent instream, possibly as a result of livestock access and other sedimentation sources. Instream habitats were mostly sandy and rocky runs, with a few side boulder pools, and a few embedded riffles at the beginning of the reach. Overall, similar habitat scores were recorded as in previous years and no outstanding habitat changes were evident since the last assessment in 2013. The 2018 sampling provided new DWR records at this station for snail bullhead and yellow bullhead. Notwithstanding these new records (bringing the total catfish species count to three), and the loss of the one previously known sucker species, the fish community here exhibited similar species richness, abundance, and trophic structure as in 2013. One margined madtom was observed with yellow grub, and 11 bluegill were seen with popeye (resulting in a slightly higher percentage of diseased fish in 2018). Overall, this relatively small watershed has been rated

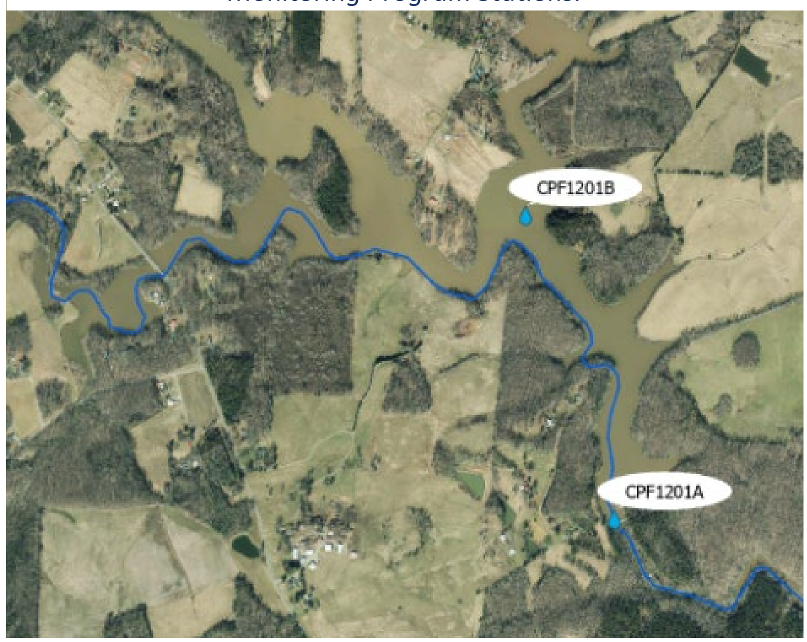
Good-Fair during 4 of 5 NCIBI assessments at this location, and continues to show stable water quality, despite its agricultural and other nonpoint influences.

7.7.5.1.2 Upper Rocky River Reservoir on the Rocky River

The upper Rocky River Reservoir [AU #17-43-(1)b and 17-43-(5.5)a; WS-III] is an impoundment located on the Rocky River in Chatham County and serves as a water supply for the Town of Siler City. It is located upstream of Charles L. Turner Reservoir. The watershed is primarily agricultural with some pasture immediately adjacent to the lake. The upper Rocky Reservoir was first 303(d) listed for chlorophyll *a* impairment in 2010, based on data collected from ambient monitoring station B5859000 (now lake station CPF1201B). The reservoir is monitored at two stations (CPF1201A and CPF1201B) on a five-year cycle as part of the Ambient Lakes Monitoring Program (ALMP) and most recently monitored monthly from May through August 2018.

At station CPF1201B, three of the four chlorophyll *a* samples were above the state standard of 40 µg/L with an overall average of 48.3 µg/L and ranged from 18 µg/L in May to 72 µg/L in August 2018. The upper Rocky River Reservoir remains impaired on the 2022 IR and will be monitored as part of the 2023 basinwide lakes assessment (*Table 7-18* and *Figure 7-52*).

Figure 7-52: Upper Rocky River Reservoir Ambient Lakes Monitoring Program Stations.



Based on the 2018 growing season NCTSI scores, the lake trophic status for the Upper Rocky River Reservoir was determined to be hypereutrophic, or exhibiting exceptionally elevated biological productivity. This reservoir was also hypereutrophic in 2003, 2008 and 2013 (2018 Cape Fear River Basin ALMP Report).

A summary of the 2018 assessment includes:

- Secchi depths were less than a meter (ranged from 0.4 to 0.7 meter), indicating limited water clarity. Secchi depths of less than a meter were previously observed by DWR in 2003, 2008 and 2013.
- Surface dissolved oxygen ranged from 5.7 to 10.7 mg/L.
- Surface pH values ranged from 6.7 to 7.4 s.u.
- Total phosphorus concentrations ranged from 0.06 to 0.12 mg/L.
- Total Kjeldahl Nitrogen (TKN) concentrations ranged from 1.1 to 1.4 mg/L.
- Nitrite plus nitrate (NOx) concentrations ranged from <0.02 to 0.30 mg/L.
- Ammonia concentrations ranged from <0.02 to 0.50 mg/L.

7.7.5.1.3 Charles L. Turner Reservoir on the Rocky River

The Charles L. Turner Reservoir [AU # 17-43-(5.5)b, WS-III, CA] is an impoundment located on the Rocky River in Chatham County downstream of upper Rocky River Reservoir. The land use draining to this reservoir is primarily agricultural with some pastureland immediately adjacent to the reservoir. This reservoir, which serves as a water supply for the Town of Siler City, was expanded in 2009 by the construction of a new dam downstream of the existing 24-acre Upper Rocky River Reservoir. It is narrow and relatively shallow with a maximum depth of 5.74 m. The Charles L. Turner Reservoir encompasses 162 acres and serves as the second largest of Siler City's four drinking water reservoirs (after the Upper Rocky River Reservoir), with a total capacity of 359 million gallons. As part of their 401 Certification, a continuous minimum release/discharge of water below the dam varies depending on the month and drought status. Water for this discharge is generally taken from a depth of 1 meter.

DWR monitored this reservoir for the first time in 2013 and again in 2018 with monthly sampling from May to August at five stations CPFTR01, CPFTR02, CPFTR03, CPFTR05 and CPFTR06 (*Figure 7-53*). Station CPFTR04 was only sampled in 2013. Notably between the 2013 and 2018 sampling events in Charles L. Turner Reservoir, a special study was completed that included sampling at three of these five stations (CPFTR01, CPFTR03 and CPFTR05) six times between May 25 and July 14, 2016. This special study is discussed in more detail in the next section alongside the special study sampling that occurred in the mainstem Rocky River. The 2016 special study was requested to assess low DO issues downstream of the Charles L. Turner Reservoir Dam (NCDEQ, 2017). This study also aimed to understand the impacts conveyed downstream from the hypereutrophic water quality conditions in the Charles L. Turner Reservoir. The additional 2016 data resulted in Charles L. Turner Reservoir being added to the 2018 303(d) impaired waters list for exceeding the chlorophyll *a* standard. The 2013, 2016 and 2018 summary statistics for chlorophyll *a* at the three stations (CPFTR01, CPFTR03, and CPFTR05) shows very high concentrations throughout the reservoir, with the highest mean

Figure 7-53: Charles L. Turner Reservoir Ambient Lakes Monitoring Program Stations

over the three assessment years of 79.5 µg/L at station CPFTR01, located just upstream of the dam (*Table 7-21* and *Figure 7-53*). Seventy-three percent of the samples collected at station CPFTR01 exceeded the standard and had the highest recorded chlorophyll *a* reading of 210 µg/L (July 7, 2016). The calculated NCTSI score was 5.8, indicating the reservoir was hypereutrophic in 2016.

During the 2016 special study, the field crew noted a surface bloom forming in the upper end of the reservoir on July 7, 2016. The bloom was still present on July 14, 2016, but had moved downstream and concentrated at the dam. A grab sample was collected near the dam at station CPFTR01 for phytoplankton identification and enumeration (*Figure 7-53*). The algal assemblage was dominated by cyanobacteria (blue-green algae), primarily by *Planktolyngbya* and *Dolichospermum* (formerly classified as *Anabaena*). The bloom was also documented downstream in the Rocky River and was heaviest at the reservoir behind the Hackney Dam (just above US 64 in Siler City). High pH and DO values were also recorded at the three stations (CPFTR01, CPFTR03, and CPFTR05) in July 2016 corresponding with the visible algal blooms. At depths below 1.5 meters, the DO was consistently low (< 2 mg/L). This is typical for hypereutrophic stratified waterbodies. For more details on the 2016 special study see Subbasin Chapter Appendix for the *Impact Assessment on Physical Water Quality Related to Hackney Dam in Rocky River*, February 20, 2017, report.

During the 2018 sampling, available nutrients in the reservoir resulted in chlorophyll *a* response with values ranging from 14 to 88 ug/L. Of the 17 chlorophyll *a* samples collected in 2018 from Charles L. Turner Reservoir, 14 samples (82%) had values greater than the state water quality standard of 40 ug/L. The EPA Region 4 Laboratory conducted an Algal Growth Potential Test (AGPT) on water samples collected by DWR on July 10, 2018. Results indicated that the limiting nutrient for algal growth was nitrogen at each of the five sampling sites.

A summary of the 2018 assessment includes:

- Secchi depths were less than a meter (ranged from 0.2 to 0.6 meter), indicating that the clarity of the water was poor to moderate.
- Surface dissolved oxygen (DO) ranged from 3.9 mg/L at the sampling site located upstream of Ed Clapp Road (CPFTR3) in June to 10.7 mg/L at the sampling site near the dam (CPFTR1) in May.
- Surface water temperatures ranged from 23.3°C to 28.2 °C.
- Surface pH values ranged from 6.8 to 7.5 s.u.
- Total phosphorus concentrations ranged from 0.09 to 0.19 mg/L.
- Total Kjeldahl Nitrogen concentrations ranged from 1.1 to 1.6 mg/L.
- Total organic nitrogen ranged from 1.08 to 1.59 mg/L.
- Nitrite plus nitrate-nitrogen concentrations ranged from <0.02 to 0.30 mg/L.
- Ammonia concentrations ranged from <0.02 to 0.21 mg/L.

Based on the calculated NCTSI scores for 2018, Charles L. Turner was determined to exhibit exceptionally elevated biological productivity or hypereutrophic conditions. Low Secchi depths, along with elevated chlorophyll *a*, total phosphorus and total organic nitrogen concentrations in the lake contributed to this trophic state determination. Charles L. Turner Reservoir was previously determined to be hypereutrophic in 2013 (2018 Cape Fear River Basin ALMP Report).

Table 7-21: Charles Turner Reservoir Chlorophyll a 2013, 2016 and 2018 Combined Summary Statistics.

2013-2018 Statistics	CPFTR01 Near Dam	CPFTR03 Mid-Reservoir	CPFTR05 Upper Reservoir
Mean (µg/L)	79.5	72.8	66.2
Median (µg/L)	68.0	69.5	55.0
Minimum (µg/L)	15	44	33
Maximum (µg/L)	210	140	130
n	15	14	14
n>40 ug/L	11	14	13
%>40 ug/L	73.3	100.0	92.9
% confidence	1	1	1

7.7.5.1.4 Rocky River Downstream from Charles L. Turner Reservoir

The mainstem Rocky River [AU#: 17-42-(8)] downstream from Charles L. Turner Reservoir is characterized by a meandering mix of pools and riffles with the dominant bottom substrate consisting of embedded cobble and gravel. The Rocky River flows through the historic Hackney Millpond Dam about 1,000 feet upstream of the US 64 bridge in Siler City. The backwater/reservoir upstream from Hackney Dam consists of 1.17 miles of river beginning 2.75 miles downstream of the dam at Charles Turner Reservoir. This section of the river runs adjacent to Siler City. The land use of the watershed, which is approximately 67 square miles in size, is mainly classified as mixed upland hardwoods with some managed herbaceous cover. Some areas of grazing pasture for livestock are also located along the drainage area directly adjacent to the Hackney Dam area.

The data collected over the last several years shows that the Hackney Dam has a significant impact on the instream water quality conditions of the Rocky River during low flow conditions, which exist frequently in this system. When stream flows are persistently low, water does not flow over the dam, resulting in discharge from Hackney Dam only through two sluiceway openings at the bottom of the structure, and additional seepage from the dam itself. The limited data collected behind the dam shows that the water column is stratified, and water with low dissolved oxygen is being released through the sluice gates, resulting in low instream dissolved oxygen concentrations in the mainstem Rocky River downstream to at least where Loves Creek adds flow to the system (~0.35 miles downstream) (*Table 7-22*) (NCDEQ, 2017). It is recommended that some type of action should be taken to eliminate this source of low dissolved oxygen coming from the bottom of the pool behind Hackney Dam.

Table 7-22: 2016 Rocky River Water Quality Data for Station CPFRR04 Behind Hackney Millpond Dam.

CPFRR04 Sample Date	Chl *a* (µg/L)	Bottom Depth (m)	Surface Sample		Bottom Sample		Mean Daily DO at USGS Gage at US-64 (mg/L)	Mean Daily Flow at USGS Gage at US-64 (cfs)	July 7, 2016 Vertical Profile at CPFRR04 Hackney Dam			
			DO (mg/L)	Temp °C	DO (mg/L)	Temp °C			Depth (m)	Temp °C	DO (mg/L)	pH (S.U.)
5/26/2016	41	2.7	8.2	23.8	2.2	18.8	7.5	20	0.2	31.8	10.4	8.3
6/2/2016	52	2.0	13.3	26.7	1.4	22.3	4.6	9.5	0.5	28.7	10.9	8.4
6/9/2016	42	3.2	7.4	26.5	3.9	25.1	6.5	25	1.0	28.0	10.2	8.5
6/13/2016	32	3.0	9.0	29.1	0.6	24.1	4.2	7.4	1.5	27.6	6.2	7.5
6/20/2016	64	2.0	9.9	28.5	3.9	24.1	4.5	5.5	2.0	27.2	3.6	6.9
7/7/2016	80	2.3	10.4	31.8	1.1	26.7	4.1	3.4	2.3	26.7	1.1	6.7

The mainstem Rocky River [AU 17-43-(8)a; class C] from Charles L. Turner Reservoir Dam to Varnals Creek (6.7 miles) is currently on the 2022 IR due to a Fair benthic macroinvertebrate bioclassification at stations BB192, located upstream of US 64 bridge (*Table 7-18* and *Figure 7-54*). Historically, this segment of the Rocky River had been on the impaired waters list for low dissolved oxygen between 2010 and 2020 (*Table 7-23*). This section was considered Supporting in the 2022 IR, due to higher flows in 2018-2020, during the critically low DO periods resulted in more water going over Hackney Dam resulting in improved instream DO conditions at station B5950000 near US 64 and reducing the number of samples not meeting the 4 mg/L DO standard (6.0% for 2016-2020 data window) (*Table 7-23* and *Figure 7-55*).

Table 7-23: Rocky River Dissolved Oxygen Use Support Summary at Station B5950000 (US 64 Bridge) and Yearly Percent Exceedance of the 4 mg/L State Standard. (Use of % confidence was added to use support assessment in 2012).

IR Year	Data Range	%<4 mg/L	% Confidence	Use Support
2022	2016-2020	6.0 %	6.8%	Supporting
2020	2014-2018	10.7 %	EC3*	Impaired
2018	2012-2016	17.6 %	97.9 %	Impaired
2016	2010-2014	31.8 %	> 99.9 %	Impaired
2014	2008-2012	32.9 %	> 99.9 %	Impaired
2012	2006-2010	22.4 %	> 99.9 %	Impaired
2010	2004-2008	12.9 %	86 %	Impaired
2008	2002-2006	8.2 %		Supporting
2006	2000-2004	1.2 %		Supporting

* Excursion rate > 10 %, confidence in excursion rate < 90%, Previously exceeding criteria, new data years excursions >1

Figure 7-54: 2016 Rocky River Special Study, DO Monitoring Locations.

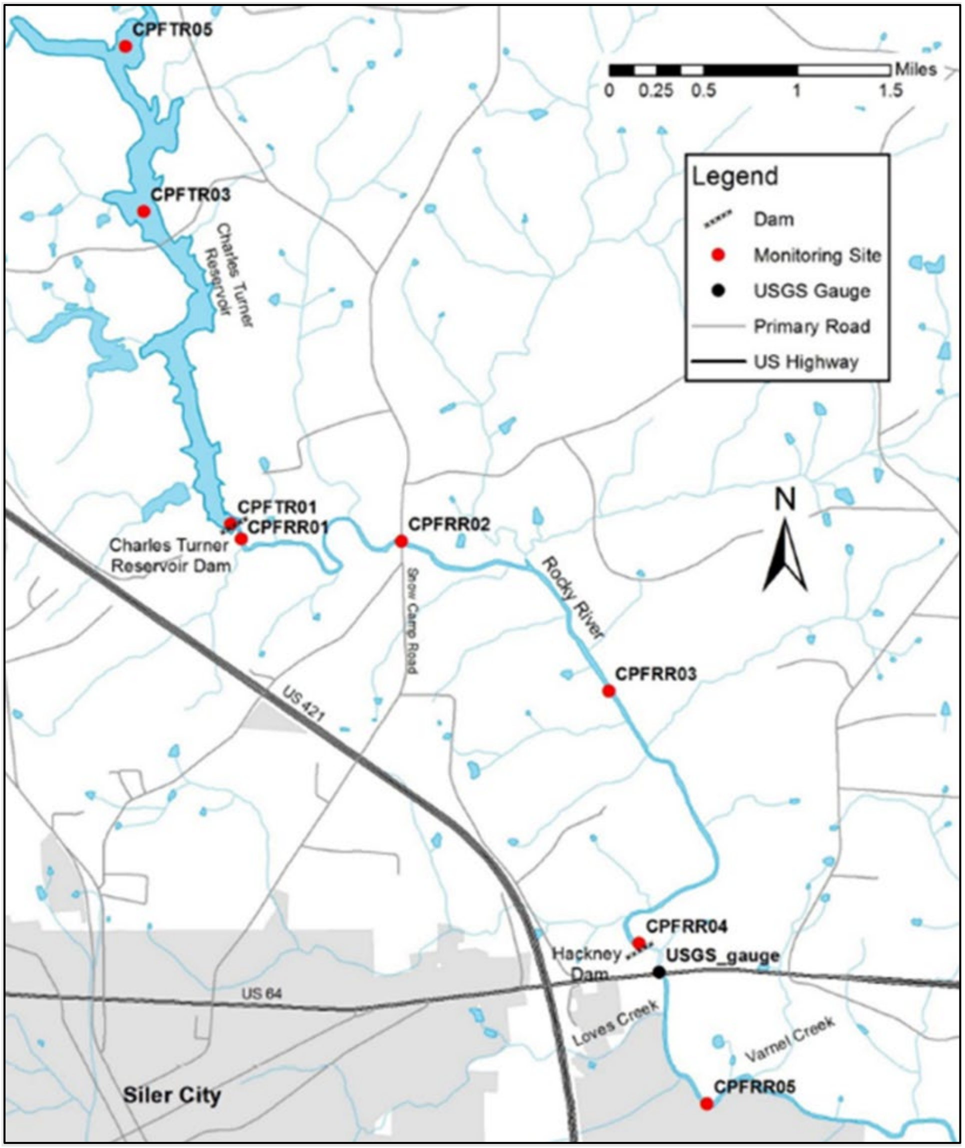


Table 7-24: Sites Sampled, Rocky River 2016 Special Study.

Site Name	Site Description
CPFTR05	Charles Turner Reservoir- Muddy Lick Creek Arm
CPFTR03	Turner Reservoir Upstream of SR 1312 Near Unnamed Tributary
CPFTR01	Turner Reservoir at Dam
CPFRR01	Rocky River Below Charles Turner Dam
CPFRR02	Rocky River at Siler City-Snow Camp Road
CPFRR03	Rocky River 1.7 miles Upstream of Hackney Dam
CPFRR04	Rocky River at Hackney Dam
US64	Rocky River at US 64 near Siler City
CPFRR05	Rocky River Near Medical Park Drive

As briefly mentioned above in the Charles L. Turner Reservoir of the Rocky River section, in 2016, a special study was conducted by the DWR's Intensive Survey Branch at the request of the Basinwide Planning Branch (BPB), Modeling and Assessment Branch (MAB), and the Raleigh Regional Office (RRO). This study was performed to assess the impact of Charles Turner Reservoir and Hackney Dam on DO levels along a 6.7-mile stretch in the Rocky River system near Siler City from May to July 2016 (*Table 7-24*). This stretch of Rocky River was classified as impaired (2010-2020) due to recurring low DO below the state standard of an instantaneous reading of 4.0 mg/L during the late summer months. Physical and chemical parameters were collected from eight sites in the area of study (*Table 7-24*) three in Charles Turner Reservoir, four downstream of Charles Turner Reservoir and upstream of Hackney Dam, and one site downstream of Hackney Dam (*Table 7-25*). In addition to data collected by the ISB, water quality information was collected from the USGS gaging station (02101726) at US 64 near Siler City where US 64 crosses the Rocky River, downstream of Hackney Dam. This gaging station is co-located with an ambient monitoring station B5950000.

The USGS gage (02101726) records data every 15 minutes which provides a complete picture of the ongoing conditions at this location. The yearly mean stream flow at the USGS gage (02101726 at US 64) was higher in 2018-2020 which resulted in a higher yearly mean DO, with concentrations very similar to the ambient monitoring data (*Figure 7-56*). It is however clear from the daily USGS gage data that low dissolved oxygen is still an issue in this section of the Rocky River during the warmer summer months (*Figure 7-57*). This segment will likely fluctuate on and off the 303(d) impaired waters list depending on the frequency of monitoring and what the overall flow impacts are during the five-year assessment period.

To directly show the impact of flow on DO at this co-located station, the ambient data was paired with the daily mean flow for each of the sampling everts and assigned a category of low (bottom 25th percentile), medium (>25th & < 75th percentile), or high flow (top 75th percentile) (see the water quality assessment section for more detail on this method). The mean DO concentrations shows an increase within each flow category, increasing from a mean of 4.72 mg/L at low flows up to 9.48 mg/L at high flows (*Figure 7-58*).

Figure 7-55: Yearly Mean Dissolved Oxygen Concentration, Percent of Samples Below the 4 mg/L Standard and Mean Flow at USGS Flow Gage (0210166029) at Crutchfield Crossroads, NC.

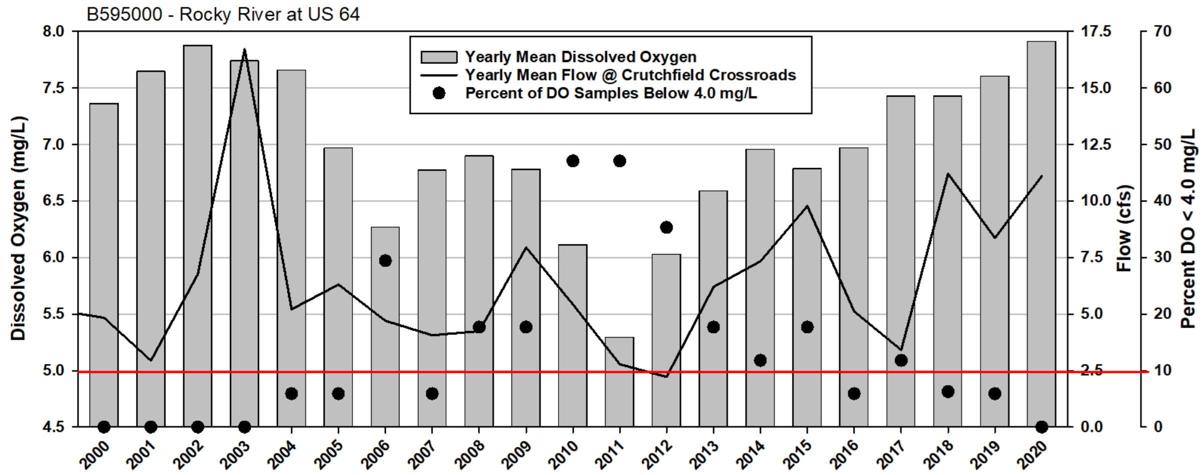


Figure 7-56: Rocky River Year Mean Flow and Dissolved Oxygen Concentrations at USGS Water Quality/Flow Gage 02101726 at US 64 Near Siler City, NC.

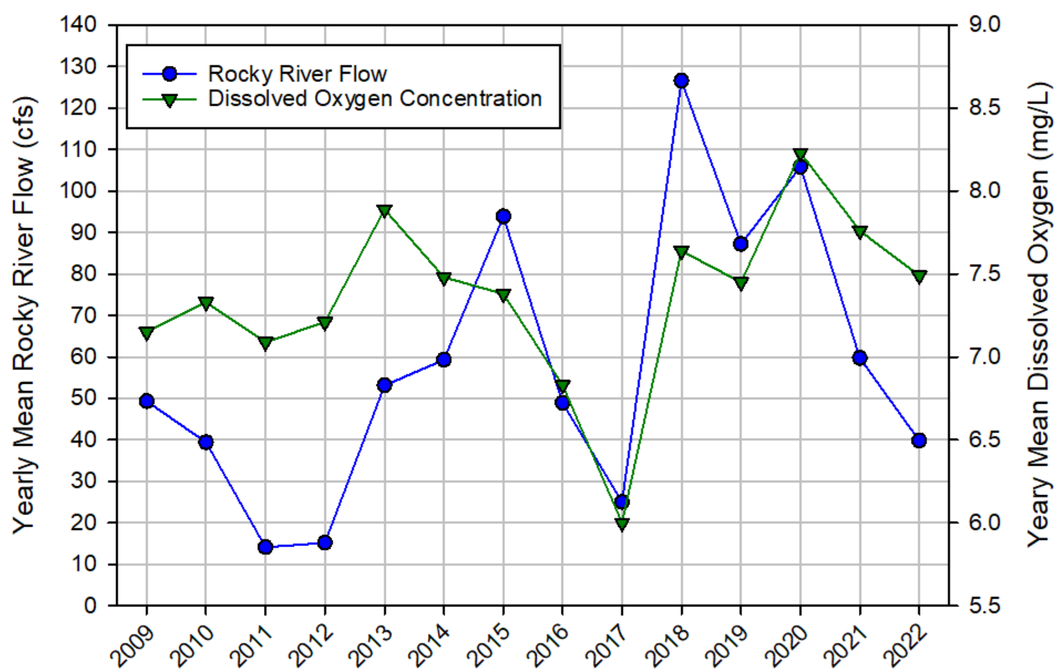
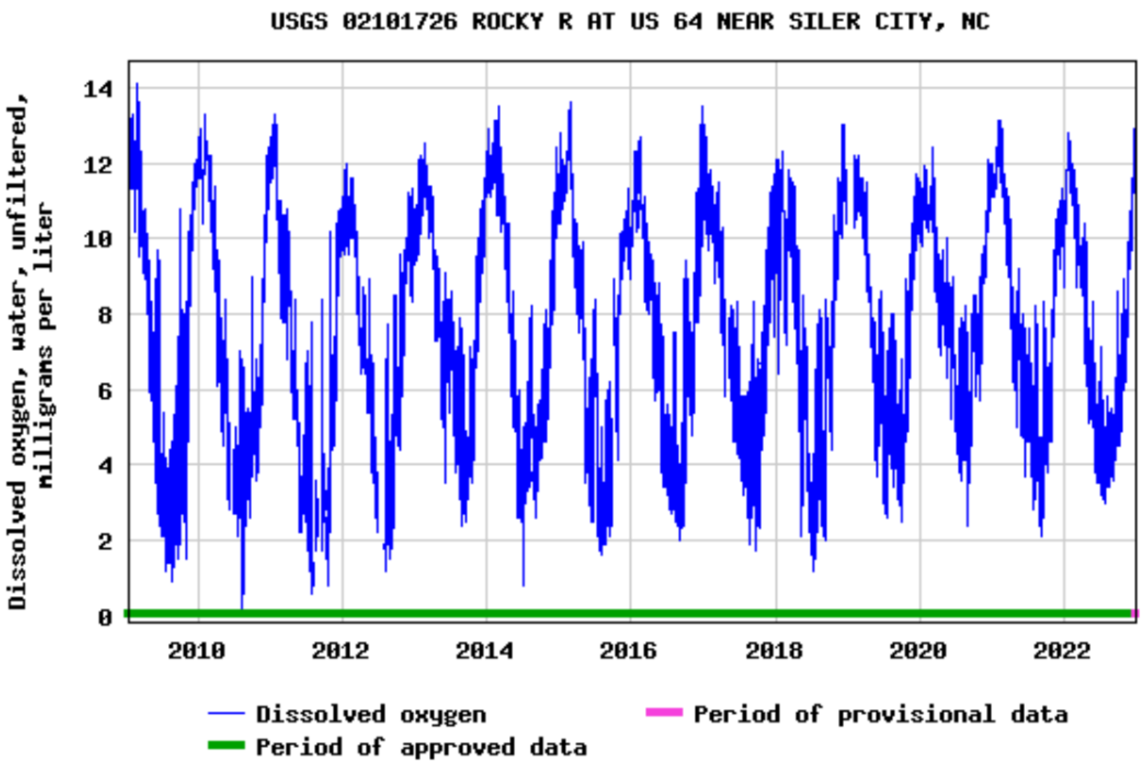


Figure 7-57: Rocky River Daily Dissolved Oxygen Concentrations at USGS Water Quality/Flow Gage 02101726 at US 64 Near Siler City, NC for 2009-2020 and for 2016-2020 (2022 IR assessment period).



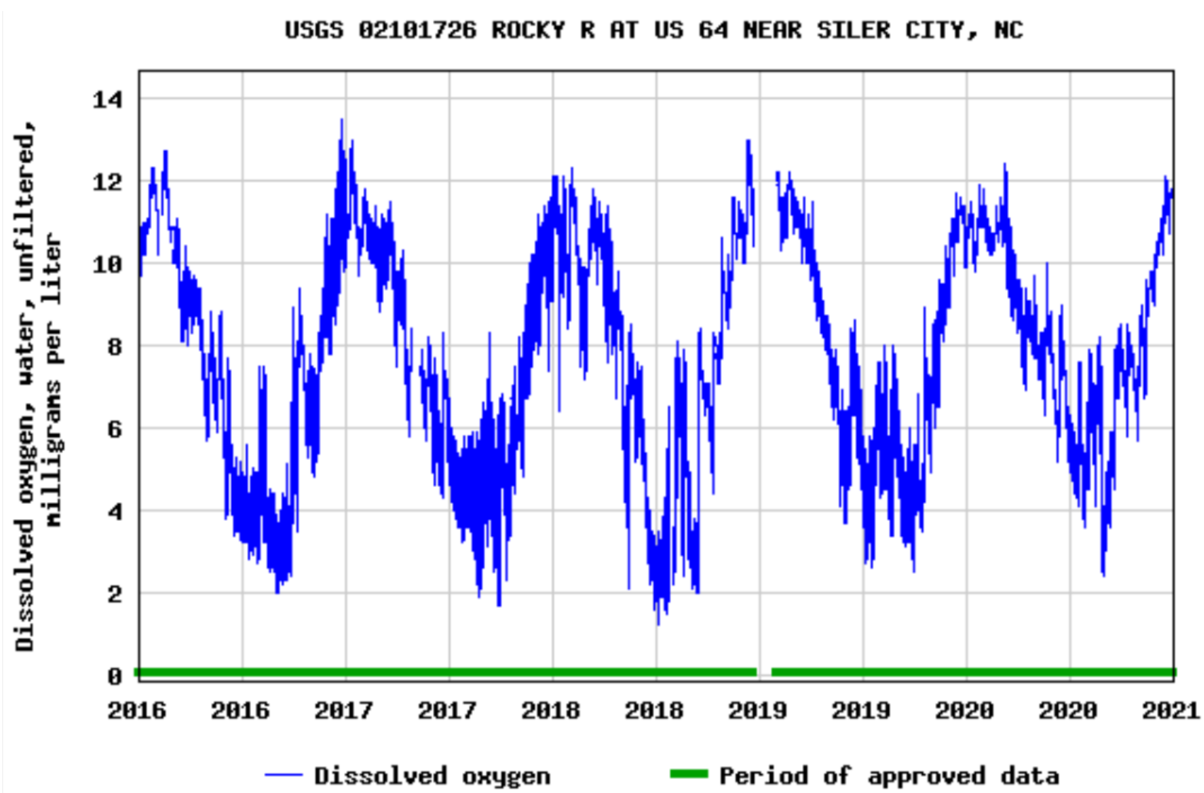
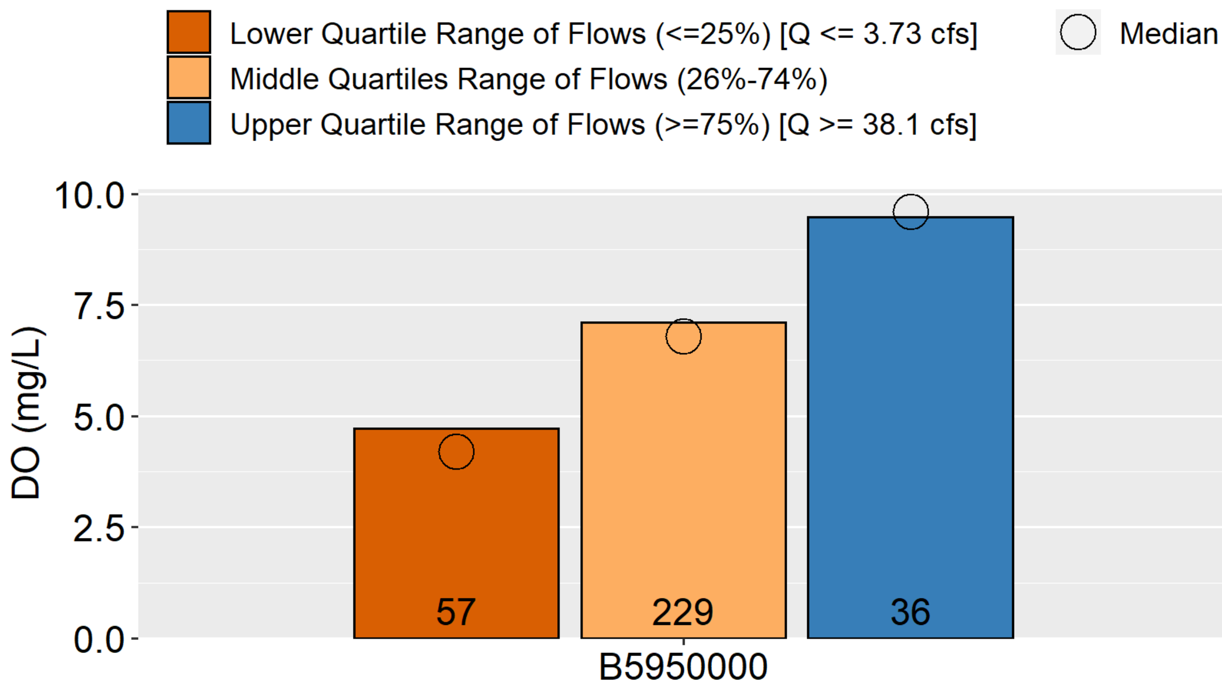


Figure 7-58: Nineteen Year (2002-2020) Flow Separated Mean and Median Dissolve Oxygen Concentration Separated by Low flows ≤ 25th Percentile, Medium Flows between 26th and 74th Percentile and High Flows ≥ 75th Percentile; at USGS Gage Station 02101726 at US 64).



Rocky River Between Charles Turner Reservoir and Above the Influence of the Hackney Dam Reservoir

Downstream of Charles Turner Reservoir and upstream of the Hackney Dam reservoir, two riverine samples were collected at sites CPFRR01 and CPFRR02 (*Figure 7-54*). CPFRR01 was located directly downstream of the Charles Turner Dam discharge and site CPFRR02 was sampled upstream of the bridge at Snow Camp Road (*Figure 7-54*). No exceedances of state water quality standards in the surface readings (< 0.2 m) were observed during the course of this study for DO, temperature, or pH. Minimum, median, and maximum values for physical parameters are listed in *Table 7-25*. Low dissolved oxygen was recorded at CPFRR01 while using a deployed multiparameter data sonde during a pulsing assessment from the Charles Turner Reservoir (July 7, 2016 to July 14, 2016). Additional information on the pulse portion of the study is available below and in the *Impacts Assessment on Physical Water Quality Related to Hackney Dam in Rocky River* final report (Subbasin Chapter Appendix).

Table 7-25: Minimum, Median, and Maximum Values for Rocky River Sites CPFRR01, CPFRR02, CPFRR03, CPFRR04 CPFRR05 and US64 Gaging Station May to July 2016. (Red values are low DO concentrations contributing to low DO readings downstream.)

	CPFRR01 Surface	**CPFRR02** Surface	**CPFRR03** Surface	**CPFRR04** Surface	**CPFRR04** Bottom	**US64** Surface	**CPFRR05** Surface
Temperature	°C	°C	°C	°C		°C	°C
Minimum	24.4	22.9	23.2	23.8	18.8	22.1	22.3
Median	26.5	25.5	24.9	27.6	24.1	25.9	25.9
Maximum	29.5	27.2	26.8	31.8	26.7	28.7	28.6
DO	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L
Minimum	5.7	5.4	4.6	7.4	0.6	3.8	2.3
Median	6.8	6.2	5.0	9.4	1.8	5.1	5.9
Maximum	7.7	7.6	6.7	13.3	3.9	7.9	6.7
pH	s.u.	s.u.	s.u.	s.u.		s.u.	s.u.
Minimum	7.2	6.8	6.7	7.2	6.6	6.6	7.1
Median	7.5	7.1	7.0	8.1	6.6	6.8	7.3
Maximum	7.9	8.4	7.0	9.0	6.8	7.2	9.7
Specific Conductivity	µS/cm	µS/cm	µS/cm	µS/cm		µS/cm	µS/cm
Minimum	83	85	84	84	85	87	159
Median	84	88	90	90	92	95	205
Maximum	92	100	99	92	96	100	347

Hackney Reservoir/Backwaters

Sites CPFRR03 and CPFRR04 were designated as the upstream and downstream sites in the reservoir/backwater located upstream of Hackney Dam (*Figure 7-54*). CPFRR03 located 1.7 miles upstream of the Hackney Dam remained relatively shallow during the course of the study, with the depth ranging between about 1.0 and 2.0 meters deep. Physical conditions for surface measurements did not exceed state water quality standards at this site during the study with a median value of 5.0 mg/L and a minimum value of 4.6 mg/L, observed on 6/20/2016. This station was stratified and the DO fell below 4 mg/L on three of the five profiles dates. Low dissolved oxygen was also recorded at CPFRR03 while using a deployed multiparameter data sonde during a pulsing assessment from the Charles Turner Reservoir between 7/7/2016 and 7/14/2016.

At site CPFRR04, depth varied from 2.0 m to 3.2 m. The maximum temperature observed at this site, 31.8°C on 7/7/2016, was close to the state standard of 32°C, but no exceedances occurred during discrete site visits. Surface measurements for DO and pH remained elevated at CPFRR04 during this study, indicative of increased algal productivity. Water column profile information was collected throughout the course of the study; subsurface DO remained consistently low, with a median value of 1.8 mg/L and a minimum reading of 0.6 on June 13, 2016 (*Table 7-25*). Thermal stratification with hypoxic conditions at depth are normal summer conditions for eutrophic standing bodies of water and is the main contributor to reduced DO levels observed downstream of the Hackney Dam in Rocky River due to the discharge mainly through the bottom sluice gates.

Downstream of Hackney Dam

Below Hackney Dam, a gaging station (02101726) is maintained by the USGS in cooperation with the Town of Siler City to collect physical parameters every 15 minutes using a multiparameter sonde (*Figure 7-54*). For this study, readings collected from the station at noon on days when the Intensive Survey Branch collected samples at the other eight sites were used as representative readings for the site at US Highway 64 (US64). The temperature remained below the state standard with a maximum value of 28.7 °C and a median value of 25.9 °C. Specific conductivity remained consistent with the rest of the watershed and had a median value of 95 µS/cm. The median and minimum pH values of 6.8 and 6.6 s.u., respectively, are similar to those observed in other riverine sections of the Rocky River and do not exceed state standards. Dissolved oxygen remained relatively low with a median DO of 5.1 mg/L and a minimum value of 3.8 mg/L recorded on 7/14/2016 (*Table 7-25*). Additional readings taken after the conclusion of field sampling for this study exhibited extended periods of DO concentrations below the state standard in August and September 2016. This time period had overall decreased rainfall and reduced streamflow.

CPFRR05 was the furthest Rocky River downstream site in the study area, located a half-mile downstream of the confluence of Loves Creek (*Figure 7-54*). During the study, temperature remained below the state standard with maximum and median values of 28.6 and 26.0 °C, respectively. Specific conductivity was elevated at CPFRR05, with a median value of 205 µS/cm and a maximum value of 347 µS/cm observed on 7/7/2016. Elevated conductivity is a result of the close proximity to the Siler City wastewater treatment plant discharge. The minimum pH value of 7.1 s.u. and the maximum of 9.7 s.u. are elevated in comparison to the gaging station located immediately upstream, and the maximum value of 9.7 s.u. exceeds the state standards. Higher pH value is often associated with increased algal production in the system. The median and minimum DO values of 5.9 and 2.3 mg/L do not indicate consistent algal blooms similar to those seen in the upstream reservoir areas of this study. The minimum value was observed on the first day of sampling, 5/26/2016. Subsequent sampling events showed instantaneous readings >4.0 mg/L and a maximum value of 6.7 mg/L on 6/9/2016 (*Table 7-25*). Nutrient and chlorophyll *a* samples were also collected as part of the 2016 *Impact Assessment on Physical Water Quality Related to Hackney Dam on the Rocky River* Study (DEQ, 2017). For more details see the report in the Subbasin Chapter Appendix.

A summary of the 2016 special study assessment includes:

- Total phosphorous values ranged from 0.06 mg/L to 0.11 mg/L throughout the area of study. Total phosphorus values in the Charles L. Turner Reservoir were higher than downstream riverine sections of the watershed studied (*Table 7-26*).
- Ammonia concentrations remained at or below detection levels for all sites with the exception of CPFRR05, which are due to the close proximity of the permitted WWTP discharge located immediately upstream at Loves Creek (*Table 7-26*).
- Nitrate + nitrite-nitrogen (NOx) results ranged from below detection limits (<0.02 mg/L) to 0.05 mg/L in Charles L. Turner Reservoir, with slightly higher values observed downstream at CPFRR01. Sites CPFRR02, CPFRR03, and CPFRR05 all showed higher NOx with a maximum value of 6.7 mg/L observed at CPFRR05 on 7/7/2016. The higher nutrient levels observed at CPFRR05 are due to the close proximity of the permitted WWTP discharge located immediately upstream at Loves Creek (*Table 7-26*).

- Total Kjeldahl nitrogen (TKN), ranged from a low of 0.58 mg/L observed at CPFRR02 to a high of 1.30 mg/L observed at CPFTR05 and CPFTR01 during the month of July 2016 which was association with algal blooms occurring at the time. Highest median values for TKN were observed in the upstream section of Charles L. Turner Reservoir. Similar values were observed at CPFRR01, directly downstream of the Charles L. Turner Reservoir, as well as at site CPFRR04 located upstream of the Hackney Dam (*Table 7-26*). These are the same areas with the higher chlorophyll *a* concentrations due to elevated algal growth (*Table 7-27*).
- Chlorophyll *a* concentrations in the mainstem Rocky River below Charles L. Turner Reservoir appears to be influenced by the location in relation to each of the dam structures (*Table 7-27*).

Table 7-26: Median values for nutrient parameters from May 2016 to July 2016 (highest values in bold).

Site	TKN (mg/L)	TP (mg/L)	NH_3 (mg/L)	NO_2+NO_3 (mg/L)
CPFTR05	1.10	0.09	0.02	0.03
CPFTR03	**1.15**	**0.10**	0.02	0.03
CPFTR01	0.99	0.07	0.02	0.03
CPFRR01	0.94	0.07	0.02	0.04
CPFRR02	0.67	0.06	0.02	0.31
CPFRR03	0.67	0.08	0.03	0.17
CPFRR04	0.92	0.07	0.02	0.04
CPFRR05	0.84	0.06	**0.05**	**2.40**

Elevated chlorophyll *a* concentrations occurred at CPFRR01 just below the Charles Turner Reservoir with a mean of 33.8 µg/L (*Table 7-27*) and one of the six samples above the state standard (60 µg/l on 6/2/2016). During low flow periods, the area below Charles L. Turner Reservoir only receives flow as result of the minimum flow releases resulting is a more stagnant pool right below the dam as well as receiving water with elevated levels of algal activity from the reservoir. The chlorophyll *a* concentration dropped in the more free-flowing section of the Rocky River at station CPFRR02 with a study mean of 8.8 µg/L and a maximum concentration of 22 µg/L (6/9/2016). The next station downstream, station CPFRR03, is 1.7 miles upstream of the Hackney Dam and is in the upper reaches of the dam's backwater/reservoir where the stream begins to slow down and had a maximum depth during this study of 2.0 m (6/2/2016). The chlorophyll *a* concentrations were generally higher than the upstream station with a study mean concentration of 19.1 µg/L and a maximum concentration of 31 µg/L (6/13/2016).

The depth of the pool behind Hackney Dam at station CPFRR04 ranged between 2.0 and 3.2 meters deep. The water column was stratified and did not spill over the dam during any of the sampling events (*Table 7-25).* The chlorophyll *a* concentrations ranged between 32 and 80 µg/L, with 83% of the samples exceeding the state standard of 40 µg/L (*Table 7-27*). During this study, the Hackney reservoir received a calculated NCTSI score of 4.2 indicating it is eutrophic.

The furthest downstream station in this study, CPFRR05, about a half mile downstream from the confluence with Loves Creek had elevated chlorophyll *a* concentrations on two occasions with values of

16 and 19 µg/L. This station had the lowest overall mean concentration of 7.9 µg/L over the study period. The highest concentrations coincided with the two higher daily and prior week's mean flow (at USGS station 02101726 at US 64) which may have resulted in some of the algal bloom being flushed from behind Hackney Dam downstream in the days prior to sampling (*Table 7-27*). There was a low DO reading of 2.3 mg/L at this station on May 26, 2016, which corresponded to the highest chlorophyll *a* reading of 19 µg/L. The low DO could have been caused by a senescent/dying algal bloom that was flushed downstream during a larger stream flow event in the days before. The Rocky River stream flow was 250 cfs on May 22, 2016, and slowly dropped to 20 cfs on the day it was monitored (May 26, 2016). Additional parameters were monitored as part of this study include BOD_5, TOC, dissolved phosphorus, dissolved organic nitrogen. See the report in Subbasin Chapter Appendix for more information.

Table 7-27: Mainstem Rocky River Chlorophyll a Concentrations and Summary Statistics from the 2016 ISB Special Study. Corresponding Mean Flow and DO Data (Daily and week (7 days) preceding sampling date) from USGS Gage Station #02101726 at US 64 Near Siler City, NC.

Chlorophyll Sample Date	CPFRR01	CPFRR02	CPFRR03	CPFRR04	CPFRR05	Mean Daily & Preceding Week DO at USGS Gage (mg/L)	Mean Daily & Preceding Week Flow at USGS Gage (cfs)
5/26/2016	33	11	13	**41**	19	7.5 / 8.0	20 / 83
6/2/2016	**60**	10	6.7	**52**	2.6	4.6 / 5.7	9.5 / 13.5
6/9/2016	38	22	26	**42**	16	6.5 / 6.0	25 / 47
6/13/2016	24	4.6	31	32	4.6	4.2 / 5.6	7.4 / 33
6/20/2016	33	4	16	**64**	2.6	4.5 / 4.1	5.5 / 6.5
7/7/2016	15	1.1	22	**80**	2.4	4.1 / 3.8	3.4 / 3.9

2016 Summary Statistics	CPFRR01	CPFRR02	CPFRR03	CPFRR04	CPFRR05	DO Monthly June / 2016 yearly (mg/L)	Flow Monthly June / 2016 yearly (cfs)
Mean	33.8	8.8	19.1	51.8	7.9	4.69 / 6.83	16 / 48.9
Median	33	7.3	19	47	3.6		
min	15	1.1	6.7	32	2.4		
max	60	22	31	80	19		
n	6	6	6	6	6		
n>40	1	0	0	5	0		
%>40	**16.7**	0	0	**83.3**	0		
% Confidence	0.53			1.00			

Required 20 cfs Pulse Flow Impacts

The data collected as part of this 2016 special study shows that during normal summer low flow conditions, the segment of the Rocky River behind Hackney Dam and likely extending somewhat upstream in the backwater pool, exceeded the chlorophyll *a* standard a majority of the time. The dam restricts the flow of the Rocky River, which results in stratification and low/hypoxic dissolved oxygen concentrations. During periods of low flow, this potentially hypoxic bottom water is the major source of streamflow for the Rocky River between Hackney Dam and the confluence of Loves Creek, resulting in DO levels frequently below the state standard. *It is recommended that local stakeholders evaluate the current uses and condition of the Hackney Dam and determine the feasibility of modifying or removing the dam to improve water quality and aquatic habitat.* There are several groups interested in removing dams to improve fish passage and aquatic habitat that could potentially assist with this effort, these include the Piedmont Conservation Council and American Rivers.

As part of the 401 Certification, the Town of Siler City is required to maintain a constant discharge from the Charles L. Turner Reservoir. During the course of the study, minimum flows of 0.8 cfs for May, 5.0 cfs for June and 2.5 cfs for the month of July were recorded by the water treatment plant. This is in addition to any additional spillover from the dam. The 401 Certification also requires a 12-hour, 20-cfs stream flow pulse from the Charles L. Turner Reservoir every 30 days if a natural event does not occur. On July 8, 2016, from approximately 8 a.m. to 8 p.m. the town fulfilled their requirement and released a pulse from the reservoir. The town was also required to support the installation and maintenance of the USGS flow gage and water quality station (02101726) at US 64 in Siler City. It is critical that this flow gage and water quality station remain active in order to understand how flows from the reservoir and the watershed change over time and impact water quality.

As part of the 2016 study, multiparameter data sondes were deployed from July 7, 2016, to July 14, 2016, at stations CPFRR01 (just below Charles L. Turner Reservoir Reservoir) and CPFRR03 (1.7 miles upstream of the Hackney Dam in the upper reach of the backwater) to monitor physical parameters every 15 minutes in order to understand the impacts from the pulses to the water quality downstream of both dams.

At station CPFRR01, a rapid rise in stage (stream depth) coincided with the increased flow from the pulse event. The depth rose from an average of 0.11 to 0.28 meters during the pulse. Low DO concentrations with a sustained average of 3.2 mg/L prior to the pulse increased to an average of 6.48 mg/L before returning to low values with an average of 1.49 mg/L on July 9, 2016.

At station CPFRR03, the stage increase was delayed and more gradual with a peak stage of 1.16 meters, up from a pre-pulse average of 0.74 meters. After reaching the peak, water levels dropped gradually over the rest of the deployment period in contrast to the flash flow observed at CPFRR01 concurrent with the pulse event's beginning and end. Dissolved oxygen exhibited a spike during the initial rise in stage, reaching a peak of 5.9 mg/L at 1:40 pm on July 8, 2016, up from a pre-pulse average of 1.5 mg/L. Dissolved oxygen levels decreased gradually over July 9 before returning to pre-pulse levels and resuming diurnal fluctuation patterns on July 10, 2016. The data provided by the sondes indicate a mixing event occurred caused by the initial flush of the pulse in the upstream portion of the Hackney Dam reservoir.

It was determined that the 20-cfs pulse on July 8, 2016, was insufficient to raise the stage at CPFRR04 high enough to flow over Hackney Dam. A similar joint study by DWR and DWQ in 2011 during an extended drought found similar results to the pulse study in 2016. While the 2011 study was unable to capture a pulse due to drought protocols eliminating the pulse requirement to protect the drinking water supply, a few natural events occurred. Only the most extreme events resulted in high enough flow to cause the Rocky River to flow over the Hackney Dam. The Rocky River quickly returned to pre-storm flows and the dam returned to restricting flows downstream through the bottom sluice gates. It appeared that Hackney Dam acted as a re-regulating weir such that during low river flows the dam's discharge through the gates and dam leakage exceeded the inflow, causing the pond's elevation to drop. The pulse flow was captured by the Hackney Dam and succeeded in only refilling the pond. For more information and pulse graphics, see the 2016 *Impact Assessment on Physical Water Quality Related to Hackney Dam on the Rocky River* Study (DEQ, 2017) in the Subbasin Chapter Appendix.

Remaining Rocky River Mainstem Ambient Water Quality Assessment [AUs 17-43-(8)a, 17-43-(8)b1, 17-43-(8)b2, and 17-43-(8)b3]

The Rocky River below Hackney Dam broadens, flow is slower, and the bottom is characterized as a silty mixture of clay and sediment with steep banks characteristic of a typical piedmont river system. The Rocky River is assessed using three mainstem ambient monitoring stations (B5950000, B5980000, and B6000000) and three benthic macroinvertebrate stations (BB192, BB376 and BB422) (*Table 7-28*).

The only segment of the Rocky River below the Charles Turner Reservoir currently listed as impaired/exceeding criteria on the 2022 IR is AU # 17-43-(8)a, from Charles Turner Reservoir to Varnals Creek (*Table 7-28* and *Figure 7-54*). The long-term low dissolved oxygen concentration downstream of Hackney Dam as described above has likely impacted the aquatic life at station BB192 which is co-located with the ambient water quality monitoring station B5950000 and USGS gage/water quality station 02101726. The Rocky River benthic macroinvertebrate station BB192 was last sampled in 2018 and received a rating of Fair, which is a decline from the 2013 Good-Fair bioclassification. The Fair benthic rating kept the Rocky River between the Charles Turner Reservoir Dam and Varnals Creek on the 2022 impaired waters list [AU # 17-43-(8)a].

Table 7-28: Rocky River (Below Charles L. Turner Reservoir) Monitoring Stations Used to Assess Use Support and Associated 2022 IR Overall Assessment.

Rocky River AU #	Stream Length (miles)	AMS Station #	Benthic Station #	2022 IR Overall Assessment	Additional Watershed Information
17-43-(8)a	6.7	B5950000	BB192 - Fair	Exceeding Criteria/ Impaired - Benthos	Low DO issues; ~ 0.2 miles upstream of Loves Cr.
17-43-(8)b1	15.2	B5980000	BB376 - Good-Fair	Not Rated - Fecal Coliform	~ 4 miles downstream of Loves Cr.
		B6000000	Old station		~10 miles downstream of Loves Cr.
17-43-(8)b2	0.9	None	None	Not Rated - Chlorophyll *a*	Dam Removed in 2018; (pond was ~35 Acres)
17-43-(8)b3	5.5	None	BB422 - Good	Meeting Criteria/ Supporting - Benthos	~2.25 miles downstream of former Woods Dam and ~3.4 miles upstream of Deep R.

The low EPT richness (14), elevated seasonally corrected NCBI (6.48) and low EPT abundance (EPTN=77) led to the Fair benthic bioclassification (*Table 7-29*). In 2003, BB192 was sampled and received a bioclassification of Not Rated due to drought conditions. Drought conditions were also observed in 2008 so a sample was not collected. Despite a low EPT taxa richness (14), this site received a Good-Fair rating in 2013. EPT richness has not recovered at this station since the 2003 drought and this is likely attributed to upstream Siler City water supply impoundments and the Hackney Dam preventing macroinvertebrate recolonization, chronic low flow conditions, warm summer stream temperatures and low dissolved oxygen levels. The closest impoundment (Hackney Millpond Dam) is only 400 meters upstream of the sampling station. *Continued benthic monitoring at this location is recommended to assess any water quality declines or improvements.*

The dissolved oxygen concentration in the Rocky River improved downstream of the confluence with Loves Creek (*Figure 7-59*). The 2022 IR assessment period mean DO concentrations were 7.46, 7.54 and 9.50 mg/L for the three Rocky River Stations B5950000, B5980000 and B6000000 respectively (*Table 7-30*, *Table 7-31*, and *Table 7-32*). Station B5980000 only had a single record (3.80 mg/L) below the DO standard during that period and B6000000 had none.

Table 7-29: Biological Community Analysis: Rocky River (BB192) at US 64.

Year	Study	Sample Type	EPT BI	Biotic Index	Bioclassification
2003	Basin Sample	Full Scale	5.29	6.5	Not Rated
2013	Basin Sample	Full Scale	4.82	6.29	Good-Fair
2018	Basin Sample	Full Scale	4.67	6.3	Fair

Table 7-30: Rocky River Ambient Monitoring Station B5950000 2022IR Data Summary (Upstream of US 64).

Parameters	Mean	Median	Min	Max	75th Percentile	n Total	n Non-detects
Ammonia	0.04	0.02	0.02	0.22	0.04	70	39
Chlorophyll a	14.24	10.80	1.83	46.20	19.92	34	0
DO	7.46	7.20	3.20	11.80	9.65	84	0
Fecal Coliform	632	67	6	12,600	206	60	0
NOx	0.29	0.23	0.02	1.07	0.39	70	1
pH	6.92	6.90	6.40	7.50	7.10	84	0
Phosphorus	0.09	0.08	0.02	0.30	0.11	70	0
Specific conductance	89	88	53	124	99	84	0
Temperature	20.3	22.1	4.9	30.8	27.1	84	0
TKN	1.00	0.94	0.20	3.15	1.12	70	1
Total Nitrogen	1.29	1.21	0.22	3.62	1.61	70	2
Turbidity	13.21	8.25	1.40	114.00	16.80	70	0

Table 7-31: Rocky River Ambient Monitoring Station B5980000 2022IR Data Summary (~4 miles downstream of Loves Creek).

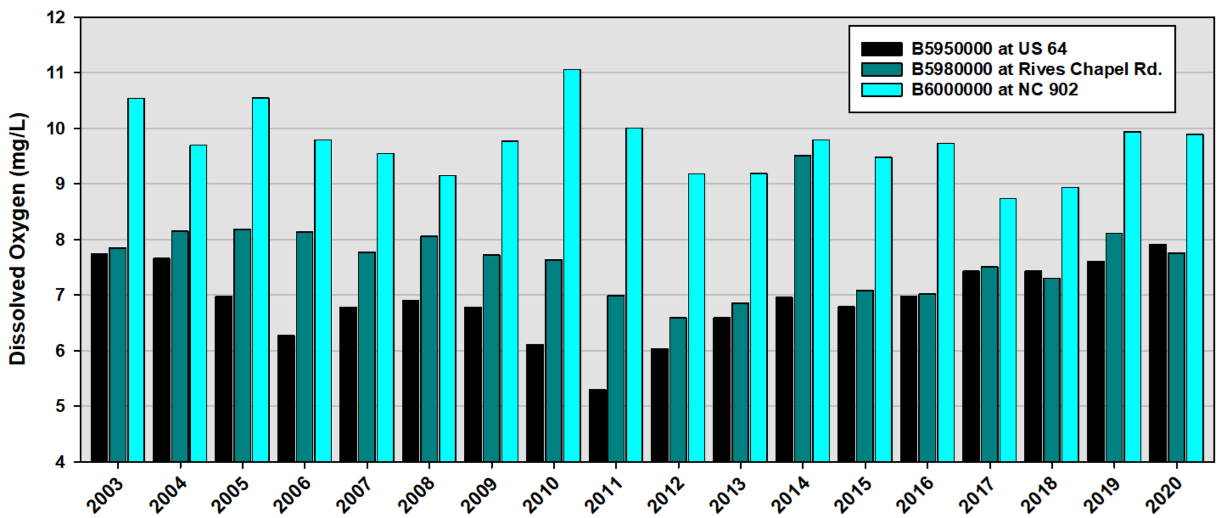
Parameters	Mean	Median	Min	Max	75th Percentile	n Total	n Non-detects
Ammonia	0.04	0.02	0.02	0.51	0.04	60	37
DO	7.54	6.80	3.80	12.60	9.03	84	0
Fecal Coliform	618	105	18	9,800	348	60	0
NOx	2.13	1.40	0.07	8.15	3.23	60	0
pH	7.05	7.00	6.30	7.60	7.20	84	0
Phosphorus	0.08	0.07	0.02	0.31	0.10	60	2
Specific conductance	246	176	72	913	318	84	0
Temperature	19.6	21.9	4.4	29.7	25.9	84	0
TKN	1.03	0.96	0.37	2.51	1.18	60	0
Total Nitrogen	3.17	2.44	0.99	8.68	4.32	60	0
Turbidity	18.93	7.60	1.00	305.00	16.52	60	1

Table 7-32: Rocky River Ambient Monitoring Station B6000000 2022IR Data Summary (~10 miles downstream of Loves Creek).

Parameters	Mean	Median	Min	Max	75th Percentile	n Total	n Non-detects
Ammonia	0.02	0.02	0.02	0.04	0.02	67	45
Chlorophyll *a*	3.7	2.4	1.2	17.0	4.70	27	3
DO	9.50	9.20	4.84	14.80	11.40	66	0
Fecal Coliform	152	56	6	1,200	120	55	0
Hardness Carbonate	55.53	46.00	30.00	110.00	61.00	17	0
NOx	1.40	0.96	0.17	6.30	1.40	67	0
pH	7.59	7.58	6.00	8.70	7.80	66	0
Phosphorus	0.06	0.06	0.02	0.14	0.09	67	2
Specific conductance	231	172	86	721	272	66	0
Temperature	17.6	18.7	2.6	28.6	25.7	63	0
TKN	0.67	0.64	0.39	1.20	0.74	65	0
Total Nitrogen	2.08	1.54	0.86	7.07	2.14	65	0
TSS	6.97	6.20	6.20	13.00	6.20	41	36

Parameters	Mean	Median	Min	Max	75th Percentile	n Total	n Non-detects
Turbidity	7.27	4.40	1.00	38.00	11.00	67	6

Figure 7-59: Rocky River Yearly Mean Dissolved Oxygen Concentrations.



Turbidity is a measure of how turbid or cloudy the water column is and is used to understand the potential impacts to aquatic life and their habitat. Turbidity in the Rocky River system is generally well below the state standard of 50 NTU in class C waters, however recent maximum values collected between 2016-2020 indicate pulses of elevated turbidity occur at stations B5950000 and B5980000 (*Table 7-30*, *Table 7-31*, *Table 7-32*). Turbidity in the Rocky River system is generally well below the state standard of 50 NTU in class C waters, however recent maximum values collected between 2016-2020 indicate pulses of elevated turbidity occur at stations B5950000 and B5980000 (*Table 7-30*, *Table 7-31*, *Table 7-32*). During high flow years, the middle station (B5980000) generally has the highest mean concentrations (see 2015, 2018, 2020; *Figure 7-60*). The Hackney Dam likely captures some sediments during more normal flow events, allowing for settling to occur in the backwaters of the dam structure. The most downstream station (B6000000) had the lowest yearly means in 2016-2020, but this has not always been the case. A flow separated assessment at the co-located AMS/USGS station at US 64 show the turbidity concentrations are considerably higher during high flow period with a mean of 23.64 NTU at high flow and 4.44 NTU at low flow (*Figure 7-61*).

The mainstem Rocky River has a fairly well-developed riparian buffer and is a mostly rural watershed, with about 25% agriculture, 58% forest and only 9.2% developed (2019 NLCD). There is evidence that cattle have access to the river at several locations which can result in increased sedimentation. Siler City is the largest town and drains mainly to Loves Creek which drains to the Rocky River between the two upper stations. Stormwater from Siler City is likely a contributing factor to the elevated turbidity levels recorded at station B5980000. The 2022 IR mean concentrations were 13.2, 18.9 and 7.3 NTU at the three stations respectively. Station B5980000 at Rives Chapel Road had the highest mean (18.9 NTU) and maximum (305 NTU) concentrations and an exceedance rate of 6.6% during the 2022 IR period (*Figure 7-60*).

Several of the threatened and endangered species in this watershed are known to be sensitive to sedimentation. Since turbidity is not a direct measure of total suspended solids (TSS), the Rocky River Interagency Workgroup *recommends monitoring TSS* along with turbidity (see discussion below). Because there are sensitive species that need extra protection and there are excess nutrients impacting water quality, it is recommended that *Soil and Water Conservation Districts work with farmers to exclude cattle from the streams* throughout the entire Rocky River (HUC10: 0303000305) watershed.

Figure 7-60: Rocky River Yearly Mean Turbidity Concentrations and Flow at USGS Station 0210166029 Crutchfield Crossroads, NC.

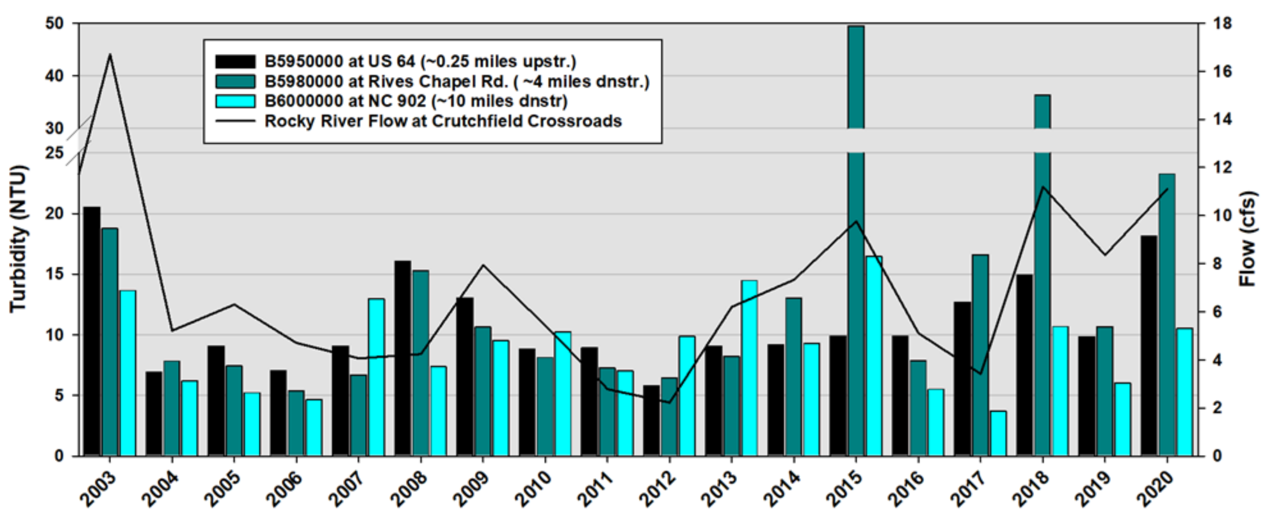
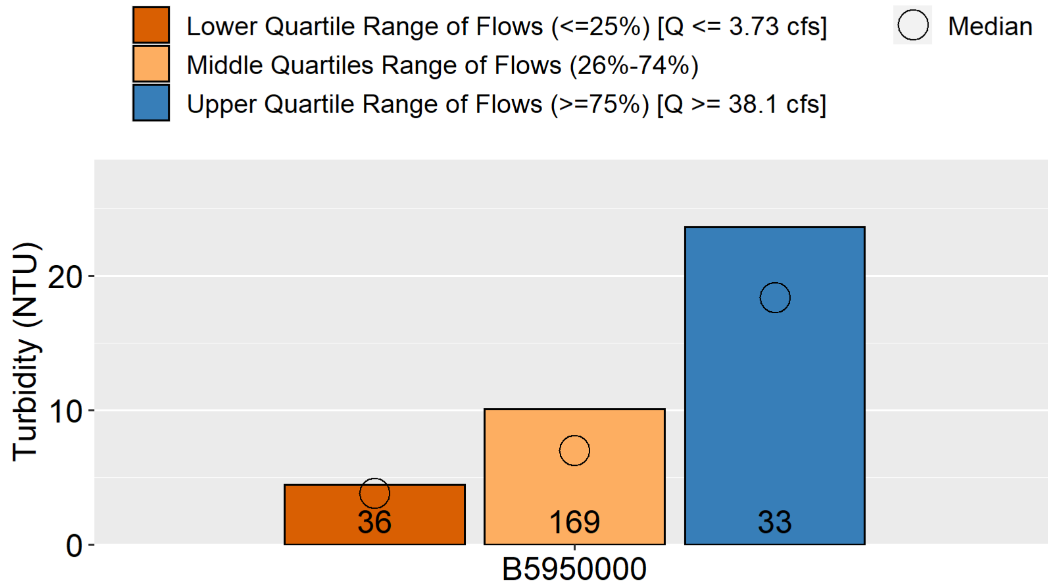


Figure 7-61: Nineteen Year (2002-2020) Flow Separated Mean and Median Turbidity Concentration Separated by Low Flows ≤ 25th Percentile, Medium Flows between 26th and 74th Percentile and High Flows ≥ 75th Percentile; at USGS Gage Station 02101726 at US 64).



Instream Fecal Coliform Bacteria (FCB) indicates that there is a source or fecal material from either humans or other warm-blooded animals and is used as an indicator of a potential health risk for individuals exposed to the water. While the fecal coliform standard applies specifically to sampling as five samples collected within a 30-day period (5-in-30), yearly and five-year IR averages from monthly data provide a snapshot of the overall general water quality conditions in the watershed.

There does not appear to be a specific pattern in the data, other than the upper two stations tend to have higher instream concentrations (*Figure 7-62*, *Table 7-30*, *Table 7-31,* and *Table 7-32*). The upstream station (B5950000) had the highest mean and maximum reading of 632 and 12,600 cfu/100mL, respectively, for the 2022 IR assessment (*Table 7-30*). Twenty percent of the samples were above the 400 cfu/100 mL state standard (2022IR). The middle station (B5980000) had the next highest mean of 618 cfu/100 mL with a maximum reading of 9,800 cfu/100 mL (*Table 7-31*). This station had a higher percent exceedance with 23% of the samples over the standard (2022IR). The lowest station in the watershed (B6000000) only had 7% exceeding the standard (2022IR) with a mean and maximum concentration of 75 and 1,200 cfu/100 mL, respectively (*Table 7-32*).

The flow separated assessment at B5950000 indicates that, in general, the mean fecal coliform bacteria concentrations are much higher during high flows. This is likely due to some very extreme concentrations since the median concentrations are not substantially different (*Figure 7-63*). The overall mean and median concentrations were very similar for the low and medium flow ranges. Instream fecal coliform bacteria violations have been shown to occur at both high and low flows throughout much of the Cape Fear River system, suggesting that contamination due to fecal coliform occurs during both wet and dry weather conditions. Low flow, dry weather fecal coliform bacteria loading is often associated with human sources such as from leaky sanitary sewer systems, failing septic systems and direct illicit discharges.

In agricultural watersheds, fecal coliform bacteria are often associated with animal access to the creek. Correspondingly, non-point sources and sporadic sources such as sanitary sewer overflows result in elevated fecal coliform during high flows. Urban stormwater, domestic animal waste, livestock grazing on agricultural lands and wildlife are often identified as contributing sources. The Town of Siler City is in the process of addressing the leaky sanitary sewer system issues in the town as part of their Special Order of Consent (SOC) and wastewater treatment system upgrades. This will likely improve the dry weather source as well as reduce the chances of sanitary sewer overflows, which can result from large rain events. The SOC and the Town of Siler City wastewater treatment plant are discussed later in this section.

Figure 7-62: Rocky River Yearly Mean Fecal Coliform Bacteria Concentrations and Flow at USGS Gage Station 0210166029 Crutchfield Crossroads, NC.

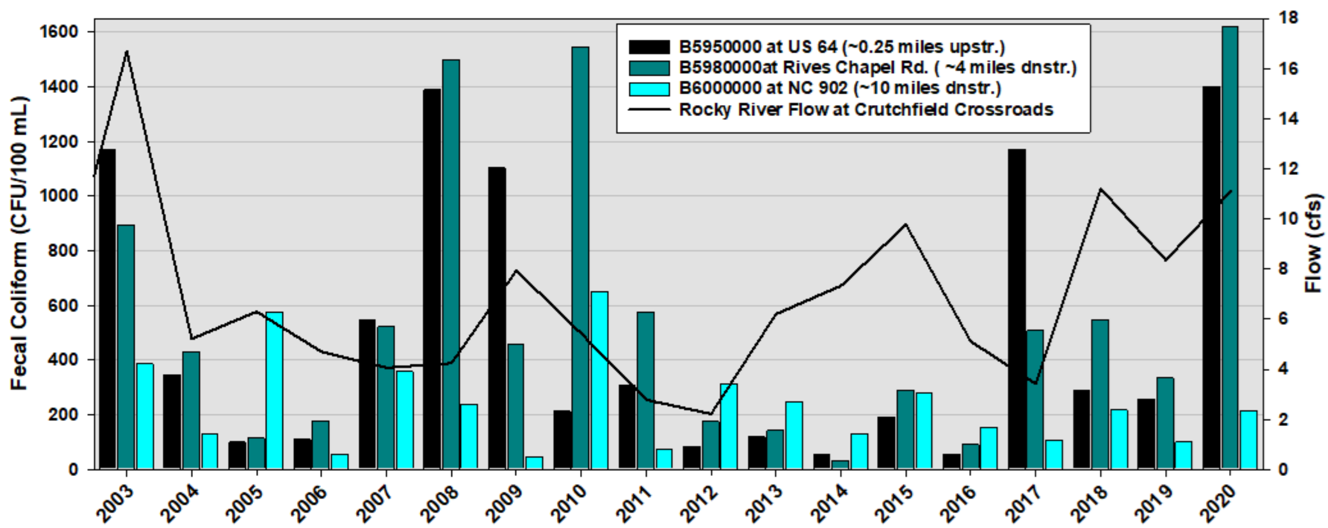
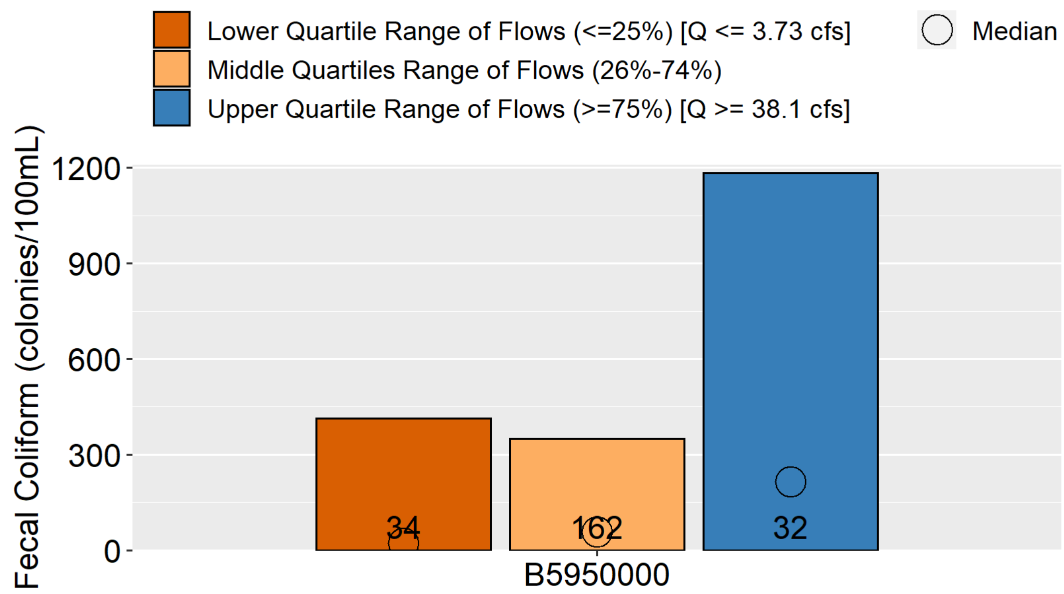


Figure 7-63: Nineteen Year (2002-2020) Flow Separated Mean and Median Fecal Coliform Bacteria Concentration Separated by Low Flows ≤ 25th Percentile, Medium Flows between 26th and 74th Percentile and High Flows ≥ 75th Percentile; at USGS Gage Station 02101726 at US 64.



Rocky River segment AU # 17-43-(8)b1 from Varnals Creek to the backwaters of Hoosier Dam (Woodys Dam) was listed as not rated on the 2022 IR due to the 23% exceedance of the 400 cfu/100 mL water quality standard described above at station B5980000. A 5-in-30-day assessment would need to verify an impairment and due to limited resources, the Division prioritized these assessments in class B waters across the state. All other instream water quality standards tested at this location were meeting the standard. This section is listed as not rated for a few other parameters (1-4 Dioxane, chloride, and fluoride) due to insufficient number of samples to make an assessment (< 10). Only three samples of each of these parameters were collected between 2016 and 2020 and none exceeded a state standard.

Table 7-33: Biological Community Analysis Rocky River (BB376) at Rives Chapel Road.

Year	Study	Sample Type	EPT BI	Biotic Index	Bioclassification
2002	Special Study	EPT	4.83	4.83	Not Rated
2003	Basin Sample	Full Scale	4.97	6.09	Good-Fair
2008	Basin Sample	Full Scale	5.49	6.71	Not Rated
2013	Basin Sample	Full Scale	4.59	5.87	Good-Fair
2018	Basin Sample	Full Scale	4.4	5.85	Good-Fair
2022	Special Study	Full Scale	5.05	6.10	Good-Fair

Benthos community site BB376 at Rives Chapel Rd. is co-located with ambient monitoring station B5980000 and has been monitored since 1989. Droughts occurred in 2002 and in 2008, so benthos samples were not rated in those years, but during non-drought years, this site has been consistently rated

Good-Fair since 1997. Sampling in 2018 resulted in the collection of 19 EPT taxa. The EPT fauna was dominated by mayflies (10 taxa) and caddisflies (7 taxa). However, the overall tolerance of the community was somewhat facultative (EPT BI=4.40) and the addition of 18 midge taxa (Chironomidae) further increased the overall biotic index to 5.85, essentially the same value calculated 5 years prior in 2013 (*Table 7-33*). ***The fauna present is indicative of water degraded by sediments and excess nutrients*** which will be discussed in detail below. Instream habitat was mostly available except for root mats, which were rare. Fontinalis moss and macrophytes were prevalent in the wetted channel. In addition, ***a profuse covering of periphyton on the hard substrates, indicating excessive nutrient inputs into the river, made sampling challenging***. EPT richness (23) and total richness (87) in 2013 suggested a recovery of the benthic community and water quality improvement from drought conditions in 2008. Furthermore, the highest total and EPT taxa richness and lowest NCBI (5.87) and EPTBI (4.59) since sampling began in 1989 was observed in 2013. Beginning in 1997, specific conductance (342 µS/cm in 2013) has remained elevated above 200 µS/cm in the Rocky River. Benthic macroinvertebrate habitats (HS=82) are good in this sampling reach and the consistent Good-Fair bioclassification indicate some degradation from upstream point and nonpoint source pollutants. A special study was conducted in 2022 and received Good-Fair benthic rating, consistent with 2013 and 2018 (*Table 7-33*).

Rocky River segment AU # 17-43-(8)b2, the former pond area behind Hoosier Dam is currently listed as data inconclusive or not rated for chlorophyll *a* on the 2022 IR. In 2009, North Carolina State University conducted a special water quality study focusing on the area behind Hoosier Dam (Line and Blackwell, 2009). They monitored this area 10 times between June and September 2009 and found that the mean chlorophyll *a* concentration was 53.6 µg/L and ranged between 31.8 and 90.1 µg/L, with 70% of the samples exceeding the state criteria (40 µg/L). They also collected water quality data upstream at Carolina Hill (CH) Road (just downstream of B9580000) and downstream at Chatham Church (CC) Road (between Hoosier Dam and US 15/501). The mean chlorophyll *a* concentrations were 2.5 µg/L (CH) and 11.3 µg/L (CC) respectively, with no exceedances of the state standard. However, a high reading of 36.4 µg/L was collected on August 26, 2009, downstream of the dam at CC station. There were no major flow events in August 2009 and the average flow was only 0.96 cfs. The high chlorophyll *a* at this site coincided with a low dissolved oxygen reading of 2.6 mg/L. This indicates that a

bloom could be senescent/dying resulting in low DO. Notes from the study indicated that the researchers saw algae floating on the river bottom. It is unclear if the elevated chlorophyll *a* at this location was a result of a bloom occurring at this location or could have been transported downstream from the pond behind Hoosier dam. North Carolina State University had a quality assurance project plan which allowed the Division to use the data for use support purposes.

Hoosier (Woodys) Dam was located about 5.5 miles upstream of the confluence with the Deep River. The 235-foot-long and 25-foot-high dam was built in 1922 and produced power until January 2016 when a fire destroyed the primary 150 kilowatt generator. The US Fish and Wildlife Service (USFWS) designated the section of the Rocky River up- and downstream from Hoosier Dam as well as sections of Bear Creek as critical habitat for the Cape Fear shiner, a federally listed endangered species. Hoosier Dam was removed in the Fall of 2018 for the purpose of reconnecting this critical habitat. In 2016, Unique Places LLC received a National Fish and Wildlife Foundation Grant to complete the environmental, engineering and construction related components and worked with a large group of resource agency specialists to remove the dam. For more information on the project see the Unique Places to Save website and see Chapter 4 (Local Initiatives section) for more information on Unique Places and their restoration efforts in the Cape Fear River Basin.

Rocky River segment AU # 17-43-(8)b3, from Hoosier Dam to the Deep River was assessed using the benthic macroinvertebrate station BB422 located at the US 15-501 crossing (*Table 7-34*). This segment is currently meeting uses (Supporting, according to the 2022IR) based on the Good benthic community bioclassification. Station BB422 is the most downstream basin site on the Rocky River, located approximately five miles upstream of its confluence with the Deep River in Chatham County. Siler City is the only urban area upstream in the catchment and land use is dominated by agricultural activities. In 2018, BB422 received a bioclassification score of Good. This site has rated Good in all previous sampling events except for a Good-Fair rating in 2008, when the number of EPT taxa were reduced and specific conductivity was significantly higher than in previous sampling years [1998 (26 EPT; 126 µS/cm), 2003 (28 EPT; 130 µS/cm), 2008 (21 EPT; 289 µS/cm)]. This was likely attributable to drought conditions in 2008. Overall, the biological metrics indicate that conditions at this location are stable.

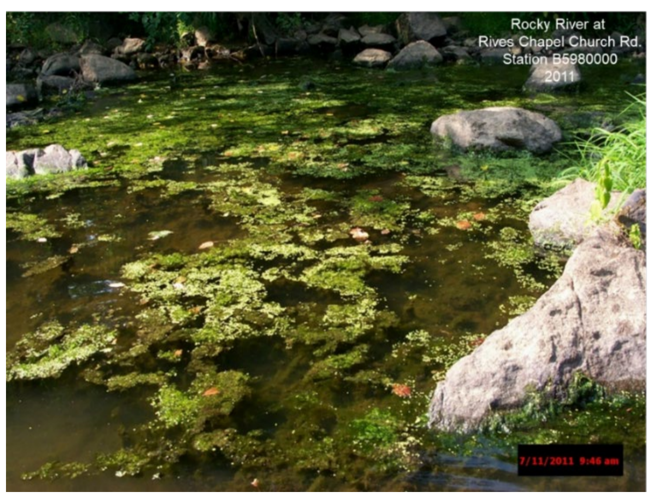
Though water quality conditions in this section of the Rocky River have remained static, a mixture of upstream point- and nonpoint source pollutants coupled with water level fluctuation, particularly in drought years, does likely affect water quality conditions. As of 2023, there were no instream nutrient criteria developed to assess instream concentrations. There has been some understanding of what concentrations are associated with minimally impacted healthy Piedmont streams such as those in *Table 7-35* (from subbasin instream constituent comparison *Table 7-12*).

Table 7-34: Biological Community Analysis: Rocky River (BB422) at US 15-501.

Year	Study	Sample Type	EPT BI	Biotic Index	Bioclassification
2003	Basin Sample	Full Scale	4.63	5.53	Good
2008	Basin Sample	Full Scale	4.98	6.28	Good-Fair
2013	Basin Sample	Full Scale	4.22	5.4	Good
2018	Basin Sample	Full Scale	4.25	5.21	Good

Table 7-35: Nutrient impacts to the mainstem Rocky River below Hackney Dam.

Healthy Piedmont Instream Concentrations			2016-2020 Rocky River (0303000305)
Parameters	**NC**	**EPA**	
TP (mg/L)	0.05	0.038	0.07
TN (mg/L)	0.80	0.70	3.48
NH_3 (mg/L)	0.05		0.09
NO_x (mg/L)	0.30		2.62
TKN (mg/L)	0.50		0.85
Conductivity (µS/cm)	12-90		275
Subset of Information from *Table 7-12*			



The instream nutrient concentrations in the Rocky River watershed have been a concern for many years. Nutrients in the upper portion of the Rocky River watershed have resulted in eutrophic and hypereutrophic conditions in the impoundments (upper Rocky River Reservoir and Charles L. Turner Reservoir) where the nutrients are utilized to support planktonic algal growth. Instream nutrient concentrations recorded at the ambient monitoring stations are generally highest in the Rocky River watershed (HUC 10: 0303000305) in comparison to the other watersheds in the Deep River subbasin, with the exception of total phosphorus (*Table 7-12*). The concentrations at B5950000 are fairly low when compared to the two Rocky River stations downstream of Loves Creek confluence, B5980000 (about 4 miles at Rives Chapel Road) and B6000000 (about 10 miles downstream at highway 902) (*Table 7-30*, *Table 7-31*, and *Table 7-32*).

The only major wastewater treatment plant in the watershed discharges to Loves Creek about 0.35 miles upstream of the confluence with the Rocky River (Siler City WWTP Permit # NC0026441). The wastewater treatment plant has had an impact on the overall nutrient loading to this system. The actual loads have changed over the years as the industries served by the town have changed. This was briefly described in the general description of the Rocky River and data showing the instream changes will be presented below.

The load from the wastewater treatment plant has altered this slate belt ecosystem over the years. Watershed stakeholders have voiced their concerns and have participated in watershed group discussions and have taken the opportunities to comment on permits and certifications during public comment periods. Many of the stakeholders and landowners recall a time in the past when the Rocky River was frequently utilized for recreational opportunities and that the instream conditions have changed with the increase of excessive periphytic growth covering the rocky stream substrates that has limited and at times prohibits safe recreational uses of the river. These concerns and stakeholder actions led to the inclusion of the Rocky River Management Team as part of the 401 Certification, the pulsing from the Charles L. Turner Reservoir and WWTP permit modifications to address their ongoing concerns.

In 2010, the EMC directed the Division to work with the town of Siler City to improve water quality conditions. At the same time, two of the town's industrial chicken processing plants closed, resulting in an overall lowering of the nutrient load to the WWTP due to no longer receiving high nutrient-laden wastewater from the industrial processing plants [Significant Industrial User (SIU)]. However, the closings also left the town with limited resources due to loss of revenue. The 2014 Siler City NPDES permit renewal was issued with a nutrient reopener (A.(3)) special condition clause that included a trigger mechanism for accepting "future industrial process wastewater that is expected to contain concentrations of total nitrogen (TN) and/or total phosphorus (TP) greater than typical domestic wastewater concentrations." This allowed the director of DWR to reopen the permit to require supplemental nutrient limits for total nitrogen and/or total phosphorus (June 1, 2014, NPDES permit # NC0026441). On December 9, 2016, the Town of Siler City notified

Important Dates and Permits

Poultry Processing Plant Closures

- May 2008 (Pilgrim's Pride)
- October 2011 (Townsend)

Poultry Processing Plant Opens

- January 2019 (Mountaire Farms)

4 MGD Wastewater Treatment Plant (Built in 1994)

- TP limits (took effect April 2010)
    - Summer = 0.5 mg/L
    - Winter = 2.0 mg/L
- Ammonia (NH_3) limits
    - Summer = 1.0 mg/L (m) & 3.0 mg/L (wk)
    - Winter = 2.0 mg/L (m) & 6.0 mg/L (wk)

2019 Permit modification to included interim TN Load

- TN Load of 243,455 lb/yr

2022 Permit Renewal with expansion to 6 MGD

- 4 MGD TN load schedule
    - 182,646 lb/yr (through 12/31/2022)
    - 146,117 lb/yr (1/1/2023 – 12/31/2023
    - 115,678 lb/yr (1/1/2024-12/31/2024)

6 MGD expansion complete 2027

- TN Load 54,800 lb/yr
- TP same as above
- Ammonia (NH_3) limits
    - Summer = 1.0 mg/L (m) & 3.0 mg/L (wk)
    - Reduced Winter to 1.9 mg/L (m) & 5.7 mg/L (wk)
    - TKN Summer = 3.0 mg/L (m) & 4.5 mg/L (wk)
    - Permit Link – see permit limits page for details

Special Order of Consent (SOC WQ S22-003; WQ S22-003 Ad I)

- EMC approval – 2023; amended May 2025

DWR of its intentions to accept waste from a new significant industrial user (SIU), Mountaire Farms. The permit modification became effective May 1, 2019, with interim total nitrogen load limits. The Town of Siler City is in the process of upgrading and expanding their 4 MGD plant to 6 MGD which will meet very strict nitrogen limits included in their new 2022 permit renewal.

Over the last several years (2019-2022), the treatment plant has been unable to consistently comply with the effluent limits set forth in its NPDES Permit NC0026441, including effluent limits for Biochemical Oxygen Demand (BOD), ammonia, nitrogen, Total Suspended Solids (TSS) and fecal coliform bacteria. The EPA has designated Siler City's WWTP as being in "significant non-compliance." The Division has issued several civil penalties for noncompliance with their NPDES permit (NC0026441), Collection System Permit (WQCS00056) and the associated water quality laws.

Due to the Town's ongoing compliance issues, including treatment capacity issues, the Division placed the Town's WWTP under a moratorium in May 2022, which prohibits the introduction of additional wastewater flow to the treatment plant. The Town is causing or contributing to pollution of the waters of the State within an area for which standards have been established, therefore the EMC has the authority to enter into a Special Order of Consent (SOC). The SOC was approved by the Environmental Management Commission (EMC SOC WQ S22-003) and finalized on April 14, 2023. The SOC draws up a clear set of expectations for treatment upgrades including sewer rehabilitation, WWTP expansion and improved treatment capabilities, and WTP pretreatment and solids handling. It also provides a clear schedule for each required action and provides relief from some of the penalties previously imposed, however it also lays out clear penalties for failing to meet the obligations set out in the Special Order of Consent (SOC). For more information, see the finalized SOC (EMC SOC WQ S22-003 and 2025 amended SOC WQ S22-003 Ad I).

Siler City SOC update:

On August 30, 2024, the Town of Siler City submitted an application for an amendment to a SOC. At the time of the request. The Town had completed 20 of the 28 scheduled activities required in the 2023 SOC (WQ S22-003). Out of the eight remaining required activities, six cannot be completed in the original time frame allotted in the 2023 SOC which could result in large stipulated penalties. For more information see write up in section 7.7.5

As of May 19, 2025, DWR and the Environmental Management Commission approved an amended SOC (EMC SOC WQ S22-003 Ad I). In the amended SOC, the Town proposed to bring the WWTP into compliance more quickly with the requirements of the NPDES Permit NC0026441 by upgrading the current 4 MDG plant by installing a four-stage BNR process until construction of the 6.0 MGD WWTP expansion is complete (Paragraph 1(h)(vi).

The instream nutrient conditions should improve in the near future as the Town of Siler City upgrades their wastewater and drinking water treatment plants. The data provided here will show the changes in the instream nutrients over time as the industries (SIUs) have changed in Siler City. The town's 2022 wastewater permit renewal includes a timeline for reducing their total nitrogen loading. When the treatment plant upgrades are completed in 2027, the amount of nitrogen loading will be reduced by using biological nutrient removal (BNR) technology. There is also a modeling effort and an instream Nutrient Criteria Development Plan process (NCDP - see section in Chapter 2) that will help guide the division and the NPDES Permitting Branch on what this system can support, potentially develop instream nutrient criteria that can be used to protect sensitive ecosystems like the Rocky River watershed, provide an assessment tool and provide an understanding of what actions must be taken to meet those standards.

The instream total nitrogen (TN) concentrations increase substantially at the two downstream stations below the confluence with Loves Creek (B5980000 and B600000) (*Figure 7-64*). The instream TN concentrations dropped following the closure of the poultry processing plants in 2008 and 2011. The yearly mean instream TN concentration dropped from 15.5 mg/L in 2007 to 3.0 mg/L in 2012 at B5980000 and dropped from 8.3 mg/L to 2.0 mg/L, respectively, at B6000000 (*Figure 7-65*). The instream concentrations in the Rocky River are also influenced by the amount of flow in the system to dilute the overall concentrations.

Total nitrogen is made up of a series of nitrogen components (NOx=NO_3+NO_2, TKN, and NH3=NH_3+NH_4^+). Total Kjeldahl nitrogen (TKN) is the organic nitrogen component plus ammonia nitrogen, where the ammonia is normally a minor fraction of the overall TKN value in surface waters. The TN components change based on the source of nitrogen and how nutrients are processed in the stream ecosystem. TKN often increases as the inorganic nitrogen components (NOx and NH3) are taken up as part of the biological processes such as algal or periphyton productivity. The difference in what makes up TN is clearly seen when comparing the upstream station B5950000, to the two downstream stations. TN at B595000 is made up of mostly organic nitrogen (TKN-NH3) (*Figure 7-65*). For example, in 2020 TKN makes up 77.2 % of TN while NOx makes up only 22.8% (4.3 % of TKN was NH3). Just downstream at stations B5980000 and further downstream at B6000000 the primary component of TN is NOx (*Figure 7-65*). This ratio is dropping along with the TN concentrations as there is less nitrate-nitrogen being discharged from the WWTP (*Figure 7-66* and *Figure 7-65*). The TN and NOx instream concentrations should continue to drop as the new upgraded WWTP is brought online.

The scale of the nitrogen-axis is different for each of the graphs in *Figure 7-65*. The instream concentrations are much higher at the two downstream stations, with station B6000000 (~10 miles downstream of Loves Creek) at about half the concentration of station B5980000. The NOx concentrations have dropped since the peak mean and median concentration of 15.1 and 13.0 mg/L respectively in 2007 to 2.1 and 1.9 mg/L respectively in 2012 at B5980000. At station B6000000 the mean and median dropped from 7.4 and 7.0 mg/L NOx in 2007 to 1.2 and 0.9 mg/L respectively in 2012.

The 1.5 mg/L increase in the yearly mean NOx from 2018 to 2019 at station B6000000 was investigated to see if there was a potential link to the wastewater treatment discharge. *Figure 7-66 (A)* shows the monthly TN concentrations at all three Rocky River stations and the corresponding daily average flow at the US 64 USGS gage. It was evident that the river flow was very low in the latter half of 2019 which likely resulted in higher instream nutrient concentrations due to limited dilution occurring. The water quality samples are collected on different dates (two monitoring programs collect the data), but it is obvious that high instream TN concentrations occurred at both downstream stations. *Figure 7-66 (B)* shows the Siler City wastewater NOx effluent concentration (on right Y-axis) and plotted over the instream concentrations at B6000000 (on left Y-axis). High instream readings appeared to correspond to elevated effluent concentrations. *Figure 7-66 (C)* shows that the majority of the TN signature of the peak readings were made up of NOx. This is clear evidence that high concentrations being discharged from the wastewater treatment plant can impact the conditions well downstream, especially during low flow periods which are very common in the Rocky River.

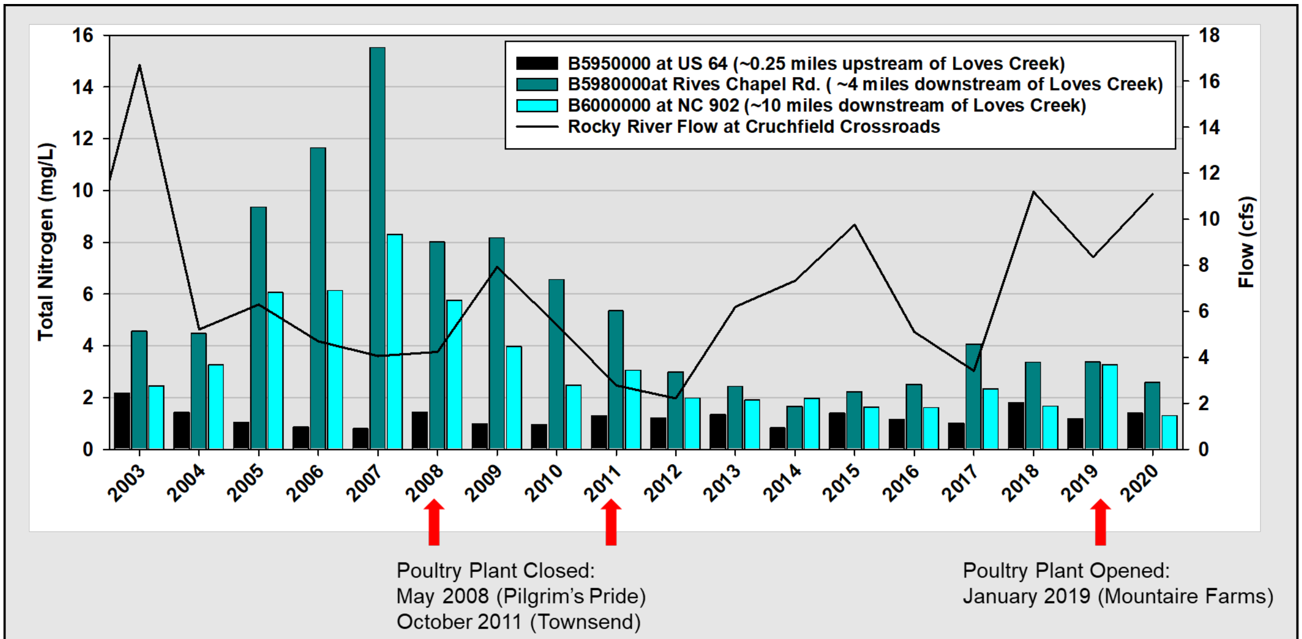
Overall, the yearly mean concentrations of TKN throughout the Rocky River are relatively similar from year to year with a few spikes (2018 and 2020) at the two upstream stations (*Figure 7-67*). Station B6000000 remained relatively steady between 0.6 and 0.8 mg/L. In 2019, a NC Wildlife Resources Commission biologist doing a fish and mussel survey in and around the former Hoosier dam reported an incident with high instream ammonia concentrations. The Division began to investigate the issue which was of concern due to the potentially toxic levels of ammonia in the known critical habitat area for the Cape Fear shiner. More information on this will follow the write-up on Loves Creek.

The yearly mean total phosphorus (TP) concentrations drop at the two downstream stations in 2009 (*Figure 7-64*). New wastewater TP permit limits went into effect in 2010 with summer limits of 0.5 mg/L (April 1- October 31) and winter limits of 2.0 mg/L (November 1-March 31). These limits have substantially reduced the instream concentration downstream of Loves Creek.

Local Watershed Action Plan for Rocky River

The Conservation Fund, in partnership with Biocenosis and Lover Creek Watershed Stewards, were awarded a North Carolina Land and Water Fund grant in 2022 to develop a Watershed Action Plan (WAP) as well as a written watershed restoration and protection plan based on the 2008 EPA 9-element watershed plan handbook for each of six smaller subwatersheds that drain into 303(d) listed segments of the upper Rocky River, including two water supply reservoirs owned by the Town of Siler City. The project objectives are to develop a comprehensive watershed planning effort through WAPs and EPA 9-key element watershed plans to identify critical/impaired areas for project implementation; prioritize project implementation areas, especially as related to drinking water protection and Cape Fear shiner habitat protection and improvement; and create dynamic online WAPs that allow public participation and contributions.

Figure 7-64: Rocky River Yearly Mean Instream Total Nitrogen and Total Phosphorus Concentrations at Ambient Monitoring Stations B5950000, B5980000 and B6000000 with USGS Flow at Crutchfield Crossroads (0210166029) (poultry processing plant closures and openings identified).



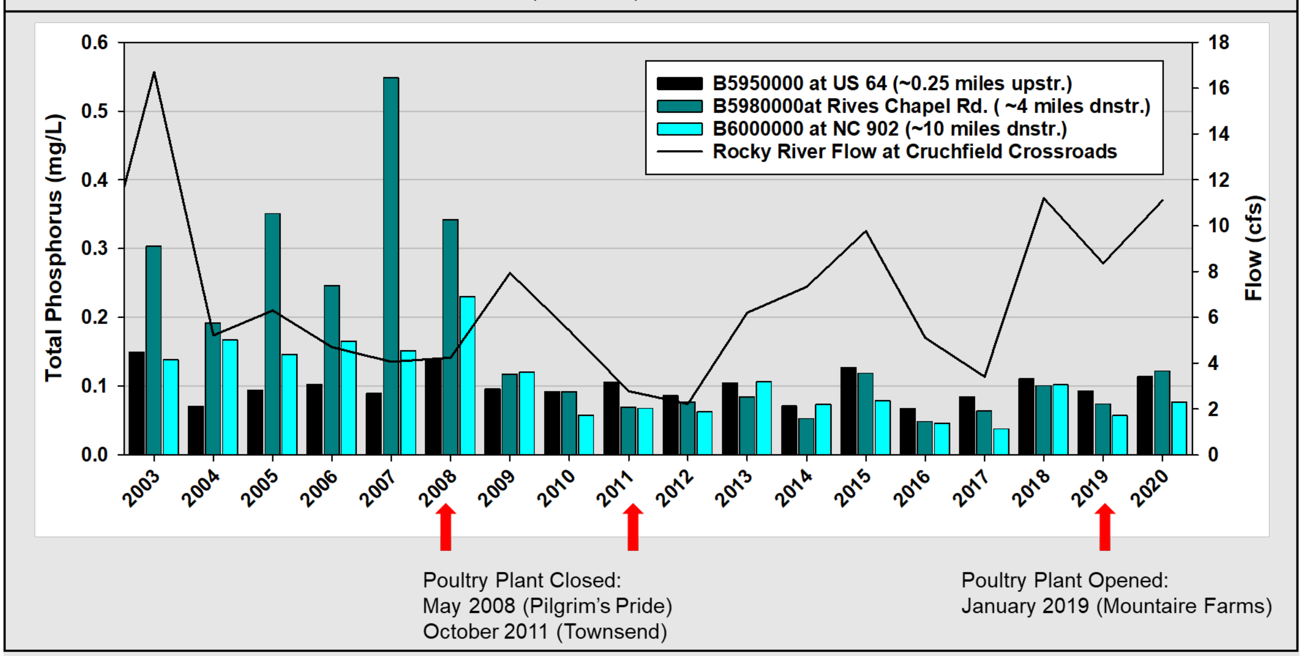


Figure 7-65: Rocky River Yearly Mean Instream Nitrogen Series Concentrations at Ambient Monitoring Stations B5950000, B5980000 and B6000000 with USGS Flow at Crutchfield Crossroads (0210166029). (Note the nitrogen axis scale differences between the three stations.).

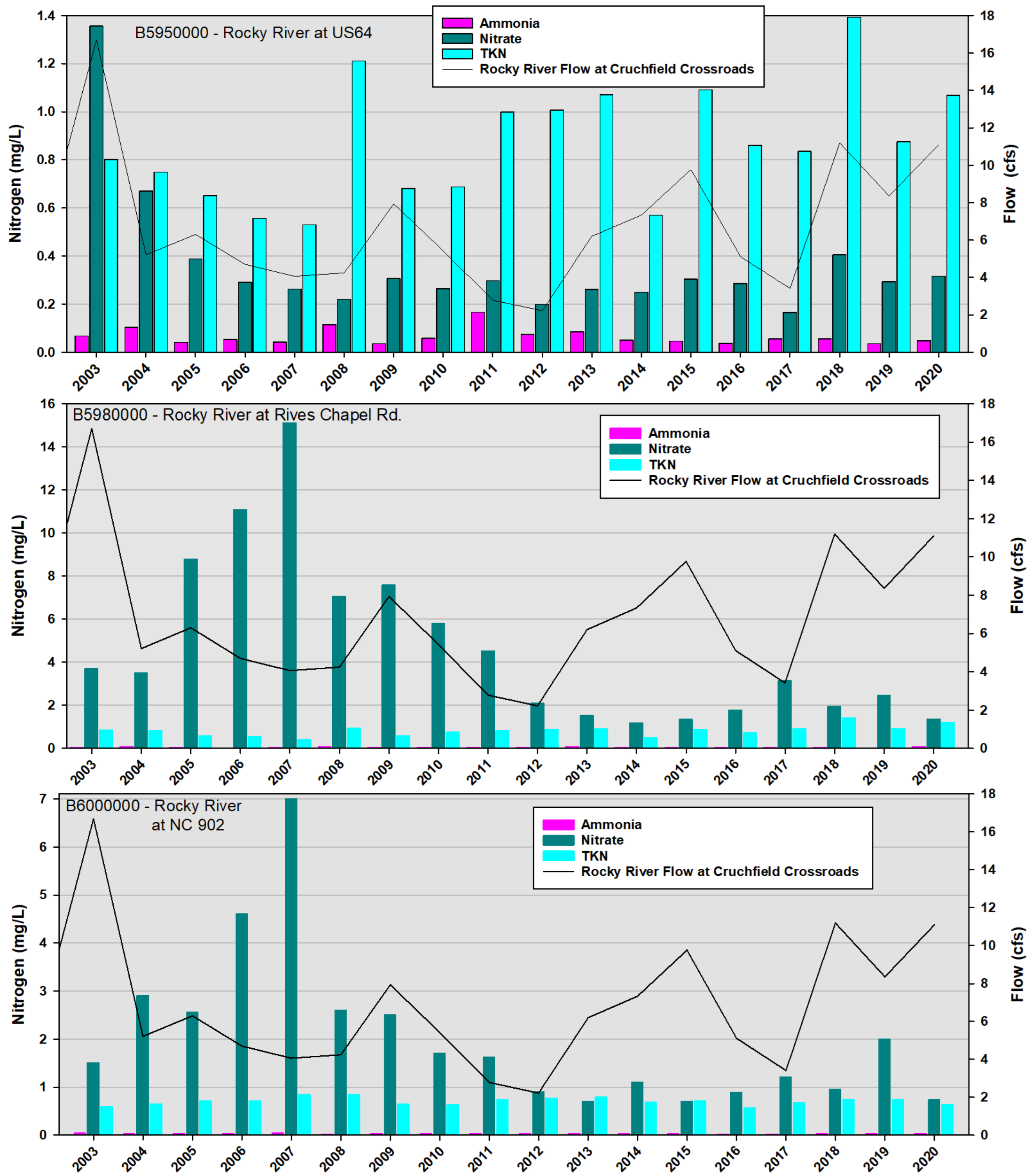


Figure 7-66: A. 2019 Rocky River Instream Total Nitrogen Concentrations at Ambient Monitoring Stations B5950000, B5980000 and B6000000 with corresponding daily USGS Flow at US 64 (02101726). B. 2019 Station B6000000 Instream Nitrate Concentration with Siler City WW WWTP Nitrate Effluent Concentration and Rocky River Flow. C. 2019 Instream Nitrogen Series at Station B6000000.

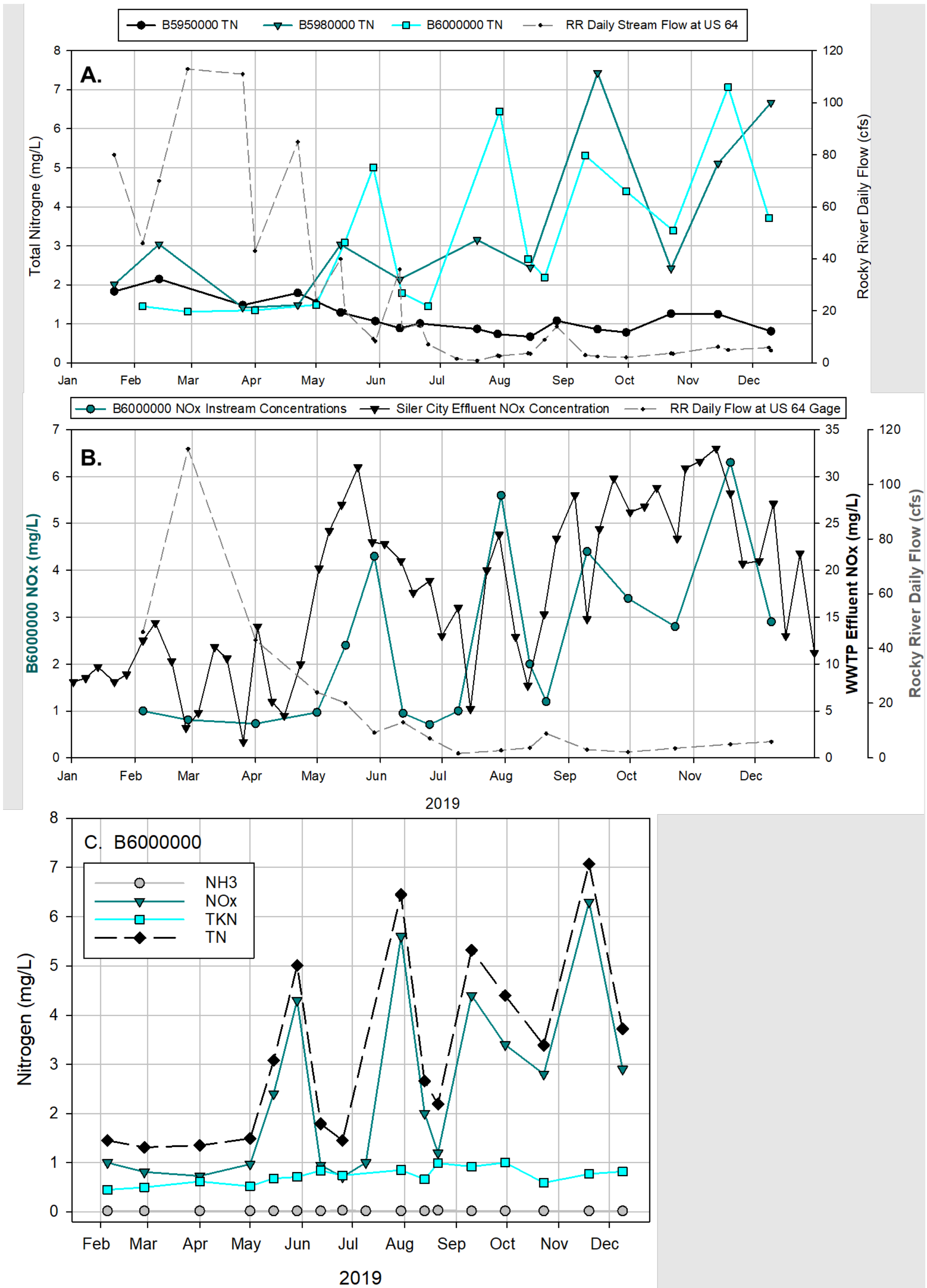
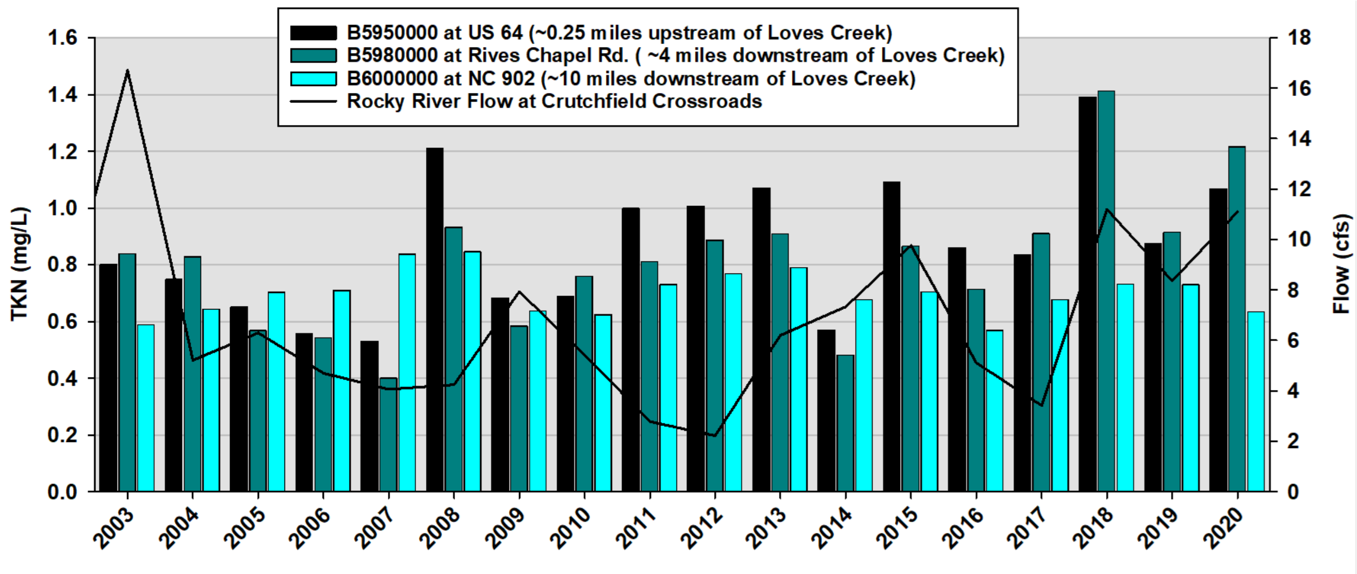


Figure 7-67: Rocky River Yearly Mean Instream Total Kjeldahl Nitrogen Concentrations at Ambient Monitoring Stations B5950000, B5980000 and B6000000 with USGS Flow at Crutchfield Crossroads (0210166029).



7.7.5.2 Loves Creek [17-43-10]

The 8.2 square mile Loves Creek watershed drains the majority of the Town of Siler City and is a tributary to the Rocky River. The confluence of Loves Creek and Rocky River is 9.6 miles upstream of US Fish & Wildlife Service designated Cape Fear shiner critical habitat. The Siler City WWTP is located about 0.35 miles upstream of the confluence with the Rocky River and is a major contributor of nutrients to the Rocky River.

The entire length of Loves Creek is impaired for benthic macroinvertebrate community health and structure. A 2004 Local Watershed Plan produced by the NC Division of Mitigation Services (DMS) characterized streambank erosion in the Loves Creek watershed as “extreme” and aquatic habitat as poor. While the lower portion of the watershed is dominated by urban land use, the upper portion of the mainstem Loves Creek is mostly in forest and small amount of agriculture (NC DMS, 2005). Urban development, stormwater runoff and low flow conditions are likely all contributing to habitat impacts and biological impairments.

As result of the nutrient impacts identified in the Rocky River below Loves Creek, two stations were added to the 2009 WWTP permit monitoring requirements. Station B5890000 located upstream of the WWTP at Waste Management Plant Rd and station B5920000 downstream of the WWTP at Progress Blvd were added in order to understand the contributions from the watershed upstream separate from that of the treatment plant’s discharge to Loves Creek. These two stations are used to assess the water quality conditions in Loves Creek (*Table 7-36*). Several benthic and fish stations have also been monitored over the years as part of many special studies (*Table 7-36*). In 2009-2010, a RAMS station (B5885000) was located off of Moonrise Meadow Drive about 0.8 miles upstream of B5890000. RAMS monitoring generally collects data on water quality parameters that are rarely examined at most AMS stations, such as total and dissolved metals, mercury and volatile organics. The only parameter that violated instream standards during the 2009 to 2010 period was low dissolved oxygen, and as a result, Loves Creek was added to the impaired waters list in 2012 for exceeding this criterion. For more information go to the RAMS program website and the 2014 summary report.

The Loves Creek mainstem is fairly well buffered; however, there are minimally buffered sections that flow through agricultural fields, industrial properties, railroad tracks and the Siler City Country Club (golf course) and the stream receives flow from several unnamed tributaries that drain much of the Town of Siler City. The Loves Creek Watershed Restoration Plan and the Loves Creek Watershed Stewards focus much of their restoration and watershed improvement efforts on these smaller unnamed tributaries in order to improve the water quality in the mainstem Loves Creek and Rocky River.

Loves Creek is a very low flow stream with an average flow of 7.8 cfs and a summer 7Q10 of zero, which means during low flow periods there is little baseflow in the stream and the WWTP discharge is the majority of the flow draining to the Rocky River. According to the September 2022 NPDES WWTP permit fact sheet, the average daily effluent flow from the WWTP between April 2018 and March 2022 was 2.83 MGD and ranged between 0.86 and 10.89 MGD. The annual average flow for calendar year 2020 was 3.212 MGD or 80.3% of the design flow of 4.0 MGD, and over the 80% threshold at which the Permittee must submit an evaluation of future wastewater treatment (15 A NCAC 02T .0118). Siler City is in the process of upgrading and expanding their WWTP to 6 MGD which should be completed by the end of 2024 (Final NPDES Permit Renewal & Expansion, September 28, 2022).

Table 7-36: Loves Creek Monitoring Stations Used to Assess Use Support and Associated 2022 IR Overall Assessment.

Loves Creek AU #	Stream Length (miles)	AMS Station #	Biology Station #	2022 IR Overall Assessment	Additional Watershed Information
17-43-10a & 17-43-10b1	5.6	RAMS # B5885000	BB29, BB174, BB195, BB210, BB517	Exceeding - Benthos & DO	Upstream of US Hwy 421
17-43-10b2	0.2	B5890000	BF58	Exceeding Criteria - Benthos & Fish (FCB - not rated/3a)	Upstream of WWTP Outfall
17-43-10c	0.4	B5920000	BB174	Exceeding Criteria - Benthos	Downstream of WWTP outfall

Loves Creek [AU #s 17-43-10a, 17-43-10b1, 17-43-10b2, and 17-43-10c; Class C] from the source to Rocky River is impaired due to Fair and Poor benthic macroinvertebrate ratings from samples collected from many stations throughout the watershed, collected over many years. Loves Creek segment AU # 17-43-10b1 (from Chatham Ave to US 421) is also listed as impaired due to low dissolved oxygen identified as part of the RAMS assessment described above (*Table 7-36*).

Love Creek [AU # 17-43-10b2] from US 421 to Siler City WWTP is currently (2022 IR) listed as not rated for fecal coliform bacteria (FCB) due to 27% of the monthly samples exceeding the 400 cfu/100 mL standard (*Table 7-36*). There was no 5-in-30 monitoring done to confirm an impairment. The urban runoff from

Siler City is likely a contributing factor to the elevated fecal concentrations sampled at station B5890000 (*Table 7-37*). The FCB and instream turbidity concentrations generally declined once flow from the WWTP was added to the stream (*Figure 7-68*). The yearly mean turbidity concentrations were generally higher in the years with the higher mean flows, whereas FCB did not follow the same trend.

Instream fecal coliform bacteria violations have been shown to occur at both high and low flows throughout much of the Cape Fear River system, suggesting that contamination due to fecal coliform occurs during both wet and dry weather conditions. Low flow, dry weather fecal coliform bacteria loading is often associated with human sources such as from leaky sanitary sewer systems, failing septic systems and direct illicit discharges. Correspondingly, nonpoint sources and sporadic sources such as sanitary sewer overflows result in elevated fecal coliform during high flows. Urban stormwater and domestic animal waste as well as livestock grazing on agricultural lands, and wildlife are often identified as contributing sources. The Town of Siler City is in the process of addressing the leaky sanitary sewer system issues in the town as part of their SOC and wastewater treatment system upgrades. This will likely improve the dry weather source as well as reduce the chances of sanitary sewer overflows which can result from large rain events. The 2022 IR mean, and maximum reading were 1,260 and 12,000 cfu/100 mL upstream (B5890000) and 650 and 8,400 cfu/100 mL downstream (B5920000) respectively (*Table 7-37*, *Table 7-38*).

Table 7-37: Loves Creek Ambient Monitoring Station B5890000 2022IR Data Summary (upstream of WWTP).

Parameters	Mean	Median	Min	Max	75th Percentile	n Total	n Non-detects
Ammonia	0.04	0.02	0.02	0.21	0.02	59	44
DO	7.9	7.6	1.9	11.9	9.4	83	0
Fecal Coliform	1,260	162	5	12,200	460	59	0
NOx	0.47	0.44	0.03	1.24	0.58	59	0
pH	7.2	7.2	6.3	7.7	7.3	83	0
Phosphorus	0.05	0.04	0.02	0.16	0.056	59	3
Specific conductance	190	182	78	1,044	217	83	0
Temperature	18.2	20.4	3.3	26.8	23.9	83	0
TKN	0.65	0.52	0.2	2.45	0.82	59	6
Total Nitrogen	1.12	0.96	0.26	3.31	1.43	59	6
Turbidity	17.74	10.1	1.3	166	16.9	59	0

Turbidity levels exceeded the state standard of 50 NTU 8.5% of the time at the upstream and 5% of the time at the downstream stations with the 2022 IR 5-year means of 17.7 and 10.3 NTU, respectively. The maximum recorded monthly readings were 166 and 110 NTU, respectively (*Table 7-37* and *Table 7-38*).

The instream DO concentration improved at the downstream station with zero exceedances (2022 IR) and a mean and minimum DO concentration of 8.5 and 5.4 mg/L, respectively (*Table 7-38*). The added flow from the WWTP improved the overall instream DO concentration (*Figure 7-69*). Conditions upstream were more impacted with a 2022 IR exceedance rate of 4.8% and mean and minimum readings of 7.9 and 1.9

mg/L, respectively (*Table 7-37*). The instream conditions of Loves Creek likely play a significant role in the health of the aquatic systems and the ability to support a healthy and diverse instream benthic macroinvertebrate and fish population.

The instream pH levels are not violating the low (<6) or high (>9) state standard at either Loves Creek station. The yearly median pH levels are higher downstream of the WWTP, but are well within the normal range for a piedmont stream (*Table 7-37*, *Table 7-38* and *Figure 7-69*). The conductivity (specific conductance) is elevated at the upstream station with a 2022 IR period mean value of 190 µS/cm (*Table 7-37*). The instream conductivity is extremely high directly downstream of the WWTP with a mean of 608 µs/cm (*Table 7-38* and *Figure 7-69*). The specific constituents in the wastewater causing the extremely high values and the impacts on aquatic life are not clearly known. Typically, instream conductivity levels are used as an indicator of a local pollutant source. The levels typically found in a minimally impacted piedmont stream would be below 100 µS/cm. Due to the very high instream conductivity concentration downstream of the WWTP and due to the WWTP receiving industrial wastewater, daily monitoring of effluent conductivity was added to the November 1, 2022, permit renewal [permit sections A. (1.) and A. (2.)]. Also, based on a Reasonable Potential Analysis (RPA) showing a reasonable potential to exceed stream standards, limits were added for chlorides with monthly monitoring requirements [permit sections A. (1.) and A. (2.)].

Table 7-38: Loves Creek Ambient Monitoring Station B5920000 2022IR Data Summary (downstream of WWTP).

Parameters	Mean	Median	Min	Max	75th Percentile	n Total	n Non-detects
Ammonia	0.31	0.02	0.02	7.52	0.03	60	41
DO	8.5	7.9	5.4	13.3	9.97	84	0
Fecal Coliform	657	76	1.00	8,400	225	60	1
NOx	9.31	8.19	0.34	25.40	15.18	60	0
pH	7.6	7.6	6.9	8.4	7.8	84	0
Phosphorus	0.05	0.03	0.02	0.22	0.05	60	3
Specific conductance	608	620	100	1,210	813	84	0
Temperature	20.8	21.8	5.9	29.5	26.68	84	0
TKN	0.86	0.30	0.15	8.13	0.98	60	26
Total Nitrogen	10.16	8.61	1.49	25.60	15.38	60	26
Turbidity	10.29	3.60	1.00	110.00	9.53	60	5

Figure 7-68: Loves Creek Yearly Mean Turbidity and Fecal Coliform Bacteria Concentrations at Station B5890000 Upstream of WWTP and B5920000 Downstream of WWTP with Yearly Mean Rocky River USGS Flow at Crutchfield Crossroads (0210166029).

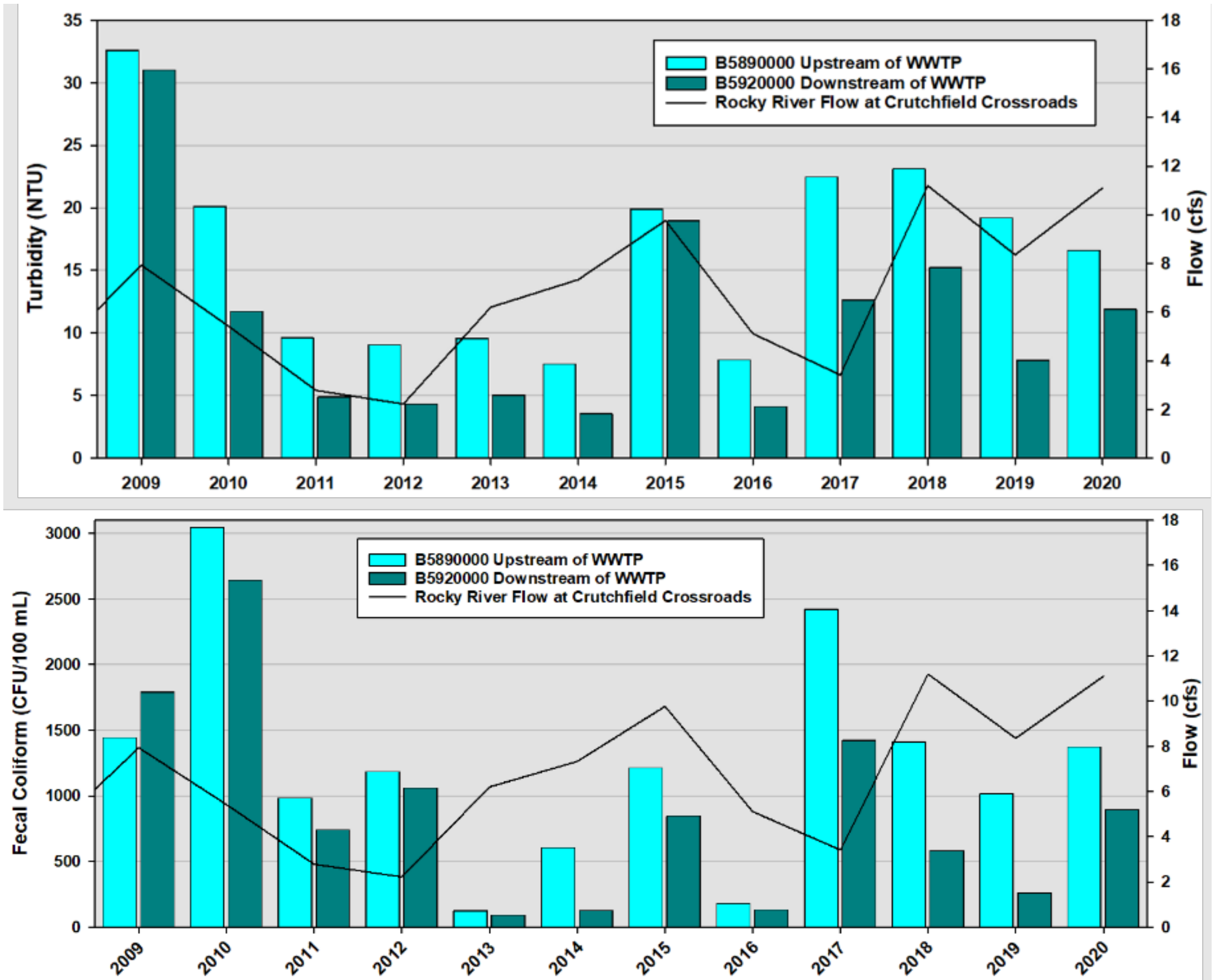
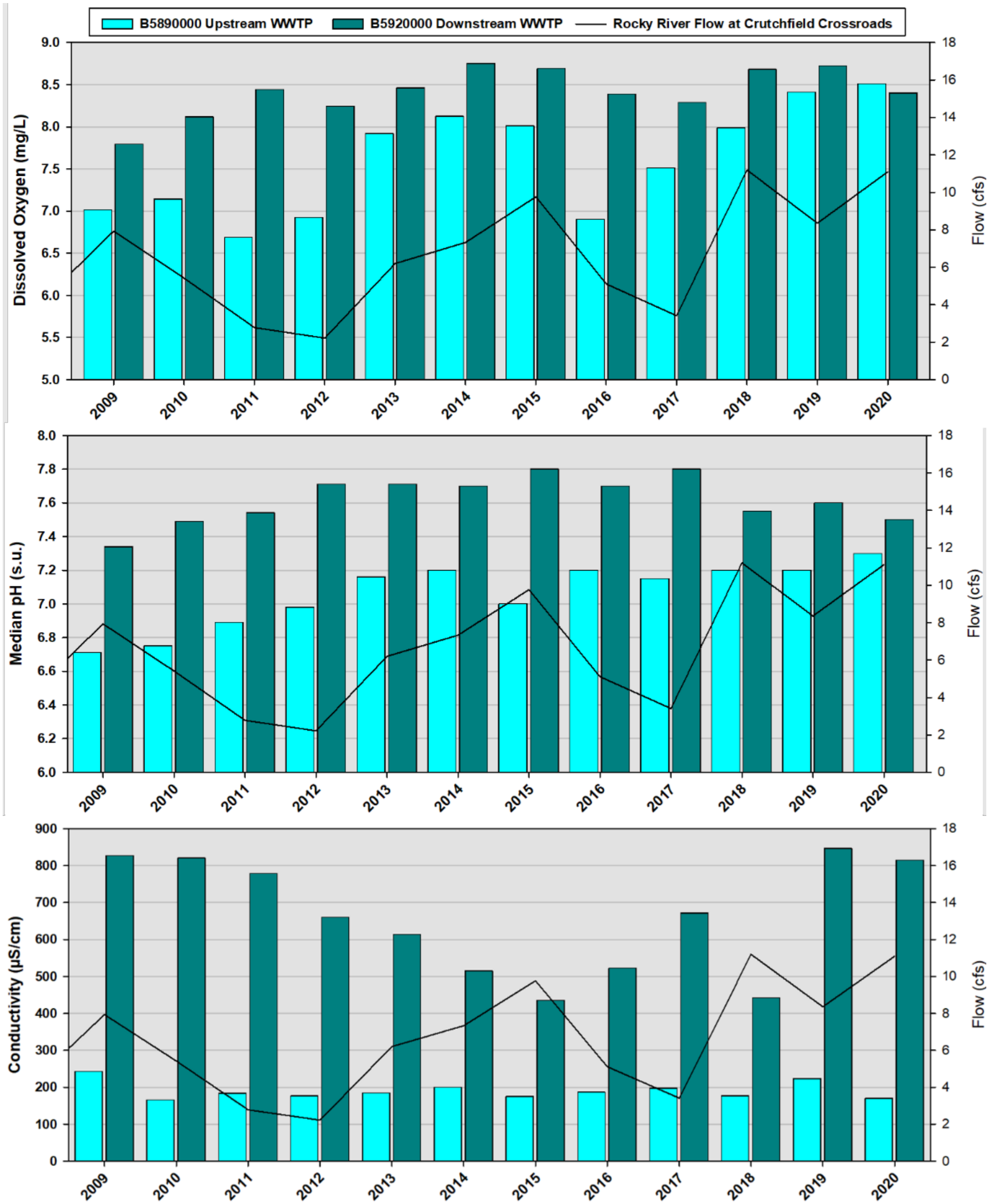


Figure 7-69: Loves Creek Yearly Mean Dissolved Oxygen, Conductivity and Median pH levels at Station B5890000 Upstream of WWTP and B5920000 Downstream of WWTP with Yearly Mean Rocky River USGS Flow at Crutchfield Crossroads (0210166029).



A series of benthos special studies have been performed on Loves Creek since 2003. All the special study sites were either Not Rated or were rated as Poor or Fair (*Table 7-39*). Most stations had gravel or sand dominated instream habitat, indicative of highly erodible streambanks and overland inputs of sediment. Elevated specific conductance measurements at all sites also indicate impacts from point and non-point sources of pollution. The physical and chemical conditions, including elevated specific conductance, in Loves Creek are not suitable for biological communities. The highest conductivity of all sites measured during the reporting period was 1323 µS/cm at benthic community site BB174, Loves Creek near US 64, which is downstream of the Siler City Wastewater Treatment Plant.

As part of the overall RAMS assessment in Loves Creek, a corresponding benthic macroinvertebrate assessment was conducted at a co-located benthic community site BB517 on October 29, 2009. The biologist reported that Loves Creek had extremely high biotic index values (7.42) and extremely low ETP richness (3). They reported numerous pollution tolerant invertebrates and that although the stream is located in the Carolina Slate Belt, the taxa present in 2009 did not indicate any significant lack of flow as two taxa of filter feeding hydropsychid caddisflies were widespread at this location. The stream received an overall Poor benthos rating with the biological data suggestive of highly unfavorable physical and chemical conditions in Loves Creek (*Table 7-39*).

As a special request from the Raleigh Regional Office, NPDES Permitting Branch and the Basin Planning Branch, the biologists resampled BB174 downstream of the WWTP in August 2022 to see how the ongoing issues with the Siler City WWTP were impacting the biological community. They described the site as "odiferous and highly enriched" and that "many of the taxa we collected are specifically correlated with high organic loadings." Site BB174 was rated Fair as it was in 2003 (*Table 7-39*).

As part of the 2018 basinwide fish assessment, station BF58 located just upstream of the WWTP (SR 2229) and about 0.5 miles upstream of the confluence with Rocky River was resampled. The close proximity to the Rocky River allows for migration and likely influences the highly diverse species richness found at this location. However, the decline in the NCIBI score from Good-Fair in 2014 to Fair in 2018 was mainly due to the loss of the pollution intolerant Piedmont Darter and Notchlip Redhorse (*Table 7-39*). The biologist noted that the fish community in Loves Creek continues to show good species richness in this relatively small urban catchment, however an imbalanced trophic structure persists with more than half of the total fish assemblage consisting of tolerant sunfish (exotic green sunfish and redbreast sunfish). *<u>This station should continue to be monitored as part of the basinwide assessment of the Cape Fear River Basin.</u>*

Table 7-39: Biological Community Analysis for Loves Creek Watershed.

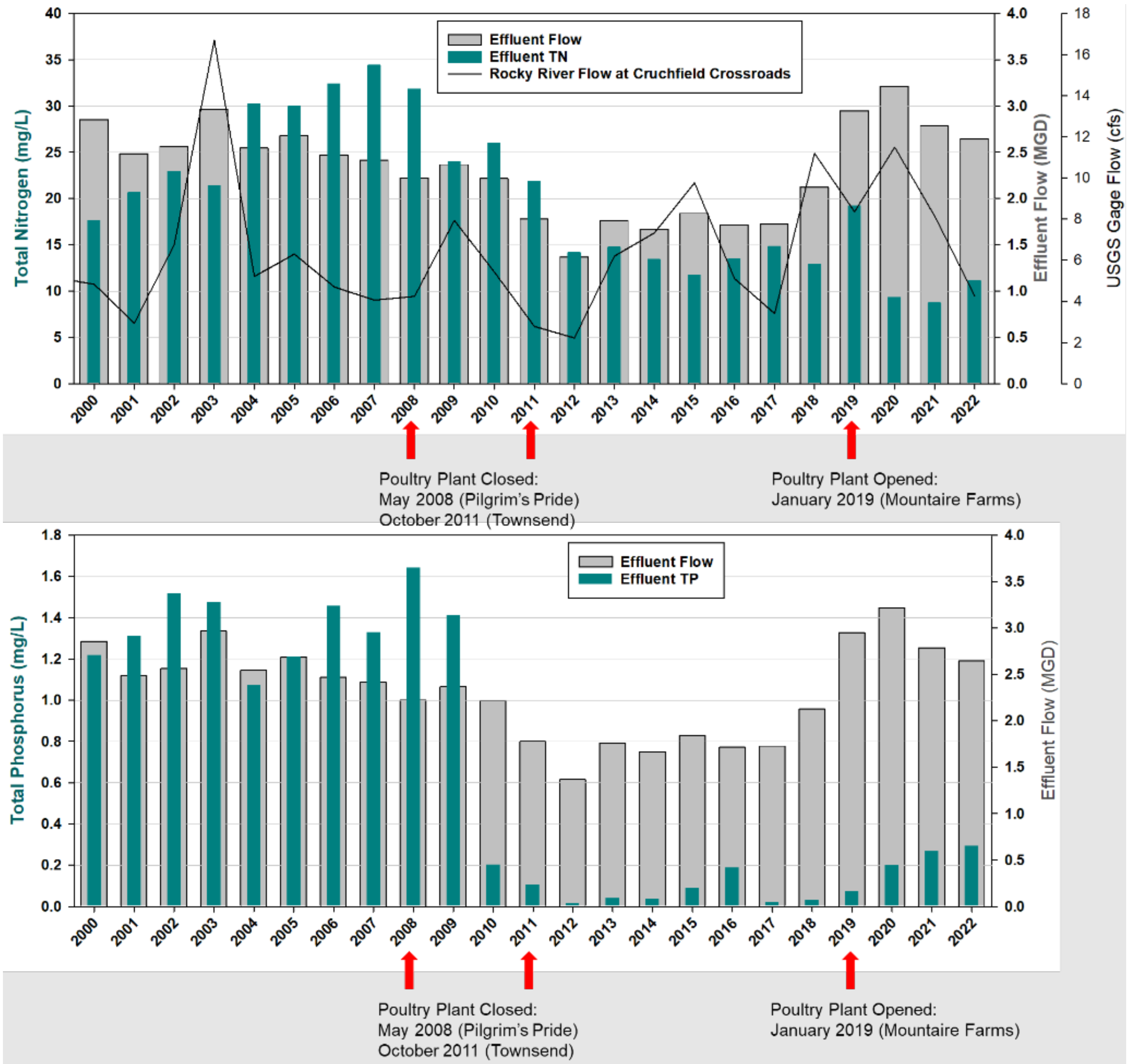
Station #	Location	Year	Study	Sample Type	EPT BI	Biotic Index	Bioclassification
BB174	Near US 64	2003	Special Study	Full Scale	6.96	6.82	Fair
		2022	Special Study	Full Scale	5.74	6.48	Fair
BB210	Second St.	2003	Special Study	Full Scale	6.28	6.94	Fair
BB221	SR 1006	2003	Special Study	Qual 5	7.07	7.23	Not Rated
BB29	WWTP Rd.	1989	N/A	Full Scale	7.03	7.48	Fair
		1997	N/A	Full Scale	6.64	7.19	Fair
		2003	Special Study	Full Scale	6.89	7.31	Fair
BB36	Near Patterson St.	2003	Special Study	Qual 5	4.05	6.08	Not Rated
BB517	Off of Moonrise Meadow Rd.	2009	Special Study	Full Scale	6.38	7.42	Poor

Station #	Location	Year	Study	Total Species		NCIBI Score	Bioclassification
BF58	SR 2229/W Wastewater Treatment Plant Rd.	2013	Basinwide	13		32	Not Rated
		2014	Basinwide follow up	21		44	Good-Fair
		2018	Basinwide	19		38	Fair

It has been recognized that much of the Rocky River watershed is known to be nutrient enriched and that one of the main sources of nutrients is the wastewater contribution from the Siler City WWTP. The yearly mean total nitrogen effluent concentration and flow declined in response to the poultry processing plant closures in May 2008 and October 2011 (*Figure 7-70*). The increase in effluent flow in 2019 is in response to taking waste from the new Mountaire Farms poultry processing plant but could also be due to the higher winter precipitation resulting in higher inflow and infiltration (I&I) to the treatment plant. The town is currently working to reduce their inflow and infiltration as part of their special order of consent, which will reduce the potential for the treatment plant becoming overwhelmed with inflow volume from stormwater and the need for bypassing their final filters as well as reduce the likelihood of sanitary sewer overflows. Addressing inflow and infiltration I also reduces leakage from the wastewater collection system, reducing nonpoint sources of nutrients and fecal coliform bacteria during dry weather periods.

The reduction in the yearly mean total phosphorus effluent concentration is directly related to permit limits that went into effect in April 2010 (*Figure 7-70*). There has been a small increase in their yearly mean TP concentration and is likely the result of treating more industrial waste but has remained below their seasonal quarterly average effluent limits of 0.5 mg/L (April 1-October 31) and 2.0 mg/L (November 1 – March 31) (*Figure 7-70*).

Figure 7-70: Siler City Wastewater Treatment Plant Yearly Mean Effluent Flow (MGD) with Total Nitrogen Concentrations (mg/L) and Total Phosphorus Concentrations (mg/L) between 2000-2022 and Yearly Mean Rocky River Flow at USGS Gage (0210166029) at Crutchfield Crossroads.



The Siler City WWTP was designed to reduce the influent nitrogen to the least toxic form, nitrate-nitrite nitrogen (NOx). The WWTP had been very efficient in doing this and the majority of the nitrogen discharged in their effluent had been NOx, up until mid-2019 when they began to experience treatment issues that resulted in spikes of ammonia discharged to Loves Creek and violation of their discharge limits (*Figure 7-71* and *Figure 7-72*). This is a concern because ammonia can be toxic to aquatic life at certain instream concentrations, however it is highly dependent on the corresponding instream temperature and pH level.

One main issue at the WWTP was their inability to remove and apply their solid waste/sludge, which resulted in the need to turn off the aeration in their oxidation ditches. This did not allow for the proper nitrification process to occur, resulting in the discharge of ammonia instead of NOx (*Figure 7-71*). The DWR Raleigh Regional Office has worked closely with town staff to address the many issues that occurred, including the inability to comply with effluent limits for biochemical oxygen demand (BOD), total suspended solids (TSS) and fecal coliform bacteria (FCB) (DEQ 2023- Draft SOC). They also failed several of their Whole Effluent Toxicity (WET) tests between 2020 and 2022 (*Table 7-40*).

Siler City's WWTP chronic whole effluent toxicity testing is required quarterly (March, June, September, and December). Their permit requires that "The effluent discharged shall at no time exhibit observable inhibition of reproduction or significant mortality to *Ceriodaphnia dubia* at an effluent concentration of 90%" at the permitted flow [2022 final NPDES permit A. (5.)]. They passed all their Whole Effluent Toxicity (WET) tests in 2018 and 2019, but the number of samples failing increased to one of six in 2020, two of eight in 2021 and five of 12 in 2022 (*Table 7-40*). If the quarterly sample results in a "Failure or Chronic Value below the permit limit" (90%), then multiple-concentration testing shall be performed at a minimum, in each of the two following months. On May 12, 2022, the Town of Siler City received a letter from the director of DWR requiring the town to increase their chronic WET testing to monthly and to use the multiple-concentration toxicity testing method. This request will stay in place until the DWR notifies the town in writing that the increased monitoring is no longer required and will go back to the quarterly monitoring listed in their permit.

Civil penalties were levied for many of the permit violations which occurred since 2019 and an SOC has been implemented to address the ongoing issues as well as to utilize their resources to improve their treatment process as soon as possible. As previously noted above, they are in the process of upgrading and expanding their treatment plant to 6 MGD. The new treatment process will reduce their overall nitrogen export using BNR and will be required to comply with total nitrogen loading limits.

As result of their significant noncompliance issues over the last several years and their potential instream impacts, a new "Instream Assessment of Biological Integrity" requirement was added to their 2022 NPDES permit [A. (4.)]. This requires Siler City to conduct an annual biological integrity assessment and must use a DWR-approved study plan and methodologies as well as submit a report to DWR within 60 days of completion.

Figure 7-71: Siler City WWTP Monthly Mean Effluent Concentrations for A.) TN, NOx, and TKN for 2009-2022, B.) TKN and NH3 for 2009-2022, and C.) TN, NOx, TKN and NH3 for 2019-2022.

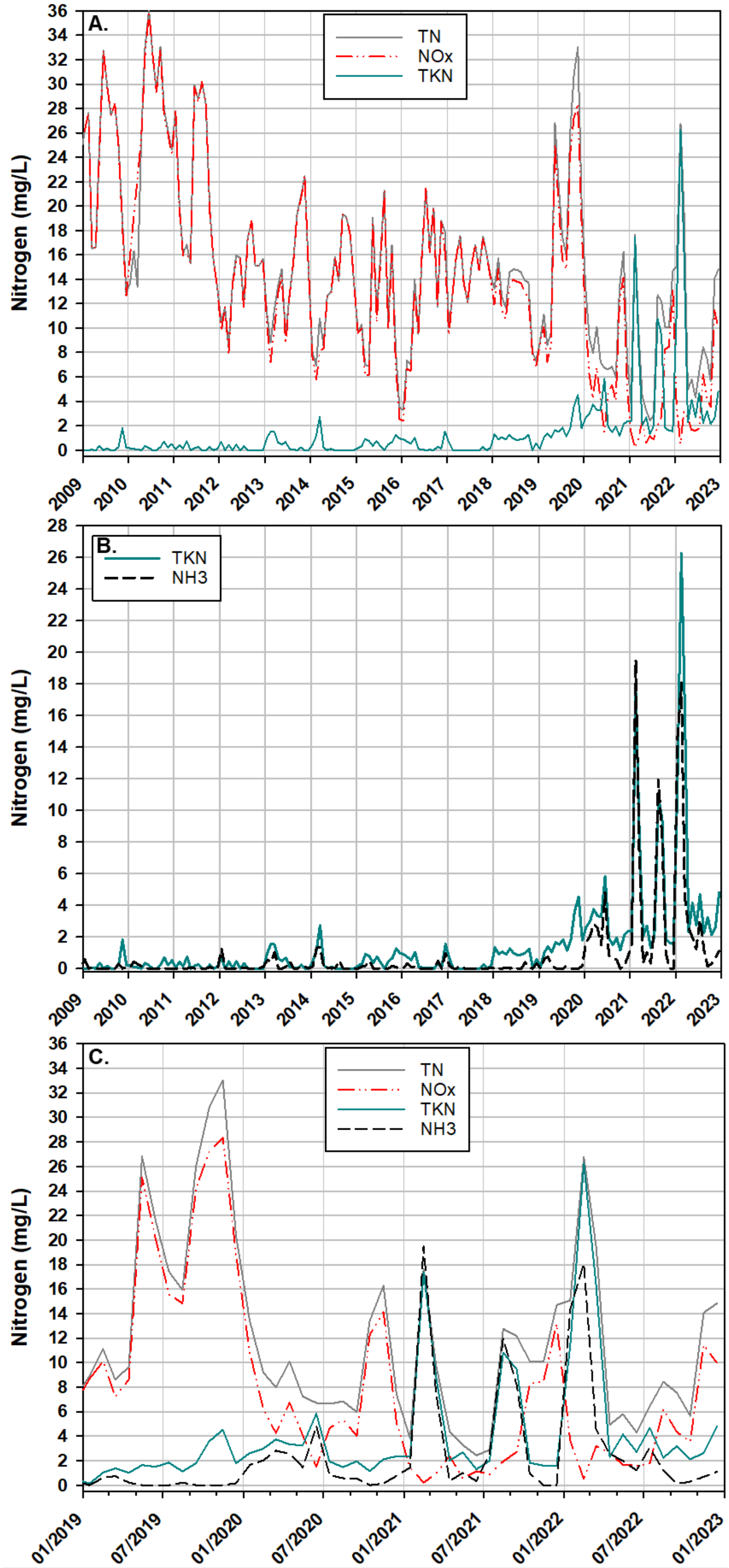
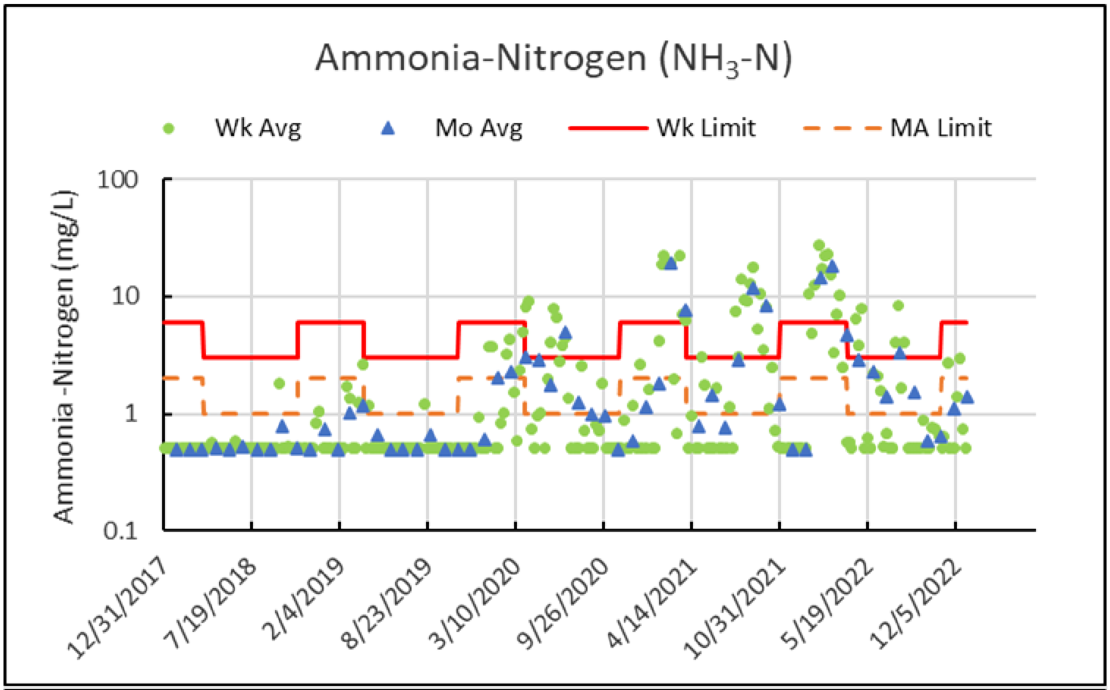


Figure 7-72: Siler City NPDES Wastewater Ammonia Effluent Concentrations: Daily, Weekly Averages (Wk Ave), Monthly Averages (Mo Ave) with Effluent Limits [Weekly Limits (Wk Limit) and Monthly Limits (MA Limit)] for 2018-2022. [Note: Summer limits = 1.0 mg/L (MA) & 3.0 mg/L (Wk) and Winter limits = 2.0 mg/L (MA) & 6.0 mg/L (Wk)]



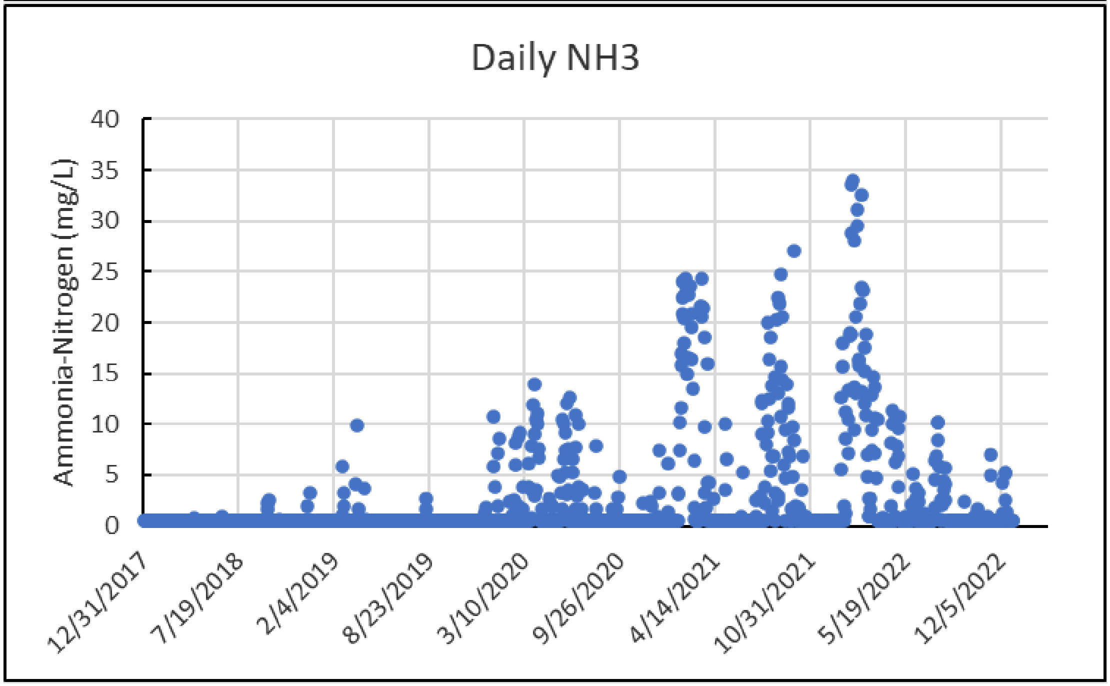


Table 7-40: Siler City WWTP Wastewater Effluent Toxicity (WET) Test Results for 2020 to 2022 During a Period of Significant Non-Compliance. (Quarterly testing is required in March, June, September, and December of each year.).

Date	Test Type	Results Pass/Fail or Chronic Value*	Compliance (C) or Non-Compliance^ (NC)
3/9/2020	Ceriodaphnia 7 day - Pass/Fail	Pass	C
6/8/2020	Ceriodaphnia 7 day - Pass/Fail	Pass	C
9/14/2020	Ceriodaphnia 7 day - Pass/Fail	Fail	NC
10/12/2020	Ceriodaphnia 7 day – Chronic Value	> 100	C
11/9/2020	Ceriodaphnia 7 day – Chronic Value	> 100	C
12/7/2020	Ceriodaphnia 7 day - Pass/Fail	Pass	C
3/8/2021	Ceriodaphnia 7 day - Pass/Fail	Pass	C
6/21/2021	+Fathead Minnow 7day – Chronic Value	> 100	P
6/21/2021	Ceriodaphnia 7 day - Pass/Fail	Pass	C
9/13/2021	Ceriodaphnia 7 day - Pass/Fail	Fail	NC
10/18/2021	Ceriodaphnia 7 day – Chronic Value	> 100	C
11/15/2021	Ceriodaphnia 7 day – Chronic Value	> 100	C
12/6/2021	Ceriodaphnia 7 day - Pass/Fail	Fail	NC
12/6/2021	+Fathead Minnow 7day – Chronic Value	94.9	C
1/17/2022	Ceriodaphnia 7 day – Chronic Value	58.1	NC
2/14/2022	Ceriodaphnia 7 day – Chronic Value	58.1	NC
3/14/2022	Ceriodaphnia 7 day - Pass/Fail	Fail	NC
4/11/2022	Ceriodaphnia 7 day – Chronic Value	> 100	C
5/16/2022	Ceriodaphnia 7 day – Chronic Value	82.6	NC
6/13/2022	Ceriodaphnia 7 day – Chronic Value	> 100	C
7/25/2022	Ceriodaphnia 7 day – Chronic Value	82.2	NC
8/15/2022	Ceriodaphnia 7 day – Chronic Value	> 100	C
9/12/2022	Ceriodaphnia 7 day - Pass/Fail	Pass	C
10/4/2022	Ceriodaphnia 7 day – Chronic Value	> 100	C
11/7/2022	Ceriodaphnia 7 day – Chronic Value	> 100	C
12/12/2022	Ceriodaphnia 7 day – Chronic Value	> 100	C

***** The Siler City WWTP chronic value limit is 90%. Any chronic value below 90 fails. Chronic Pass/Fail test use 90% effluent for the assessment.

+ Second species test required for permit renewal;

^ When a quarterly WET test is Non-Compliant (NC), a follow up WET test is required in the following two months.

The Loves Creek instream TN concentration increases significantly downstream of the WWTP at station B5920000 (*Table 7-37*). The 2022 IR assessment period mean TN concentrations were 1.12 mg/L at stations B5890000 (upstream) and 10.16 mg/L at station B5920000 (downstream), with maximum concentrations of 3.31 and 25.60 mg/L respectively (*Table 7-37* and *Table 7-38*). A reduction in the instream concentration at station B5920000 (downstream) in 2012 corresponded with the decline in the WWTP TN effluent concentrations due to the closure of the poultry processing plant (*Figure 7-70* and *Figure 7-73*). The instream yearly mean TN concentration dropped from 18.9 mg/L in 2011 to 11.0 mg/L in 2012, a nearly 8 mg/L TN drop (*Figure 7-73*). The highest upstream (B5890000) reading was 1.5 mg/L in 2018 which coincided with a high flow year which likely resulted in more stormwater runoff of nutrients to the system.

The constituents making up the TN are very different upstream and downstream of the WWTP. For the last six years, the upstream (B5890000) TN was made up of slightly more TKN than NOx (*Figure 7-74*). The 2022 IR mean concentrations were 0.65 mg/L-TKN and 0.47 mg/L-NOx (*Table 7-37*). As for the downstream station (B5920000), the instream nitrogen species is more reflective of the discharged from the WWTP with the nitrogen species being dominated by NOx (*Figure 7-74*). The 2022IR mean concentrations were 0.86 mg/L-TKN and 9.31 mg/L-NOx (*Table 7-38*).

Siler City WWTP Effluent Monitoring	
Date	**Ammonia (mg/L)**
2/01/2022	13.6
2/02/2022	9.4
2/03/2022	13.1
2/04/2022	20.6
2/07/2022	29.5
2/08/2022	31.1
2/09/2022	16.4
2/10/2022	15.8
2/11/2022	16.2
2/14/2022	21.8
2/15/2022	13.2
2/16/2022	32.5
2/17/2022	23.4
2/18/2022	23.1
2/21/2022	17.6
2/22/2022	15.3
2/23/2022	12.1
2/24/2022	18.8
2/25/2022	10.9
2/28/2022	7
Feb 2022 Monthly Average	**18.1**

The instream ammonia concentrations are generally very low at both stations except for the 2020 downstream station (B5920000), where the yearly mean instream concentration jumped to 1.43 mg/L, reflecting the higher ammonia discharged from the WWTP (*Figure 7-75*). Due to the concern with the high ammonia discharged from the wastewater treatment plant and the possible impacts to aquatic life, the instream Loves Creek ammonia data was processed for 2021 and 2022 for inclusion in this basin plan. The yearly instream mean ammonia concentration increased to 1.91 and 1.98 mg/L for 2021 and 2022, respectively (*Figure 7-75*). The highest instream ammonia reading was 9.05 mg/L collected on February 2, 2022, where the corresponding effluent concentration was reported as 9.4 mg/L on that date (*Figure 7-76*). The ammonia concentrations were elevated throughout February 2022, with the monthly effluent ammonia mean of 18.1 mg/L, which violated their monthly limit of 2.0 mg/L as well as their weekly limit of 6 mg/L.

The Loves Creek instream TP concentrations have dropped both upstream and downstream of the WWTP (*Figure 7-73*). A reduction in the 2010 downstream (B5920000) yearly mean corresponds with the reduction in the concentration discharged from the WWTP (*Figure 7-70*). The slight increase in the effluent concentration in 2020 was also reflected in a slight increase in the instream concentration with the yearly mean concentration of 0.08 mg/L in 2020, up from 0.05 mg/L in 2019 (*Figure 7-73*).

The improvements clearly identified in the Town of Siler City's special order of consent will result in an improved collection system, pretreatment program and drinking water system, as well as a wastewater treatment plant with expanded capacity to 6 MGD. All of these actions along with several other capital improvement projects taken by the town should result in improved water quality downstream in Loves Creek and the Rocky River. The town is also working to improve water quality in many of the small unnamed tributaries draining to Loves Creek with the cooperation of the Loves Creek Watershed Stewards and the many grant funded projects designed to reduce stormwater impacts and improve stream habitat (see local initiative section below for details). A Loves Creek Watershed Action Plan, which has identified additional watershed projects, is nearly complete. *The town should continue to support the Loves Creek Watershed Stewards and implement the Loves Creek Watershed Action Plan, along with the upgrade to the Siler City WWTP and collection system*. These are critical to the improvement in water quality in both Loves Creek and the mainstem Rocky River.

Figure 7-73: Loves Creek Yearly Mean Instream Total Nitrogen and Total Phosphorus Concentrations at Ambient Monitoring Stations B5890000 and B5920000 with Rocky River USGS Flow at Crutchfield Crossroads (0210166029). (Poultry processing plants closures and openings

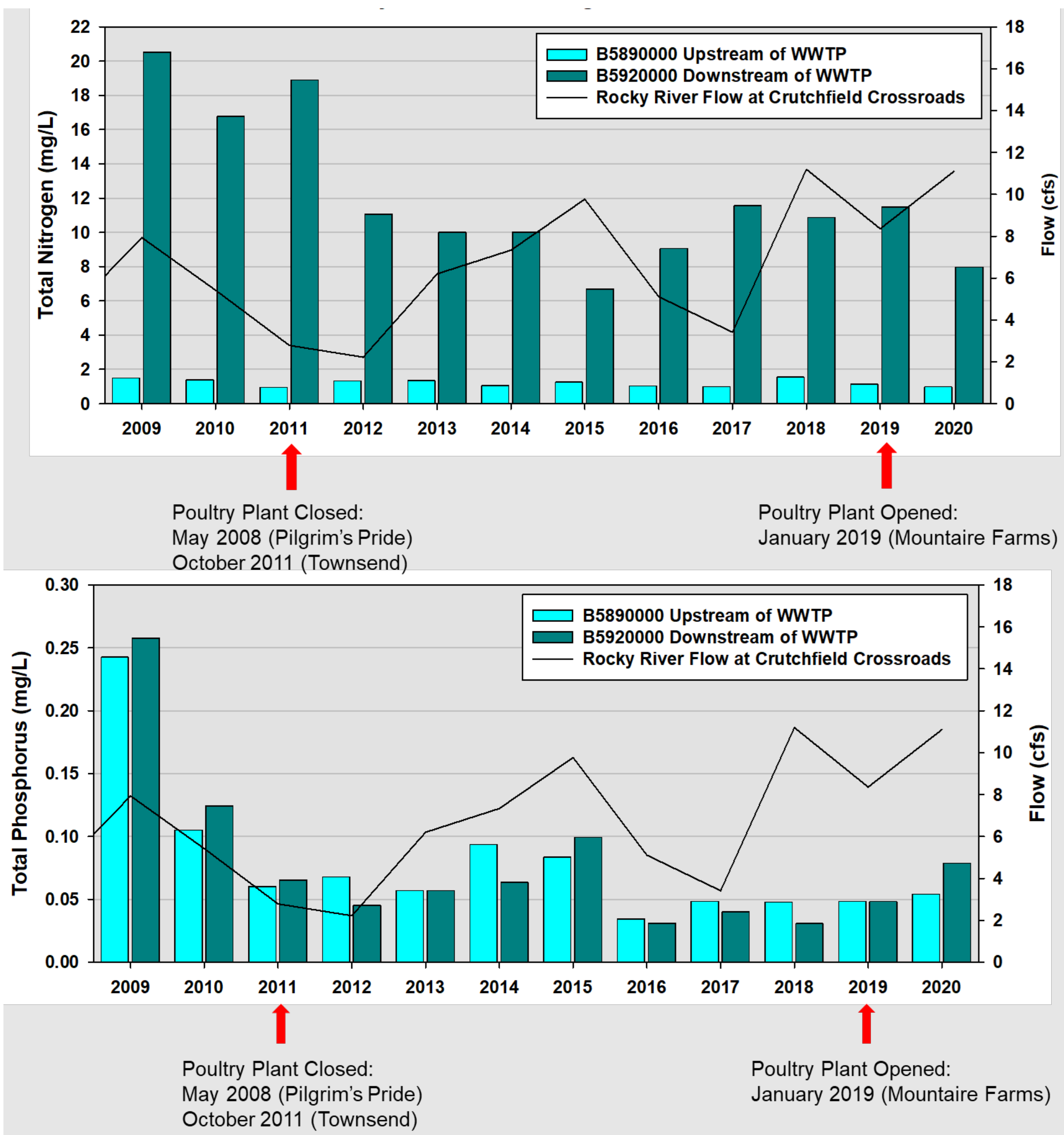


Figure 7-74: Loves Creek Yearly Mean Instream Nitrogen Series Concentrations at Ambient Monitoring Stations B5890000 and B5920000 with Rocky River USGS Flow at Crutchfield Crossroads (0210166029) [Note the nitrogen axis scale differences between the two stations (1 mg/L versus 20 mg/L).]

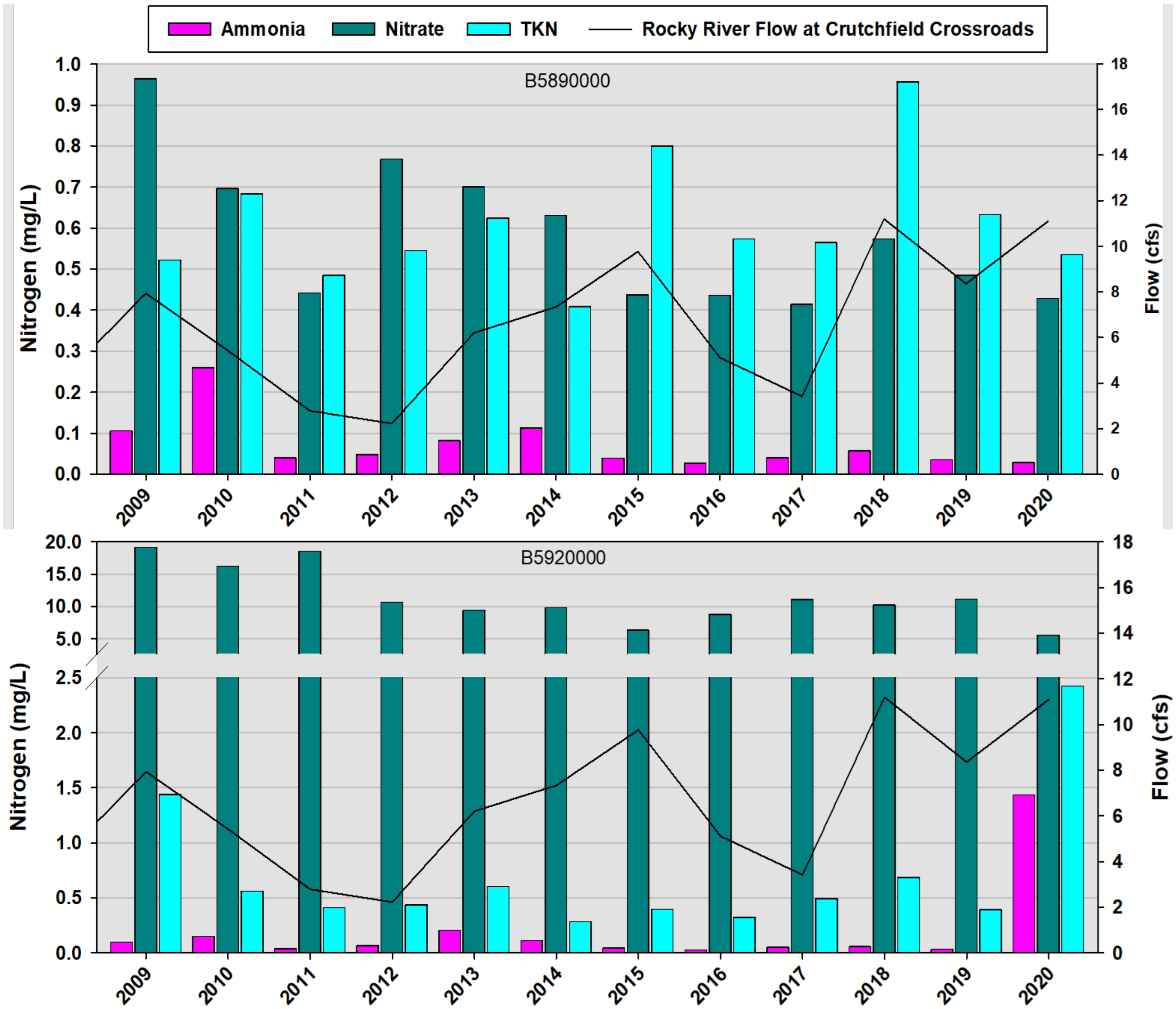


Figure 7-75: Loves Creek Yearly Mean Instream Ammonia-Nitrogen Concentrations at Ambient Monitoring Stations B5890000 and B5920000 for 2019-2022

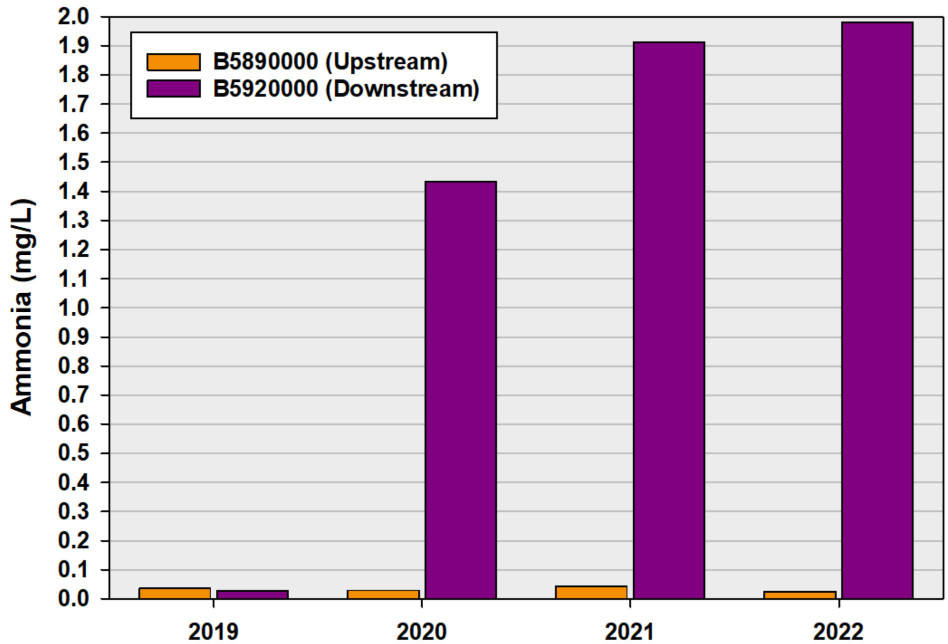
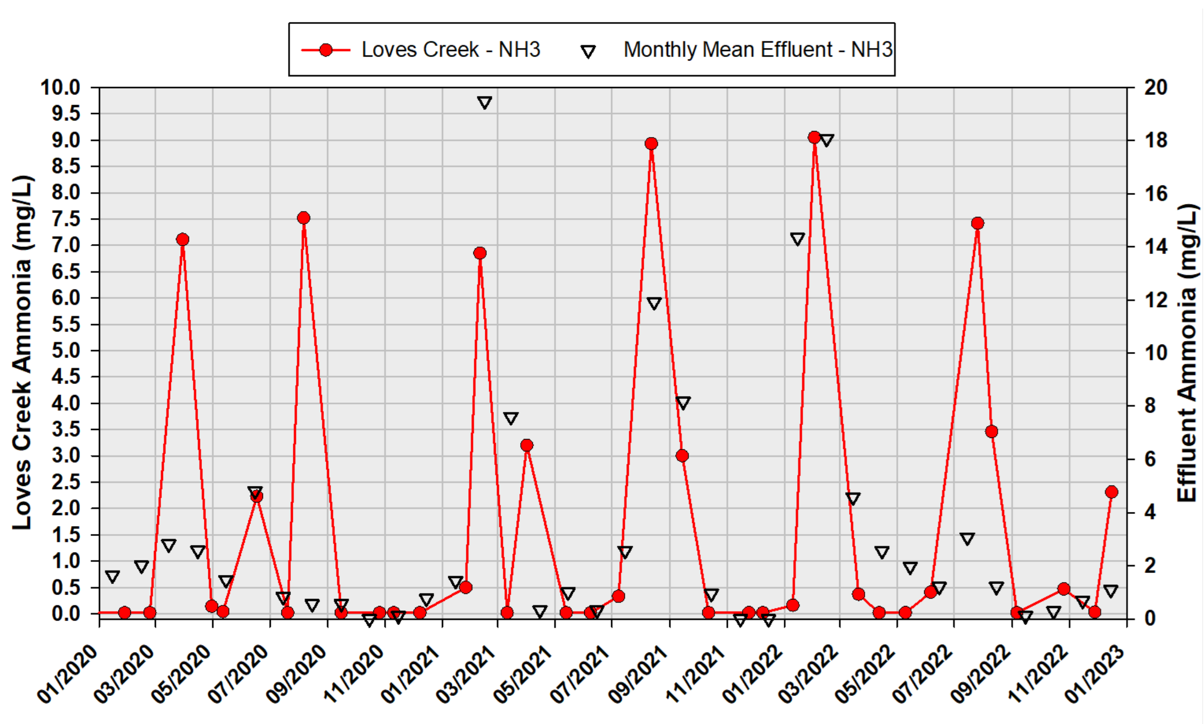


Figure 7-76: 2020-2022 Loves Creek Monthly Instream Ammonia-Nitrogen Concentration at Station B5920000, Downstream of the WWTP and the Monthly Effluent Mean Ammonia-Nitrogen Concentration



Loves Creek Watershed Local Initiatives

Photos: Loves Creek Watershed Stewards, Bolin Creek Park Stormwater Wetlands Project (319 Funded)

- In 2012, efforts to improve water quality in Loves Creek included installing stormwater best management practices (BMPs) in a “pocket park” in downtown Siler City. North Carolina State University (NCSU) and NC Cooperative Extension were awarded a $30,000 EPA 319 grant to implement a high-profile demonstration stormwater retrofit system installed at the NC Arts Incubator in an effort to reduce runoff and educate residents about water quality and stormwater runoff.

- The Loves Creek Watershed Stewards (LCWS) is a local stakeholder group formed in 2014 that continues to meet quarterly to discuss ways to improve Loves Creek and its tributaries. Numerous stakeholders including the Town of Siler City, Biocenosis LLC, Piedmont Conservation Council (PCC), Chatham County, Chatham County Soil and Water Conservation District (SWCD), DWR, Siler City Economic Development Organization, NCSU, NC Cooperative Extension, Rocky River Heritage Foundation, The Conservation Fund, local landowners, other local businesses and community organizations support the group.

- The Triangle J Council of Governments (TJCOG) was awarded an $18,000 EPA 205(j) planning grant in 2015 to identify important natural resources and develop draft policy language options to promote water quality protection and help integrate it with other goals held by the Town of Siler City, such as economic development and parks and recreation. This project built upon existing efforts to support the Town of Siler City to protect water quality as it grows. The project was focused on the Town of Siler City’s corporate limits and extra-territorial jurisdiction. Findings from the project were integrated into the natural resource section of the *2017 Town of Siler City Land Development Plan*.

- With a focus on stormwater runoff and control in the urban areas, PCC in cooperation with Loves Creek Watershed Stewards, NC State, Biocenosis LLC, and the Town of Siler City was awarded an EPA 319 non-point source grant of $150,000 in 2015 to implement BMPs including stormwater wetlands and a buffer along the upper reach of Loves Creek within Boling Lane Park.

- The Town of Siler City was awarded $536 through a 2015 Chatham County SWCD CCAP grant. An eroding hill slope that drains to a tributary of Loves Creek within Boling Lane Park was stabilized with vegetation in efforts to prevent sediment runoff into the creek.

- In 2016, Piedmont Conservation Council (PCC), in cooperation with Biocenosis LLC, Kris Bass Engineering and the Town of Siler City, received an environmental enhancement grant (EEG) of $270,000 through the NC Attorney General's office to restore the stream and floodplain of a degraded tributary to Loves Creek within downtown Siler City. The stream and floodplain rehabilitation project initially sought to purchase a large parcel of land in downtown Siler City, which was the former site of Boling Chair Company. The site itself was located within the floodplain of Loves Creek Tributary 1 and the proposed project aimed to install specific BMPs, remove impervious surface and implement stream and buffer restoration to target stormwater. Ultimately the goal was to create an urban environmental learning park. However, the subject parcel acquisition fell through, and the project was extended to allow for purchase of a different set of properties downstream, also located along Tributary 1. The project included land acquisition of 6 acres between South Chatham Avenue and South Cedar Avenue, removal of a condemned house along South Chatham Avenue, extensive invasive plant and trash removal, and stream and floodplain restoration. At project completion, the land was gifted to the Town of Siler City for use as open green space that could potentially be used in the future by the town as an area for an environmental learning park and/or floodplain trail. Project accomplishments and maintenance guidance are documented in the *Paper Alley Floodplain Restoration – Loves Creek Tributary 1 Project and Maintenance Plan* (2021).

- Additionally, in 2016, the Chatham County Soil and Water Conservation District awarded a $3,618 CCAP grant to the Town of Siler City to establish a buffer along the tributary to Loves Creek within Boling Lane Park with a primary objective to protect and enhance water quality as well as improve instream habitat. This work was performed concurrently with the 2015 BMP implementation grant awarded to PCC.

- In 2017, a Clean Water Management Trust Fund (CWMTF) planning grant of $101,219 was awarded to PCC in cooperation with NCSU, Biocenosis LLC, and the Town of Siler City to perform a detailed study of potential improvements and/or restoration methodologies to be applied to the Piggly Wiggly/Park Shopping Center/Southern States subwatershed of Loves Creek within the town limits. The project is documented in the *Park Shopping Center/Loves Creek Tributary 2 Restoration Study* (2019).

- The Siler City Stormwater Infrastructure Mapping and Assessment project was funded $20,963 in 2018 by EPA 205(j) grant through Triangle J Council of Governors in cooperation with Biocenosis LLC to map and assess the Town of Siler City's stormwater infrastructure within the town's contiguous town limits. The project provided the Town of Siler City with much needed detailed documentation on the location and maintenance needs of the stormwater system that are critical for the town to maintain their system and improve water quality. The project is documented in the *Siler City Stormwater Infrastructure Mapping and Assessment Project* (2020).

- Following up on the 2017 Clean Water Management Trust Fund planning grant, PCC was awarded a $221,013 EPA 319 grant in 2019 to design and install stormwater controls, rain gardens, stream buffers and other stormwater control measures to reduce peak stormwater flows in the Piggly Wiggly / Park Shopping Center subwatershed of Loves Creek. Due to lack of suitable sites in this small subwatershed, the stormwater control implementation effort was expanded to adjacent subwatersheds. These projects, along with others throughout the Loves Creek watershed, can be found on the online *Loves Creek Watershed Action Plan* hosted by the NC Division of Water Resources. The project is documented in the *Stormwater Controls in the Piggly Wiggly Subwatershed of Loves Creek Final Report* (2023).

- In 2020, PCC in cooperation with Biocenosis LLC, Chatham County SWCD, and the Town of Siler City, was awarded an $83,137 NC Land and Water Fund grant to develop a watershed restoration and protection plan for Loves Creek and its tributaries. The plan includes the EPA 9-key elements for restoring waters in impaired watersheds. The project is documented in the *Loves Creek Watershed Restoration and Protection Plan* (2024).

- The Town of Siler City was awarded a $210,000 Golden Leaf Foundation grant in 2022 to complete a hydrologic analysis and inventory of stormwater infrastructure of and within the Tributary 2 subwatershed of Loves Creek. The aim of the project was to develop floodplain mapping as well as determine methods to mitigate for flooding events within the subwatershed.

Through the efforts of Loves Creek Watershed Stewards and its partners, more than $1.1 million in direct grant funding has been awarded to various planning and implementation projects throughout this watershed since 2012.

Loves Creek Watershed Restoration and Protection Plan

The Piedmont Conservation Council received funding from the NC Land and Water Fund to create a watershed restoration and protection plan for Loves Creek that will address the nine key watershed planning elements recommended by the EPA (2024, PDF version; June 2024 StoryMap version). The goal of the plan is to serve as a guide to improve water quality and help restore functional uplift and critical habitat to the aquatic and riparian ecosystems. This is a tool to help stakeholders within the Loves Creek watershed achieve the collective goal of removing Loves Creek from the State's 303(d) list of impaired waters. The plan includes a watershed inventory of existing and needed data to characterize the watershed as well as a history of the work and partnership-building that has been accomplished by the Loves Creek Watershed Stewards. The plan identifies causes of impairment and pollution sources and, where applicable, provides an estimate of the load reductions expected for the nonpoint source management measures. Additionally, nonpoint source management measures and recommended projects in targeted critical areas are included within the document. An information and education component has also been included in the plan.

Additionally, watershed improvement projects documented in the Loves Creek Watershed Restoration and Protection Plan are identified, described and mapped in a dynamic online Loves Creek Watershed Action Plan (WAP)[Add link when available]. The WAP, hosted by NC Division of Water Resources, is an ongoing process that will allow all stakeholders and interested community groups to interact with the provided information to develop solutions for the Loves Creek Watershed.

The Town of Siler City has begun implementation of several projects that are in line with the goals of the Watershed Restoration Plan. They have begun development of a long-range capital improvement plan that will include water and wastewater load predictions and improvement plan, future water supply and wastewater treatment alternatives, a water and wastewater capital improvement program capacity study, water and wastewater system development fee analyses, a comprehensive water and wastewater rate study/financial plan and model, and a stormwater utility fee conceptual evaluation. Further, the town is submitting an NC DEQ asset and inventory grant application for sewer asset inventory and assessment (AIA) as well as for stormwater utility fund and AIA.

7.7.5.3 Meadow Creek

BB206*	
Year	**Bioclassification**
2003	Fair
*Special Study	

The land use in the Meadow Creek [AU#: 17-43-12] watershed is dominated by agriculture and forest; the upper and middle sections of the stream flow through pasture and row crop and many areas are devoid of buffer or have very sparse buffer. The headwaters are impounded in a farm pond. The lower third of the stream is heavily forested, which is where biological community site BB206, Meadow Creek at Reeves Chapel Rd., was sampled once in 2003 as part of a special study. The site received a bioclassification of Fair. Specific conductance at the site was elevated at 134 µS/cm, indicating potential inputs of pollution from non-point sources in the catchment. Similar to Loves Creek, agricultural runoff, livestock access to the stream, and low flow conditions are likely all contributing to impacts to the benthos community. Meadow Creek should be resampled as time and funding allows.

7.7.5.4 Tick Creek

Tick Creek [AU#: 17-43-13 to 17-43-13b] drains southwest Chatham County and is a direct tributary of the Rocky River. Land use in the upper two-thirds of the drainage is dominated by agriculture, including the Mountaire Farms Mount Vernon Hatchery, which holds a state stormwater permit. There are also land application fields used by the City of Sanford in the catchment. The headwaters of Tick Creek are impounded by a farm pond. Most of the upper two thirds of the stream has sparse or non-existent buffer. Spring sampling is necessary in most smaller Level IV ecoregion slate belt streams like Tick Creek due to the isolation from ground water inputs, resulting in naturally occurring low flows during the summer. Tick Creek AU # 17-43-13a is impaired for fish (BF72) and AU # 17-43-13b is impaired for benthos (BB360).

Fish Community Site BF72, located just upstream of highway US 421, was assessed as part of a special study in 2003. The immediate land use in the sample area is horse pasture and the buffer appears sparse. The site rated Fair at the time of sampling, which impairs this AU for fish.

Year	Bioclassification
BF72	
2003	Fair
BB360	
2003	Good-Fair
2009	Good-Fair
2013	Not Rated
2018	Fair
BF136	
2018	Good-Fair
2013	Good-Fair
2009	Good

Benthic macroinvertebrate sampling in the spring of 2018 at benthic community site BB360 resulted in Tick Creek receiving a Fair bioclassification rating. Fourteen EPT taxa were collected in all, but 4 taxa were spring seasonal taxa. Seasonal taxa are removed from the analysis to better compare to samples taken during the summer, the seasonal zenith for aquatic macroinvertebrate taxa. Tick Creek is a highly enriched and embedded stream with much of the watershed relegated to animal operations and cultivation (30%). ***Direct cattle access to the stream channel was evident*** just upstream of the bridge at the sampling reach. ***High amounts of algae and silt were present*** in the channel and were so heavy in places that macroinvertebrates were all but choked out of the interstitial spaces typically utilized by these organisms. Additionally, ***sampling was difficult due to the sheer amount of periphyton on the substrate making walking in the stream difficult and treacherous***. Reduced EPT richness at this site was likely due to high precipitation in the two weeks prior to sampling. The site was Not Rated, although as the 2018 sample demonstrates, land use and habitat could have also impacted the EPT taxa. The site rated Good-Fair in both 2003 and 2009. EPT diversity and EPT biotic index were similar to previous samples. Seasonal taxonomic differences were the only differences between the summer sampling in 2003 and the spring sample in 2009.

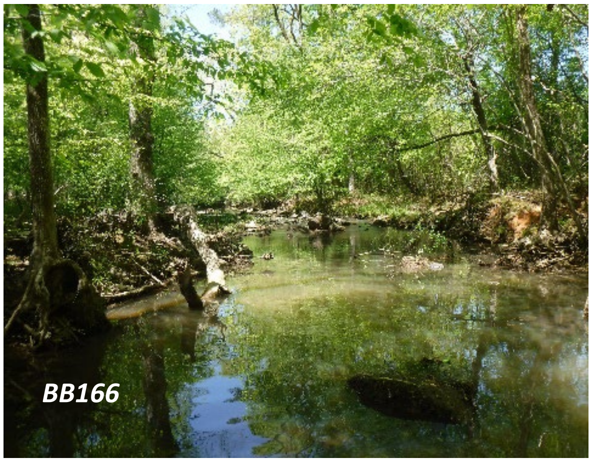
Fish community site BF136 drains southwest Chatham County (south of Siler City) and is about 2 miles above the creek's confluence with the Rocky River. The riparian buffer at this site is mature but thin, with pastures on both sides and livestock fenced out. Stream banks are mostly vegetated in the lower part of the sample reach, but several scoured banks exist towards the upstream end, which is evidence of high flow events. Moderate quality instream habitats consist of primarily run-pool complexes with good undercuts and root mats, and a fair amount of coarse woody debris in the channel. Riffle habitats are infrequent at this site. Overall, habitats look unchanged between the 2013 and 2018 assessments, with similar total scores (69 in 2013, 71 in 2018). In 2018, water clarity was at the upper end of turbidity that is suitable for fish sampling (the site would not have been sampled if deep pools were present), potentially reducing observations of species richness and abundance. A low abundance community was collected in 2018 with more than 50% of the catch represented by tolerant species: eastern mosquitofish (36%), redbreast sunfish (12%), and green sunfish (7%). However, trophic structure metrics all received maximum scores in 2018. Species with young-of-year cohorts present in 2018 include bluegill and tessellated darter (a few individuals each, numbers potentially reduced by low visibility). Eighteen fish species have now been collected from this site since sampling began in 2009, with only one pollution intolerant individual, a piedmont darter, collected in 2009. A slightly lower number of fish was collected in 2018 as compared to 2013, but a slightly higher percentage of multiple age classes was present. Otherwise, similar trophic characteristics persist at this location, with the same NCIBI score and bioclassification in the last two fish community assessments.

7.7.5.5 Harlands Creek (Hollands Creek)

BB166	
Year	**Bioclassification**
2003	Good-Fair
2009	Good-Fair
2013	Not Rated
2018	Fair

Harlands Creek [AU#: 17-43-15] drains a small catchment to the west of Pittsboro. Land use in the watershed is dominated by agriculture and forest. The Chatham County Solid Waste & Recycling Main Facility (which offers yard waste disposal, tire disposal, mulch sales, household hazardous waste disposal), along with a prison and animal control facility are located in the catchment. An approximately 80-acre unlined municipal solid waste landfill was also located on this site, but closed in 1993 (Chatham County, 2023). Groundwater and surface water monitoring, required by DEQ semi-annually, was most recently performed at the former landfill site in November 2022 and showed that the site exceeded DEQ's Solid Waste Section Groundwater Protection Standards for cobalt, vanadium, nickel, 1,4-dioxane, and benzene. Laboratory results indicated that the water quality at the Chatham County Landfill is generally consistent with reported historical detections. Inorganic constituent detections are likely due to naturally occurring conditions in conjunction with high sample turbidity concentrations that influenced analytical results.

Two stations on Harlands Creek are also monitored upstream and downstream of the former landfill. However, in the past several monitoring events, the stream has been dry at both sites. Stream monitoring results from 2018 detected vanadium at both the upstream and downstream station. The facility will continue semi-annual monitoring; the next event is scheduled for May 2023 (NCDEQ, 2023).



Benthic community site BB166, Harlands Creek at NC 902, is located approximately three miles upstream from its confluence with Rocky River and is downstream of the former landfill site. High amounts of precipitation were observed in this catchment in both 2013 and 2018 when EPT richness dropped from 24 in 2009 to 12 in 2013 and 11 in 2018. This benthic macroinvertebrate sampling site was not rated in 2013 due to heavy storms possibly scouring the site just prior to sampling. There were high amounts of precipitation in 2018 and a clear cut was noted upstream of the sampling location. Forest cover in the catchment has declined by at least 12% beginning in 1992. EPT richness declines in this reach of Harlands Creek could be associated with this increased development and agriculture leading to elevated nonpoint source pollution runoff from upstream. The entire length of Harlands Creek is impaired for benthos as a result of the 2018 sample.

7.7.5.6 Bear Creek

Year	Bioclassification
BF56	
2013	Good
BB495*	
2008	Fair
BB372	
2003	Not Rated
2009	Good-Fair
2013	Not Rated
2018	Fair
*Special study	

Bear Creek [AU#: 17-43-16a, 17-43-16b, and 17-43-16c] and its tributary, Sandy Branch, comprise an agriculture-dominated catchment. There is also a fair amount of timber management in the lower end of Bear Creek. Regulated activities within the watershed include several residual solids land application fields associated with Harnett County and Pilgrim's Pride, a minor WWTP associated with Chatham County Schools, single family wastewater permits, and wastewater irrigation permits. All of these uses combined are likely affecting water quality and biological communities in the catchment. The lower third of Bear Creek, AUs 17-43-16b and 17-43-16c, are impaired for benthos. Biological monitoring should also be performed in the upper two thirds of the watershed to more accurately pinpoint areas of impairment throughout the drainage.

Fish community site BF56 and benthic community site BB495, Bear Creek at SR 2187, are co-located. The site is typical of a Carolina Slate Belt-type stream with angular rocks; shallow cobble riffles with low flow; and deep pools at the beginning and end of the reach. Field staff noted Justicia, Podostemum, and Fissidens growing in the riffles and stated that instream habitats were especially flow dependent. Dischargers may be contributing to the elevated specific conductance which fluctuated from 91 µS/cm in 1998 to 148 µS/cm in 2008 and then declined slightly when fish were sampled in 2013 to 121 µS/cm. In 2013, samplers saw less dominance by insectivores than in 2008, which resulted in a more trophically balanced community, an increase in the NCIBI score, and an increase in the fish NCIBI rating. Twenty-five fish species are known from this site including three species of darters (including the Carolina Darter, *Etheostoma collis*, a state special concern species which has been collected six times since 1998, but has not been collected since 2003), one intolerant species, and only one nonindigenous species. The number of fish collected has been stable since April 2008 (range 225-283); drought recovery studies conducted in 2008 were summarized in Biological Assessment Unit (BAU) Memorandum F-20090122. Based upon all the data collected, field staff noted no persistent long-term change in water quality in the Bear Creek watershed. Except for the two Fair ratings during extremely low flow events, the community ratings have fluctuated between Good-Fair and Good. Benthic community site BB495 was collected once in 2008 as part of a special study and received a bioclassification of Fair. Continued basinwide assessment of this site, including benthos monitoring, should be conducted in 2023 to document any potential impacts from changing land use in the watershed.

Benthic community site BB372 was sampled in the spring of 2018 to avoid the low flows common to Carolina Slate Belt streams in the summer, and it rated Fair for the first time. The only other time Bear Creek was rated was in 2009 when the stream garnered a Good-Fair bioclassification. The loss of seven EPT over 10 years is likely due to the increase in development pressures within the Bear Creek watershed. Excessive nutrient enrichment has led to high amounts of periphyton on the substrate, creating difficult sampling conditions. The increase in sediment in the channel along with choking algal biomass present has effectively reduced the amount and quality of instream macroinvertebrate habitat. Continued monitoring of the macroinvertebrate community at this site is necessary to document the deteriorating conditions underway in Bear Creek.

7.7.5.7 Additional Rocky River Watershed Studies and Stakeholder Actions

Intensive Survey Branch (ISB) 2020-2021 Ammonia Assessment and Mussel Bioindicator Study

In response to a request from the Basin Planning Branch and the Raleigh Regional Office, the Intensive Survey Branch (ISB) conducted a field investigation to help identify potential sources of ammonia in the Rocky River. Field staff for the NC Wildlife Resources Commission contacted DWR for support in May 2020 after observing elevated instream ammonia values and documenting concerning declines in native freshwater mussel and the Cape Fear shiner.

Beginning in August 2020, and continuing through September 2021, the Intensive Survey Branch conducted physical and chemical monitoring of the lower Rocky River and Loves Creek at nine sites located throughout the drainage from U.S. 64 to the confluence with the Deep River near Moncure. Handheld multi-parameter hydrosondes were used to monitor temperature, pH, dissolved oxygen, ammonia/ammonium and conductivity at each of the nine sites during monthly sampling events. Analytical samples for total residue, suspended residue, ammonia, total Kjeldahl nitrogen, NOx, total phosphorus, turbidity, 5-day biochemical oxygen demand and chlorophyll *a* were also collected during monthly site visits at certain stations.

In addition to the chemical and physical data collection efforts described, ISB also deployed and monitored six in situ mussel cages as a bioindicator of water quality. Eastern Elliptio (*Elliptio complanata* [n=48]), a native freshwater mussel, was collected from the headwaters of the Rocky River upstream of the study area and randomly assigned to a study site. In an effort to identify potential sources affecting water quality and mussel populations, cages were strategically deployed at the following stations: Rocky River at US64 (B5950000), Loves Creek upstream of WWTP (CPFLC010), Rocky River at 0.1 miles downstream of Loves Creek (CPFRR05), Rocky River at NC 902 (B6000000), Rocky River at Pittsboro Goldston Road (CPFRR060), and Rocky River at old Woodys (Hoosier) Dam (CPFRR070). Survival and condition assessments (length, weight, and visual assessment) were conducted in conjunction with the scheduled monthly water quality sampling. The in-situ cages were deployed from November 2020 to March 2022. See the report for detailed results (add link). A summary of the most significant findings include:

Ambient Results -

- Ammonia results ranged from 0.2 mg/L (PQL) to 6.5 mg/L. The highest discrete values of 6.5 and 4.5 mg/L were recorded on September 15, 2021, from B5920000 (Loves Creek downstream of WWTP) and CPFRR05 (Rocky River 0.1 mile downstream of the confluence with Loves Creek), respectively. Ammonia toxicity to aquatic life is highly dependent on ambient temperature and pH. There is currently no regulatory or narrative standard for ammonia in NC. Ammonia concentrations were less than 0.1 mg/L at the other downstream stations on that date.
- Of the 36 samples collected, only a single chlorophyll *a* exceedance was documented in June at station CPFRR06 (43 µg/L).

- Chloride values ranged from 5.7 to 200 mg/L. All recorded values were below the US EPA national recommended water quality criteria for aquatic life (≤ 230 mg/L). Though mussels are sensitive to chloride concentrations, additional research is needed to determine if there are chloride sensitive species present in the Rocky River watershed that would warrant further assessments of instream chloride concentrations. Instream chloride concentrations were identified by the Rocky River Interagency Workgroup as a potential parameter of concern.

Mussel Bioindicators –

- Mussel mortality only occurred at station CPFRR05, located 0.1 mile downstream of the confluence of Loves Creek.
- Visual signs of stress (valve gape and unresponsive mantle tissue) were first documented on August 12, 2021.
- On September 20, 2021 (the next monitoring period following the August 12, 2021, assessment), 4 of the 8 mussels (50%) were no longer alive. The highest instream ammonia concentration recorded as part of this special study was collected on September 15, 2021, with a concentration of 4.5 mg/L.
- Visual signs of stress were again recorded on February 11, 2022, in the remaining mussels.
- On March 21, 2022, another mussel died, leaving only 3 of the 8 mussels surviving at the station downstream of the WWTP on the Rocky River (CPFRR05).
- No other mussel mortalities were documented at any of the other Rocky River stations or the Loves Creek station upstream of the WWTP.

The initial source of elevated ammonia reported by NC Wildlife Resources Commission (WRC) could not be identified due to a storm event that washed out any remnants of elevated ammonia prior to the regional office responding to the concern. The wastewater treatment plant has had issues with discharging elevated ammonia in their effluent over the last several years, however. This was discussed above in the Loves Creek and Rocky River watershed write-ups. Elevated levels of ammonia have been documented in the Rocky River downstream of the confluence with Loves Creek as a result of the issues at the wastewater treatment plant. This special study found a significant impact on the mussels located in the Rocky River at the station 0.1 mile downstream of the confluence with Loves Creek (CPFRR05). This is likely the result of acute or chronic toxicity levels of ammonia at this location. Neither the next Rocky River station, approximately 10 miles downstream (B6000000), nor any of the other Rocky River stations, experienced any mortality during the 16-month special study. See the final report for more details (add link once available). The Basin Planning Branch would like to acknowledge and extend our gratitude to ISB for the extra effort and long hours they put into this study. They incorporated in situ ammonia ambient monitoring and mussel bioindicators into this study, which was a first for the Division.

Rocky River Interagency Workgroup

The 2021 formation of a Rocky River Interagency Workgroup, focused on the intersection of local water quality and the life-requisites of the Cape Fear shiner and the river's mussel community. Initiated by the DEQ, WRC and the US Fish and Wildlife Service, the workgroup brought together more than a dozen federal, state, and local agencies and interest groups. The initial meetings included reviewing Rocky River water quality, the extent of chemical, biological, and physical monitoring, and the habitat and water quality needs of Cape Fear shiners and mussels. The group shared conservation actions in-progress and future study plans and will continue to meet in order to advance initiatives related to water quality and rare species protections with the goal of future adaptive management to support the sensitive aquatic fauna that inhabit this watershed. (Link to website with meeting materials and presentations.)

Rocky River Watershed SWAT Model Development

The Rocky River in the upper Cape Fear River Basin in NC has been listed as impaired for chlorophyll *a*, dissolved oxygen, and benthos on the NC 303(d) list since 2010. In order to better understand the sources of impairments, DWR developed a watershed scale hydrologic model, Soil and Water Assessment Tool (SWAT). The watershed model used 2011 LANDSAT satellite imagery data to determine land type for the Rocky River watershed. The watershed is mostly comprised of forest (55.43%) and hay land (33.13%) with the remaining as urban (3.75%), pasture/cattle grazing (4.22%), crop (0.40%), wetlands (0.60%), and water (0.47%) land types. Most of the hay lands are treated/fertilized with biosolid applications. There was an estimated 311 septic tanks within one mile of the Rocky River and 4 NPDES permitted wastewater dischargers with Siler City as the only major discharger. The 2008 through 2013 modeling period included wet and dry years. Climactic data was acquired through the NC State Climate Office for weather stations in Siler City, Asheboro and at the Sandhills Research Station.

The SWAT model was calibrated and validated from 2008 to 2013 for:

- Flow
- Total nitrogen (TN)
- Total phosphorus (TP)
- Dissolved oxygen (DO)
- Suspended sediment concentration (SSC)

Flow

- Calibrated at USGS gage station 2101726 - Rocky River at US 64 Near Siler City
- Validated at USGS gage station 210166029 - Rocky River headwater near Crutchfield Crossroads

Nutrients

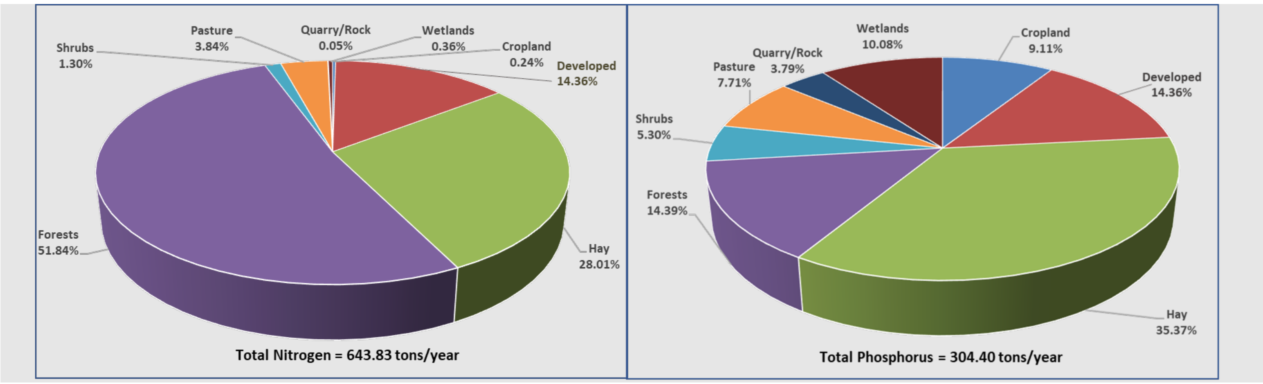
- Calibrated at UCFRBA station B5950000 at US 64 near Siler City
- Validated at AMS station B6000000 at NC 902 near Pittsboro

The results of the SWAT model include:

Nonpoint sources contributions

- The Rocky River watershed nonpoint sources contributed on average 643.83 tons/year (67.85 kg/ha/year) of TN and 304.40 tons/year (25.05 kg/ha/year) of TP during the study period. Of the total TN loads, forested land, hay land, and developed land contributed 52%, 28%, and 14%, respectively. For TP, hay lands contributed the highest amount, 35% with forested lands and developed lands contributed about 14% each (*Figure 7-77*).

Figure 7-77: SWAT Model Distribution of Total Nitrogen and Total Phosphorus from each Land Use Category in the Rocky River Watershed.



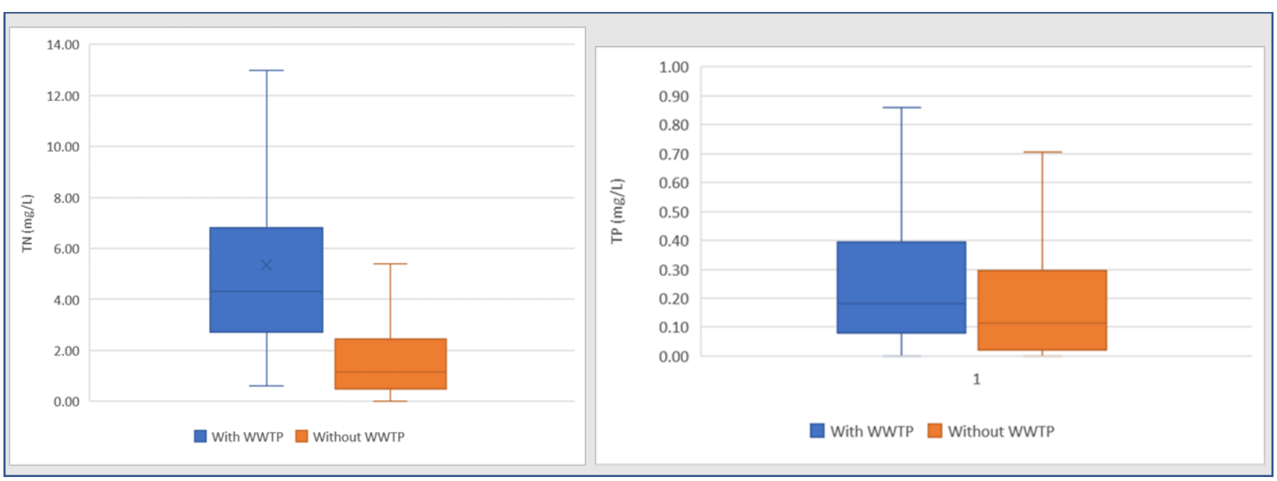
- Bio-Solid application in hay lands appeared to be a major contributor in the watershed. Approximately, 56% of TN and 71% of TP loads from the watershed were reduced when the residual application was replaced with fertilizer application as needed.

- Onsite wastewater systems delivered approximately 15% of TN annually from residential area to the Rocky River. However, delivery of TP was not apparent since soils did not get saturated with TP during the study period.

Point sources contributions (load from point sources not calculated)

- Water Quality in the Rocky River downstream from Loves Creek at ambient station B6000000 improved considerably when the Siler City WWTP effluent was removed from the model run. The average instream TN concentrations dropped 67% from 5.36 mg/L to 1.75 mg/L at B6000000. Similarly, TP dropped approximately 18% from 0.32 mg/L to 0.27 mg/L (*Figure 7-78*).

Figure 7-78: SWAT Model Average Total Nitrogen and Total Phosphorus with and without the Siler City WWTP in the Rocky River at Station B6000000 (2008-2013).



An analysis of the model results is ongoing. There is significant nutrient processing occurring in the water supply reservoirs which has resulted in excessive biological productivity and water quality impairments. Nitrogen and phosphorus reductions will be required to achieve water quality improvements in the reservoirs. An assessment of the impacts on DO will be completed as DWR continues to finalize the SWAT model and prepares a final report (personal communication Narayan Rajbhandari, July 2023).

7.7.5.8 Rocky River Watershed Summary and Recommendations

The Rocky River watershed has been identified as nutrient enriched due to the excessive periphytic growth and due to the hypereutrophic status of the two drinking water reservoirs in the upper portion of the watershed. Both reservoirs are currently listed as impaired on the 2022 IR due to high chlorophyll *a* concentrations (*Table 7-18*). The sources of nutrients vary throughout the watershed. The upper portion is mainly impacted from agricultural and bio-solid application related sources which drain to the drinking water reservoirs. There are agricultural impacts downstream of the Charles L. Turner Reservoir as well, however the main source of nutrients to the lower Rocky River mainstem is the Siler City WWTP discharge.

The Town of Siler City is in the process of upgrading and expanding their 4 MGD plant to 6 MGD which will meet very strict nitrogen limits included in their new 2022 permit renewal. The treatment plant expansion and upgrades should be completed by February 2027. Due to the town's ongoing compliance issues a Special Order of Consent (SOC) was approved by the Environmental Management Commission (EMC SOC WQ S22-003) in April 2023. The SOC draws up a clear set of expectations for treatment upgrades including sewer rehabilitation, WWTP expansion and improved treatment capabilities, and water treatment plant pretreatment and solids handling.

Siler City SOC update:
As of January 2025, DWR is in discussions with the Siler City regarding proposed amendments to the April 2023 SOC. Once finalized the updated draft SOC will go out for public comment before being finalized. For more information see section 7.7.5.

Many of the impairments throughout the Rocky River watershed are related to impacted aquatic life (bugs and fish) and instream habitat issues. Recreational uses have been impacted due to the excessive periphyton growth documented in the Rocky River as result of excess nutrients. There are many stakeholders (county, state and federal resource agencies, Siler City personnel and local citizens and conservation groups) that are working together to understand the water quality concerns and the impacts from point and nonpoint sources of pollutants throughout this watershed.

The US Fish & Wildlife Service (FWS) designated a portion of the Rocky River watershed as Cape Fear shiner critical habitat. The Rocky and Deep Rivers and their tributaries have had the highest numbers of the endangered species Cape Fear shiner (*Notropis mekistocholas*) among all waterways surveyed (*Section 7.7.5.1.4*). The NC WRC and US FWS are working together to protect and improve conditions in the Rocky River and Deep River watersheds. In 2018, the Hoosier/Woodys Dam was removed on the lower Rocky River which expanded the range for the Cape Fear shiner. The removal of the Hoosier Dam also eliminated a water quality impairment (delisted in 2020) on the Rocky River. A Rocky River Interagency Workgroup was also formed in 2021, specifically to address water quality and habitat concerns for the threatened and endangered species in this watershed.

Much of the land area in the Rocky River watershed is characterized by forestry and agriculture. Many state and local resource agencies have noted a need to investigate the extent of cattle access to streams as well as waste management and land application rates in the upper reaches of the watershed. In addition to these potential nutrient and bacterial sources, poultry processing plants closed and reopened which reintroduced a significant industrial user (SIU) to the Town of Siler City's wastewater treatment plant (WWTP) and required them to reopen their NPDES discharge permit for an interim limit for total nitrogen (TN) until upgrades can be made to their WWTP. With the reopening of the poultry processing plant, local resource agencies are concerned that there may be additional deemed permitted animal operations built in the watershed which in turn would add more nutrients to an already nutrient enriched watershed. In an effort to reduce the impacts from increased animal operations (particularly poultry), *local resource agencies are encouraged to work with the agricultural community to recommend and encourage BMPs that reduce or eliminate nutrient runoff and ensure appropriate waste utilization plans (WUPs) are in place.* *Sufficient funding also needs to be provided to existing state and federal cost share programs for technical assistance and voluntary implementation of BMPs.* BMPs should target nutrient and bacterial reductions and *include excluding cattle from streams*. In addition to BMPs, *data collection needs to be expanded*. DWR has little to no information on deemed permitted facilities. More information is needed to better understand their impact on water resources throughout the basin. Data collected could be used by an interagency workgroup consisting of water resource professionals, the agricultural community, researchers (academia), database managers, and interested community members to review the existing regulatory framework, identify which BMPs are most effective at reducing the amount of sediment, bacteria, and nutrients leaving a site, and how best to manage and track waste generated on the farm.

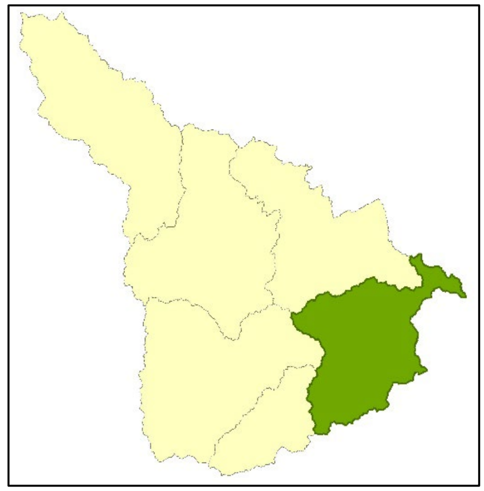
Watershed action plans are being written, stakeholder groups meet on a regular basis as well as modeling efforts are ongoing, all to improve the conditions in the Rocky River watershed and downstream in the Deep and Cape Fear rivers. *Implementation of approved watershed actions plans will be critical to improving water quality conditions*.

Additional actions and recommendations for the Rocky River watershed include:

- Preservation of riparian buffers is critically important in this watershed to protect the sensitive endangered species that need extra protections and protect the watershed from stormwater runoff.
- Siler City should continue to work with the Loves Creek Watershed Stewards and implement the watershed action plans to improve stormwater impacts and instream habitat in the Loves Creek and Rocky River watersheds.
- Stakeholders should work to find a solution to modify or remove Hackney Dam. The Hackney Dam has a significant impact on the instream water quality condition of the Rocky River during low flow conditions resulting in an impaired segment of the Rocky River.

- DWR will continue to support the efforts of the Rocky River Management Team and the Rocky River Interagency Workgroup and as resources allow, will work toward holding regular yearly meetings.
- DWR will attempt to incorporate the needs of the Rocky River watershed into the NCDP process to address excessive periphytic growth and nutrient export downstream into the central Cape Fear River.

7.7.6 Lower Deep River Watershed (0303000306)



The Lower Deep River watershed is the predominately forested final segment of the river before it joins the Haw to form the mainstem of the Cape Fear River. The Town of Goldston falls entirely within the watershed along with part of the City of Sanford. There are a little more than six miles of designated High-Quality Waters and no Outstanding Resource Waters in this watershed.

As of 2022, there is one major and three minor NPDES wastewater facilities and two single family NPDES permits with a combined as-built discharge of 13 MGD. The major NPDES discharger is the City of Sanford's Big Buffalo WWTP (NC0024147; 12 MGD), which discharges to the Deep River. The three minor NPDES dischargers are the City of Sanford's Water Treatment Plant (NCG590023), Moncure Community Health Center (NC0030384; 2,500 gpd), and the Pilgrim's Pride Sanford Processing Plant (NC0072575; 1MGD). There are no AFO facilities in this watershed.

There are 31 NPDES stormwater permitted facilities, 641.76 acres of non-discharge wastewater irrigation and residual solids land application fields, and no state stormwater facilities in this watershed. Most of the residual solids land application fields are associated with the City of Sanford (WQ000543; 336.1 acres) and Terra Renewal Services – Pilgrim's Pride (WQ0039391; 155.7 acres). There are also nine wastewater and single-family wastewater fields; the largest of those are associated with Pilgrim's Pride (WQ0014565; 78.3 acres). The rest are less than an acre. The City of Sanford also has two spray fields totaling 57.47 acres associated with the Big Buffalo WWTP (WQ0020248).

7.7.6.1 Indian Creek

The Indian Creek [AU#: 17-35] is a WS-IV classified waterway dominated by agricultural land uses, including poultry production, pasture, and many acres of fields used by the City of Sanford, Town of Apex, and the Brooks Compost Facility for the application of residual solids. Most of the forested land in the watershed appears to be in timber management. While Little Indian Creek, a tributary of Indian Creek, has not been assessed for biological or water quality impairments the mainstem Indian Creek is impaired for fish.

Fish community site BF59, drains southeast Chatham County, and is just downstream of Indian Creek's confluence with Little Indian Creek and about 1.8 miles above its confluence with the Deep River. Although the site is located in the Triassic Basins ecoregion, most of the watershed lies within the Carolina Slate Belt. It was last sampled in 2018, when biologists noted a relatively thin but forested riparian corridor and pastures bordering both riparian margins. Cattle have full access to the sample reach, especially along the left bank where a few access points exist (vegetative breaks where banks are continually trampled).

BF59	
Year	**Bioclassification**
2003	Fair
2005	Good
2013	Poor
2018	Poor

A few scoured vertical areas also exist from high flows in the upstream part of the reach. Instream habitats are mostly embedded (>50%) gravely runs, with side snag pools of various sizes, and a few small riffles. There was a relatively sparse fish community with low species richness and no intolerant taxa collected (piedmont darter was last collected at this site in 2005), with the tolerant eastern mosquitofish enduring as the dominant species (56% in 2018 vs. 70% in 2013 and 35% in 2005). In total, about half as many fish were collected in 2018 when compared to the 2013 assessment (209 in 2013 vs. 111 in 2018). However, the number of species collected in 2018 increased by two with new records for black crappie and eastern silvery minnow. Overall, the 2018 NCIBI score increased by four points (4 metric improvements and 2 metric declines among 12 total metrics), but the site was still rated Poor. This watershed continues to be impacted by sedimentation and a lack of BMP utility. Consequently, the fish community has declined substantially over the past few basin cycles (reductions in species richness, total abundance, and trophic structure), only to be replaced by a more tolerant fish assemblage. The fish community here earned this site an Excellent rating some 20 years ago, but Poor NCIBI ratings have occurred during the last two basin assessments.

7.7.6.2 Big Buffalo Creek

The Big Buffalo Creek [AU#: 17-40] is a Class C waterway in a watershed that has a varied mix of land uses. The upper and middle portions of the watershed are in the Sanford metro area and are experiencing moderate residential and industrial development. The stream is constrained in this area by homes, roads, businesses, and parking lots, in some areas right up to the edge of the stream. There is one wastewater discharge permit for a poultry processing plant that discharges to Purgatory Branch, a tributary of Big Buffalo Creek, three NPDES stormwater permits for metal fabricators, and one NPDES stormwater permit for a waste disposal service in the catchment. Sanford's Big Buffalo WWTP is also located in this watershed, although the NPDES outfall for the facility is on the Deep River. The lower portion of the Big Buffalo watershed is more forested with lighter density development and stream buffers are wider.

BF37	
Year	**Bioclassification**
2003	Fair

The stream was sampled once for fish in 2003, when fish community site BF37 rated Fair. The sample reach is adjacent to a pasture, just upstream of a road crossing and, according to aerial photos, a good portion of the buffer appears to have recently been cut. It is approximately 0.75 mi upstream of Big Buffalo Creek's confluence with the Deep River. *Land and buffer disturbances and stormwater and wastewater inputs are likely contributing to the impaired nature of the fish community, although sampling should be done at this site, as resources allow, to determine if* *this impairment persists. It is also recommended to sample for benthic macroinvertebrates and to assess the possible need for an instream ambient monitoring station in the Big Buffalo Creek subwatershed.*

7.7.6.3 Georges Creek

Georges Creek [AU#: 17-41] is Class C headwater stream in southeastern Chatham County about nine miles south of Pittsboro. This highly forested watershed (82%) also has a fair number of animal operations in the catchment including pastures immediately adjacent to the sampling reach.

2003	Not Rated
2009	Good-Fair
2018	Good-Fair

Benthic macroinvertebrate sampling in 2018 resulted in the second consecutive Good-Fair rating at station BB368. This station was sampled in the spring to reduce the summer low-flow effects on the benthos seen in other Slate Belt lotic systems, 16 EPT were collected from this reach. The EPT community is intolerant as a whole and includes some taxa seen only in slate belt streams such as the stonefly *Isoperla borisi* and taxa only collected from small headwater streams like the caddisfly *Neophylax atlanta*. Other taxa collected, like the caddisfly *Ironoquia puntatissima*, are intermittent stream indicators suggesting that flows in Goerges Creek are highly reduced or may cease entirely during drought years. Georges Creek rated Good-Fair in 2009 after being Not Rated in 1993 and 2003. This site had a low EPT biotic index compared with other streams in this area suggesting an intolerant macroinvertebrate community here. A high habitat score balances out the fact that this site has a hydrology that includes flow stoppages in drier years.

7.7.6.4 Little Buffalo Creek

Little Buffalo Creek [AU#: 17-42] is a Class C waterway in a rapidly urbanizing watershed. The upper portions of the stream flow through the middle of Sanford with little to no buffer in these areas. As it flows downstream, Little Buffalo Creek bisects the Sanford Municipal Golf Course and then an industrial area that includes oil, brick and tile, and glass and concrete product manufacturers. It is then impounded approximately 1.2 miles upstream of its confluence with the Deep River. The last stretch of Little Buffalo Creek after the impoundment is the only portion of this stream that has intact forested buffers.

BB291	
Year	**Bioclassification**
2003	Not Rated

Little Buffalo Creek was sampled once for benthos in 2003, when benthic community site BB291 received a bioclassification of Not Rated. Biologists noted that instream substrate was 90% sand and 5% silt, indicating likely impacts from development and other land disturbing activities. The overall habitat assessment score was 41 out of 100 and EPT BI was 6.66, indicating a poor community structure. Specific conductance was elevated (144 µS/cm), likely due to excessive stormwater runoff in this catchment area. This stream continues to experience significant impacts from development pressure in the Sanford area. Little Buffalo Creek is listed as Category 3a (Data Inconclusive) for benthos. *The benthos community should be resampled as resources allow to determine if the stream should be impaired for benthic macroinvertebrates.*

7.7.6.5 Deep River in the Lower Deep River Watershed

The Deep River in the Lower Deep River watershed [AU#: 17-(28.5)a, 17-(28.5)b, 17-(32.5), 17-(33.5), 17-(36), 17-(36.5), 17-(38.3), 17-(38.7), 17-(43.5)] spans from the McLendons Creek confluence with the Deep River to the Deep River confluence with the Cape Fear River. This section of the Deep River has several water classifications as it flows across the landscape based on the best intended uses of the river. The upstream sections [AU#: 17-(28.5)a, 17-(28.5)b, and 17-(32.5)] of the Deep River in this watershed are a WS-V or WS-IV with a supplemental classification of high quality waters. The middle sections [AU#: 17-(33.5), 17-(36), 17-(36.5), and 17-(38.3)] of the Deep River in this watershed are classified as WS-IV and as the waterway approached the currently inactive Town of Gulf-Goldston and Lee County water supply intakes it picks up the CA classification. The last two sections of the Deep River are either classified as Class C [AU#: 17-(38.7)] or WS-IV [AU#: 17-(43.5)] waterways as it approached the confluence with the Haw River to form the Cape Fear River. There are four surface water quality monitoring stations along Deep River in this watershed from upstream to downstream. These stations are identified by the following station names B5575000, B5685000, B5820000, and B6040300. These four surface water quality monitoring station aid in understanding the impacts from both point and nonpoint sources of pollution influencing the water quality in the Deep River.

The upstream sections of the Deep River in this watershed from the confluence of McLendons Creek with the Deep River to N.C. Hwy. 42 [AU#: 17-(28.5)a, 17-(28.5)b, and 17-(32.5)] is dominated by agricultural and forested land uses. While the area is predominantly forested, a large swath of that is in timber management, with areas in various stages of regeneration. Buffers along long stretches of the river in this section appear to be only one or two trees wide, with the City of Sanford residual solids spray field (Permit# WQ0000543) extending almost to the banks. This stretch of the Deep River is monitored by station B5575000. In 2005 the Carbonton Dam was removed from this section of the Deep River.

The middle section of the Deep River in this watershed from N.C. Hwy. 42 to the inactive Lee County water supply intake [AU#: 17-(33.5), 17-(36), 17-(36.5), and 17-(38.3)] does not have surface water quality monitoring stations. The drainage area of this section of the Deep River is also dominated by agricultural and forested land uses with several locations for the Terra Renewal Services - Pilgrim's Pride residual solids spray field (Permit# WQ0039391). The Town of Gulf-Goldston and Lee County water supply intakes are no longer in use and those systems purchase water from the City of Sanford. Only the Pilgrim's Pride Water System (Facility ID: 0285-0007) has a non-transient and non-community water intake in this section of the Deep River.

The downstream section of the Deep River [AU#: 17-(38.7)] is a Class C waterway spanning from the inactive Lee County water supply intake to a point 0.4 mile upstream of Rocky Branch. This drainage area is dominated by forested land uses with some agriculture. The Pilgrim's Pride Poultry Processing Plant is in the upper end of this assessment unit and includes the plant property, a large residual solids spray field (NPDES permit #WQ0014565), and an industrial process and commercial wastewater discharge outfall to the river (NPDES permit #NC0072575).

The last downstream section [AU#: 17-(43.5)] is a WS-IV from a point 0.4 mile upstream of Rocky Branch to Cape Fear River. The Wake Stone Corporation Moncure facility (NPDES permit #NCG020003) is located in this assessment unit, and the edge of the quarry property comes as close as 135 feet from the riverbank.

The permit for this facility was renewed in 2021. The historic Lockville Hydropower Dam, owned by Brooks Energy LLC in Goldston NC, is also located in this AU, directly adjacent to the Wake Stone Moncure Quarry. Built in 1922 to replace another dam at the same location, the FERC-exempt Lockville Dam was unintentionally breached on April 19, 2023. The breach is approximately 40-50 feet wide, and the entire river is now passing through the breach. Consequently, American Rivers recently received NOAA grant funding to remove several dams in the Cape Fear Basin, including the Lockville Dam (personal communication). Notably, the most downstream section of the Deep River [AU#: 17-(43.5)] listed as Category 3a (data inconclusive) for dissolved chronic chromium, dissolved chronic copper, dissolved chronic lead, dissolved chronic nickel, dissolved chronic silver, dissolved chronic zinc, 1,4-dioxane, and turbidity.

1,4-Dioxane was sampled three time between July 18 and August 15, 2018, at stations B6040300 (at old US1) in a WS-IV portion of the Deep River. Two of the three samples were above the PQL of 1 µg/L (1.6 and 1.7 µg/L) exceeding the EPA health-based drinking water concentration representing a 1-in-a-million (1×10^{-6}) cancer risk level for 1,4-dioxane of 0.35 µg/L (EPA IRIS, 2013).

Overall water quality along the Deep River in the Lower Deep River watershed (HUC10: 0303000306) is currently meeting available water quality criteria. Although water quality criteria are being met, there are changes in the water quality as viewed from upstream to downstream. The median pH and mean dissolved oxygen levels from upstream to downstream are interesting as both the most upstream station B5575000 and most downstream station B6040300 typically have the highest annual median or mean values compared to stations B5685000 and B5820000 located in-between the two (*Figure 7-79* and *Figure 7-80*). Notably, station B5820000 located between the most upstream and downstream stations has recorded several dissolved oxygen samples that were below the 4 mg/L water quality standard in 2009, 2010, and 2017 (*Figure 7-81*). The pH values recorded at stations B5685000 and B5820000 occasionally recorded exceedances of the pH water quality standard, however, the most recent occurred between 2008 and 2011 with typically a 6% annual exceedance rate.

The changes in pH and dissolved oxygen water quality are most likely influenced by sampling differences between the stations where data is collected. Station B5575000 is monitored monthly by the Division of Water Resource; however, prior to 2005 the UCFRBA had a co-located station collecting monthly samples. The next two stations, B5685000 and B5820000 are monitored monthly and then twice a month during the months of May – September. The lower flow conditions during the summer months and the increased sampling frequency could be a reason the lower pH and dissolved oxygen reading occur at these two stations compared to the upstream station B5575000. Further downstream, station B6040300 is monitored by both the Division of Water Resources and the UCFRBA which provides more data throughout the year and while the pH and dissolved oxygen levels are not as low adjacent stations, the higher values could be attributed to flashy streamflows from the adjoining Rocky River and the increased monitoring year-round. Other possible contributing factors include unknown nonpoint sources and/or natural conditions in the adjoining tributaries including Indian Creek, Smiths Creek, Pocket Creek, Patterson Creek, and Cedar Creek. Notably, since the removal of the Carbonton Dam at the end of 2005 the dissolved oxygen levels at station B5575000 have remained above 4 mg/L indicated by no exceedance of the water quality standard (*Figure 7-81*).

Turbidity is a water quality parameter of concern in this stretch of the Deep River due to the frequency of samples which exceed the turbidity water quality standard of 50 NTU. Based on the annual exceedance rates, station B5575000 has approached or exceeded the turbidity water quality standard during as much as 25% of the samples collected in 2010 and 2012 (*Figure 7-82*). The remaining stations in this watershed do not have annual exceedance rates quite that high, however, at least one turbidity exceedance was recorded at every station during nine out of the past 19-years on record (*Figure 7-82*).

One of the most concerning water quality parameters in this section of the Deep River is fecal coliform bacteria levels. During most years, every station recorded at least one exceedance of the water quality standard, with the highest exceedances rates observed at stations B5685000 and B5820000. Annual exceedance rates at those two stations have reached greater than 40% in the years 2008 and 2020 (*Figure 7-83*). There is also a considerable increase in the annual mean fecal coliform bacteria concentrations between stations B5575000 and B5685000 (*Figure 7-84*). The nonpoint sources that maybe contributing to elevated fecal coliform levels include, but not limited to the residual solids land application fields along the Deep River, single-family residence wastewater irrigation systems, and/or possible septic tanks. A review of the enforcement cases for both Pilgrim's Pride Corporation (NC0072575) and Big Buffalo WWTP (NC0024147) records the last fecal coliform bacteria permitted limit exceedance that proceeded to enforcement occurred in 2011 for Pilgrim's Pride Corporation. Since these are not Class B water, a 5-in-30 study for fecal coliform bacteria has not been prioritized due to limited resources. *Monitoring should continue at these four stations and localized investigations into the adjoining tributaries to understand the sources of elevated fecal coliform bacteria should be considered.*

Nutrients (total nitrogen and phosphorus) in the Deep River are also a water quality parameter of concern. Annual mean total nitrogen and total phosphorus concentrations are considerably higher than the concentrations considered normal for healthy Piedmont streams (TN $\leq$ 0.8 mg/L, TP $\leq$ 0.05 mg/L). The annual mean total nitrogen concentrations at stations along this section of the Deep River display a considerable increase in annual mean values between stations B5685000 and B5820000 which coincides with a section of the Deep River with several point source discharger's return flows, as well as adjoining tributary flows from Big Buffalo Creek and Georges Creek (*Figure 7-85*). This considerable increase is also pronounced in the annual mean NOx concentrations between these two stations (*Figure 7-86*). Notably, in 2020 the upstream station B5685000 had a higher annual mean total nitrogen concentration than the downstream station B5820000 and the annual mean NOx concentrations at both stations were similarly below 0.5 mg/L, which is the first year that has occurred (*Figure 7-85* and *Figure 7-86*). These concentrations are still higher than the concentrations considered normal for healthy piedmont streams (NOx $\leq$ 0.3 mg/L)

The annual mean total Kjeldahl nitrogen concentrations do not show as large of a change in concentration between these two stations, however the concentrations do typically increase between station B5685000 and B5820000, except in 2020 (*Figure 7-87*). Ammonia is a component of the total Kjeldahl nitrogen concentrations, which also typically increases in concentration between those two stations (B5685000 and B5820000 in the Deep River based on annual mean values, except in 2013 (*Figure 7-88*). Similar to the annual mean total nitrogen concentrations, annual total phosphorus concentrations display a considerable increase in annual mean values between stations B5685000 and B5820000 (*Figure 7-89*).

The considerable increase in nutrients alongside contributing streamflow from Indian Creek, Smiths Creek, Pocket Creek, Patterson Creek, Cedar Creek, Little Buffalo Creek, and Rocky River influence the difference the annual mean nitrogen and phosphorus concentrations between the upstream and downstream in this watershed. The most likely influences are both point and nonpoint sources, as well as adjoining tributaries. *Reductions in all the nitrogen and phosphorus species should be pursued to reduce the total nitrogen and total phosphorus concentrations in the Deep River.*

Between July 18 and August 15, 2018, the Deep River at station B5575000 (WS-IV; HQW) in Carbonton was monitored for 1,4-dioxane three times. All three samples exceeded the EPA health-based drinking water concentration representing a 1-in-a-million (1 x10^{-6}) cancer risk level for 1,4-dioxane of 0.35 µg/L (EPA IRIS, 2013). The samples ranged between 1.4 and 1.9 µg/L. Further downstream in the Deep River at station B6040300 (WS-IV) near Moncure at old highway US 1, two of the three were above the PQL of 1 µg/L (1.6 and 1.7 µg/L). DWR will continue to work with upstream dischargers to identify and reduce the source of 1,4-dioxane at the source of the contaminant. For more information on 1,4-dioxane and other emerging contaminants, see Chapter 2 (section 2.13.2) and Chapter 13 for summary tables and figures for 1,4-dioxane in the Cape Fear River Basin between 2016 and 2024.

Alongside the annual mean and median concentrations presented above, station B6040300 has a co-located USGS gage which allows for an analysis of the water quality paired with the flow dynamics of the Deep River. At station B6040300 the pH, NOx, specific conductance, and total phosphorus concentrations are typically higher during the lower flow periods (≤ 177 cfs) and lower during higher flow periods (≥ 1,100 cfs) (*Figure 7-90*). This could suggest point sources are influencing the water quality during lower flow periods as low flow conditions are most influenced by these sources of pollution. During higher flow periods the contribution of stormflows with lower concentrations of these parameters is aiding in diluting these concentrations in the streamflow.

Dissolved oxygen, fecal coliform, turbidity, total nitrogen, total Kjeldahl nitrogen, and ammonia concentrations are typically highest during higher flow periods (≤ 1,100 cfs) and lower during lower flow periods (≥ 177 cfs) (*Figure 7-90*). This could suggest that stormflows are mobilizing fecal coliform bacteria and turbidity from nonpoint sources across the landscape which ultimately flow into the Deep River alongside water with higher concentrations of dissolved oxygen. These stormflows are also bringing waters with higher organic nitrogen and ammonia concentrations increasing the total nitrogen concentrations in the Deep River.

Figure 7-79: Annual Median pH levels for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

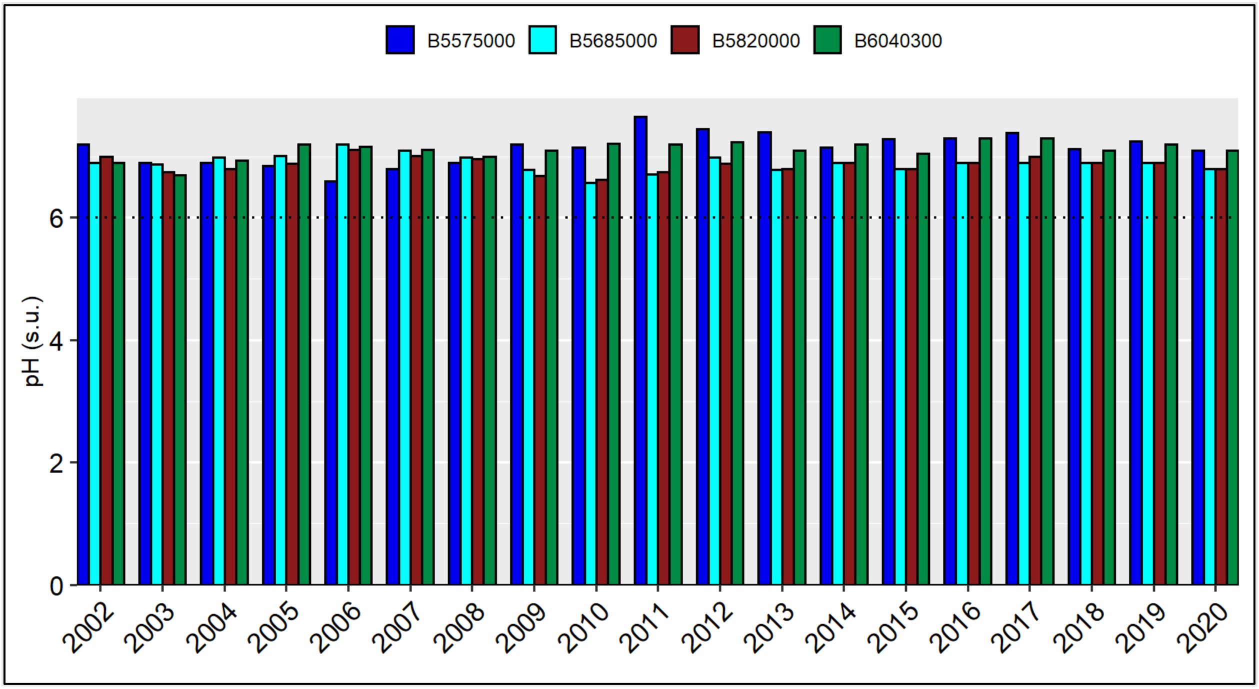


Figure 7-80: Annual Mean Dissolved Oxygen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

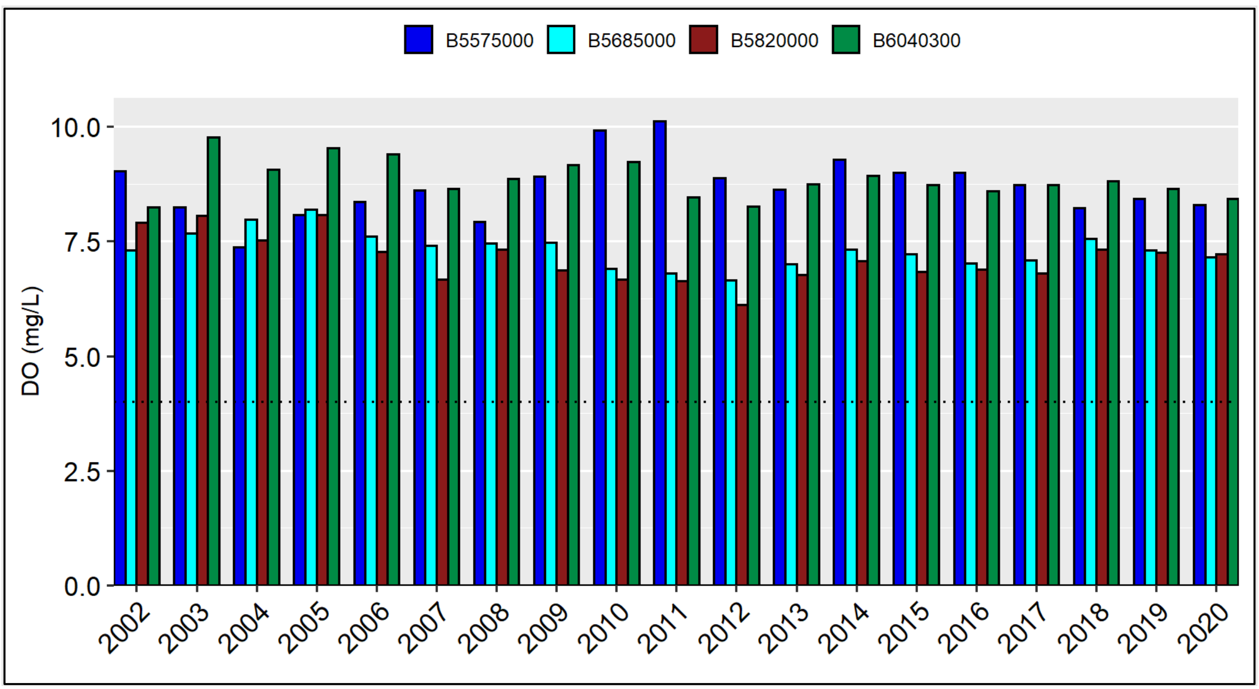


Figure 7-81: Annual Dissolved Oxygen Exceedance Rates for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

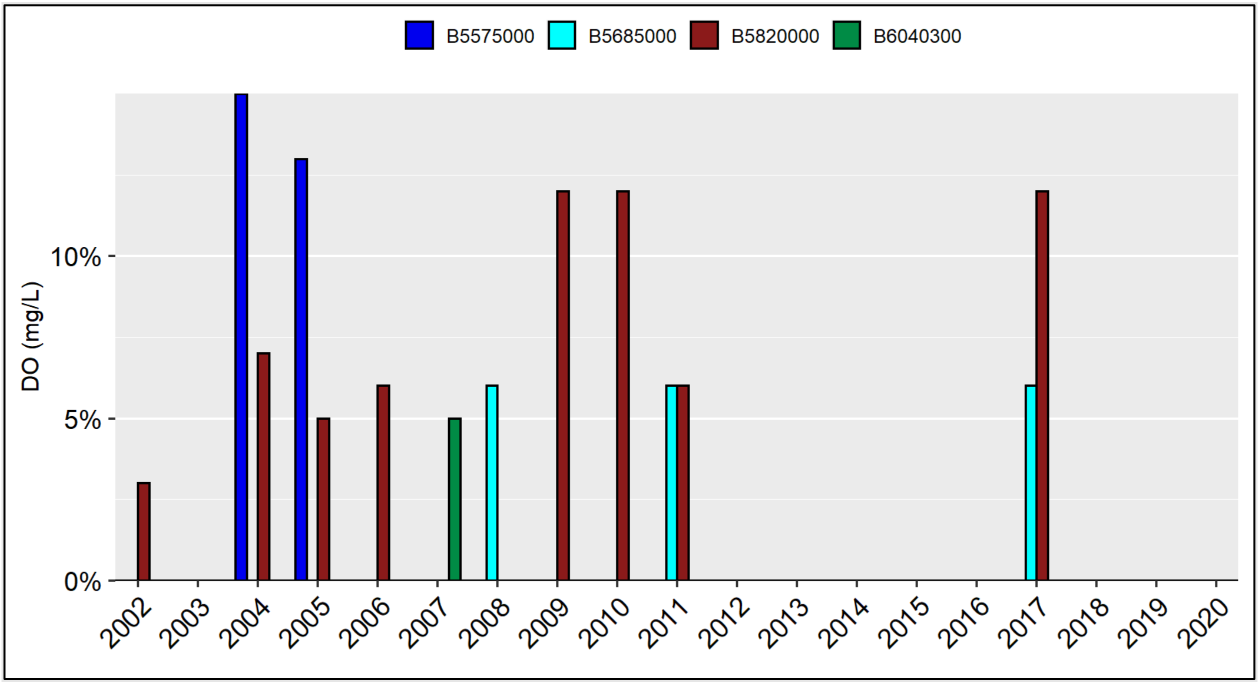


Figure 7-82: Annual Turbidity Exceedance Rates for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

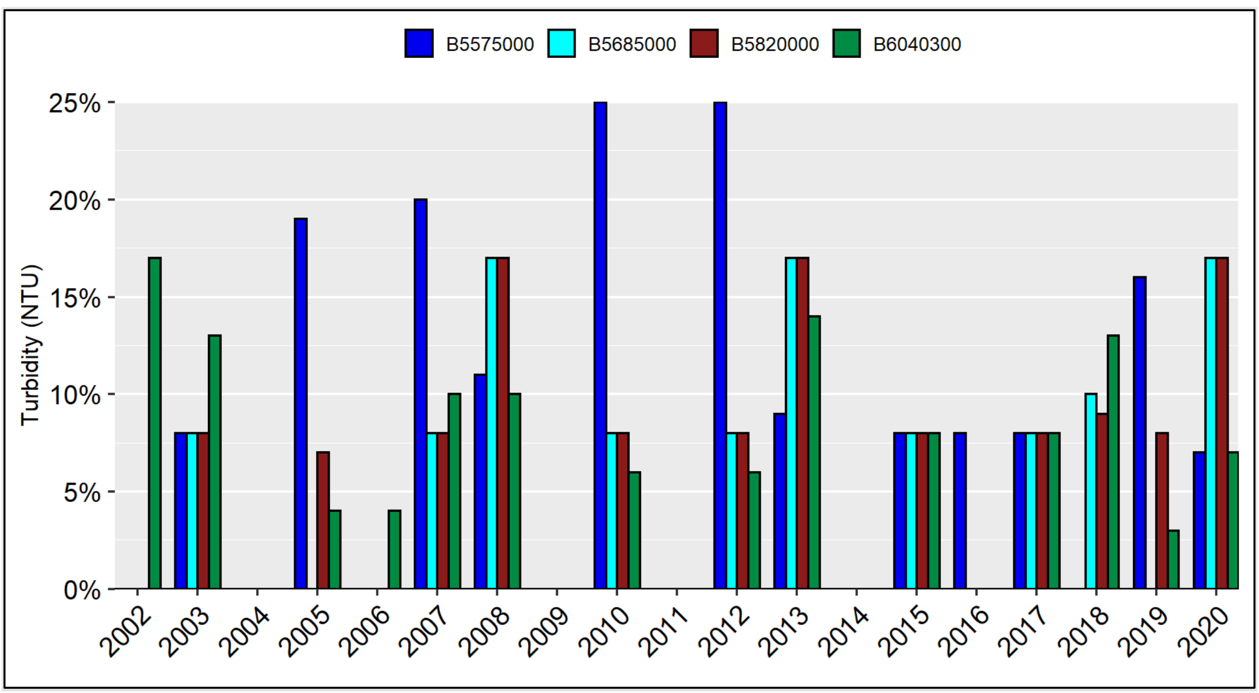


Figure 7-83: Annual Mean Fecal Coliform Bacteria Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

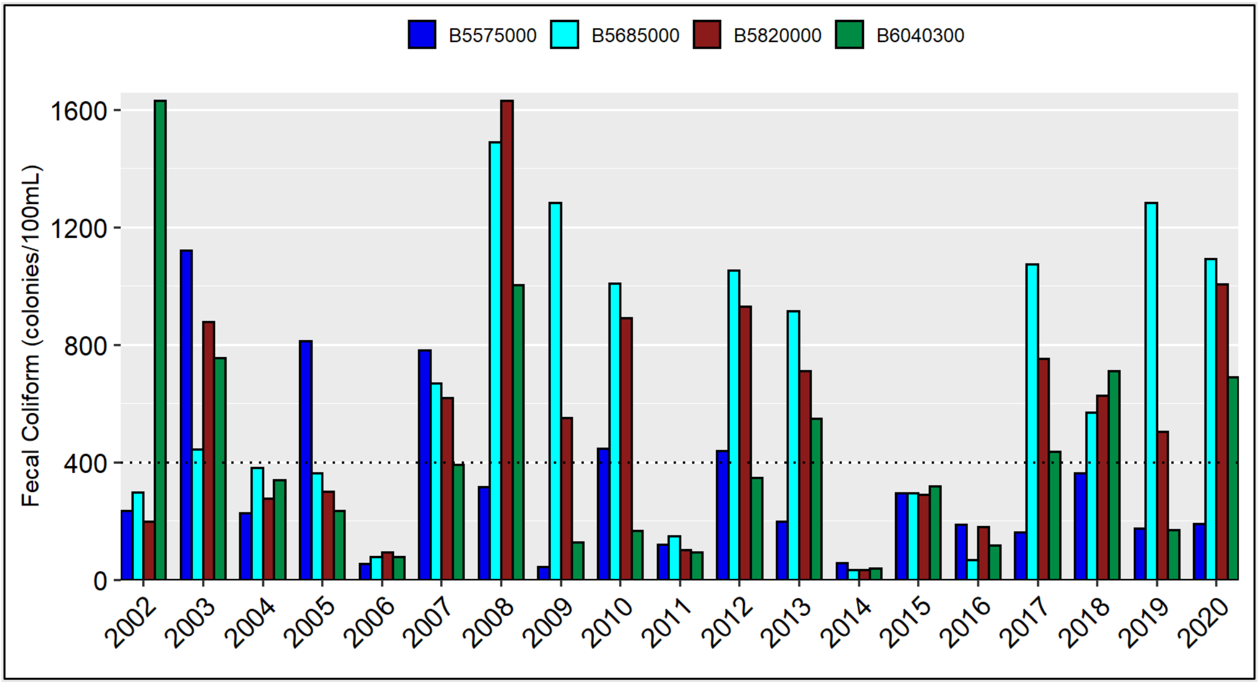


Figure 7-84: Annual Fecal Coliform Bacteria Exceedance Rates for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

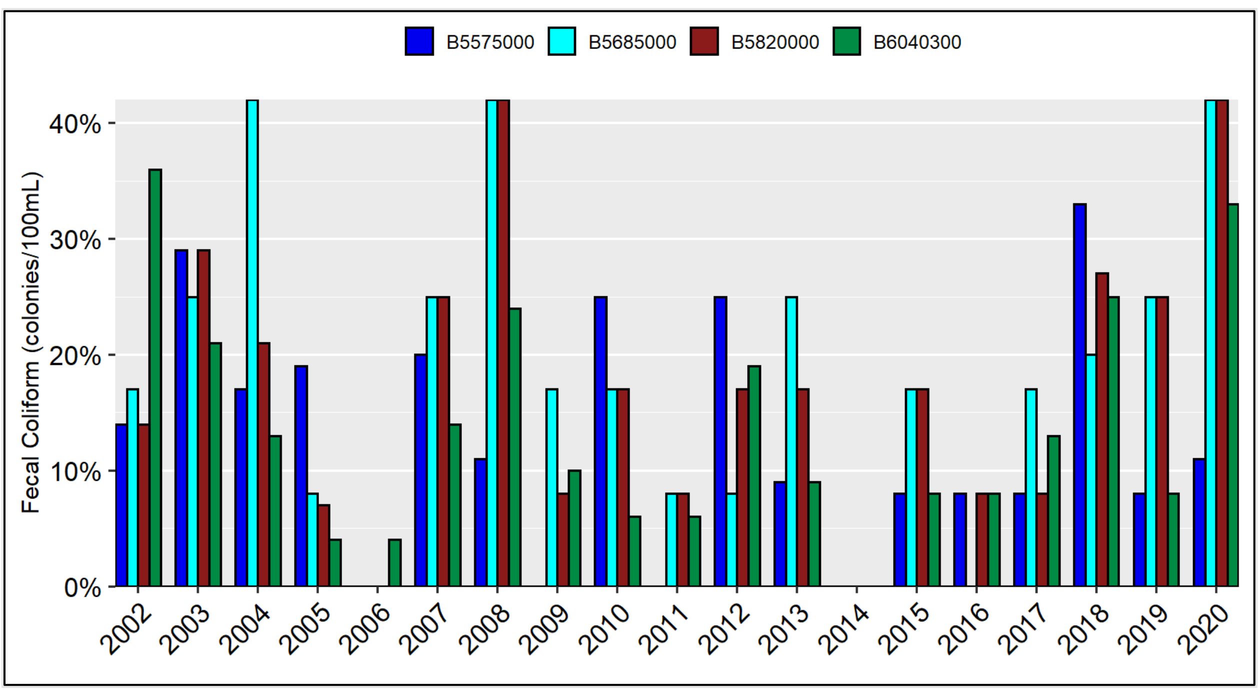


Figure 7-85: Annual Mean Total Nitrogen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

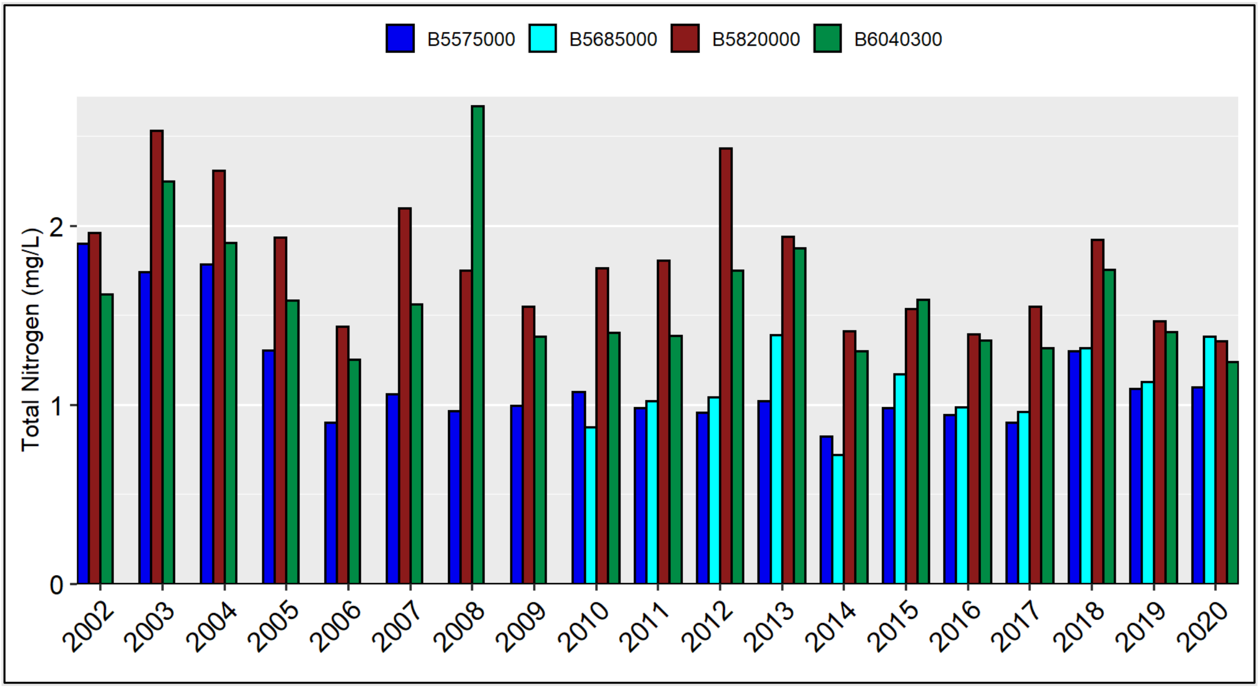


Figure 7-86: Annual Mean Nitrate+Nitrite Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

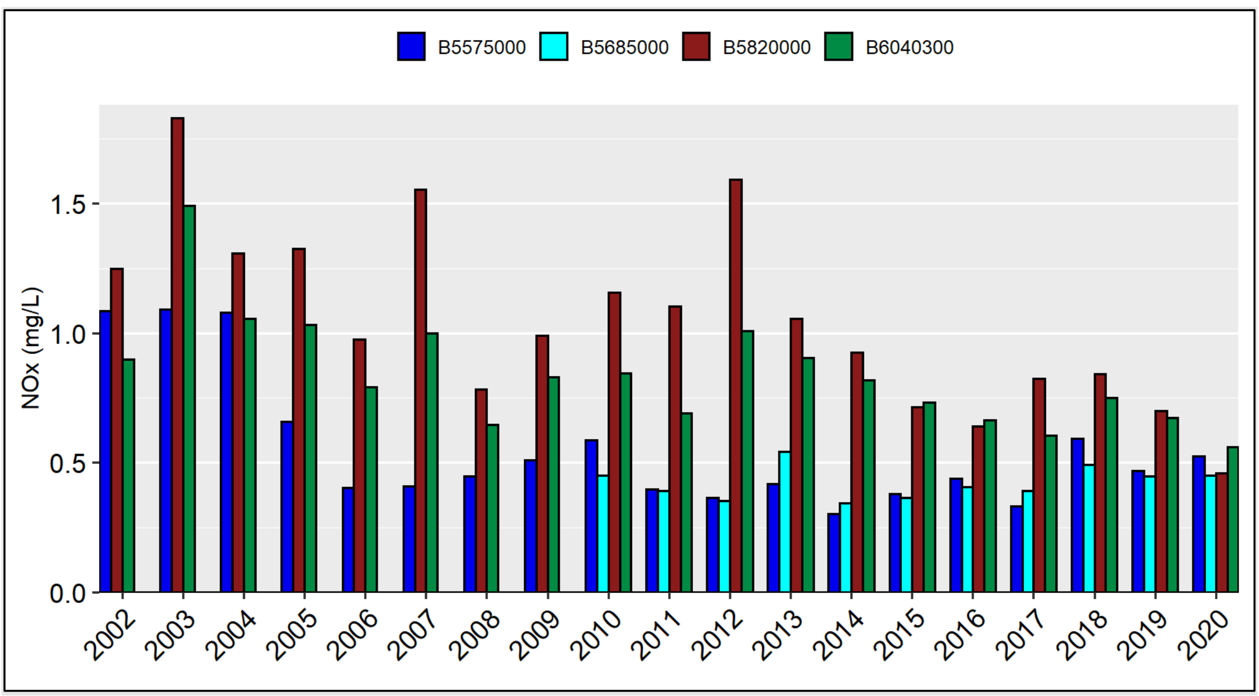


Figure 7-87: Annual Mean Total Kjeldahl Nitrogen Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

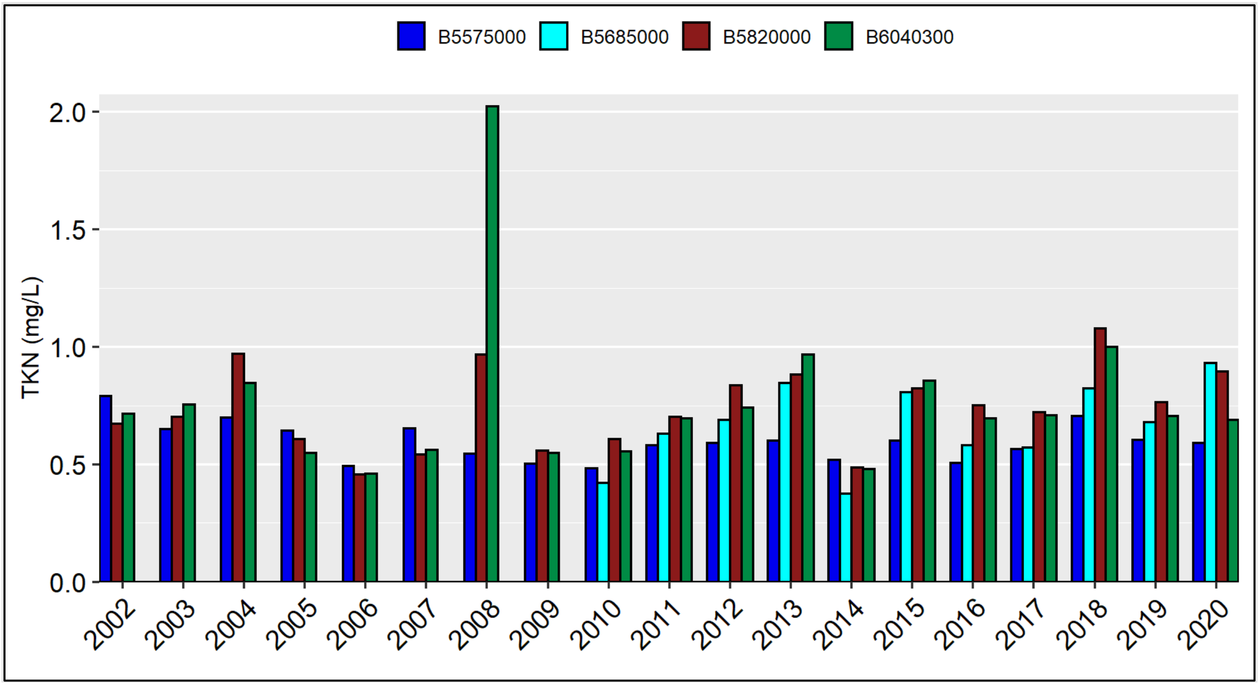


Figure 7-88: Annual Mean Ammonia Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

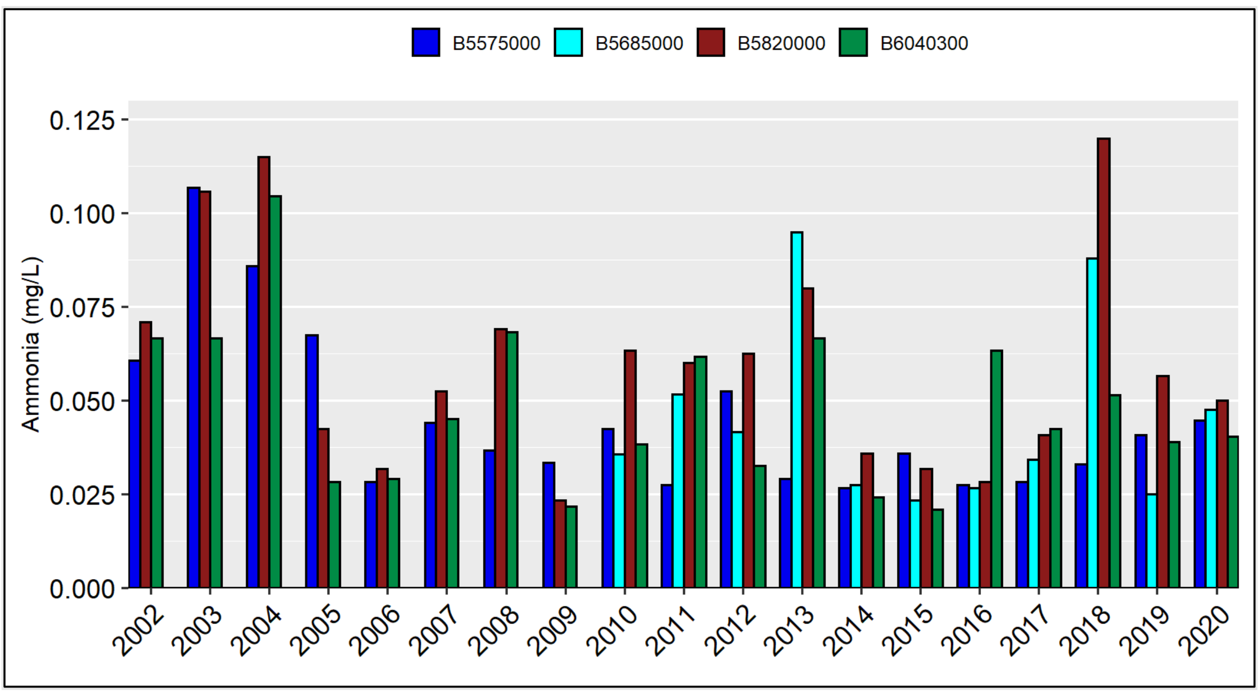


Figure 7-89: Annual Mean Total Phosphorus Concentrations for Ambient Water Quality Stations along the Deep River from Upstream to Downstream (B5575000, B5685000, B5820000, B6040300).

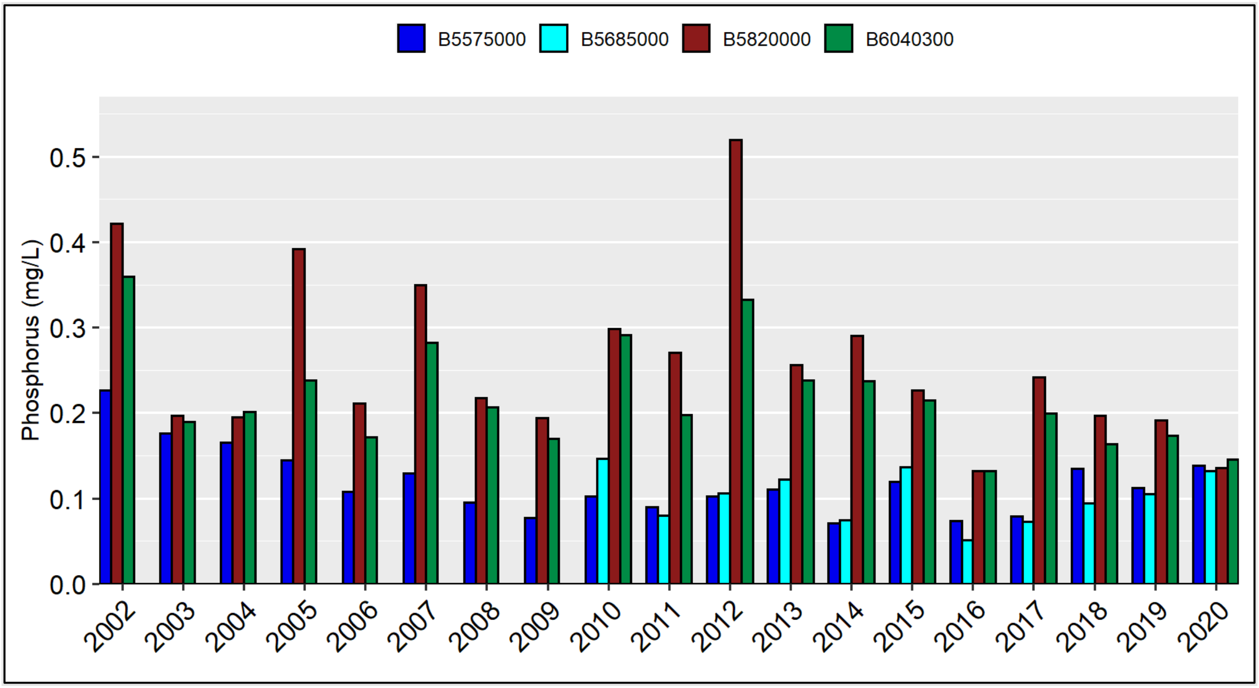
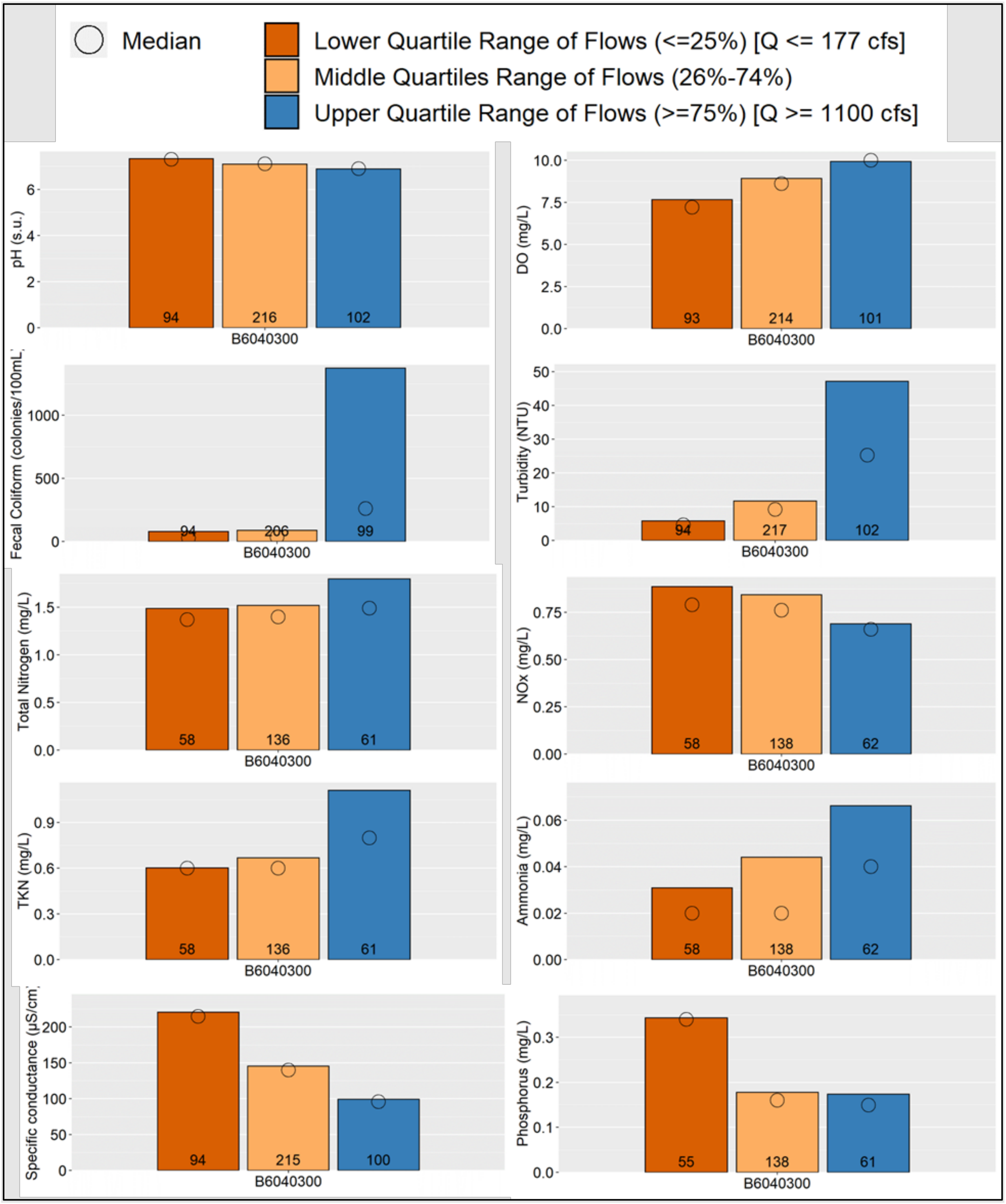
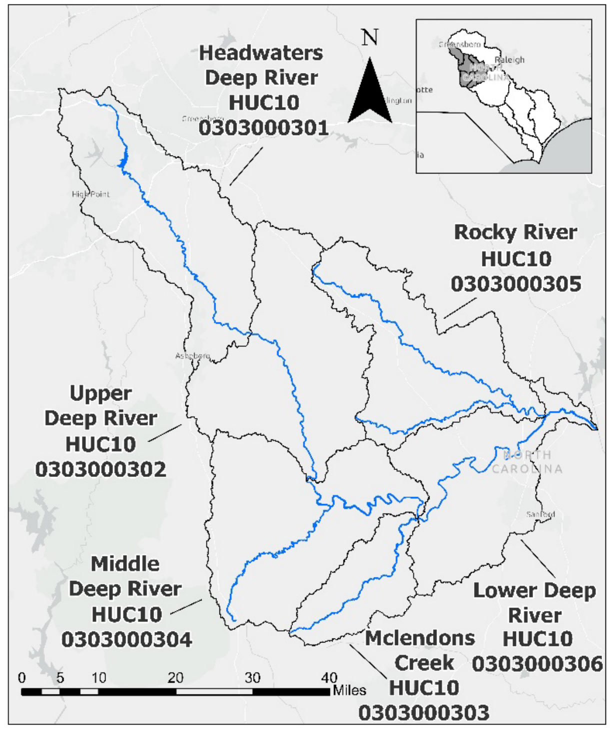


Figure 7-90: Average and Median Values for Water Quality Data Collected at Station B6040300 between 2002 and 2020 Separated into Flow Bins based on Discharge Percentiles using data Collected Between 1991 and 2020 at USGS Gage 02099000.



7.8 Deep River in the Deep River Subbasin Summary



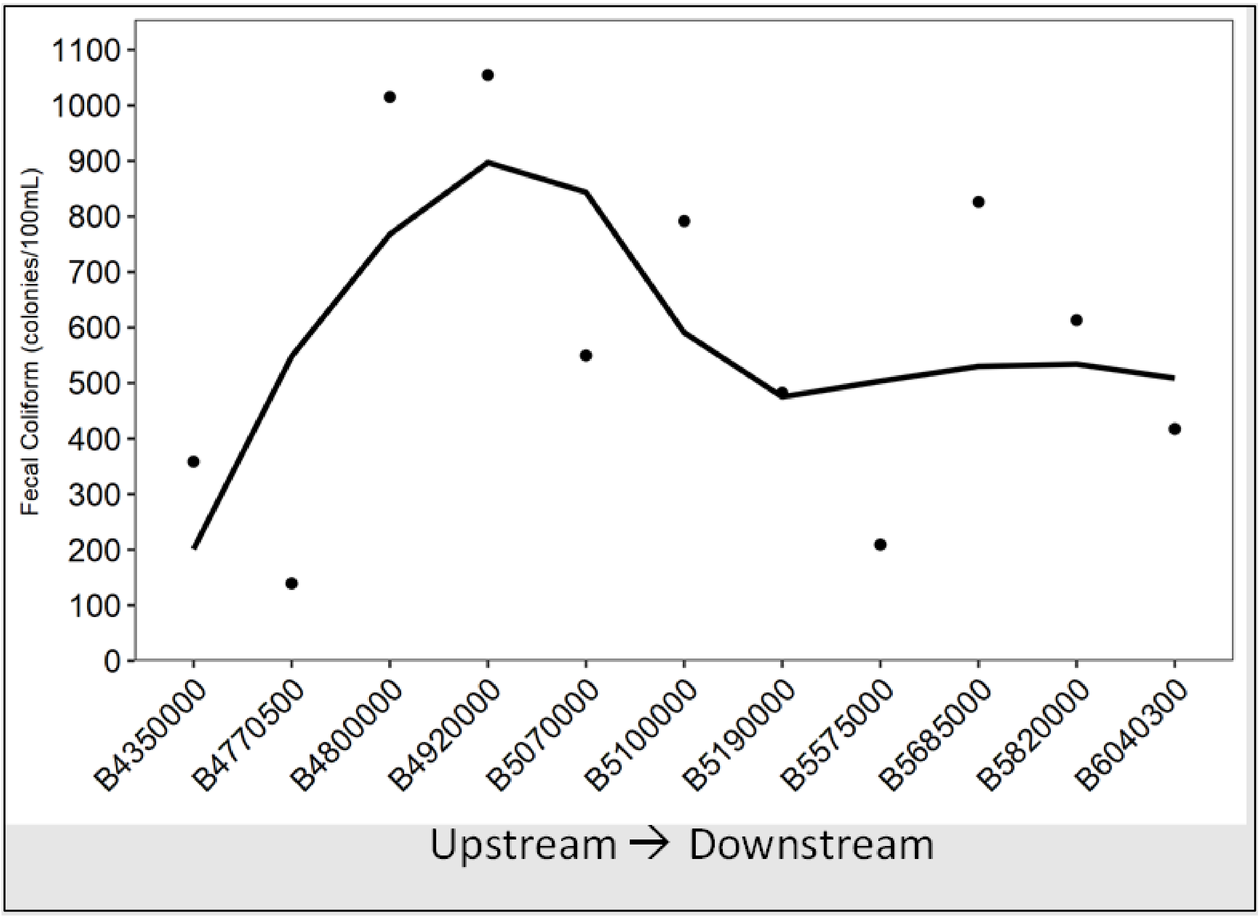
Eleven (11) ambient surface water quality monitoring stations are positioned along the entire length of the Deep River. These stations span nearly the entire length of the Deep River and represent the water quality in the Deep River across each of the four HUC10 watersheds that the Deep River flows through before joining the Haw River to form the Cape Fear River. These stations have also been monitored regularly between 2016 and 2020, providing an understanding of water chemistry changes along the Deep River. Station B6040300 is monitored by both DWR and the UCFRBA, so results from both programs are used in this analysis which means twice as many results were used to calculate the mean values presented in the figures below.

The West Fork Deep River which flows into Oak Hollow Reservoir and the East Fork Deep River which flows into High Point Lake are headwater streams which come together to form the Deep River. These two headwater waterways have elevated fecal coliform bacteria levels which potentially influence the water quality in the Deep River. This is reflected in the elevated fecal coliform bacteria concentrations in the most upstream surface water quality monitoring station B4350000 which had a five-year mean value of 359 colonies/100 mL, which is slightly lower than the 400 colonies/100 mL water quality standard (*Figure 7-91, Table 7-41*). Additionally, the East Fork Deep River and the Deep River downstream from station B4350000 have established TMDLs for fecal coliform bacteria (*Table 7-13*). The next station downstream is B4770500, is directly downstream from the Randleman Reservoir. This station displays a considerably lower fecal coliform bacteria five year mean value most likely as the result of dilution (*Figure 7-91, Table 7-41*). Notably, several adjoining tributaries to the Randleman Reservoir have TMDLs for fecal coliform bacteria including the Deep River, Richard Creek, and Muddy Creek (*Table 7-13*).

The next downstream stations are B4800000 and B4920000 which receive additional streamflow from Polecat Creek and Haskett Creek downstream from the Randleman Reservoir outlet. The combined influence of point and nonpoint sources of pollution in those waterways contribute to the elevated fecal coliform bacteria levels recorded at these two stations during the 2016-2020 time frame (*Figure 7-91, Table 7-41*). These five-year mean fecal coliform bacteria levels sustain values that are above the 400 colonies/100 mL water quality standard through much of the Deep River as recorded at stations B4920000, B5070000, B5100000, and B5190000 (*Figure 7-91, Table 7-41*). Downstream from station B5190000, the fecal coliform bacteria concentrations decline to levels below 400 colonies/100 mL at station B5575000. Bear Creek is the only tributary monitored for fecal coliform bacteria between these two stations and as noted previously this waterway has elevated fecal coliform bacteria concentrations with at least one measured value exceeding the 400 colonies/100 mL water quality standard each year since the year 2016. While elevated fecal coliform bacteria concentrations are recorded, the annual means are often below the 400 colonies/100 mL water quality standard.

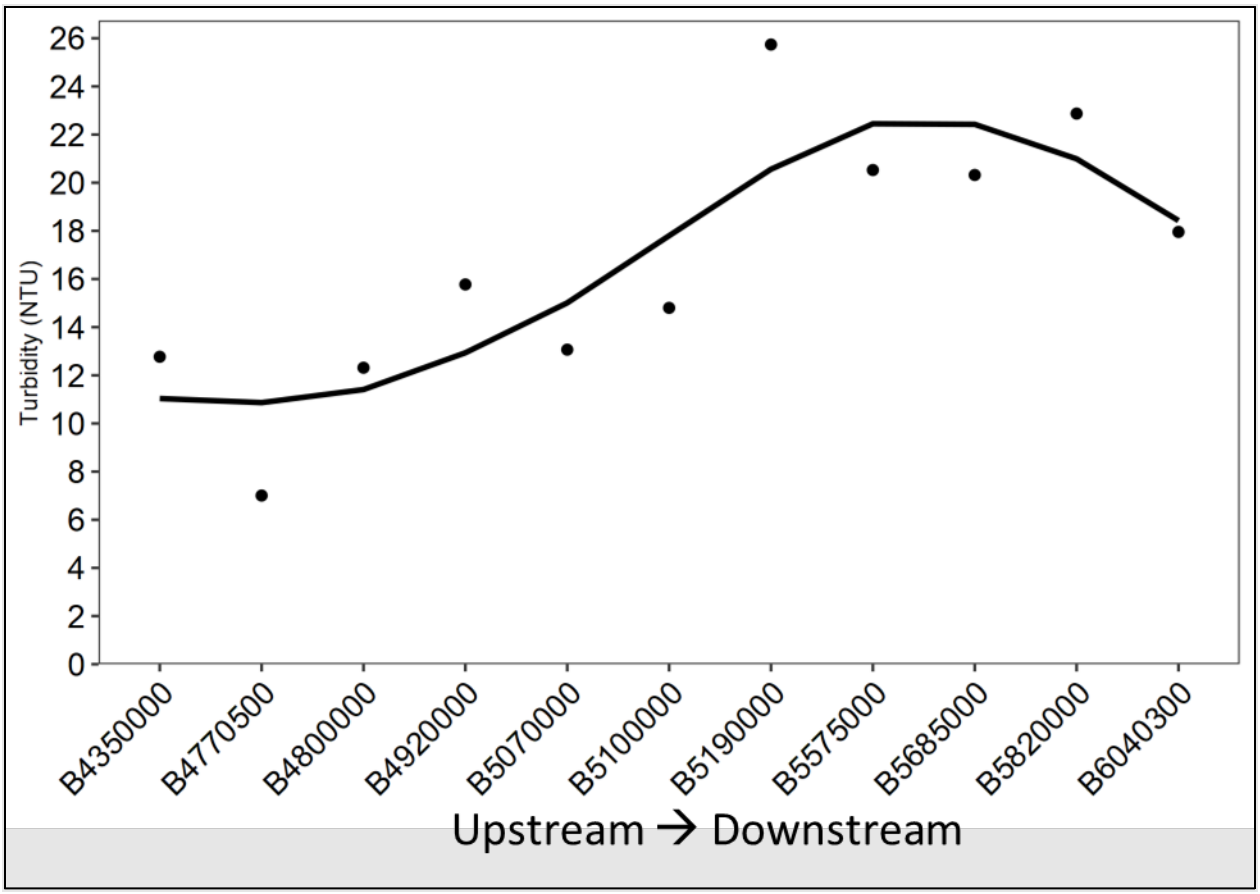
The next three downstream stations (B5685000, B5820000, and B6040300) have five-year means above the 400 colonies/100 mL water quality standard (*Figure 7-91, Table 7-41*). The most downstream station B6040300 on the Deep River receives streamflow from all the major adjoining tributaries in the Deep River subbasin. There is an observable increase in five-year mean fecal coliform bacteria concentrations between stations B5575000 and B6040300 suggesting the point and nonpoint sources of pollution in the drainage area between these two stations are contributing to these elevated levels. As noted previously, possible nonpoint sources of pollution that maybe contributing to elevated fecal coliform levels include, but not limited to the residual solids land application fields along the Deep River, single-family residence wastewater irrigation systems, and/or possible septic tanks.

Figure 7-91: Deep River Mainstem 2016-2020 Five-Year Means for Fecal Coliform Bacteria.



Overall turbidity along the entire span of the Deep River is variable. The headwaters of the Deep River comprised of the West Fork Deep River and East Fork Deep River are influenced by pulses of elevated turbidity driven by stormwater as discussed previously. In 2006, Oak Hollow Reservoir was listed on the impaired waters list for turbidity; however, it has since been removed. Additionally, the East Fork Deep River has a total maximum daily load for turbidity (*Table 7-13*). Both the Oak Hollow Reservoir and High Point Lake are beneficial in capturing and settling portions of the elevated turbidity pulses from the developed areas of Greensboro and High Point. The Randleman Reservoir also aids in reducing the turbidity levels as recorded at station B4770500 (*Figure 7-92, Table 7-41*). East Fork Deep River, West Fork Deep River, Long Branch, Hickory Creek, record both stressed fish and benthos communities likely impacted by sedimentation, urbanization, and habitat degradation. Downstream from station B4770500, turbidity levels fluctuate between increasing and decreasing; however, five year means generally increase from upstream to downstream (*Figure 7-92, Table 7-41*). Notably, the five-year mean turbidity values do not exceed the 50 NTU water quality standard, although stations B5190000 has a five-year mean value that are slightly more than half of that water quality standard value (*Figure 7-92, Table 7-41*). The most downstream water quality monitoring stations B5190000, B5575000, B5820000, and B6040300 record the highest five-year mean values (*Figure 7-92, Table 7-41*).

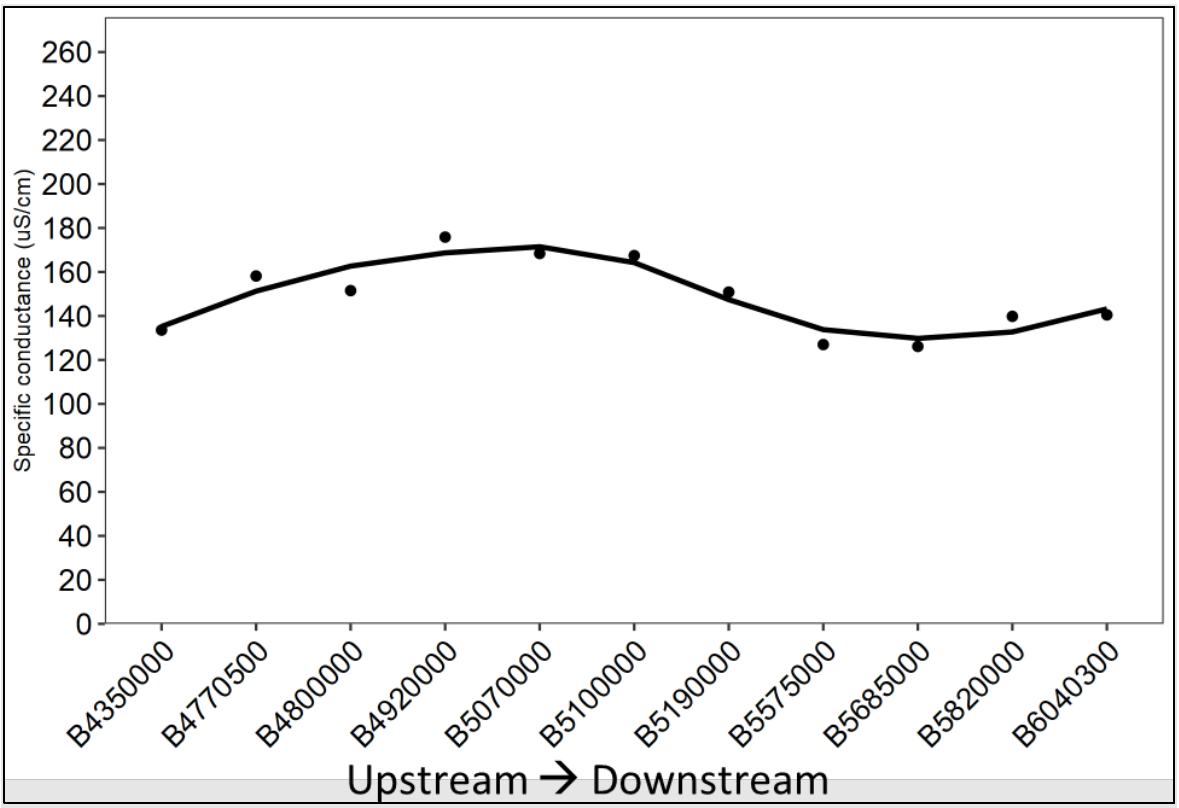
Figure 7-92: Deep River Mainstem 2016-2020 Five-Year Means for Turbidity.



As noted previously, stormwater flushing nonpoint source pollution from the landscape to the Deep River is the most likely contributing factor to the elevated fecal coliform bacteria and turbidity levels. This was observed in the results from the East Fork Deep River station B4240000, both stations along the Deep River B5070000 and B6040300, as well as the station on the Rocky River B5950000 which record higher fecal coliform bacteria concentrations and turbidity levels during higher flow periods and lower concentrations during low flow periods (*Figure 7-16*, *Figure 7-44*, *Figure 7-63*, and *Figure 7-90*).

Specific conductance provides a way to observe locations and instances where waterways contain more ions in solution. As suggested by the five-year mean values for specific conductance in the mainstem Deep River, the concentration of ions in solution generally fluctuate between increasing and decreasing from upstream to downstream (*Figure 7-93, Table 7-41*). Between stations B4350000 and B4920000, which is just downstream from the confluence with Haskett Creek, the specific conductance generally increases (*Figure 7-93, Table 7-41*). Downstream from the Haskett Creek confluence the Deep River specific conductance values decline until stations B5820000 which displays a considerable increase (*Figure 7-93, Table 7-41*). This is downstream from the return flows from two NPDES point source dischargers. These specific conductance values remain constant through to station B6040300 based on five-year mean values before the Deep River joins with the Haw River to form the Cape Fear River.

Figure 7-93: Deep River Mainstem 2016-2020 Five-Year Means for Specific Conductance.



Overall total nitrogen and NOx concentrations in the upper reaches of the Deep River are typically the lowest based on most recent five-year (2016-2020) mean value at station B4350000 (*Figure 7-94, Table 7-41*). These relatively low total nitrogen and NOx concentrations continue downstream through to station B4800000, after which concentrations increase considerably based on the 2016-2020 mean values as recorded at station B4920000 (*Figure 7-94, Table 7-41*). As noted previously, Richland Creek and Muddy Creek have slightly elevated total nitrogen concentrations during certain years which can contribute to the slightly elevated total nitrogen and NOx concentrations in the Deep River. Most likely the largest contributor to the elevated total nitrogen and NOx concentrations in the Deep River at station B4920000 is from the Haskett Creek tributary which received return flows from the Asheboro WWTP.

These elevated total nitrogen and NOx concentrations decline slightly downstream from station B4920000 through to stations B5575000 and B5685000. While the total nitrogen and NOx concentrations are typically lower in the middle section of the Deep River, the values are still higher than concentrations considered normal for healthy piedmont streams (TN ≤0.8 mg/L; NOx ≤ 0.3 mg/L) (*Figure 7-94, Table 7-41*). While generally declining total nitrogen and Nox concentrations were observed in the five-year means through much of the Deep River downstream from station B4920000, the five-year mean total nitrogen concentrations at stations B5820000 and B6040300 increased considerable due to a combination of both point and nonpoint sources of pollution (*Figure 7-94, Table 7-41*). During the most recent five-year interval (2016-2020) stations B4920000, B5070000, B5100000, B5820000, and B6040300 recorded some of the highest 5-year total nitrogen and NOx concentrations along the Deep River (*Figure 7-94, Table 7-41*).

A fraction of the total nitrogen signature is comprised of total Kjeldahl nitrogen. Additionally, total Kjeldahl nitrogen is composed of both organic and ammonia. Based on the 2016-2020 data collected at stations in the upper reaches of the Deep River, similar total Kjeldahl nitrogen concentrations were observed between stations B4350000 through B5100000 (*Figure 7-94, Table 7-41*). Notably, there is a slight increase in total Kjeldahl nitrogen concentrations at station B4920000 followed by generally declining five-year mean values through to station B5575000 (*Figure 7-94, Table 7-41*). The total Kjeldahl nitrogen concentrations in the Deep River increase again following station B5575000 to reach similar values as those observed in the upper reaches of the Deep River at station B5820000 and B6040300 (*Figure 7-94, Table 7-41*). Stations B4920000 and B5820000 had the highest five-year mean total Kjeldahl nitrogen values of stations on the Deep River based on the 2016-2020 data (*Figure 7-94, Table 7-41*).

As ammonia concentrations comprise part of the total Kjeldahl nitrogen signature, it is worth noting that ammonia concentrations are lowest at the most upstream station on the Deep River B4350000 followed by a considerable increase as recorded at station B4770500 (*Figure 7-94, Table 7-41*). This could be due to the Randleman Reservoir impoundment resulting in changes in the water chemistry as a result of storage and releases. Ammonia concentrations generally decline following this increase through to station B5685000. Downstream from station B5685000, there is another considerable increase observed at station B5820000 followed by lower values observed at the most downstream station B6040300 (*Figure 7-94, Table 7-41*).

Based on the 2016-2020 total phosphorus mean concentrations, values typically increase from upstream to downstream based on data collected at all the stations along the Deep River. While five-year mean values between stations fluctuate between increasing and decreasing, the overall pattern is generally increasing (*Figure 7-94, Table 7-41*). The largest increase in concentrations is observed between stations B5685000 and B5820000 (*Figure 7-94, Table 7-41*).

DWR conducted a screening level Mann-Kendall seasonal and nonseasonal trend tests for water quality parameters in the mainstem Deep River. *Table 7-41* includes the trends that were found to have increased or decreased between either 2000-2019 or 2010-2019. As suggested by the trends analysis, most water quality parameters were found to have a declining trend for stations along the mainstem Deep River at 95% confidence. Notably, total Kjeldahl nitrogen for several stations B4350000, B4770500, B480000, B5070000, B5100000, B5820000, B6040300 displayed increasing trends based on either a seasonal or nonseasonal trend test for data collected between 2000-2019 and/or 2010-2019 (*Table 7-41*). Another notable water quality parameter that displayed an increasing trend was turbidity for stations B4920000, B5070000, B5100000, B5190000, B5685000, and B5820000 based on a seasonal trend test for data collected between 2010 – 2019 (*Table 7-41*). The last noteworthy water quality parameter that displayed an increasing trend based on either a seasonal or nonseasonal trend test was fecal coliform bacteria at stations B5190000, B5685000, and B5820000 (*Table 7-41*).

Figure 7-94: Deep River Mainstem 2016-2020 Five-Year Means TKN, NOx, TN, Ammonia (NH4), and TP

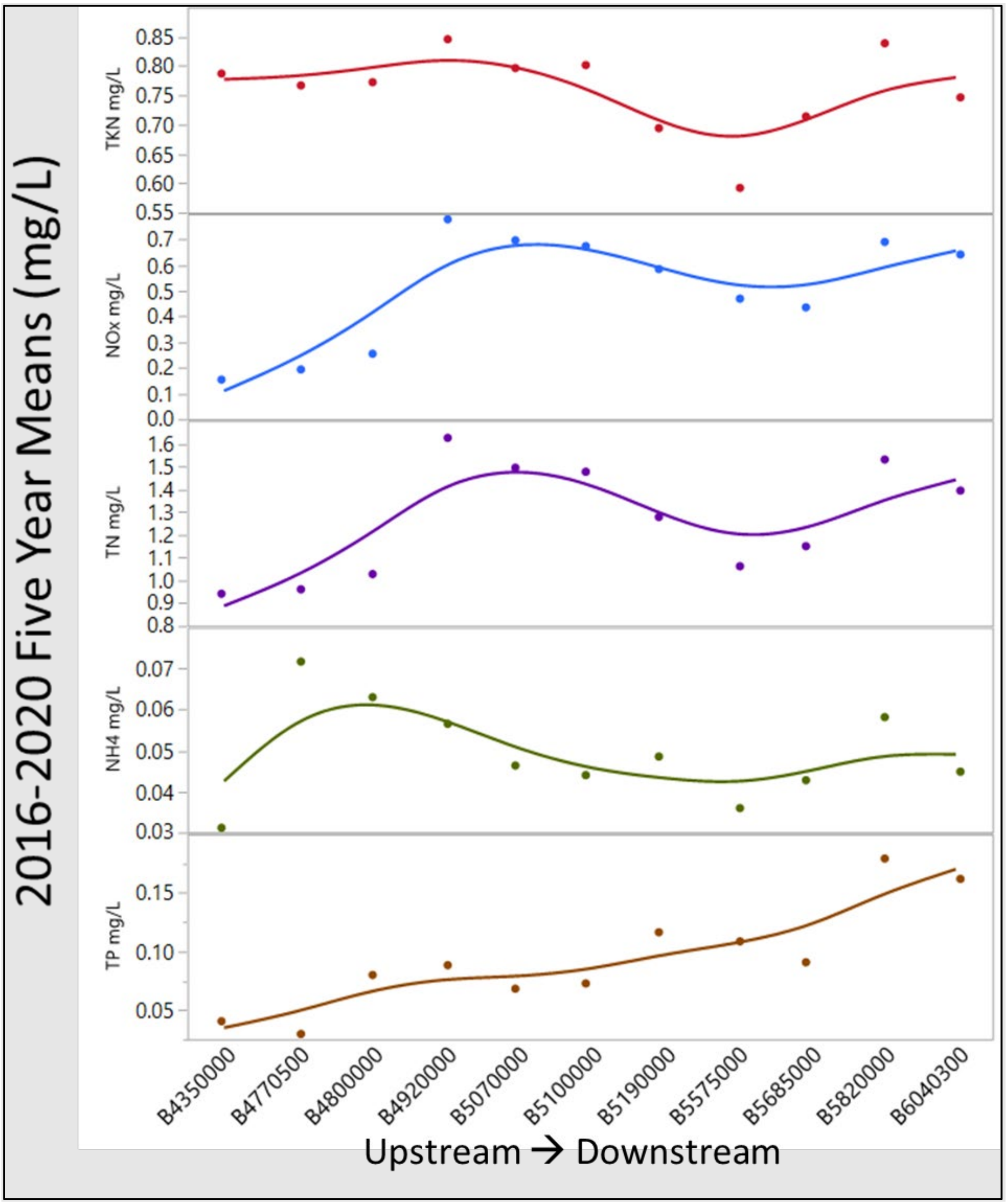


Table 7-41: Five-Year Mean Values for Total Nitrogen, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Ammonia, Total Phosphorus, Fecal Coliform Bacteria, Turbidity, and Specific Conductivity based on Data Collected Between 2016-2020 for Mainstem Stations on the Deep River.

Parameter	**TN[#] (mg/L)**	**NOx (mg/L)**	**TKN (mg/L)**	**NH3 (mg/L)**	**TP (mg/L)**	**Fecal C. (cfu/100 mL)**	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**Station Trend* Information** **2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)**	**Watershed Information**
B4350000	0.94	0.15	0.79	0.03	0.04	359	12.77	134	TKN - ↑ S 10-19; TP – ↓ S 10-19 Fecal C - ↓ NS 00-19 Cond. - ↓ S 00-19	Downstream from High Point Lake
B4770500	0.96	0.19	0.77	0.07	0.03	139	7.01	158	NOx - ↓S 10-19 NH3 - ↓ S 10-19 TKN - ↑ NS 10-19 TP - ↓ NS 00-19 & NS 10-19 Fecal C - ↓ S 00-19 Turbidity – ↓ S 00-19 Cond. - ↓N S 00-19	Downstream from Randleman Reservoir
B4800000	1.03	0.26	0.77	0.06	0.08	1015	12.31	152	NOx - ↓ S 00-19 NH3 - ↓ NS 00-19 TKN - ↑ NS 10-19; TP - ↓ S 00-19 Fecal C - ↓ NS 00-19 Turbidity – ↓ S 00-19 Cond. - ↓ NS 00-19	Downstream from Randleman WWTP
B4920000	1.62	0.78	0.85	0.06	0.09	1055	15.77	176	NOx - ↓S 10-19 TP - ↓ S 00-19 & S 10-19 Turbidity – ↑ S 10-19 Cond. - ↓ S 00-19 & S 10-19	Downstream from Asheboro WWTP
B5070000	1.49	0.70	0.80	0.05	0.07	550	13.07	168	NOx - ↓ NS 00-19 NH3 - ↓ NS 00-19 TKN - ↑ NS 00-19; & NS 10-19 TP - ↓ S 00-19 & S 10-19 Turbidity – ↑ S 00-19 Cond. - ↓ S 00-19 & S 10-19	Downstream from Franklinville WWTP

Parameter	TN# (mg/L)	NOx (mg/L)	TKN (mg/L)	NH3 (mg/L)	TP (mg/L)	Fecal C. (cfu/100 mL)	Turbidity (NTU)	Conductivity (µS/cm)	Station Trend* Information 2000-2019 & 2010-2019 Decreasing (↓) or Increasing (↑) Seasonal (S) or Non-Seasonal (NS)	Watershed Information
B5100000	1.48	0.67	0.80	0.04	0.07	792	14.80	167	NOx - ↓S 10-19 TKN - ↑ NS 10-19 TP - ↓ S 00-19 & S 10-19 Turbidity – ↑ S 10-19 Cond. - ↓ S 00-19 & S 10-19	Downstream from Ramseur WWTP
B5190000	1.28	0.59	0.69	0.05	0.12	483	25.74	151	NOx - ↓ S 00-19 & ↑ S 10-19 TKN - ↑ NS 00-19 TP - ↓ S 00-19 Fecal C - ↑S 00-19 Turbidity – ↑ S 10-19	Upstream of Bear Creek Confluence and Robins WWTP and Star WWTP
B5575000	1.06	0.47	0.59	0.04	0.11	209	20.53	127	NOx - ↓ S 00-19 NH3 - ↓ NS 00-19 TKN - ↓ NS 00-19 TP - ↓ NS 00-19 Turbidity – ↓ S 00-19	Downstream of Bear Creek Confluence and Robins WWTP and Star WWTP
B5685000	1.15	0.44	0.71	0.04	0.09	826	20.32	126	Fecal C - ↑ NS 10-19 Turbidity – ↑ S 10-19 Cond. - ↓ S 10-19	Upstream of Sanford Processing Plant and Big Buffalo WWTP
B5820000	1.53	0.69	0.84	0.06	0.18	613	22.87	140	NOx - ↓ S 00-19 & S 10-19 NH3 - ↓ S 00-19 TKN - ↑ S 00-19 & NS 10-19 TP - ↓ S 00-19 & 10-19 Fecal C - ↑ NS 10-19 Turbidity – ↑ S 10-19 Cond. - ↓ S 10-19	Downstream of Sanford Processing Plant and Big Buffalo WWTP
B6040300	1.39	0.64	0.75	0.04	0.16	417	17.95	140	NOx - ↓S 10-19 TKN - ↑ NS 10-19 TP - ↓ S 00-19 & S 10-19 Cond. - ↓ S 10-19	Downstream of Rocky River confluence

TN is calculated as NOx + TKN. Both values were required to develop a TN value.

* DWR conducted a seasonal or nonseasonal Mann-Kendall trend test at most AMS stations that had sufficient data available; reporting only significant increasing or decreasing trends, calculated at 95% confidence from data collected from 2000-2019 and 2010-2019.
For Non-detects or records below the detection limit, the detect limit value is used in the overall summary means and half the detection limit for trends analysis.

7.9 Deep River Subbasin Water Use

Water resources in the Cape Fear River Basin include surface and ground water, as well as water moving through built infrastructure. North Carolina has a diverse array of water users throughout the state including public and private water supply systems that supply drinking water to their customer base, industries such as food production, wood manufacturing and metal processing; and energy production (hydroelectric and thermoelectric). Water is also used statewide for agricultural, mining, and recreational purposes. The availability and continued use of water by all users is vital to the continued prosperity of the communities and ecosystems of this state.

There are several programs within the North Carolina Department of Environmental Quality (DEQ) that provide information about how much water is being used in North Carolina. These include the Water Withdrawal and Transfer Registration (WWATR) Program, the Local Water Supply Planning (LWSP) Program, the Central Coastal Plain Capacity Use Area (CCPCUA), and the Interbasin Transfer (IBT) Certification Program. Several programs are also in place to protect drinking water sources including the Source Water Assessment Program (SWAP), the Surface Water Protection Program (SWPP), and the Wellhead Protection Program (WHP). Additionally, the Groundwater Resources Branch (GWRB) oversees the assessment, monitoring, and management of the state's groundwater resources. More information about these programs can be found in Chapter 3 and Chapter 5.

In addition to administering programs for water use and protection, DEQ plays a critical role in providing technical and managerial support for the development and use of surface and ground water resources and calculating the volume of water moving through a system. For agriculture water use, the North Carolina Department of Agriculture & Consumer Services (NCDA&CS) plays a critical role in collecting statewide water use data. Information included in this section is taken from the Water Quantity Assessment and Planning in the Cape Fear River Basin, Chapter 5.

7.9.1 Water Use and Availability Reported in Local Water Supply Plans

The information presented in this section quantifies water demand/use and available water supply on a subbasin scale based on public water supply systems that submitted (2020) local water supply plans in the Deep River subbasin. Per North Carolina General Statutes §143-355(l), the Local Water Supply Planning Program applies to units of local governments and community water systems that regularly serve 3,000 or more individuals or have 1,000 or more service connections. See Chapter 5 for more information on water use and availability along with data qualifications and methodologies.

Twenty-one (21) water systems are included in the Deep River subbasin. Based on the information reported by users, not including ecological flow, domestic users, non-reporters, and other unknown usages; there are no apparent water supply issues in the Deep River subbasin. The 2020 Deep River subbasin population served by public water supply systems was 171,499. The public water supply systems in this subbasin had a combined average daily water demand of 22.05 MGD in 2020. Comparing this to the total available supply reported by these 21 public water supply systems in 2020 of 99.40 MGD, the combined average daily demand of the public water supply systems in the Deep River Subbasin was about 22% of available supply. The City of High Point is the largest system in the subbasin, with an average daily water demand in 2020 of 9.66 MGD, or approximately 34% of the total subbasin demand. A detailed description of the public water supply availability, demand, and projections for the Deep River subbasin is in Chapter 5.

January 2025 update:
In 2021, an interlocal agreement was reached between the City of Sanford and Pittsboro, Chatham County, Holly Springs, and Fuquay-Varina to study, design, and complete construction of an additional 18-million gallon per day water treatment facility upgrade in Sanford to meet the water supply needs of all five partners. This will increase the current treatment capacity from 12 MGD to 30 MGD when complete. The expansion of water plant was started on October 29, 2024, with an anticipated completion in 2028. In March 2024, the City of Sanford announced it was intending to provide regional water utilities to surrounding towns and counties under the name TriRiver Water (https://www.tririverwater.com/). This information will be included in future local water supply plans.

7.9.2 Interbasin Transfer Certificates

The North Carolina Legislature adopted the Regulation of Surface Water Transfers Act (NCGS §143-215.22L) in 1993. The intent of the law is to regulate large surface water transfers between river basins by requiring a certificate from the Environmental Management Commission (EMC). NCGS §143-215.22G established 38 interbasin transfer (IBT) basins. An IBT certificate is required for a transfer greater than 2.0 million gallons per day (MGD) between any of the defined IBT river basins. In the Deep River (2-2) basin, which overlaps reasonably well with the Deep River subbasin (03030003), there is one IBT Certificate for the Piedmont Triad Regional Water Authority to transfer from the Deep River (2-2) "source" basin to Yadkin River (18-1) and Haw River (2-1) "receiving" IBT basins. This IBT certificate was issued in 1991 to the Piedmont Triad Regional Water Authority under previous statutes (NCGS § 162A-7 and § 153A-285). The Piedmont Triad Certificate allowances are used primarily by the City of Greensboro to transfer water between the Deep River (2-2) and Haw River (2-1) within their distribution system. This IBT Certificate has maximum allowable amounts of 28.5 MGD to the Yadkin River (18-1) and 2.0 MGD to the Haw River (2-1). More information about IBT Certificates in the Cape Fear River Basin can be found in Chapter 5.

7.10 Protecting Water Resources in the Deep River Watershed

The Basin Planning Branch (BPB) continually works with the Nonpoint Source Planning Branch (NPSPB), Soil and Water Conservation Districts (SWCD), Natural Resources Conservation Service (NRCS), and various stakeholders throughout the region to improve our understanding of point and nonpoint sources of pollution and encourage continued efforts to implement best management practices (BMPs) and restoration activities that reduce nutrients, bacteria, sediment loads, and flow volume to receiving waterbodies.

Urban, industrial, and agricultural stormwater; wastewater treatment plants; on-site wastewater management systems (septic systems); and animal operations are examples of sources of pollution in the Deep River watershed.

Reductions for fecal coliform bacteria should be sought through identification and repair of aging sewer infrastructure as well as targeting other stormwater-driven sources. There are 40 single-family domestic wastewater treatment systems in this subbasin, concentrated in Chatham County. *There is a need for homeowner education on how to properly maintain and operate single-family wastewater treatment systems to reduce their impact on water quality. Connecting single-family NPDES waste management system to regional wastewater facilities* would likely improve water quality as many of these systems are not well maintained and are known to contribute nutrient and bacterial loading to local streams. Single-family wastewater treatment systems which discharge less than 1,000 gallons per day of (100%) domestic waste fall under NPDES general permit number NCG550000. For NCG550000 permit as well as operation and maintenance information see the October 2020 DEQ technical bulletin and the NPDES general permits website.
Enforcement of stormwater BMP requirements for construction sites, additional education related to farming practices and other land disturbing activities, and additional urban stormwater controls for sediment are also potential management options for improving bacteria and turbidity levels in the Deep River.

Recommendations and actions to improve and protect water quality are listed in detail throughout the Deep River subbasin chapter. Some of the key recommendations include:

- Implement stormwater BMPs to reduce pollutant runoff and reduce peak flows throughout the subbasin. This could include strengthening ordinances controlling stormwater runoff, encouraging low impact development within the local jurisdictions, and promoting financial and technical support to local governments to effectively manage and improve infrastructure.
- Maintain existing effective regulatory strategies, such as the use of vegetated buffers and stormwater controls, throughout the river basin to reduce nonpoint source pollution and minimize cumulative losses of fish and benthos habitat and impacts to water quality.
- Encourage the removal or modification of dams that are impacting water quality and impeding aquatic migration and fracturing habitats for endangered species (example includes Hackney Millpond Dam on the Rocky River).
- Basin Planning and DWR staff will continue to work with resource agencies and stakeholders to improve and protect the water quality in the Deep River and Rocky River watersheds for the protection of the Cape Fear shiner.
- Existing WWTPs are encouraged to pursue nutrient optimization to improve nutrient removal processes at existing treatment plants. This should include an evaluation of existing treatment components and operations and identifying additional opportunities to improve and optimize nitrogen and phosphorus reduction. Existing WWTPs are also encouraged to develop a standard

operating procedure to mitigate treatment inefficiencies associated with staff turnover and promote consistent high performance.

- As directed by the EPA, DWR will continue to work with the Nutrient Criteria Development Plan (NCDP) Scientific Advisory Council (SAC) to develop appropriate instream criteria and response variables to accurately assess the health and protect both small streams and large riverine systems. This could include the development of TMDLs and/or nutrient management strategies as needed to reduce nutrient loading from point and nonpoint sources to protect designated uses throughout the basin.
- Publicly Owned Treatment Works (POTWs) must work with DWR to determine if their Pretreatment Program is sufficiently evaluating indirect dischargers to protect against accepting waste with potential emerging contaminants.
- Provide sufficient funding to existing state and federal cost share programs (urban, agriculture, and forestry) for technical assistance and the voluntary implementation of BMPs. This includes cost share programs managed by the NCDA&CS Division of Soil & Water Conservation (DSWC) and NC Forest Service (NCFS) and federal programs managed by the USDA Natural Resources Conservation Service (NRCS). Programs should promote BMPs that reduce nutrients, turbidity, and bacteria in waterways.
- Expand existing data collection (including source identification) to include agricultural watersheds with high concentrations of deemed permitted animal operations. DWR has little to no information on deemed permitted facilities making it difficult to determine if they are having an impact on water quality. Data could also be used by multiple local, state, and federal agencies to review the existing regulatory framework as it relates to deemed permitted facilities and help target BMP implementation.

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