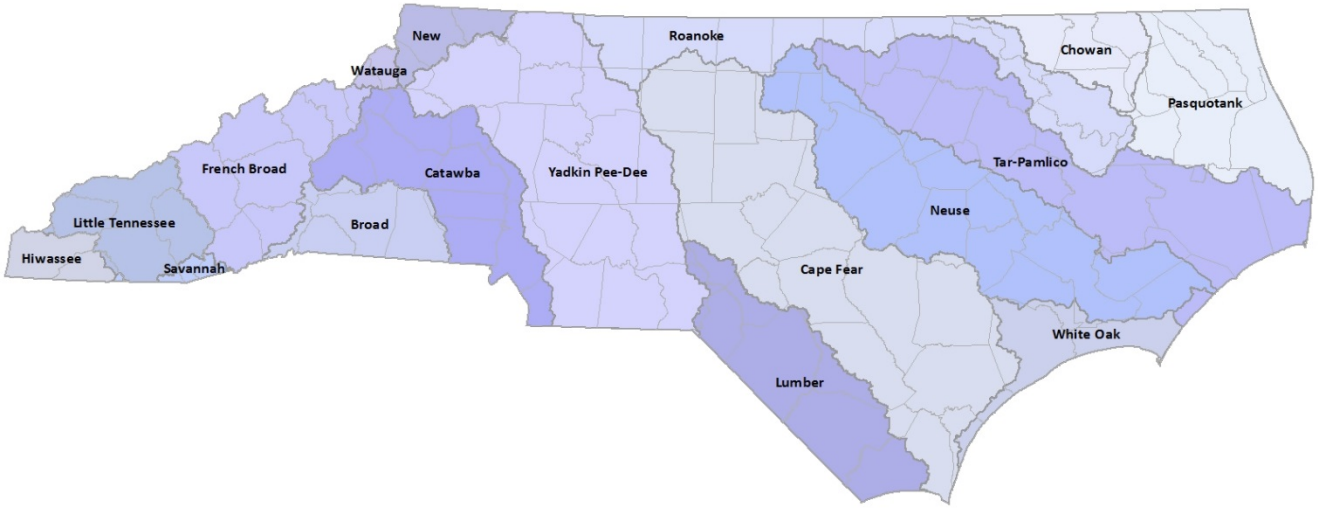
Annual Report to the General Assembly
Environmental Review Commission
Basinwide Water Management Planning
July 2017 to June 2018



Environmental Management Commission
North Carolina Department of Environmental Quality
Division of Water Resources

This report is submitted to meet the requirements of G.S. 143-215.8B(d) and 143-355(p), which requires annual reporting on the development of basinwide water quality management plans and hydrologic models.

Contents

Executive Summary

Since 1983, North Carolina has used an integrated, watershed-based approach to evaluate point and nonpoint sources of pollution from municipal wastewater facilities, industrial facilities, on-site wastewater collection systems and stormwater. When available, land use changes, agricultural operations and potential nutrient contributions from groundwater and atmospheric deposition are also included. The approach is continuously evolving and efforts are underway to develop an integrated report that includes both water quality and water quantity issues.

Basinwide water management plans (basin plans) are developed by the Basin Planning Branch (BPB) in the Division of Water Resources (DWR) in the North Carolina Department of Environmental Quality (DEQ or Department). The basin plans are prepared for each of the 17 major river basins and are used to communicate with policy makers, entities required to adhere to water quality standards (wastewater managers and operators, stormwater engineers, contractors and developers, etc.) and the public on water resource issues across the state. When applicable, the basin plans also include recommendations and explanations regarding why there are long-term management strategies in place for rivers designated as nutrient sensitive waters (NSW) as well as those waters identified has having significant or outstanding water quality. Numerous federal, state and local agencies as well as watershed groups, universities and the public are contacted throughout the basin planning process.

General Statue (G.S.) 143-215.8B(d) states that the Environmental Management Commission (Commission) and the Department shall each report on an annual basis to the Environmental Review Commission (ERC) on "the progress in developing and implementing basinwide water quality management plans and on increasing public involvement and public education in connection with basinwide water quality management planning. The report to the Environmental Review Commission by the Department shall include a written statement as to all concentrations of heavy metals and other pollutants in the surface waters of the State that are identified in the course of preparing or revising the basinwide water quality management plans." In October 2017, G.S. 143-355 (p) directed the Department to also include progress on developing basinwide hydrologic models in the annual report submitted to the ERC for basinwide water management plans. These models are often referred to as "water supply" models, and information on the status of hydrologic models is included in the report submitted to the ERC.

Progress on Developing and Implementing Basin Plans

Currently, the Broad, Cape Fear, Chowan, Neuse, Pasquotank, Watauga and White Oak River Basin plans are being updated. In-depth water quality assessments and recommendations for protecting water quality will be updated in each basin plan. Where information exists, the basin plans will also include an overview of water availability and current and future water demands and projections. Information about water quality concerns identified in the most recent basin plan for the remaining ten basins is also included in the ERC report. DWR relies heavily on state and local agencies, as well as local watershed groups, to implement recommendations, action plans and/or nutrient management strategies presented in the basin plan.

Public Involvement and Education

Staff continually work with various stakeholders throughout the basin planning process. Stakeholders include technicians from Soil and Water Conservation Districts (SWCD) and the USDA Natural Resources

Conservation Service (NRCS), watershed groups, riverkeepers, and local governments. Public input is sought during a public comment period, and the public is encouraged to report water quality concerns to DWR for inclusion in the basin plan.

Statement on the Concentration of Metals and Other Pollutants

Water quality monitoring for total recoverable metals assessment was suspended in April 2007 to allow for evaluation and re-adoption of revised standards using the most current science. In November 2014, as part of the Triennial Review process, the EMC approved new dissolved metals standards, which became effective for state purposes in January 2015. The EPA approved these standards for Clean Water Act (CWA) purposes in April 2016. DWR began collecting dissolved metal samples at certain locations in 2016. This data is being reviewed internally for quality assurance. An assessment for metals will be incorporated into the 2018 integrated report required under the CWA and submitted to the EPA.

Nonpoint source pollution continues to have the greatest impact on water quality across the state. While seen statewide, aquatic habitat degradation and biological impairments are increasingly obvious in urban and suburban areas where large impervious surface areas are resulting in greater stormwater runoff, higher peak flows and lower baseflows. Nutrients, land application of waste and emerging compounds (e.g., GenX, 1,4-dioxane, perfluorinated compounds) will be included in basins plans currently under development as pollutants of concern where applicable.

Progress in Developing Hydrologic Models

DWR hosts hydrologic models for the Tar-Pamlico, Roanoke and Broad River basins along with the combined Cape Fear-Neuse River basin model. A hydrologic model is also available for the Catawba-Wateree River basin. Efforts are underway to develop models for the French Broad, Watauga and New River basins.

1. Introduction

Basinwide water management plans (basin plans) are developed by the Basin Planning Branch (BPB) in the Division of Water Resources (DWR) in the North Carolina Department of Environmental Quality (DEQ). Basin plans are prepared for each of the 17 major river basins and are used to communicate with policy makers, government officials, entities required to adhere to water quality standards (wastewater managers and operators, stormwater engineers, contractors and developers, etc.) and the public on water resource issues across the state. When applicable, the basin plans also include recommendations for protecting water quality and explanations regarding why there are long-term management strategies in place for rivers designated as nutrient sensitive waters (NSW) as well as those identified has having significant or outstanding water quality. Numerous federal, state and local agencies, as well as watershed groups, universities and the public, are contacted throughout the basin planning process.

Implementation of recommendations, action plans or strategies presented in the basin plan is coordinated with various resource agencies and local communities. Regional, voluntary measures or regulatory actions may be used to address water quality concerns identified in the basin plan. Information presented in each basin plan also aids local watershed groups in developing and prioritizing site-specific restoration and protection strategies.

The basin plans have been referenced in many watershed restoration plans for EPA Section 319 watershed restoration projects. They are also referenced in applications for grants offered through federal and state agencies including the North Carolina Clean Water Management Trust Fund (CWMTF), cost share funds offered through the North Carolina Department of Agriculture & Consumer Services (NCDA&CS), Agriculture Cost Share Program (ACSP) and Community Conservation Assistance Program (CCAP) and the USDA Natural Resources Conservation Service (NRCS). Basin plans are not a rule, are circulated to local agencies and the public for review and comment, and are approved by the North Carolina Environmental Management Commission (EMC) at least every 10 years.

Each year, the Commission and DEQ are required to report to the Environmental Review Commission (ERC) on the progress in "developing and implementing" the basin plans as well as "increasing public involvement and public education in connection with" the basin plans. The statute also requires that the report include "a written statement as to all the concentrations of heavy metals and other pollutants in the surface waters of the State that are identified in the course of preparing or revising" the basin plans (G.S. 143-215.8B). In October 2017, G.S. 143-355 (p) directed the Department to also include progress on developing basinwide hydrologic models in the annual report submitted to the ERC for basinwide water management plans. These models are often referred to as "water supply" models, and information on the status of hydrologic models is included in this report.

As with the 2017 annual report, the 2018 annual report includes additional information related to water quality issues that go beyond the reporting requirement of the basinwide planning statute. EMC members requested the inclusion of the additional information to inform the ERC on additional environmental concerns as they relate to water quality. The Basin Planning Branch (BPB) worked with several staff members within DWR to acquire additional information, much of which can be found in Section 3 Statewide Water Resource Issues and Section 4 as it relates to nutrients and evaluating emerging compounds in

Jordan and Falls lake. DWR will continue to work with the EMC to explore other alternatives for capturing additional topics that go beyond the requirements of this report.

2. Basin Plan Development and Progress on Developing Hydrologic Models

Developing basin plans is a multi-year process built on monitoring water quality and aquatic habitat, reviewing discharge permits, and communicating with stakeholders prior to presenting the results. When available, computer models that evaluate the effects of water withdrawals on water availability are also included in the analysis.

2.1. Basin Plan Development and Schedule

Since 1983, North Carolina has used an integrated, watershed-based approach to evaluate point and nonpoint sources of pollution from municipal wastewater facilities, industrial facilities, on-site wastewater collection systems and stormwater. Development of the basin plans for approval by the EMC and reports generated for the ERC are continually evolving. Session Law (S.L.) 2013-413 merged the former Division of Water Quality (DWQ) with DWR, resulting in a combination of water quality and water quantity. The Tar-Pamlico River basin plan was approved by the EMC in 2015 and was the first plan to incorporate water quality and quantity issues. The basin plan included in-depth water quality assessments and recommendations for improving water quality, as well as information made available through the hydrologic model. For basins that do not have a hydrologic model, information about future water demands, projections and groundwater use will be based on best available data collected by DWR.

Currently, the Broad, Cape Fear, Chowan, Neuse, Pasquotank, Watauga and White Oak River basin plans are under development. Table 1 lists the 17 river basins within North Carolina and the schedule for monitoring and planning. The table also includes information about the hydrologic model platform used in determining water availability.

2.2. Progress on Developing Hydrologic Models

Hydrologic models are based on historic stream flow data and capture the effects of current management protocols (i.e., regulated releases from dams), surface water withdrawals, and wastewater discharges. The models can be used to evaluate the potential effects on surface water availability produced by anticipated changes in water demands and management regimes. Although not as precise as a site-specific study for accessing impacts, the models are also used to evaluate potential impacts of permit decisions including the approval of water supply allocations from lakes and reservoirs or approval of surface water transfers. The models are available to anyone who requests access and can be used to evaluate potential flow impacts from proposed projects and identify flow conditions, the reoccurrence of which, could produce water shortages limiting the ability to meet expected demand. The models also evaluate the possible magnitude of the water shortages. By statute, the models are subject to a 60-day comment period and must be resubmitted to the EMC if there are substantial comments and/or updates.

DWR hosts hydrologic models for the Tar-Pamlico, Roanoke and Broad River basins along with the combined Cape Fear-Neuse River basin model. A hydrologic model is also available for the Catawba-Wateree River basin. Hydrologic models for the French Broad, New and Watauga River basins are currently being developed. An introduction to the model and how data will be collected was presented at two stakeholder meetings in April 2018. The meetings were held in Boone and Asheville. Representatives from both the

public and private sector participated in the meetings and included DEQ, Wildlife Resources Commission (WRC), NC Department of Agriculture & Consumer Services (NCDA&CS), Soil & Water Conservation Districts (SWCD), municipalities, riverkeepers and Duke Energy. DWR continues to work with HydroLogics to review water use data that will be incorporated into the model and ensuring all water users are accounted for in the basins. The models are scheduled to be complete early 2019.

Table 1: Basin Planning Schedule

River Basin	Last EMC Approved Plan	Next Plan Update	NPDES Permits Renewal Year	Biological Basinwide Monitoring	Quantity Model Platform	Strategy/ Studies	Web Links to Executive Summary
Chowan	2007	2019	2017	2020	n/a	NSW	CHO
Pasquotank	2007	2019	2017	2020	n/a	Albemarle Sound NCDP	PAS
Watauga	2007	2018	2017	2018	UD - OASIS		WAT
White Oak	2007	2019	2017	2019	n/a	New River - NSW	WOK
Broad	2008	2019	2018	2020	OASIS		BRD
Neuse	2009	2019*/ 2020	2018	2020	OASIS	NSW	NEU
Cape Fear	2005	2019	2016	2018	OASIS	Haw River -NSW; Mid CF - NCDP	CPF
Yadkin	2008	2020	2018	2016	TBD	High Rock NCDP	YAD
Lumber	2010	2020	2019	2016	TBD		LBR
French Broad	2011	2020	2020	2017	UD - OASIS		FBR
Catawba	2010	2021	2020	2017	CHEOPS		CAT
New River	2011	2021	2016	2018	UD - OASIS		NEW
Hiwassee	2012	2021	2017	2019	TVA		HIW
Little Tennessee	2012	2021	2017	2019	TVA		LTN
Savannah	2012	2021	2017	2019			SAV
Roanoke	2012	2022	2017	2019	OASIS	216 Study	ROA
Tar-Pamlico	2015	2023	2019	2017	OASIS	NSW	TAR

NSW = Nutrient Sensitive Waters Strategy
NCDP = Nutrient Criteria Development Plan
* = NSW Strategy and regulatory update prior to NPDES permits renewal; full plan completion 2020.
n/a = hydrologic models are not applicable for in these basins.
TVA = Tennessee Valley Authority Model
UD = Under development; 2019 estimated completion.
TBD = hydrologic models that need to be developed

3. Statewide Water Resource Issues

Several water resource issues span multiple basins. Table 2 provides a quick reference guide to water resource issues identified during the basin planning process. The table is not meant to be all-inclusive but touches upon issues presented in the most recent basin plan or those that will be highlighted in future basin plans.

3.1. Biological Impairments and Habitat Degradation

Many of the biological impairments across the state are due to poor and degraded aquatic habitat and the associated water quality impacts. While seen statewide, degradation is increasingly obvious in urban and suburban areas where large impervious surface areas are resulting in greater stormwater runoff, higher peak flows (flashy streams) and lower baseflows. Streambank and instream habitat erosion along with elevated turbidity and increased concentrations of pollutants are making it difficult to protect sustainable aquatic populations. Pesticide and nutrient management from urban and agricultural lands, disconnected or reduced floodplains, animal access to streams, and damaged or aging wastewater collection systems are also identified as key contributors to poor aquatic habitats. Maintaining or establishing riparian buffers can minimize the impact from stormwater overland flow by reducing pollutants and stabilizing streambanks. In addition, adopting stormwater management in areas where stormwater management is not required as well as education and outreach can also assist with improving aquatic habitats statewide.

3.2. Nutrients

Compounds of nitrogen and phosphorus are major components of living organisms and thus are essential to maintain life. These compounds are collectively referred to as “nutrients”. When nutrients are introduced to an aquatic ecosystem from municipal and industrial treatment processes or runoff from urban or agricultural land, the growth of algae and other plants can result in eutrophic conditions and increased biological productivity/algal blooms.

A basinwide planning branch requirement for all NSW (Nutrient Sensitive Waters) basins is an evaluation of the progress towards meeting NSW strategy goals. To fulfill this requirement, a robust in-depth statistical trends analysis is done. The results of these analyses indicate that there has been a steady increase in organic nitrogen in the Neuse and Tar-Pamlico NSW watersheds since the early 2000’s. A recent statewide evaluation of organic nitrogen instream concentrations indicate that this increase is occurring across NC. Mechanisms driving this increase are not well understood. Changes in urban, agricultural and waste disposal activity, and effects from groundwater, legacy sediments, and atmospheric deposition may also be contributing along with changes to stream flow. Changes in stream flow could also be impacting permit limits which may also be contributing to the increased nutrient values. Additional research and analytical tools are needed to help DWR understand the sources of increasing organic nitrogen and how to properly manage this load. In addition, more detailed research and reporting on best management practices (BMP) and the efficiency in removing nutrients could help identify the most appropriate BMPs for a specific reduction need.

3.3. Algal Blooms

Algae are responsive to the physical and chemical conditions in the aquatic environment. Blooms occur when favorable conditions exist, such as optimal temperatures, sufficient nutrients, and static or stable

waterbodies. Several of the 2017 algal blooms were identified as being dominated by bluegreen algal species (cyanobacteria), some of which may produce toxins. Blooms that are dominated by bluegreen species are referred to as potentially harmful algal blooms, or pHABs. Algae are of most concern in drinking water supplies, reservoirs, impoundments and slow-moving/flushing estuaries. While some algae have the ability to potentially produce toxins, many non-toxic blooms can also cause taste and odor problems, water discoloration, form large mats which can interfere with boating, swimming and fishing, and can be associated with fish kills and decreased biodiversity.

DWR now documents reported algal blooms on an online interactive map. In 2017, DWR collected 46 episodic bloom samples in nine different river basins. Of those, 31 met the criterion to be considered an algal bloom (unit density > 10,000 units/mL), with 20 of those being categorized as pHABs (bluegreen dominant). The 2017 pHABs occurred in the Neuse, Catawba, Cape Fear, Chowan, Pasquotank, French Broad and Little Tennessee River basins. As of June 2018, DWR collected 22 episodic bloom samples in six different river basins, these include the Neuse, Catawba, Cape Fear, Chowan, Pasquotank and White Oak River basins. Of those, 16 met the bloom density criterion, with eight categorized as pHABs.

In addition to episodic bloom evaluations, algal monitoring is done as part of the routine basinwide monitoring of many lakes and estuaries. Sites chosen are generally in areas likely to have favorable conditions for algal growth, so the numbers are not necessarily representative of what is happening in all waterbodies in NC. Overall, there were 384 routine samples collected in 2017. Of those, 283 (74%) met the algal bloom density criterion with 111 (29%) of those being categorized as pHABs. It is important to note that Jordan and Falls lake are part of the routine monitoring for this time period, which are known to generally have bloom densities (> 10,000 units/mL) a large portion of the year. Without Jordan and Falls lake samples, there were 310 samples with 209 (67%) reported as having bloom densities and 37 (12%) identified as having pHABs associated with the bloom (most of these samples are collected during the summer months). Routine basinwide monitoring is underway for 2018. A total of 63 monitoring stations will be sampled monthly between May and September from 39 different waterbodies. The results will be available in late 2018.

Along with episodic algal bloom and routine algal investigations, DWR is in the process of developing in-house algal toxin testing capabilities. The ability to conduct algal toxin testing in-house will allow DWR to determine when a bloom represents a health risk to humans, animals or the environment. Standard Operating Procedures (SOP) for algal bloom and cyanotoxin field collection, as well as pHAB response protocols, are currently being reviewed and field tested. Three special studies for microcystin (bluegreen algal cyanotoxin) are underway. These include:

- ❑ Pilot study using cyanotoxin test strips as a screening tool by DWR Regional Office field staff, with direct comparison to laboratory analysis.
- ❑ Split sample comparison of analytical methods and results between DWR chemistry laboratory and DHHS laboratory.
- ❑ Pilot project/feasibility assessment for monitoring drinking water supply reservoirs. This pilot project entails collecting monthly microcystin samples near drinking water intakes at 18 Cape Fear River Basin reservoirs (May through September 2018). The intent is to develop a baseline microcystin

concentration dataset. This could be added to the Intensive Survey Branch's (ISB) basinwide ambient lakes monitoring program, thereby assessing each drinking water reservoir on the 5-year monitoring rotation.

Microcystin is just one of the many cyanotoxins of concern in freshwater systems. DWR staff will continue to expand the algal toxin program to include analysis of other known cyanotoxins.

EPA uses the Unregulated Contaminant Monitoring Rule (UCMR) to collect data for contaminants that are suspected to be present in drinking water but do not have a maximum contaminant level established under the Safe Drinking Water Act (SDWA). Monitoring under the fourth round of the UCMR (UCMR 4) will occur between 2018 and 2020. In NC, all 100 large surface water providers serving more than >10,000 people and 32 randomly selected small surface water providers will be required to collect finished water samples twice a month for four consecutive months between March and November, based on an established EPA schedule. Samples will be analyzed by an EPA UCMR-approved laboratory for cyanotoxins; these include total microcystin, anatoxin-a and cylindrospermopsin. Samples containing total microcystin concentrations ≥ 0.3 ug/L will be further analyzed for six additional microcystin congeners and nodularin. The first results are expected to be posted to the National Contaminant Occurrence Database (NCOD) later this year. DWR will monitor the NCOD for NC water treatment facility results. For more information on the UCMR 4 assessment see the EPA UCMR 4 website and link to fact sheets.

3.4. Impacts from Land Application of Waste

Agricultural, industrial and municipal wastes can provide much needed plant nutrients for farmers, landscapers and home gardeners. Examples of operations that can produce waste for land application include food-processing plants, pharmaceutical companies, animal operations, wastewater treatment plants, and wood-product manufacturers. Regardless of the type of waste, it must be analyzed for nutrients and metals before it is land applied in order to ensure that the amount applied as fertilizer, or as a soil amendment, can be utilized by vegetation (i.e., crops, landscaped areas).

The state has statutes and rules in place that require that the application of waste be made at agronomic rates. Agronomic rates are defined as the amount of waste materials that will provide all the nitrogen needs of the crop, while minimizing the amount of nitrogen that leaches below the root zone to groundwater. Research from NC State University estimates that the amount of nitrogen harvested by crop plants is generally between 30 and 75 percent of the applied nitrogen and will vary depending on the crop and soil types, as well as the season (Deanna Osmond, NC State Extension Nitrogen Management and Water Quality Soil Facts Sheet). Records must be maintained on the type, amount and location of where permitted waste is applied. If not effectively utilized by vegetation, nutrients can enter surface water by atmospheric deposition, groundwater transport and stormwater runoff. Excess nutrients in surface water can impact aquatic ecosystems, and the type and amount of treatment required to ensure that water is safe for human consumption.

Understanding the impacts from large-scale waste application can be challenging due to minimal monitoring in the watersheds in which they are located. Waste treatment from concentrated animal feeding operations (CAFOs) normally includes a liquid waste treatment lagoon. Solids settle to the bottom of the lagoon, and the liquid waste is applied to crops through a spray irrigation system. DEQ has regulatory

authority over swine and cattle operations that use dry or liquid manure waste management systems and poultry operations that use a liquid waste management system (i.e., spray irrigation). These permitted animal facilities are inspected annually. A Certified Animal Waste Management Plan (CAWMP) is required before a permit is issued or renewed.

Most poultry operations, however, produce a dry litter waste that typically falls under the deemed permitted category (NCAC 02T .1303), and they do not require an NPDES or state permit. Operations that fall into this category are only inspected if a complaint is filed. Because information about the location, number of animals, amount of waste produced or fields on which the dry litter is applied is unknown, determining the extent of potential impacts from poultry waste to water quality is difficult to assess. Often, information about these facilities is restricted due to federal rules and regulations under the USDA. Additional information is needed about the location of deemed permitted operations and land application sites to assist DWR in establishing new monitoring stations to assess potential nutrient impacts to aquatic ecosystems and water quality.

3.5. Emerging Compounds

GenX, 1,4-dioxane and perfluorinated compounds are examples of compounds that are commonly referred to as emerging compounds. They often go undetected and untreated because facilities do not have the analytical tools, methods or treatment systems in place that can detect, eliminate or treat them. Emerging compounds are a potential issue for all waters (surface and ground) of the state and come from a wide range of sources including pharmaceuticals, pesticides, disinfection by-products, wood preservatives, personal care products and industrial chemicals as well as their by-products. Potential sources include conventional wastewater treatments plants, individual on-site wastewater collection systems, and industrial and chemical manufacturing facilities.

While a contaminant may be unique to a specific source or river basin, many are widespread. The effects of emerging compounds on aquatic ecosystems and on human health are mostly unknown, and the lack of appropriate analytical methods and monitoring techniques makes identification and management a challenge. The uncertainty of whether these contaminants are present, their effects on human health and their impacts to aquatic ecosystems is a growing public concern. Because emerging compounds are not fully understood, it limits the State's ability to protect water quality. It also limits the State's ability to assess whether to regulate the contaminants or identify treatment options for water treatment facilities to provide safe drinking water to the public and ensure that aquatic ecosystems are protected.

Specific NC emerging compound monitoring activities include:

- In July 2017, DWR started a second sampling project assessing 1,4-dioxane along with bromide in selected surface waters used as public drinking water supply sources. Sampling will occur monthly for 18 months during 2017-2018. The monitoring locations were determined based on watersheds identified has having elevated concentrations of 1,4-dioxane as part of the EPA's Third Unregulated Contaminant Monitoring Rule (UCMR 3) assessment. Monitoring locations for bromide were based on quarterly disinfection byproducts (DBPs) monitoring at drinking water treatment facilities. For specific information related to this assessment see the 1,4-Dioxane and Bromide Monitoring Plan.

- In June 2017, DWR Fayetteville Regional office started collecting daily samples Monday-Friday at the Chemours facility wastewater facility and then shifted to composite sampling in the fall of 2017 on Mondays and Thursdays which continue to the present time. These are composite samples collected every three hours over a three- and four-day period. The regional office also collects finished drinking water grab samples from the Bladen Bluffs WTP, International Paper, NW Brunswick WTP, Pender County WTP, and CFPUA Sweeny WTP. The Cape Fear River is the source of water for all of these water treatment facilities. The samples are sent to the EPA's Athens, GA laboratory for analysis of a suite of PFOA and PFOS compounds. Results of the analysis can be found on the GenX Sampling website.

- In 2018, DWR is monitoring for a set of emerging compounds (23 selected PFAS including GenX, PFOA and PFOS) in Jordan and Falls lakes and their surrounding watersheds. Each lake will be monitored monthly for six months (Jordan Lake monitored January - June; Falls Lake monitored July - December).

- In 2018, DWR's ambient lakes monitoring program will sample 18 water supply reservoirs as part of a pilot project for cyanotoxins (microcystin) as well as a one-time assessment for emergent compounds (23 selected PFAS including GenX, PFOA and PFOS) at a lake station closest to a water supply intake.

- In 2018, the NC General Assembly appropriated funds to the NC Policy Collaboratory to conduct a statewide public water supply baseline water quality testing for a set of emergent compounds. The study will be managed by the UNC Gillings School of Global Public Health. The study will be finalized in fall of 2019, with a final report due to the Legislature December 1, 2019.

3.6. Integration of Water Quality and Quantity Planning

Understanding the relationship of water quality and quantity and effectively managing the parameters of each is crucial to protecting all waters of the state. DWR is directed by G.S. 143-215.8B(a) to provide information about water quality and quantity in basin plans. For decades, these two aspects of water science have been studied and managed independently. To integrate information from both components requires developing techniques to correlate historic data that was not collected or managed with the other in mind. DWR is making progress integrating water quality and quantity into the basin planning process and offering recommendations to protect water quality while considering instream and off-stream uses.

While North Carolina's agency goal is to manage water quality and quantity to prevent violations of the federal and state standards, the standards vary based on each program's purpose and how it relates to the programs' individual water management goals. Environmental and human health water quality standards are established by the EPA to meet federal requirements under the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA). Although no standards exist for flow in the state, impacts to water quantity from some proposed projects are evaluated jointly by federal and state agencies under the National Environmental Policy Act (NEPA) and the North Carolina Environmental Policy Act. In response to a permitting action, DWR works with public and private entities seeking water supply on site-specific projects, in conjunction with other resource agencies, to establish flow regimes necessary to protect water quality and maintain aquatic habitat.

DWR uses water quality and quantity models in part to evaluate if changes to the state's waters can meet increased water supply demand, assimilate additional wastewater, and rehabilitate impaired waters.

Wastewater discharge permits are issued with consideration of both historical flows at a discharge location and reduced historic low flows from the cumulative impact of the increased number and capacity of withdrawals, changes in land use and climatic patterns. Significant alteration of stream flow regimes will also impact ecological integrity. These same alterations may contribute to public water supply shortages.

For water quantity planning purposes, to estimate impacts to stream flow from known water withdrawals and wastewater discharges, DWR manages and models water-use data submitted by subject water systems, farms, utilities, irrigators and others, depending on the amount withdrawn. Although permitted, site-specific flow requirements are included in DWR's hydrologic models, the capability to provide insights into assessing basinwide ecological integrity, as defined in G.S. 143-355(o), is constrained due to the inability to consider ecological flows as deemed by the EMC. Therefore, basin hydrologic models are presently not being approved by the EMC.

3.7. Impact from Excessive Flooding (Hurricanes)

In October 2016, the Cape Fear, Chowan, Lumber, Neuse, Roanoke, Tar-Pamlico and Roanoke River basins were severely impacted as result of excessive flooding due to Hurricane Matthew. A special study of the surface water quality impacts associated with the hurricane was conducted. Thirty samples were collected across the seven river basins and results indicated that any negative impacts to surface waters from the severe flooding appeared to have been transient, lasting several weeks. Water quality returned to pre-storm baseline conditions when flows returned to normal (Survey of Surface Water Quality Associated with Hurricane Matthew, October 2016 – Final Report). It may take years to determine the long-term impact to the basins from such a historic flooding event. Biological monitoring will be done in the future to assess the impacts and recovery to the aquatic ecosystems.

DEQ is working through the Division of Water Infrastructure's Master Plan to encourage and support water and wastewater utilities in efforts to develop and maintain viable systems that safeguard public health, protect the environment, support vibrant communities, and encourage economic development. These efforts include collaboration with DWR to promote sustainable planning within areas that are continuing to experience more frequent and intense flooding events from what is becoming routine weather systems and those from seasonal hurricanes. Lessons learned from Hurricane Matthew and other events have led the Department to encourage utilities that may have struggled to rebound from past flooding to evaluate resiliency measures, including regionalization, to provide a pathway forward that may not otherwise be explored. Systems cannot be replaced and repaired time and time again in the same historic manner. DWI is working at the local level to facilitate these critical conversations in communities across the state. Collaboration among the state and local agencies is paramount to ensure funding is invested in a manner that promotes sustainable solutions as climate changes impact our water infrastructure.

3.8. Groundwater

Groundwater is an extremely important water source in North Carolina with nearly half of the state's population relying on it for water supply. For most public water supply systems in the coastal plain, ground water is the primary water source. The Central Coastal Plan Capacity Use Area (CCPCUA) is a 15-county area that was designated by the EMC in August 2002 because of concerns about the viability of several groundwater sources, or aquifers. Portions of the Cape Fear, Neuse, Pasquotank, Roanoke, Tar-Pamlico,

and White Oak river basins are located in the CCPCUA. The CCPCUA requires water use permits for large entities that use more than 100,000 gallons of groundwater per day. It also requires that small ground- and surface water users that use more than 10,000 gallons per day register their withdrawal under CCPCUA.

Over a 16-year period, many large water users in the CCPCUA were required to reduce their withdrawals by up to 75% from certain aquifers and use alternate water sources. August 1, 2018 signaled the end of the last phase of reductions so, going forward permit holders are required to meet the most stringent reduction; however, most permit holders had already met this final reduction once they implemented their alternative source. The CCPCUA assessment, required by the CCPCUA rule during each reduction phase, is available on-line at https://www.ncwater.org/CCPCUA. Based on the analysis of water level and chloride concentration conditions in the CCPCUA that were gathered through November 2017, DWR recommended to the EMC Water Allocation Committee on July 11, 2018 and will recommend to the full EMC in October 2018 not to adjust either the CCPCUA reduction zone boundaries or reduction percentages. Although water levels in many areas have risen and aquifer dewatering is less of a concern, salt water encroachment is still problematic. Withdrawals from alternative water sources including surface water and shallower aquifers have replaced the reduced amount withdrawn from the Cretaceous Black Creek and Upper Cape Fear aquifers and allowed for modest growth of water withdrawals in the area.

North Carolina continues to monitor groundwater quality and gauge contamination based on the 2L rules for groundwater standards. Recently, the Ground Water Management Branch (GWMB) conducted a pilot study in Sampson and Duplin counties to assess the most common nonpoint source pollutants in groundwater at DWR's monitoring wells. Efforts have begun to broaden this sampling effort to all wells in DWR's statewide monitoring network to provide ambient measurements of a large number of parameters and quantify background concentrations.

3.9. Limited Data and Data Management

The spatial location of many point sources of pollution are readily available. Many of these facilities are often required to keep records of effluent concentrations that can then be used by DWR to assist with identifying impacts to water quality. It is difficult, however, to account for all nonpoint sources of pollution.

G.S. 143-215.8B(a)(1) states that the EMC "shall consider the cumulative impacts" of "all activities across a river basin and all point and nonpoint sources of pollutants, including municipal wastewater facilities, industrial wastewater systems, septic tank systems, stormwater management systems, golf courses, farms that use fertilizers and pesticides for crops, public and commercial lawn and gardens, atmospheric deposition, and animal operations." The amount and type of fertilizers, pesticides or herbicides used on farms, golf courses, public and commercial lawn and gardens is not readily available. In addition, the location of poultry operations that utilize a dry waste management system and the fields on which the waste is applied are not easily accessible or known. DWR works with several local agencies to identify potential nonpoint sources of pollution and the types of activities that may be impacting water quality in the area, but data is usually not available to quantify the amount of fertilizers, pesticides, herbicides or dry waste applied to land.

DEQ is in the process of developing a statewide integrated data management system to replace the current, segmented system. This process was initiated several years ago, and is a multi-divisional product that will

improve efficiencies and duplicative efforts. This data management system will not only allow DWR to analyze data in a more in-depth and efficient manner but will also improve DWR's ability to share data and analytical results with the public in a variety of outputs.

3.10. Environmental Justice Agreement

DEQ has reached a settlement agreement with a coalition of community-based environmental groups that will improve regulatory oversight of industrial swine operations and better protect nearby communities from health and environmental impacts. The agreement marks the resolution of civil rights complaints filed against the state environmental agency in 2014 and 2016.

Under the agreement, which resolves complaints filed under the federal Title VI anti-discrimination law, DEQ proposes to make several modifications to the state's animal operations general permit to provide closer regulatory oversight and stronger measures for environmental protection. The general permit is up for renewal this year. DEQ will seek public input from stakeholders and other interested parties when the permit is available for review.

DEQ will also design and implement an air quality study in Duplin County and expand its existing water quality monitoring program in Sampson and Duplin counties. The new monitoring will help the State determine if environmental impacts are occurring in the region, and if so, how to best eliminate those impacts. In addition, DEQ will develop a more robust Title VI program governing all DEQ activities, including a method to assess potential community impacts related to agency decisions. After completing the new measures, DEQ will review the outcome of the general permit renewal process, the monitoring data collected, and the results of an assessment of community impacts to determine if additional action is needed.

Specifically, to the role of DWR and BPB, basin planners have worked with the Water Sciences Section (WSS) to identify watersheds and stream access points within areas with high concentrations of animal feeding operations. A short-term study was started in April 2018 to help evaluate water quality in streams adjacent to areas with a high density of animal operations and to identify an appropriate long-term monitoring station in these agriculturally focused watersheds. Generally, WSS's long-term ambient monitoring program was designed to assess impacts from point source dischargers and less from nonpoint sources of pollutants. The special study and long-term monitoring station data will help to inform future management needs as the knowledge of these specific sources and impacts are better understood.

A copy of the signed agreement can be viewed here.

3.11. Rules Review and Readoption

General Statute §150B-21.3A requires state agencies to review existing rules every 10 years. DEQ's rules are located by subchapters in Title 15A of the NC Administrative Code. Rules administered by DWR and the timeline of each are included in Table 3.

Table 2: Quick Basin Reference Guide for Issues/Concerns Identified (Issues listed are not all-inclusive or in any order of importance or priority.)

Issue/Concern	BRD	CPF	CAT	CHO	FBR	HIW	LTN	LBR	NEU	NEW	PAS	ROA	SAV	TAR	WAT	WOK	YAD
Algal blooms (includes potentially harmful algal blooms)		x		x	x		x				x						x
Animal feeding operations (NPDES or state permit, certificates of coverage)	x	x	x	x	x	x		x	x	x	x	x		x		x	x
Central Coastal Plain Capacity Use Area (CCPCUA)	NA	x	NA	NA	NA	NA	NA	NA	x	NA	x	x	NA	x	NA	x	NA
Coal ash ponds	x	x	x		x				x			x					x
Elevated levels of bacteria	x	x	x		x	x	x		x	x	x					x	x
Elevated levels of bromide		x										x					
Emerging compounds	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Fish consumption advisories for PCBs			x						x								
Impacts to trout waters (temperature, low dissolved oxygen, habitat degradation)	NA	NA	NA	NA	x	x	x	NA	NA	x	NA	NA	x	NA	x	NA	NA
NPDES wastewater facilities and collection systems (sewer overflows, inflow and infiltration, level of treatment, emerging compounds, nutrients, location of return)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Nutrient management strategy (nutrient sensitive waters)	NA	NA	NA	NA	NA	NA	NA	NA	x	NA	NA	NA	NA	x	NA	NA	NA
Nutrients (inorganic nitrogen, organic nitrogen, phosphorus)		x	x	x	x	x	x	x	x		x			x		x	x
Onsite wastewater collection systems (damaged or failing systems)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Poultry operations that produce a dry litter waste and are deemed permitted under NCAC 02T .1303*	x	x	x	x				x	x	x	x	x		x		x	x
Sediment loads increasing (habitat degradation, increased treatment costs for water supplies)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Issue/Concern	BRD	CPF	CAT	CHO	FBR	HIW	LTN	LBR	NEU	NEW	PAS	ROA	SAV	TAR	WAT	WOK	YAD
Shellfish harvesting areas closed (coastal basins) due to elevated bacterial levels	NA	x	NA	x	NA	NA	NA	x	x	NA	x	NA	NA	NA	NA	x	NA
Stormwater (includes concerns related to increased volume and velocity)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Increasing temperature (higher temperatures can contribute to algal blooms, decrease dissolved oxygen concentrations, decrease benthic and fish productivity)	x			x	x	x	x			x			x		x		

*The location of operations that are deemed permitted are unknown. Information about the number and types of birds in a county can be found in the USDA National Agriculture Statistics Service (NASS) Quick Stats query tool.

Table 3: Rules Review Administered by DWR and the Status of Each

Rule Number	Item Description	Rule Review	Readoption Date
15A NCAC 02B .0100, .0200, .0300	Water Quality Standards & Classifications / "Triennial Review", NSW rules* except Jordan/Falls lake rules	Completed	10/2019
15A NCAC 02B .0200 **(selected rules)**	Jordan/Falls NSW rules*	Completed	Postponed by SL 2018-5, Jordan begins by 12/2020, Falls begins by 2024
15A NCAC 02B & 02H	Wetlands, Buffers, Surface Water Permitting	Completed	10/2019
15A NCAC 02C	Well Construction & Contracting	Completed	12/2019
15A NCAC 02E	Water Use Registration & Allocation	Completed	Date not set
15A NCAC 02G	Water Projects, Aquatic Weeds	In Progress	Date not set
15A NCAC 02H .0800, .1100	Laboratory Certifications	Completed	10/2019
15A NCAC 02L .0100	Groundwater General Consideration	Completed	Date not set
15A NCAC 02L .0200, .0300	Groundwater Standards & Classifications	Completed	N/A
15A NCAC 02T	Non-Discharge Permitting	Completed	Completed
15A NCAC 02U	Re-use Water Program	Completed	Completed
15A NCAC 18C	Rules Governing Public Water Systems	Completed	July 31, 2019.
***NSW rules propsed for transfer to 15A NCAC 02B .0700**			

Proposed rules are available on the EMC's Proposed Rules webpage.

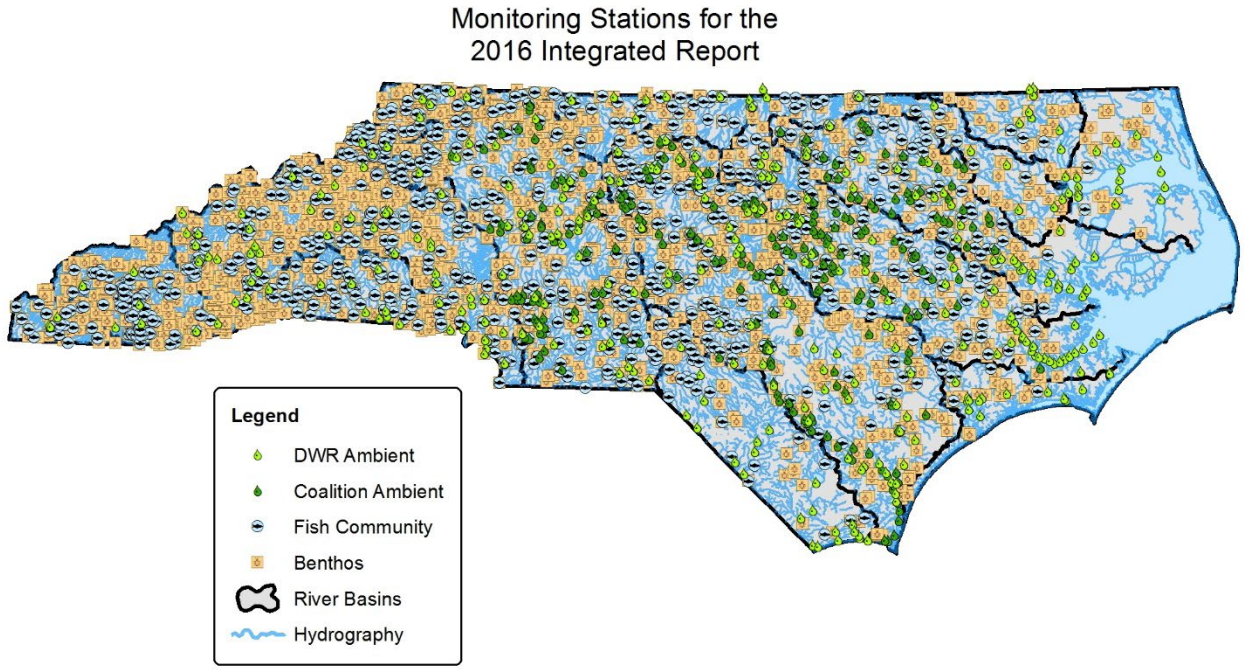
4. Water Quality Monitoring and Pollutant Concentrations

DWR's Ambient Monitoring System (AMS), along with seven monitoring coalitions, collect physical and chemical data from ambient monitoring stations across the state. A monitoring coalition is a group of stakeholders that combine resources and expertise to collectively fund and perform an instream monitoring program (e.g., NPDES coalition, citizen science). Coalitions can be found in the Cape Fear, Neuse, New, Tar-Pamlico and Yadkin-Pee Dee river basins.

Data collected from 361 DWR-AMS stations and 269 coalition monitoring stations was used to assess water quality for the 2016 Integrated Report (IR) (Figure 1). The IR lists all monitored waters, the parameters used to assess that waterbody, the assessment criteria status, and the category it is assigned (Table 4). It fulfills

the reporting requirements of Section 305(b) of the federal Clean Water Act (CWA). Impaired waters are reported on the 303(d) list (named for Section 303(d) of the CWA). The 303(d) list is submitted to the EPA for approval every two years and uses a five-year dataset. Procedures used to evaluate water quality and assign categories are explained in detail in the IR methodology.

Figure 1: Ambient Monitoring Stations – 2016 Integrated Report



All water quality parameters (Table 5) collected in a waterbody or assessment unit (AU) are assessed independently. Assessment criteria are based on the frequency of exceedances of the numeric or narrative water quality standards. There are currently 13,402 AUs in the state. Each AU varies in size based on the specific characteristics of the waterbody being evaluated. Because the characteristics of AUs vary, some units are only monitored for a subset of parameters.

4.1. Impairment Summary

Water quality impairments are compiled and submitted to the EPA for review and approval pursuant to Section 303(d) of the Clean Water Act. The results are based on a five-year compilation of data that has been quality assured and quality controlled (QA/QC). The 2014 and 2016 impairment assessments are based on data collected from 2008-2012 and 2010-2014, respectively. Figure 2 illustrates the number of AUs impaired for each assessment period based on the water quality parameters shown on the bottom of the graph and denotes an increase (red) or decrease (blue) in the number of AUs between the two periods. Figure 3 is a map of the 2016 IR use support stream status for all waters of the state.

Table 4: North Carolina Assessment Criteria and Associated IR Categories

Assessment Criteria Status	Integrated Report Category	Use Support
MC – Meeting standard criteria for parameter of interest	1	Supporting
DI – Data inconclusive to make an assessment for parameter of interest	3	Not Rated
EC – Exceeding standard criteria for parameter of interest	4	Impaired (with approved management strategy)
	5	Impaired (on 303(d) list; management measures/ strategy needed)
No Data - No Data available to make an assessment	NA	

Table 5: North Carolina Ambient Monitoring Program Water Quality Parameters[+]

Physical Parameters	Chemical Parameters	Biological Parameters
Dissolved Oxygen	Nutrients – NH_3, NO_2+NO_3, TKN, TP	Fecal Coliform Bacteria – Fresh & Saltwater
pH	Hardness	*Enterococcus* Bacteria - Saltwater
Specific Conductance	Chlorophyll *a* *	
Water Temperature	Metals ^ – Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Zn	
Turbidity		

+ Not all parameters listed are collected at each station or collected at the same sampling frequency. Generally, all stations are monitored monthly.

* Chlorophyll *a* is collected in lakes and estuaries or in areas of slower moving water such as behind a dam on flowing streams.

^ The standard for metals changed from total recoverable to dissolved metals as part of the 2015 Triennial review process. In 2007, DWR suspended sample collection for total recoverable metals due to the change in the proposed metals standard. In 2016, DWR started collecting dissolved metals for assessment purposes at select stations throughout the state. At this time, no new metals data is available for assessment purposes. Dissolved metals will be assessed and included in the upcoming 2018 303(d) Impaired waters list.

Water quality monitoring for total recoverable metals assessment was suspended in April 2007 to allow for evaluation and re-adoption of revised standards using the most current science. In November 2014, as part of the Triennial Review process, the EMC approved new dissolved metals standards, which became effective for state purposes in January 2015. The EPA approved these standards for CWA purposes in April 2016. DWR began collecting dissolved metal samples at certain locations in 2016. An assessment for metals will be incorporated into the next integrated report in 2018. The metals data included below are for total recoverable metals impairments (Figure 2).

The draft 2018 statewide water quality impaired waters assessment (303(d) list) will be available for public review in late summer 2018 along with the 2018 303(d) listing and delisting methodology. The 2018 listing and delisting methodology includes changes to listing and delisting decisions to account for small sample sizes and statistical confidence in meeting criteria. The 2018 listing and delisting methodology was approved by the EMC on March 8, 2018. DWR intends to submit the 2018 303(d) list to EPA in January 2019.

Figure 2: Statewide Water Quality Impairments for Integrated Reporting (IR) Years 2014 and 2016

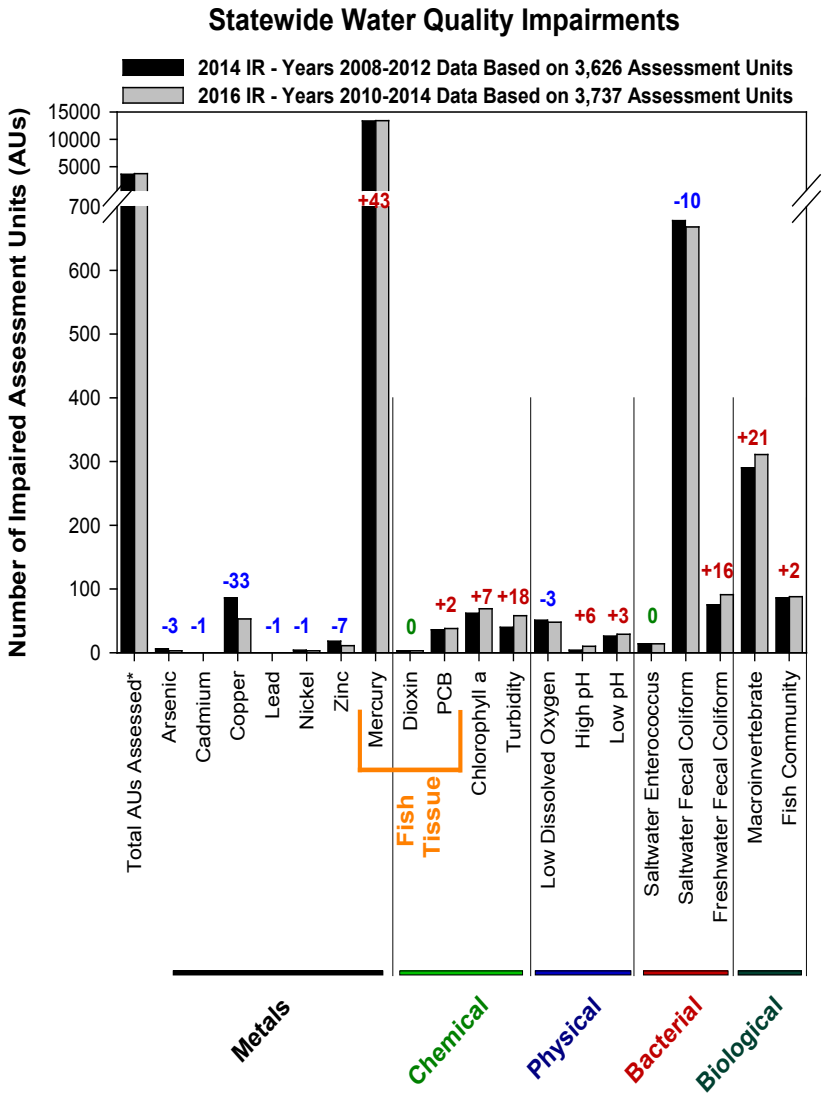
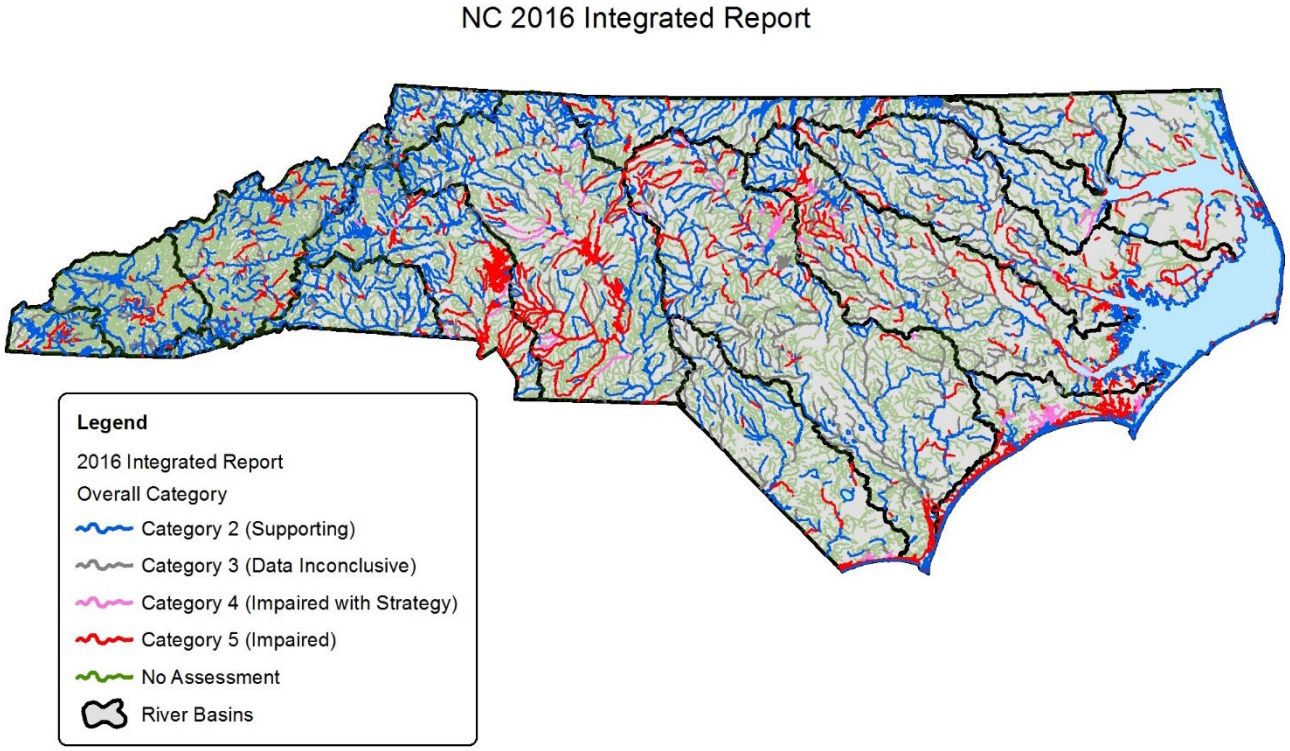


Figure 3: Overall Categories for Monitored Waters in North Carolina – 2016 Integrated Report



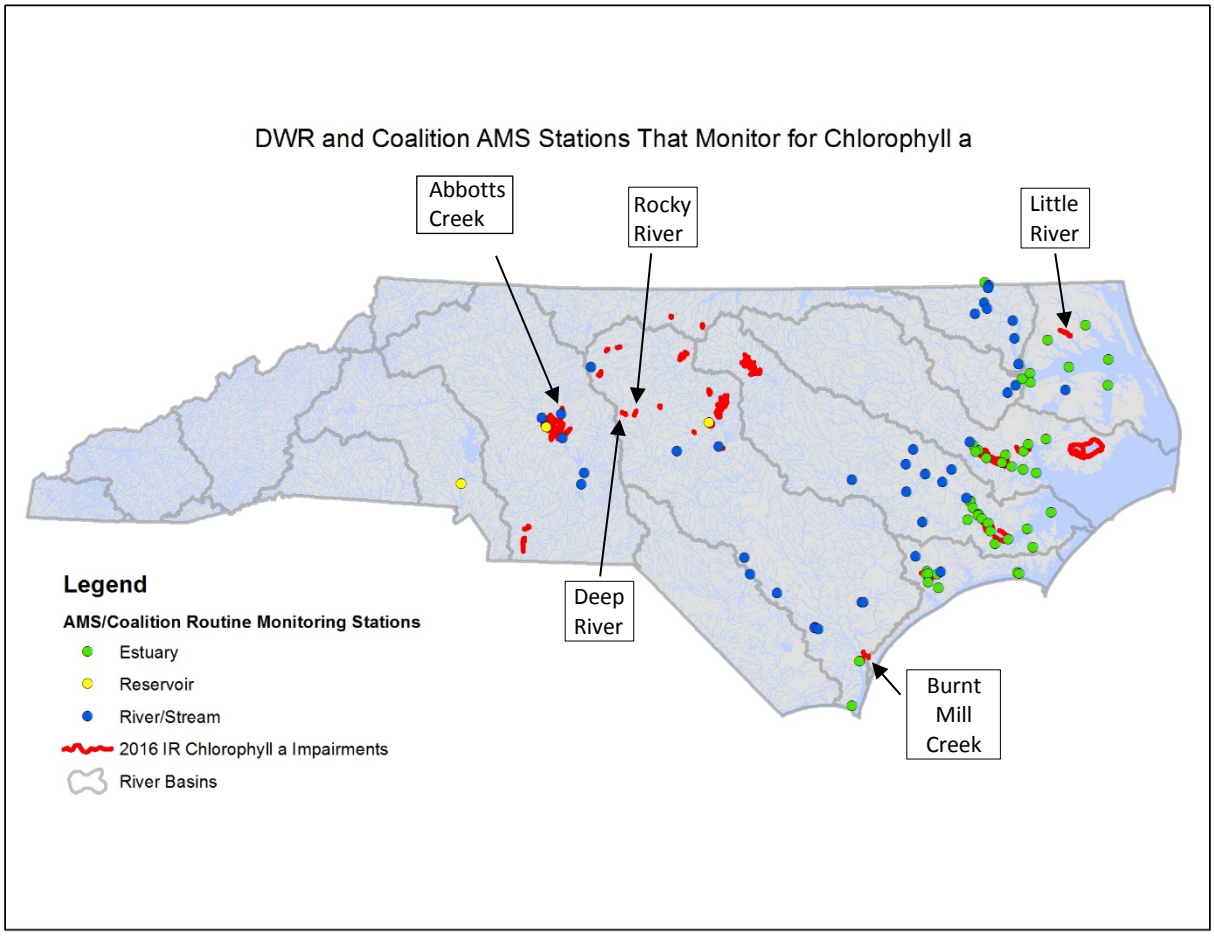
4.2. Evaluating Nutrients in Surface Waters using Existing NC Criteria and Lakes Trophic State

North Carolina does not currently have instream numeric nitrogen or phosphorus standard criteria to protect all designated surface water uses. Generally referred to as nutrients, nitrogen and phosphorus can act as a pollutant at high concentrations resulting in eutrophic conditions and increased biological productivity. Chlorophyll *a* is commonly used to assess planktonic/water column algal productivity (i.e. a measure of algal biomass). Currently, the NC chlorophyll *a* standard of 40 µg/L is used to determine when the biomass may have negative effects on an aquatic environment. Chlorophyll *a* is generally accepted as a primary response variable that supports the identification of waterbodies that are impacted by excessive nutrient inputs. However, this measure is only effective in waters that support the growth of phytoplankton, as opposed to waters that have attached algae or filamentous mats. Therefore, the measure has limited use outside of lakes, reservoirs, large (slow-moving) rivers and estuaries (1992, *Standard Methods for the Examination of Water and Wastewater*, 18th Edition, Section 10200 Plankton, page 10-2). Dissolved Oxygen and pH are also accepted secondary response indicators once there is excess biological productivity occurring in a nutrient impacted waterbody.

Of the 590 ambient monitoring stations evaluated across the state for the 2016 IR assessment (DWR-AMS program and NPDES monitoring coalitions), there were 87 stations at which chlorophyll *a* was collected and evaluated as part of the routine monitoring programs (generally monitored monthly/12 times per year). Of the 87 stations monitored, only 39 stations are in what was classified as a "river/stream" waterbody type (6.6% of the total stations were assessed for chlorophyll *a*). The majority of these are located in the eastern

portion of the state (Figure 4). The only river/stream station that is currently violating the 40 µg/L chlorophyll *a* standard is station Q5970000 in the Abbotts Creek arm of High Rock Lake. Of the remaining 48 stations evaluated for chlorophyll *a*, 45 stations are estuarine and 3 are in reservoirs (Figure 4). There are four additional flowing river segments that are impaired for chlorophyll *a*; these include a small portion of the Deep River, Rocky River and Burnt Mill Creek in the Cape Fear River Basin as well as the upper portion of the Little River in the Pasquotank River Basin (Figure 4). These impairments are behind dams or in very slow-moving coastal streams and rivers. These segments were not monitored for chlorophyll *a* as part of the 2016 IR assessment, the impairment status is carried forward from an earlier assessment until such times that they can be further assessed.

Figure 4: 2016 IR Chlorophyll *a* Impairments (category 4 and 5) and Associated Ambient Monitoring Program Stations (No Basinwide Lakes Stations Included).



DWR generally monitors for chlorophyll *a* in the state's recreational lakes and drinking water reservoirs. Lakes are valued for the multiple benefits they provide to the public, including recreational boating, fishing, drinking water, and aesthetic enjoyment. The Intensive Survey Branch (ISB) collects and interprets a variety of biological, chemical, and physical data that are incorporated into the basinwide planning process. The ISB monitoring program includes the Ambient Lake Monitoring Program (ALMP) and other special study projects like the long-term assessment of the nutrient management strategy implementation effect on

Jordan and Falls lakes. The ALMP originated under EPA's Clean Lakes Program and the data are used to calculate the state of nutrient enrichment (trophic state) and determine if lakes meet their designated uses. The 2016 IR methodology requires 10 or more samples collected in a 5-year period to determine if a lake is meeting its designated use. There are at least 16 lakes listed as exceeding the chlorophyll *a* criterion (40 µg/L) (Figure 4, 5 a and 5b).

Generally, lakes are monitored on a basin rotation with each basin monitored every five years. Monitoring is performed monthly during the summer (May through September) and the number of stations in each lake varies depending on the size and characteristics of the lake. Between 2012 and 2016, ISB monitored 130 lakes, in 15 river basins and determined the trophic status of each lake (24 had at least 10 samples collected). The trophic state is a relative description of the biological productivity of a lake based on the calculated North Carolina Trophic State Index (NCTSI) value. The NCTSI was specifically developed for NC lakes as part of the state's original Clean Lakes Classification Survey (1982). The index accounts for nutrients along with chlorophyll *a* concentration and Secchi depth to calculate the lake's biological productivity. Trophic states may range from extremely productive (hypereutrophic) to very low productivity (oligotrophic) (Table 6). Trophic states are not used to determine the overall use support status of a lake.

Table 6: Trophic State Description and Generally Expected Data Ranges (Carlson and Simpson, 1996*)

Trophic State	Chl a* (µg/L)	Secchi Depth* (m)	TP* (µg/L)	Trophic State Description
Dystrophic				Low primary productivity associated with high humic color
Oligotrophic	0-2.6	>8-4	0-12	Low primary productivity associated with low nitrogen and phosphorus levels
Mesotrophic	2.6-20	4-2	12-24	Intermediate level of primary productivity and medium levels of nutrients
Eutrophic	20-56	2-0.5	24-96	High primary productivity associated with high nitrogen and phosphorus levels
Hypereutrophic	56-155+	0.5-<0.25	96-384+	Very high productivity and nutrient levels characterized by frequent and severe nuisance algal blooms and low transparency.

* Carlson, R.E. and J. Simpson. 1996. *A Coordinator's Guide to Volunteer Lake Monitoring Methods*. North American Lake Management Society. 96 pp.

Figure 5a: Ambient Lakes Assessment Programs 2012-2016 Lake Trophic State Determination and Mid-Lake Station Median Chlorophyll *a* Concentration Values in Western NC.

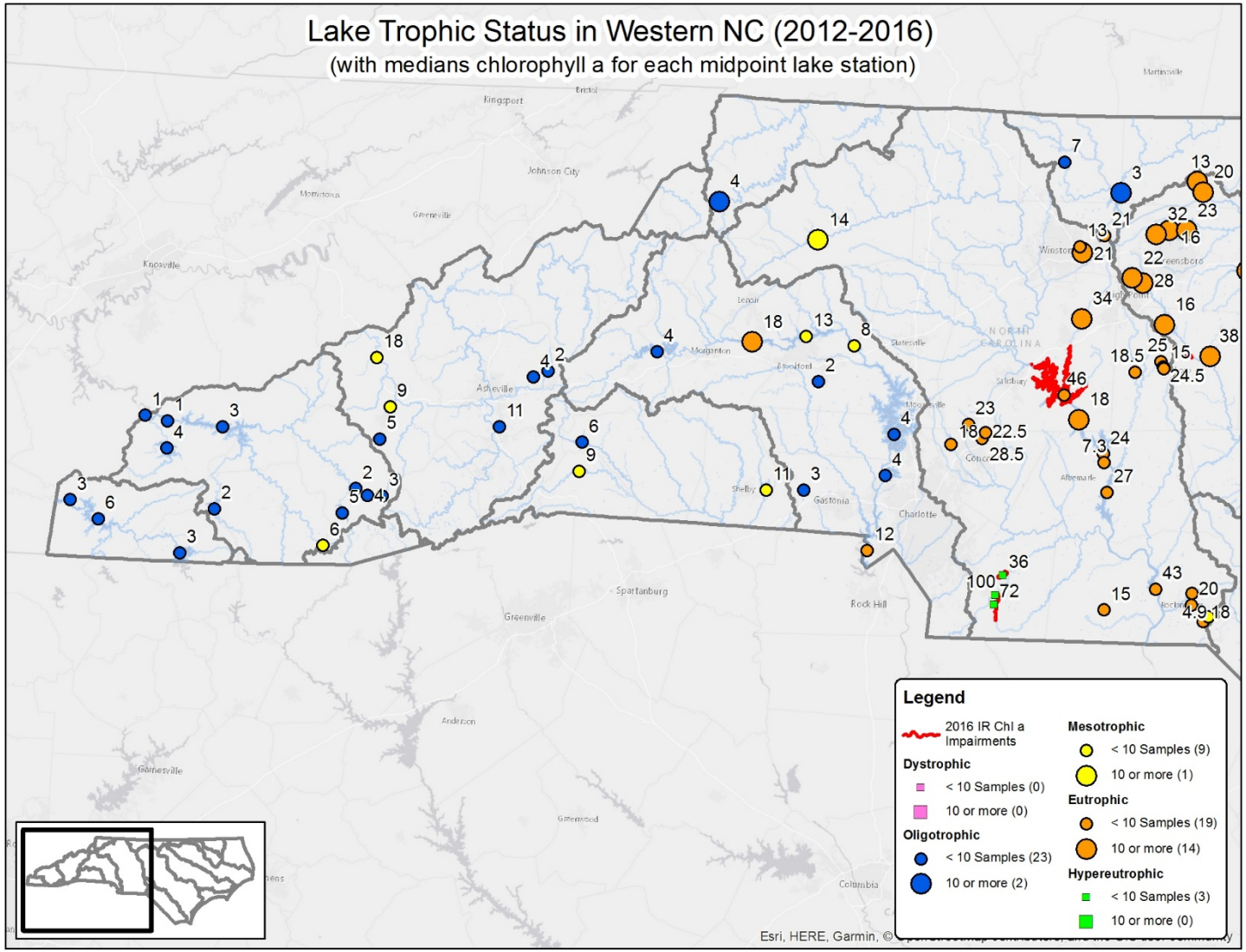
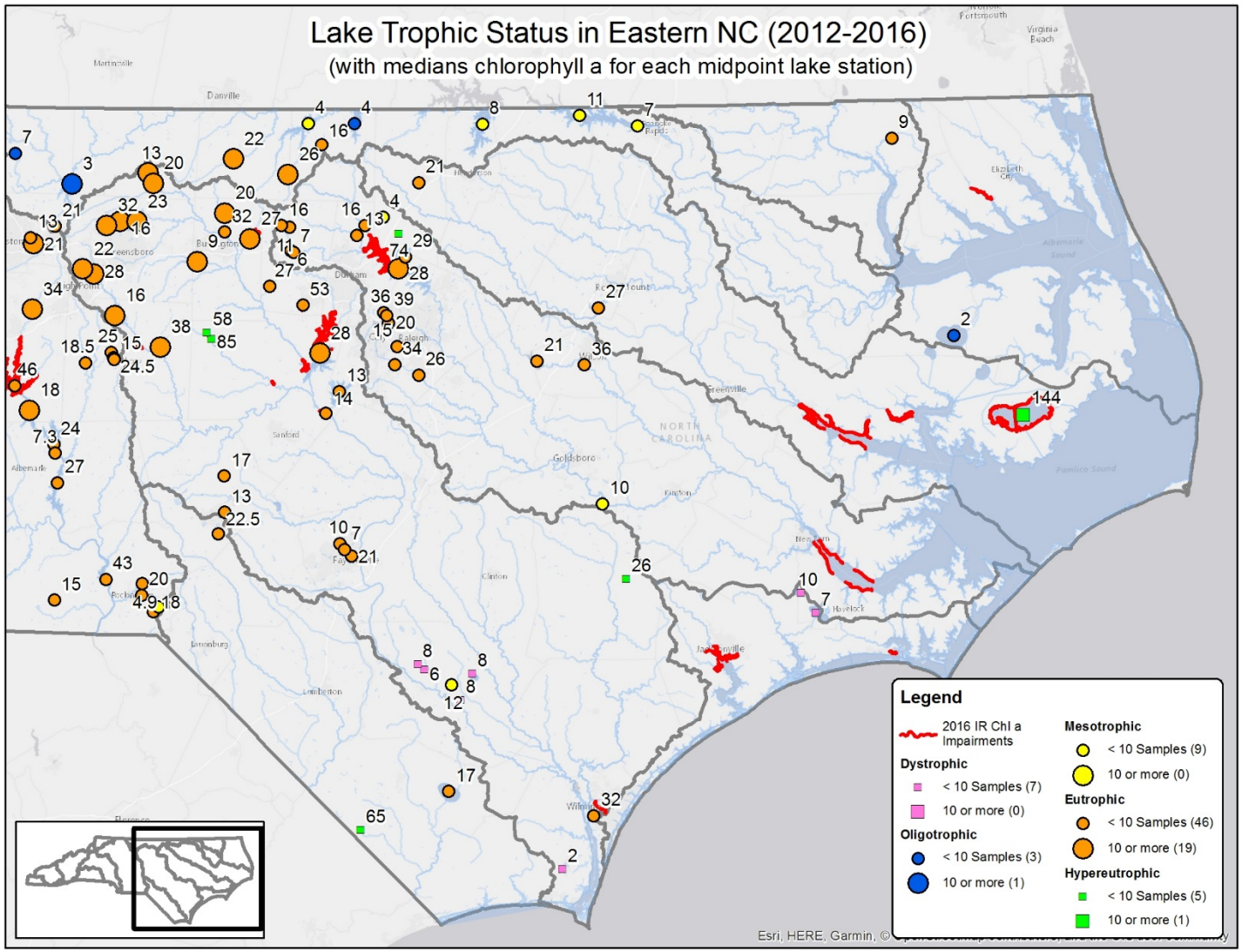


Figure 5b: Ambient Lakes Assessment Programs 2012-2016 Lake Trophic State Determination and Mid-Lake Station Median Chlorophyll *a* Concentration Values in Eastern NC.



The estimated trophic state for each lake is the overall lake status for the last year the data were collected (Table 7). The median chlorophyll *a* value represented on the map is for the station closest to the center of the lake (Figure 5a and 5b). Over the 2011-2016 evaluation period, 71 lakes in eight river basins were identified as eutrophic and 9 lakes in 5 river basins were identified as hypereutrophic (Table 8 and Figure 5a and 5b). The majority of the eutrophic and hypereutrophic lakes are located in the Piedmont and Coastal Plain of NC. The chlorophyll *a* concentrations ranged between 1-119 µg/L in the eutrophic lakes and between 10-215 µg/L in the hypereutrophic lakes (Table 8). The highest median chlorophyll *a* concentration of 144 µg/L was in Lake Mattumuskeet, which was determined to be hypereutrophic in 2012. There were 27 lakes in eight river basins identified as oligotrophic, of these the chlorophyll *a* concentration ranged between 1-28 µg/L (Table 8 and Figure 5a and 5b). The majority of the oligotrophic lakes are located in the western half of the state (Figure 5a and 5b). It should be noted that because lakes are dynamic, the trophic status of a lake can change during the season due to changes in flow, nutrient input and uptake, as well as changes in turbidity and sedimentation. Data collected at two lakes as a result of chronic algal bloom occurrences, White Lake in the Cape Fear River Basin and Waterville Lake in the French Broad River Basin, are showing signs of eutrophication resulting in the trophic status shifting from mesotrophic in 2013 and 2012, respectively, to eutrophic based on data collected in 2017 and 2018. Information on these two lakes can be found in the river basin specific summaries in Section 5 of this report.

Table 7: ISB Ambient Monitoring Program, Number of Lakes and River Basins Evaluated by Year.

Year	Number of Lakes Monitored	Lakes Monitored as Part of the Basinwide Lakes Assessment
2012	18	Catawba, French Broad, Tar-Pamlico
2013	34	Cape Fear, New
2014	26	Hiwassee, Little Tennessee, Roanoke, White Oak
2015	23	Broad, Chowan, Neuse, Pasquotank
2016	28*	Lumber, Yadkin-Pee Dee

*Rockingham City Lake was not monitored in 2016, so the trophic status reported on the map are for data collected in 2011 as part of the basinwide ambient lakes monitoring program. A total of 131 different lakes have been assessed between 2011 and 2016.
In 2017, the Catawba, French Broad and the Tar-Pamlico river basins were sampled and in 2018, the Cape Fear and New river basins are being sampled as part of the basinwide ambient lakes monitoring program.

Jordan and Falls lakes are currently categorized as eutrophic. ISB is continuing a special study on Jordan and Falls lakes by monitoring for a suite of parameters that includes chlorophyll *a* and algal speciation at least monthly. The individual yearly summaries can be found here. An assessment of use support will be completed for both lakes as part of the 2018 303(d) and IR requirement, which will include the data from years 2012-2016. Large portions of both Falls Lake and Jordan Lake remained listed as exceeding water quality criteria for the 2016 IR.

Table 8: NC Lakes Trophic State and Chlorophyll *a* Concentration Ranges (Based on a Single Mid-Lake Station, 2011-2016 Collection Years).

Trophic State	Number of Lakes	Chl a µg/L Data Range	Chl a µg/L Mean Range	Chl a µg/L Median Range	River Basins
Dystrophic	7	1-28	2-13	2-10	Cape Fear, White Oak
Oligotrophic	27	1-28	1-13	1-11	Broad, Catawba, French Broad, Hiwassee, Little Tennessee, New, Pasquotank, Roanoke
Mesotrophic	20	2-92	4-28	4-18	Broad, Cape Fear, Catawba, French Broad, Little Tennessee, Lumber, Neuse, Roanoke, Yadkin-Pee Dee
Eutrophic	71	1-119	6-54	5-53	Cape Fear, Catawba, Chowan, Lumber, Neuse, Roanoke, Tar-Pamlico, Yadkin-Pee Dee
Hypereutrophic	9	10-215	35-104	26-144	Cape Fear, Lumber, Neuse, Tar-Pamlico, Yadkin-Pee Dee

The purpose of the Jordan Lake study is to evaluate progress in reducing nutrient and nutrient related pollution. The study began in 2009 and currently collects samples from nine monitoring locations from the three distinct arms of the lake. See the Jordan Lake Study Plan for specific details. A preliminary statistical analysis comparing 2016 to 2006-2015 mean chlorophyll *a* concentration at one station in each of the three nutrient management segments of the lake found no significant difference between the two-time periods (table 9). However, 2016 mean and median values in in the Morgan and New Hope Creek Arms are noticeably reduced relative to the earlier time period unlike those in the Haw Arm.

As detailed in a separate DEQ report to the ERC, implementation of portions of the Jordan Lake strategy has been postponed by a series of legislative actions subsequent to 2009 enactment of the rules. While wastewater discharge phosphorus limits have been in effect since 2010, nitrogen limits are postponed to 2019, an action contested by EPA. Implementation of both New Development and Existing Development Stormwater rules by local governments is stopped indefinitely while state/federal New Development stormwater requirements remain underway since 2012. Agricultural compliance is delayed from 2015 to 2018. Riparian buffer protection rules remain in effect since 2010.

The purpose of the Falls Lake study is to evaluate the progress in attainment of water quality standards and use support as required by the nutrient management strategy rules. The study began in May 2010 and currently collects samples from 12 stations throughout the lake. See the Falls Lake Study Plan for specific details. A preliminary statistical analysis comparing 2016 to 2006-2015 mean chlorophyll *a* concentration at station NEU013B in the upper section of Falls Lake (below Interstate 85) found a statistically significant difference (95% confident) between the 2016 (31.5 µg/L chl *a*) and the 2006-2015 (43.5 µg/L chl *a*) concentration using the non-parametric Wilcoxon/Kruskal-Wallis Rank Sums test (Table 9). This suggests that under the climatic conditions experienced in 2016, it appears that the initial implementation measures in place, as result of the Falls Lake management strategy, may be exerting a positive impact on the water quality in this segment of the lake. Additional analysis is needed to understand the results on the entire lake and over a broader time period and under different climatic conditions.

A large increase in the 2017 yearly mean chlorophyll *a* concentrations occurred at nearly all stations in both lakes. The mean and percent of samples exceeding the 40 µg/L standard for several stations representing different segments of the lakes can be seen in Table 10. Additional analysis are needed to understand the drivers behind the increase associated with the 2017 chlorophyll *a* concentrations over 2016 levels. A large rain event in October 2016 (Hurricane Matthew) and a much wetter than normal 2017 spring, may have triggered an elevated algal response as result of added nutrient inputs to these systems. Precipitation driven variability in nutrient inputs is indicative of nonpoint source runoff and supports the need of for implementing nonpoint source controls of nutrients throughout both watersheds, including the full implementation of reductions from existing development.

The Upper Neuse River Basin Association (UNRBA; www.unrba.org) was formed in 1996 to provide an ongoing forum for cooperation on water quality protection and water resource planning and management within the Falls Lake watershed. The Association is made up of seven municipalities, 6 counties, and local Soil and Water Conservation Districts in the watershed. The UNRBA's mission is two-fold: to help its members comply with the Stage I of the Falls Lake Rules and to jointly reevaluate the Stage II rules in order to develop an updated nutrient management strategy that will improve water quality through the application of innovative and cost-effective principles of watershed management. Since August 2014, the UNRBA has invested more than $800,000 per year collecting and analyzing water quality data in Falls Lake and its watershed. The UNRBA's 2018 annual monitoring report can be found here. The main objective of the monitoring program is to develop a revised lake response and watershed model, support alternative regulatory options as needed and allocate nutrient load to sources and jurisdictions. After October 2018, the associations efforts are expected to shift from primarily monitoring towards modeling and analytical efforts.

The Division and the UNRBA continue to work in collaboration on rule implementation and the strategy reexamination process. Staff are currently working with the UNRBA to develop their existing development Stage I jurisdiction loads, expanding the toolbox of nutrient removing practices, and creating a model program document to provide guidance to local government implementing the requirements of the rule. The UNRBA also continues to collaborate with the Division on their monitoring and remodeling efforts as they engage stakeholders and work towards agreement on modeling and assessment tool viability that will allow the reexamination process to focus efforts on development of an updated Nutrient Management Strategy.

As a requirement of the Falls Lake Nutrient Management Rules, DWR is required to report to the EMC on progress of implementation of the rules, evaluating changes in nutrient loading to the lake, detailing progress towards achieving the chlorophyll *a* water quality standard, and characterizing advances in scientific understanding and control and accounting technologies. The first report was completed in 2016 and will be reassessed and presented to the EMC every five years. The 2016 Status Report, Falls Lake Nutrient Strategy is available on the DWR Nonpoint Source Planning website.

Table 9: Statistical Analysis Comparing 2016 to 2006-2015 Mean Chlorophyll *a* Concentrations at Several Lake Stations in Jordan and Falls Lake^

Lake	Station*	Assessment Period	Number of Samples	Mean Chl a (µg/L)	Standard Deviation	Significant^
Jordan Lake	Haw River Arm CPF055C	2016	14	30.1	18.8	Not Significant (P=0.6072)
		2006-2015	143	31.7	16.2	
	Morgan Creek Arm CPF086C	2016	14	50.8	19.5	Not Significant (P=0.1945)
		2006-2015	143	60.4	24.1	
	New Hope Creek Arm CPF081A1C	2016	14	50.1	20.4	Not Significant (P=0.2044)
		2006-2015	143	58.8	23.5	
Falls Lake	Upper Lake (Below I-85) NEU13B	2016	12	31.5	14.9	**Significantly Different** (P=0.0465)
		2006-2015	113	43.5	18.2	

*See link for Map of Jordan Lake Stations and 2016 data summary; Map of Falls Lake Stations and 2016 data summary.
^Statistical Test - Non-parametric Wilcoxon/Kruskal-Wallis Rank Sums Test.

4.3. Evaluating Emerging Compounds in Jordan and Falls Lake

The Intensive Survey Branch has completed a study in Jordan Lake and started a study in Falls Lake to identify emerging compounds in the lakes and surrounding watersheds. The objective of the study is to provide DWR information on per- and polyfluoroalkyl substances (23 selected PFAS including GenX, PFOA and PFOS), as well as 1,4-dioxane and bromide levels in lakes and connecting creeks and rivers. Bromide and 1,4-dioxane samples will be analyzed by DWR's WSS in Raleigh, and PFAS samples analyzed by EPA's Science and Ecosystem Support Division (SESD) in Athens, GA.

The Jordan Lake and associated watershed monitoring occurred between January and June 2018 at six lake stations and seven watershed ambient monitoring stations. A Jordan Lake watershed report should be completed by the end of 2018.

The Falls Lake and associated watershed monitoring is occurring between July and December 2018 at five lake stations and five watershed ambient monitoring stations. A Falls Lake watershed report should be completed by the spring of 2019.

Table 10: 2016 and 2017 comparison of Yearly Mean Chlorophyll *a* Concentration and Percent Exceedance of the Standard at Several Lake Stations in Jordan and Falls lakes.

Lake	Station*	Sample Year	Number of Samples	Mean Chl a µg/L	Percent Exceeding Standard
Jordan Lake	Haw River Arm CPF055C	2016	14	30.1	21.4 %
		2017	12	41.9	50.0 %
	Morgan Creek Arm CPF086C	2016	14	50.8	71.4 %
		2017	12	62.1	75.0 %
	New Hope Creek Arm CPF081A1C	2016	14	50.1	71.4 %
		2017	12	61.8	83.3 %
	Lower New Hope Area CPF087D	2016	14	29.4	14.3 %
		2017	12	42.1	41.7 %
Falls Lake	Upper Lake (Below I-85) NEU13B	2016	12	31.5	25.0 %
		2017	12	40.1	50.0%
	Upper Lake (Above NC 50) NEU13B	2016	12	24.2	0 %
		2017	12	41.6	33.3 %
	Lower Lake (Below NC 50) NEU19E	2016	12	23.8	0 %
		2017	12	39.4	25.0 %
	Lower Lake (Below NC 98) NEU19P	2016	12	19.5	0 %
		2017	12	36.9	25.0 %
Annual data summary sheets for Jordan Lake and Falls Lake can be found here - https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/intensive-survey-branch/falls-jordan-lakes-monitoring					

5. Summary of Each River Basin

5.1. Broad River Basin

The Broad River basin plan is currently being updated and is scheduled to be presented to the EMC for approval in 2019. Habitat degradation and the associated water quality impacts have been identified as a major water quality concern throughout the basin. In most cases, it is degraded by the cumulative effect of several stressors acting in concert. These stressors often originate in the upstream portions of the basin and may include runoff from impervious surface, sedimentation from construction runoff, general agricultural practices, and/or other land disturbing activities. Naturally erodible soils in the Broad River basin make streams highly vulnerable to these stressors. Habitat degradation (as indicated by impaired biological integrity and high turbidity) was identified as a major stressor for nearly 270 miles of streams in the Broad River basin. The wide distribution of turbidity standard violations at ambient monitoring stations

makes it difficult to isolate a single source whether point or nonpoint in the Broad River basin. However, it appears that violations are highest in urban and agricultural areas and lower in the upper headwater portions of the basin where land use is predominantly forested and there are more natural, wider stream buffers to reduce the amount of nonpoint source runoff from entering the stream.

Fecal coliform bacteria and low pH are also stressors identified in the basin. Even though no waters in the basin were impaired for fecal coliform bacteria, concentrations were above the standard of 400 CFU/100 mL water quality guidelines in more than 20 percent of samples at four of the eight ambient monitoring stations. The presence of fecal coliform bacteria in the aquatic environment indicates that the water has been contaminated from the fecal material of humans or other warm-blooded animals. Low pH was noted in two stream segments: First Broad River and Sugar Branch. Values below 6.5 may indicate the effects of acid rain or other acidic inputs. Additional research is needed to determine the sources resulting in low pH.

Stormwater, increased flow and velocity, erosion and sediment control, steep slope development, pesticide/herbicides and nutrient management from urban and agricultural land (crop, animal and aquaculture facilities), animal access to streams, and damaged or aging wastewater collection systems have been identified as key contributors to water quality issues and habitat degradation in the basin. It has been recognized that there are several abandoned furniture manufacturing plants that are contributing large amounts of stormwater runoff issues to the system due to unmaintained BMPs and large concentrations of impervious cover. This is one area in which economic redevelopment with appropriate stormwater controls could improve downstream water quality.

5.2. Catawba River Basin

Habitat degradation and the associated water quality impacts have been identified as a major water quality concern and has resulted in many biological impairments throughout the entire basin. Changes in land use, particularly an increase in developed and impervious surface areas in and around urban areas, has resulted in more stormwater runoff. Stormwater runoff can quickly increase a stream's velocity even during small rain events. The sudden increase in volume and velocity can cause significant scouring and eroding along streambanks eliminating aquatic habitat and increasing sedimentation. Additional studies are needed to determine where stormwater management practices could have the greatest impact on protecting aquatic habitats.

In the upper portion of the basin, high levels of fecal coliform bacteria have been an ongoing issue. Sources of bacteria include failing septic systems, straight pipes and animal operations. For many years, the Wastewater Discharge Elimination (WaDE) Program provided financial assistance to repair failing systems in lower income areas. Progress was being made and fecal coliform bacteria levels were starting to decline but progress has slowed with the loss of the WaDE Program. Local efforts by the counties and the Western Piedmont Council of Government (COG) continues the efforts established by WaDE to provide financial assistance on a limited basis which has resulted in the continuing decline in fecal coliform bacteria levels. Reinstatement of the WaDE Program would greatly decrease the rate at which fecal coliform bacteria is released in streams often used for recreational purposes.

The 2010 Catawba River basin plan also notes that many of the lakes in the basin are becoming more eutrophic due to elevated nitrogen levels. Increased nutrient monitoring and additional studies are needed to determine the sources of the excess loading.

S. L. 2017-209, House Bill 56, Section 12 directed DWR to conduct a "water quality sampling program for nutrients along the mainstem of the Catawba River, which includes sampling for nutrients above, in and below each major tributary of the Catawba River." Upon consultation with the NC General Assembly, DWR's Water Sciences Section (WSS) developed a study plan to meet the requirements under S.L. 2017-209. The study focuses on the Catawba River mainstem and major tributaries upstream of Lake Norman as well as the South Fork Catawba River and major tributaries in Burke and Caldwell Counties. Nutrient data collected from existing ambient monitoring stations is being analyzed. Ten new monitoring stations were also added to the study in an effort to understand nutrients in the basin. Data continues to be analyzed and is being shared through a Catawba River Nutrient Study Story Map developed by WSS. A report on the results of the study is due to the ERC by October 1, 2018.

5.3. Cape Fear River Basin

The Cape Fear River basin plan is currently being updated and is scheduled to be presented to the EMC for approval in 2019. Nutrient enrichment has been identified as a major water quality concern throughout the basin and led to the development of a TMDL and nutrient management strategies in portions of the basin. The basin is also experiencing many of the common water quality concerns seen throughout the state, including increased aquatic life impairments and habitat degradation due to excessive stormwater runoff. In addition to habitat degradation, excessive stormwater runoff also leads to increased sedimentation and often elevated fecal coliform concentrations. The lack of riparian buffer protections and requirements throughout the basin may be contributing to many of the water quality issues identified in the basin. The continual loss of riparian buffers will continue to exacerbate impacts to water quality.

A Jordan Lake TMDL was approved by EPA in 2007, and in May 2008, the EMC adopted a nutrient management strategy for the Haw River/Jordan Lake watershed. Implementation of nutrient management strategies has been delayed as result of multiple legislative mandates beginning in 2012 and resulting in the prohibition of local implementation of new development and Stage 2 existing development stormwater rules.

S.L. 2016-94 Section 14.13(e) and S.L 2017-57 Section 13.24 mandated the study of in-situ treatments, including algaecide and phosphorus locking technologies and extended the study window. In Fall 2017 a proposed study was denied approval by the US Army Corps of Engineers primarily due lack of data about effects on biological communities and the potential loss of water storage in the lake.

S.L. 2016-94 Section 14.13(c) established the NC Policy Collaboratory to undertake a nutrient management study to evaluate the effectiveness of the Jordan and Falls nutrient strategies, as well as the costs and benefits of nutrient strategies in other states. The final results of this study will include recommendations for further actions regarding nutrient strategies, including any statutory or regulatory changes necessary to implement the recommendations.

S.L. 2018-5 Section 13.8 mandates the NC Policy Collaboratory provide the final results and recommendations of its Jordan Lake study by December 31, 2019 and update a quantitative model of Jordan Lake and the Haw River subbasin of the Cape Fear River. Interim reports are due December 31, 2016, 2017, and 2018. Interim reports can be found on line at https://collaboratory.unc.edu/current-projects/legislative-studies. This session law also requires the Environmental Management Commission begin Jordan Lake watershed rulemaking upon receipt of the final results and recommendations and the associated modeling or monitoring, or by December 31, 2020, whichever comes first. The continued strategy implementation delays will most likely result in additional nutrient reduction needs in order to sufficiently reduce algae growth to meet water quality standards in Jordan Lake.

Water quality issues can also be found in the Haw, Deep and Cape Fear rivers below Jordan Lake as a result of elevated nutrient loading. In recent years, portions of the Cape Fear River have begun to experience algal blooms, some of which are potentially toxic and have resulted in human contact advisories. Research is occurring at the university level to determine the causes and potential solutions. In addition, DWR is in the beginning stages of development of nutrient and dissolved oxygen models for portions of the Cape Fear River Basin to provide tools to evaluate assimilative capacity and to provide a mechanism to evaluate the relative impact of various sources on nutrient and dissolved oxygen conditions in the mainstem Cape Fear River. The modeling will begin following a two-year intensive monitoring study that will begin in January 2019 with support from DWR and the associated discharger monitoring coalitions.

In accordance with the Nutrient Criteria Development Plan (NCDP), DWR staff are also working closely with a Science Advisory Council (SAC) and the Criteria Implementation Committee to evaluate, implement, and/or revise nutrient-related water quality criteria for the central portion of the Cape Fear River basin.

Emerging compounds have been identified as a serious concern throughout the Cape Fear River basin. Division staff have worked closely with research being done by NC State University (NCSU) to locate elevated levels of polyfluoroalkyl substances such as C8, GenX and Nafion byproducts as well as 1,4-dioxane throughout portions of the basin. The basin plan will include information on these new emergent compounds. As described in Section 4.3, Jordan Lake and the watershed draining to the lake were monitored for several emerging compounds from January through June 2018. A Jordan Lake watershed report should be completed by the end of 2018. Eighteen water supply reservoirs were also monitored as part of a pilot project for cyanotoxins (see Section 3.5) as well as a one-time assessment for emergent compounds at a station closest to a water intake.

White Lake is a unique Carolina Bay Lake used extensively for water-based recreation activities. This NC State Park lake, historically had clear acidic water with low biological productivity. DWR has monitored White Lake since 1981 as part of the routine basinwide ambient lakes monitoring program. A shift in the biological productivity has occurred over the last several years. In 2015, DWR initiated a study as a result of concerns about reduced water clarity and increased algal productivity. To understand why the water quality has changed so drastically in the last several years, a groundwater/surface water survey was done in 2017 which indicated that the deep groundwater aquifers many no longer provide the inflows that were experienced in the past. It appears the hydrology of the system is now predominantly driven by precipitation and nutrient-rich (nitrogen and phosphorus) shallow groundwater.

In 2018, a White Lake Technical Advisory Committee (TAC) was developed to assist the resource agencies and the Town in understanding and resolving the water quality issues in White Lake. DEQ have a number of staff members with a wide range of knowledge participating on the TAC. The Town of White Lake is funding researchers from UNCW and the Bald Head Island Conservancy to help better document the sources of groundwater, surface water and nutrients to the lake. This information will help to guide the Town and the Division to what actions are needed to reduce the nutrient loading to the system and lower the biological productivity.

Several algal blooms have occurred in White Lake over the last two years and a large fish kill was documented in May of 2018. The Town of White Lake requested a permit from DWR to apply alum (aluminum sulfate) to the lake to help improve the water clarity and reduce the phosphorus concentrations, thereby limiting algal growth. This treatment coincided with an ongoing algal bloom. DWR determined that the co-stressors of an intense algal bloom and the alum treatment caused the fish kill. This was supported by a NCSU fish necropsy report, which referenced a combination of stresses caused by environmental factors from an algal bloom (DO and pH fluctuations) and "acute exposure to Alum" as "a cause of this multi-species fish kill". Dissolved metals analyses from samples collected during the fish kill later confirmed that the concentrations of copper and aluminum were at levels that could cause toxic effect on aquatic organisms.

DWR has currently deployed (June – September) a water quality monitoring platform in the center of the lake to collect hourly measurement on a variety of parameters that will help inform the science, as there are often significant temporal changes that cannot be seen with weekly or monthly monitoring.

The long-term water supply needs of the public water systems that depend on surface water from the Deep, Haw and Cape Fear river subbasins were evaluated. The multi-year process resulted in round four of the Jordan Lake surface water allocation. The allocation was approved in March 2017 by the EMC and included new and increased water supply allocations from the Jordan Lake water supply pool. To support the decision-making process, the current and future water demands of the community water systems and self-supplied industrial operations that use surface water from the Deep, Haw and Cape Fear river subbasins were evaluated using the Cape Fear-Neuse River Basins Hydrologic Model. Given the assumptions in the model, the increased allocations from Jordan Lake and the water shortage response plans submitted by public water supply systems, these users are not expected to face flow-related water supply shortages through the level of withdrawals needed to meet demands expected through 2060, with one exception. The Chatham County-North water system, with its increased allocation from Jordan Lake, is expected to meet the level of withdrawals needed to supply anticipated customer demands through 2045. If customer demands increase to the levels expected to be needed in 2060, the system may need to find additional sources of water. Details of the Jordan Lake water supply allocations and the Cape Fear River surface water supply evaluation can be found on the DWR website (https://deq.nc.gov/about/divisions/water-resources/planning/basin-planning/map-page/cape-fear-river-basin-landing/jordan-lake-water-supply-allocation/jordan-lake-water-supply-allocation-round-4).

5.4. Chowan River Basin

The Chowan River basin plan is currently being updated and is scheduled to be presented to the EMC for approval in 2019. Nutrient loading continues to be a water quality issue in the Chowan River basin. First documented in the 1990s, the Chowan River basin was the first basin to have nutrient reduction goals with a 20 percent reduction of nitrogen and 35 percent reduction of phosphorus. The goals were established through the Nutrient Sensitive Waters (NSW) Water Quality Management Plan for the Chowan River Basin. Even with the NSW management plan in place, the Chowan River and its tributaries have seen a steady increase in organic nitrogen concentrations since 2000 with significant algal blooms reported between 2015 - 2018.

Approximately 75 percent of the river basin is in Virginia with the all the headwaters draining to North Carolina. Working with the Albemarle-Pamlico National Estuary Partnership (APNEP), efforts are underway to collaborate with natural resource agencies and stakeholders in Virginia, as well as North Carolina, to better understand nutrient loading and its impact to water quality in North Carolina. The Albemarle Commission has obtained a Clean Water Management Trust Fund (CWMTF) grant to study the drivers of algal blooms in the Chowan River and the Potecasi River. They are collaborating with state and local environmental groups. Local resource agency staff have noted an increase in poultry operations throughout the basin, but specific geographical spatial locations, number of animals and amount of dry litter waste produced and land applied is not readily available due to rules put into place by the United Stated Department of Agriculture (USDA) making it difficult to evaluate water quality impacts from this potential nutrient source.

5.5. French Broad River Basin

Sediment, nutrients and bacteria are the most significant threats to water quality and aquatic habitats in the French Broad River basin. Several stream segments and waterbodies within the basin are classified for recreational use, and fecal coliform bacteria has been identified as a water quality concern in some of these recreational areas. Sources of bacteria include (but are not limited to) failing septic systems, straight pipes, sanitary sewer overflows and animal access to streams. Heavy storm events often result in increased levels of fecal coliform bacteria due to nonpoint source runoff. Increased flows also resuspend or mix bottom sediment which can increase bacterial levels in the water during and after rain events.

Over the past few years, cyanobacteria blooms (often referred to as bluegreen algae) have been occurring in Waterville Lake. Waterville Lake (also known as Walters Dam) is an impoundment on the Pigeon River. Cyanobacteria blooms have been shown to produce cyanotoxins. DWR staff from WSS and the Asheville Regional office (ARO) are working with Duke Energy and Warren Wilson College to collect monthly physical and chemical parameters and monitor the blooms should they reoccur to determine potential causes and whether the blooms are having any downstream effects.

5.6. Hiwassee

Water quality has been an ongoing concern for stakeholders throughout the Hiwassee River basin because river recreation (boating, kayaking, fishing, swimming) is a vital part of the economy for counties located within the basin. Habitat degradation from excess sediment and warmer temperatures in areas with

inadequate riparian buffers and unstable streambanks is a significant issue. Bacterial contamination caused by a combination of cattle access to streams, failing septic systems, year round Canada geese populations, and a wastewater treatment plant in need of equipment updates have been associated with bacterial impairments in the basin. Significant hydrologic modification in the basin from the Chatuge, Hiwassee, and Appalachia dams along the Hiwassee River have altered the natural flow regime and stream habitat. Generally, the water released from the dams is good quality as TVA has implemented measures to aerate discharge waters and maintain minimum flows. Although, the colder temperatures have changed the fish community from historic records and there is limited information on what alterations to the benthic communities may have occurred. The magnitude and duration of the dam release have also caused some downstream problems; stream bank erosion from fast moving water and flooding of homes and agricultural fields due to dam releases after heavy rains this past spring.

Construction in the basin has increased impervious surface areas and altered natural hydrology by inhibiting stormwater infiltration. Building near steep and unstable streambanks has been particularly problematic for stream sediment inputs. Implementation of stormwater BMPs is highly needed. Monitoring by DWR in the Hiwassee River basin is also extremely limited. Currently, there are only two permanent ambient monitoring stations in the entire 644 square mile basin.

5.7. Little Tennessee River Basin

Impairments in the Little Tennessee River basin are mostly associated with aquatic communities and high levels of fecal coliform bacteria. Steep slope development, agricultural runoff, streambank erosion, limited riparian areas, failing culverts, individual on-site wastewater collection systems as well as damaged or aging municipal wastewater collection systems were identified key contributors to water quality issues identified in the 2012 basin plan.

Fontana Lake, a Tennessee Valley Authority (TVA) impoundment, is formed by a dam downstream of the confluence of the Little Tennessee, Tuckasegee and Nantahala rivers. For the past three summers (2015, 2016 and 2017), the Tuckasegee arm of Fontana Lake has seen potentially harmful algal blooms (pHABs). Adverse health effects have not been reported, but the public was encouraged to avoid contact with large accumulations of algae and prevent children and pets from swimming or ingesting water near or in the affected areas. Water quality data collected at the ambient monitoring station just upstream of the backwaters of the lake indicate that nonpoint source runoff during rain events may be adding excess nutrients to the river and contributing to the algal blooms. The exact source of the nutrients or the reason for the algal blooms is unknown. Additional research and analytical tools are needed to help the department understand the cause of the algal blooms.

5.8. Lumber River Basin

Stormwater, rapid growth and development, damaged or aging wastewater infrastructure, and large agricultural operations were identified as water quality issues in the 2010 Lumber River basin. Elevated bacteria concentrations from stormwater runoff, leaking septic systems and/or municipal wastewater collection systems are impacting shellfish harvest areas with all shellfish waters impaired due to either permanently or frequently closed shellfish areas. Much of the stormwater runoff can be attributed to

population growth in Brunswick County which is in the lower part of the basin. Brunswick County alone has grown over 500 percent in the last 50 years.

Efforts are underway to reduce stormwater runoff in the Lockwoods Folly River watershed along the Brunswick County coast. A Water Quality Management Plan became effective in 2014 and includes Lockwoods Folly River north from the Intracoastal Waterway to a line extending from Genoes Point to Mullet Creek to protect and improve water quality throughout the watershed. Proper planning including stormwater management programs, wastewater treatment plant upgrades, and land conservation are required to protect water quality as the area continues to grow. For activities, such as stormwater controls, proactive implementation prior to development can save considerable costs compared to retrofitting. Low dissolved oxygen, turbidity and low pH have also been identified as parameters of interest in the basin.

5.9. Neuse River Basin

The Neuse River Basin Water Resource Plan is currently being updated. The basin plan will be completed in two steps. The first piece, to support the NPDES renewal process, will include an assessment of the Neuse River Basin NSW Strategy and trend analysis. The full plan will follow and will include a Falls Lake Management implementation progress, the Cape Fear–Neuse River basin hydrologic model and analysis along with the general water quality and quantity issues at the subbasin and basin level. Information about the hydrologic model can be found in Section 5.3.

DWR resources and implementation activities in the Neuse River Basin have focused primarily on the implementation of the Falls Lake Water Supply Nutrient Strategy (15A NCAC 02B .0275 to .0282 and 15A NCAC 02B .0235 and .0315), which became effective January 15, 2011. Neuse River estuarine NSW implementation efforts are ongoing and have been reported to the Water Quality Committee (WQC) and EMC as requested and through the annual agricultural report to the EMC.

Falls Lake nutrient management and rule review were affected by Session Law 2016-94, Section 14.13. Section 14.13(d) requires initiation of re-adoption steps by March 2019. S.L. 2018-5 Section 13.8 modified this timeline, mandating that the NC Policy Collaboratory provide the final results and recommendations of its Falls Lake study by December 31, 2023 (instead of December 2021), with interim reports due December 31, 2019 and 2021. It further requires the Environmental Management Commission begin Falls Lake rulemaking upon receipt of the final results and recommendations and the associated modeling or monitoring, or by December 31, 2024, whichever comes first.

SL 2018-5 Section 13.8.(c) also modified SL 2016-94 14.13(h) to extend the end of current Stage 1 of the Falls Lake nutrient strategy from December 2020 to the date that amended Falls rules become effective.

Water quality analysis of the Neuse River Basin finds that the overall NSW goal to reduce total nitrogen by 30 percent has not been achieved. The original nutrient reduction efforts were successful in reducing loads from both municipal and agricultural sources. The required riparian buffers have helped to limit additional nutrient-laden stormwater runoff from new and existing development throughout the basin. However, despite these efforts and reductions that have been made, DWR has identified an increase in the organic nitrogen load. This increase is currently offsetting the reductions made as result of the NSW rules. See Section 3.2 for additional information about increasing nutrients and its impact to water quality.

As part of the required basin planning process in a designated NSW watershed, the success and limitations of the NSW rules are assessed. In the Neuse River basin, the last assessment identified gaps in the existing nutrient management strategy and included recommendations or modifications to possibly improve the strategy in order to meet water quality standards in the estuary. As a result of the required rules review legislation (§150B-21.3A), the Neuse River Basin Nutrient Sensitive Waters (NSW) Management Strategy rules found in 15 NCAC 02B .0232 - .0242 must be re-adopted.

The DWR's Planning Section continues to develop and assess new information that can inform future nutrient strategy improvements. Recent internal efforts have focused on identifying potential sources of increasing organic loads to the Neuse River Estuary. Areas of inquiry include the potential influence of poultry operations, an evaluation of organic nitrogen trends in North Carolina and neighboring states, and an evaluation of laboratory methods over time. To date, no single source has been identified as the cause for increasing organic nitrogen trends. Further systematic evaluation is needed to identify or exclude many potential sources of increasing organic nitrogen in the Neuse River basin. Since 2014, DEQ has worked with stakeholders to address concerns with the existing nutrient management strategy and the nutrient offset rule that applies across nutrient strategies. Because the water quality standard is still not met in the Neuse River Estuary, DEQ has proposed minor modifications. The modifications address the recommendations identified during the basin planning process as well as the rules review and stakeholder input process. Reviewing and modifying the existing rules provides an opportunity for the State to grant additional protection and/or management measures in the basin to achieve the required goal of improving water quality and meet water quality standards in the Neuse River Estuary. As land use changes and development continues, it is important to utilize the adaptive management approach to improve the outcome and protections necessary to improve water quality in the estuary. As technology and scientific knowledge improves, utilizing the adaptive management option will play an important role in meeting water quality standards.

5.10. New River Basin

Habitat degradation (as indicated by impaired biological integrity and high turbidity) and the associated water quality impacts have been identified as a major water quality concern in the New River basin. In most cases, degradation was the result of the cumulative effect of several stressors acting in concert. The stressors often originate in the upstream portions of the basin and include runoff from impervious surface, sedimentation from construction runoff, general agricultural practices, and/or other land disturbing activities. The distribution of turbidity permit violations and standard exceedances at AMS stations make it difficult to isolate potential sources in the New River Basin. However, it appears that violations are highest in urban and agricultural areas. Violations are lowest in most headwater portions of the basin where land use is predominantly forested. This demonstrates the importance of protecting and conserving stream buffers and natural areas.

Data collected between 1997 and 2009 at the six AMS stations within the basin showed an increase in pH levels. An increase in surface water pH can be influenced by many different natural factors including drought, heavy rains, algae, other aquatic plant growth, and/or decomposition of organic material among others. Human influences to rising pH levels include discharging acidic effluent, atmospheric deposition, and stormwater runoff containing excessive nutrients. Monthly data shows a gradual increase from 2001

to 2008. The presence of periphyton was noted several times during the last biological sampling cycle. Periphyton is an algae-like growth that flourishes in waterbodies with elevated nutrient levels and ample sunlight. These conditions during periods of drought can greatly accelerate aquatic plant growth. The photosynthesis process uses CO_2 within the water column, which can cause pH levels to increase. This may be one possible cause of the increasing pH levels. Other possible causes of the increasing levels in the basin could be atmospheric deposition, groundwater or precipitation. The exact reasons for the increase in pH is unknown.

5.11. Pasquotank River Basin

The Pasquotank River basin plan is currently being updated and is scheduled to be presented to the EMC for approval in 2019. Nutrients continue to be a water quality issue throughout the basin. Since the early 1990s, monitoring data has shown a steady increase in phosphorus in the Little River, and a steady increase in organic nitrogen has also been identified across all AMS stations since the mid-1990s. The steady increase in nutrients across the basin likely contributed to the algal blooms that were reported in the Albemarle Sound, Little River and Perquimans River in 2015, 2016 and 2017. Aquatic weeds (such as alligator weed and hydrilla) have also been identified as a concern throughout the basin over the years. Aquatic weeds can impede recreational activities (a vital part of the economy for counties located within the basin) and cause navigational hazards. A recommendation was made in the 2007 basin plan to develop a regional approach to control the spread of these invasive weeds.

The Albemarle Resource Conservation and Development Council (RC&D) was awarded a 319 grant to install an instream wetland on a private agricultural ditch in order to address the chlorophyll *a* impairment downstream in the Little River. This is the second 319 grant the RC&CD was awarded in this watershed. They recently applied for 319 funds to install a third instream wetland hoping to develop a critical mass of wetlands to manage stormwater runoff. Agricultural operations have opened drainage canals that directly carry sediments and nutrients to the river, and residential and commercial developments have increased pollution from stormwater runoff.

5.12. Roanoke River Basin

Three stream segments have been added to the 2016 303(d) list for fair or poor fish community. Field biologists have noted the increase in sedimentation at these sites and recommended additional sampling be done on these sites to confirm their rating . Elevated water temperatures, chlorophyll *a*, fecal coliform bacteria and turbidity are also identified as continuing water quality concerns throughout the basin. These water quality concerns will be addressed in the next basin assessment.

Since the approval of the 2012 basin plan, a major water quality issue that has been identified in the basin is the coal ash spill that occurred in the Dan River from Duke's Dan River Steam Station near Eden, which occurred in February 2014. Current water quality monitoring data of the Dan River indicate that levels of coal ash related constituents are similar to conditions measured upstream indicating that the constituents are naturally occurring, or background readings. Coal ash excavation from the onsite basins started in November 2015. The excavation will continue and the coal ash basins are scheduled to be properly closed by August 1, 2019.

The development and implementation of three Dan River watershed restoration plans have contributed to effective management measures in the basin. The plans were developed by local resource agencies and stakeholders throughout the basin and funded through EPA Section 319 grants administered through DWR. There continue to be benthic macroinvertebrate community impairments on Smith Creek and Smith River. The continued implementation of these three watershed restoration planning efforts are working towards improving the water quality and habitat causing these impairments. The three restorations planning documents are the *Dan River Watershed Restoration Plan for Agricultural Non-Point Sources of Pollution* (2012), *Smith Creek Watershed Restoration Plan* (2008) and *Eden Area Watershed Restoration Plan* (2014).

5.13. Savannah River Basin

Several streams in the Savannah River basin have the supplemental classification of Trout (Tr) and Outstanding Resource Waters (ORW) with portions of two rivers (Horsepasture and Chattooga) being designated as National Wild and Scenic Rivers. Low pH, elevated temperatures and fecal coliform bacteria are identified as water quality concerns in portions of the basin.

Due to public concerns about erosion near whitewater boat trails and access points, sedimentation in the river and its impact to trout habitat, a special biological study was performed in the Chattooga River in September 2016. The special study noted that between 1991 and 2011, land use has changed from a mostly forested watershed to a mixed watershed with forest and urban or developed areas, increasing the imperviousness of the watershed. The study determined that, although no rainbow or the native brook trout were collected, the population and the diversity of age classes of brown trout supported the continued classification of the river as an ORW. The benthic macroinvertebrate portion of the biological assessment also found no impacted due to the alleged increase in sedimentation and all the sites received an Excellent bioclassification.

5.14. Tar-Pamlico River Basin

The 2015 Tar-Pamlico River basin plan was the first attempt to integrate water quality and water quantity planning. Stormwater, increased flow and velocity, erosion and sediment control, pesticide and nutrient management from urban and agricultural land (crop, animal and aquaculture facilities), and damaged or aging wastewater collection systems have been identified as key contributors to water quality issues in the basin. Several communities in the basin do not have or do not fall under a stormwater management program and additional research is needed to assess how uncontrolled stormwater runoff is impacting surface waters and nutrient loading to the estuary. Protecting existing riparian buffers can also play a critical role in stabilizing and protecting streambanks and reduce nutrients from overland flow.

Because nutrients have been a water quality concern for the basin, waters in the basin were designated as Nutrient Sensitive Waters (NSW) in 1989. Despite the apparent successful implementation in reducing nutrient loads from municipal wastewater facilities and several agricultural practices, the goal of reducing total nitrogen by 30 percent has not been met. Data collected over the last several years indicate that organic nitrogen is increasing and additional information about organic nitrogen can be found in Section 3.2. As described in the Neuse River Basin section, recent internal efforts have focused on identifying potential sources of increasing organic loads to North Carolina's estuarine waters. The plan also notes that it is likely that there are nutrient sources beyond those regulated under the nutrient management strategy

that may be contributing to the nutrient loads and that some nonpoint sources may not have been accounted for or are exceeding the original source (i.e., land use changes or changes to agricultural operations). While the implementation efforts taken to date have not fully achieved compliance with the NSW strategy, the nutrient reductions achieved by point sources and agriculture have helped reduce the severity of fish kills in the Pamlico River and Estuary. DEQ is continuing to work with municipal wastewater facilities and the agricultural community to maintain their compliance with the strategy.

As part of the required basin planning process in a designated NSW watershed, the success and limitations of the NSW rules are assessed. In the Tar-Pamlico River basin, the assessment identified gaps in the existing nutrient management strategy and included recommendations or modifications to possibly improve the strategy in order to meet water quality standards in the estuary. As a result of the required rules review legislation (§150B-21.3A), the Tar-Pamlico River Basin Nutrient Sensitive Waters (NSW) Management Strategy rules found in 15 NCAC 02B .0255 - .0261 must be re-adopted.

Since 2014, DEQ has worked with stakeholders to address concerns with the existing nutrient management strategy and the nutrient offset rule that applies across nutrient strategies. Because the water quality standard is still not met in the Pamlico River Estuary, DEQ has proposed minor modifications. The modifications address the recommendations identified during the basin planning process as well as the rules review and stakeholder input process. Reviewing and modifying the existing rules provides an opportunity for the State to grant additional protection and/or management measures in the basin to achieve the required goal of improving water quality and meet water quality standards in the Pamlico River Estuary. As land use changes and development continues, it is important to utilize the adaptive management approach to improve the outcome and protections necessary to improve water quality in the estuary. As technology and scientific knowledge improves, utilizing the adaptive management option will play an important role in meeting water quality standards.

Located in the Tar-Pamlico River basin, Lake Mattamuskeet is the largest natural lake in NC and is part of the Mattamuskeet National Wildlife Refuge. The lake provides habitat for over 250,000 wintering waterfowl and other migratory birds. The entire lake was added to the 2016 impaired waters list due to elevated chlorophyll *a* concentrations and pH levels. USGS monitored the lake on four occasions between May and September 2017. DWR monitored the lake in May 2017 and found that the lake trophic status has increased from eutrophic to hypereutrophic. The chlorophyll *a* concentrations in 2017 ranging between 110 and 210 µg/L (state standard is 40 µg/L). DWR is working with the US Fish and Wildlife Service (FWS) to better understand the water quality of this unique system and to understand the nutrient sources and algal bloom issues. The FWS is considering posting signs around the lake for the public to take caution due to the pHABs that have been identified over the last few years and possible toxins associated with them.

A local watershed restoration planning effort began in 2016 and has involved many different stakeholders in order to identify the sources of the problems within the watershed as well as identify solutions. The North Carolina Coastal Federation is partnering with the US Fish and Wildlife Service, the NC Wildlife Resources Commission and Hyde County to develop the *Lake Matthamuskeet Watershed Restoration Plan*. Development of the plan has included eleven stakeholder meetings and four public meetings to date. The three main goals of the plan are:

1. Protect the way of life in Hyde County while supporting the lake's natural resources.
2. Reduce flooding by improving the ability to control lake levels.
3. Restore water quality by reducing nutrients and sedimentation, which will promote the growth of submerged aquatic grasses for waterfowl habitat and removing the lake from the state's impaired waters list.

The final draft of the plan will be presented during a public symposium in Hyde County on December 3, 2018.

5.15. Watauga River Basin

The Watauga River basin plan has undergone internal review with local resource agencies and watershed groups, and is scheduled to be presented to the EMC for approval in 2018. Stormwater, steep slope development, limited riparian areas, streambank erosion, individual onsite wastewater collection systems as well as damaged or aging public water supply systems and municipal wastewater collections systems are impacting water quality and quantity in the Watauga River basin. Beaverdam Creek is the only impaired water in the North Carolina portion of the basin, and several agricultural best management practices have been installed and continue to be installed throughout the watershed in an effort to improve aquatic habitat and remove the stream from the impaired waters list. Water quality data collected at the ambient monitoring stations and by the Wildlife Resources Commission (WRC) indicates that temperature is increasing in the mainstem of the Watauga River. Many of the streams in the basin support a rich and diverse trout population, but the numbers have been declining over recent years due to development, limited shade from riparian areas and increased stormwater runoff.

The Town of Beech Mountain is located in the Beech Creek watershed. The Beech Mountain public water supply (PWS) system serves a year-round population of 340 people and a seasonal population of over 5,000 people during the months of January, February, March, June, July, August and December. Based on information reported in the 2012 local water supply plan (LWSP), the PWS system cannot meet the current or long-term water supply needs for its customer base. Working with the town, DWR issued a Water Supply Availability report in September 2015 that identified the needs and challenges associated with the town's current water supply. In the 2015 LWSP, the town reported that it has taken several steps over the past several years to monitor water use and identify areas for improvement. The improvements have resulted in water loss being reduced from 85 to 47 percent, but the town is still not able to meet its long-term water supply needs. DWR's Water Supply Development Program continues to work with the Town of Beech Mountain to identify how best to meet current and future water supply needs.

5.16. White Oak River Basin

The White Oak River basin plan is currently being developed and is scheduled to be presented to the EMC for approval in 2019. Stormwater runoff, new development/construction, impervious surface areas, animal waste management, and damaged or aging wastewater collection systems are impacting water quality in the White Oak River basin. Coastal communities in the basin are constantly changing, and for decades, the traditional uses of waterfront property have been shifting to accommodate an increase in permanent residents, seasonal rental properties and new development. Residential development has moved inland along tidal creeks and rivers introducing more impervious area and increased stormwater runoff. As a result,

many of the water dependent resources that people seek out from the North Carolina coastline are diminishing. Public waterfront access is limited, high fecal coliform levels prevent shellfish harvesting and beach recreation, fish houses have closed, and overall fish harvests have continued to decline in the White Oak River basin.

Several agencies, including DWR, Division of Coastal Management (DCM), Division of Energy, Mineral & Land Resources (DEMLR), Division of Marine Fisheries (DMF), the Soil and Water Conservation Districts (SWCDs), Parks and Recreation, and Environmental Health, are responsible for many coastal activities, policies and education and outreach throughout the basin. Topics include stormwater management, development, erosion control programs, agriculture and land preservation, shellfish protection and recreational monitoring. Additional state programs and many interagency and group partnerships work together to protect the resources found in coastal waters and communities. The Coastal Habitat Protection Plan (CHPP) is a plan to manage and restore aquatic habitats critical to North Carolina's commercial and recreational fisheries resources. The New River NSW strategy will be evaluated as part of the basin plan update and may include recommendations for possible nonpoint source nutrient contribution reductions.

5.17. Yadkin-Pee Dee River Basin

Several streams in the Yadkin-Pee Dee River basin are impaired for aquatic life due to habitat degradation and the associated water quality impacts. This is occurring throughout the basin but largely in urban/suburban areas where increasing impervious surfaces result in greater stormwater runoff, higher peak flows (flashy stream) and lower baseflows. Streambank and instream habitat erosion along with elevated turbidity and pollutant loading concentrations are making it difficult to protect sustainable aquatic populations.

Elevated fecal coliform bacteria due to stormwater runoff in urban and agricultural areas is also identified as a water quality concern in the basin. Protecting the existing riparian buffers can aid in the protecting and stabilizing streams, reducing impacts to water quality.

Local resource agencies and data collected through the NCDA&CS is indicating that there has been a large increase in poultry operations in the upper Yadkin-Pee Dee watershed, particularly in Yadkin and Wilkes counties. Specific geographical spatial locations, numbers of birds and amount of dry litter waste production is not available making it difficult to evaluate water quality impacts from this potential nutrient source.

High Rock Lake is impaired for turbidity, chlorophyll *a*, and high pH. The lake is very turbid in the upper reaches, and for a large portion of the year, experiences algal blooms downstream of the location where the sediment settles out. Nutrient-related water quality criteria are being evaluated for High Rock Lake through the Science Advisory Council (SAC) in accordance with the Nutrient Criteria Development Plan (NCDP) facilitated by DWR. This process, to date, has been supported by extensive data analysis, ambient monitoring studies, and a watershed and lake model. The data indicate that the lake's trophic status is eutrophic to hypereutrophic depending on the time of year. A regulatory approach to reducing nitrogen, phosphorus and sediment may ultimately be warranted for High Rock Lake. However, this determination largely depends on the nutrient-related criteria that are adopted in accordance with the NCDP. DWR is also

working with stakeholders in the basin, specifically the Yadkin Pee Dee River Basin Association, whose members hold NPDES permits, to understand their concerns.

The Yadkin Pee Dee Water Management Group (YPDWMG), a basin work group formerly created in 2016 and composed of 18 public utilities and reservoir operators (modeled after the Catawba Wateree Water Management Group) has started collaborating with DWR on planning a hydrologic model. Three hydrologic model platforms are being considered; the Computerized Hydroelectric Operations Software (CHEOPS) model owned by HDR, the Operational and Simulations of Integrated Systems (OASIS) model owned by Hydrologics, or a CHEOPS/OASIS combination model. A technical committee has been formed to review the water quantity planning needs of both YPDWMG and DWR and the technical and financial feasibility of developing the three model types to determine which model platform type will be best to pursue by DWR for contractual development, potentially during the 2019/2020 fiscal year. The YPDWMG also plans to use the model to develop a regional level "Master Water Supply Plan" and "Drought Response Plan" for the basin to ensure communities will be able to meet the growing demand for water in future years and that water managers can provide a coordinated response to drought emergencies.

6. Public Involvement and Education

Public involvement and education on a variety of water quality and quantity issues is an important component of the basin planning process. Examples include specific feedback on new rules and environmental protection measures, requests for data for watershed planning and assessment, and basin plan review and comments. Basin planners work with the public and resource agencies daily and act as a clearinghouse for basin related information. DWR continues to improve on data sharing capabilities to increase public access and enhance the public's ability to explore data on which basin plans are based.

While developing a basin plan, staff work directly with specific watershed stakeholders and resource agencies with the knowledge needed to understand and explain a concern or issue that has been identified in the basin. The number and amount of interaction varies depending on where the plan is in the development process. Over this annual reporting period, staff worked directly with several soil and water conservation districts (SWCD), regional Natural Resource Conservation Service (NRCS) offices, local governments as well as non-profits and watershed groups throughout the basins. Planners have presented water quality and quantity information at several venues, including the 2017 Wildlife Resources Commission (WRC) Wildlife Action Plan (WAP) Regional Workshops, Watershed Stewardship Network Workshops, and Water Education for Teachers (Project WET)/teacher education workshops. Staff have also participated in watershed meetings around the state.

In May 2018, the Environmental Management Commission (EMC) members agreed to work with the DWR Basinwide Planning Branch to develop an Adopt-A-Basin partnership. The EMC members will serve as an informal liaison between the two partners, which will enhance the EMC discussion and bring a greater depth of understanding of basin specific issues to the full EMC basin approval process. The Basinwide Planning Branch thanks the EMC members for their participation in this partnership and look forward to working directly with the members on basin specific issues, actions and goals.

DWR encourages local governments, the general public and watershed specific groups to organize stream cleanup projects in their waterways. These efforts across the state, like the Clean Jordan Lake partnership, have removed tons of trash and pollutants that wash into rivers and stream with every rain event.

DEQ's Stream Watch program is undergoing renewed initiatives to incorporate hands-on and interactive technology as well as broaden the audience of potential stream watch participants to include more schools and educational groups. Public involvement and citizen science programs, like NC Stream Watch, help connect local communities with state agencies like DWR. This network of active "stream watchers" benefits our environment while promoting relevant educational opportunities. Watershed groups and other stakeholders are able to utilize user-friendly surveys for stream monitoring on their mobile device or paper/pencil forms. During their time in the stream, they can collect data on a range of topics, depending on their interest. From simple trash tracking to educational water quality monitoring, the NC Stream Watch program allows stream monitoring to be relevant to communities as well as supportive for education. Teachers, students, and watershed networks will find the program useful because it creates a network of involved citizens while also creating awareness for water resource management issues. As this program grows, North Carolina citizens can access a GIS map that is populated with data collected by various groups across the state. Eventually, NC Stream Watch hopes to be a robust educational program that is commonly utilized to promote the importance of water resource management and water quality issues.

Education and stakeholder interactions are a critical aspect of basin planning. Stakeholders provide information on local water quality issues, watershed activities, and issues affecting water availability. Site specific watershed restoration projects are included in each of the basin plans with a few examples presented in this report.

In an effort to make the basin plans more easily accessible and user-friendly, BPB has spent the last two years working to develop online resources for the basin plans. Examples of new formats and mapping capabilities are available through the Department's Open Data website and on the 2018 draft of the Watauga River Basin Water Resources Plan.