# Environmental Management Commission

# North Carolina Department of Environmental Quality

# Division of Water Resources

## Annual Report to the General Assembly

## Environmental Review Commission

## Basinwide Water Quality Management Planning

## July 1, 2016 to June 30, 2017

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

# Contents

## 1. Introduction

Basinwide water quality management plans are required under General Statute 143-215.8B. The plans evaluate point and nonpoint sources of pollution using biological and ambient water quality data as well as computer modeling and analysis. The plans for the 17 river basins are reviewed and revised by the Environmental Management Commission (EMC) at least every ten years to reflect changes in water quality, improvements in modeling methods, improvements in wastewater treatment technology and advances in scientific knowledge. The plans are also reviewed to ensure waters of the state are meeting their designated uses or if management strategies need to be modified. The basinwide water quality management plans are not rule; however, "any water quality standard or classification and any requirement or limitation granted applicability that implements a basinwide water quality management plan is a rule and must be adopted in Article 2A of Chapter 150B of the General Statutes."

To analyze surface water availability, the Division of Water Resources (DWR) uses hydrologic models. The models are based on historic streamflow data and capture the effects of current management protocols, surface water withdrawals and wastewater discharges over the range of streamflows in the historic flow records. The models can be used to evaluate the potential effects on surface water availability produced by anticipated changes in water demands and management regimes. 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. Currently, 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. A combined model will be developed for the Watauga and New River basins.

Session Law 2013-413 combined the former Division of Water Quality (DWQ) with DWR which resulted in developing data management schemes and planning initiatives to support the creation of integrated basinwide plans to address water quality and quantity issues. Information presented in the combined plans supports a variety of state and local programs aimed at protecting and improving water resources in North Carolina's streams, rivers, and estuaries. Water resource issues documented in basinwide plans provide support for local governments, natural resource groups, researchers, soil and water agencies and other state and local agencies in identifying current water resource issues, potential impacts from existing conditions and potential project areas to focus restoration, conservation or preservation activities to protect water quality.

DWR's basinwide planning program also takes advantage of stakeholder input. Stakeholders provide information essential to protecting and enhancing watershed water quality and issues associated with reliability of water supplies. Partnering stakeholders typically include watershed associations, land trusts, water quality monitoring coalitions, soil and water conservation districts, public water systems, and other federal, state, and local agencies. DWR staff members regularly assist municipal water systems with developing and updating their local water supply plans as well as provide essential water quality data when available.

For implementation, the basinwide planning program relies heavily on other branches and sections within the Department of Environmental Quality (DEQ), DWR and other state and local agencies to implement water quality improvement practices. This can be through regulatory directives and/or voluntary measures. If a management strategy is in place, the plans provide detailed updates on the implementation of that strategy including successes, additional needs or changes that may require rule making or legislative action. DWR is expanding the capacity to present integrated basin plans electronically, increasing the availability to the public and enhancing the public's ability to explore data on which basin plans are based. Basinwide water resource management plans are available at: http://deq.nc.gov/about/divisions/water-resources/planning/basin-planning.

General Statue 143-215.8B(d) requires that the Commission and the Department report to the Environmental Review Commission (ERC) on an annual basis. The report includes progress on developing and implementing basin plans as well as public involvement and education. The report also includes a statement regarding "concentrations of heavy metals and other pollutants identified in the course of preparing or revising the basin plans." Table 1 identifies the sections in this report where each of these issues is addressed.

Table 1: Report Topics and Sections

| Report Topic | Section 1: Introduction | Section 2: Plan Development | Section 3: Challenges | Section 4: Statewide Issues/ Concerns | Section 5: Monitoring | Section 6: Basin Summaries |
|---|---|---|---|---|---|---|
| Progress in developing plans | | x | | | x | x |
| Progress in implementing plans | | x | | | | x |
| Public involvement | x | x | x | x | | x |
| Public education | x | | x | x | | x |
| Concentration of heavy metals | | | | | x | |
| Pollutants identified in surface water | | | x | x | x | x |

## 2. Basin Plan Development

Currently, the Broad, Cape Fear, Chowan, Pasquotank, Watauga and White Oak River Basin Water Resource Plans are under development. Along with in-depth water quality assessments and recommendations for improving water quality, these integrated water resource plans will include detailed evaluations of surface water availability. Whenever possible, the plans will also include information about future water demands and groundwater use. Table 2 lists the 17 river basins within North Carolina and the schedule for DWR monitoring, planning and implementation. Figure 1 shows the basin boundaries.

Table 2: Basin Planning Schedule

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

NSW = Nutrient Sensitive Waters, NCDP = Nutrient Criteria Development Plan,
* NSW Strategy and regulatory update prior to NPDES permits renewal; Full plan completion 2019.
n/a – currently hydrologic models are not being developed for coastal areas.

Figure 1: North Carolina’s Seventeen River Basins


## 2.1. Public Involvement and Educational Opportunities

An important component to basinwide planning is public involvement and public education on a variety of basinwide water quality and quantity issues. DWR Planning Section staff participate in many aspects of stakeholder interactions which range from requesting specific feedback on new rules and environmental protection measures to requests for data for watershed planning and assessment and basin plan development. Basin planners work with the public and resource agencies daily and act as a clearinghouse for all basin related information. In the course of developing a basin plan, staff work directly with specific watershed stakeholders and resource agencies with the knowledge of a specific area or concern in the basin. The amount of interactions can vary depending on the stage of the plan development process. Over this annual reporting period while developing the six plans listed above, 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 as well as participated in watershed meetings around the state. Education and stakeholder interactions are a critical aspect of basinwide planning. This is where implementation and water quality improvements begin.

# 3. Challenges

There are many challenges in identifying nonpoint sources of pollution. These include limited data, source identification, contaminant or pollutant identification, and available analytical software.

## 3.1. Limited Data

Due to limited available data, it is difficult 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 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 the DWR to assist with identifying impacts to water quality. The amount and type of fertilizers, pesticides or herbicides used on farms, golf courses, public and commercial lawn and gardens, however, 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.

## 3.2. Unknown Sources

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 may be accelerated. Data collected over the past several years indicate that organic nitrogen is increasing throughout the state (Figure 4). The sources of the organic nitrogen in the aquatic system is not well understood at this time. Groundwater, legacy sediments, biosolids application, atmospheric deposition as well as changes to streamflow and its impact to permit limits may also be contributing to the increased nutrient values. Additional research and analytical tools are needed to help DWR understand the source of increasing organic nitrogen and how to properly manage this load. In addition, more detailed reporting on agricultural best management practices (BMP) and changes to operations (i.e., moving from crop production to animal operation) could assist with identifying nutrient sources and appropriate BMPs to address the source.

## 3.3. Full Integration of Water Quality and Quantity Planning

The basin plans include information about water quality and quantity. However, fully integrating both aspects and offering recommendations to protect and enhance instream and off-stream uses is a challenge due to data gaps and interpretation as well as governing policies and federal mandates related to water resource programs. Environmental and human health standards are established by the U.S. Environmental Protection Agency (EPA) to meet federal requirements under the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA), while maintaining adequate flows associated with federal actions can be evaluated through the National Environmental Policy Act (NEPA). Information on all entities that withdraw water and water use data, however, is managed by state policies and the overarching umbrella of riparian rights within the state.

Hydrologic models are used to determine the places, times, frequencies and intervals in which water may be inadequate to meet known water demands. To better incorporate flows to protect water uses, including ecological integrity, data are needed for points of interest throughout the basins to assess flow and water availability. Including these points of interest within a hydrologic model can assist with determining when off-stream uses (drinking water supplies, manufacturing and industrial uses, thermoelectric power generation) cannot be met or when aquatic communities may be impacted. DWR works cooperatively with public and private entities seeking water supply on site-specific projects to establish flow regimes necessary to maintain aquatic habitat. North Carolina is not alone in understanding the complexities of water quality and quantity. Understanding how fluctuations in water quantity affect water quality is critical to protecting all waters of the state.

### 3.4. Analytical Tools

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 as well as provide more accurate and up-to-date sampling results.

## 4. Statewide Water Quality/Quantity Issues

Table 3 provides a quick glance of major issues that are identified in each of the 17 river basins. Several issues span all the basins and include biological impairments, algal blooms, potential impacts from agricultural operations and emerging contaminants.

### 4.1. Biological Impairments and Habitat Degradation

Many of the biological impairments across the state are due to poor and degraded aquatic habitat. 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 base flows. 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 could potentially minimize the impact from stormwater overland flow by reducing pollutants and stabilizing stream banks. In addition, adopting stormwater management in areas where stormwater management is not required as well as education and outreach could also assist with improving aquatic habitats statewide.

### 4.2. Algal Blooms

Several algal blooms were reported across the state over the past year including the Neuse, Cape Fear, Chowan, Pasquotank, French Broad and Little Tennessee River basins. Data collected at the ambient water quality monitoring stations over the past several years indicates that organic nitrogen is increasing throughout the state and these increases are offsetting nitrogen reductions made as a result of rules established for nutrient sensitive waters (NSW). Currently, the sources of the organic nitrogen are not well understood. Groundwater, legacy sediments, biosolids application, atmospheric deposition as well as changes to streamflow and its impact to permit limits may be contributing to the increased nutrient values. Additional research and analytical tools are needed to help DEQ understand the source of increasing organic nitrogen and how to properly manage this load. In many areas, there is a direct connection between groundwater and surface water and understanding the potential for groundwater to transport nutrients from biosolids and wastewater land application fields to surface water is critical in identifying potential sources of organic nitrogen. In addition, more detailed reporting on agricultural BMP and changes to operations (i.e., moving from crop production to animal operation) could assist with identifying nutrient sources and the appropriate BMP to address the source.

## 4.3. Impacts from Agricultural Operations

Understanding the impacts from large-scale agricultural operations 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. If not effectively utilized by vegetation, nutrients produced by animals can enter surface waters 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. 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. Most poultry operations, however, produce a dry litter waste that typically falls under the deemed permitted category (NCAC 02T .1303) and 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 animal waste to water quality is difficult to assess. 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.

## 4.4. Emerging Contaminants

Emerging contaminants are a potential issue for all waters (surface and ground) of the state. Emerging contaminants 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. These contaminants are released into water from multiple sources including conventional wastewater treatments plants, individual onsite wastewater collection systems, and industrial and chemical manufacturing facilities. Many of these potential sources do not have treatment systems in place that are designed to detect, eliminate or treat these poorly understood contaminants. While a contaminant may be unique to a specific source or river basin, many are widespread. The effects of emerging contaminants 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 contaminants are not fully understood, it limits the State's ability to protect water quality. It also limits the State's ability 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.

Table 3: Issues/Concerns Identified in Each River Basin

| 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 contaminants | 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 contaminants, 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 |
| 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.

### 4.5. Ground Water

Ground water 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 ground water sources or aquifers. The CCPCUA requires water use permits for large entities that use more than 100,000 gallons of ground water 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 are required to reduce their withdrawals by up to 75% from certain aquifers and use alternate water sources.

North Carolina continues to monitor ground water quality and gauge contamination based on the 2L ground water standards rules. 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 ground water at DWR's monitoring wells. Long term plans include broadening the 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.

### 4.6. 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. 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 as a whole.

## 5. Water Quality Monitoring

### 5.1. Water Quality Monitoring and Pollutant Concentrations

DWR's ambient monitoring program, along with seven monitoring coalitions, collect physical and chemical data at many stations across the state (Table 4). Data was assessed to identify possible statistically significant statewide concentration changes over time. This statewide trend assessment is a screening tool that DWR is using to identify changes occurring across the state that need further investigation and analysis. This could result in pollutant source identification studies, prioritization for stream restoration work, development of an EPA 9-element watershed restoration plan, basinwide management plan focus area or the development of a total maximum daily load (TMDL).

The trend analysis was developed using a seasonal and non-seasonal version of the non-parametric Mann-Kendal trend test to determine temporal trends in water quality (Steve Winkler, 2004. St. Johns River Water Management District Technical Publication SJ2004-4. *A Users-Written SAS Program for Estimating Temporal Trends and Their Magnitude*. ftp://secure.sjrwmd.com/technicalreports/TP/SJ2004-4.pdf). The dataset encompasses 1997 to August 2016, only stations with at least 5 years and 40 samples, and that have at least one sample in the past 5 years (Figure 2). The trends analysis indicates whether a parameter concentration is increasing or decreasing with a 90 percent confidence. Those stations that do not show a significant change are identified as "insignificant." This analysis does not indicate impairment or the magnitude of the concentrations or change. Concentrations of the different parameters are different from station to station and from ecoregion to ecoregion. This screening tool only assessed a change at a specific station over the set period of time. This analysis is to be used as a screening tool and should not be used for any other purposes outside of its intended use.

Table 4: 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 | Turbidity | |
| Water Temperature | Chlorophyll *a* * | |
| | Metals ^ – Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Zn | |

+ 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.

For the purposes of this annual report, the division focused on the changes in turbidity, total Kjeldahl nitrogen (TKN) which represents mostly organic nitrogen, fecal coliform bacteria, and pH. These are the constituents that were identified as parameters of concern in the basin planning process over this last year and verified by this screening tool as areas in which DWR needs to provide additional resources to understand the causes of water quality degradation.

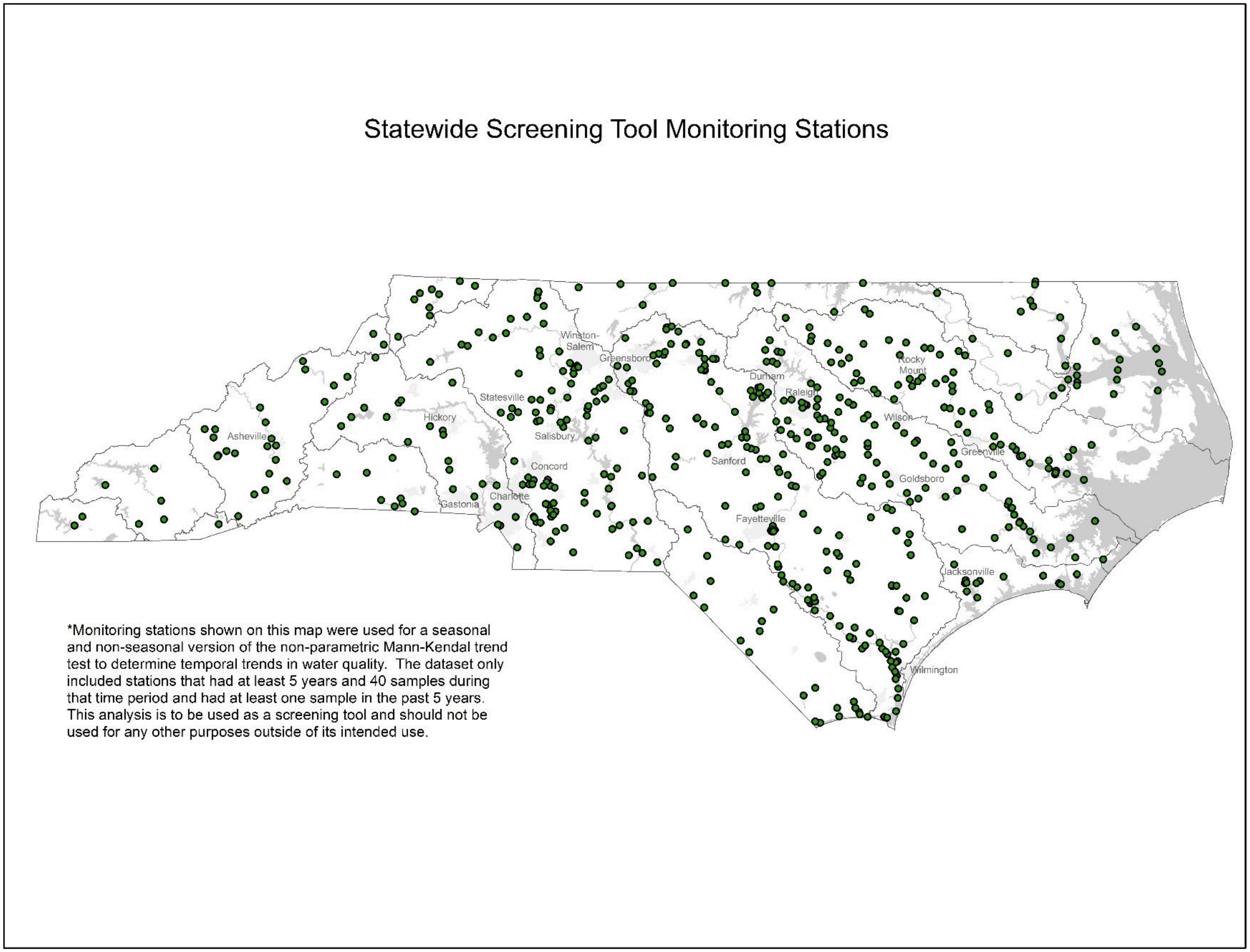
### 5.1.1. Turbidity

Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy. Particulate matter can include sediment, fine organic and inorganic matter, algae and other microscopic organisms. Turbidity is a pollutant that generally increases as result of nonpoint sources during precipitation events, streambank scouring from elevated peak flows, and/or added nutrients which can increase biological (algal) productivity. The turbidity standard varies depending on the surface water classifications as seen in Table 5.

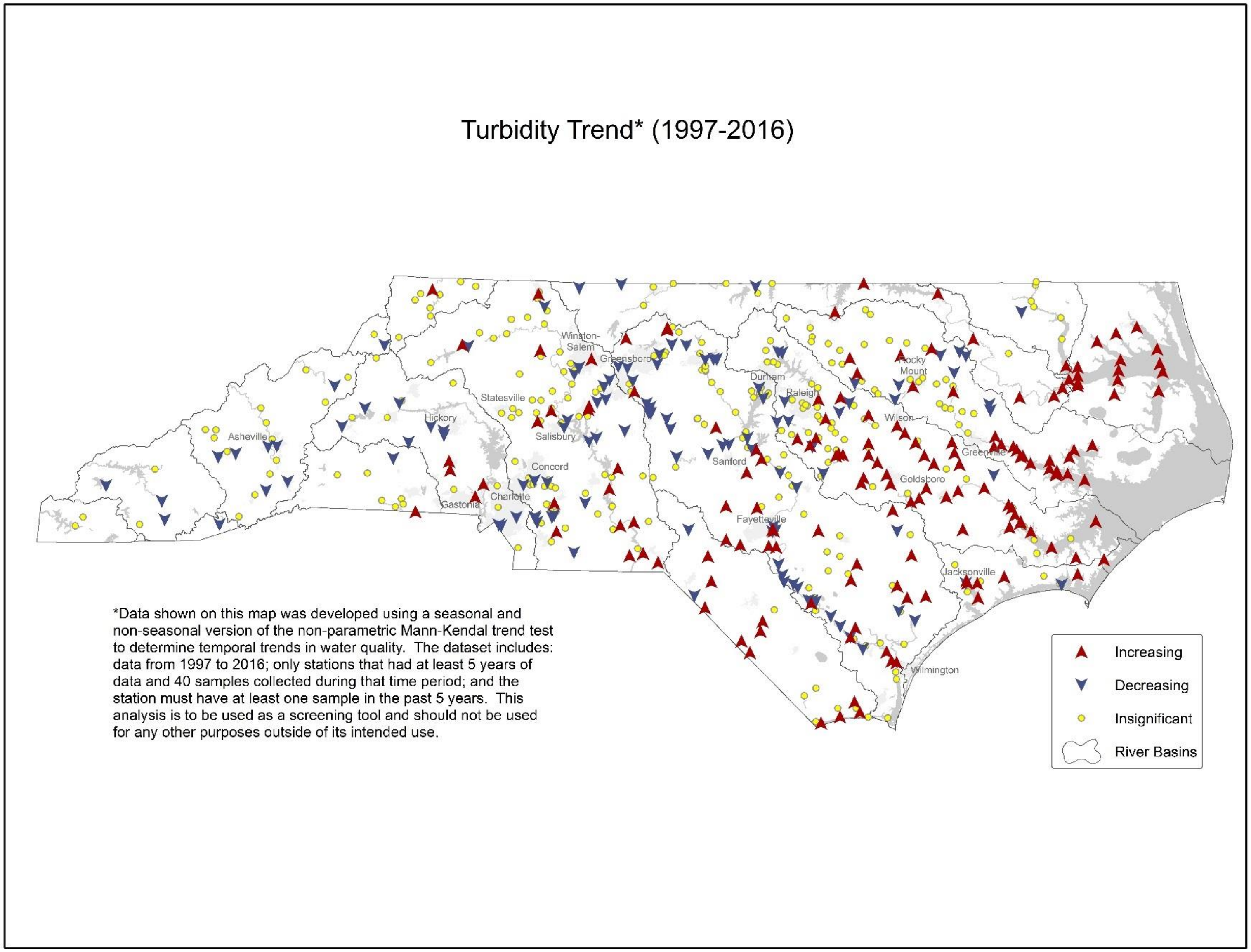
Table 5: North Carolina Turbidity Standards Based on Surface Water Stream Classification.

| Stream Classification | Turbidity Standard (NTU) |
|---|---|
| Trout Streams & Lakes (Tr) | 10 |
| Lakes (C & B) | 25 |
| Estuaries (SC & SB) | 25 |
| All Other Streams (C & B) | 50 |

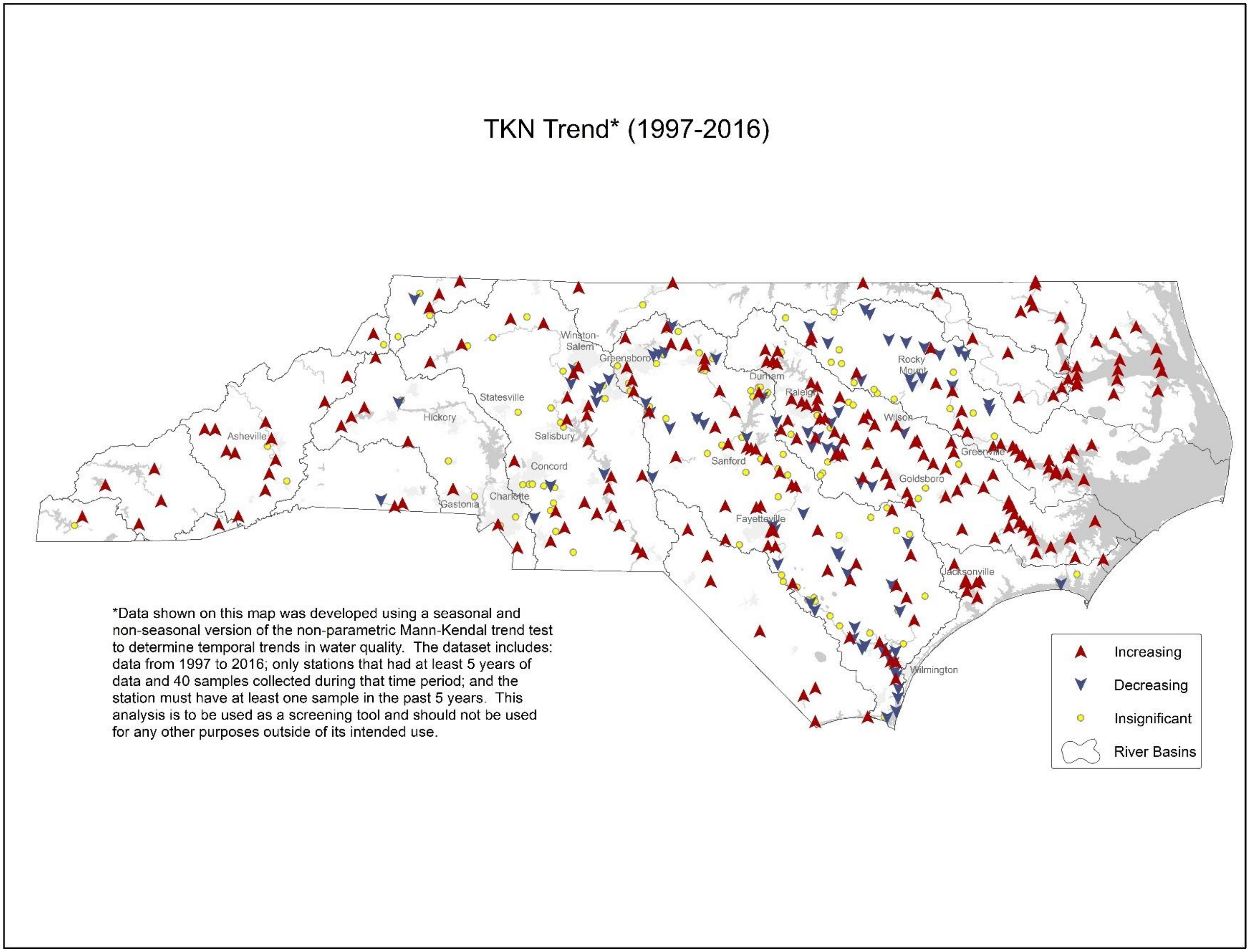
Figure 2: Statewide Monitoring Sites Used to Assess Trends



## Figure 3: Turbidity



## Figure 4: Nutrients - Total Kjeldahl Nitrogen (TKN)



## Figure 5: Fecal Coliform Bacteria

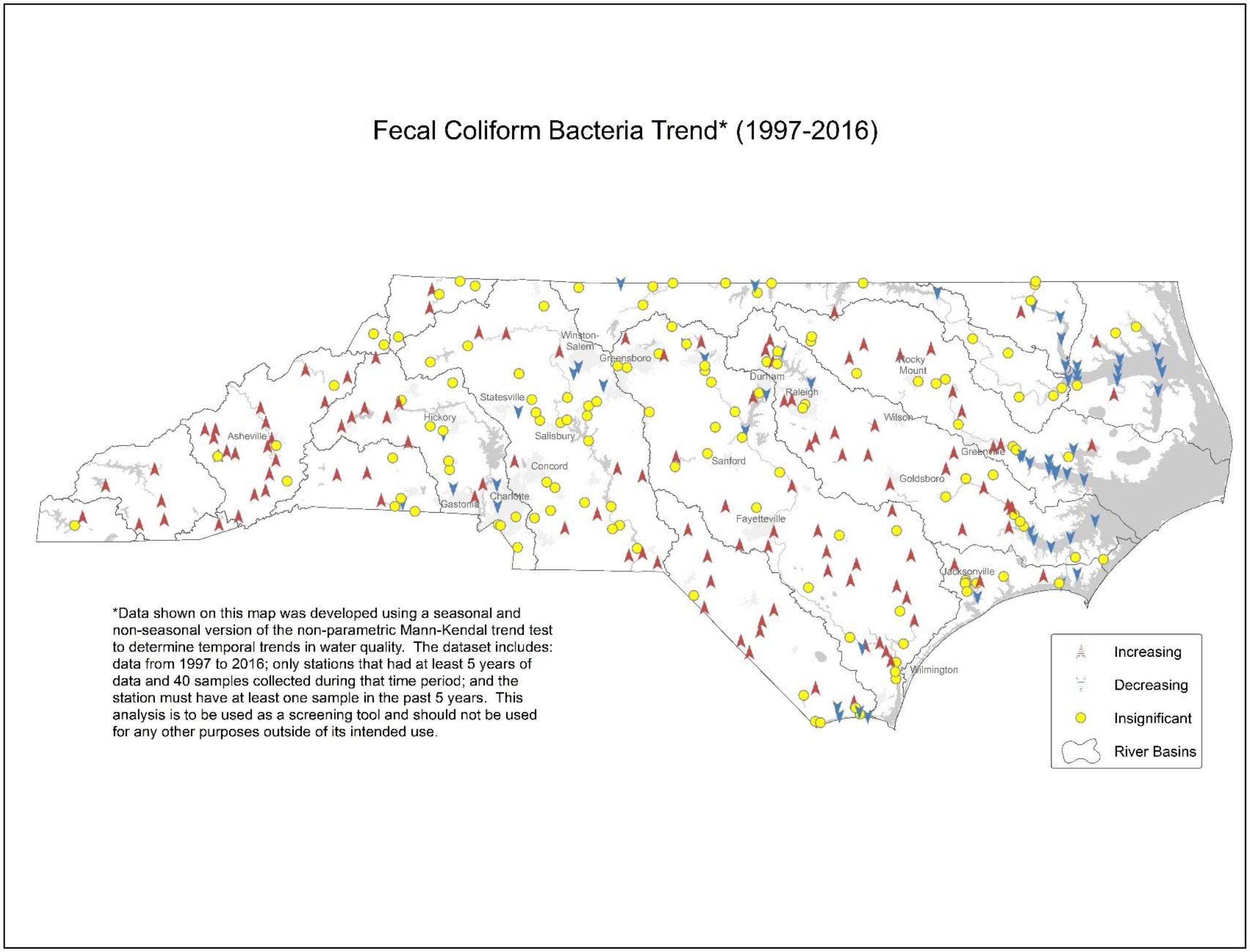
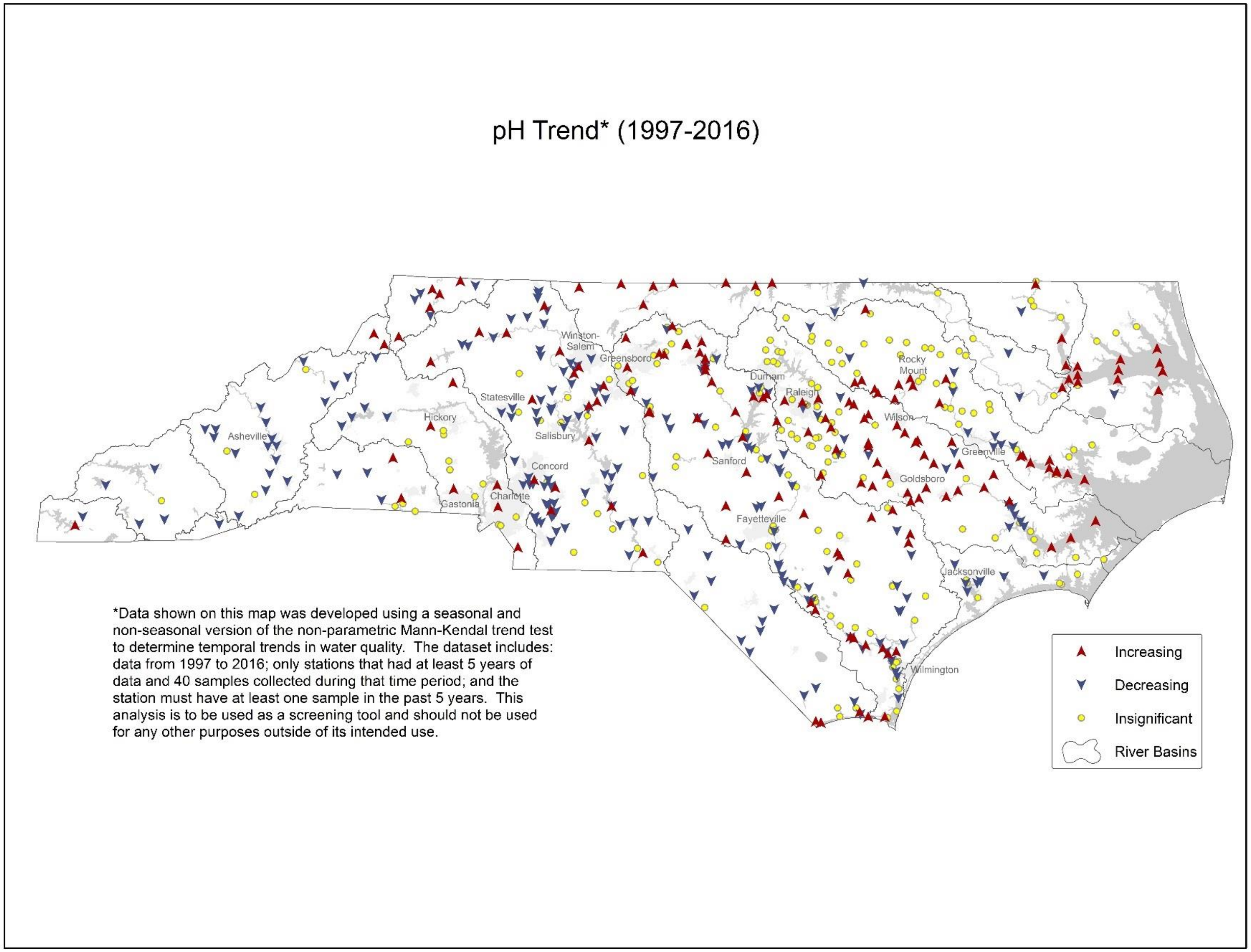


Figure 6: pH


pH Trend* (1997-2016)
Winston-Salem
Greensboro
Durham
Raleigh
Rocky Mount
Statesville
Hickory
Asheville
Salisbury
Concord
Charlotte
Gastonia
Sanford
Wilson
Greenville
Goldsboro
Fayetteville
Jacksonville
Wilmington
*Data shown on this map was developed using a seasonal and non-seasonal version of the non-parametric Mann-Kendal trend test to determine temporal trends in water quality. The dataset includes: data from 1997 to 2016; only stations that had at least 5 years of data and 40 samples collected during that time period; and the station must have at least one sample in the past 5 years. This analysis is to be used as a screening tool and should not be used for any other purposes outside of its intended use.
Increasing
Decreasing
Insignificant
River Basins

The trend assessment shows an increasing trend in turbidity concentrations throughout much of the Piedmont and Coastal Plain (Figure 3). The reason behind this is not completely understood. It could be due to climatic differences between the ecoregions; extended periods of drought over the last several years in the mountain ecoregion; difference in the number of stations assessed; or more protected and natural forested areas that provide buffers that reduce stormwater and sediment from entering the streams. It is important to recognize that these trends don't necessarily indicate the magnitude of the instream concentration or the impairment status, just if the concentration is going up or down at specific stations for this specific time period.

### 5.1.2. Nutrients - Total Kjeldahl Nitrogen (TKN)

Nitrogen and phosphorus, generally referred to as nutrients can be a pollutant at high concentrations resulting in eutrophic conditions and increased biological productivity. Sources of nitrogen and phosphorus include both point and nonpoint sources. While North Carolina does not currently have instream nutrient standards, DWR, as an EPA requirement, is in the process of developing nutrient criteria with the assistance of a Science Advisory Council (SAC). The goal is to develop lake, stream and estuarine standards that will be applied to the surface waters of NC.

A basinwide planning branch requirement for all NSW basins, is an assessment of the NSW strategy as part of the plan development process. To fulfill this requirement, a robust in depth statistical trends analysis is done. DWR has reported a steady increase in organic nitrogen (TKN) in many of the NSW watersheds assessed to date. The statewide screening trend assessment tool provides strong evidence that the trends documented in the Neuse and the Tar-Pamlico River Basins are occurring throughout the state as well (Figure 4). The sources of the organic nitrogen are not well understood. It is likely that there are nutrient sources beyond those regulated under the NSW strategy that are contributing to the nutrient loads and 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). Groundwater, legacy sediments, biosolids application, atmospheric deposition as well as changes to streamflow and its impact to permit limits may also be contributing to the increased nutrient concentrations. Additional research and analytical tools are needed to help DWR understand the source of increasing organic nitrogen and how to properly manage this load.

### 5.1.3. Fecal Coliform Bacteria

Fecal coliform bacteria are indicators of fecal contamination and of the potential presence of other harmful pathogens. This can be the result of both point and non-point sources. The trend assessment (Figure 5) shows increasing concentrations of fecal coliform bacteria occurring across the state. The reasons for increasing concentrations is likely due to changes in stormwater runoff from impervious cover and development, failing infrastructure (onsite and municipal), animal access to streams where BMPs are not in place or insufficient, or waste application near streams with inadequate riparian buffers in place.

The area of decreasing concentrations is mainly located in estuarine waters. This needs further investigation as to why there is a decrease, but it is likely due to the assessment methodology that are now used in the coastal areas. The areas that are classified as SA (Shellfish Harvesting Waters) are now sampled well after rain event when the Shellfish Sanitation Program expects the waters to have low bacterial counts, allowing these waters to open to shellfish harvesting. Collecting data only when there is expected low concentrations can skew the data to indicate a trend that is not truly present.

Fecal coliform impairments occur across the state. Instream concentrations vary widely and are generally higher after rain events. The standard is based on a specific sampling protocol of collecting at least five samples during a 30-day period and using the geomean or greater than 20 percent exceedance for assessment (Table 6).

Table 6: North Carolina Fecal Coliform Bacteria Standard

| Stream Classification | Geomean Standard | Mean Standard |
|---|---|---|
| All Class C & B Streams | Not to exceed 200 CFU/100mL* | Not to exceed 400 CFU/100mL* in more than 20 percent of the samples |
| Class SA (Shellfish Harvesting Waters) | Not to exceed 14 CFU/100mL | Not to exceed 43 CFU/100mL in more than 10 percent of the samples |
| Class SC and SB waters have an Enterococcus standard instead of a Fecal Coliform standard.<br>*Impairments are based upon at least five consecutive samples examined during a 30-day period. | | |

### 5.1.4. pH

pH is a measure of how acidic or basic a waterbody is. pH of waters affects the normal physiological functions of aquatic organisms as well as affects the solubility and toxicity of chemicals and heavy metals in the aquatic ecosystem. For example, as pH increases the toxicity of ammonia to aquatic species also increases. The pH standards vary by stream classification (Table 7). The trend assessment (Figure 6) shows increasing pH levels occurring in the eastern and northern portions of the state, while the southern and western portions show a significant decline in pH levels. Acid rain deposition, mine drainage or stormwater runoff from highly impervious areas could lower pH levels, while increased pH could be the result of increased biological productivity or swamp drainage to a system. Additional research is needed in order to understand the shifts in pH across the state.

Table 7: North Carolina pH Standard

| Stream Classification | pH Standard (SU) |
|---|---|
| Class C & B Streams (Freshwater) | Range between 6.0 and 9.0 |
| All Sw (Swamp) (Fresh or saltwater) | As low as 4.3 if it is the result of natural conditions |
| Class SC & SB (Saltwater) | Range between 6.8 and 8.5 |

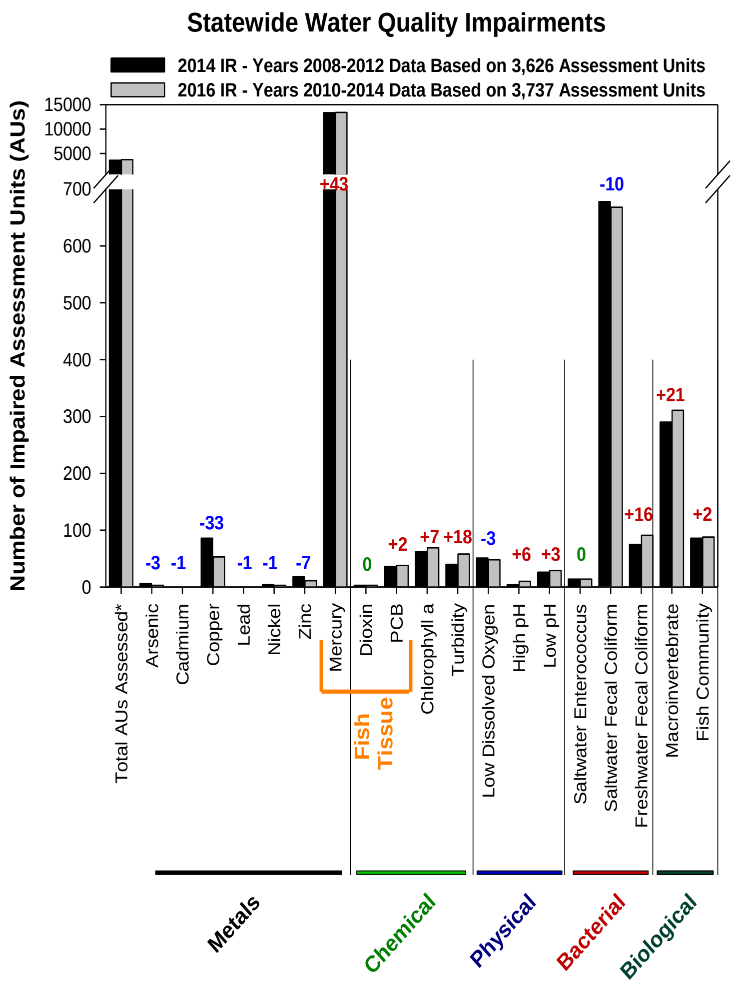
### 5.1.5. Metals

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 purposes in April 2016. DWR began collecting dissolved metal samples at certain locations in 2016. This data has not been assessed by the basinwide planning branch to date. 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 7).

## 5.2. Water Quality Monitoring and Associated Impairment Summary

All water quality parameters collected in a waterbody or assessment unit (AU, a defined portion of a waterbody) are assessed independently. Assessment criteria are based on frequency of exceedance of numeric and narrative water quality standards. There are 13,393 AUs in the state and they vary in size based on the specific characteristics of the water body being evaluated. Because the characteristics of AUs vary, some units are only monitored for a subset of the parameters shown below (Figure 7).

Figure 7: Statewide Water Quality Impairments for Integrated Reporting (IR) Years 2014 and 2016




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 draft 2016 impairment assessments are based on data collected from 2008-2012 and 2010-2014, respectively. Figure 7 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.

# 6. Summary of Each River Basin

## 6.1. Broad River Basin

The Broad River Basinwide Water Quality Plan is being updated and is scheduled to be presented to the EMC for approval in 2018. In most cases, habitat 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 make 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 Broad River 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 this 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.

## 6.2. Catawba River Basin

In the Catawba River Basin chain of lakes, the majority of the lakes are becoming more eutrophic (specifically, elevated nitrogen levels). Increased nutrient monitoring and additional studies are needed to determine the sources of excess nutrient loading. Better understanding of these sources would be beneficial prior to South Carolina's implementation of the nutrient TMDL currently under development.

Many of the biological impairments within the basin are due to poor habitat. Increasing amounts of impervious surfaces in and around urban areas are causing streams in the Catawba River Basin to become increasingly flashy even during small rain events. This sudden increase in volume and velocity of stream flow can cause significant scouring and eroding streambanks which eliminates aquatic life habitat. Additional studies are needed to determine where stormwater management efforts would have the greatest impact.

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 some animal operations. Efforts have been made on a local level to financially assist with septic system repairs in low income areas. However, progress has diminished when the State lost funding for the Wastewater Discharge Elimination (WaDE) Program. Levels fecal coliform bacteria have been slowly declining as a result of efforts by the counties and the Western Piedmont Council of Government (COG). Reinstatement of the WaDE Program would greatly decrease the rate at which fecal coliform bacteria is released in streams often used for recreational purposes.

## 6.3. Cape Fear River Basin

The Cape Fear River Basin Water Resource Plan is currently under development and is scheduled to be presented to the EMC for approval in 2018. A major water quality concern in the Cape Fear River Basin is nutrient enrichment. 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. The implementation of these management rules has been delayed as result of legislative mandates. The latest, Session Law 2016-94 Section 14.13 indefinitely prohibits local implementation of new development and existing development stormwater rules. It also prevents initiation of re-adoption steps for the Jordan nutrient rules prior to October 2019. It funded the development of a NC Policy Collaboratory at UNC. The Collaboratory will 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 its study and recommendations for further actions regarding the Jordan strategy, including any statutory or regulatory changes necessary to implement the recommendations, are due December 31, 2018. Session Law 2016-94 Section 14.13 also mandates the study of in situ treatments including algaecide and phosphorus-locking technologies to determine improvements in water quality and cost effectiveness of the treatment. Session Law 2017-57 13.24 extends this study and funding period and removes the requirement for determining cost effectiveness. The continued delays in implementing the best management practices and nutrient reduction strategies will most likely result in additional nutrient reduction needs in order to meet the water quality standards in Jordan Lake.

The Haw, Deep and Cape Fear Rivers below Jordan Lake are also experiencing issues due to 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. DWR staff is working closely with a Science Advisory Council on the development of instream nutrient criteria (as part of the Nutrient Criteria Development Plan (NCDP) process) for the central portion of the Cape Fear River basin. This process involves extensive data analysis, additional ambient monitoring and model development. Some of the analysis and a detailed description of the process will be included in the 2018 plan.

Emerging contaminants have been identified as a serious concern throughout the Cape Fear River Basin. Division staff has worked closely with research being done by NC State University 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 contaminants. While specific contaminants may be unique to a particular basin, unknown/unregulated contaminants from a variety of possible sources are occurring across NC. Public expectations of our ability to monitor and quantify these substances is somewhat different than what is achievable. Most emergent contaminants are not monitored due to the lack of scientific knowledge of how to sample for them, and acceptable scientific methodologies are not yet established on how to analyze for them. As with GenX, it can take years to identify an unknown substance and develop a quantitative analytical method. Once there is a known concentration, the number has limited value without an appropriate standard and/or the understanding of how these compounds might affect human and aquatic health. These are significant challenges for DEQ and the scientific community to overcome and difficult to explain to the public who rightfully want to know that their water supplies and recreational waters are safe to drink and swim in.

Basin Planning and the Modeling and Assessment Branch (MAB) have worked together to evaluate the long term (through 2060) Cape Fear River water supply needs of the public water systems that depend on surface water from the Deep River, Haw River and Cape Fear River subbasins. This information is critical for the water quantity assessment that is now part of the integrated Water Resource Management Plan.

Round four of the Jordan Lake surface water allocation process is complete. In March 2017, the EMC approved 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 River, Haw River and Cape Fear River basins 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 included water shortage response plans 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 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 at 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 .

A Cape Fear River Basin water quantity special study as required as part of Session Law 2015-196 was completed and is currently being reviewed internally for additional comments and edits.

The Cape Fear River Basin is experiencing many of the common water quality concerns seen throughout North Carolina such as increased aquatic life impairments and habitat degradation due to excessive stormwater runoff. This also leads to increased sedimentation and often elevated fecal coliform concentrations. There is a lack of riparian buffer protections and requirements throughout the basin.

Without these protections in place the continual loss of riparian buffers will only make these environmental concerns grow. A Cape Fear River Partnership was formed in 2011 with a vision of a healthy Cape Fear River for fish and people. DWR staff participated along with many other State and Federal resource agencies and stakeholders to develop the *Cape Fear River Basin Action Plan for Migratory Fish*, in 2013. Staff members continue to participate in the water quality, water quantity, habitat and socioeconomic subcommittees which are working towards implementation of this action plan. Habitat protection and improvement is needed in order to successfully restore the fisheries and improve the tourism potential of this critical ecosystem.

Over the last several years a lot of efforts have occurred that will be included in the water resources management plan. The Cape Fear River Basin has over 150 ambient monitoring stations from four different monitoring programs. The goal is to complete the comprehensive water quality and water quantity analysis for the Cape Fear River Basin in 2018.

## 6.4. Chowan River Basin

The Chowan River Basin Water Resource Plan is currently under development and is scheduled to be presented to the EMC for approval in 2018. Algal blooms have returned to the Chowan River and tributaries in 2015, 2016 and 2017. The Chowan NSW Water Quality Management Plan nutrient reduction goals of 20 percent for nitrogen and 35 percent for phosphorus were documented in the 1990's, but since 2000 the Chowan River and tributaries have seen a steady increase in organic nitrogen concentrations. Approximately 75 percent of the watershed is in VA, draining to NC. More collaboration with VA partners is necessary to address the algal bloom issues. Additional research and analytical tools are needed to help the department understand the source of increasing organic nitrogen and how to properly manage this load.

In the Chowan River Basin, there is a large number of Concentrated Animal Feeding Operations (CAFOs). Waste treatment from hog operations normally includes a liquid waste treatment lagoon and application of liquid to crop spray fields. If not effectively utilized by vegetation, nutrients can enter surface waters by atmospheric deposition, groundwater and stormwater runoff. 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. Most poultry operations, however, produce a dry litter waste that typically falls under the deemed permitted category (NCAC 02T .1303) and 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 animal waste to water quality is difficult to assess. 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.

In the Chowan River Basin, there is a direct connection between groundwater and surface water in many places. There is a need to understand the potential for groundwater contamination and transport of nutrients from biosolids and wastewater land application fields to the surface waters.

The biological impairment within the basin is likely due to stormwater runoff from agricultural fields. Erosion and sediment control, clearcutting and damaged or aging wastewater collection systems have been identified as possible contributors to water quality issues in the basin.

## 6.5. French Broad River Basin

Sediment, nutrients and bacteria are the most significant threat 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. Fecal coliform bacteria is an indicator species that is used to determine if there is a potential threat to human health. 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. Several inquiries have been made over the past year to DWR about the overall health risk of swimming, boating and kayaking the rivers throughout the basin. DWR and local watershed groups are actively working to educate the public about nonpoint source pollution and its impact to water quality.

Algal blooms have been identified as a concern in Waterville Lake on the Pigeon River. The levels of algal toxin detected in the lake were associated with a low risk of adverse health effects. 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 area. More information and data is needed to identify the cause of the algal blooms in Waterville Lake.

Many of the biological impairments within the basin are due to poor habitat. Stormwater, increased flow and velocity, erosion and sediment control, steep slope development, pesticide and nutrient management from urban and agricultural land (crop, animal and trout farms), animal access to streams, and damaged or aging wastewater collection systems have been identified as key contributors to water quality issues in the basin.

## 6.6. Hiwassee

Fecal coliform bacteria impairments were identified in over 30 stream miles of the Hiwassee River Basin in 2012. The presence of fecal coliform in the water along these impaired segments poses a potential health risk to individuals exposed to the water during recreational activities. This impairment has resulted in an on-going concern for river recreation, which is a vital part of the economy in the Hiwassee Basin. Bacteria discharged from failing septic systems or directly straight piped into streams are likely a primary cause for this fecal coliform bacteria impairment. Another potential source of fecal coliform in the basin is livestock access to streams. Local watershed plans are currently being developed for the sections of stream added to the 2014 303(d) impaired waters list. TMDLs are also being developed to address the fecal coliform bacteria impairments.

Construction in the Hiwassee River Basin has increased impervious surface areas and altered natural hydrology by inhibiting stormwater infiltration. Riparian buffers have historically protected water quality throughout the basin and mitigated stormwater runoff, but the removal of the riparian buffers has resulted in an increase in nonpoint source pollution. Building near steep and unstable stream banks has been particularly problematic for stream sediment inputs. Unstable stream banks in rural areas continue to be an issue for sediment input.

Biological impairments to the fish community have been identified on over 20 miles of stream in the Hiwassee River basin. A combination of factors is likely causing these impairments and includes untreated sewage, turbidity from unstable banks and increased pollutants. In addition to fecal coliform bacteria, the Hiwassee Watershed Coalition has identified nutrients and high instream water temperatures as water quality concerns. DWR will work with the coalition to address these issues.

## 6.7. 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 are key contributors to water quality issues throughout the basin.

Fontana Lake is formed by a dam downstream of the confluence of the Little Tennessee River, the Tuckasegee River and the Nantahala River. 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.

## 6.8. Lumber River Basin

Stormwater, rapid growth and development, damaged or aging wastewater infrastructure, and large agricultural operations are issues impacting water quality in the 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 located 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 in effort 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.

In October 2016, the Lumber River Basin along with the Cape Fear, Chowan, Neuse, Roanoke, White Oak and Tar-Pamlico 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 found that the negative impacts to surface waters from the severe flooding appears to have been transient, lasting several weeks. Water quality returned to pre-storm baseline conditions when flows returned to normal. It may take years to determine the long-term impact to the basin from such a catastrophic event. Biological monitoring will be done in the future to assess the impacts and recovery to the aquatic ecosystem as a whole. The most recent Lumber River basin plan was completed in 2010.

## 6.9. Neuse River Basin

The Neuse River Basinwide Water Resource Plan is proposed to be completed in 2019. The goal is to have an update on critical portions of the plan prior to the NPDES permit renewal process scheduled for some time in 2018. This would include an assessment of the Neuse River Basin NSW strategy and trend analysis, Falls Lake Management implementation progress and concerns with known water quality and quantity issues in the basin. A Cape Fear-Neuse River basin hydrologic model and analysis is complete and will be included as part of the final Integrated Neuse River Basin Water Resource Plan.

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. Basin Planning Branch staff will work with the Modeling and Assessment Branch to update estuarine trends over the next year for incorporation into the proposed 2018 update.

Falls Lake nutrient management and rule review were affected by the Session Law 2016-94, Section 14.13. This legislation prevents initiation of re-adoption steps for the Falls Lake nutrient rules prior to October 2022. It also funded the development of a NC Policy Collaboratory at UNC. The Collaboratory is tasked with evaluating the effectiveness of the Jordan Lake and Falls Lake nutrient strategies as well as the costs and benefits of nutrient strategies in other states. The final results of the study and recommendations for further actions regarding the Falls Lake strategy, including any statutory or regulatory changes necessary to implement the recommendations, are due December 31, 2021.

The water quality analysis of the Neuse River Basin finds that the overall NSW 30 percent total nitrogen reduction goal 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 all of these efforts, and reductions made, DWR has identified an increase in the organic nitrogen load which is currently offsetting the reductions made as result of the NSW rules. The sources of the organic nitrogen are not well understood at this time. Additional research and analytical tools are needed to understand the source of increasing organic nitrogen and how to properly manage this load. The trend in increasing organic nitrogen loading appears to be occurring across the state. It is critical that the department support research in order to identify the possible sources of organic nitrogen to assist with reevaluating the existing management goals to reduce the overall loading to this very sensitive system.

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 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 (General Statute §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.

Since 2013, DEQ has worked with stakeholders to address concerns with the existing nutrient management strategy and the adaptive management rule in the Neuse River basin. Because the Neuse River Estuary continues to exceed water quality standards, 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.

### 6.10. New River Basin

In most cases, habitat 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. Habitat degradation (as indicated by impaired biological integrity and high turbidity) was identified as a major stressor for nearly 136 miles of streams in the New River basin. The distribution of turbidity permit violations and standard exceedances at ambient monitoring station (AMS) sampling locations make it difficult to isolate a single source 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 protection and conserving stream buffers and natural areas.

Data collected between 1997 and 2009 at the six AMSs within the New River basin showed an increase in pH levels. An increase in surface water pH can be influenced by many different natural factors: drought; heavy rains; algae or other aquatic plant growth; and 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 sampling cycle. This algae-like growth flourishes in water columns 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 influences or precipitation influences. However, the exact reasons for this basinwide increase is unknown at this time.

## 6.11. Pasquotank River Basin

The Pasquotank River Basin Water Resource Plan is currently under development and is scheduled to be presented to the EMC for approval in 2018. The Pasquotank river is not classified as a Nutrient Sensitive Water (NSW), but the Albemarle Sound, Little River and Perquimans River have experienced algal blooms in 2015, 2016 and 2017. Monitoring data show a steady increase of phosphorus on the Little River since the early 1990's. There is also a steady increase of organic nitrogen across all monitoring stations since the mid 1990's. The sources of the organic nitrogen are not well understood at this time. Additional research and analytical tools are needed to understand the source of increasing organic nitrogen and how to properly manage this load

Aquatic weeds such as alligator weed and hydrilla are impeding recreational activities and causing navigational hazards. There is a need for a regional approach in this area to control the spread of these invasive weeds.

Many of the biological impairments within the basin are due to copper. Other key contributors to water quality issues identified in the basin are: stormwater; increased flow and velocity; erosion and sediment control; development; pesticide and nutrient management from urban and agricultural land (crop, animal and aquaculture facilities); and damaged or aging wastewater collection systems.

## 6.12. Roanoke River Basin

The main water quality concern in the Roanoke River Basin has been the coal ash spill 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 levels of coal ash related constituents similar to conditions measured upstream, or what is considered to be background conditions. A formal Closure Plan is being developed to support the proposed closure of the coal ash basins. Coal ash excavation from the onsite pits started in November 2015.

There is an active Bi-State Commission in the Roanoke basin that focuses on water quantity and quality issues. A Roanoke River Basin Bi-State Commission meeting is scheduled to be held in November 2017. The main water quality concerns identified in the 2012 basinwide management resource plan included copper, turbidity and fecal coliform. The cause of the turbidity in the Dan River has previously been linked to instream mining operations and agricultural fields along the river. However, no permitted mining operations remain and many agricultural practices have adopted better management practices to reduce sediment reaching the stream. The development and implementation of three Dan River subbasin 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).)

## 6.13. Savannah River Basin

The only ambient monitoring station in the Savannah River Basin is located on Horsepasture River. The data indicate that this portions of Horsepasture River is impacted on occasions by low pH as well as elevated temperatures and fecal coliform bacteria. The statewide trend screening assessment tool verified the trend in decreasing pH and increasing bacteria concentrations in this watershed (Figure 6). Horsepasture River is classified as Trout (Tr) waters, which makes this area extra sensitive to changes in water quality. There is a need to identify the source of these changes in this watershed. Downstream of the ambient monitoring station the river is part of the North Carolina Natural and Scenic Rivers System and is also a National Wild and Scenic River.

The Chattooga River also has the National Wild and Scenic River designation. A special biological study was performed in the Chattooga River in September 2016 due to public concerns of trout habitat degradation from sedimentation. The river is classified as B (primary recreation), ORW (Outstanding Resource Waters), Tr (trout). The study was the result of a specific public concern related to the impact of whitewater boat trails and access points contributing to increased erosion in the river. The special study reported a trend between 1991 to 2011 in land-use patterns with land use changing from forested to more developed and increased imperviousness. 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 Outstanding Resource Water.

## 6.14. Tar-Pamlico River Basin

The Tar-Pamlico River basin was 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 for reducing total nitrogen by 30 percent has not been met. Data collected over the last several years indicate that organic nitrogen is increasing. The sources of the organic nitrogen are not well understood. It is likely that there are nutrient sources beyond those regulated under the NSW strategy that are contributing to the nutrient loads and 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). Groundwater, legacy sediments, biosolids application, atmospheric deposition as well as changes to streamflow and its impact to permit limits may also be contributing to the increased nutrient concentrations. Additional research and analytical tools are needed to understand the source of increasing organic nitrogen and how to properly manage this load. In addition, more detailed reporting on BMP and changes to operations (i.e., moving from crop production to animal operation) could assist with identifying nutrient sources and the appropriate BMP to address the source.

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. There are several communities within the basin that do not have or do not fall under a stormwater program. Additional research and analytical tools are needed to assess how uncontrolled stormwater runoff is impacting surface water and the nutrient loads in the estuary. Protection of existing riparian buffers play a critical role in stabilizing and protecting stream banks as well as reducing nutrients from overland flow in these areas.

While the implementation efforts taken to date have not fully achieved compliance with the TMDL, 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 (General Statute §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 2013, DEQ has worked with stakeholders to address concerns with the existing nutrient management strategy and the adaptive management rule in the Tar-Pamlico River basin. Because the Pamlico River Estuary continues to exceed water quality standards, 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.

## 6.15. Watauga River Basin

The Watauga River basin plan is being developed, 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 system (PWSS) serves a year-round population of 340 people and a seasonal population of over 5,000 people during the months of January, February, March, July, July, August and December. Based on information reported in the 2012 local water supply plan (LWSP), the PWSS cannot meet the current or long-term water supply needs for its customer base. Working with 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. The report included several options for the town to consider. 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.

## 6.16. White Oak River Basin

The White Oak River basin is currently being developed and is scheduled to be presented to the EMC for approval in 2018. 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.

Most of the White Oak River basin lies within the designated Central Coastal Plain Capacity Use Area (CCPCUA) established by the EMC in 2002. Water users that withdraw more than 100,000 gallons per day of ground water within the designated area must obtain a permit from DWR and regularly report the quantity of water withdrawn. In April 2004, the Public Water Supply (PWS) Section completed source water assessments for all drinking water sources and generated reports for the PWS systems using these sources. In the White Oak River basin, 257 public water supply sources were identified. All of the public water supply sources are ground water wells. Of the 257 ground water sources, 28 have a High susceptibility rating, 141 have a Moderate susceptibility rating and 88 have a Low susceptibility rating. For a public water supply to be determined susceptible, a potential contaminant source must be present and the existing geological and hydrological conditions of the PWS intake location must be such that a water supply could become contaminated. PWS is currently reassessing the wells in the CCPCUA and results should be released by the end of 2017 or early 2018.

Several agencies, including DWR, Coastal Management, Land Resources, Marine Fisheries, 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.

## 6.17. Yadkin-Pee Dee River Basin

Many streams in the Yadkin-Pee Dee River Basin are impaired for aquatic life due to degraded habitat. 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 base flows. Stream bank and instream habitat erosion along with elevated turbidity and pollutant loading concentrations are making it difficult to protect sustainable aquatic populations, which are leading to stream impairments.

Elevated fecal coliform bacteria due to stormwater runoff in urban and agricultural areas is occurring. There are minimal required riparian buffers throughout the Yadkin-Pee Dee River Basin to aid in the protection and stabilization of streams and to reduce impacts to water quality.

There is a large increase in poultry operations in the Upper Yadkin-Pee Dee watershed. 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 growing source.

High Rock Lake is impaired for turbidity, chlorophyll *a*, and high pH. High Rock 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. There is a Nutrient Criteria Development Plan (NCDP) process well underway which will aid in the development of appropriate instream standards for this system. This process involved extensive data analysis, ambient monitoring studies and a watershed and lake model. A science advisory council (SAC) was developed to aid DWR on developing these standards. The data indicate that High Rock Lake’s trophic status is eutrophic to hypereutrophic depending on the time of year. Nitrogen, phosphorus and sediment reductions could be required in the future in order for High Rock Lake to comply with instream water quality standards. This determination and a regulatory process will follow after appropriate instream standards are finalized.