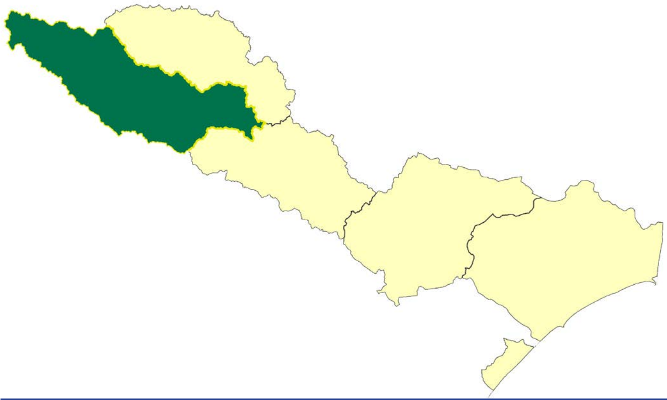


# Overview

## Upper Tar River Subbasin 03020101

## General Subbasin Information

This subbasin, hydrologic unit code (HUC) 03020101, contains the Tar River headwaters and its tributaries down to Tarboro, covering ~1,305 square miles. It was previously delineated as DWR subbasins 03-03-01 and 03-03-02.

The headwaters of the Tar River originate in eastern Person County, with the majority of the upper portion of this subbasin in Granville, Nash, and Franklin counties. Most of the land use in the upper subbasin consists of a mixture of active and inactive agriculture, rural residences, and remnant patches of forest. The subbasin includes several ecoregions, including the Northern Outer Piedmont, small portions of the Triassic Basin and Carolina Slate Belt, the Rolling Coastal Plain, and small patches of Southeastern Floodplains and Low Terraces. Streams in or near the Carolina Slate Belt ecoregion are vulnerable to drying during periods of drought because of poor groundwater recharge. With the exception of the Triassic Basin and Carolina Slate Belt, the infiltration capacity of soils in the less disturbed areas of this subbasin are high and stream flow is maintained during drier periods by base flows via groundwater inputs. However, in more developed areas where impervious surfaces dominate the landscape, overland flow during heavy precipitation events can lead to flashier stream flows. Land use in the lower portion of this subbasin is divided relatively evenly between agriculture, undisturbed forest, rural residences, and urbanized areas.

This subbasin provides habitat for several threatened and endangered aquatic species (e.g., Tar River spinymussel, dwarf wedgemussel). Shelton Creek, Fox Creek, North Fork Tar River, and Cub Creek provide good habitat conditions, supporting a stable dwarf wedgemussel population considered to be some of the best in North Carolina. Swift Creek supports populations of the Tar River spinymussel. However, increased urbanization and other disturbances could increase pollutant delivery to these areas and potentially threaten these species. Therefore, protection of the upper Tar River and Swift Creek watersheds are crucial for the continuation of the species.

### Subbasin at a Glance

**Counties:**

Person, Granville, Vance, Warren, Franklin, Nash, Edgecombe

**Municipalities:**

Oxford, Kittrell, Henderson, Franklinton, Youngsville, Louisburg, Centerville, Bunn, Castalia, Spring Hope, Momeyer, Nashville, Red Oak, Dortches, Rocky Mount, Whitakers

**Permitted Facilities:**

| | |
|---|---|
| NPDES WWTP: | 20 |
| Major | 4 |
| Minor | 16 |
| NonDischarge: | 19 |
| Animal Operations: | 45 |
| Water Withdrawals: | |
| Registered | 7 |
| Local Water Supply Plans: | 7 |

**Population:**

2010 Census: 198,792

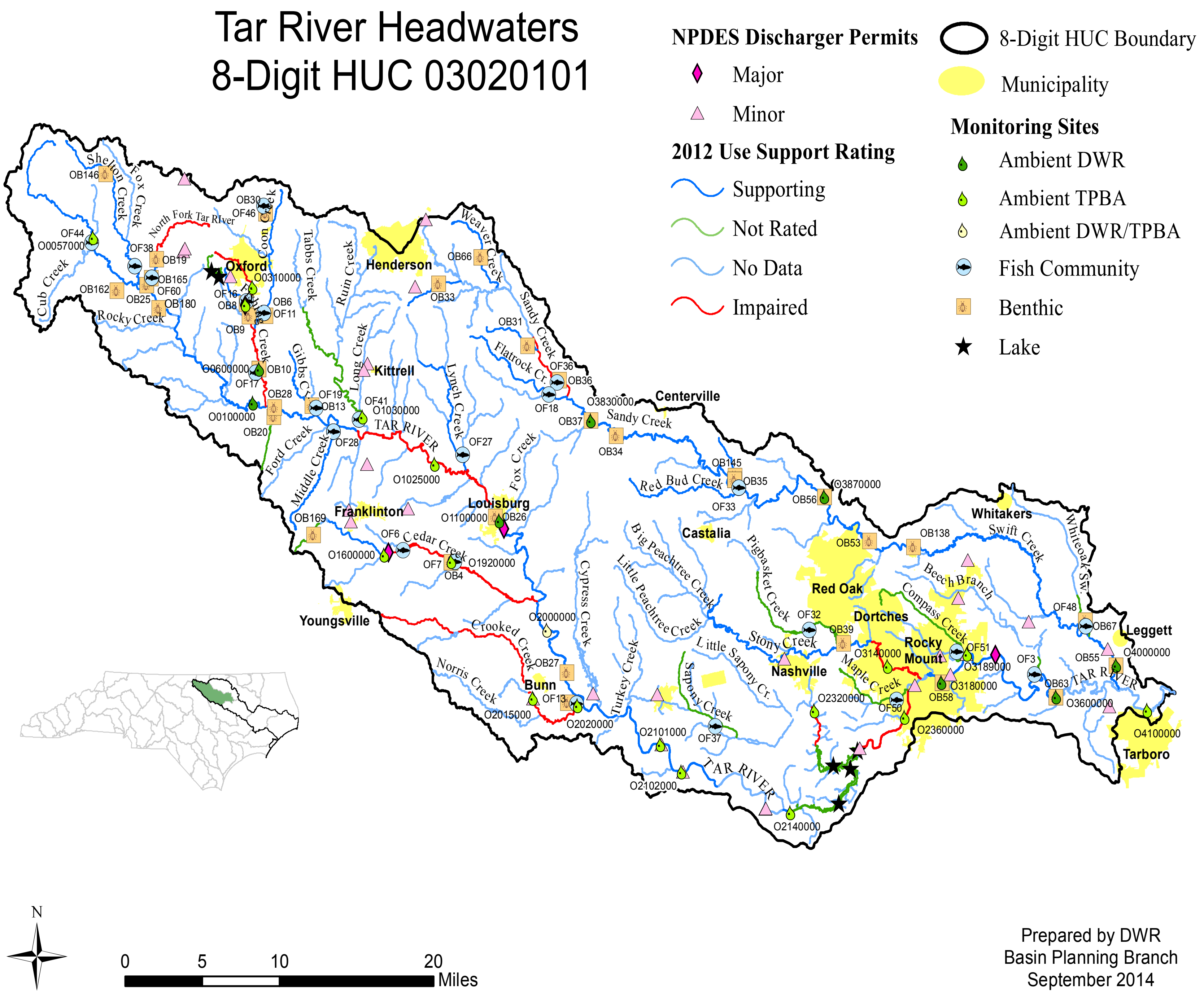
**Drainage Area:**

Upper Tar River: 1,305 sq mi.

**Impervious Surface:**

Estimate: 24 sq mi.

Figure 1: Upper Tar River Subbasin



There are several major and minor NPDES dischargers to the Tar River in this subbasin. Major dischargers include the Oxford WWTP (3.5 million gallons/day (MGD)), which discharges into Fishing Creek, the Franklin County WWTP (3 MGD) discharges to Cedar Creek, and Louisburg WWTP (1.37 MGD) and the Tar River Regional WWTP (21 MGD) discharge to the Tar River.

Due to the rural nature of the subbasin many of the water supply needs are provided by private groundwater wells; however, most of the incorporated towns in the subbasin maintain individually operated public water supply systems. These water systems obtain their water from both surface and groundwater sources. The primary sources of surface water in the Upper Tar River subbasin for water supply systems are the two Franklinton Reservoirs (0.228 MGD average in 2012), the Tar River [(City of Rocky Mount)(3 MGD average in 2012)], and the Tar River Reservoir [(City of Rocky Mount)(6.42 MGD average in 2012)]. The town of Louisburg withdrawals an average 0.6 MGD from the Tar River. Other public water supply systems in the subbasin are served with surface water from the Roanoke River basin by the Kerr Lake Regional Water System and/or municipal groundwater wells. The other major withdrawers of surface waters within the subbasin are limited to mining, golf courses and agricultural operations.

## Use Support History

Table 1: 03020101 - Subbasin Impairment Totals Based on 2008, 2010, 2012 and 2014 Integrated Reports

| Impaired Parameter | 2008 IR* | | 2010 IR* | | 2012 IR* | | 2014 IR* | | Impairment Type |
|---|---|---|---|---|---|---|---|---|---|
| | # of AU's | Miles/ Acres | # of AU's | Miles/ Acres | # of AU's | Miles/ Acres | # of AU's | Miles/ Acres | |
| Low Dissolved Oxygen | -- | | 7 | 61.8 m | 6 | 41.7 m | 4 | 29.7 m | Aquatic Life |
| Turbidity | -- | | 2 | 17.7 m | 3 | 33.0 m | -- | | Aquatic Life |
| Chlorophyll a | -- | | -- | | -- | | -- | | Aquatic Life |
| Fecal Coliform | -- | | -- | | -- | | -- | | Recreational |
| Enterrococcus | -- | | -- | | -- | | -- | | Recreational |
| Copper | -- | | -- | | -- | | | | Aquatic Life |
| Zinc | -- | | -- | | -- | | -- | | Aquatic Life |
| Water Column Mercury | -- | | -- | | -- | | -- | | Aquatic Life |
| Biological Integrity - Macroinvertebrate | 4 | 13.1 m | 5 | 19.0 m | 5 | 19.0 m | 5 | 19.0 m | Aquatic Life |
| Mercury | All waters of the state are Impaired and fall under the Statewide TMDL: http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls/mercury | | | | | | | | Fish Consumption |

*Note: There is not a direct comparison between the IR assessment periods. There could be methodology assessment changes (based on EPA guidance), splits in an assessment units (AU's) due to changes in the watershed or extent of an identified problem or corrections made.
m = miles; a = acres;

## Classifications

The entire basin was classified as nutrient sensitive waters(NSW) by the North Carolina Environmental Management Commission (EMC) in 1989 (Table 2).

Table 2: Upper Tar River Classificition Summary

| Classifications found in HUC 03020101: | | | |
|---|---|---|---|
| Freshwater | Miles | Freshwater | Acres* |
| Total | 995 | Total | 821 |
| Supplemental Classifications: | | | |
| B;NSW................. | 35 | WS-II;HQW,NSW,CA... | 99 |
| B;NSW+:............... | 36 | WS-IV,B;NSW,CA...... | 619 |
| C;NSW................. | 497 | WS-IV;NSW,CA........ | 103 |
| C;NSW+:.............. | 92 | | |
| C;ORW,NSW........... | 14 | | |
| WS-II;HQW,NSW....... | 4 | | |
| WS-II;HQW,NSW,CA... | 1 | | |
| WS-IV;B,NSW,CA....... | 3 | | |
| WS-IV;NSW............ | 241 | | |
| WS-IV;NSW,CA......... | 18 | | |
| WS-V;NSW............. | 54 | * Reservoirs and impoundments | |

Classification descriptions are found at:
http://portal.ncdenr.org/web/wq/ps/csu

## Population

As population increases so does our demand for clean water from aquifer and surface water sources and for the land and water to assimilate wastes. The 2010 census estimated population for this subbasin is 198,792. Population estimates for each watershed within this subbasin are listed in the table below.

Table 3: Population Estimates for the Upper Tar River Subbasin

| 10-Digit HUC | 1990 Population | 2000 Population | 2010 Population | 2010 Population Density (per sq mi) | 2020 Estimated Population | 2030 Estimated Population |
|---|---|---|---|---|---|---|
| 0302010101 | 6,572 | 8,405 | 9,404 | 319 | 11,181 | 12,443 |
| 0302010102 | 24,342 | 26,412 | 29987 | 729 | 33,198 | 36,406 |
| 0302010103 | 12,837 | 14,262 | 15,848 | 456 | 20,686 | 24,103 |
| 0302010104 | 11,217 | 16,259 | 22,225 | 746 | 25,133 | 29,851 |
| 0302010105 | 16,291 | 18,944 | 21,202 | 1,144 | 22,618 | 24,342 |
| 0302010106 | 27,367 | 31,249 | 36,656 | 1,294 | 37,819 | 40,952 |
| 0302010107 | 18,390 | 20,389 | 20,293 | 676 | 23,703 | 25,462 |
| 0302010108 | 6,024 | 5,764 | 6,070 | 180 | 5,836 | 5,858 |
| 0302010109 | 37,849 | 39,350 | 37,108 | 1,427 | 38,995 | 38,739 |
| 03020101 | 160,889 | 181,038 | 198,792 | 6,969 | 219,172 | 238,158 |

*NC Office of State Budget and Management: http://www.osbm.state.nc.us/

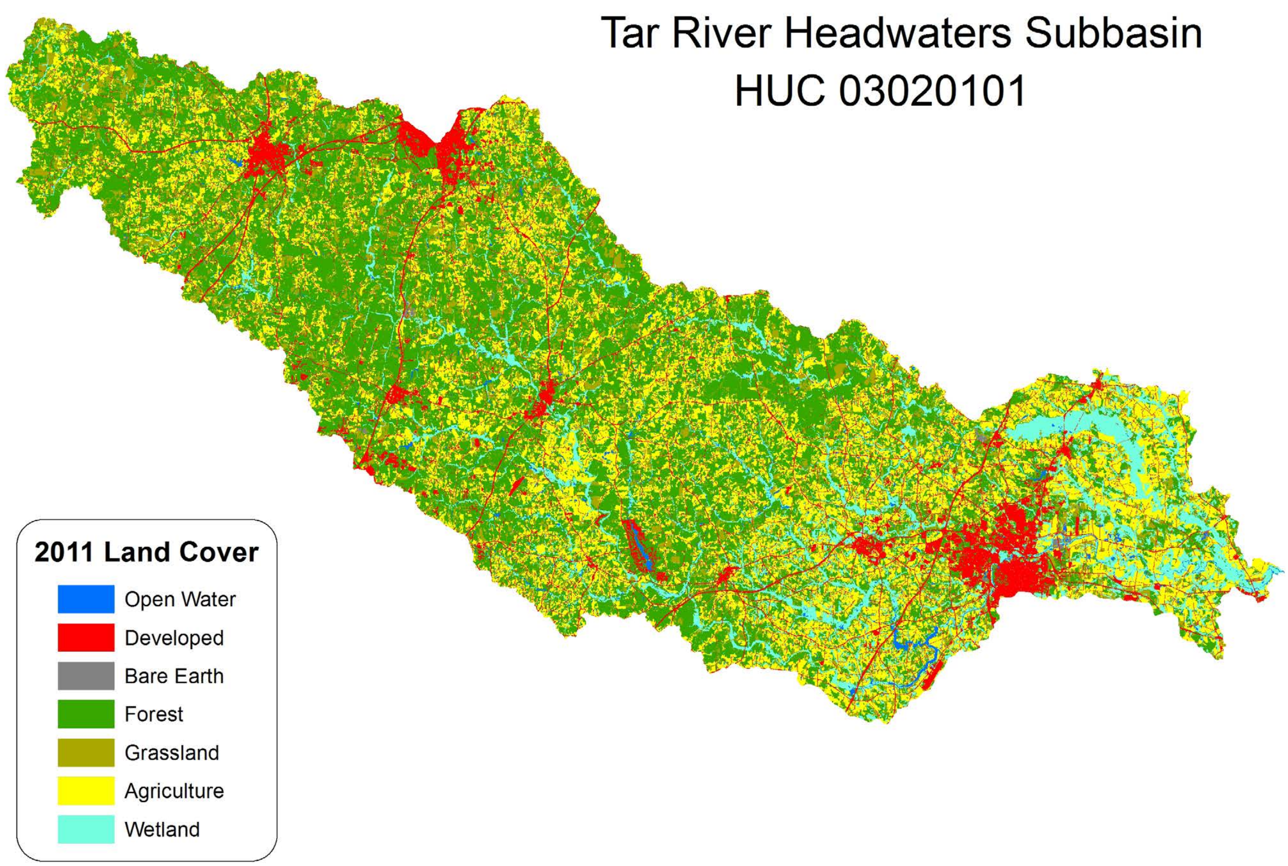
## Land Use

Data from the 2011 National Land Cover Database for this subbasin is presented in Table 4 and Figure 2.

Table 4: 2011 Land Cover Percentages

| Land Cover Type | Percent |
|---|---|
| Developed Open Space | 6.77 |
| Developed Low Intensity | 1.95 |
| Developed Medium Intensity | 0.76 |
| Developed High Intensity | 0.26 |
| Total Developed | 9.74 |
| Bare Earth Transition | 0.22 |
| Deciduous Forest | 23.20 |
| Evergreen Forest | 15.21 |
| Mixed Forest | 5.07 |
| Total non-Wetland Forest | 43.70 |
| Scrub Shrub | 4.81 |
| Grassland Herbaceous | 6.66 |
| Pasture Hay | 15.53 |
| Cultivated Crops | 11.46 |
| Total Agriculture | 38.46 |
| Woody Wetlands | 7.44 |
| Emergent Herbaceous Wetland | 0.65 |
| Total Wetlands | 8.09 |

Figure 2: Land Cover in Subbasin 03020101



## Aquatic Species Protection

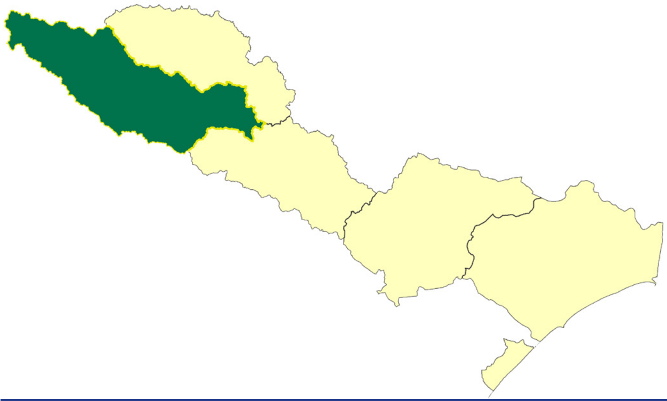
Within this subbasin, two specific management areas are the focus of aquatic species protection, these include: the Upper Tar River headwaters (North Fork Tar River, Fox Creek, Shelton Creek, Cub Creek, and Tar River) and Lower Swift Creek.

The Upper Tar River headwaters (HUC 0302010101) and its riparian habitat support rare fish, mussels, and plants, in addition to the federally-listed as endangered dwarf wedgemussel. Based on this diversity, several drainages within the management area have been identified as state (North Fork Tar River and Fox Creek) and nationally (Shelton Creek, Cub Creek, and Tar River) significant. The federal species of concern and state endangered Atlantic pigtoe (*Fusconaia masoni*), green floater (*Lasmigona subviridis*), and yellow lampmussel (*Lampsilis cariosa*) are known to occur in the upper Tar. Other mussels known from this area include the state-listed as threatened triangle floater (*Alasmidonta undulat*a), creeper (*Strophitus undulatus*), and eastern lampmussel (*Lampsilis radiata*), as well as the notched rainbow (*Villosa constricta*), which is a State species of concern.

The Upper Tar River headwaters provide habitat for: the federal species of concern and state significantly rare pinewoods shiner (*Lythrurus matutinus*), the state special concern North Carolina spiny crayfish (*Orconectes carolinensis*), the state special concern Neuse River waterdog (*Necturus lewisi*), the state rare and federal species of concern Roanoke bass (*Ambloplites cavifrons*), and the state and federally endangered plant Harperella (*Ptilimnium nodosum*).

Lower Swift Creek and its riparian habitat support rare fish, mussels, and plants in addition to the federally-listed endangered Tar River spinymussel. The federal species of concern and State endangered Atlantic pigtoe (*Fusconaia masoni*), yellow lance (*Elliptio lanceolata*), and yellow lampmussel (*Lampsilis cariosa*) are known to occur in the lower reaches of Swift Creek. Other mussels known from this reach include the state-listed threatened triangle floater (*Alasmidonta undulata*), creeper (*Strophitus undulatus*), Roanoke slabshell (*Elliptio roanokensis*) and eastern lampmussel (*Lampsilis radiata*), as well as the notched rainbow (*Villosa constricta*), a state species of concern. Two rare fish, the Carolina madtom (*Noturus furiosus*) and pinewoods shiner (*Lythrurus matutinus*), the Neuse River waterdog (*Necturus lewisi*), the state special concern North Carolina spiny crayfish (*Orconectes carolinensis*), two significantly rare plants and two significantly rare insects have also been documented in this portion of the subbasin. While the development of site-specific water quality management strategies are specifically aimed at the Tar spinymussel, they will also benefit other rare species in this watershed.

In 2005, wildlife resource agencies (US Fish & Wildlife, NC Natural Heritage Program and NC Wildlife Resources Commission) wrote a technical support document providing management recommendations for the threatened and endangered aquatic species in the Upper Tar River headwaters. Many of the recommendations include activities that are currently in place or are not resources that DWR has regulatory authority over. Therefore, DWR will identify efforts that can be regulated by DWR to protect water quality for the propagation of threatened and endangered aquatic life (e.g., Tar River spinymussel & dwarf wedgemussel). DWR is currently considering the development of a statewide mussel species management plan to avoid the lengthy process of individual site specific plans and rulemaking.



# Water Demand Projections

## Upper Tar River Subbasin 03020101

## OVERVIEW

The Upper Tar subbasin has, and likely will continue to observe the largest population growth of any of the subbasins, due in large part to its proximity to the City of Raleigh. Based upon existing water supplies, the OASIS hydrologic model predicted small water supply deficits for the Town of Louisburg in 2030 and 2060, and also predicted small water supply deficits in 2060 for the Town of Franklinton and the Franklin County water system. Franklinton has intakes on two separate reservoirs, which provides adequate supplies through the 2030 planning period. The Franklin County water system purchases all of its water supply from the Kerr Lake Regional Water System (KLRWS) and, to a lesser degree, from the Town of Louisburg. According to the 2012 LWSP, under the current water contracts, Franklin County will be utilizing 78% of its total contracted water supplies by 2030 and exceeding those contracts by 2050. As a result, Franklin County has been working with the KLRWS to obtain the required Interbasin Transfer (IBT) Certificate from the Environmental Management Commission (EMC) to increase the amount of water KLRWS is allowed to transfer from the Roanoke basin to the Neuse and Tar basins. Other water systems in this subbasin are also dependent upon water from the KLRWS, either directly or indirectly. The direct recipients are the City of Henderson, the Town of Oxford, and Warren County. These water systems sell water to smaller water systems throughout the region. It is anticipated that this IBT will enable the water systems in the region to provide adequate water supplies to support the projected growth.

Another municipality in the Upper Tar subbasin with similar growth issues is the City of Rocky Mount. During the drought conditions of the 2000’s, Rocky Mount successfully dealt with low water supply conditions primarily through strong water conservation initiatives. As a result, the Rocky Mount public utilities department monitors the daily water supply levels in the Tar River, both in its reservoir and flows downstream of the dam. Monitoring is important because the OASIS hydrologic model indicates the possibility of significant demand deficits with the longest deficits lasting for 132 days and 193 days for 2030 and 2060 demand scenarios, respectively. The hydrologic model also predicts at least one occurrence of demand exceeding supply during the majority of years in the flow record if water shortage response plans are not enacted. With the water conservation measures included, the model results show that the water supply deficits will be significantly reduced. To help further mitigate deficits, Rocky Mount has an emergency water supply interconnection with the City of Wilson in the Neuse River basin.

## Tar River Basin OASIS Hydrologic Model

The model used for this analysis, the Tar River Basin Hydrologic Model, uses Operational Analysis and Simulation of Integrated Systems, or OASIS, developed by HydroLogics, Inc. The Tar River Basin Hydrologic Model is a computer- based mathematical model that simulates surface water flows in the Tar River Basin. It can be used to evaluate changes in water availability with changing water demands and operational protocols.

The geographic scope of the model extends from the headwaters of the upper Tar River and Fishing Creek, in eastern Person and Vance Counties, respectively, down to Greenville in lower Tar River, where the river becomes tidally influenced. The schematic map (figure 1) of the basin shows the geographic coverage of the model and the relative location of the various model nodes.

The model uses a set of estimated daily natural inflows to characterize the water entering the river system. The inflow dataset was developed using 80 years of flow records adjusted for known withdrawals, discharges, and reservoir operations. The portion of the Tar River basin covered by the model was subdivided into smaller drainage areas. An average daily inflow was estimated for each drainage area and for each of the more than 29,000 days in the 80 years of flow data.

Water is removed from the system at discrete withdrawal nodes shown as blue boxes on the model schematic. Withdrawals include water supply systems, industrial water users, or agricultural water usage. Public water supply withdrawals are based on local water supply plan data submitted to DWR by local water utilities. Self-supplied industrial water withdrawals were derived from data submitted under DWR's water withdrawal registration program.

For modeling and analysis purposes the following definitions are used:

- Water demand **without** water shortage response plans (WSRP) considered in the model run is defined as the water use that is needed to meet demands when no water use restrictions are being required by a water shortage response plan.

- Water demand **with** water shortage response plans considered in the model run is defined as the water use that is needed to meet demands during the periods when the water shortage response plans are at the most severe mandatory level of restrictions measures.

In the model, 2010 conditions are used as the base case against which the scenarios of future demands and return flows are compared. Using the model to compare future demand conditions with the base case conditions, provides information to identify the possible impacts on reservoir water levels and stream flows at points of interest around the basin due to increasing surface water withdrawals. For this analysis, three different projected demand scenarios were modeled: a characterization of current conditions (2010) and two scenarios of future withdrawals based on withdrawals needed to meet estimated 2030 and 2060 demands.

A scenario based on water demands anticipated for the year 2030 was constructed using local water supply plan data and any updated projections received from water systems. While the levels of withdrawals included in this scenario are based on the estimated demands for 2030, this volume of withdrawals could occur before then, or in some year after 2030. Demands are assumed to follow future water use projections provided to the division by water withdrawers and the water systems that depend on them.

To project water use 50 years into the future, a scenario was evaluated based on anticipated demands needed to meet customers' water demands in the year 2060. Demand projections are based on information supplied to DWR in the local water supply plans and other registered water withdrawals. As with the 2030 scenario, the projected values are based on current understanding of the number of customers expected to be served and their expected demands for water in 2060.

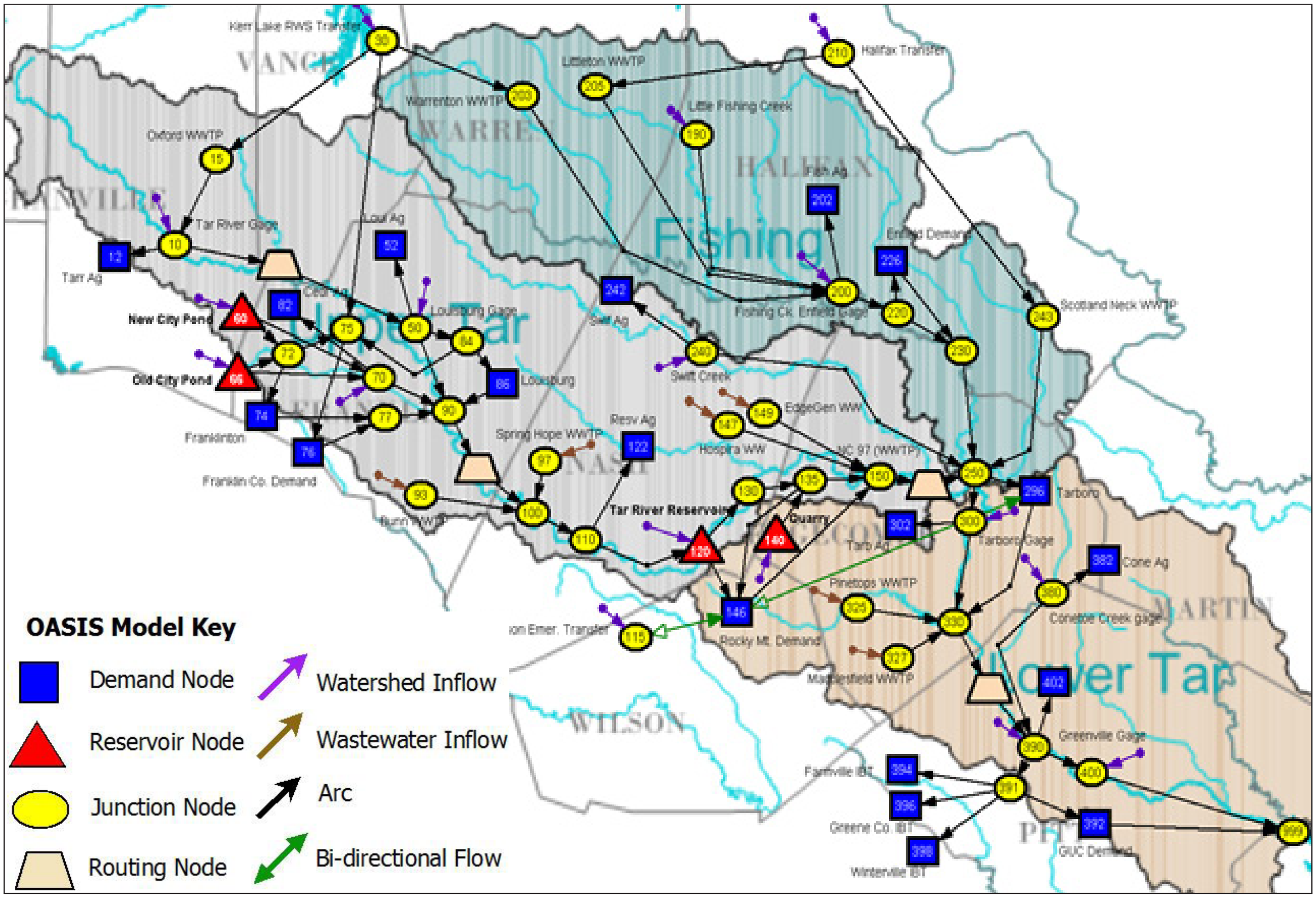
## Model Results

TABLE 1: YIELD SUMMARY FOR AVAILABLE SUPPLIES

| Model Scenario | | All Water Needs Without WSRP | | | | Essential Water Needs With WSRP | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model Node | Water Systems | Avg Demand (mgd) | Avg Deficit (% of Demand) | Longest Deficit (Days) | No of Years Demand Not Met Out of 80 | Avg Demand (mgd) | Avg Deficit (% of Demand) | Longest Deficit (Days) | No of Years Demand Not Met Out of 80 |
| | | **2010** | | | | **2010** | | | |
| 74 | Franklinton | 0.3 | 0.0% | 0 | 0 | 0.3 | 0.00% | 0 | 0 |
| 76 | Franklin County | 2.4 | 0.0% | 0 | 0 | 2.4 | 0.00% | 0 | 0 |
| 86 | Louisburg | 0.6 | 0.0% | 7 | 1 | 0.6 | 0.00% | 7 | 1 |
| 146 | Rocky Mount | 10.2 | 0.0% | 4 | 1 | 10.2 | 0.00% | 0 | 0 |
| | | **2030** | | | | **2030** | | | |
| 74 | Franklinton | 0.4 | 0.0% | 0 | 0 | 0.4 | 0.0% | 0 | 0 |
| 76 | Franklin County | 5.3 | 0.0% | 0 | 0 | 5.3 | 0.0% | 0 | 0 |
| 86 | Louisburg | 0.6 | 0.0% | 13 | 2 | 0.6 | 0.0% | 13 | 2 |
| 146 | Rocky Mount* | 12.3 | **0.7%** | **132** | **50** | 12.3 | 0.0% | 96 | 45 |
| | | **2060** | | | | **2060** | | | |
| 74 | Franklinton | 0.5 | 0.0% | 15 | 1 | 0.5 | 0.05% | 15 | 3 |
| 76 | Franklin County | 11.4 | 0.0% | 16 | 1 | 11.4 | 0.00% | 16 | 1 |
| 86 | Louisburg | 0.9 | 0.0% | 13 | 2 | 0.9 | 0.00% | 13 | 2 |
| 146 | Rocky Mount* | 15.2 | **2.3%** | **193** | **50** | 15.1 | **2.00%** | **112** | **45** |

Note: average deficit <0.1% of demand is shown as 0.0%
Pink Highlighted= – Inadequate
Yellow Highlighted = Adequate with manageable deficits
WSRP= Water Shortage Response Plan (i.e., drought plan)
*Rocky Mount's inadequate supply is a result of model input vs. actuality of a shortage

### Figure 1: Model Node Map




## Model Schematic Definitions

1. Demand Nodes (blue square): Demand nodes are nodes to which water is delivered. Delivery to a demand node is a basic, built-in operating goal. The delivery may meet, but never exceed, a specified target value referred to simply as the demand. The deficit between delivery and demand is called shortage.

2. Reservoir Nodes (red triangle): Reservoir nodes are nodes at which water can be stored. OASIS computes the storage at the end of every time step, which is the storage at the beginning of the next time step. Maintaining storage at a reservoir node is a basic, built-in operating goal. OASIS has built-in features to model many types of rules associated with a reservoir node.

3. Junction Nodes (yellow ellipse): Junction nodes are the simplest type of nodes. Unlike demand or reservoir nodes, junction nodes are not automatically associated with any special operating rules. Therefore, there are no special input tables for junction nodes.

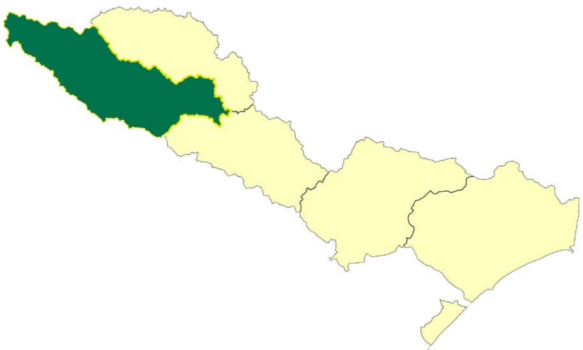
4. Routing Node (beige trapezoid): An innovative feature that simulates the routing of water by solving a linear program. Operating rules are expressed as operating goals or operating constraints.

5. Watershed Inflow (purple arrow): These denote water inflow such as streams and river tributaries entering into the system.

6. Wastewater Inflow (brown arrow): Captures inflow from a Wastewater Treatment Plant (WWTP) that gets water from a groundwater system or water sources outside of the model.

7. Arc (black arrow): Arcs represent conveyance from one node to another. In OASIS, every node must have at least one arc connecting to it.

8. Bi-directional Flow (green, two-ended arrow): Water can move in two directions



# Monitoring Data

## Upper Tar River Subbasin 03020101

## Use Support Assessment Summary

All surface waters in the state are assigned a classification reflecting the best-intended use of that water. To determine how well waterbodies are meeting their best-intended uses chemical, physical, and biological parameters are regularly assessed by DWR. These data are used to develop use support ratings every two years as reported to EPA; a collected list of all monitored waterbodies and their water quality rating is called the Integrated Report (IR) and Impaired waters are also reported on the 303(d) list. Water quality evaluation levels and how a waterbody earns a rating of Supporting or Impaired is explained in detail in the IR methodology.

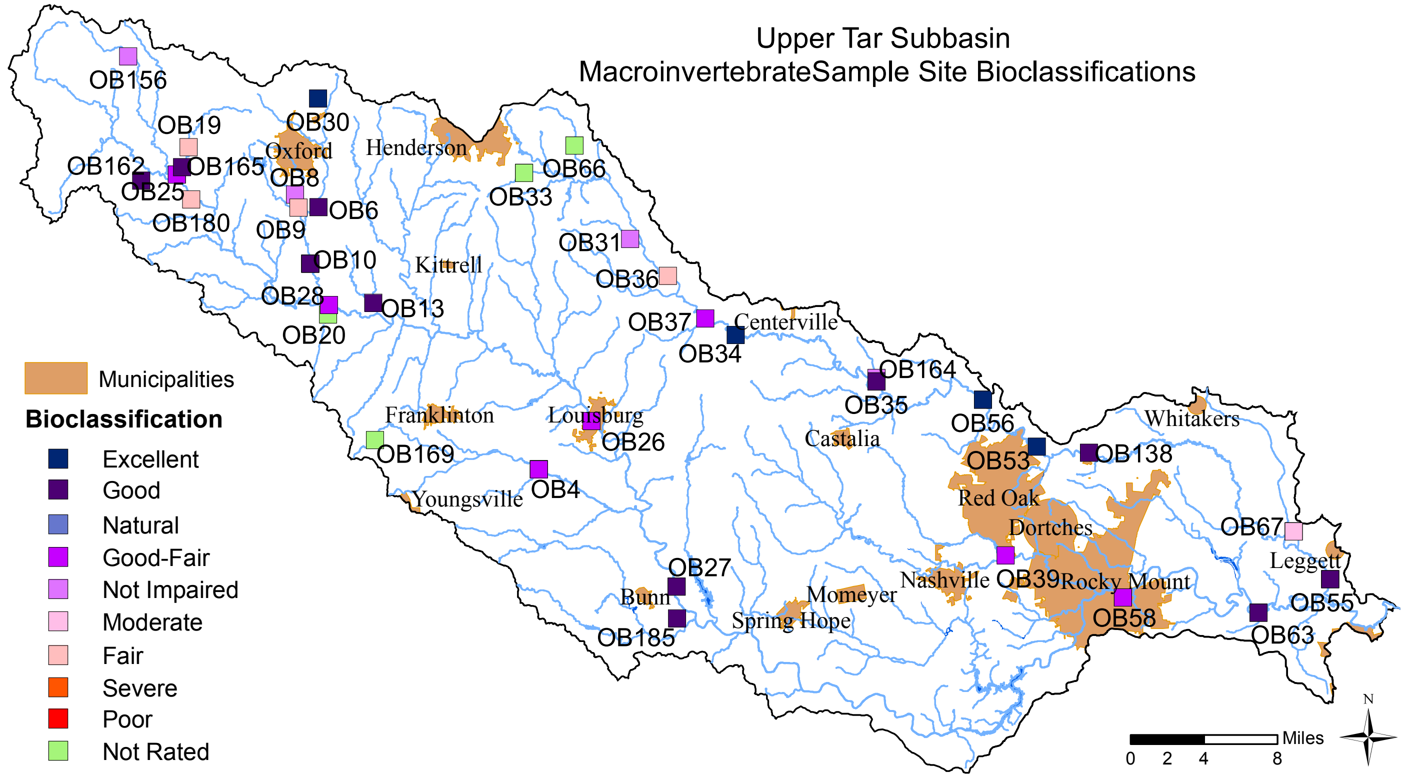
In this subbasin, use support was assigned for aquatic life, recreation, fish consumption and water supply categories. Waters are Supporting, Not Rated, or No Data in the aquatic life and recreation categories on a monitored or evaluated basis. All waters are Supporting in the water supply category on an evaluated basis based on reports from regional water treatment plant consultants. The Integrated Report provides a list of waterbodies in this subbasin and their most recent use support rating if monitored.

## Biological Data

Biological samples were collected during the spring and summer months of 2012 as part of the basinwide sampling five year cycle. Eight benthic macroinvertebrate sites and 10 fish community sites were sampled as part of the basinwide sampling cycle. The 2012 basin sampling efforts were greatly reduced compared to previous years primarily because of the lack of personnel resources. The limited data shows four sites with improvements and four sites with declining bioclassifications since the 2007 sample period. Tables 1 and 2 provide summaries of most recent sample results and a description of the stream location corresponding to Figures 1 and 2.

## Benthos Community Sampling Summary

### Figure 1: HUC 03020101 Macroinvertebrate Sites Sampled between 2000-2012




### Table 1: Benthos Biological Sample Results in HUC 03020101

| Station ID | Waterbody | Assessment Unit # | Description | County | Site Location | Date | Sample Result |
|---|---|---|---|---|---|---|---|
| OB33 | Martin Cr | 28-78-1-3 | From source to Sandy Creek | Vance | SR 1519 | 4/23/03 | Good-Fair |
| OB66 | Weaver Cr | 28-78-1-7 | From source to Southerlands Pond | Vance | SR 1533 | 4/23/03 | Good-Fair |
| OB25 | Tar R | 28-(1) | From source to a point 0.6 mile upstream of Oxford Water Supply | Granville | SR 1150 | 7/3/07 | Good-Fair |
| OB180 | Tar R | 28-(1) | replaced OB25 b/c of bridge construction | Granville | SR 1139 | 6/26/12 | Fair |
| OB28 | Tar R | 28-(5.7) | From Oxford Water Supply Intake to 0.6 mile upstream of Taylors Creek | Granville | SR 1622 | 7/22/02 | Good |
| OB156 | Shelton Cr | 28-4 | From source to Tar River | Granville | SR 1309 | 4/20/06 | Not Impaired |
| OB19 | N Fk Tar R | 28-5a | From source to 0.2 miles south of US 158 | Granville | US 158 | 6/25/07 | Fair |
| OB165 | N Fk Tar R | 28-5b | From 0.2 miles south of US 158 to the Tar River | Granville | SR 1151 | 5/22/07 | Good |
| OB13 | Gibbs Cr | 28-13 | From source to Tar River | Granville | SR 1620 | 3/24/06 | Good |
| OB20 | Sand Cr | 28-12 | From source to Tar River | Granville | SR 1623 | 3/22/06 | Not Rated |

| Station ID | Waterbody | Assessment Unit # | Description | County | Site Location | Date | Sample Result |
|---|---|---|---|---|---|---|---|
| OB6 | Coon Cr | 28-11-5 | From source to Fishing Creek | Granville | SR 1609 | 3/22/06 | Good |
| OB30 | UT Coon Cr | 28-11-5 | From source to Coon Cr | Granville | SR 1515 | 3/22/06 | Excellent |
| OB162 | UT Tar R | 28-(1)ut37 | From source to Tar River | Granville | SR 1126 | 4/20/06 | Not Rated |
| Special Study | Hatcher's Run | 28-11-3-(2) | From dam at Devin Lake to Fishing Creek | Granville | SR 15 | 8/25/06 | Fair |
| OB8 | Fishing Cr | 28-11b | From SR 1649 to #1 outfall | Granville | SR 1607 | 3/22/06 | Not Impaired |
| OB9 | Fishing Cr | 28-11c &<br>28-11d | From #1 outfall to SR 1608 to Coon Creek | Granville | SR 1608 | 3/2/06 | Fair |
| OB10 | Fishing Cr | 28-11e | From Coon Creek to Tar River | Granville | SR 1643 | 6/26/12<br>6/25/07 | Good<br>Good-Fair |
| OB26 | Tar R | 28-(24.7)a | In Louisburg | Franklin | SR 1229 | 7/22/02 | Good-Fair |
| OB27 | Tar R | 28-(24.7)a | From Louisburg Water Supply Intake to Cypress Creek | Franklin | SR 1609 | 6/27/07 | Good |
| OB185 | Tar R | 28-(24.7)a | site moved downstream of OB27 because of low flow | Franklin | SR 1611 | 6/27/12 | Good |
| OB4 | Cedar Cr | 28-29-(2)b | From Franklinton Branch to Tar R. | Franklin | SR 1109 | 6/26/12<br>6/26/07 | Good-Fair<br>Good |
| OB31 | Buffalo Cr | 28-78-1-10 | From source to Sandy Creek | Franklin | US 401 | 4/21/03 | Not Impaired |
| OB37 | Sandy Cr | 28-78-1-(8)b | From Flat Rock Creek to NC 561 | Franklin | SR 1436 | 6/27/07 | Good-Fair |
| OB34 | Sandy Cr | 28-78-1-(8) b2 | From N.C. Hwy. 561 to Nash Co. 1004 | Franklin | NC 561 | 4/24/03 | Excellent |
| OB36 | Sandy Cr | 28-78-1-(8) b1 | From NC 401 to Flat Rock Cr | Franklin | SR 1412 | 4/21/03 | Fair |
| OB145 | Shelly Br | 28-78-1-16 | From source to Sandy Creek | Nash | SR 1180 | 7/18/07 | Not Impaired |
| OB35 | Sandy Cr | 28-78-1-(14) | From N.C. Hwy. 561 to Nash Co. 1004 | Nash | SR 1405 | 6/27/12<br>6/26/07 | Good<br>Good |
| OB56 | Swift Cr | 28-78-(0.5) | From source to Nash Co. SR 1003 | Nash | SR 1310 | 6/26/07 | Good |
| OB53 | Swift Cr | 28-78-(0.5) | From source to Nash Co. SR 1003 | Nash | SR 1003 | 6/25/04 | Excellent |
| OB138 | Swift Cr | 28-78-(2.5) | From Nash SR 1003 to 1.4 miles upstream of Edgecombe SR 1409 | Nash | I-95 | 6/25/04 | Good |

| Station ID | Waterbody | Assessment Unit # | Description | County | Site Location | Date | Sample Result |
|---|---|---|---|---|---|---|---|
| OB39 | Stoney Cr | 28-68a | From source to Lassiters Creek | Nash | SR 1603 | 7/24/02 | Good-Fair |
| - | Stoney Cr. Boddies Millpond | 28-68b | From Lassiters Cr to Tar R. | Nash | - | 1992 | Impaired |
| OB58 | Tar R | 28-(69) | From dam at Rocky Mount Mills to 0.9 mile downstream of Buck Swamp | Edgecombe | NC 97 | 7/19/12<br>6/27/07 | Good-Fair<br>Good-Fair |
| OB63 | Tar R | 28-(74)a | From a point 0.9 mile downstream of Buck Swamp to Subbasin boundary | Edgecombe | SR 1252 | 6/28/12<br>6/27/07 | Good<br>Good |
| OB55 | Swift Cr | 28-78-(6.5) | From 1.4 miles upstream of Edgecombe Co. SR 1409 to Tar R. | Edgecombe | SR 1253 | 6/27/07 | Good |
| OB67 | White Oak Swp | 28-78-7-(2) | From 1.8 miles upstream of Edgecombe Co. SR 1428 to Swift Cr. | Edgecombe | SR 1428 | 2/7/12<br>2/5/07 | Moderate<br>Moderate |
| Bioclassification of Excellent, Good, Natural, Good-Fair, Not Impaired or Moderate Stress = Supporting<br>Fair, Severe Stress or Poor = Impaired | | | | | | | |

## Fish Community Sampling Summary

Figure 2: HUC 03020101 Fish Sites Sampled between 2000-2012

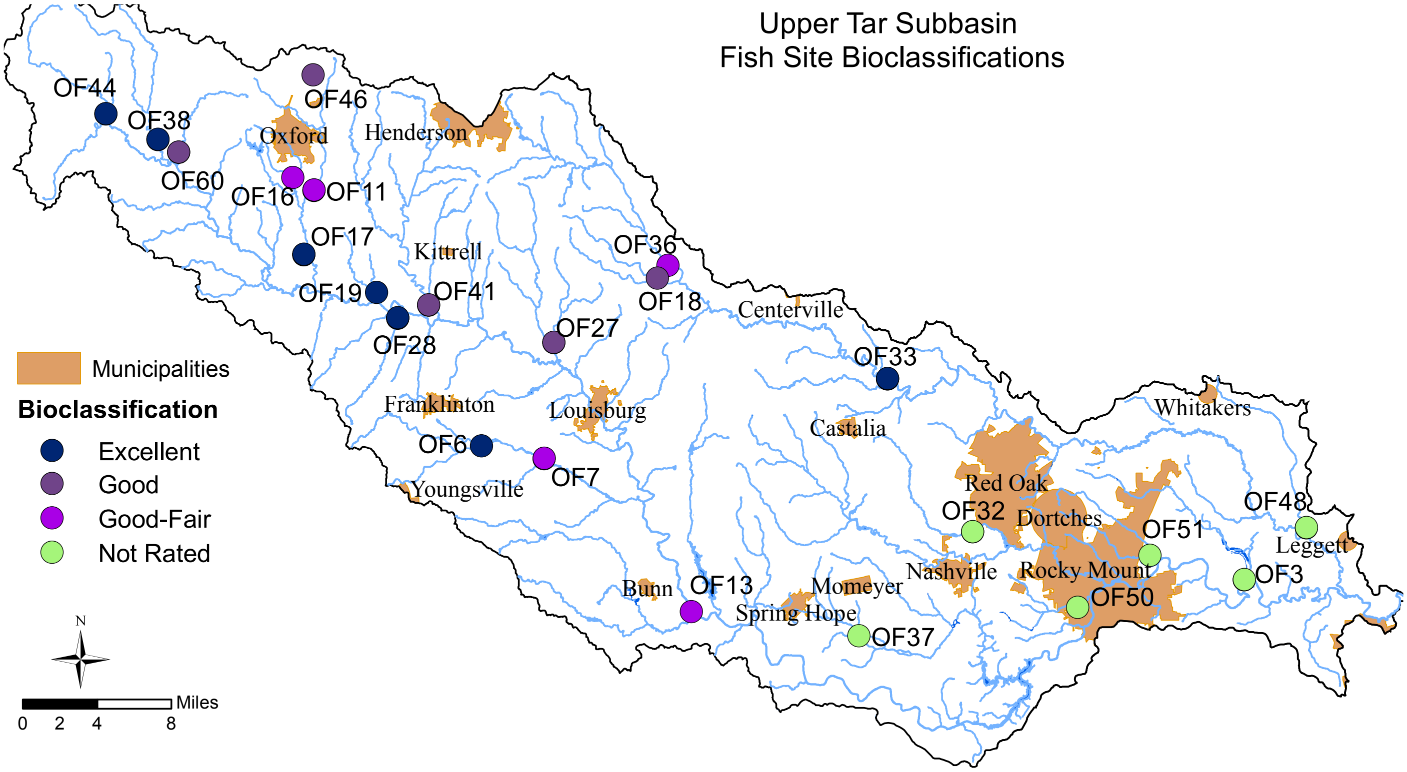



Table 2: Fish Community Sample Results in HUC 03020101

| Station ID | Waterbody | Assessment Unit # | Description | County | Site Location | Date | Sample Result |
|---|---|---|---|---|---|---|---|
| OF41 | Tabbs Cr | 28-17-(0.5)b | From Poplar Creek to Vance County SR 1100 | Vance | SR 1100 | 4/19/12<br>4/10/07 | Good<br>Good |
| OF44 | Tar R | 28-(1) | From source to a point 0.6 mile upstream of Oxford Water Supply | Granville | US 158 | 4/18/12<br>4/9/07 | Excellent<br>Good |
| OF38 | Shelton Cr | 28-4 | From source to Tar River | Granville | US 158 | 4/16/12<br>5/17/06 | Excellent<br>Good |
| OF60 | N Fk Tar R | 28-5 | From source to Tar River | Granville | SR 1151 | 4/16/12<br>4/9/07 | Good<br>Excellent |
| OF17 | Fishing Cr | 28-11e | From Coon Creek to Tar River | Granville | SR 1643 | 4/18/12<br>5/18/06 | Excellent<br>Excellent |
| OF16 Special Study | Fishing Cr | 28-11b | From SR 1649 to #1 outfall | Granville | SR1607 | 5/17/06 | Good-Fair |
| OF11 | Coon Cr | 28-11-5 | From source to Fishing Creek | Granville | SR 1609 | 4/16/12<br>5/18/06 | Good-Fair<br>Good |

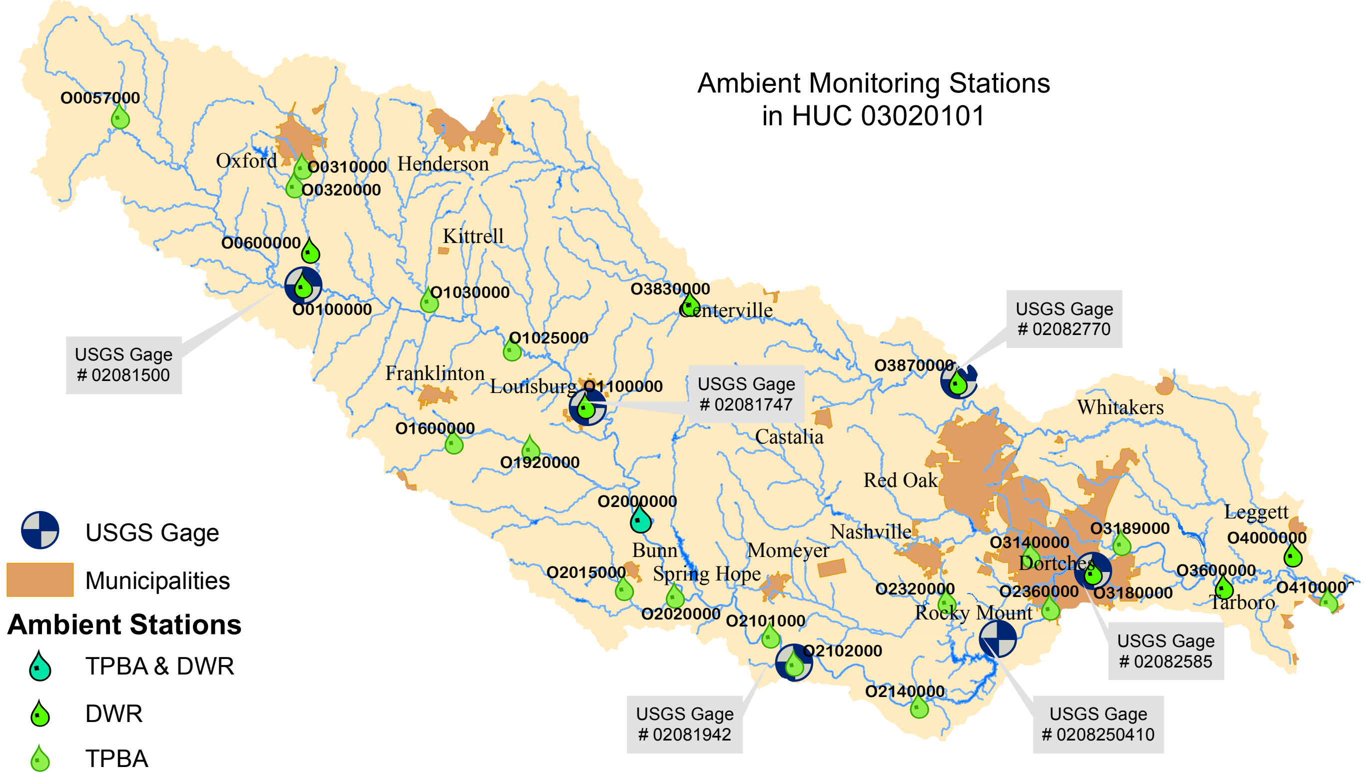
| Station ID | Waterbody | Assessment Unit # | Description | County | Site Location | Date | Sample Result |
|---|---|---|---|---|---|---|---|
| OF46 Special Study | UT Coon Cr | 28-11-5ut10 | From source to Coon Creek | Granville | SR 1515 | 5/17/06 | Good |
| OF19 Special Study | Gibbs Cr | 28-13 | From source to Tar River | Granville | SR 1620 | 5/18/06 | Excellent |
| OF28 | Middle Cr | 28-15 | From source to Tar River | Franklin | SR 1203 | 4/17/12<br>4/9/07 | Excellent<br>Excellent |
| OF27 | Lynch Cr | 28-21-(0.7) | From Vance County SR 1547 to Tar River | Franklin | SR 1235 | 4/17/12<br>4/10/07 | Good<br>Good |
| OF6 | Cedar Cr | 28-29-(2)b | From Franklinton Branch to Tar River | Franklin | SR 1105 | 6/10/04 | Excellent |
| OF7 | Cedar Cr | 28-29-(2)b | From Franklinton Branch to Tar River | Franklin | SR 1109 | 4/17/12<br>4/10/02 | Good-Fair<br>Excellent |
| OF13 | Crooked Cr | 28-30b | From NC 98 to Tar River | Franklin | NC 98 | 4/10/02 | Good-Fair |
| OF37 | Sapony Cr | 28-55-(1) | From source to mouth of Gabe Branch | Nash | SR 1145 | 4/18/02 | Not Rated |
| OF32 | Pig Basket Cr | 28-68-3-(2) | From Nash County SR 1425 to Stony Creek | Nash | SR 1433 | 4/10/07 | Not Rated |
| OF50 | Maple Cr | 28-66 | From source to Tar River | Nash | SR 1713 | 5/8/07 | Not Rated |
| OF18 | Flatrock Cr | 28-78-1-12 | From source to Sandy Creek | Franklin | SR 1412 | 4/9/02 | Good |
| OF36 | Sandy Cr | 28-78-1-(8) b1 | From NC 401to Flatrock Creek | Franklin | SR 1412 | 4/9/02 | Good-Fair |
| OF33 | Red Bud Cr | 28-78-1-17 | From source to Sandy Creek | Nash | SR 1407 | 4/19/12<br>4/11/07 | Excellent<br>Good |
| OF51 | Compass Cr | 28-72 | From source to Tar River | Edgecombe | NC 97 | 5/8/07 | Not Rated |
| OF3 | Beech Br | 28-75-(4) | From Falling Run to Tar River | Edgecombe | NC 97 | 5/8/07 | Not Rated |
| OF48 | White Oak Swp | 28-78-7-(2) | From 1.8 miles upstream of Edgecombe C SR 1428 to Swift Cr. | Edgecombe | SR 1428 | 5/9/07 | Not Rated |

Not Rated = Fish community metrics and criteria have yet to be developed for Coastal Plain streams
Excellent, Good or Good-Fair = Supporting
Fair or Poor = Impaired

## Ambient Data

Subbasinwide, monthly chemical and physical samples are taken by DWR (9 stations) (note- due to limited personnel resources some DWR stations were reduced to quarterly monitoring) and by the Tar Pamlico Basin Association (19 stations) starting in 2007. A majority of the ambient stations are associated with waterbody locations where potential pollution could occur from known land use activities. There are also portions of the subbasin where no water quality data are collected; therefore, we cannot evaluate the condition of the water quality in those areas. Parameters collected depend on the waterbody classification, but typically include conductivity, dissolved oxygen, pH, temperature, turbidity, nutrient measurements, metals, and fecal coliform. Each classification has an associated set of standards the parameters must meet in order to be considered supporting the waterbody's designated uses. Ten sample results are required within the five year data collection window in order to evaluate the water quality parameter and compare it to the water quality standards. Stressors are either chemical parameters or physical conditions that at certain levels prevent waterbodies from meeting the standards for their designated use. Ambient stations are listed in Table 3, and their locations are found in Figure 3.

Figure 3: Ambient Monitoring Stations in the Upper Tar River Subbasin




USGS= United States Geological Survey, TPBA= Tar Pamlico Basin Association, DWR= Division of Water Resources

Table 3: Ambient Stations in HUC 03020101

| Station ID | Agency | Active Since | Waterbody | AU# | Station Location | Stressors |
|---|---|---|---|---|---|---|
| O0057000 | TPBA | 3/1/07 | Tar River | 28-(1) | US 158 near Berea | - |
| O0100000 | NCAMBNT | 6/11/68 | Tar River | 28-(5.7) | NC 96 near Tar River | Fecal Coliform Bacteria |
| O0310000 | TPBA | 3/1/07 | Foundry Br | 28-11-2 | SR 1649 New Commerce Dr at Oxford | Low DO, Fecal Coliform Bacteria |
| O0320000 | TPBA | 2/3/10 | Fishing Cr | 28-11b | SR 1607 near Oxford | Fecal Coliform Bacteria |
| O0600000 | NCAMBNT | 6/11/68 | Fishing Cr | 28-11e | SR 1643 near Clay | Turbidity, Fecal Coliform Bacteria, Copper, Zinc |
| O1025000 | TPBA | 3/1/07 | Tar River | 28-(15.5) | SR 1003 Sims Bridge Rd near Louisburg | Turbidity, Fecal Coliform Bacteria |
| O1030000 | TPBA | 3/1/07 | Tabbs Cr | 28-17-(0.5)b | SR 1100 Egypt Mountain Rd near Kittrell | Low DO, Fecal Coliform Bacteria |
| O1100000 | NCAMBNT | 11/20/80 | Tar River | 28-(24.7)a | US 401 at Louisburg | - |
| O1600000 | TPBA | 3/1/07 | Cedar Cr | 28-29-(2)a | SR 1116 Cedar Creek Rd near Franklinton | - |
| O1920000 | TPBA | 3/1/07 | Cedar Cr | 28-29-(2)b | SR 1109 Timberlake Rd near Louisburg | Turbidity, Fecal Coliform Bacteria |
| O2000000 | Both | 6/17/68 | Tar River | 28-(24.7)a | SR 1001 near Bunn | Fecal Coliform Bacteria |
| O2015000 | TPBA | 3/1/07 | Crooked Cr | 28-30a | SR 1719 Bunn Elementary School Rd near Bunn | Low DO, Fecal Coliform Bacteria |
| O2020000 | TPBA | 3/1/07 | Crooked Cr | 28-30b | NC 98 near Bunn | Low DO |
| O2101000 | TPBA | 3/1/07 | Tar River | 28-(24.7)b | SR 1145 Old Spring Hope Rd near Spring Hope | - |
| O2102000 | TPBA | 3/1/07 | Tar River | 28-(24.7)b | NC 581 near Stanhope | - |
| O2140000 | TPBA | 3/1/07 | Tar River | 28-(35.5) | SR 1981 Tar River Church Rd near Cliftonville | Fecal Coliform Bacteria |
| O2320000 | TPBA | 3/1/07 | Sapony Cr Tar River | 28-55-(5.5) 28-(36)b | SR 1704 Batchelor Dr near Nashville to Tar R. | Low DO, Fecal Coliform Bacteria |
| O2360000 | TPBA | 3/1/07 | Tar River | 28-(64.5) | US 301 Byp at Rocky Mount | Low DO, Fecal Coliform Bacteria |
| O3140000 | TPBA | 3/1/07 | Stony Cr (Boddies Millpond) | 28-68b | Winstead Ave near Little Easonburg | Low DO, Fecal Coliform Bacteria |
| O3180000 | NCAMBNT | 11/20/80 | Tar River | 28-(69) | NC 97 at Rocky Mount | Fecal Coliform Bacteria |

Table 3: Ambient Stations in HUC 03020101

| Station ID | Agency | Active Since | Waterbody | AU# | Station Location | Stressors |
|---|---|---|---|---|---|---|
| 03189000 | TPBA | 3/1/07 | Tar River | 28-(69) | SR 1250 Springfield Rd at Rocky Mount | Fecal Coliform Bacteria |
| 03600000 | Both | 7/5/68 | Tar River | 28-(74)a | SR 1252 near Hartsease | Fecal Coliform Bacteria |
| 03830000 | NCAMBNT | 4/9/75 | Sandy Cr | 28-78-1-(8)b2 | SR 1432 near Gupton | - |
| 03870000 | NCAMBNT | 7/1/02 | Swift Cr | 28-78-(0.5) | SR 1310 at Hilliardston | Fecal Coliform Bacteria |
| 04000000 | NCAMBNT | 3/14/74 | Swift Cr | 28-78-(6.5) | SR 1253 near Leggett | - |
| 04100000 | TPBA | 3/1/07 | Tar River | 28-(74)b | NC 33 near Tarboro | Fecal Coliform Bacteria |
| 00065000 | RAMS | 2007-2008 | North Fork Tar River | 28-5 | at SR 1151 near Berea | - |
| 01190000 | RAMS | 2009-2010 | Cedar Creek | 28-29-(1) | at SR 1127 near Pocomoke | ? |
| TAR017C TAR015E TAR015F TAR015G | DWR Lake | 1989 | Tar River | 28-(36)a 28-(63) | Rocky Mount Reservoir | High Temperature, Chlorophyll a |
| TAR001C TAR001E | DWR Lake | 1989 | Hatchers Run | 28-11-3-(1) | Lake Devin | high pH, turbidity, chlorophyll a |
| TPBA=Tar Pamlico Basin Association, NCAMBNT= DWR, RAMS= Random Ambient Monitoring System, sampled by DWR“-” indicates no stressors identified. “?” stressors to be determined | | | | | | |

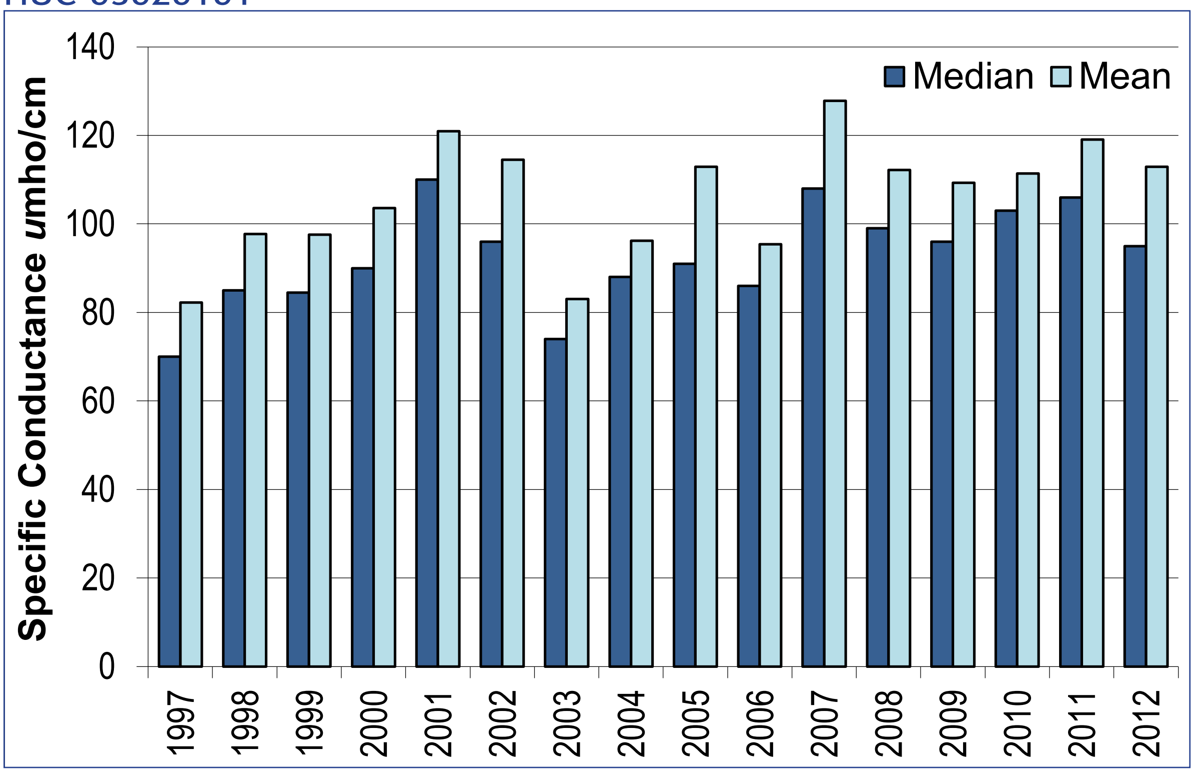
## Water Quality Monitoring Parameters

The following discussion of ambient monitoring parameters includes graphs showing the median and mean concentration values for all ambient stations (n=28) in this subbasin for a specific parameter over each year (note: sample size increased with the addition of Tar Pamlico Basin Association sampling in 2007). These graphs are not intended to provide statistically significant trend information or loading numbers, but rather provide an idea of how changes in land use conditions, natural fluctuations, or climate changes effect parameter readings over the long term. The difference between median and mean results indicate the presence of outliers in the dataset.

### Specific Conductance

Specific conductivity is a measure of the ability of water to pass an electrical current. Higher conductivity concentrations can be an indicator of pollutants associated with discharge of chlorides, phosphates, nitrates and other inorganic dissolved solids. There is no standard for specific conductance in NC. (Figure 4)

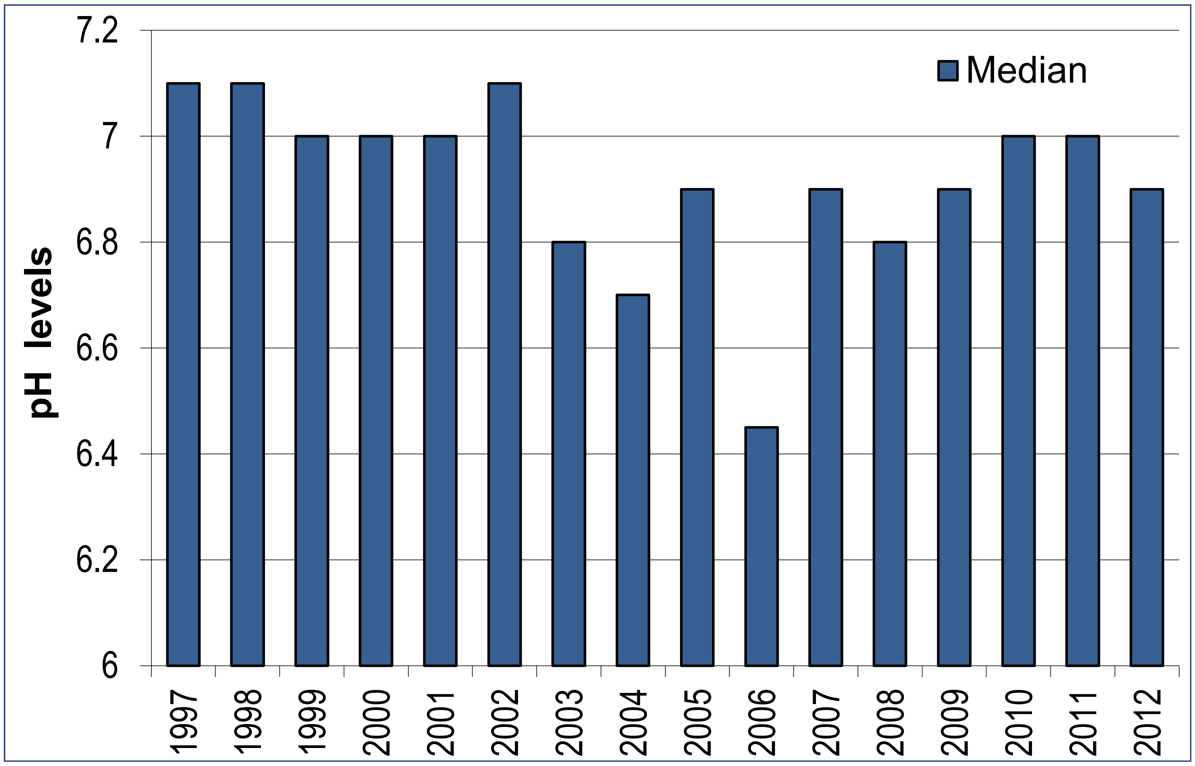
Figure 4: Summarized Specific Conductance Levels for Data collected at Ambient Stations in HUC 03020101



## pH

The water quality standard for pH in surface freshwater is 6.0 to 9.0 standard units. Swamp water (supplement Class Sw) may have a pH as low as 4.3 if it is the result of natural conditions. pH is a measure of hydrogen ion concentration that is used to express whether a solution is acidic or alkaline (basic). Low values (< 7.0) can be found in waters rich in dissolved organic matter, such as swamp lands, whereas high values (> 7.0) may be found during algal blooms. Lower values can have chronic effects on the community structure of macroinvertebrates, fish and phytoplankton. (Figure 5).

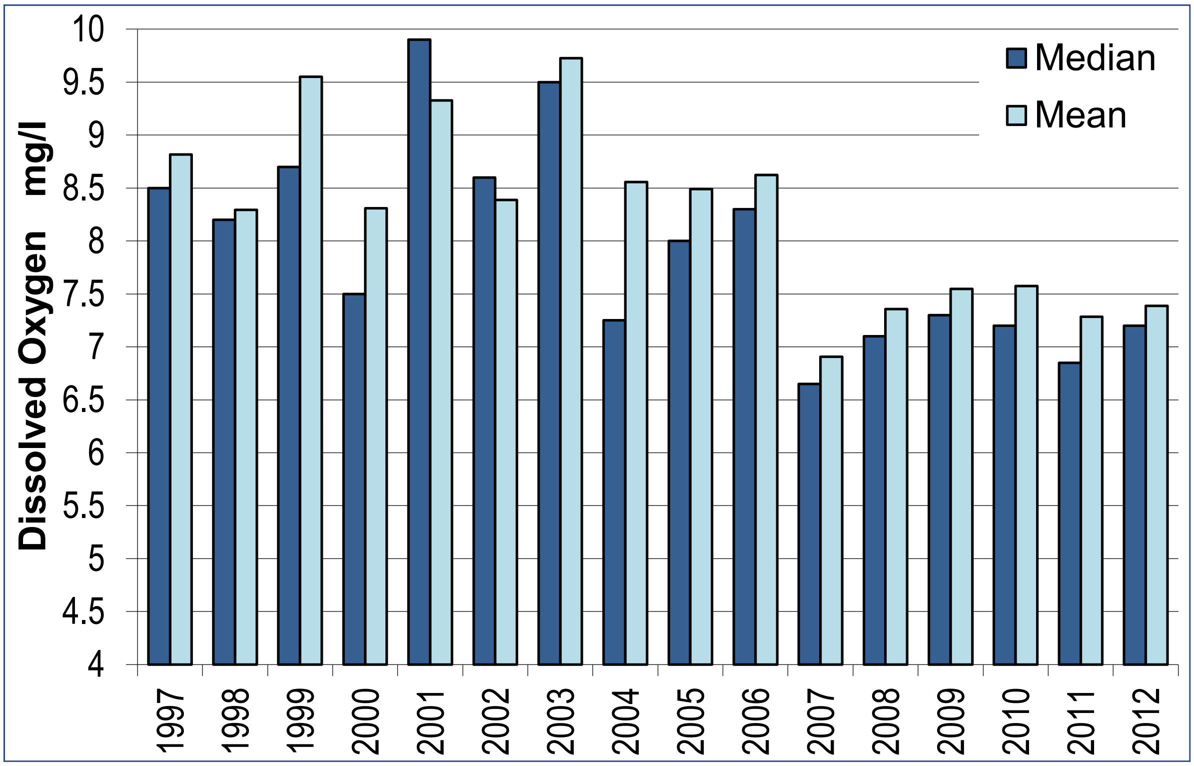
Figure 5: Summarized pH values for all data collected at Ambient Stations in huc 03020101



## Dissolved Oxygen

The dissolved oxygen (DO) water quality standard for freshwater is not less than a daily average of 5 mg/L or a minimum instantaneous value of not less than 4 mg/l. Swamp waters may have lower values if the low DO level is caused by natural conditions. Dissolved oxygen can be produced by wind or wave action that mix air into the water or through aquatic plant photosynthesis. During the day, DO levels are higher when photosynthesis occurs and they drop at night when respiration occurs by aquatic organisms. High levels are found mostly in cool, swift moving waters and low levels are found in warm, slow moving waters. In slow moving waters, such as reservoirs or estuaries, depth is also a factor. Wind action and plants can cause these waters to have a higher dissolved oxygen concentration near the surface, while biochemical reactions lower in the water column may result in concentration as low as zero at the bottom. (Figure 6).

Figure 6: Summarized Dissolved Oxygen Levels for all data collected at Ambient Stations in HUC 03020101







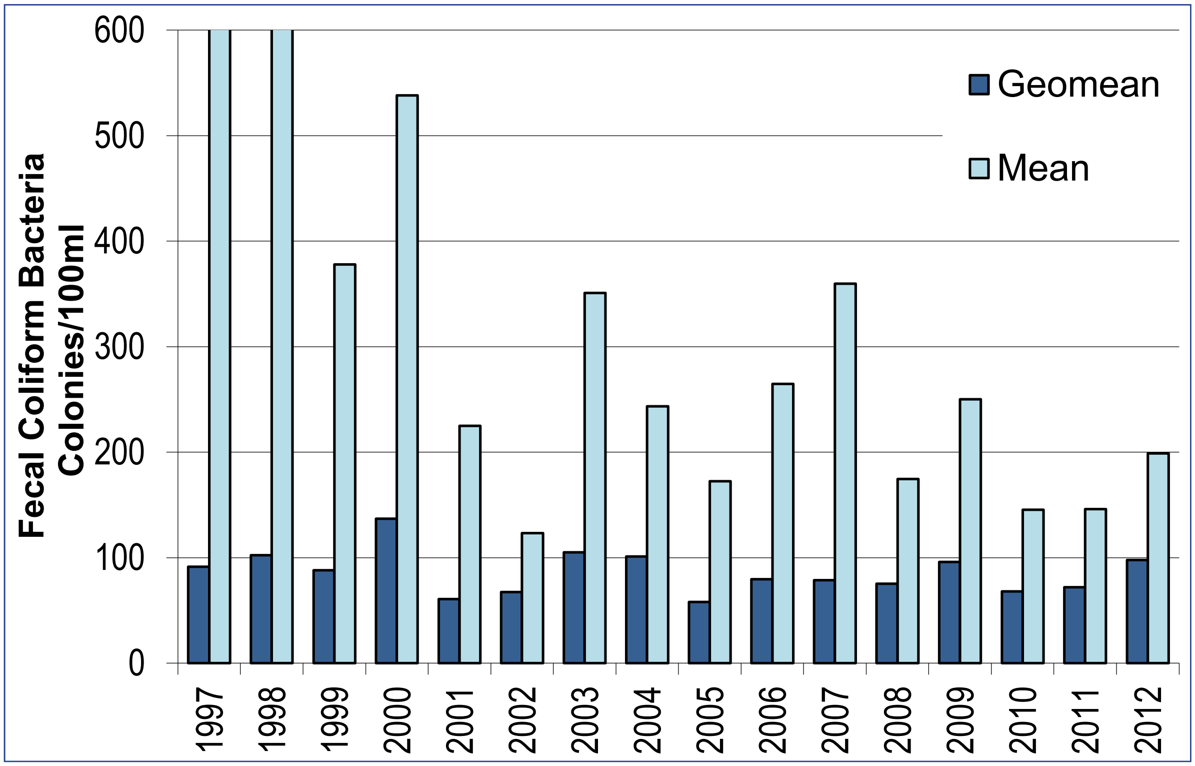

Revised 2/13/15

## Fecal Coliform Bacteria

The fecal coliform bacteria standard for freshwater streams is not to exceed the geomean of 200 colonies/100ml or 400 colonies/100ml in 20% of the samples where five samples have been taken in a span of 30 days (5-in-30). Only results from a 5-in-30 study are to be used to indicate whether the stream is Impaired or Supporting. Waters with a classification of B (primary recreation water) will receive priority for 5-in-30 studies. Other waterbodies will be studied as resources permit.

The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of humans or other warm-blooded animals. At the time this occurred, the source water might have been contaminated by pathogens or disease producing bacteria or viruses that can also exist in fecal material. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste. (Figure 7)

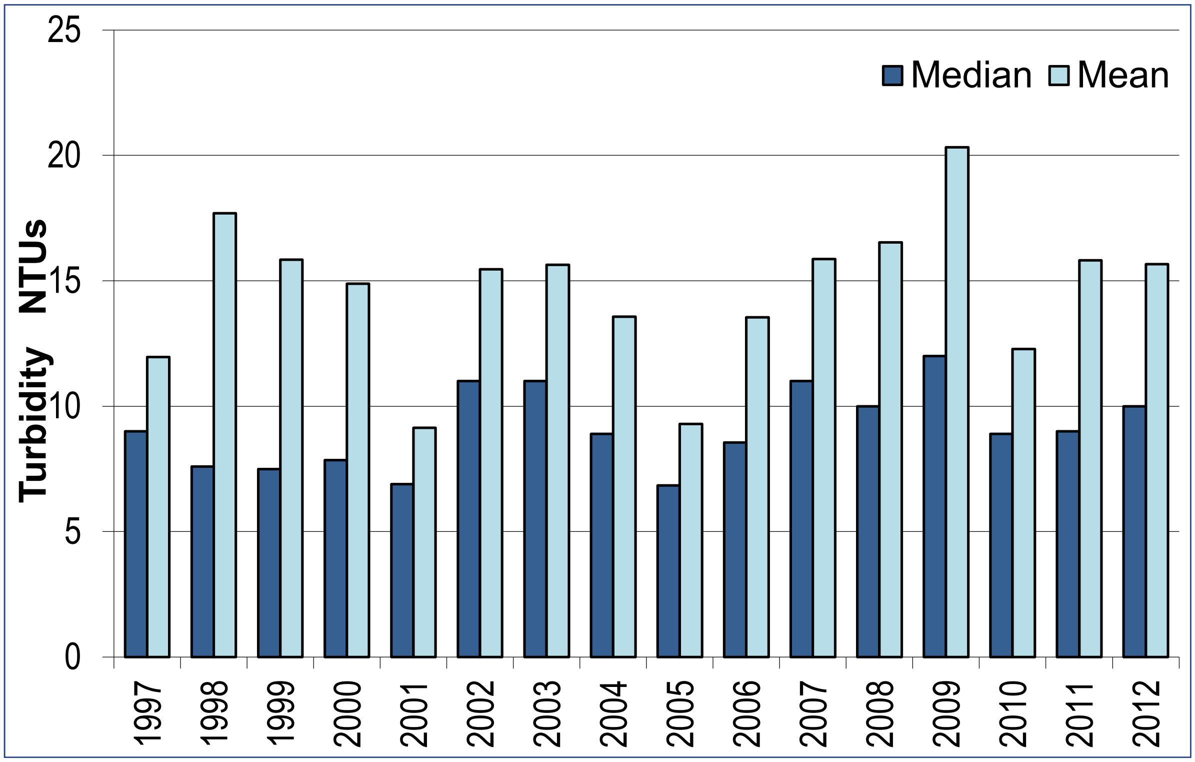
Figure 7: Summarized Fecal Coliform Bacteria for Data collected at Ambient Stations in HUC 03020101



## Turbidity

The turbidity standard for freshwater streams is 50 NTUs. Turbidity is a measure of cloudiness in water and is often accompanied with excessive sediment deposits in the streambed. Excessive sediments deposited on stream and lake bottoms can choke spawning beds (reducing fish survival and growth rates), harm fish food sources, fill in pools (reducing cover from prey and high temperature refuges), and reduce habitat complexity in stream channels. Excessive suspended sediments can make it more difficult for fish to find prey and at high levels can cause direct physical harm, such as clogged gills. Sediments can cause taste and odor problems, block water supply intakes, foul treatment systems, and fill reservoirs. (Figure 8).

Figure 8: Summarized Turbidity values for all data collected at Ambient Stations in HUC 03020101




The Upper Tar River basin has shown signs of increasing turbidity. While partially attributed to new development and landuse changes, there is a possibility that more rural streams are also contributing to this problem via legacy sediments, along with severe erosion of stream banks. Research is needed to determine the extent of the problem and whether it contributes to the increases in organic nitrogen load. A special study within the Upper Tar watershed should include ambient monitoring of storm events to capture the extent of the turbidity problem.

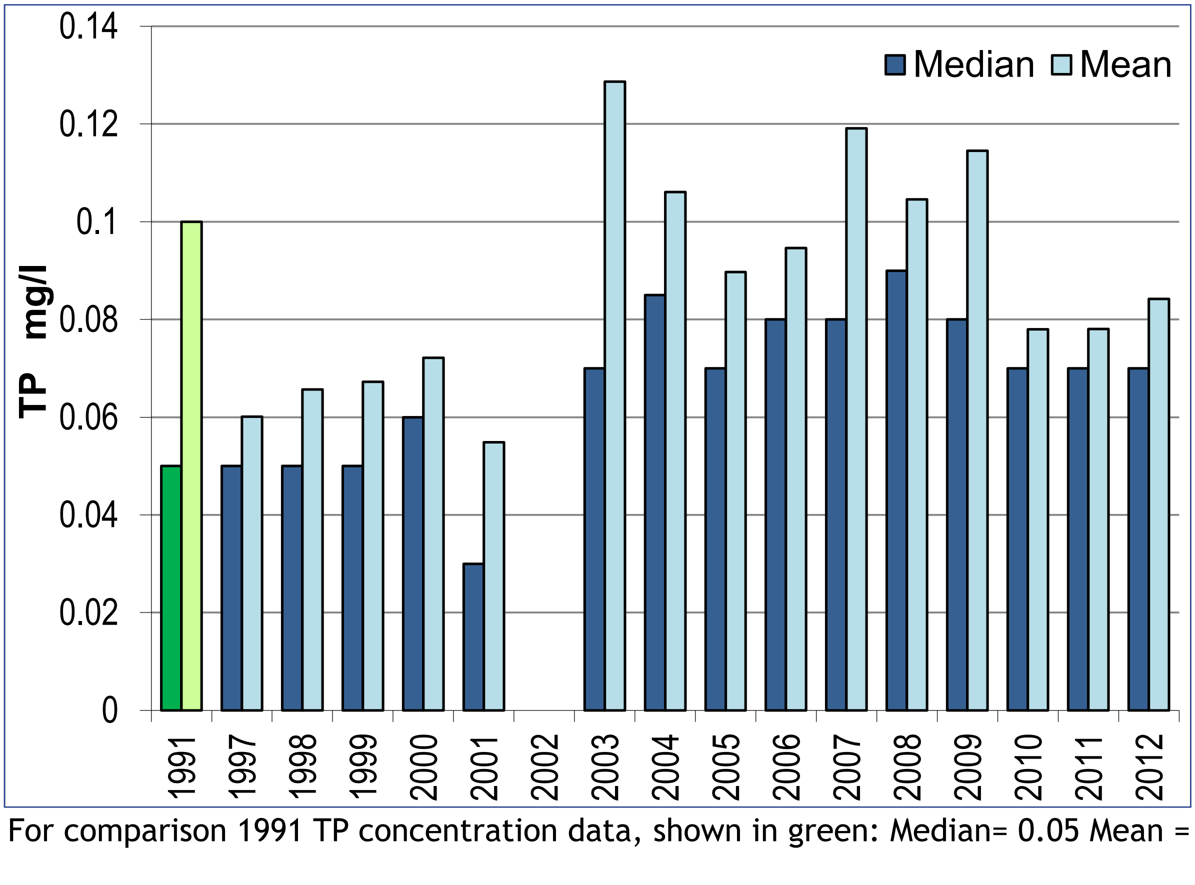
Buffalo Creek- photo courtesy of PTRF

## Nutrient Enrichment

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". Nitrogen compounds include ammonia as nitrogen ($NH_3$), Total Kjeldahl Nitrogen (TKN) and nitrite+nitrate nitrogen ($NO_2$+$NO_3$). Total nitrogen (TN) is the sum of TKN and $NO_2$+$NO_3$. Phosphorus is measured as total phosphorus (TP) by DWR. 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. In addition to the possibility of causing algal blooms, ammonia-nitrogen may combine with high pH water to form ammonium hydroxide ($NH_4OH$), a form toxic to fish and other aquatic organisms. Due to excessive levels of nutrients resulting in massive algal blooms and fish kills, the entire Tar-Pamlico River Basin was designated as Nutrient Sensitive Water (NSW) in 1989. This designation resulted in the development and implementation of a nutrient management strategy to achieve a decrease in TN by 30% and no increase in TP loads compared to 1991 conditions. Even though implementation of the strategy has occurred by wastewater treatment plant (WWTP) dischargers, municipal stormwater programs, and agriculture, nutrient enrichment continues to be cumulatively impacting the Pamlico Estuary.

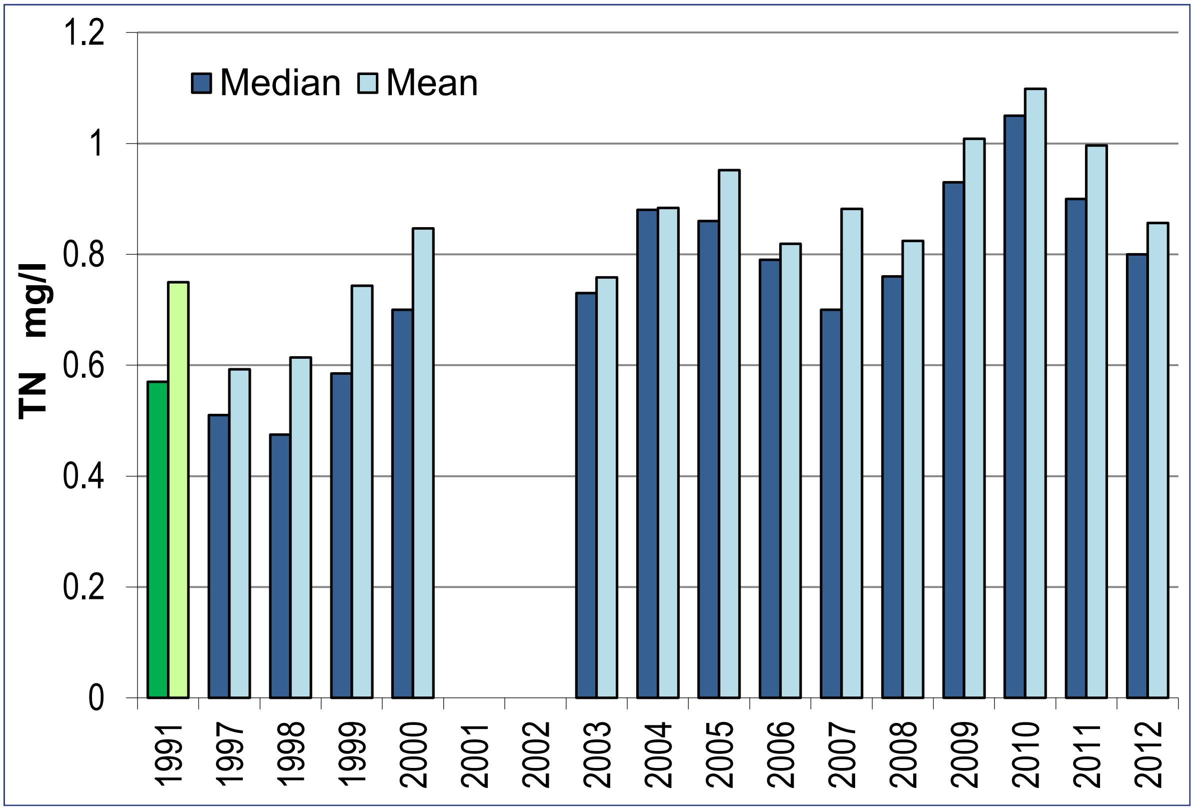
Basin trend analyses were completed for nutrient concentration and flow-normalized loads to evaluate progress towards meeting TMDL reduction goals, as discussed in detail in the NSW report. These analyses detected a statistically significant increase in TKN and TP concentrations and a decrease in $NO_2$+$NO_3$. There were no detected trends for $NH_3$ or TN concentrations. TKN is defined as total organic nitrogen and $NH_3$. An increase in organic nitrogen is the likely source for the increase in TKN concentrations since $NH_3$ concentrations have remained stable basinwide. (Figures 9, 10 & 11).

Figure 9: Summarized Total Phosphorus values for all data collected at Ambient Stations in HUC 03020101



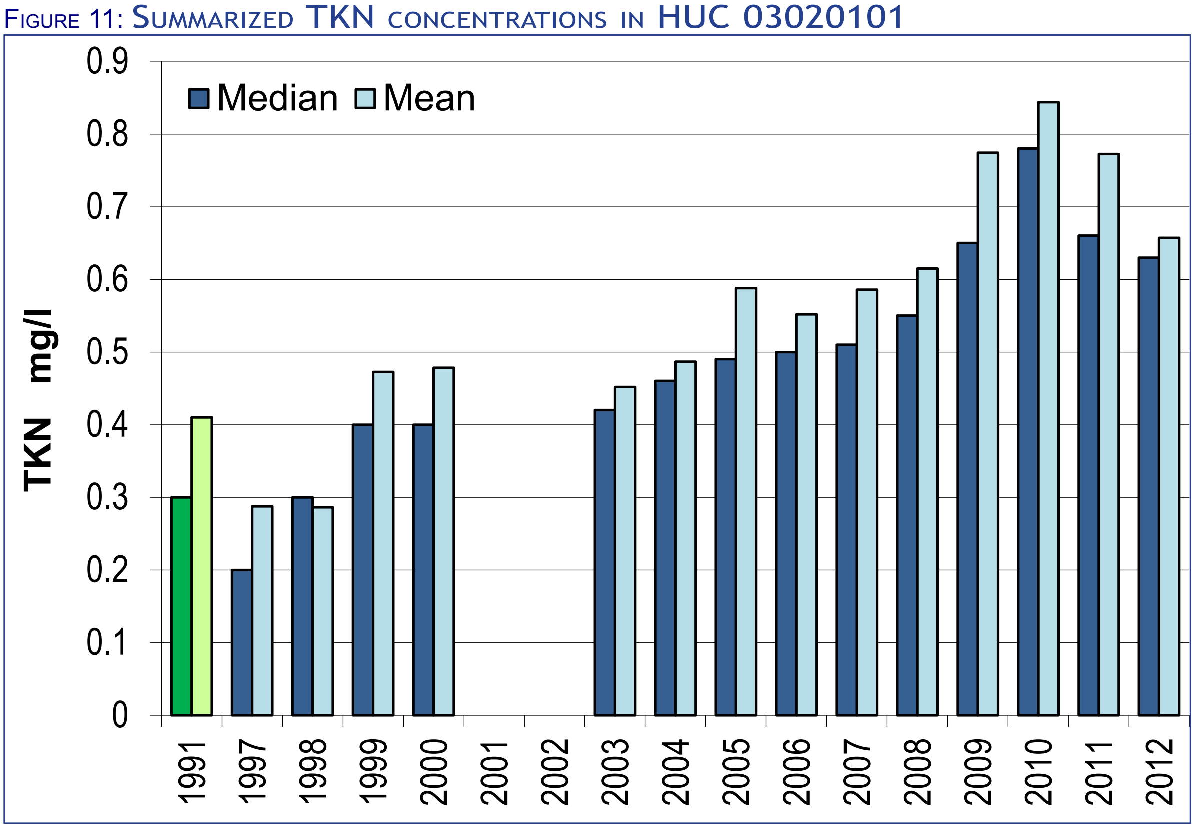

For comparison 1991 TP concentration data, shown in green: Median= 0.05 Mean = 0.10

Figure 10: Summarized Total Nitrogen values for all data collected at Ambient Stations in HUC 03020101




For comparison 1991 TN concentration data shown in green: Median= 0.57 Mean = 0.75

Figure 11: Summarized TKN concentrations in HUC 03020101




For comparison, 1991 TKN concentration data: Median= 0.30 Mean = 0.41

# TRENDS at Ambient Station O0100000

The following information is also presented in the Aycock Creek Watershed (0302010101) report and the NSW Analysis report.

Station O0100000 and USGS gage # 02081500 are co-located on Tar River. To help understand upstream conditions and their contributions to the nutrient loading to the estuary a trend analysis was performed using data from 1991-2013 on the nutrient parameters collected from Tar River at NC 96 (AMS O0100000). More details about these trends are available in the NSW Report.

***Flow adjusted concentration***

The results of the Seasonal Kendall test for flow-adjusted concentrations of ammonia (NH3-N), nitrate/nitrite (NOx-N), Total Kjeldahl nitrogen (TKN), total nitrogen (TN), and total phosphorus (TP) at O0100000 are provided in Table 4. Except for Ammonia-N and TN, the results indicate that there were statistically significant trends for NOx-N, TKN and TP. TKN and TP showed increasing trends in concentration, while NOx-N showed a decreasing trend. The upward slopes of TKN and TP suggest that the average increase in median concentration represent a 37% and a 36%, respectively, over the 22 years of study period.

Table 4: Result of Seasonal Kendall Trend Analysis for Nutrient Concentrations at NC 96 (1991-2013)

| Water Quality Constituents (mg/L) | Seasonal Sen Trend Slope (mg/L/year) | Significant Trend at 95% | First 12 month Median | Average % Change in Median |
|---|---|---|---|---|
| Ammonia-N | - | No Trend | 0.035 | - |
| NOx-N | -0.00291 | Decreasing | 0.04 | -160.05* |
| TKN | 0.00678 | Increasing | 0.4 | 37.29 |
| TN | - | No Trend | 0.49 | - |
| TP | 0.00057 | Increasing | 0.035 | 35.83 |
| * Note that NOx-N values are highly variable at this location. While a 160% decrease could not actually occur, this result is statistically valid. | | | | |

***Flow-normalized load***

Assessment of trends in annual nutrient loads at AMS O0100000 were performed using flow-normalized concentrations and loads computed for flow intervals representing low, medium, and high flows. Nutrient concentrations were estimated from the mean of available data and flow-weighted average concentrations. A detailed description of this approach is presented in a peer-reviewed article by Lebo et al.,(2011). The results from a flow-normalized loading analysis indicates an overall 20% decrease in nitrate/nitrite(NOx-N), 24% increase in Total Kjeldahl nitrogen (TKN), 10% increase in total nitrogen (TN) and 7% increase in total phosphorus (TP). Flow-normalized estimates are designed to remove the effect of random stream flow-driven variations and are ideal for evaluating progress towards nutrient reduction goals (Sprague et al., 2011).

### Flow-Normalized Total Nitrogen Loading at AMS O0100000

Figure 12: Total Nitrogen Load at AMS O0100000 (Tar River)

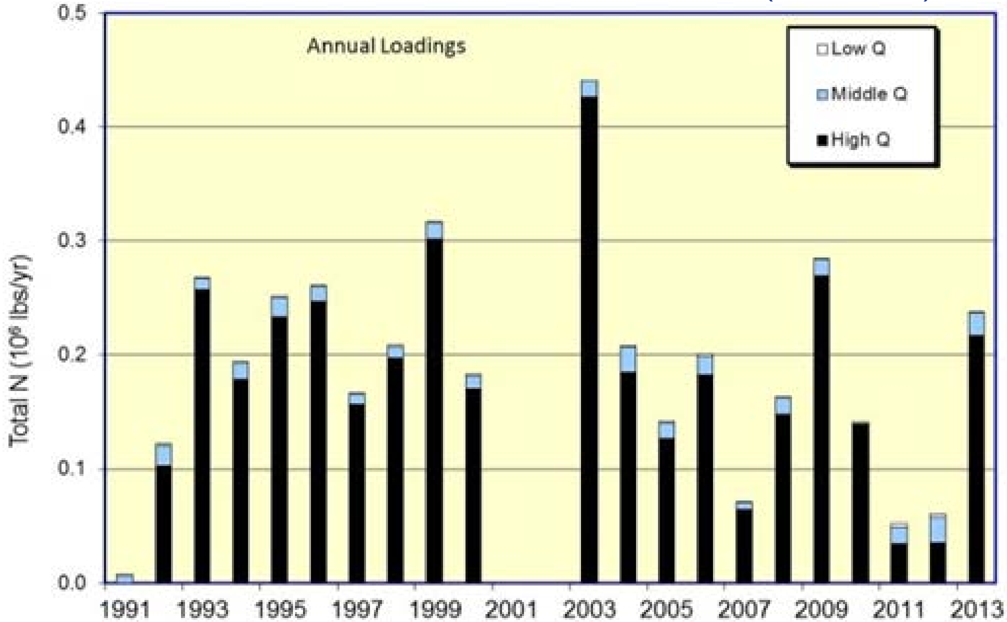
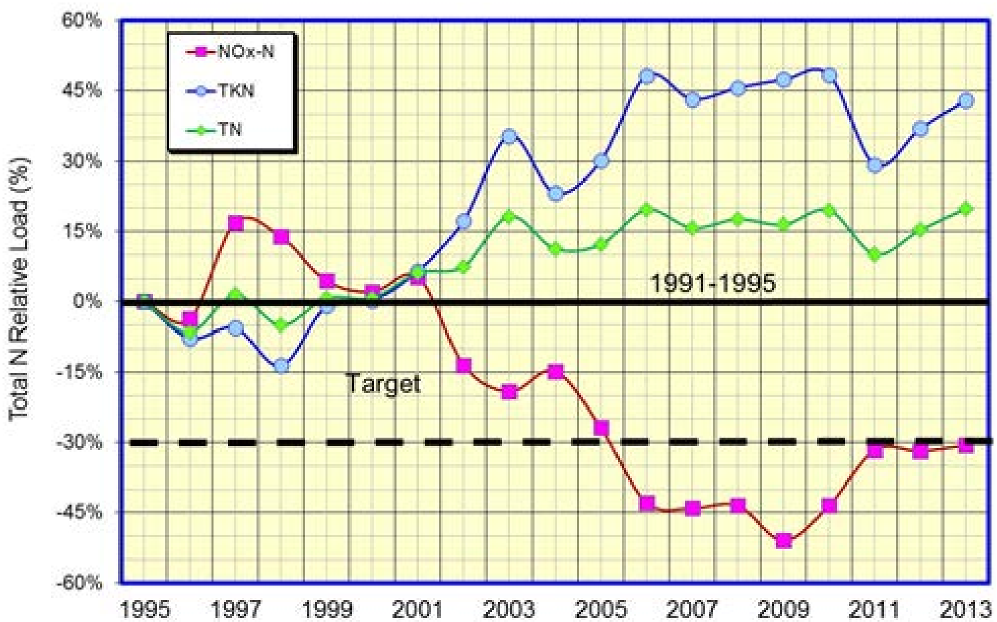



Figure 12 shows annual TN loading at Tar River by flow interval. The average TN contributions from low, middle, and high flow interval were 1, 7 and 92%, respectively. The results indicate that annual TN loading at this station ranged from 0.1 to 4.4 x $10^5$ lbs/year for the 1991–2013 timeframe. Average contributions of Ammonia–N, NOx-N, and Organic-N to the TN load for 1991–2013 period were 6, 23 and 71%, respectively. Organic Nitrogen was computed as TKN minus Ammonia. Overall, there was an increase in the contribution of the Organic-N fraction and a decrease in that of the NOx-N fraction to TN loading at Tar River for the study period (1991-2013).

Figure 13: Relative N Load Reduction- Comparison to 1991-1995

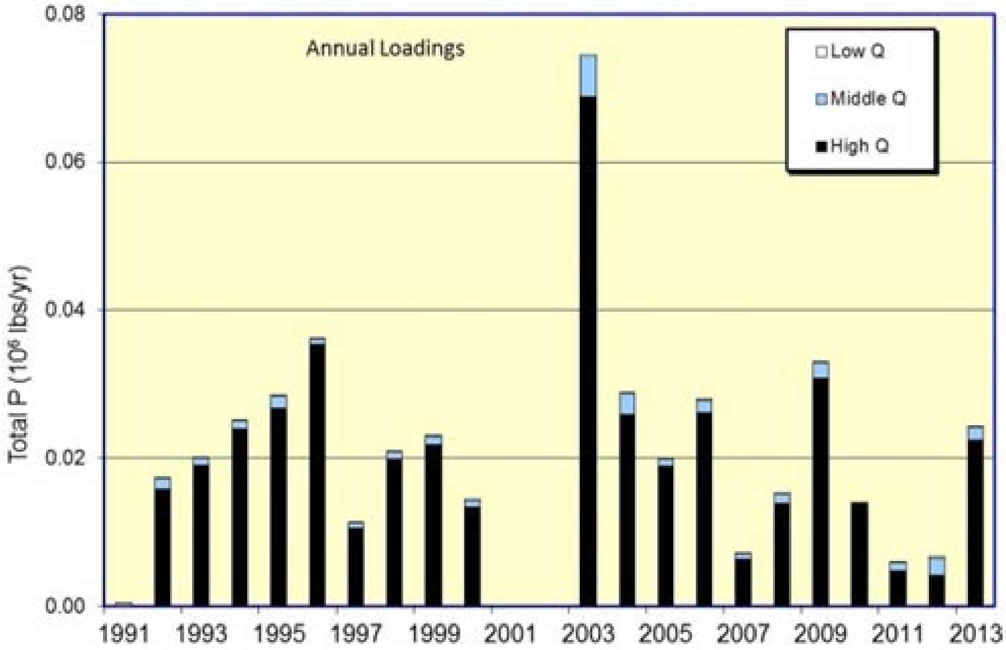



The results of the flow-normalized loading analysis indicate reduction in flow-normalized NOx-N loading, but an increase in TKN loading. Flow-normalized TKN loading has been consistently higher than the 1991–1995 baseline period throughout the past 14 five-year periods and increased by about 33% during this period. Since Ammonia loading declined over the same time period, the increase in TKN loading was primarily due to an increase in the Organic-N fraction. The recent increase in TKN flow-normalized loadings appears to be mainly due to increases for the high flow intervals. Flow-normalized TN loading exhibited the combination of the patterns for NOx-N and TKN and has been consistently higher than the corresponding 1991-1995 beginning the 1995-1999 period ending with the 2009-2013 period. The flow-normalized TN loading decreased to a minimum value of -6.5% in the 1992-1996 period and increased gradually afterwards. The average increase in flow-normalized TN loading for the periods beginning in 1995-1999 ending in 2009-2013 was approximately 13% (Figure 13).

### Flow-Normalized Total Phosphorus Loading at AMS O0100000

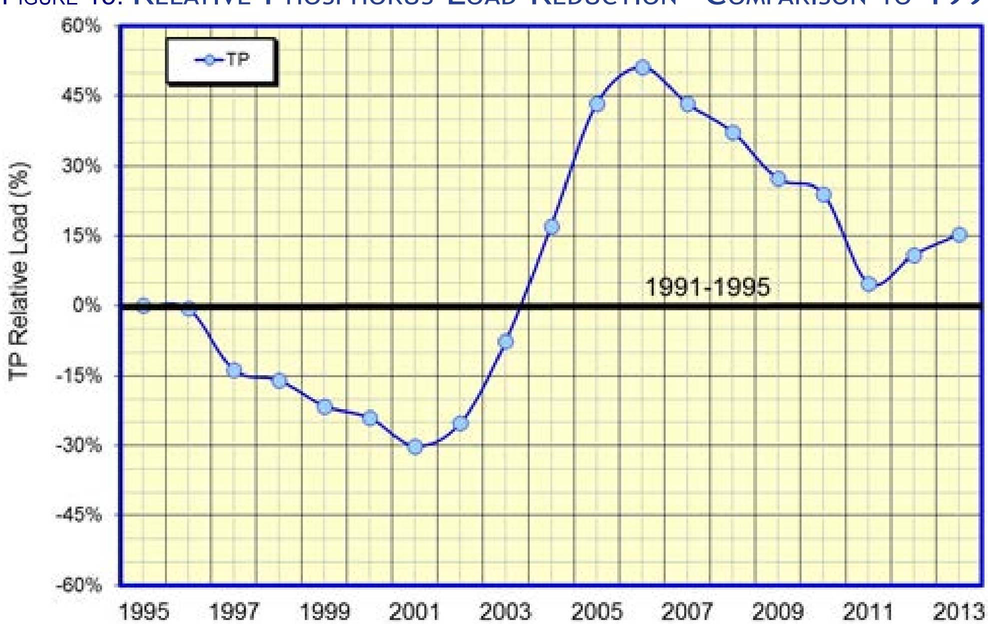
The annual TP loading at Tar River ranged from 0.06 to 0.7 x $10^5$ lbs/year, with a median value of 0.20 x $10^5$ lbs/year. Figure 14 shows annual TP loading at Tar River by flow interval. The average TP contributions from low, middle, and high flows were 0.6, 6.6 and 92.8%, respectively. These results show that high flow events contribute substantially large amount of nutrients in this watershed.

Figure 14: Total Phosphorus Load at AMS O0100000 (Tar River)




Flow-normalized TP loading at Tar River has been consistently lower than the corresponding 1991-1995 loading until the 1997-2001 period and then gradually increased and became higher than the 1991-1995 loading since the 2000-2004 period (Figure 15). The flow-normalized TP loading decreased to a minimum value of -16.6% in the 2003-2007 period and increased gradually afterwards. The flow-normalized TP loading reached to a maximum value of 51.2% in the 2002-2006 period and declined afterwards, but remained higher than the 1991-1995 period loading. The average reduction in flow-normalized TP loading for the periods ending in 1999-2003 was approximately 17%. The average increase in flow-normalized TP loading for the periods beginning in 2000-2004 and ending in 2009-2013 was approximately 27%.

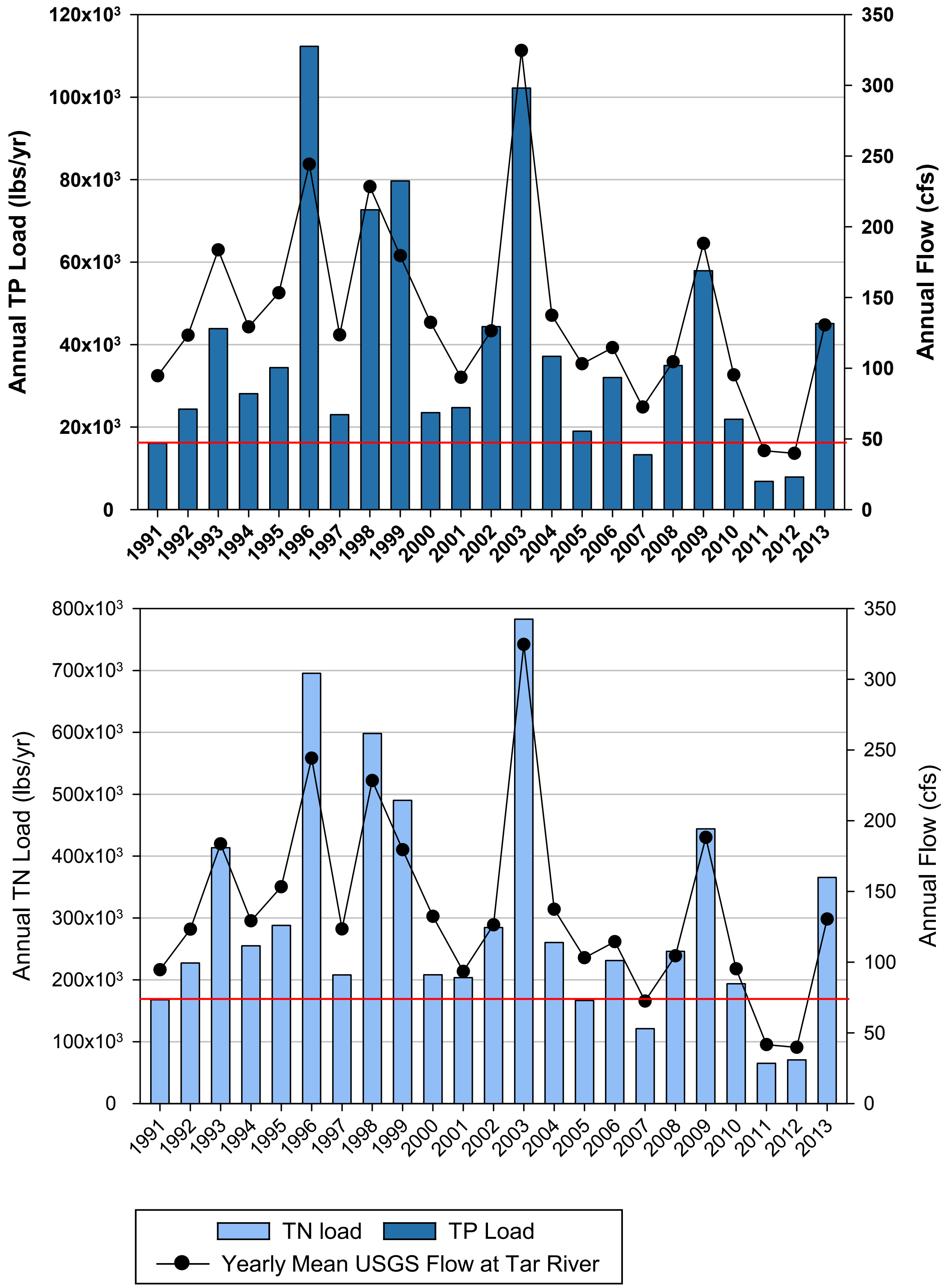
Figure 15: Relative Phosphorus Load Reduction- Comparison to 1991-1995



*Annual Load*

Annual Load estimates were run using USGS's **LOAD ESTimator**. Figure 16 shows the annual total phosphorous and total nitrogen load results in comparison to the 1991 baseline year (shown as a red horizontal line). The mean estimated TP loading at the upper Tar River station was 39,105 lbs/yr and fell below the 1991 loading in 3 of the 22 years. The 23 year estimated TN mean loading was 300,929 lbs/yr in the upper Tar River fell and below the 1991 baseline load in 4 of the 22 years post 1991.

FIGURE 16: LOADEST TOTAL PHOSPHORUS & TOTAL NITROGEN LOAD ESTIMATES AT AMS O0100000



Using the watershed size of each ambient station and the LOADEST results helps understand what level of loading is being delivered per square mile and what amount of loading might be expected from a specific type of land use. Figure 17 & 18 shows TN & TP unit area load estimates for all five watersheds assessed. The 23 year estimated mean loading was 300,929 lbs/yr with an estimated unit area loading of 1,807 lbs/mi²/yr. The estimated mean unit area TP loading was 234 lbs/mi²/yr. The upper Tar River has a relatively high level loading for a head water region that is mostly forested. Additional research is needed in order to determine the source of the high loading in this small headwater portion of the upper Tar River watershed.

Figure 17: LOADEST TN Unit Area Load Estimates for all Watershed Assessed with USGS Tar River at Tarboro Annual Mean Flow (1991-2013)

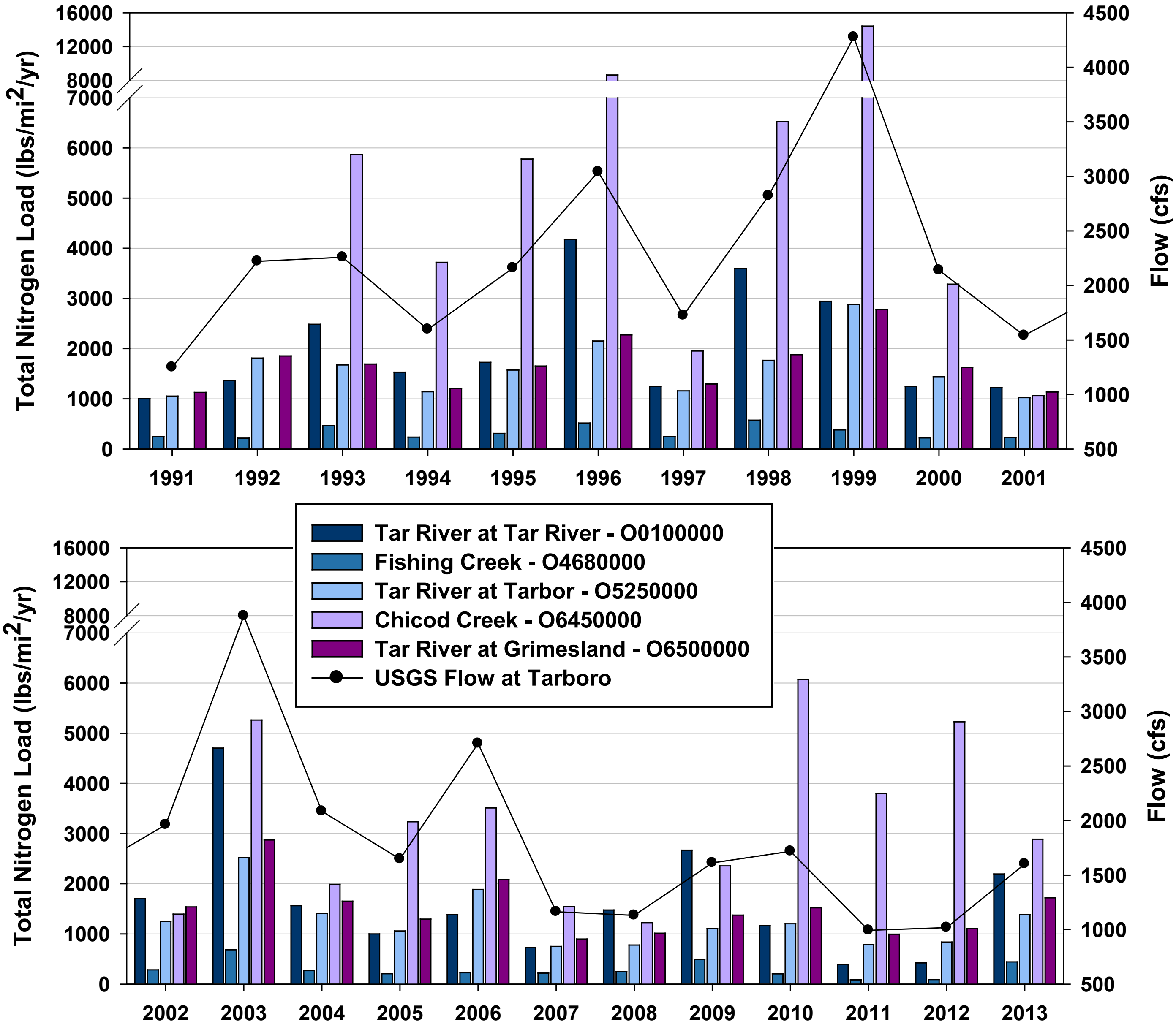
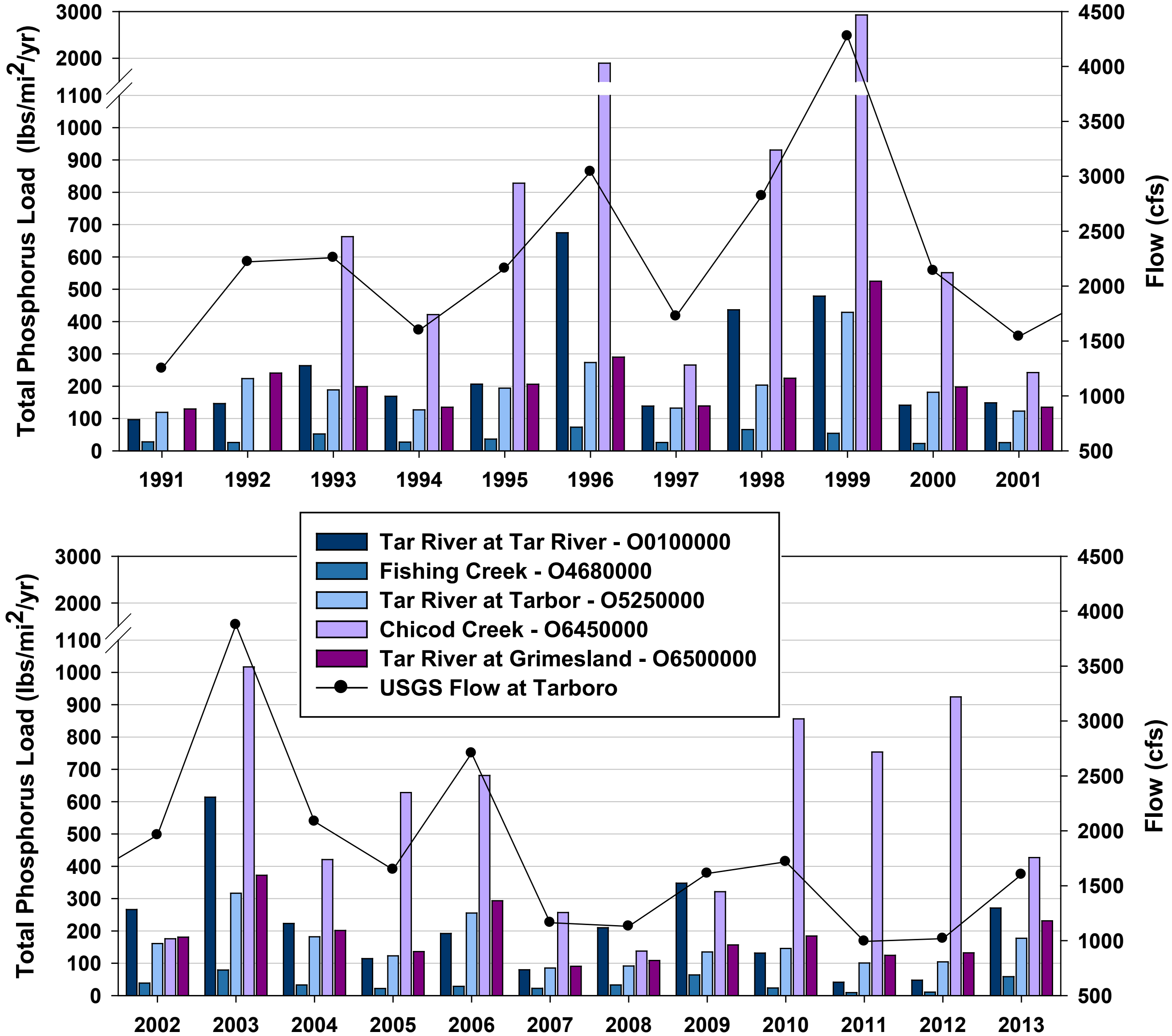


Figure 18: LOADEST TP Unit Area Load Estimates for all Watershed Assessed with USGS Tar River at Tarboro Annual Mean Flow (1991-2013)



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## Land Cover

To help understand land use changes and potential impacts on water quality an analysis of the change in land cover was performed for the area draining to AMS O0100000 on the Tar River. Changes in land use between data collected for the 2001 National Land Cover Database and the 2011 dataset indicate that the loss of forested acres likely resulted in the gain of scrub and grassland acres (Table 5).

Table 5: NLCD Land Cover changes between 2001-2011

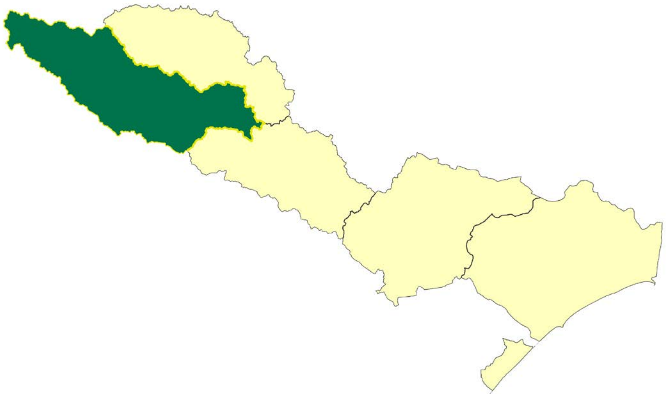
| Land Use | 2011 Percent Land Cover | Percent change | Acres Lost/ Gained |
|---|---|---|---|
| Water | 0.49 | -2.6 | -14.0 |
| Developed | 4.8 | 2.2 | 108.1 |
| Barren | .17 | -5.2 | -10.0 |
| Forest | 53.87 | -7.2 | -4,448.8 |
| Scrub | 6.31 | 137.5 | 3,894.8 |
| Grassland | 9.65 | 12.8 | 1,165.8 |
| Agriculture | 22.71 | -2.7 | -677.7 |
| Woody Wetlands | 1.96 | -1.7 | -36.0 |
| Emergent Wetlands | .04 | 60.2 | 15.8 |

***References***

Lebo, M. E., Paerl, H. W., & Peierls, B. L. (2011). Evaluation of Progress in Achieving TMDL Mandated Nitrogen Reductions in the Neuse River Basin, North Carolina. Environmental Management, 49(1), 253-266.

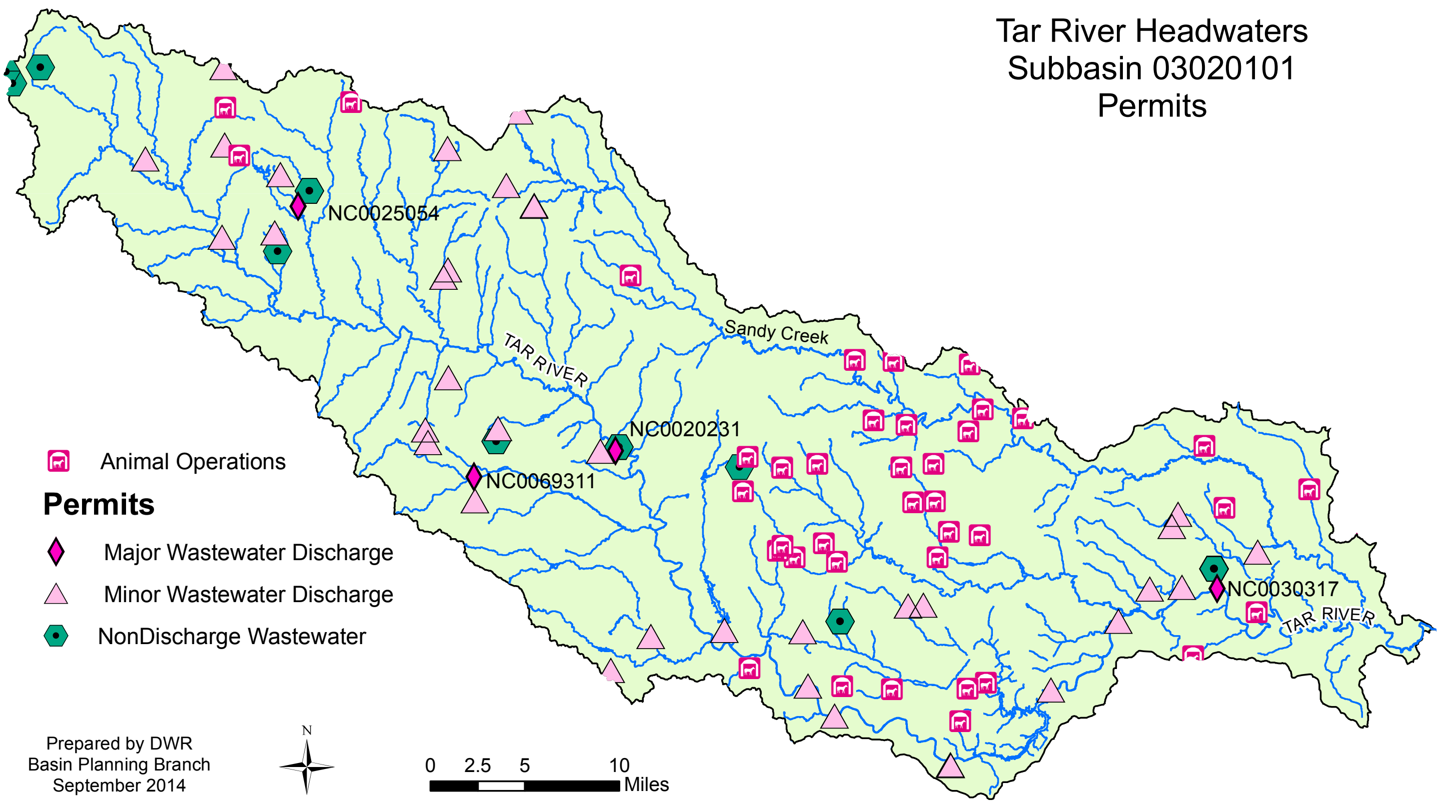
Sprague, L. A., Hirsch, R. M., & Aulenbach, B. T. (2011). Nitrate in the Mississippi River and its tributaries, 1980 to 2008: Are we making progress? Environmental Science and Technology, 45, 7209–7216.

National Land Cover Database 2011 (NLCD 2011) http://www.mrlc.gov/nlcd2011.php



# Permitted & Registered Activities

## Upper Tar River Subbasin 03020101




## Wastewater Dischargers

The National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States, as authorized by the Clean Water Act. Non-compliance with permit limits on wastewater flow and constituents can lead to discharge of pollutants that degrade surface waters making them unsafe for drinking, fishing, swimming, and other activities. The NPDES Permitting and Compliance Programs of DWR is responsible for administering the program for the state. These permits are reviewed and are potentially renewed every 5 years. A list of NPDES permits are listed in Table 1 and a map of major facilities are located here: [http://portal.ncdenr.org/web/wq/npdes-major-facility-map](http://portal.ncdenr.org/web/wq/npdes-major-facility-map) and minor facilities here: [http://portal.ncdenr.org/web/wq/npdes-minor-facility-map](http://portal.ncdenr.org/web/wq/npdes-minor-facility-map).

The Federal and State Pretreatment Program gives regulatory authority for EPA, States, and Municipal Governments to control the discharge of industrial wastewater into municipal

Wastewater Treatment Plants (WWTPs) or Publicly Owned Treatment Works (POTWs). The objectives of the Pretreatment Program are to prevent pass-through, interference, or other adverse impacts to the POTW, its workers, or the environment; to promote the beneficial reuse of biosolids; and to assure all categorical pretreatment standards are met. There are currently around 700 Significant Industrial Users (SIUs) who discharge industrial wastewater to over 120 POTWs throughout the state of North Carolina. The WWTPs covered by POTW Pretreatment Programs in this subbasin are Oxford, Rocky Mount, and Franklin County.

Table 1: NPDES Discharge Permits

| Permit # | Facility Name | Owner Type | Permit Type | Class | Receiving Stream | Permit Flow MGD |
|---|---|---|---|---|---|---|
| NC0002852 | Franklinton WTP | Government - Municipal | Water Plants and Water Conditioning | Minor | Taylors Creek | 0 |
| NC0020061* | Spring Hope WWTP | Government - Municipal | Municipal Wastewater Discharge, < 1MGD | Minor | Tar River | 0.4 |
| NC0020231* | Louisburg WWTP | Government - Municipal | Municipal Wastewater Discharge, Large | Major | Tar River | 1.37 |
| NC0025054* | Oxford WWTP | Government - Municipal | Municipal Wastewater Discharge, Large | Major | Fishing Creek | 3.5 |
| NC0029131 | Kittrell Job Corps Center | Non-Government | Discharging 100% Domestic < 1MGD | Minor | Long Creek | 0.025 |
| NC0030317* | Tar River Regional WWTP | Government - Municipal | Municipal Wastewater Discharge, Large | Major | Tar River | 21 |
| NC0037885 | Southern Nash Middle School | Government - County | Discharging 100% Domestic < 1MGD | Minor | Tar River | 0.015 |
| NC0042269* | Bunn WWTP | Government - Municipal | Municipal Wastewater Discharge, < 1MGD | Minor | Crooked Creek | 0.15 |
| NC0042510 | Lake Royale WWTP | Non-Government | Discharging 100% Domestic < 1MGD | Minor | Cypress Creek | 0.08 |
| NC0047279 | Heritage Meadows WWTP | Non-Government | Discharging 100% Domestic < 1MGD | Minor | N. Fork Tar River | 0.01 |
| NC0048631 | Long Creek Court WWTP | Non-Government | Discharging 100% Domestic < 1MGD | Minor | Long Creek | 0.007 |
| NC0050415 | Phillips Middle School | Government - County | Discharging 100% Domestic < 1MGD | Minor | Moccasin Creek | 0.01 |
| NC0069311* | Franklin County WWTP | Government - County | Municipal Wastewater Discharge, Large | Major | Cedar Creek | 3 |
| NC0072125* | Tar River WTP | Government - Municipal | Water Plants and Water Conditioning | Minor | Tar River | 0 |





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| Permit # | Facility Name | Owner Type | Permit Type | Class | Receiving Stream | Permit Flow MGD |
|---|---|---|---|---|---|---|
| NC0072133* | Sunset Avenue WTP | Government - Municipal | Water Plants and Water Conditioning | Minor | Tar River | 0 |
| NC0077437 | Battleboro plant | Non-Government | Industrial Process & Commercial | Minor | Tar River | 0.904 |
| NC0083038 | Saint-Gobain Containers | Non-Government | Industrial Process & Commercial | Minor | Martin Creek | |
| NC0001589 | Hospira, Inc. -RM1 | Industrial Process & Commercial | | Minor | | |
| NC0079227 | Nash remediation site | Groundwater Remediation | | Minor | | |
| NC0089010 | Louisburg Lumber Mill | Non-Government | Industrial Process & Commercial | Minor | Tar River | |
| * Indicates Tar-Pamlico Basin Association Permittee Member<br>+ Indicates pretreatment | | | | | | |

## On-Site Wastewater Treatment Systems (Septic Systems)

Wastewater from many households is treated on-site through the use of permitted septic systems instead of being sent to a wastewater treatment facility. Poorly planned and/or maintained systems can fail and contribute to nonpoint source pollution. Wastewater from failing septic systems can contaminate groundwater and surface water. Failing septic systems are health hazards and are considered illegal discharges of wastewater if surface waters are impacted. Information about the proper installation and maintenance of septic tanks can be obtained by contacting the local county health departments or for more technical issues, contact the Dept of Health and Human Services. Local health departments are responsible for ensuring that new systems are sited and constructed properly and an adequate repair area is available. County, town and city planners need to understand the economic and human health ramifications caused by failing septic systems and plan for long-term septic system sustainability.

In 2007, North Carolina Agricultural Research Service completed a report concerning nitrogen contributions from on-site wastewater systems for each river basin. The results for this subbasin based on 1990 census data indicate a population of 73,318 people using 29,169 septic systems resulting in a nitrogen loading of 733,179 lbs/yr and nitrogen loading rate of 564 lbs/mi$^2$/yr. These numbers reflect the TN discharged to the soil from the septic system and does not account for nitrogen used because of soil processes and plant uptake. (Pradhan et al. 2007).

*Pradhan, S.S., Hoover, M.T., Austin, R.E. and H. A. Devine. 2007. Potential Nitrogen Contributions from On-site Wastewater Treatment Systems to North Carolina's River Basins and Sub-basins Technical Bulletin 324. North Carolina Agricultural Research Service North Carolina State University Raleigh, NC.*

## Wastewater Residuals (Biosolids)

Residuals, biosolids or treated sludge, are by-products of the wastewater treatment process. After pathogen reduction, vector attraction reductions, and metal limits are met, these residuals are disposed in a manner to protect public health and the environment. Disposal sites include landfills, dedicated residual disposal sites, agricultural land for crops not for human consumption, and distribution to the public for home use. When applied to the land, steps must be taken to assure that residuals are applied at or below agronomic rates based on the soil and crop types present at the disposal site. If these criteria cannot be met, permitted disposal must take place at a dedicated residual disposal site or landfill.

In this subbasin, four facilities that produce wastewater residuals (Class B) apply their treated sludge on 165 available fields covering 2,776 acres (not all fields are used every year). A rough estimate of 194,320 lbs/yr of nitrogen and 249,840 lbs/yr of phosphorous are applied to these fields. This estimate does not include Class A residuals which are not monitored by DWR but can also contribute nitrogen and phosphorus loading (which is not accounted for) within the basin. Additional research would be necessary to determine if organic nitrogen from biosolids is contributing to the basinwide increase in organic nitrogen.

## Non-Discharge

Non-discharge systems have been the preferred alternative to discharge to surface waters for some NSW waterbodies and DWR requires all new and expanding NPDES permit applicants to provide documentation that considers alternatives to surface waters. Non-discharge wastewater options include spray irrigation, rapid infiltration basins, and drip irrigation systems. Although these systems are operated without a discharge to surface waters, they still require a DWR permit. The permit insures that treated wastewater is applied to the land at a rate that is protective of groundwater resources, and does not produce ponding or runoff into a waterbody. More information about land application and non-discharge requirements can be found on the DWR Non-Discharge Permitting Unit's website: http://portal.ncdenr.org/web/wq/aps/lau. Non-discharge permits in this subbasin are listed in Table 2 and a map of facilities is located here: http://portal.ncdenr.org/web/wq/aps/lau/map.

Run-off and spills are not common at non-discharge facilities. In general, maintaining compliance with permit conditions largely falls back to having a properly managed facility. Aging sewer systems may lead to increased flows from inflow and infiltration or a facility may not be properly prepared to expand as flows increase and the upper limits of a plant's capacity are reached. Non-discharge facilities, just like any other, must properly plan for any elevated flows and take action to ensure that the facility is capable of managing the wastewater.

Groundwater moving into surface water is a mechanism to introduce nutrients into the surface water system in the absence of direct discharges and in NSW systems it is important to be able to better quantify these potential nutrient loads. Some facilities have a groundwater monitoring program to measure compliance with groundwater quality standards. However, it should be noted that a facility can be compliant with groundwater quality requirements while still contributing to the overall nutrient loading of a surface water system. A better understanding of the groundwater/surface water interaction process at non-discharge facilities may help to identify and quantify nutrient loading from these locations.

Novozymes (WQ0002806) is permitted to apply wastewater on an ~900 acre sprayfield. Their wastewater is currently low in nitrogen; however, past applications (>10 yrs ago) were not. Novozymes has groundwater standard violations associated with nitrates in the groundwater; the nitrate groundwater standard is 10 mg/L whereas expected total nitrogen level, in surface waters are around 0.8 mg/L N. The excess nitrates may be discharging off-site into local surface waters, but the amount of nitrogen contributions from groundwater to surface waters has not been quantified. In September 2009, Novozymes initiated a partial groundwater treatment system to address contaminated groundwater. Additional remediation of groundwater will likely be required.

Table 2: Non-Discharge Permits

| Facility Name | Permit Type | Permit # | Size |
|---|---|---|---|
| Saint Gobain Containers Incorporated | Wastewater Recycling | WQ0000221 | Minor |
| Novozymes North America Inc - Franklin County | Surface Irrigation | WQ0002806 | Major |
| Ball's Laundromat | Surface Irrigation | WQ0002848 | Major |
| Eastern Minerals Incorporated-Henderson | Surface Irrigation | WQ0003075 | Minor |
| Granville Family Park Incorporated | Surface Irrigation | WQ0004410 | Major |
| Single Family Residence | Surface Irrigation | WQ0007524 | Minor |
| McCracken Enterprises Incorporated | Groundwater Remediation | WQ0012614 | Minor |
| Green Hill Country Club (golf course) | Reuse | WQ0020302 | Minor |
| Curtis Insulation | Wastewater Recycling | WQ0001122 | Minor |
| Bass Farms Inc. | Surface Irrigation | WQ0002004 | Minor |
| Town of Tarboro Residuals Land Application | Land Application of Residual Solids | WQ0002047 | Major |
| NZNA Franklinton, NC Manufacturing Facility | Distribution of Residual Solids | WQ0003487 | Major |
| Town of Louisburg Residuals Land Application | Land Application of Residual Solids | WQ0005981 | Minor |
| Wilton Elementary School WWTP | Gravity Sewer Extension, Pump Stations, & Pressure Sewer | WQ0020807 | Minor |
| Single Family Residence | Surface Irrigation | WQ0022963 | Minor |
| City of Rocky Mount Residuals Land Application Program | Land Application of Residual Solids | WQ0005568 | Major |
| City of Oxford Residuals Land Application Program | Land Application of Residual Solids | WQ0011244 | Major |
| Green Hill Country Club (golf course) | Reclaimed Water | WQ0020302 | Minor |
| Eastern Compost | Wastewater Recycling | WQ0033492 | Minor |
| Major = Wastewater irrigation, high-rate infiltration, other non-discharge wastewater and reclaimed water facilities with an average daily flow >or= to 10,000 gallons per day (GPD); Class A residual management systems distributing > or = to 3,000 dry tons; Class B residual management systems containing > or = to 300 acres. Minor= < than above amounts. | | | |

## Animal Operations

The Animal Feeding Operations Unit is responsible for the permitting and compliance monitoring of animal feeding operations across the state. A map of permitted animal facilities is available here: http://portal.ncdenr.org/web/wq/animal-facility-map.

Animal waste is often stored in lagoons before it is applied to fields. Numerous environmental hazards exist from these lagoons including: ammonia emissions, overflows into surface waters, and groundwater contamination. A better understanding of groundwater quality in relation to animal feeding operation locations is needed. Most animal operations are located immediately adjacent to surface water bodies. Groundwater that is moving from beneath a facility into the surface water system may transport significant levels of nutrients. However, lack of groundwater quality data at animal operations hampers quantifying their impacts.

## Water Withdrawals

Agricultural water users that withdraw one million gallons of water a day or more and non-agricultural water users that withdraw one hundred thousand gallons of water a day are required to register with DWR.(Table 3). Registrants must also report their water usage annually; annual reports can be found at: http://www.ncwater.org/Permits_and_Registration/Water_Withdrawal_and_Transfer_Registration/report

Table 3: Water Withdrawals

| Registration # | County | Facility Name |
|---|---|---|
| CU3110 | Edgecombe | Barnhill Contracting Co. (Boseman Pit) |
| CU3266 | Edgecombe | Barnhill Contracting Company - Old Town Pit |
| CU3239 | Edgecombe | Barnhill Contracting Company (Logsboro Pit) |
| CU3038 | Edgecombe | Great Pit-Pretty Good Sand Co. |
| CU3030 | Edgecombe | Hanson Aggregates Southeast (Rocky Mount Quarry) |
| CU4012 | Edgecombe | NCDOT U-3329 |
| CUR0014 | Edgecombe | Silas Smith Farms |

## Local Water Supplies

Local governments and other large community water systems that provide water to the public are required to prepare local water supply plans (LWSP). The LWSPs describe current and projected water sources and demands. Customer demands can be met by withdrawing surface water or groundwater and by purchasing water from a neighboring community. LWSPs with service within this subbasin are listed in table 5. Details about each LWSP can be found at: http://www.ncwater.org/Water_Supply_Planning/Local_Water_Supply_Plan/search.php

Table 4: Local Water Supplies

| PWS ID | Name | Ownership |
|---|---|---|
| 0464055 | CASTALIA, TOWN OF | CASTALIA, TOWN OF |
| 0498010 | WILSON, CITY OF | CITY OF WILSON |
| 0235010 | FRANKLINTON, TOWN OF | FRANKLINTON, TOWN OF |
| 0235015 | LOUISBURG, TOWN OF | LOUISBURG, TOWN OF |
| 0464020 | NASHVILLE, TOWN OF | NASHVILLE TOWN OF |
| 0464010 | ROCKY MOUNT, CITY OF | ROCKY MOUNT, CITY OF |
| 0464025 | SPRING HOPE, TOWN OF | SPRING HOPE, TOWN OF |

## Public Water Systems

In addition to the Local Water Supplies, public water systems found within this subbasin are listed in table 5. Public water supplies are those which provide piped drinking water to at least 15 connections or 25 or more people 60 or more days per year. These water systems must report their status to the Public Water Supply Section of DWR. Community systems are those that supplies water to the same population year-round, a transient non-community system provides water in a place such as a gas station or campground where people do not remain for long periods of time and non-transient non-community systems regularly supply water to at least 25 of the same people at least six months per year, but not year-round.

## Riparian Buffers

Riparian buffers in the basin are to be protected and maintained on both sides of intermittent and perennial streams, lakes, ponds, and estuarine waters. Tar-Pamlico River Basin Buffer Rules (15A NCAC 2B.0259) do not establish new buffers unless the existing use in the buffer area changes. The footprints of existing uses such as agriculture, buildings, commercial, and other facilities, maintained lawns, utility lines, and on-site wastewater systems are exempt. A total of 50 feet of riparian area is required on each side of waterbodies; within this 50 feet, the first 30 feet is to remain undisturbed and the outer 20 feet must be vegetated. Activities that disturb this buffer require a buffer authorization from DWR or may require a major variance approval from the Environmental Management Commission. More information about the buffer rules are available at: http://portal.ncdenr.org/web/wq/swp/ws/401/riparianbuffers.

## Wetland Or Surface Water Disturbance (401 Certification)

The "401" refers to Section 401 of the Clean Water Act. The DWR is the state agency responsible for issuing 401 water quality certifications (WQC). When the state issues a 401 certification this certifies that a given project will not degrade waters of the state or violate State water quality standards. A 401 WQC is required for any federally permitted or licensed activity that may result in a discharge to waters of the U.S. Typically, if the United States Army Corps of Engineers determines that a 404 Permit or Section 10 Permit is required because a proposed project involves impacts to wetlands or surface waters, then a 401 WQC is also required. A map of 401 WQCs is found here: http://portal.ncdenr.org/web/wq/401-buffer-permit-tracker. Examples of activities that may require permits include:

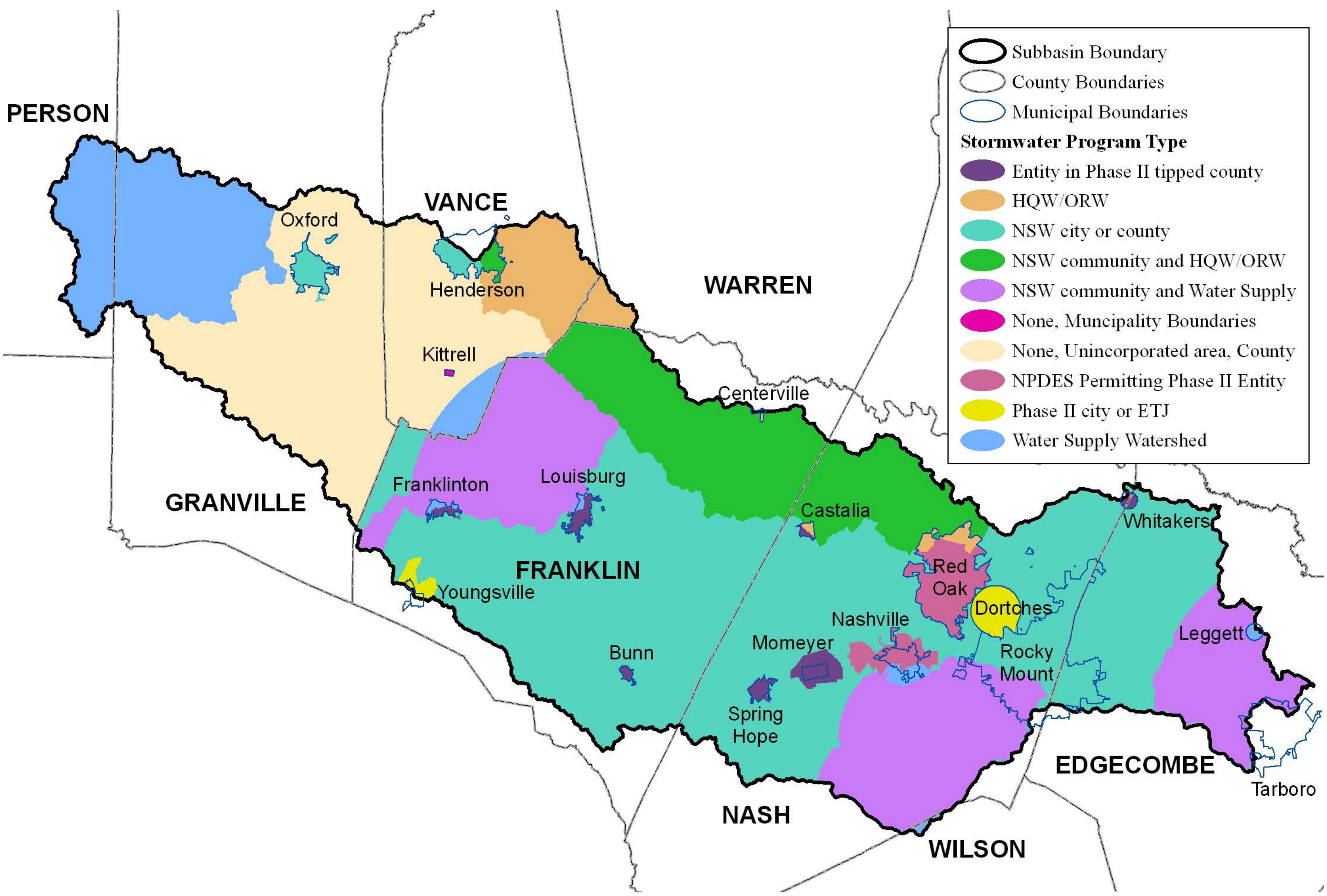
- Any disturbance to the stream bed or banks,
- Any disturbance to a wetland,
- The damming of a stream channel to create a pond or lake,
- Placement of any material within a stream, wetland, or open water, including material that is necessary for construction, culvert installation, causeways, road fills, dams, dikes, or artificial islands, property protection, reclamation devices and fill for pipes or utility lines, and
- Temporary impacts including dewatering of dredged material prior to final disposal and temporary fill for access roads, cofferdams, storage, and work areas.

## Stormwater

There are several different stormwater programs administered by Division of Energy, Mineral and Land Resources **(DEMLR)**. One or more of these programs affects many communities in the Tar-Pamlico River Basin. The goal of the DEMLR stormwater discharge permitting regulations and programs is to prevent pollution from entering the waters of the state through the use of stormwater runoff controls. These stormwater control programs include Phase II NPDES and State post-construction, coastal stormwater, HQW/ORW stormwater, Tar-Pamlico River Basin NSW stormwater, and associated with the Water Supply Watershed Program requirements. Figure 2 shows the different stormwater programs in this subbasin.

Henderson, Oxford, and Rocky Mount and Franklin, Nash, and Edgecombe counties are required to implement actions to prevent and treat stormwater runoff under the Tar-Pamlico NSW stormwater rules. These local programs include new development controls to reduce nitrogen runoff by 30 percent compared to pre-development levels and to keep phosphorus inputs from increasing over pre-development levels. Local programs must also identify and remove illicit discharges; educate developers, businesses, and homeowners; and make efforts toward treating runoff from existing developed areas. As of July 2009, there are 55 general stormwater permits and nine individual stormwater permits issued in this subbasin.

Figure 1: Stormwater Programs in HUC 03020101






Revised 2/05/15

## Table 5: Public Water Systems in Subbasin 03020105

| PWS ID | Name | Type |
|---|---|---|
| 0235101 | FOX PARK MHP | Community |
| 0235105 | TWIN OAKS MHP | Community |
| 0235109 | RUSTIC RIDGE MHP | Community |
| 0235118 | CAREBRIDGE ASSISTED LIVING COMMUNITY | Community |
| 0235119 | PINES REST HOME | Community |
| 0235123 | PINE FOREST MHP | Community |
| 0235125 | WILDERS VILLAGE S/D | Community |
| 0235127 | SWEET BRIAR S/D | Community |
| 0235129 | RANSDELL MHP | Community |
| 0235133 | CLEGHORN MHP NO 1 | Community |
| 0235149 | SCARBORO MHP | Community |
| 0235400 | ROWLAND CHAPEL CH OF CHRIST | Transient Non-Community |
| 0235404 | MT ZION BAPTIST CH | Transient Non-Community |
| 0235405 | JONES CHAPEL MISSIONARY BAPTIST CHURCH | Transient Non-Community |
| 0235406 | ALERT PENTECOSTAL HOLINESS CH | Transient Non-Community |
| 0235407 | MOUNTAIN GROVE BAPTIST CHURCH | Transient Non-Community |
| 0235409 | HAYWOOD BAPTIST CH | Transient Non-Community |
| 0235415 | ALLEN CHAPEL BAPTIST CHURCH | Transient Non-Community |
| 0235417 | MITCHELL MISSIONARY BAPT CH | Transient Non-Community |
| 0235420 | CORINTH BAPTIST CHURCH | Transient Non-Community |
| 0235421 | TRINITY UMC | Transient Non-Community |
| 0235425 | CEDAR ROCK BAPTIST CHURCH | Transient Non-Community |
| 0235427 | HICKORY ROCK BAPTIST CHURCH | Transient Non-Community |
| 0235432 | SANDY CREEK BAPT CH | Transient Non-Community |
| 0235433 | CENTERVILLE BAPT CH | Transient Non-Community |
| 0235434 | LEONARD`S GROCERY | Transient Non-Community |
| 0235437 | WOOD BAPTIST CHURCH | Transient Non-Community |
| 0235438 | RED BUD BAPTIST CHURCH | Transient Non-Community |
| 0235439 | MANASSEH CHAPEL BAPTIST CHURCH | Transient Non-Community |
| 0235440 | ST DELIGHT UNITED CH OF CHRIST | Transient Non-Community |
| 0235441 | WHITE LEVEL BAPTIST CHURCH | Transient Non-Community |
| 0235443 | HICKORY GROVE BAPTIST CHURCH | Transient Non-Community |
| 0235451 | CEDAR ROCK FIRST BAPTIST CH | Transient Non-Community |
| 0235457 | DUKE MEMORIAL BAPTIST CHURCH | Transient Non-Community |
| 0235459 | HOMESTEAD GSC FIELD NO 1 | Transient Non-Community |
| 0235469 | HILL KING METHODIST CHURCH | Transient Non-Community |
| 0235474 | KINCHES CHAPEL CHRISTIAN CHURCH | Transient Non-Community |
| 0235476 | LETTUCE HALL MISSIONARY BAPT | Transient Non-Community |
| 0235481 | MOUNT OLIVET BAPTIST CH | Transient Non-Community |
| 0235482 | MAPLE SPRINGS BAPTIST CHURCH | Transient Non-Community |
| 0235483 | MT MORIAH MISSIONARY BAPTIST | Transient Non-Community |
| 0235487 | NELSON CHAPEL BAPT CHURCH | Transient Non-Community |
| 0235488 | NELSON HEADSTART DAYCARE | Non-Transient Non-Community |
| 0235493 | PEARCE BAPTIST CHURCH | Transient Non-Community |
| 0235494 | PERRY`S CHAPEL BAPTIST CH | Transient Non-Community |
| 0235498 | POPES CHAPEL UNITED CHRISTIAN CHURCH | Transient Non-Community |

Table 5: Public Water Systems in Subbasin 03020105

| PWS ID | Name | Type |
|---|---|---|
| 0235501 | POPLAR SPRING BAPTIST CHURCH | Transient Non-Community |
| 0235506 | ROCKY CHAPEL MISSIONARY BAPT | Transient Non-Community |
| 0235513 | WALNUT GROVE MISS BAPTIST CH | Transient Non-Community |
| 0235515 | EDWARD BEST MIDDLE SCHOOL | Non-Transient Non-Community |
| 0235516 | LAUREL MILL SCHOOL | Non-Transient Non-Community |
| 0235521 | KIDDIE RANCH DAYCARE & MINI SC | Non-Transient Non-Community |
| 0235531 | HOMESTEAD GSC-TREEHOUSES | Transient Non-Community |
| 0235532 | HOMESTEAD GSC-WELCOME SHELTER | Transient Non-Community |
| 0235535 | ANNIE LEE`S GROCERY | Transient Non-Community |
| 0235537 | RIVER GOLF CLUB | Transient Non-Community |
| 0235545 | SIDS QUICK STOP | Transient Non-Community |
| 0235548 | FRANKLIN COUNTY AIRPORT | Transient Non-Community |
| 0235550 | WALT'S FOOD MART | Transient Non-Community |
| 0235557 | FRANKLIN ANIMAL CLINIC | Transient Non-Community |
| 0235559 | TABERNACLE BAPTIST CHURCH | Transient Non-Community |
| 0235565 | BROAD INC COMMUNITY CENTER | Transient Non-Community |
| 0235566 | GETHSEMANE MISSIONARY BAPTIST | Transient Non-Community |
| 0239103 | GRANVILLE FAMILY PARK | Community |
| 0239118 | HERITAGE MEADOWS REST HOME | Community |
| 0239406 | HESTER BAPTIST CHURCH | Transient Non-Community |
| 0239410 | NEW HOPE GRANVILLE BAPT CHURCH | Transient Non-Community |
| 0239411 | SHARON BAPT CHURCH | Transient Non-Community |
| 0239420 | HUNTSVILLE BAPTIST CHURCH | Transient Non-Community |
| 0239424 | TABBS CREEK BAPT CH | Transient Non-Community |
| 0239432 | BRASSFIELD BAPTIST CHURCH | Transient Non-Community |
| 0239441 | PEACES CHAPEL BAPTIST CHURCH | Transient Non-Community |
| 0239444 | HAWKINS CHAPEL BAPTIST CHURCH | Transient Non-Community |
| 0239445 | BANKS UNITED METHODIST CHURCH | Transient Non-Community |
| 0239449 | TALLY HO FIRST BAPTIST CHURCH | Transient Non-Community |
| 0239450 | PROVIDENCE BAPTIST CHURCH | Transient Non-Community |
| 0239455 | ENON BAPTIST CHURCH | Transient Non-Community |
| 0239458 | ANTIOCH BAPTIST CHURCH | Transient Non-Community |
| 0239462 | DOT-OXFORD MAINT YARD | Non-Transient Non-Community |
| 0239477 | MERRY MART | Transient Non-Community |
| 0239479 | SERVICE U.S.A. | Transient Non-Community |
| 0239482 | MUNCHING MARVINS GRILL | Transient Non-Community |
| 0239487 | COUNTRY STORE & GRILL | Transient Non-Community |
| 0239489 | ILONG BAPTIST CHURCH | Transient Non-Community |
| 0239490 | HARDIE GROVE BAPTIST CHURCH | Transient Non-Community |
| 0239493 | BEREA BRANCH LIBRARY | Transient Non-Community |
| 0239494 | HOLY TEMPLE CHURCH OF GOD | Transient Non-Community |
| 0273445 | HAWKINS CONV. MART AND GRILL | Transient Non-Community |
| 0291102 | KNOLL TERRACE MHP | Community |
| 0291104 | EDGEWOOD ESTATES | Community |
| 0291108 | LAKE VANCE MOBILE ESTATES | Community |
| 0291109 | WOODMONT MHP | Community |

## Table 5: Public Water Systems in Subbasin 03020105

| PWS ID | Name | Type |
|---|---|---|
| 0291120 | HUNTER`S RIDGE S/D | Community |
| 0291121 | LYNNBANK ESTATES | Community |
| 0291125 | BROOKHAVEN VILLAGE | Community |
| 0291417 | MT MORIAH AME ZION CHURCH | Transient Non-Community |
| 0291422 | POPLAR CREEK BAPTIST CHURCH | Transient Non-Community |
| 0291423 | REHOBOTH UMC | Transient Non-Community |
| 0291439 | SHILOH BAPTIST CHURCH | Transient Non-Community |
| 0291443 | HUMPTY DUMPTY NURSERY | Non-Transient Non-Community |
| 0291462 | NEW SANDY CREEK BAPTIST CH | Transient Non-Community |
| 0291464 | LIBERTY CHRISTIAN CHURCH | Transient Non-Community |
| 0291465 | CAREY BAPTIST CHURCH | Transient Non-Community |
| 0291468 | THOMAS CHAPEL PHC | Transient Non-Community |
| 0291515 | HENDERSON HEAD START DAYCARE | Non-Transient Non-Community |
| 0291526 | RALEIGH ROAD OUTDOOR THEATRE | Transient Non-Community |
| 0291530 | LEONA`S COUNTRY CORNER& GRILL | Transient Non-Community |
| 0291533 | BLESSED HOPE BAPTIST CHURCH | Transient Non-Community |
| 0291536 | DABNEY CONVENIENCE STORE | Transient Non-Community |
| 0291538 | KITTRELL CHURCH OF GOD | Transient Non-Community |
| 0433120 | WINSTEAD MOBILE TERRACE | Community |
| 0464101 | BASS MH COURT | Community |
| 0464115 | OAK LEVEL MHP | Community |
| 0464117 | RED OAK ELEMENTARY SCHOOL | Non-Transient Non-Community |
| 0464118 | RIVERSIDE MHP | Community |
| 0464119 | WESTMOUNT PARK | Community |
| 0464125 | PEACHTREE HILLS GOLF CLUB | Transient Non-Community |
| 0464128 | TWIN OAKS TP | Community |
| 0464130 | HILLTOP MHP | Community |
| 0464133 | SHEPHERDS WAY S/D | Community |
| 0464402 | SOUTHERN NASH JR HIGH SCHOOL | Non-Transient Non-Community |
| 0464404 | NORTHERN NASH SCHOOL | Non-Transient Non-Community |
| 0464408 | DALE BONE FARMS INC MLC #1-#5 | Transient Non-Community |
| 0464409 | NASHVILLE SOUTH PROPERTIES LLC MLC | Transient Non-Community |
| 0464414 | BARNES FARMING CORP MLC NO 1 | Transient Non-Community |
| 0464415 | BARNES FARMING CORP MLC NO 3 | Transient Non-Community |
| 0464418 | BARNES FARMING CORP MLC NO 4 | Transient Non-Community |
| 0464419 | BARNES FARMING CORP MLC NO 5 | Transient Non-Community |
| 0464426 | CEDAR GROVE ELEM SCHOOL | Non-Transient Non-Community |
| 0464433 | CAROLINA STEEL | Non-Transient Non-Community |
| 0464471 | ROYCE BONE MCL 5357 | Transient Non-Community |
| 0464481 | BARNES FARMING CORP MLC NO 10 | Transient Non-Community |
| 0464491 | HOWARD JOHNSON`S | Transient Non-Community |
| 0464493 | OAK LEVEL MAINTENANCE OFFICE | Non-Transient Non-Community |
| 0464500 | RED OAK CAFE` | Transient Non-Community |
| 0464503 | RED CARPET INN | Transient Non-Community |
| 0464511 | L & L FOOD STORE NO 12 | Transient Non-Community |
| 0464514 | GRIFFINS FOOD STORE N0 6 | Transient Non-Community |

## Table 5: Public Water Systems in Subbasin 03020105

| PWS ID | Name | Type |
|---|---|---|
| 0464515 | L & L FOOD STORE NO 6 | Transient Non-Community |
| 0464516 | OAK LEVEL CAFE | Transient Non-Community |
| 0464519 | TAYLORS STORE | Transient Non-Community |
| 0464520 | RED OAK MIDDLE SCHOOL | Non-Transient Non-Community |
| 0464521 | EAGLE FOOD MART | Transient Non-Community |
| 0464524 | NORTH ROCKY MOUNT CH OF GOD | Transient Non-Community |
| 0464530 | VAUGHAN`S CHAPEL CHURCH | Transient Non-Community |
| 0464532 | MOMEYER BAPTIST CHURCH | Transient Non-Community |
| 0464536 | BARNES HILL FWB CHURCH | Transient Non-Community |
| 0464539 | PHILADELPHIA BAPTIST CHURCH | Transient Non-Community |
| 0464540 | SANDY CROSS UMC | Transient Non-Community |
| 0464542 | CHRISTIAN FELLOWSHIP CHURCH | Transient Non-Community |
| 0464547 | MT HERMON MISSIONARY BAPTIST | Transient Non-Community |
| 0464552 | GOOD NEWS INDEPENDENT BAPTIST | Transient Non-Community |
| 0464554 | EPHESUS BAPTIST CHURCH | Transient Non-Community |
| 0464558 | HOLLY GROVE BAPTIST CHURCH | Transient Non-Community |
| 0464559 | TAYLORS PENTECOSTAL HOLINESS | Transient Non-Community |
| 0464560 | TABERNACLE OF PRAISE | Transient Non-Community |
| 0464564 | BEULAH CHURCH OF CHRIST | Transient Non-Community |
| 0464569 | PLEASANT GROVE BAPTIST CHURCH | Transient Non-Community |
| 0464570 | ST HOPE MISSIONARY BAPTIST CH | Transient Non-Community |
| 0464572 | COUNTRYSIDE BP | Transient Non-Community |
| 0498619 | REFUGE TRINITY HOLINESS CHURCH | Transient Non-Community |
| 4035001 | COMMUNITY STORE & GRILL | Transient Non-Community |
| 4035002 | NEW HOPE WORSHIP CENTER | Transient Non-Community |
| 4035004 | FREEDOM & DELIVERANCE OUTREACH | Transient Non-Community |
| 4035007 | LIVING SPRINGS CHURCH OF GOD | Transient Non-Community |
| 4035009 | MILLSTONE S/D | Community |
| 4035012 | LEAPS & BOUNDS EARLY LEARNING CENTER | Non-Transient Non-Community |
| 4035015 | LAKE ROYALE COMFORT CENTER #2 | Transient Non-Community |
| 4039005 | M&M COUNTRY STORE AND GRILL | Transient Non-Community |
| 4039013 | GRANVILLE ATHLETIC PARK #1 | Transient Non-Community |
| 4039014 | GRANVILLE ATHLETIC PARK #2 | Transient Non-Community |
| 4064001 | J B ROSE & SONS MIGRANT CAMP | Transient Non-Community |
| 4064003 | ANDREW TYSON FARMS MLC | Transient Non-Community |
| 4064014 | OAKLAND GROVE | Transient Non-Community |
| 4073003 | BETHANY MISSIONARY BAPTIST | Transient Non-Community |
| 4073006 | NEW ST. JAMES BAPTIST CHURCH | Transient Non-Community |
| 4092067 | PARKER FALLS S/D | Community |

# Stocking Grass Carp in a North Carolina Reservoir to Manage an Aged Hydrilla Tuber Bank

### Tar River Reservoir, Nash County, North Carolina

**Created: March, 2013**
**Last Modified: June, 2013**

## General Information:

- Rocky Mount Reservoir size = 1,650 acres.
- Lake usage:
  - Municipal drinking water source
  - Recreation (boating, fishing, swimming, etc.)
- Hydrilla began infesting the Sapony Creek arm of the reservoir in early 2000's.
- Sapony Creek arm was treated with fluridone annually from 2007 to 2012.
  - Approximately 480 acres.
  - Herbicide applications have completely suppressed the growth of hydrilla and the plants ability to develop propagative structures.
- No hydrilla has been observed in the Tar River Reservoir outside of the Sapony Creek arm.

## Objective:

To gain insight in determining the number of grass carp (low stocking rate) required to prevent the reestablishment of hydrilla from a much depleted and aging tuber bank in a NC coastal plain reservoir.

## Introduction:

The biology of *Hydrilla verticillata* presents environmental managers with several challenges. The plants ability to produce subterranean turions (a.k.a. tubers) that can lay dormant in the hydrosoil for several years is particularly challenging from a management standpoint. There are currently no chemical or biological control methods available to target the tubers directly. Depending on the methods employed hydrilla extirpation projects can involve extensive disturbance to aquatic habitats. Some examples include the complete excavation of the hydrosoil containing tubers, filling in the aquatic system (transform into a terrestrial site) or dewatering for several years. Since high-disturbance methods are not always practical or acceptable, other methods, ones that impose minor disturbances to aquatic systems are often favored and implemented. Herbicide use is one example of a low-disturbance method. Herbicide(s) have been used to successfully manage hydrilla in North Carolina reservoirs. Case in point, hydrilla was successfully managed in the Tar River Reservoir using only the herbicide fluridone. During the fluridone treatment years (2007-2012) hydrilla growth was completely suppressed. Managing hydrilla using an herbicide-only approach can be tricky; early detection, monitoring, and physical dynamics of the system will have significant influence on the successfulness of an herbicide-only approach.

Research has shown that for an herbicide-only approach to be successful annual applications must be made, and all hydrilla plants must succumb to herbicide pressure before they have time to develop new tubers. Interrupting the reproductive cycle of the plant is a classic example of effective weed management. The annual applications of herbicide would need to continue for several consecutive years. When this strategy is executed the tuber bank dwindles over time and extirpation is achieved once there are no remaining tubers.

Stocking grass carp (*Ctenopharyngodon idella*) is another method of managing hydrilla. The use of grass carp has led to the complete removal of hydrilla from aquatic systems in North Carolina both large and small. Triploid grass carp are sterile White Amur (grass carp); diploid White Amur are illegal to possess in North Carolina. The grass carp is an herbivorous fish that preferentially feeds on submersed aquatic vegetation, and favors hydrilla. They readily feed on the herbaceous stems and leaves however they cannot forage for the hydrilla tubers that exist in the hydrosoil. Nevertheless, they make a good match for hydrilla management since they can live to be 15+ years old. Moreover they have been used to extirpate hydrilla from many sites. The concept of this method is:
1) Obtain the minimum number of grass carp needed to consume the entire "crop" of hydrilla in a single year (stocking rate required to consume all of the vegetative growth of hydrilla may vary).
2) Carry out supplemental stockings (additional releases) as needed to maintain the grass carp population for several years and the tubers eventually become exhausted.

Hydrilla has been successfully managed in large reservoirs throughout North Carolina by stocking grass carp at 15-20 fish per acre of infestation. This approach is very effective - in cases where hydrilla was identified during the early stages of the infestation and grass carp were released at rates that are relatively low considering the total size of the system, there is negligible impact to the desirable (off-target) aquatic vegetation. Unfortunately, hydrilla infestations often go unnoticed (or a least un-managed) until they enter into an advanced stage (i.e., hydrilla colonizes a significant portion of the littoral zone and develops a dense tuber bank). With few exceptions grass carp will effectively manage hydrilla when the stocking regime is based on the 15-20 fish per acre of hydrilla formula, regardless of the stage of the infestation. The drawback from managing extensive hydrilla infestations by applying stocking rates at this level is the relatively large population of grass carp that results (i.e., once hydrilla productivity is overwhelmed by consumption pressure from the grass carp the system is left with a lot of grass carp and limited forage). The drawback is realized not as the mere presence or particular number of grass carp in the system but their accumulative appetite; the herbivory pressure on off-target (not hydrilla) plants can be measurable. Once the "crop" of hydrilla is consumed the grass carp are left to browse on aquatic plant species that are less preferred by them as a food source. The potential impact to off-target species is concerning since those may be native and/or desirable plants. Vegetation is desirable in most aquatic systems because of their ecological functions, because they provide shoreline stability, and are aesthetically pleasing. Generally speaking, healthy aquatic systems contain a diversity of plants. The introduction and colonization of invasive plant species typically leads to less diversity (undesirable).

This study will suggest low stocking rates of grass carp with the notion that this will prevent the recovery of hydrilla from an aging tuber bank. Sapony Creek has been treated with fluridone annually for 6 consecutive years. We believe no hydrilla tubers have been produced during that time and intensive tuber monitoring has shown that the tuber bank has been drastically reduced. Even though the number of tubers remaining in the system has dramatically changed the viability of those tubers which do remain in the system has not changed. Tubers collected in 2012 proved to be viable; therefore it is assumed that the infestation would recover from the remaining tubers if management were to halt or fall below a critical level.

## 2013+ Management Proposal:

An integrated pest management approach draws on the strongest points from multiple techniques. Using multiple methods in combination or in series allows objectives to be attained while balancing environmental impacts and economics. In the case of Sapony Creek we have benefited from the effectiveness of an herbicide-only management scheme. From 2007-2012 a large-scale herbicide treatment occurred annually. Each year the cost remained about the same because the same size area was treated and the same treatment (herbicide prescription) was also used. The number of tubers remaining in the system has been dramatically reduced and thus fewer hydrilla plants sprout each year. We are at a point now where the cost to control a relatively small number of hydrilla plants would be significantly less if grass carp are used. Activities proposed for 2013-2015 involve the release of triploid grass carp and frequent monitoring to detect vegetative hydrilla growth and SAV in general. Contact herbicides will be applied to any areas hydrilla is found. We do not expect that contact herbicides will be needed; however we will be prepared to apply if necessary.

Prepared by:
Aquatic Weed Control Program – NC Division of Water Resources

## Aycock Creek Watershed (0302010101)

| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O0570000<br>O0100000 |
| Benthos | OB19<br>OB25<br>OB146<br>OB162<br>OB180 |
| Fish | OF38<br>OF44<br>OF60 |

This watershed is a priority area for protection of threatened and endangered species due to the presence of the dwarf wedgemussel in Shelton Creek [AU# 28-4, 13.9 miles], Fox Creek [AU# 28-4-1, 7.2 miles], Cub Creek [AU# 28-3, 8 miles], Tar River [AU# 28-(1), 20.1 miles] and the North Fork Tar River [AU# 28-5, 8.8 miles]. The headwaters are also classified as Water Supply-IV for Oxford Water Supply. This watershed is a priority for implementation of nonpoint source BMPs, including agricultural BMPs, stormwater control BMPs, buffer enhancement, and sediment and erosion control BMPs.

Tar River (HUC 030201010105) [AU# 28-1] is the most upstream portion of the Tar River. The headwaters are not impacted by municipalities or dishargers and land use is primarily forested or agriculture. The fish sampling site OF44 received an Excellent bioclassification in 2012 and there was no noted long term change in water quality. The sample did note the presence of two State Significantly Rare species (Mimic Shiner & Roanoke Bass). Downstream macroinvertebrates were sampled in 2012 at site OB180 which replaced site OB25. The sampled indicated a reduction in edge habitat from previous years. Dissolved oxygen in 2012 was also low (4.1 mg/l) and the conductivity was somewhat elevated (94.2 µS/cm). Therefore, unfavorable physical and chemical conditions cannot be ruled out as a possible factor influencing the decline in the benthic macroinvertebrate community from previous samples. Additional monitoring in this watershed is recommended. Data collected at AMS station O0057000 has shown incidences of low DO, low pH, high turbidity and high fecal coliform levels.

Further downstream on the Tar River [AU# 28-(5.7)] there is an ambient station AMS O0100000 and an USGS gage # 02081500. Ambient data through 2012 do not indicate any water quality problems although rising nutrients are indicated in the trends analysis as describe later in this document.

Shelton Creek (HUC 030201010103) [AU# 28-4] The fish community sample (OF38) taken in 2012 indicated an abundant and diverse community which was trophically balanced giving it an Excellent bioclassification. The sample was taken during low flow, but no long term water quality impacts were noted. The stream drains a primarily forested and agriculture land use area.

North Fork Tar River (HUC 030201010104) drains north-central Granville County and there are no municipalities or NPDES dischargers in the watershed. The fish community sample (OF60) taken in 2012 resulted in a Good bioclassification for AU# 28-5b. Ratings at this site have fluctuated between Good & Excellent over the years, where the declines are associated with persistent low flows. Macroinvertebrate sites received both Fair and Good benthos bioclassification ratings during the 2007 sampling period. Site OB19 (Fair) is upstream of site OB144 (Good). The 2007 biological sample indicated beaver dam activity may have severely interrupted flows. This stream was impaired in the 1990's; however, water quality conditions improved during lower flow conditions, suggesting nonpoint source pollution as a major contributor to the stream's biological impairment during wetter years. Continued efforts to reduce agricultural runoff are needed. A landfill was also indicated as a potential cause contributing to low DO levels as a result of iron oxidation process.

Heritage Meadows WWTP (NC0047279) is a minor discharge into an unnamed tributary to the North Fork Tar River but is not perceived to be causing the decline in biological communities. The NPDES permitted flow is 0.01 MGD, but the median daily annual flow is much less at 0.004 MGD. Parameters that have exceeded permit limits include: fecal coliform bacteria, ammonia, BOD, and DO. The current operator fixed a piping and pumping problem in 2006, improving operational conditions of the facility. Although there have been several BOD violations, no significant exceedances have been identified since 2007 that warranted a civil penalty assessment. Evaluation of the facility's discharge impact to endangered mussel species found in this segment of the river may be required.

## TRENDS at Ambient Station O0100000

Station O0100000 and USGS gage # 02081500 are co-located on Tar River. To help understand upstream conditions and their contributions to the nutrient loading to the estuary a trend analysis was performed using data from 1991-2013 on the nutrient parameters collected from Tar River at NC 96 (AMS O0100000). More details about these trends are available in the NSW Report.

***Flow adjusted concentration***

The results of the Seasonal Kendall test for flow-adjusted concentrations of ammonia (NH3-N), nitrate/nitrite (NOx-N), Total Kjeldahl nitrogen (TKN), total nitrogen (TN), and total phosphorus (TP) at O0100000 are provided in Table 1. Except for Ammonia-N and TN, the results indicate that there were statistically significant trends for NOx-N, TKN and TP. TKN and TP showed increasing trends in concentration, while NOx-N showed a decreasing trend. The upward slopes of TKN and TP suggest that the average increase in median concentration represent a 37% and a 36%, respectively, over the 22 years of study period.

Table 1: Result of Seasonal Kendall Trend Analysis for Nutrient Concentrations at NC 96 (1991-2013)

| Water Quality Constituents (mg/L) | Seasonal Sen Trend Slope (mg/L/year) | Significant Trend at 95% | First 12 month Median | Average % Change in Median |
|---|---|---|---|---|
| Ammonia-N | - | No Trend | 0.035 | - |
| NOx-N | -0.00291 | Decreasing | 0.04 | -160.05* |
| TKN | 0.00678 | Increasing | 0.4 | 37.29 |
| TN | - | No Trend | 0.49 | - |
| TP | 0.00057 | Increasing | 0.035 | 35.83 |
| * Note that NOx-N values are highly variable at this location. While a 160% decrease could not actually occur, this result is statistically valid. | | | | |

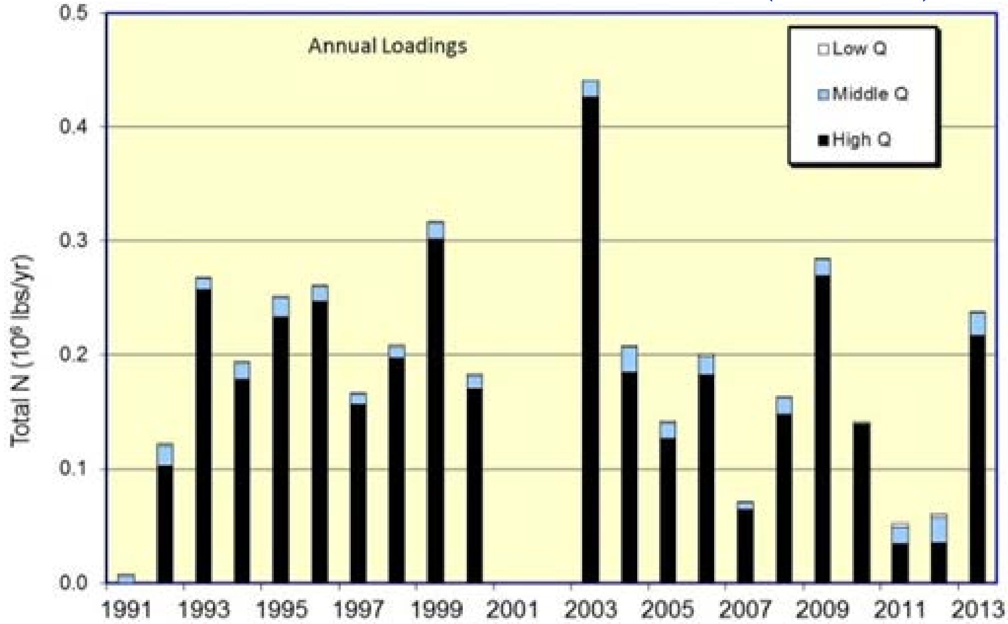
***Flow-normalized load***

Assessment of trends in annual nutrient loads at AMS O0100000 were performed using flow-normalized concentrations and loads computed for flow intervals representing low, medium, and high flows. Nutrient concentrations were estimated from the mean of available data and flow-weighted average concentrations. A detailed description of this approach is presented in a peer-reviewed article by Lebo et al.,(2011). The results from a flow-normalized loading analysis indicates an overall 20% decrease in nitrate/nitrite(NOx-N), 24% increase in Total Kjeldahl nitrogen (TKN), 10% increase in total nitrogen (TN) and 7% increase in total phosphorus (TP). Flow-normalized estimates are designed to remove the effect of random stream flow-driven variations and are ideal for evaluating progress towards nutrient reduction goals (Sprague et al., 2011).

### Flow-Normalized Total Nitrogen Loading at AMS O0100000

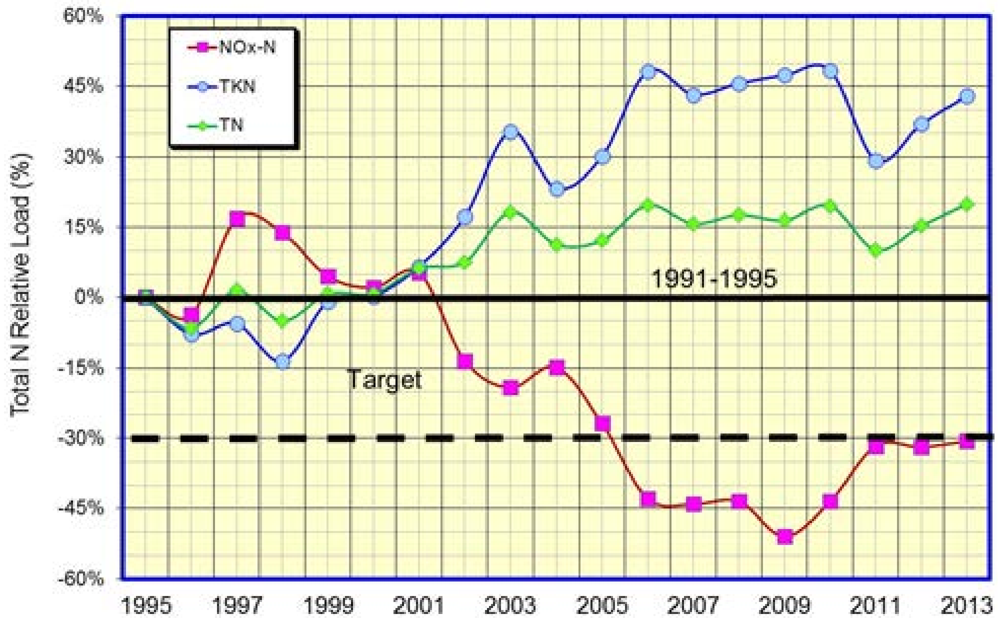
The results indicate that annual TN loading at this station ranged from 0.1 to 4.4 x $10^5$ lbs/year for the 1991–2013 timeframe. Average contributions of Ammonia–N, NOx-N, and Organic-N to the TN load for 1991–2013 period were 6, 23 and 71%, respectively. Organic Nitrogen was computed as TKN minus Ammonia. Overall, there was an increase in the contribution of the Organic-N fraction and a decrease in that of the NOx-N fraction to TN loading at Tar River for the study period (1991-2013). Figure 1 shows annual TN loading at Tar River by flow interval. The average TN contributions from low, middle, and high flow interval were 1, 7 and 92%, respectively.

Figure 1: Total Nitrogen Load at AMS O0100000 (Tar River)




The results of the flow-normalized loading analysis indicate reduction in flow-normalized NOx-N loading, but an increase in TKN loading. Flow-normalized TKN loading has been consistently higher than the 1991–1995 baseline period throughout the past 14 five-year periods and increased by about 33% during this period. Since Ammonia loading declined over the same time period, the increase in TKN loading was primarily due to an increase in the Organic-N fraction. The recent increase in TKN flow-normalized loadings appears to be mainly due to increases for the high flow intervals. Flow-normalized TN loading exhibited the combination of the patterns for NOx-N and TKN and has been consistently higher than the corresponding 1991-1995 beginning the 1995-1999 period ending with the 2009-2013 period. The flow-normalized TN loading decreased to a minimum value of -6.5% in the 1992-1996 period and increased gradually afterwards. The average increase in flow-normalized TN loading for the periods beginning in 1995-1999 ending in 2009-2013 was approximately 13% (Figure 2).

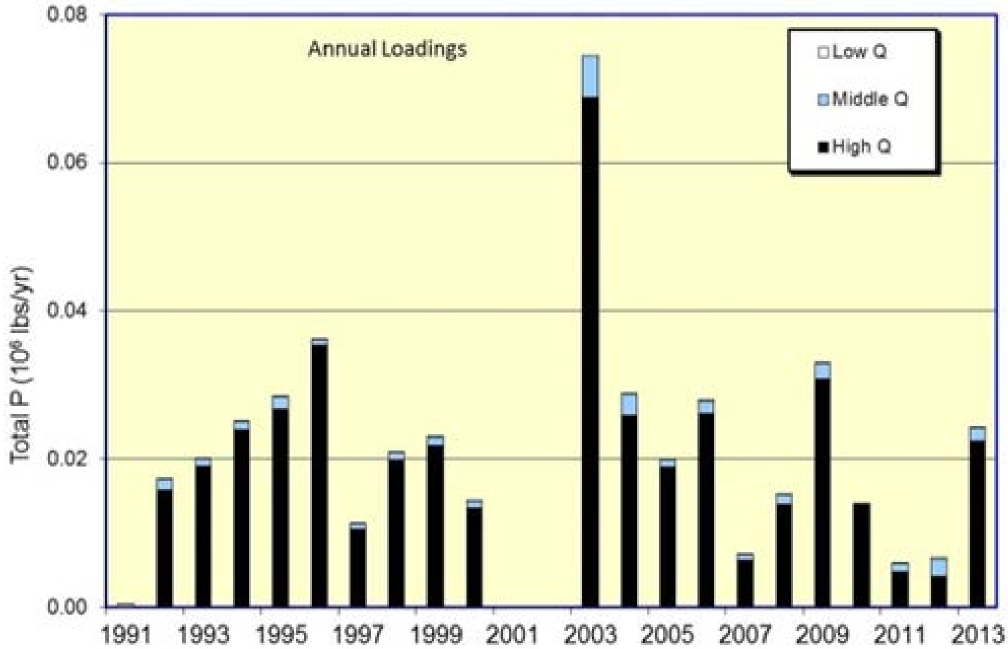
Figure 2: Relative N Load Reduction- Comparison to 1991-1995



### Flow-Normalized Total Phosphorus Loading at AMS O0100000

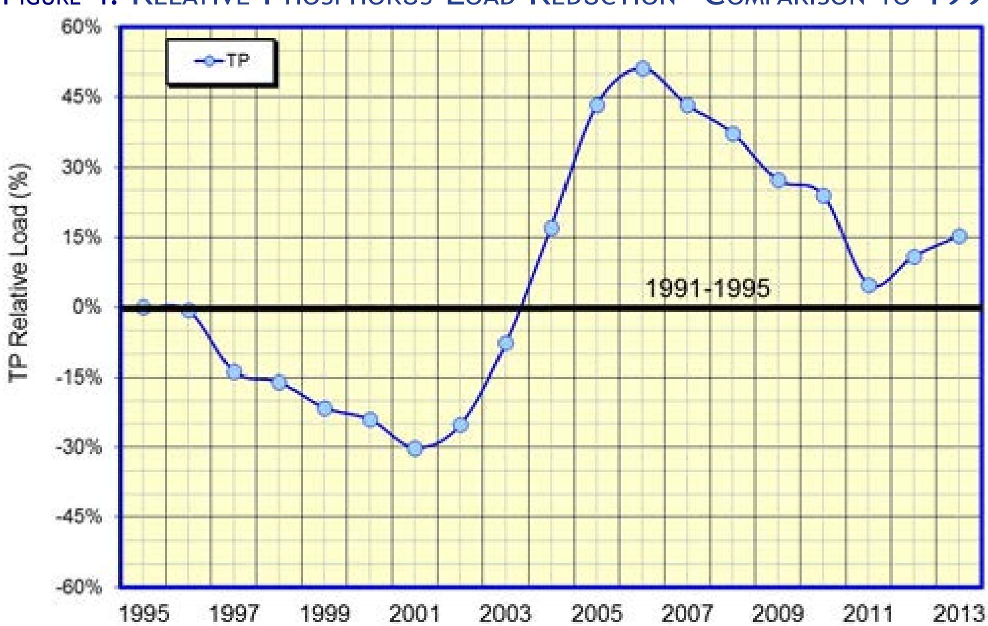
The annual TP loading at Tar River ranged from 0.06 to 0.7 x $10^5$ lbs/year, with a median value of 0.20 x $10^5$ lbs/year. Figure 3 shows annual TP loading at Tar River by flow interval. The average TP contributions from low, middle, and high flows were 0.6, 6.6 and 92.8%, respectively. These results show that high flow events contribute substantially large amount of nutrients in this watershed.

Figure 3: Total Phosphorus Load at AMS O0100000 (Tar River)




Flow-normalized TP loading at Tar River has been consistently lower than the corresponding 1991-1995 loading until the 1997-2001 period and then gradually increased and became higher than the 1991-1995 loading since the 2000-2004 period (Figure 4). The flow-normalized TP loading decreased to a minimum value of -16.6% in the 2003-2007 period and increased gradually afterwards. The flow-normalized TP loading reached to a maximum value of 51.2% in the 2002-2006 period and declined afterwards, but remained higher than the 1991-1995 period loading. The average reduction in flow-normalized TP loading for the periods ending in 1999-2003 was approximately 17%. The average increase in flow-normalized TP loading for the periods beginning in 2000-2004 and ending in 2009-2013 was approximately 27%.

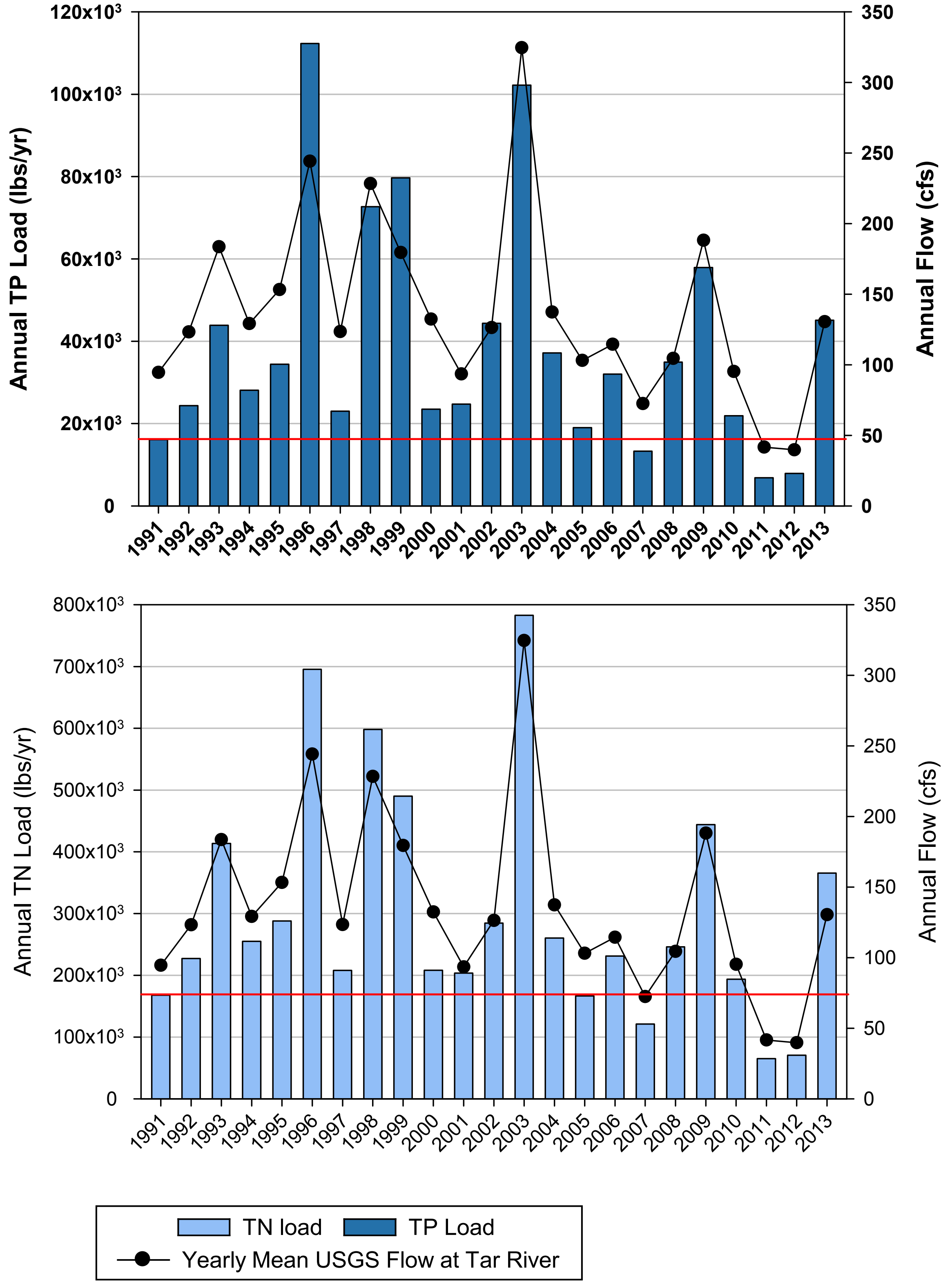
Figure 4: Relative Phosphorus Load Reduction- Comparison to 1991-1995



*Annual Load*

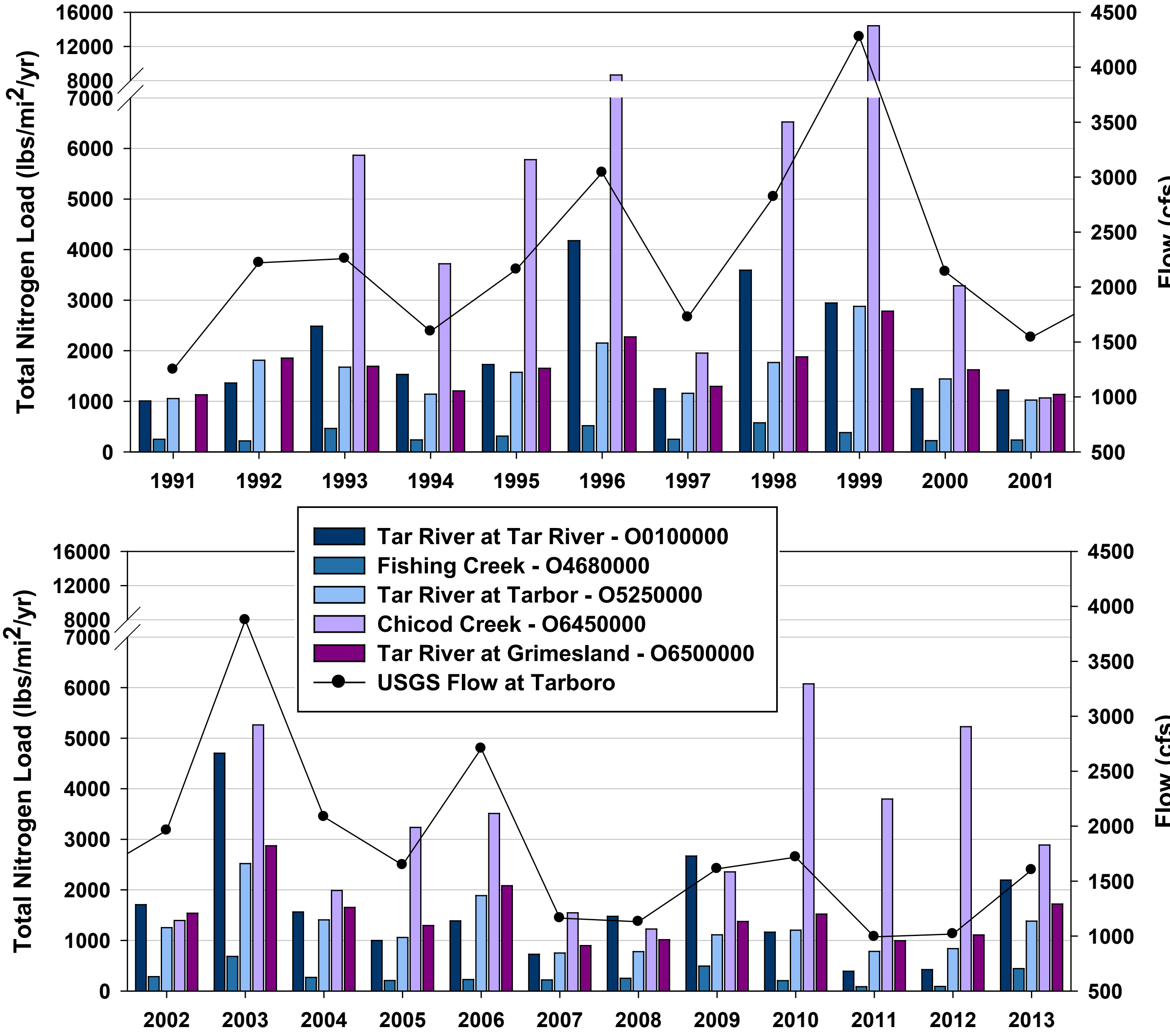
Annual Load estimates were run using USGS's **LOAD ESTimator**. Figure 5 shows the annual total phosphorous and total nitrogen load results in comparison to the 1991 baseline year (shown as a red horizontal line). The mean estimated TP loading at the upper Tar River station was 39,105 lbs/yr and fell below the 1991 loading in 3 of the 22 years. The 23 year estimated TN mean loading was 300,929 lbs/yr in the upper Tar River fell and below the 1991 baseline load in 4 of the 22 years post 1991.

FIGURE 5: LOADEST TOTAL PHOSPHORUS & TOTAL NITROGEN LOAD ESTIMATES AT AMS O0100000



Using the watershed size of each ambient station and the LOADEST results helps understand what level of loading is being delivered per square mile and what amount of loading might be expected from a specific type of land use. Figure 6 & 7 shows TN & TP unit area load estimates for all five watersheds assessed. The estimated unit area TN loading is 1,807 lbs/mi²/yr. The estimated mean unit area TP loading is 234 lbs/mi²/yr. The upper Tar River has a relatively high level loading for a head water region that is mostly forested. Additional research is needed in order to determine the source of the high loading in this small headwater portion of the upper Tar River watershed.

Figure 6: LOADEST TN Unit Area Load Estimates for all Watershed Assessed with USGS Tar River at Tarboro Annual Mean Flow (1991-2013)

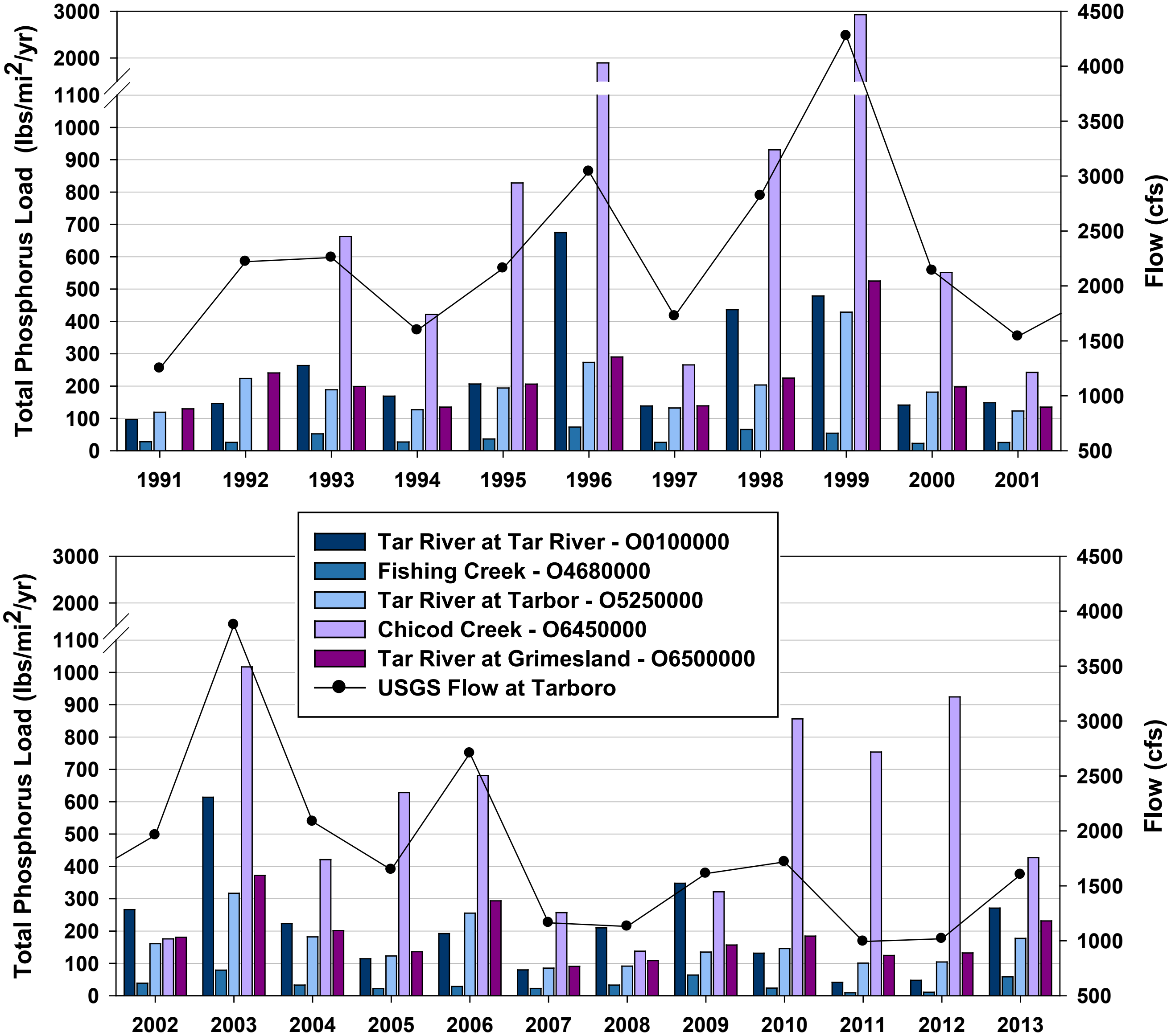







DRAFT

Figure 7: LOADEST TP Unit Area Load Estimates for all Watershed Assessed with USGS Tar River at Tarboro Annual Mean Flow (1991-2013)



## Land Cover

To help understand land use changes and potential impacts on water quality an analysis of the change in land cover was performed for the area draining to AMS O0100000 on the Tar River. Changes in land use between data collected for the 2001 National Land Cover Database and the 2011 dataset indicate that the loss of forested acres likely resulted in the gain of scrub and grassland acres (Table 2).

Table 2: NLCD Land Cover changes between 2001-2011

| Land Use | 2011 Percent Land Cover | Percent change | Acres Lost/ Gained |
|---|---|---|---|
| Water | 0.49 | -2.6 | -14.0 |
| Developed | 4.8 | 2.2 | 108.1 |
| Barren | .17 | -5.2 | -10.0 |
| Forest | 53.87 | -7.2 | -4,448.8 |
| Scrub | 6.31 | 137.5 | 3,894.8 |
| Grassland | 9.65 | 12.8 | 1,165.8 |
| Agriculture | 22.71 | -2.7 | -677.7 |
| Woody Wetlands | 1.96 | -1.7 | -36.0 |
| Emergent Wetlands | .04 | 60.2 | 15.8 |

***References***

Lebo, M. E., Paerl, H. W., & Peierls, B. L. (2011). Evaluation of Progress in Achieving TMDL Mandated Nitrogen Reductions in the Neuse River Basin, North Carolina. Environmental Management, 49(1), 253-266.

Sprague, L. A., Hirsch, R. M., & Aulenbach, B. T. (2011). Nitrate in the Mississippi River and its tributaries, 1980 to 2008: Are we making progress? Environmental Science and Technology, 45, 7209–7216.

National Land Cover Database 2011 (NLCD 2011) http://www.mrlc.gov/nlcd2011.php

## Tabbs Creek Watershed (0302010102)

| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O0600000<br>O0100000<br>O1030000<br>O0320000<br>O0310000 |
| Benthos | OB6<br>OB8<br>OB9<br>OB10<br>OB13<br>OB20<br>OB28<br>OB30 |
| Fish | OF11<br>OF16<br>OF17<br>OF19<br>OF28<br>OF41<br>OF46 |

Tabbs Creek (HUC 030201010203) is a large, low gradient tributary to the Tar River. Tabbs Creek [AU# 28-17-(0.5)b], has been monitored by the Tar Pamlico Basin Association at station O1030000 since 2007, which is below the confluence of Long Creek. Data collected from Tabbs Creek shows incidences of high turbidity levels, high fecal coliform bacteria counts, low dissolved oxygen and low pH levels. The fish community sample taken in 2012 (OF41) resulted in a Good bioclassification with no noted changes in water quality.

Kittrell Job Corps Center (NC0029131) and Long Creek Court WWTP (NC0048631) discharge into Long Creek (AU# 28-17-3). Parameters that have exceeded their permit limits include total suspended solids, fecal coliform bacteria, ammonia, BOD, and flow. Kittrell Job Corps Center's permitted flow is 0.025 MGD with a median annual daily flow 0.013 MGD (April 2008 to March 2009). The facility had been struggling to handle peak flows and slugs from improper use of the garbage disposal at the cafeteria. As of June 2010, the facility completed an upgrade that includes a new secondary clarifier, return activated sludge pump station, tertiary filtration system, post aeration, and UV disinfection. Long Creek Court WWTP's permitted flow is 0.007 MGD with a median daily annual flow 0.0043 MGD (April 2008 to March 2009). The plant's hydraulic problems (piping and pumping) have been repaired and has operated with no major noncompliance issues since 2007.

Middle Creek (HUC 030201010204) [AU# 28-15] is an important nursery stream for the Tar River. The fish community sampled taken in 2012 resulted in an Excellent bioclassification.

Lake Devin (HUC 030201010201) is a small lake located in the City of Oxford. Primarily used for public fishing, this lake originally served as the water supply source for the City. DWR staff sampled Lake Devin from May through September 2012. Nutrient levels were found to support excessive algal growth. Based on the calculated North Carolina Trophic State Index (NCTSI) scores, Lake Devin was determined to be eutrophic (exhibiting elevated biological productivity) in May and August and hypereutrophic (exhibiting excessive biologically productivity) in June and July. This is the first time that NCTSI scores for this lake have indicated hypereutrophic conditions. The 2007 drought may have contributed to increased concentration of nutrients within the lake as the water level decreased through the summer. Lake water circulation and flushing from storm events were significantly reduced in 2007. These processes normally reduce the build up of algae and subsequent elevated chlorophyll *a* concentrations. Further monitoring during more normal rainfall years may help to determine if a change in trophic status is occurring.

Hatcher's Run (HUC 030201010201) [AU# 28-11-3-(2)] from dam at Devin Lake to Fishing Creek, covering 3.9 miles, received a Fair bioclassification during a special study assessment in 2006. However, DWR Biologists noted the Fair bioclassification was primarily due to a lack of flow and resulting low DO. Upstream of the sample site, the stream flows through a cattail marsh that, along with the low release of water from Lake Devin, contributes to the low oxygen levels. Flow and low DO will continue to be naturally recurring issues here. Nutrient impacts were also noted. Additional surveys of this stream noted the stream banks as being highly eroded and undercut; sedimentation was observed, causing habitat degradation.

Foundry Branch (HUC 030201010201) [AU# 28-11-2] from source to Fishing Creek, covers 5.5 miles flowing through the City of Oxford. The Tar Pamlico Basin Association coalition station (O0310000) has been discontinued and a new site (O0320000 ) was established along Fishing Creek between the mouth of Foundry Branch and the Oxford WWTP discharge. Data from Foundry Branch shows incidences of low DO, high turbidity and high fecal coliform bacteria levels. This stream will remain Impaired until new water quality samples are taken showing improvement. DWR does not plan on taking water quality sampling until evidence suggests activities have occurred in the watershed that have the potential to improve current stream conditions.

Coon Creek (030201010201) [AU# 28-11-5] In 2006 two macroinvertebrates samples were taken as special study resulting in an Excellent bioclassification (OB30) at the upstream tributary to Coon Creek and a Good bioclassification at site OB6 further downstream on Coon Creek. A fish sample was collected in 2012 resulting in a Good-Fair bioclassification. This is a decline in conditions compared to its Excellent rating in 2002. This fish sample had the fewest species of any site sampled during 2012 in the basin. The decline may be associated with persistent low flows and habitat loss. Continued assessment of this Creek is recommended to monitor potential growth impacts of the Town of Oxford.

Fishing Creek (HUC 030201010201), [AU#s 28-11c and 28-11d], from #1 outfall to Coon Creek, covering a total of 1.9 miles, is Impaired for Aquatic Life based on a Fair bioclassification in 2006. These segments have been Impaired since the 1990s because of the poor ecological and biological integrity. The lower reach of Fishing Creek [AU# 28-11e] is Supporting biological integrity, as the habitat is typical high quality Carolina Slate Belt-type stream with shallow and deep rocky pools, shallow long riffles and rocky runs. The 2012 fish community sample (OF17) resulted in an Excellent bioclassification because of a diverse and very abundant fish community (n=23 species and n=723 fish, most ever collected at this site); one specimen of the Roanoke Bass and four specimens of Mimic Shiner (both state Significantly Rare species) were collected. The macroinvertebrate sample (OB10) taken in 2012 resulted in a Good rating with the first collection of an intolerant stonefly species.

### Fishing Creek Impairment Timeline

- 1999 - The entire length (11 miles) of Fishing Creek was Impaired. Above the WWTP, Fishing Creek and Foundry Branch are impacted by urban runoff from the City of Oxford. Oxford WWTP was placed under a moratorium after the Poor bioclassification in 1999. It was recommended that no new or expanding wastewater dischargers be connected to the Oxford wastewater treatment plant.

- 2004 - 10.4 miles of Fishing Creek were on the 303(d) list of impaired waters. DWR continued to monitor water quality in the Fishing Creek watershed. DWR Raleigh Regional Office staff continued to work with the Oxford WWTP to remedy plant problems that were adversely impacting water quality in Fishing Creek, including influent overflows and infiltration and inflow in the Foundry Branch watershed. Oxford was required to address nutrients in stormwater as part of the Tar-Pamlico NSW strategy and were advised to address the more acute impacts to Fishing Creek when developing their stormwater program.

- 2005 - The Fishing Creek subwatershed was chosen by the NC Ecosystem Enhancement Program (EEP) as a Local Watershed Planning Project area; as a result, extensive water quality assessments were completed in 2006-2007. This plan focused on projects that address sedimentation and nutrient issues related to agriculture and forestry, stormwater runoff from Oxford and from highways, and degraded mussel habitat. Information from this study included: freshwater mussel surveys, special study summaries, and a water quality summary. These documents can be found at: http://www.nceep.net/services/lwps/Fishing/Fishing_Creek.pdf.

- 2006 - Fishing Creek remained Impaired, covering 4.8 miles (from source to Coon Creek). Oxford completed its WWTP upgrades expanding the facility from 2.17 MGD to 3.5 MGD and received permit limits of 5 mg/L BOD5 and 1 mg/L $NH_3$-N, down from 15 mg/L BOD5 and 4 mg/L NH3-N. The new limits as well as those improvements implemented by Oxford were expected to further reduce impacts to Fishing Creek.

- 2007 - EPA completed a special study on Fishing Creek to help assess conditions. This study found that the flow was strongly dominated by effluent from Oxford's WWTP. The Albemarle-Pamlico National Estuary Program (APNEP) also chose Fishing Creek for restoration activities.

- 2008 - Benthos data collected in 2006 resulted in a Fair rating leaving 1.9 miles Impaired on the 2008 & 2010 303(d) list. Although the benthic sample in the southern reach of Fishing Creek resulted in a Good-Fair bioclassification in 2007, ambient station indicated high turbidity, copper, zinc and fecal coliform bacteria levels, verifying the waterbody is still impacted.

- 2010 - The Tar Pamlico Basin Association began monitoring at station O0320000 (Knotts Grove Rd near Oxford) in January 2010. This station replaced station O0310000 (Foundry Branch at SR 1649 at Oxford). The new station is located on Fishing Creek upstream of the Oxford WWTP discharge and downstream of the mouth of Foundry Branch.

- 2012 In the lower reach of Fishing Creek, the fish community sample (OF17) resulted in an Excellent bioclassification because of a diverse and very abundant fish community and the macroinvertebrate sample resulted in a Good bioclassification.

Water quality is expected to improve in Fishing Creek as long as Oxford WWTP is in compliance with its permit limits and stormwater BMPs are used. Potential water quality improvement results may be reflected in the future.

## Lynch Creek-Tar River (0302010103)

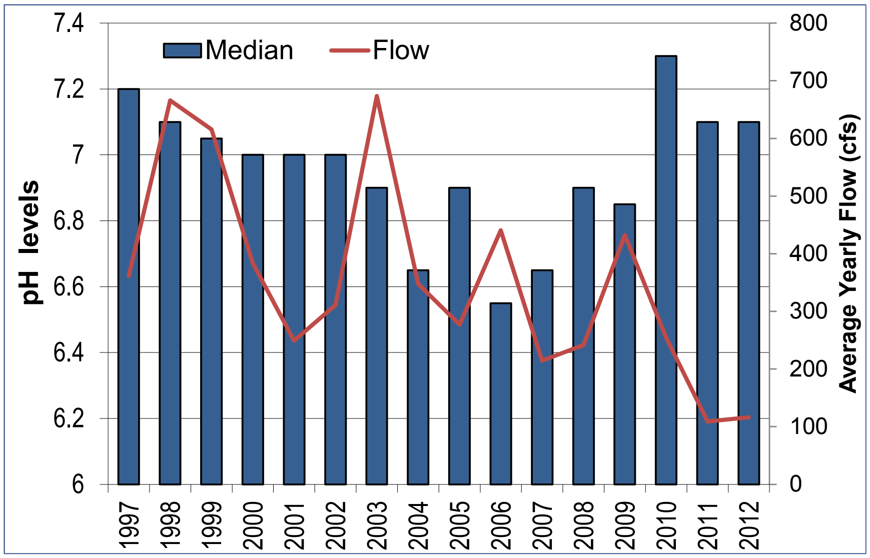
| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O1100000<br>O1025000 |
| Benthos | OB26 |
| Fish | OF27 |

Approximately half of this watershed is a Water Supply IV for the Town of Louisburg. Two ambient stations (O1025000 & O1100000) indicated increased levels of turbidity and fecal coliform bacteria. The fish sample resulted in a Good bioclassification in 2012, while the benthic samples resulted in a Good-Fair bioclassification in 2002. Additional information is needed about restoration and protection opportunities in this watershed.

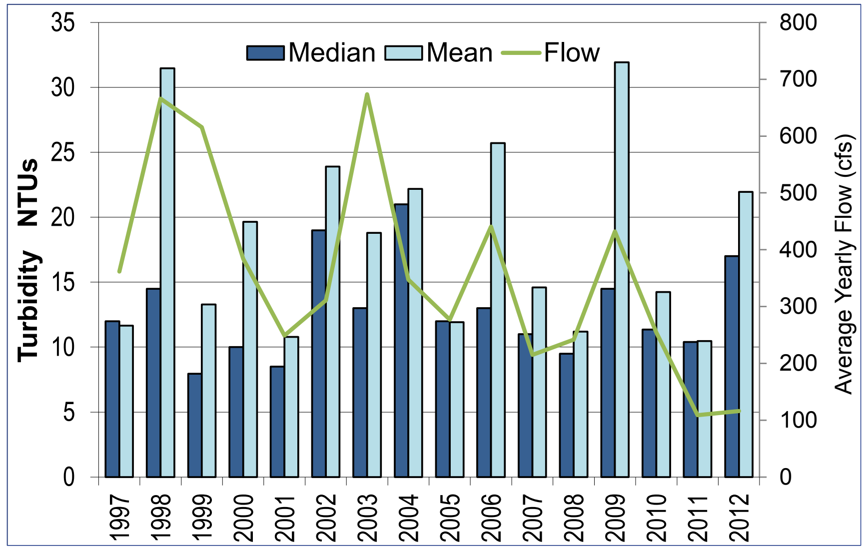
Novozymes North America (WQ0002806 and WQ0003487) in Franklin County has operated an enzyme production facility with a wastewater irrigation and residuals permit since 1981. Historic applications at rates which exceed current limits appear to have resulted in widespread groundwater contamination from Nitrates and Total Dissolved Solids. The facility has completed a Comprehensive Site Assessment that defined the extent of the groundwater contamination, and is currently drafting a Corrective Action Plan for active removal of the contaminants from the groundwater. Due to the size of the waste application fields, there is a possibility that groundwater contaminants from this facility could have an impact on adjacent surface waters.

USGS gage #02081747 is co-located with AMS O1100000 along the Tar River near Louisburg allowing for ambient data and flow to be compared over time. The following graphs show 16 years of ambient data and yearly average discharges.

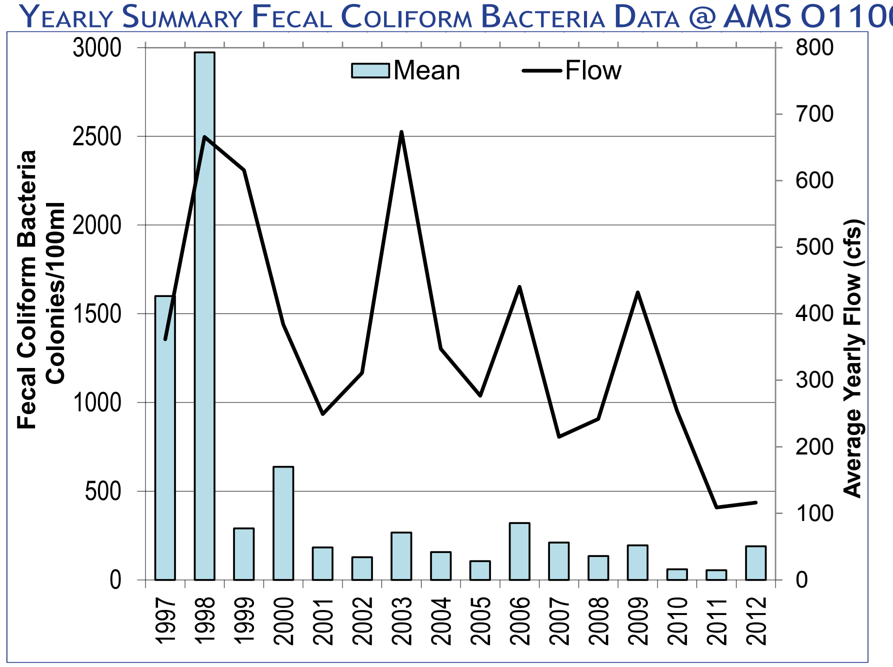
### Yearly Summary pH Data @ AMS O1100000



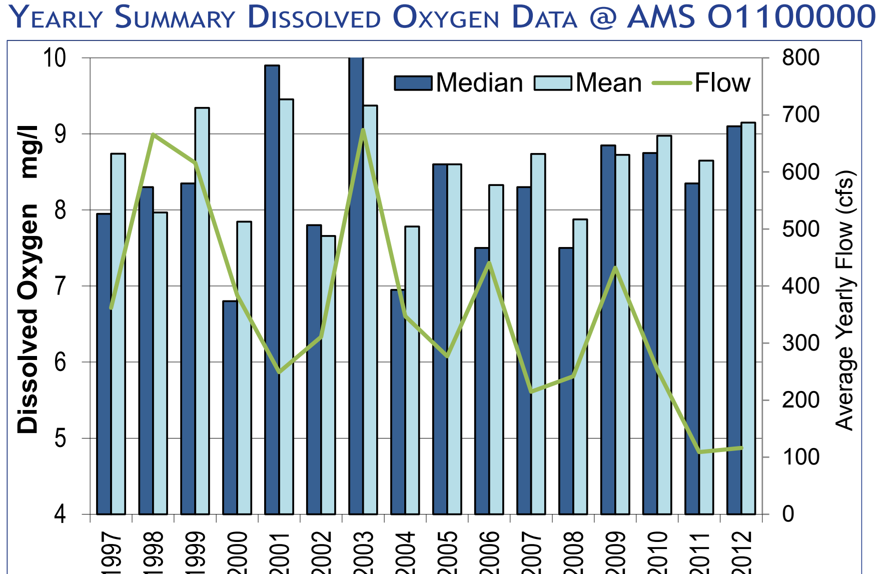
Yearly Summary Turbidity Data @ AMS O1100000




Yearly Summary Fecal Coliform Bacteria Data @ AMS O1100000




Yearly Summary Dissolved Oxygen Data @ AMS O1100000

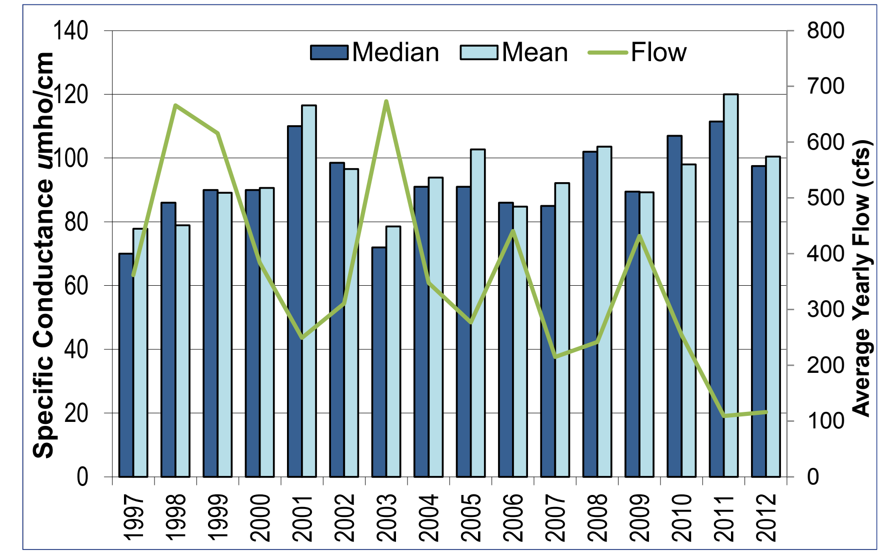









Yearly Summary Conductivity Data @ AMS O1100000






2014 DWR Tar Pamlico River Basin Plan

## Crooked Creek-Tar River (0302010104)

| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O1600000<br>O1920000<br>O2000000<br>O2015000<br>O2020000 |
| Benthos | OB4<br>OB27<br>OB169<br>OB185 |
| Fish | OF6<br>OF7<br>OF13 |

Crooked Creek (HUC 030201010404), [AU#s 28-30a & 28-30b], habitat conditions are described as transitional between Piedmont and Coastal Plain. This creek has not had a biological sample taken since 2002; therefore, it is recommended that a biological sample be taken during the next basinwide sample period. Ambient data through 2012 indicate the stream is impacted by low DO, low pH, high turbidity and high fecal coliform bacteria levels.

Bunn WWTP (NC0042269) discharges into Crooked Creek. The wastewater plant's permitted flow is 0.150 MGD and the current median annual daily flow is 0.012 MGD (6/2013-6/2014). Parameters that have exceeded their permit limits include fecal coliform. The most recent inspection, January 2014, found the permittee was compliant with permit inspections.

Cedar Creek, (HUCs 030201010401 & 030201010402), [AU# 28-29-(2)b]. The biological sample locations are below the Franklin County Public Utilities WWTP and specific conductance data has been correspondingly high with measurements of 300 µS/cm in 2002, 282 µS/cm in 2007, and 455 µS/cm in 2012 at site OB4. Interestingly, the only Good bioclassification at this location (OB4) coincided with the lowest specific conductance measurement in 2007; the 2012 macroinvertebrate sample resulted in a Good-Fair rating. The fish community site OF7 was sampled in 2012 resulting in a Good-Fair bioclassification which is a decline from it previous Excellent rating. The combination of prolonged low flow periods, the Franklin's WWTP effluent, and changing land use practices likely all factored into the decline in the NCIBI rating and water quality. It is recommended that continued basinwide assessment of this site in 2017 to document impacts from WWTP discharge and future urban growth in the watershed and to determine if the decline in the rating is real. There are two ambient stations along Cedar Creek; data from AMS station O1600000 and O1920000 indicate incidences of high turbidity levels and high fecal coliform bacteria levels.

Tar River (HUC 030201010405 )[AU# 28-(24.7)a] The macroinvertebrate sample (OB85) was temporarily moved to SR 1611 (OB185) due to insufficient habitat caused by low flow conditions at SR 1609. The benthic community has changed from previous years; low flow conditions have negatively affect the benthos, the general decrease in EPT richness over time and the highest ever recorded BI at this site suggest potentially worsening water quality. The ambient station along the Tar River (AMS O2000000) indicates the river is impacted by low pH and high turbidity levels.

## Stony Creek Watershed (0302010105)

| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O3140000 |
| Benthos | OB39 |
| Fish | OF32 |

Stony Creek (Boddies Millpond) (HUC 030201010504), [AU# 28-68b], from Lassiters Creek to Tar River covering 5.9 miles is Impaired for Aquatic Life based on a historical listing for sediment from benthos samples taken in 1992. This stream segment runs through urban areas in southwest Rocky Mount. This segment is likely a good candidate for an urban stream restoration and education project. Data from ambient station (O3140000) shows the creek is impacted from low DO, both high and low pH, high turbidity and high fecal coliform bacteria levels. This segment should be reassessed for biological integrity after land use change or restoration activity occurs. The upper portion of this creek [AU# 28-68a] was removed from the 303(d) list because of a Good-Fair bioclassification in 2002 at site OB39.

## Tar River Reservoir-Tar River (0302010106)

| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O2101000<br>O2102000<br>O2140000<br>O2320000<br>O2360000 |
| Benthos | N/A |
| Fish | OF37<br>OF50 |

Tar River Reservoir is the primary water supply source for the City of Rocky Mount. Located on the confluence of the Tar River and Sapony Creek, the reservoir is open to the public for boating and fishing. The dam is required to provide a continuous downstream release of 80 cfs.

Overall, nutrient concentrations in Tar River Reservoir were at levels capable of sustaining nuisance algal blooms. The availability of nutrients in the lake water supported the growth of algae which resulted in chlorophyll a values that ranged from 20 to 63 µg/L. Based on the calculated North Carolina Trophic State Index (NCTSI) scores for 2012, the Reservoir was determined to be eutrophic (exhibiting elevated biological productivity). Results of an Algal Growth Potential Test conducted in August 2012 indicated that algae growth in Tar River Reservoir was limited by the nutrient, nitrogen. This reservoir has been eutrophic since 1989 when it was first monitored by DWR. Hydrilla, an invasive aquatic weed, was observed along much of the shoreline of this reservoir by field staff. The City of Rocky Mount has partnered with the DWR and the Wildlife Resources Commission to control hydrilla in Tar River Reservoir through the use of herbicides and grass carp stocking.

Old Webb's Mill Hydro Project is proposed for just south of Lake Royale. This proposed hydropower project is non-jurisdictional to Federal Energy Regulatory Commission regulation and is therefore under the authority of the N.C. Utilities Commission. Conditions of the Certificate of Public Convenience and Necessity include the following: the project will only operate in a run-of-river mode (i.e. project outflow equals project inflow) and the operator will coordinate with the DWR and the Wildlife Resources Commission to determine a flow requirement during generation, if needed.

Cypress Creek (HUC 030201010601), [AU# 28-31-(3)], from dam at Lake Sagamore/Royale down 1.6 miles to the confluence with the Tar River, receives effluent from Lake Royale WWTP. There are currently no monitoring stations in Cypress Creek but ambient monitoring in the Tar River downstream of this confluence began in 2007 by the Tar Pamlico Basin Association, while the last biological sample was taken in 1992. Lake Royale WWTP (NC0042510) is a small, package-type treatment facility and receives the majority of flow on seasonal basis (summer months). Parameters that have exceeded the permit limits include fecal coliform bacteria, TSS and BOD. The NPDES permitted flow is 0.080 MGD and the median annual flow is 0.0018 MGD. This discharge occurs downstream of the Lake Royale dam. Based on a 08/21/72 letter, under the Dam Safety Law, the dam is required to release a minimum flow of at least 0.3 cfs at all times. The letter also states that a minimum release requirement of at least 1.0 cfs from the dam will be a condition within the wastewater discharge permit when the plant is in "full capacity operation," unless the permittee chooses to discharge to the Tar River. A Cypress Creek Watershed Plan was recently completed with funds secured by Franklin County through CWMTF. The plan is to provide guidance for other watersheds and identifies actions to reduce existing impacts and prevent future impacts within the Cypress Creek Watershed.

Tar River (HUC 030201010603 ), [AU# 28-(24.7)b], from Cypress Creek to a point 3.2 miles downstream of N.C. Hwy. 581 receives effluent from two minor WWTPs. Spring Hope WWTP facility (NC0020061) had problems with inflow and infiltration and was under a Special Order by Consent (expired 7/31/2010). Since 2007, inflow and infiltration into the wastewater collection system have decreased by ~80% through compliance efforts by DWR's Raleigh Regional Office. The facility upgrades were completed in May 2013. Flow permitted at 0.400 MGD and the median daily annual flow is 0.018 MGD. Southern Nash Middle School facility (NC0037885) is a septic tank-sand filter operation with a permitted flow of 0.015 MGD; while their median annual flow has been 0.0033 MGD. Proper operations were interrupted during 2006 and 2007 due to the unauthorized deconstruction of the majority of the treatment unit process. This problem has since been repaired and DWR's Raleigh Regional Office staff recently conducted a Compliance Evaluation Inspection and found facility to be in compliance.

Ambient monitoring began in 2007 and 2008 at sites O2101000 and O2102000 respectively. Data from these stations indicates the river is impacted from incidences of low pH, high turbidity and high fecal coliform bacteria levels. The last biological sample was taken in 1992. It is recommended that biological samples be collected during the next basinwide sample period or a special study conducted for the proposed Old Webb's Mill Hydro project.

## Sandy Creek Watershed (0302010107)

| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O3830000 |
| Benthos | OB31<br>OB33<br>OB34<br>OB35<br>OB36<br>OB37<br>OB66<br>OB145 |
| Fish | OF18<br>OF33<br>OF36 |

Sandy Creek (HUC 030201010703 )
[AU# 28-78-1-(8)b1], from NC 401 to Flat Rock Creek, covering 5.3 miles, is Impaired for Aquatic Life based on a Fair bioclassification result in 2003. Problems with High Roost Poultry Farm's lagoon were previously indicated as a source of pollution with reports of wastewater traveling via groundwater to the creek. In 2008, the lagoon was closed and the land put in a conservation easement. Several conservation easements have been established along Sandy/ Swift Creek with the assistance and facilitation by Tar River Land Conservancy and NC Ecosystem Enhancement Program. Restoration of this segment is especially important to protect the ORW status of this watershed. NCDENR DWR and DSWC have made numerous attempts to properly close the lagoons using cost share funds, but have been unsuccessful so far. RRO continues to inspect site for structural evaluations of lagoons and continues to explore options for closure. This site needs to be resampled to assess biological conditions post lagoon removal.

Downstream [AU# 28-78-1-(14)] Sandy Creek was sampled at site OB35, where numerous pollution intolerant invertebrate taxa have consistently been collected at this location; the site received a Good benthic bioclassification.

### Sandy/Swift Creek ORW Reclassification

The request for reclassification of ~14 miles of Swift Creek and Sandy Creek was submitted by the Pamlico-Tar River Foundation in 1995. Water quality studies indicated that ~14-mile segment of water, from SR 1003 to SR 1004 in Nash County, had excellent water quality. This entire watershed is also recognized for its exceptional State and national ecological significance. As a result of this reclassification request, rule amendments were proposed to reclassify the ~14-mile segment with excellent water quality to C ORW NSW, and to extend the ORW management strategy to the remainder of the Swift Creek watershed. This ORW classification became effective on October 7, 2003 with nearly 142 miles of named waters being affected. As an ORW watershed, regulations that affect new development activities, wastewater discharges, landfills, and DOT activities apply on a permanent basis. No new discharges or expansions of existing discharges are permitted, and stormwater controls for all new development activities requiring an Erosion and Sedimentation Control Plan in accordance with rules established by the NC Sedimentation Control Commission or an appropriate local erosion and sedimentation control program are required to follow the stormwater provisions as specified in 15A NCAC 02H .1000. Specific stormwater requirements for ORW areas are described in 15A NCAC 02H .1007.

Red Bud Creek [28-78-1-17] is a tributary to Sandy Creek and was sampled at site OF33 in 2012. The biologist noted an improvement in water quality even with low flow conditions; the site received an Excellent fish community bioclassification.

## Swift Creek 0302010108

| Watershed Monitoring Sites | |
|---|---|
| Type | Site ID |
| Ambient | O3870000<br>O4000000 |
| Benthos | OB53<br>OB55<br>OB56<br>OB67<br>OB138 |
| Fish | OF48 |

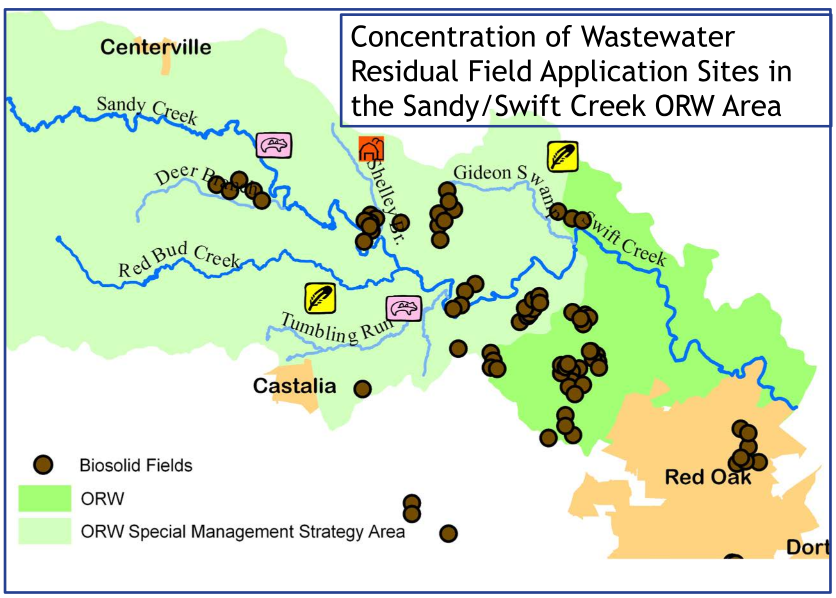
This watershed is a threatened and endangered species protection priority area, which supported the upper reach of Swift Creek receiving ORW status in 2003 [AU# 28-78-(0.5), 9.6 miles]. Thirty-eight miles of Swift Creek [AU#s 28-78-(2.5) & 28-78-(6.5)] downstream of the designated ORW area are in need of additional protection. The downstream portion of Swift Creek did not meet excellent water quality standards at the time of ORW designation, but the importance of protection in this watershed led to the request for a site-specific strategy to be developed by DWR and advising agencies. The mainstem of Swift Creek is denoted as a Natural Heritage Area of national significance as recorded by the North Carolina Natural Heritage Program. In addition, the lower portion of Swift Creek contains the Swift Creek Swamp Forest, an approximately 2,000 acre natural area of regional significance, and a wading bird rookery.

Currently no nutrient data are collected in the Sandy/Swift Creek watersheds. It is recommended that nutrient data be collected at ambient station O3870000 to be able to help identify which watersheds are significantly contributing to the accumulation of nutrients in the estuary.

There are several wastewater residual application fields in the drainage area; the impacts from potential runoff from fields is unknown. Further research may be needed to identify if any runoff from these fields may be impacting the aquatic species in Swift Creek.

This watershed is a priority for implementation of nonpoint source BMPs, including agricultural BMPs, stormwater control BMPs, buffer enhancement and sediment and erosion control BMPs.

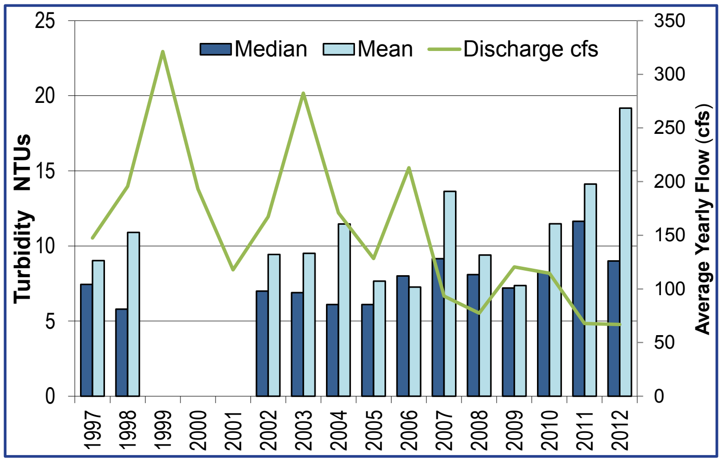
White Oak Swamp [28-78-7-(2)] is a tributary to Swift Creek. It was sampled in the winter of 2012 and received a Moderate swamp bioclassification, indicating that water quality remains stable.



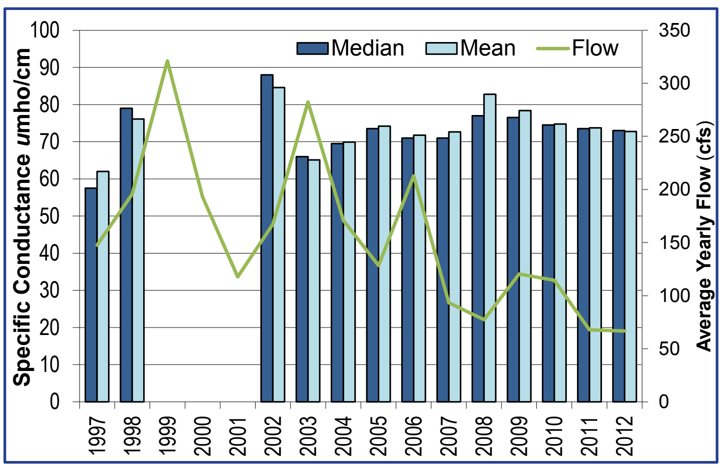

Concentration of Wastewater Residual Field Application Sites in the Sandy/Swift Creek ORW Area

USGS gage # 02082770 is co-located with AMS station O3870000 along Swift Creek [AU# 28-78-(0.5)] near Hilliardston allowing for ambient data and flow to be compared over time. The following graphs show 16 years of ambient data and average yearly flow.

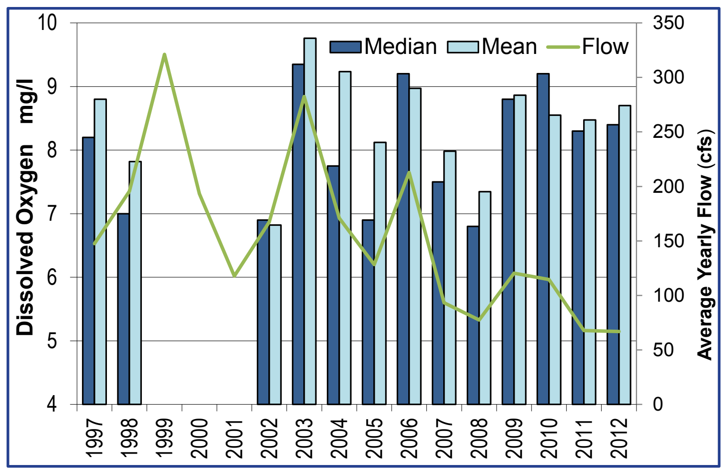
### Yearly Summary Turbidity Data at AMS O3870000



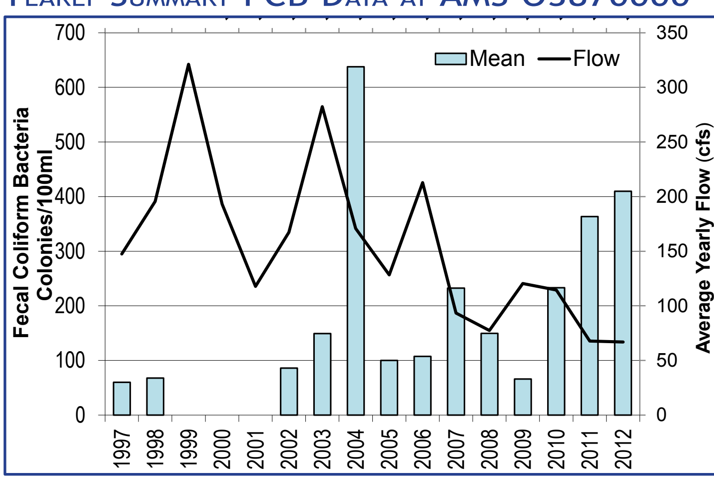

### Yearly Summary Conductivity Data at AMS O3870000



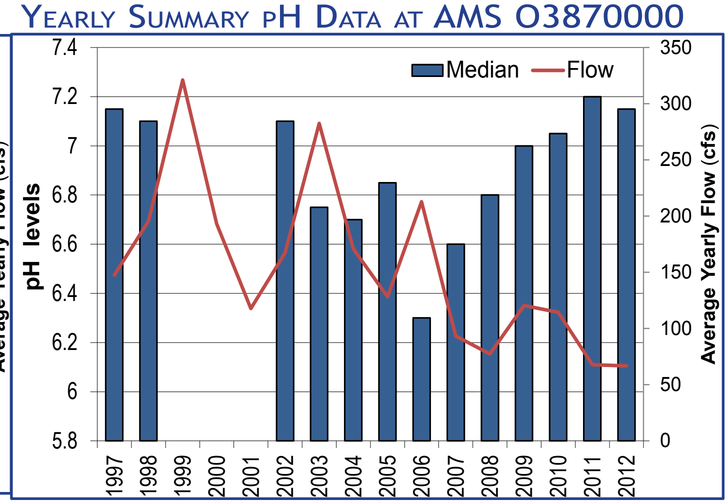

### Yearly Summary Dissolved Oxygen Data at AMS O3870000




### Yearly Summary FCB Data at AMS O3870000




### Yearly Summary pH Data at AMS O3870000



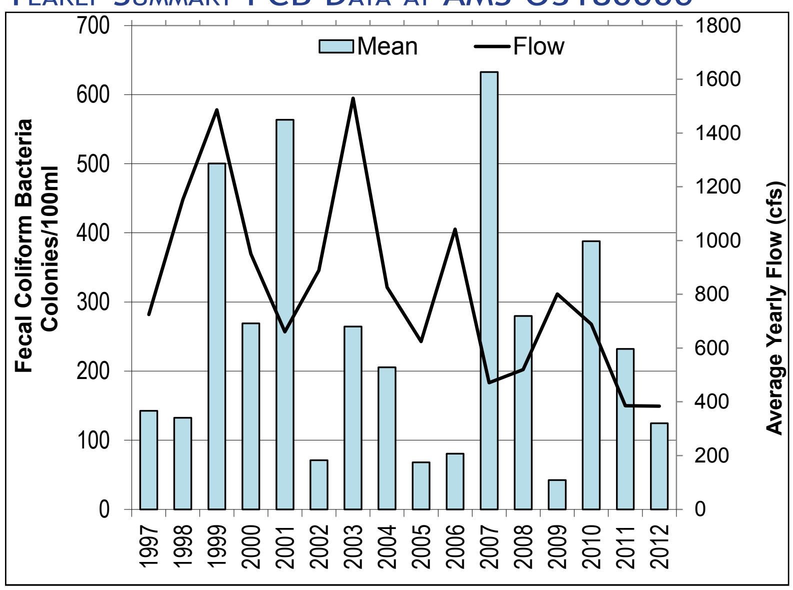
## Beech Branch-Tar River (0302010109)

| Watershed Monitoring Sites | |
|---|---|
| **Type** | **Site ID** |
| Ambient | O3180000<br>O3189000<br>O3600000<br>O4100000 |
| Benthos | OB58<br>OB63 |
| Fish | OF3<br>OF51 |

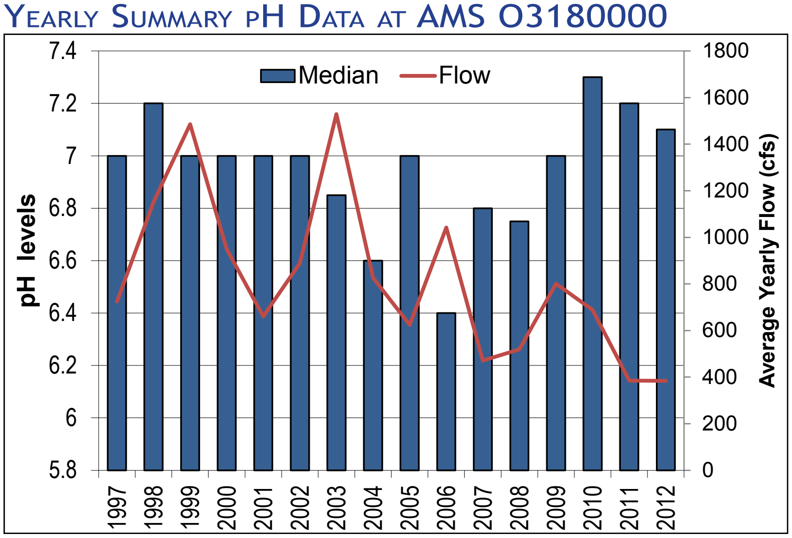
Rocky Mount Mills Dam, found along the Tar River, is a hydropower facility required to provide, under the Dam Safety Law, a continuous instantaneous minimum flow of 60 cfs in the natural channel directly below the dam. No data are available to describe water quality conditions in the upstream portion [AU# 28-(67)], while downstream of the dam [AU# 28-(69)] was sampled at site OB58 in 2012 and received a Good-Fair benthic bioclassification which is consistent with previous samples. Downstream [AU# 28-(74)a] another macroinvertebrate sample was taken in 2012 at site OB63 which received a Good bioclassification and water quality was noted as improved. Ambient data indicates the river is impacted from incidences of low pH, high turbidity and high fecal coliform bacteria levels.

Hospira WWTP (NC000001589) discharges into Beech Branch. The NPDES flow is not limited. The median annual daily flow is 0.306 MGD (2012, 2013, 2014). No parameter results in the current permit have been exceeded. In 2014, a release of aprox. 300 gallons of wastewater (with Bi-fluoride) was reported as a result of a valve failure. The stormwater permit – is now under DEMLR, but in the past the facility had a wastewater discharge out a stormwater outfall. The wastewater discharge has been eliminated as a result of DWR RRO required investigation.

### Yearly Summary FCB Data at AMS O3180000

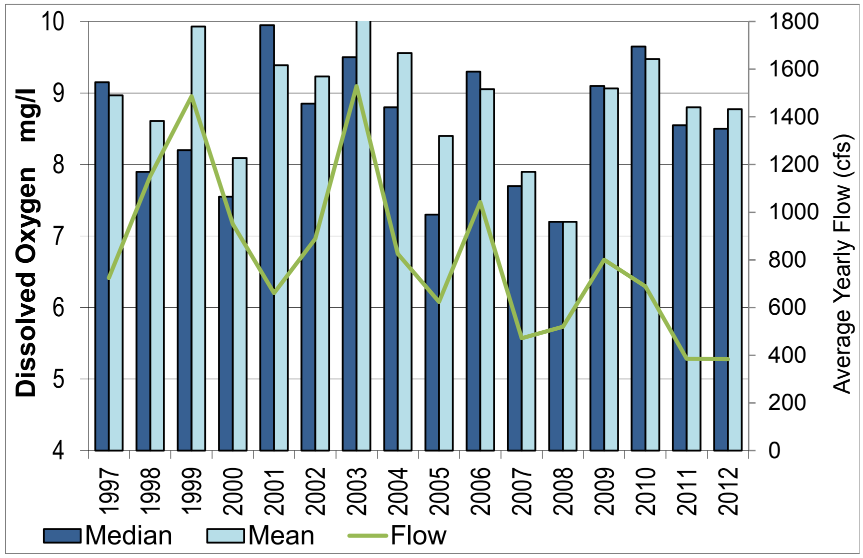



### Yearly Summary pH Data at AMS O3180000

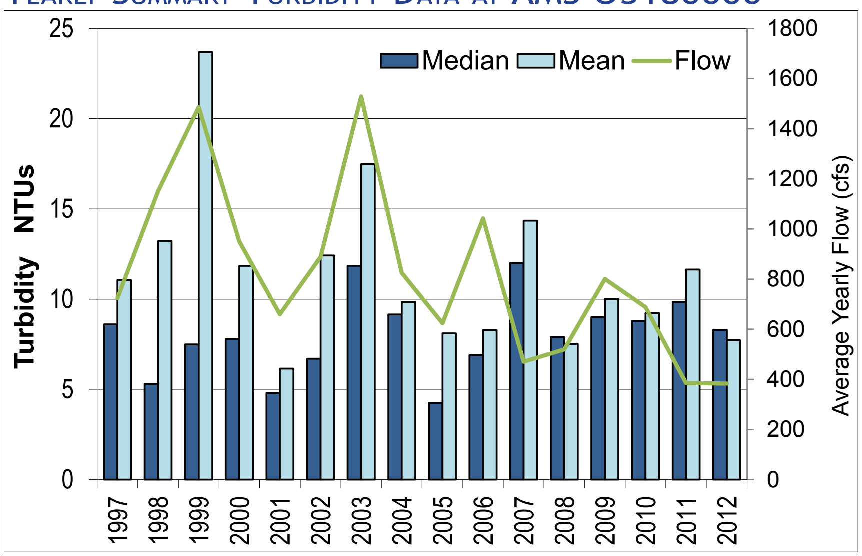



USGS gage # 02082585 is co-located with AMS station O3180000 along the Tar River [AU# 28-(69)] in Rocky Mount allowing for ambient data and flow to be compared over time. The following graphs show 16 years of ambient data and yearly average discharges.

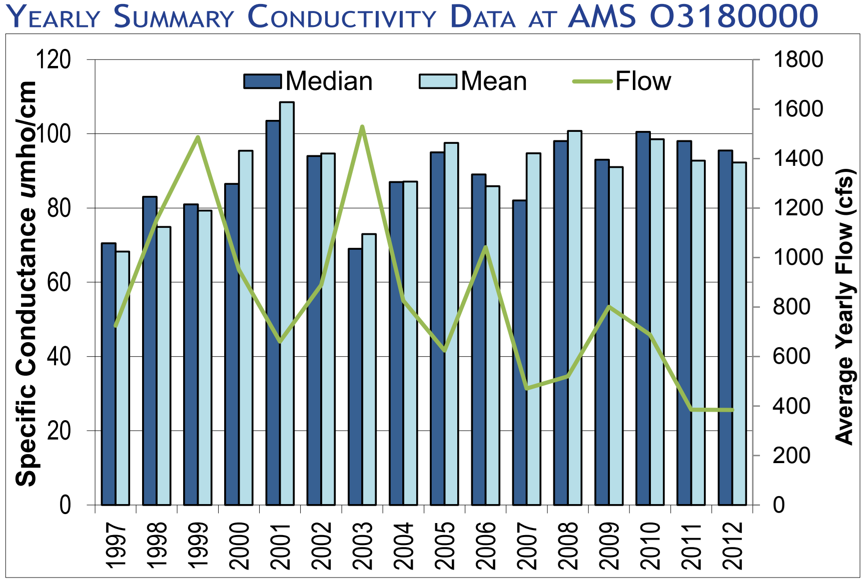
## Yearly Summary DO Data at AMS O3180000




## Yearly Summary Turbidity Data at AMS O3180000




## Yearly Summary Conductivity Data at AMS O3180000



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